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UNIVERSITY OF MONTENEGRO FACULTY OF ECONOMICS PODGORICA MSc MARTIN M. BOJAJ MAINTAINING PRICE STABILITY IN MONTENEGRO THROUGH GOVERNANCE OF EXTERNAL AND INTERNAL FACTORS OF INFLATION Ph.D. thesis Podgorica, 2020 UNIVERZITET CRNE GORE EKONOMSKI FAKULTET PODGORICA MR MARTIN M. BOJAJ

ODRŽAVANJE STABILNOSTI CIJENA U CRNOJ GORI KROZ UPRAVLJANJE SPOLJNIM I UNUTRAŠNJIM FAKTORIMA INFLACIJE 228

Doktorska disertacija

Podgorica, 2020 PODACI O DOKTORANDU: Ime i Prezime: Martin M. Bojaj Datum rođenja: 29.08.1976. Naziv završenog studijskog programa i godina završetka: 5

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UDK, OCJENA I ODBRANA DOKTORSKE DISERTACIJE Datum sjednice Senata Univerziteta na kojoj je prihvaćena teza: 8
21.03.2019. Mentor: Prof. dr Gordana Đurović, redovni profesor, Univerzitet Crne Gore, Ekonomski fakultet Komisija za ocjenu podobnosti teze i kandidata: Prof. dr Nikola Fabris, redovni professor, Univerzitet u Beogradu, Ekonomski fakultet Prof. dr Gordana Đurović, redovni profesor, Univerzitet Crne Gore, Ekonomski fakultet Prof. dr Nikola Milović, redovni profesor, Univerzitet Crne Gore, Ekonomski fakultet Komisija za ocjenu doktorske disertacije: Prof. dr Nikola Fabris, redovni professor, Univerzitet u Beogradu, Ekonomski fakultet Prof. dr Gordana Đurović, redovni profesor, Univerzitet Crne Gore, Ekonomski fakultet Prof. dr Nikola Milović, redovni profesor, Univerzitet Crne Gore, Ekonomski fakultet Komisija za odbranu doktorske disertacije: Prof. dr Nikola Fabris, redovni professor, Univerzitet u Beogradu, Ekonomski fakultet Prof. dr Gordana Đurović, redovni profesor, Univerzitet Crne Gore, Ekonomski fakultet Prof. dr Nikola Milović, redovni profesor, Univerzitet Crne Gore, Ekonomski fakultet Datum odbrane: Datum promocije: UDK broj:

ACKNOWLEDGMENTS First and foremost, I express the heartiest gratitude to my mentor, professor Gordana Đurović for her thorough guidance and enormous help for every progression in my Ph.D. work. Prof. Đurović has had inspiring guidance and constant encouragement during the marathon of this work. I owe my heartfelt gratitude to her for providing me an opportunity to pursue the research. She is endowed to the highest degree with what Romans called virtus (virtue): integrity, moral courage, prudence, sagacity, and devotion to the service of peace. Professor Đurović has been a guide for decades to thousands of students like me, raising them like her children. This thesis's successful completion is significantly due to her innovative ideas, critical analysis, excellent advice, and detailed discussions during the entire study period. I extend thanks

to Prof. dr Nikola Fabris and Prof. dr Nikola Milović for their essential contributions to this doctoral dissertation project. Finally, I want to thank all the colleagues for great team-building and pleasant conversations during our professional debates and occasional gatherings. Finally,

I would like to thank my parents and my family for their love, support, help, and	260

blessings. ZAHVALNOST Prvo i najvažnije, izražavam najiskreniju zahvalnost svojoj mentorici, Prof. dr. Gordani Đurović za njenu temeljno usmjeravanje i ogromnu pomoć za svaku stepenicu mog doktorata. Profesorka Đurović imala je nadahnjujucé vođstvo i stalno ohrabrenje tokom maratona ovog rada. Dugujem joj iskrenu zahvalnost što mi je pružila priliku da sprovedem ovo istraživanje. Ona je u izuzetno obdarena onim što su Rimljani nazivali virtus (vrlinom): integritetom, moralnom hrabroščú, znanjem, bistrinom i predanoščú miru. Profesorka Đurović decenijama je vodila veliki broj studenata poput mene i odgajala ih kao svoju djecu. Uspješan završetak ove teze je u značajnoj mjeri zasluga njenih inovativnih ideja, kritičkih analiza, odličnih savjeta i detaljne diskusije tokom cijelog perioda studija. Zahvaljujem se Prof. dr Nikoli Fabrisu i Prof. dr Nikoli Milovicú na njihovom važnom doprinosu ovom projektu doktorske disertacije. Posljednje, ali ne najmanje bitno, želim zahvaliti svim kolegama na odličnoj izgradnji tima i ugodnim stručnim debatama i povremenim druženjima. Na kraju, želim se zahvaliti roditeljima i porodici na ljubavi, podršci, pomoći i blagoslovu. PREFACE Inflation is one of the central and foundational macroeconomic indicators, and it is in- depth examined by both macroprudential policymakers and macroeconomic researchers. Government authorities have a great interest in reliable inflation forecasts. Forecasting inflation is challenging research. A significant number of researchers have estimated and forecasted the

time-series properties of inflation. The general agreement from these studious examinations is that the fundamental trend and volatility of inflation have altered significantly over time; however, there is still no consensus on the best way to forecast inflation dynamics.	11

Inflation forecasts that are free from errors are essential for other agents in the economy. Economic agents will decide about wages and prices based on inflation expectations formed and relied on accurate inflation forecasts. On the other hand, the dependency level of a small and open economy, such as Montenegro, and the dynamics of its macroeconomic indicators,

have gone through significant development changes over recent decades. Some of these changes are	235

featured in the regaining of Montenegro's independence, while others tend to be attributed to the European Union's economic and political orientation. These significant changes brought a substantial reduction in the volatility of the macroeconomic environment in Montenegro: inflation is a key indicator. Hence, the government and macroprudential policymakers of Montenegro have taken the duty and obligation to design sounder macroeconomic policies, intending to stabilize and anchor inflation. The European Commission explicitly reports the convergence criteria where the price-performance must be

sustainable and average inflation not more than 1.5 percentage points above the rate of the three best performing Member States.	1

This dissertation employs a wide range of econometric models, each carrying robust time series, and estimates and evaluates their forecasting performance across time and models. Various studies have conducted forecast comparisons on one particular model. However, we focus on

aggregating key external and internal factors of inflation and performing forecast combination puzzles of the same event: no single "best" model exists. Regardless of the existence of many highly sophisticated combination methods, forecast

accuracy is the **best when** merely **averaging** is applied **across the set of models.**	33

We employ equal and relative performance weights (inverse MSE weights) approach. It is the first time that a combined prediction has been obtained for the economy of Montenegro, suggesting high – dimensional dynamic models. Ceteris paribus, our main objective is to reveal external and internal inflation determinants in Montenegro. We explain a significantly broader and deeper

knowledge gap: first, theoretical **specification, based on which empirical examinations of**	1

inflation determinants are investigated, combining theory and empirical analysis, still is not prevailing; second, we identify recursively three structural VAR models and combine them with an equal and inverse MSE weighting approach. This approach has not been applied in previous research to Montenegrin inflation data. This dissertation's empirical findings are published in the scientific journal "Engineering Economics" (SSCI) titled Forecasting Inflation: A Combination Approach. PREDGOVOR Inflacija je jedan od centralnih odnosno osnovnih makroekonomskih pokazatelja koji se temeljno ispituje od strane kreatora makroprudencijalne politike i makroekonomskih istraživača. Vlada je veoma zainteresovana za pouzdane prognoze inflacije. Prognoza inflacije je izazovno istraživanje. Značajan broj istraživača procijenio je i predvidio svojstva vremenskih serija inflacije. Opšta saglasnost ovih studioznih ispitivanja je da se osnovni trend i volatilnost inflacije tokom vremena znatno mijenjaju; međutim, još uvijek ne postoji konsenzus o najboljem načinu predviđanja dinamike inflacije. Prognoze inflacije bez grešaka od značaja su i za ostale subjekte u ekonomiji. Ekonomski akteri cé donijeti svoje odluke o platama i cijenama na osnovu inflacionih očekivanja koje se formiraju i oslanjaju na tačnost prognoze inflacije. Sa druge strane, nivo zavisnosti jedne male i otvorene ekonomije, poput Crne Gore, kao i dinamika njenih makroekonomskih indikatora, prošli su kroz značajne razvojne promjene poslednjih decenija. Neke od ovih promjena se ogledaju u obnovi nezavisnosti Crne Gore, dok se druge pripisuju ekonomskoj i političkoj orijentaciji ka Evropskoj uniji. Ove velike promjene donijele su značajno smanjenje volatilnosti makroekonomskog okruženja u Crnoj Gori: inflacija je ključni pokazatelj. Dakle, Vlada i makroprudencijalni kreatori politike Crne Gore preuzeli su dužnost i obavezu da kreiraju jasne makroekonomske politike sa namjerom da stabilizuju i učvrste inflaciju. Evropska komisija eksplicitno izvještava o kriterijumima konvergencije u kojima performanse cijena moraju biti održive i prosječna stopa inflacije ne viša od 1,5 procentnih poena iznad stope inflacije tri države članice sa najboljim rezultatima. Ova disertacija koristi širok spektar ekonometrijskih modela, od kojih svaki nosi robustne vremenske serije, i procenjuje i ocijenjuje njihove prognozne performanse kroz vrijeme i modele. Različite studije su vršile poređenja predviđanja na jednom određenom modelu. Međutim, ova disertacija fokusira se na objedinjavanje ključnih internih i eksternih faktora inflacije i izvođenje kombinacije predviđanja za isti događaj: budući da nema pojedinačno “najboljeg” modela. Bez obzira na postojanje mnogih visoko rafiniranih kombinacionih metoda, tačnost predviđanja je često najbolja kada se primijenjuje jednostavno prosječno korišcénje na svim modelima. Mi koristimo pristup jednakih i relativnih težina performansi (inverzni MSE). Ovo je prvi put da je za ekonomiju Crne Gore dobijeno kombinovano predviđanje, sugerišući višedimenzionalne dinamičke modele. Ceteris paribus, naš glavni cilj je otkrivanje eksternih i internih determinanti inflacije u Crnoj Gori. Otkrivamo značajno širi jaz znanja: prvo, teorijska specifikacija, na osnovu koje se analiziraju empirijski determinante inflacije, koja kombinuje teoriju i empirijsku analizu, još uvijek nije opšteprihvaćena; drugo, izvođenjem identifikujemo tri strukturna VAR modela i kombinujemo ih sa jednakim i inverznim MSE pristupom ponderisanja. Ovaj pristup u dosadašnjim istraživanjima nije primijenjen na podatke o inflaciji u Crnoj Gori. Empirijska istraživanja ove disertacije objavljena su u naučnom časopisu „Engineering Economics“ (SSCI), pod nazivom Forecasting Inflation: A Combination Approach (Predviđanje inflacije: kombinovani pristup). ABSTRACT The determinants of inflation are an essential question that macroeconomic policymakers in Montenegro have faced continually over the past decade, especially since 2002, following the euro's adoption as Montenegro's formal currency. This doctoral dissertation aims to theoretically and analytically research and then examine and forecast Montenegrin's inflation determinants empirically, using the forecast

combination approach: from January 2006 to December 2016. Out-of-sample 12-month horizon forecasting is performed from January 2017 to December 2017. The central research problem is that given the struggle macroprudential policymakers have had to define proper criteria to identify and

diagnose the onset of inflation **indicators, we** felt compelled to **identify an approach and methodology that the government of Montenegro can use** 2

in maintaining price stability within the accession process towards the European Union. We research three individual-predictor SVAR models to forecast inflation. Combining three VAR and three Bayesian VAR (BVAR) models, we disclose four more VAR RMSEs: (i) two VAR equal and inverse MSE weights, and (ii) two more BVAR RMSEs. We find predicting sustainable performances:

average inflation not higher **than 1.5** p.p. **above the three best performing Member states'** average rate. **The** 1

standard VAR combination performs the best forecasting for the quarter I and II of 2017, while the BVAR combination shows the best forecasting performance for quarters III and IV of 2017. Our results allow the policymakers of Montenegro

to understand the factors **involved in identifying the onset of** inflation dynamics **and** inflation expectations better **and develop more** effective state regulations **and measures.** 2

In so doing, the findings advance and recommend the methodological tools needed, combining forecasts, to more efficiently combat the challenges of maintaining price stability by macroprudential policymakers in Montenegro. Keywords: macroeconometric forecasting, inflation; BVAR combinations, Montenegro Scientific area: Macroeconomics Scientific field: Applied econometrics REZIME Determinante inflacije su kritično pitanje sa kojim su se makroekonomske politike u Crnoj Gori suočavale kontinuirano tokom protekle decenije, a posebno od 2002. godine, nakon usvajanja eura kao zvanične valute Crne Gore. Cilj ove doktorske disertacije je da se teorijski i analitički, a zatim i empirijski istraže i predvide determinante crnogorske inflacije, koristecí pristup kombinacija prognoza, od januara 2006. do decembra 2016. godine i van-uzorka 12-mjesečno predviđanje horizonta od januara 2017. do decembra 2017. godine. S obzirom na veliki napor kreatora politika da definišu odgovarajucé kriterijume za dijagnostikovanje nastanka inflacionih indikatora, osjecáli smo se obaveznim da, kao glavni problem istraživanja, identifikujemo pristup i metodologiju koje Vlada Crne Gore može koristiti za održavanje stabilnosti cijena, a u okviru procesa pristupanja Evropskoj uniji. Istražujemo tri individualna-prediktora SVAR modela da bismo prognozirali inflaciju. Kombinujucí navedena tri VAR i tri Bayesian VAR (BVAR) modela, otkrivamo još četri RMSE-a: (i) dvije VAR jednake i inverzne MSE težine, i (ii) još dva BVAR RMSE-a. Oni pokazuju performanse prognoziranja koja su održiva: prosječna inflacija ne viša od 1,5 p.p. iznad prosječne stope tri države članice sa najboljim performansama. Standardna VAR kombinacija daje najbolje predviđanje za I i II kvartal 2017. godine, dok Bayesian VAR kombinacija pokazuje najbolje performanse predviđanja za III i IV kvartal za 2017. Naši rezultati omogucávaju kreatorima politika Crne Gore da bolje razumiju faktore koji su uključeni u prepoznavanje dinamike inflacije i inflacionih očekivanja i razviju efikasnije regualtivu i mjere. Na navedeni način, ovo istraživanje unaprjeđuje i preporučuje potrebne metodološke alate, kombinujući prognoze, kako bi se kreatori markoprudencijalnih politika u Crnoj Gori efikasnije borili sa izazovima održavanja stabilnosti cijena. Ključne riječi: makroekonomsko prognoziranje, inflacija, BVAR kombinacije, Crna Gora Naučna oblast: Makroekonomija Uža naučna oblast: Primijenjena ekonometrija ADF AIC AR ARMA ARIMA BAT BLUE C² CBCG CPI CR DF DGP E EC EGDI EGOV EMDC EMU EPI ERP EU G2B G2C GARCH GDP LIST OF ABBREVIATIONS Augmented Dickey- Fuller Akaike information criterion Autoregression Autoregressive moving average Autoregressive integrated moving average Best available technology Best, linear, unbiased estimates Law of conservation of energy Central Bank of Montenegro Consumer price index Croatia Dickey-Fuller Data generating

process Energy European Commission Electronic Government Development Index Electronic Government Emerging markets and developing countries Europen Monetary Union Export Potential indicator Economic Reform Programme European Union Government to businesses Government to citizens Generalized autoregressive conditional heteroskedasticity Gross domestic product GHG Greenhouse gas HCI Human capital index HHI Herfindahl - Hirschmann index HPP Hydropower plant IMF International Monetary Fund IS-LM-PC Investment-savings, liquidity preference- money supply, and Phillips curve ITC International trade center (ITC) KAP Aluminum Plant Podgorica KPSS Kwiatkowski, Phillips, Schmidt and Shin LM Lagrange Multiplier LME London Metal Exchange market M Markups M Law of conservation of mass M2 Broad money MA Moving average ME Montenegro MSE Mean squared error NSSD National strategy for sustainable development OLS Ordinary least squares OSI Online service index PACF Partial autocorrelation function PDI Product diversification indicator PP Phillips - Perron PS Product space RCA Revealed competitive advantage RMSE Root mean squared error SBC Schwarz Bayesian criterion SE Standard error SI Slovenia SR SVAR T² TII TPP U1 U2 Serbia ULC Structural vector UN autoregression UP Technological US development speed USD Telecommunication VAR infrastructure index VECM Thermal power plant Forecast accuracy WTO Forecast quality Unit labor cost United Nations Untapped potential United States United States dollar Vector autoregression Vector error correction mechanism World trade organization LIST OF TABLES LIST OF FIGURES

1970s. The issue is of a more serious and complex **nature in countries where inflation** is **known as** "imported inflation," making domestic policies **to** 10

control inflation ineffective. Similarly, in Montenegro, the domestic price level seems to be predominantly "imported" based on the impact of external inflation factors. Moreover, the shadow economy's size is associated with a higher inflation rate, public debt, and unemployment, hence becoming a crucial problem to mitigate the inflation level, especially in developing countries. Remembering all the multifaceted nature and complexity of inflation factors, within other policies and instruments, composite factors, as estimation of the level of economic freedom and progress of the electronic government services (or e-government), can contribute to controlling at least that part of the inflation, which is based on the impact of internal factors. Inflation is the

critical question that macroeconomic policymakers **in** Montenegro **have faced continuously over the past three decades, particularly since** 2002, **following the adoption of** 10

the euro as Montenegro's official currency1. Montenegrin authorities, in exceptional circumstances, adopted the euro as its official currency, which is entirely distinct from euro area membership and its Maastricht criteria of the accession (the convergence criteria). Montenegro started formal negotiations with the EU in June 201223. A large number of factors influence the maintenance of price stability in Montenegro, and the focus of this research will be the study of key (selected) external and internal factors 1

Fabris, N., "The monetary policy framework of the central bank of Montenegro: is financial stability a feasible central bank goal?", **in book 'The Challenge of Economic Rebalancing in Europe', Edward Elgar,** 25

2015, 222-233. 2

Djurovic, G., "Potential of the EU pre-accession assistance in financing of local economic and infrastructure development: experiences of Montenegro in MFF 2007–2013." **In: Conference proceedings, Local Economic and Infrastructure Development of SEE in the Context of EU. Academy of Sciences and Arts of Bosnia and Herzegovina, Sarajevo, September 2013,** 83

318–321. 3 Djurovic, G., and B. Bulatovic., "Proposal for the EU CAP compliant agricultural budgeting model in Montenegro," Agricultural Economics, 2014, 60(10), 479-487. of inflation, with a focus on governing these instruments in the meantime. Furthermore, the focus of research attention will be on the analysis of factors such as selected imported or exported products that affect the price stability in the country, as well as the movement of key macroeconomic indicators such as GDP growth and employment, and the efficiency of public administration and its intermediate but significant impact

on the level of the informal sector and **the** quality **of** economic governance **in** the **country.** 326

An essential factor determining the country's price stability is the price of energy, the constant oil price fluctuations on the international market. Oil is a worldwide commodity traded globally. Since oil is a profoundly requested product from huge economies and with a limited supply, oil prices are extraordinarily impacted by a few economic, financial, and geopolitical factors. These factors significantly impact the equilibrium of oil products, increasing oil prices. Large price fluctuations disrupt the market: consequently, having a non-negligible impact on the Montenegrin inflation, economy. In the Energy Balance of Montenegro, out of the total final energy consumption, oil and gas account for 36% and 37% in 2018 and 2019, respectively. The most significant oil and oil derivatives consumption is expected to take place in the transport sector, about 70% of

total consumption, followed by the industry sector. The share of the agriculture, trade, and household sectors in oil and gas consumption is at a much lower level. Given that there is no production of petroleum products or gas in Montenegro, the Montenegrin market's total quantities are imported. In other words, oil and gas consumption is a significant imported category, which derives from the Energy Balance and significantly affects the country's overall trade balance4. The Aluminum Plant Podgorica (KAP) is a significant representative of the non-ferrous metals industry in Montenegro. The products of the KAP are sold in US dollars at the London Metal Exchange. Till 2006, KAP covered 60%-80% of the overall commodities exports of Montenegro in different periods. Consequently, the London Metal Exchange (LME) stock price disparities and changes in the external demand caused by the global 4 Energetski bilans za 2020 .godinu ("Sl.list CG", br. 76/19). Energy Balance, Official Gazette of Montenegro, no. 76/19. economic and financial crisis, from 2006 to 2014, covered 36% of commodities exports on average. In case KAP would work in its full capacity (which is expected following the dynamic flow of projected investments, especially after 2020), it will reach the production of about 120,000 tons of aluminum annually, fulfilling environmental standards by applying the best available technologies (BAT), which would lead to a reduction in GHG emissions5 to the target level, as well as the inclusion of some semi-products in their offer. With adequate investment, it is estimated that aluminum and all its components could restore the leading position in Montenegrin industrial exports and thus be one of the critical factors for governing imported inflation. In line with the above, the fluctuation of aluminum shares' prices on LME will remain one of the key factors that will affect the level of inflation in Montenegro. In addition to the above mentioned, the shadow economy is one of the internal inflation factors to be considered in Montenegro. The shadow economy reduces Government revenues and, in this way, forces it to find new, additional budget revenues. An effective response to the informal sector of the economy is to increase public administration work efficiency, particularly by strengthening e-government and providing various public services to citizens and businesses, and reducing administrative barriers. The European Union categorized 20 basic e-services as a set of key eGovernment services, and today in Montenegro, there are as many as 564 electronic services provided by more than 50 institutions. As these services increase efficiency, it is reasonable to expect that by further strengthening electronic services, citizens will be more satisfied with the offered e- services, the economy will be more efficient, the growth of Montenegrin GDP will achieve better dynamics, and therefore, the control of price stability in Montenegro will be tighter. 5

Djurovic, G., J. **Cetkovic,** V. **Djurovic,** N. **Jablan.,** "Paris Agreement and Montenegro's INDC: assessing the environmental, social and economic impacts of selected investment," **Polish Journal of Environmental Studies,** 313

2018, 27(3), 1019-1032. 1.1.Objectives and hypothesis Montenegro is a transitional economy, with the euro as unilaterally introduced currency, well advanced in the EU accession talks6. Montenegro represents an illustrative example of a small euroized economy with aluminum as the main industrial export product with the potential for significant export growth (currently 40% of total commodity export with perspective to reach 60-70% in the medium term), where the domestic price level seems to be "imported" through aluminum stock price. Hence, the objective of the thesis studies the effects, inter alia, oil prices, aluminum stock price, unemployment, GDP, economic freedom, e-Government, capital stock, human capital, employment, exchange rate, broad money (M2), wages, and productivity index on inflation in Montenegro for the period from 2006:1 to 2017:12. Moreover, econometrically, the model will analyze external and internal factors determining the level of inflation in Montenegro, such as the dynamic movements of oil prices and the direction of GDP as a synthetic indicator of the dynamics of our economy. The results will be obtained using the recursive and non-recursive structural vector autoregression (SVAR) identification, Bayesian VAR, average and inverse MSE combinations, and panel econometric analysis providing empirical evidence of relations between internal and external factors of inflation, i.e., the impact of variables to inflation in Montenegro. This research is essential for policymakers in transitional economies and central banking authorities in economic policy planning, with a particular focus on maintaining price stability. Bearing in mind all of the above, one of the key research questions in this thesis is the analysis and determination of the optimal inflation rate, in fact, the analysis of the determinants that influence the achievement and maintenance of price stability in the country. Moreover, the next research question is analyzing the main factors of inflation in Montenegro and what instruments policymakers need to govern the inflation. Since 6

Zugic, R. and Fabris N., "Framework for Preserving Financial Stability in Montenegro," Journal of Central Banking Theory and Practice, 25

2014, 3(1), 27 – 41. prices are not arbitrary figures but reveal how markets value things marginally, it is one of the most principal and significant economic ideas7. Critical research assumptions and hypotheses made to draw out and test its logical and empirical results are structured as follows: H1: Achieving and maintaining price stability in Montenegro, as one of the goals of the central monetary authority in the country (and its instruments) on its path to the European Union and the European Monetary Union, is significantly contributed by the measurement of the impact of critical factors that determine the level of inflation in the country. It is important to emphasize that this is one of main Montenegro's goals in fulfilling the criterion of being a functioning market economy, which is precisely defined in the set of closing benchmarks for the EU negotiation chapter 17, European and monetary union (opened on June 26, 2018). Montenegro is also obliged to adopt the required constitutional change to ensure that the primary objective of price stability is defined in accordance with Articles 127(1) and 282(2) of the Treaty on the Functioning of the European Union. H2: Factors of inflation in the area of external demand crucial to maintaining price stability in the country, such as the Montenegrin economy and in the proposed model, are the price of energy and aluminum prices. In other words, the changes in the price of oil in the international market, expressed by the level of energy prices on the domestic market, as one of the key inputs for economic activities in the country, significantly determine the level of inflation. Montenegro's forward-looking and knowing the oil markets allows estimating the oil supply distribution, considering worldwide geographical and political events, and thus its consequences. Simultaneously, the price of aluminum affects the Montenegrin economy, which is also a stock market product. The 7

Varian, H.R., Intermediate Microeconomics: A Modern Approach, 9th ed. New York: W. W. Norton & Company, 2014. 41

more advancement of technological sophistication of KAP and its product diversification of aluminum (as the principal industrial export growth engine) – the greater assistance to policymakers to stabilize the trade balance, debt/GDP ratio, productivity growth, unemployment reduction, output gap, and consequently, limit external shocks to inflation in Montenegro, fixing price disparities and qualifying for the membership into the EU/EMU. In other words, this research will be focused on the measurement of the impact of oil prices and aluminum export growth on the average inflation rate in Montenegro. H3: Strengthening of the measures and state administration policies towards the development of e-services contributes to more efficient and efficient provision of public services, which affects GDP, productivity growth, unemployment, production gap and therefore stabilizes internal inflation shocks in Montenegro. Namely, one of the internal factors determining the inflation rate in Montenegro, in this survey, will be the level of developed e-services, included in the VAR and Bayesian VAR models, such as the EGDI index. Another critical factor in the VAR and BVAR models will be economic freedom since it is fundamental to what is regarded as economic progress. By testing the hypothesis in the models, the correlation between the selected variables will be evaluated. 1.2.Methods and research plan The main impacting factors of the inflation rate in Montenegro could be categorized as internal and external. Internal shocks predominantly come from the volume of public revenues collected, especially indirect taxes generated through trade on food and food processing products, alcohol, tobacco, and accommodation services. The external shocks come mostly from pass-through increases in oil prices and aluminum LME prices. We examine three individual-predictive recursive and non-recursive structural vector autoregressive (SVAR) and Bayesian VAR models to investigate and forecast inflation determinants of Montenegro. We continue employing the average and inverse MSE combinations approach, and the data are examined from January 2006 to December 2016. Additionally, out-of-sample 12-month horizon forecasting is performed from January 2017 to December 2017. Model 1 examines external determinants. Model 2 examines the internal determinants of inflation. Model 3 relates to demand-pull and cost-push variables. Combining the above three forecasts, using an equal and inverse MSE weighting approach, we disclose four more RMSEs: two VAR equal and inverse MSE weights and two Bayesian VAR equal and inverse MSE weights. Besides, we use

impulse responses to trace the effects of structural shocks on the endogenous variables and forecast error variance decomposition of shocks to 1

variables. Moreover, we use the panel vector error correction model (VECM) approach to forecast inflation dynamics and inflation expectations in Montenegro, Serbia, Croatia, and Slovenia from January 2006 to December 2015 out-of-sample 24-month horizon forecasting from January 2016 to December 2017. The objective of the panel cointegration approach is not only to compare two subgroups: i) Montenegro (ME) and Serbia (SR) as candidate countries for the EU membership and ii) Croatia (CR) and Slovenia (SI), already in EU, but to highlight the Montenegrin case. We employ alternative forecasting scenarios since the Central Bank of Montenegro wants to hypothetically have a forward-looking forecasting reaction of inflation in different sensitive scenarios, such as an increase in the oil price (external innovations) and economic freedom index-internal innovations. The oil price and aluminum LME price variables are used as the core factors in Montenegro to measure its economy's strength to absorb the external shocks, especially considering the aluminum as the primary potential productivity growth engine based on the revealed competitive advantage. The aluminum LME price and oil price variables are related to GDP, unemployment rate, and inflation. These factors will be included in model 1, using the recursive and non-recursive SVAR identification and Bayesian VAR analysis to measure the controlling strength of external shocks into inflation in Montenegro. The economic freedom and e-government development index8 (EGDI) will be used as critical internal factors contributing to anchor inflation in model 2. Human capital, telecommunication infrastructure, and online services are the three components that build 8 United Nations, E-Government Knowledgebase, https://publicadministration.un.org, accessed, March 13, 2020. the EGDI. Per capita growth rate, in the long run, settles down to the speed of technological change. Model 2 will include capital stock, human capital, employment, GDP, and inflation as well. Other variables, such as GDP, unemployment rate, nominal exchange rate, wages, industrial production growth, and money in circulation (broad money M2, the estimate of CBCG), are also included in another model, model 3. These variables incorporate both demand-pull and cost-push ingredients, starting from a balance between aggregate demand and aggregate supply. The recursive and non-recursive SVAR identification, Bayesian VAR, panel data analysis, and forecast combination puzzles of inflation will be applied, using an equal and inverse MSE weights approach. The variables in this research study are oil price, aluminum price, GDP, unemployment rate, exchange rate, industrial productivity growth, wages and money in circulation (broad money M2), economic freedom, EGDI, capital stock, human capital, employment, and inflation. The monthly data are observed from January 1, 2006, to December 31, 2017. The following equations represent the three models estimated: $\pi i = \alpha 0 + \alpha 1 \log(Aii)i + \alpha 2 \log(Air)i + \alpha 3 Aii + \alpha 4 AAA\_AAAi + ri$ (1) $\pi i = \alpha 0 + \alpha 1 \log(AA)i + \alpha 2 \log(AAAA)i + \alpha 3 AAriAii + \alpha 4 \log(A)t + \alpha 5 Aiii + \alpha 6 AAA\_AAAi + ri$ (2) $\pi i = \alpha 0 + \alpha 1 \log(AA)i + \alpha 2 \log(A2)i + \alpha 3 \log(A)i + \alpha 4 AriAi + ri$ (3) Some of the variables were found in the Montenegrin national publications while some in the international ones. The variables of inflation (Inf) and unemployment (Un) are collected from tradingeconomics.com9. The GDP variable time series is collected from statista.com10. The exchange rate variable time series (Exch) is obtained from oanda.com11, while aluminum price time series (Alu) and oil price (Oil) are collected from 9 Trading Economics , https://tradingeconomics.com/, accessed, October 17, 2019. 10 Statista , https://www.statista.com/, accessed, October 17, 2019. 11 Oanda , https://www.oanda.com/rw-en/, accessed, October 17, 2019. indexmundi.com12. The broad Money M2 is collected from the CBCG13. The EGDI time series is drawn from UN eGov surveys14. The economic freedom (EcoFree) variable is collected from the Heritage Foundation15. Capital stock (investments/GDP) variable comes from data.worldbank.org16 and employment (Employ) from Fred economic data17. Human capital (HumCap), wages (W), and industrial productivity (IndG) growth time series are collected from monstat.org18. In addition to the above mentioned, the following research methods will be used: descriptive method, historical method, comparative analysis, case studies, content analysis, statistical (econometric) method, and combination methods. Regarding additional quantitative research methods, the Product Space Metrics methodology will also be applied. 1.3.Scientific contribution Since the primary objective of the monetary policy of Montenegro, on its path towards the EU and the European Monetary Union, should be achieving and maintaining price stability, (which is

one of the key criteria for closing chapter 17, Economic and Monetary Policy), the 1

above could be enhanced by the study, i.e., by measuring internal and external variables that determine the level of inflation in Montenegro. The research on maintaining price stability by governing the external and internal factors of inflation will contribute to 12 Index Mundi , https://www.indexmundi.com/, accessed, October 17, 2019. 13 Central Bank of Montenegro, https://www.cbcg.me/, accessed, October 17, 2019. 14 United Nations, E-Government Knowledgebase, https://publicadministration.un.org, accessed, March 13, 2020. 15 The Heritage Foundation, https://www.heritage.org, accessed, October 31, 2019. 16 World Bank Open Data, https://data.worldbank.org/, accessed, October 31, 2019. 17 Fred Economic Data, https://fred.stlouisfed.org/, accessed, October 31, 2019. 18 Monstat, https://www.monstat.me, accessed, October 25, 2019. an in-depth understanding of the complexity of the economic governance mechanism. The research center is price stability. Montenegro is obliged to gradually harmonize its economic and monetary policy with the EU and Eurozone. Research like this one is essential for scientists and the business community to understand the final phase of the accession process and key changes in the decision-making process within the economic governance mechanism (supranational economic policy coordination mechanism of the EU Member States). Applying the above-mentioned scientific research methods, we will analyze and measure the impact of the variables on Montenegro's inflation level in current and alternative sensitivity scenarios. The analysis will consequently help macroprudential policymakers stabilize the trade balance, reduce debt/GDP ratio, enhance productivity growth, lower unemployment, run-down output gap, and govern external and internal shocks to inflation in Montenegro. At the same time, with this research, the necessary conditions that Montenegro achieves through effective economic policy implementation will be analyzed, and these are the conditions that qualify Montenegro for future membership in the EU, i.e., to the European Monetary Union. Summarizing, our findings help policymakers understand in-depth

the factors involved in detecting **the** commencement **of** inflation **dynamics and** its **expectations in** Montenegro **better and** set forth **more effective** 45

government regulations. In so doing, this research enhances and suggests the approach and methodology needed to fight the worries of many macroprudential policymakers in Montenegro, especially the Central Bank of Montenegro. 2. Governance of External and Internal Factors of Inflation Macroeconomic stabilization and structural reforms follow the transition of the Western Balkans and their convergence towards the European Union. Macroeconomic stabilization implies external and internal macroeconomic equilibrium, whereby the internal macroeconomic equilibrium mirrors, among other things, a low and stable inflation rate. Besides, structural reforms inevitably carry with themselves waves of layoffs and affect the unemployment rate. Since Montenegro is at the threshold of entering the EU, we are motivated to theoretically and empirically examine and predict external and internal inflation determinants in Montenegro. Many factors influence the maintenance of price stability in Montenegro, and the focus of this research will be the study of key (selected) external and internal factors of inflation, with a focus on governing these instruments in the meantime. Furthermore, the research attention will analyze factors such as selected imported or exported products that affect the country's price stability. The movement of key macroeconomic indicators such as GDP growth, employment, public administration efficiency, and its intermediate but significant impact on the informal sector's level and the quality of economic governance in the country will have an in-depth analysis. The objective is to reveal the internal and external determinant factors of inflation

in the specified period and forecast the inflation dynamics, using 1

VAR, Bayesian VAR, and combination puzzle approach. To achieve that objective, we estimate recursively and non- recursively three structural VAR and three BVAR identified inflation models to develop a complementary toolset to forecast inflation1920. 19 Mejía, J. D. Ch., and C. Ch. Morales., “Forecasting Inflation by Bayesian Techniques,” Banco Central De Costa Rica, Economic Research Department, 2015. 20 Lindholm, U., M. Mossfeldt., and P. Stockhammar., “Forecasting inflation in Sweden,” Economia Politica, 2020, 37, 39–68. Montenegro gave up the independent monetary policy and adopted a unilateral and official euroization in 200221. Historically, Montenegro used foreign currencies mostly22. A monetary union in Europe is a vital intermediate move toward political union2324.

Countries with "good" institutions display fear of floating: they float less than 301

announced25. A

type of government with the most substantial incentive to give up its currency is a small country with high inflation 204

history26. Montenegro, since independence, decided de jure and de facto toward building and strengthening the core institutions. A government's decision to enhance institutions depends on the conflict of institutions and the government's goodwill272829303132. Based on an IMF empirical analysis,

de jure and de facto exchange rate regime classifications for 146 EMDCs over 1980–2010 47

(Emerging Markets and Developing Countries), they find that inflation is 21

Djurovic, G., The European Union and Montenegro: The Accession Process. Podgorica: EU Info centar, 2017. 44

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Fabris, N., "The History of Money in Montenegro from 1906–1918," Conference The Economic Causes and Consequences of the First World War, Belgrade University, Faculty of Economics, 25

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L. Hanscom., and J. Knezevic., "Think globally, act locally: Implementing the sustainable development goals in Montenegro," Environmental Science & Policy, 2018, 84, 159-169. 28 Jaksic, M., and 346

A. Prascevic., Makroekonomija: analiza i politika. Beograd: Čugura, 2014. 29

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Acemoglu, D., Introduction to Modern Economic Growth, New Jersey: Princeton University Press, 12

2009. 32 Djurovic, G., M. Bigovic., and N. Milovic., "Support for Further Enlargement of the EU: Statistical Analysis of Regional Differences,"

Journal of Balkan and Near Eastern Studies, 2017, 19(3), 243-258. 44

indeed lower — especially in emerging markets — by some 4%33343536. Meanwhile, Reinhart and Rogoff (2003) find the opposite when an

official categorization is a form of the peg; roughly half the time, their classification reveals the real underlying monetary regime to be radically different, often a variant of 104

float37. Euroized

countries should have a very low pass-through inflation as their currencies are anchored to that of their principal trade partner38. On the 61

other hand, Fabris and Acimovic (2010) propose a two-nominal- anchor regime: inflation and the exchange rate39. 33

Ghosh, A. R., M. S. Qureshi, and Ch. G. Tsangarides., "On the Value of Words: Inflation and Fixed Exchange Rate Regimes," IMF Economic Review, 240

2014, 62(2), 261-287. 34 Giavazzi, F., and M. Pagano., “The Advantage of Tying One's Hands: EMS Discipline and Central Bank Credibility,” European Economic Review, 1988, 32(5), 1055-1075. 35 Hashem, E. A., “Inflation Targeting in Emerging Economies and its Applicability to the Egyptian Economy,” Arab Journal of Administration, 2015, 36(2), 421-436. 36 Hossain, A. A., “Monetary Policy for Maintaining Low, Stable Inflation in Malaysia,” The

Journal of Developing Areas, 2017, 51(2), 381-404. 37 Reinhart, C., **and** 327

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2012. 39 Fabris, N., and S. Acimovic., “Exchange Rate Policy in Serbia,” South East European Issues:Transit Stud Rev, 2010, 17, 170-180. Investigating and determining empirical inflation determinants is vital. Determining inflation factors in well-advanced and transitional

countries has been a research **topic of many empirical and theoretical** 1

studies404142434445. Researches that investigate Montenegrin inflation are narrow, and the examined works highlight that only the SVAR models would accurately predict inflation in Montenegro4647. Lipovina – Bozovic et al. (2015) highlighted that ARIMA forecasting models could not appropriately predict inflation since many external factors influence Montenegro's price movement. Mitrovic – Mijatovic and Ivanovic (2017) highlight that Montenegrin openness increased house prices. In the meantime, openness brought more money, and external shocks have a positive impact on inflation. International Monetary Fund, Montenegro-Article IV Consultation, (2018) reports that a 2 p.p. VAT and excise increase adds 1 p.p. to inflation on average48. 40Golinelli, R., and R. Orsi., “Modeling Inflation in EU Accession Countries: The Case of the Czech Republic, Hungary, and Poland,” Ezoneplus, Working Paper, 2011, No.9. 41Egert, B., “Real Convergence, Price Level Convergence, and Inflation Differentials in Europe,” CESifo Working Paper, 2007, No. 2127. 42Blanchard, O.,

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2010, 42(1), 199-215. 43Koop, G., and D. Korobilis., “Forecasting inflation using dynamic model averaging,” International Economic Review, 2012, 530(3), 867–886. 44Apostolov, M., and D. Josevski., “Aggregate Demand–Inflation Adjustment Model Applied to Southeast European Economies,”

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45Obradovic, S., S. Sapic, S. Furtula, and N. Lojanica., “Linkage between Inflation and Economic Growth in Serbia: An ARDL Bounds Testing Approach,” Inzinerine Ekonomika-Engineering Economics, 2017, 28(4): 401-410. 46Lipovina-Bozovic, M., J. Cerovic, and S. Vujosevic., “Forecasting inflation in Montenegro using univariate time series models,” BEH – Business and Economic Horizons, 2015, 11, 51-63. 47Mitrovic

-Mijatovic, M., and M. Ivanovic., "Inflation in a Fully-Euroised Economy: Could Inflation Differentials Threaten Competitiveness?," Journal of Central Banking Theory and Practice, 2017, 2, 101- 124. 30

48International

Monetary Fund, (IMF)., "Montenegro: 2018 Article IV Consultation," IMF Country Report, 2018, No 18/121, Washington, D. 110

Having only a few research papers that examine Montenegrin inflation, we have examined and investigated a broad number of empirical studies on inflation determinants. Different methodological approaches and indicators are suggested to explore and forecast inflation determinants. Cecchetti et al. (2000), among other factors, emphasize the economy's impulse response innovations to inflation49. Using a panel VAR approach, Dées and Güntner (2016) untwist the

role of unit labor costs and profit margins as the essential determinants of price dynamics 59

across euro area countries50. On the other hand, Yi and Choi (2005) examined 207 countries from 1991-2007 and found: an internet penetration rate increase of 1% decreases inflation from 0.04%- 0.13%51. Czernich et al., (2011) examined OECD from 1996-2007 and found a positive and essential relationship between broadband nexus and growth52. Acemoglu (2009) argues that economic institutions cause dissimilarities in GDP53. The Heritage Foundation (2019) highlights that free societies drive people to work, create, and invest: being protected by the government.54" The nexus between economic freedom and the endogenous growth model have shown several studies5556. Using panel data

49Cecchetti, S

.G., R. S. Chu, and Ch. Steindel., "The unreliability of inflation indicators," Current Issues in Economics and Finance, 263

2000, 6, 1-6. 50Dées, S., and J. Güntner., "Forecasting Inflation Across Euro Area Countries and Sectors: A Panel VAR Approach," Journal of Forecasting, 2016, 36, 431-453. 51Yi, M. H., and Ch. Choi., "The Effect of the Internet on Inflation: Panel Data Evidence," Journal of Policy Modeling, 2005, 27(7), 885-89. 52Czernich,

N., O. Falck, T. Kretschmer, and L. Woessmann., "Broadband Infrastructure and Economic Growth," The Economic Journal, 292

2011, 121(552) 505-532. 53Acemoglu,

D., Introduction to Modern Economic Growth. New Jersey: Princeton University Press, 2009. 246

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2004, 24(3), 205-233. econometrics, Cebula (2011) finds a positive relationship between EF and EGM57. Based on 19-panel transition economies, Hammermann and Flanagan (2007) highlight that greater liberalization would reduce higher inflation incentives 58. The speed of technological progress speed (AW) and the dynamics of expectations that workers form is essential upon the shaping of price expectations (AW) as well59. New and innovative technological progress changes the market's structural contour, making old technology no longer used60. Broad money enters short-term inflation determinants61. Bobeica et al., (2019) conclude that demand shocks, through labor costs, are passed on to inflation more likely than supply shocks62. Kilian (2009), Wei et al., (2010),

Peersman and Van Robays (2012), and Baumeister and Peersman (2013) is another coastline **that** examines **the** literature **of** 57

time-varying effects 57Cebula, R.J., "Economic Growth, Ten Forms of Economic Freedom, and Political Stability," Journal of Private Enterprise, 2011, 26(2), 61:82. 58Hammermann, F., and M. Flanagan., "What Explains Persistent Inflation Differentials Across Transition Economies?," Kiel Institute for the World Economy, Working Paper 1373, 2007. 59 Blanchard, O., Macroeconomics, 7th ed. Harlow, UK: Pearson, 2017. 60 Aghion, Ph.

And P. Howitt., The Economics of Growth. Cambridge, MA: MIT Press, 51

2008. 61Lissovolik, B., "Determinants of Inflation in a Transition Economy: The Case of Ukraine," International Monetary Fund, 2003, WP/03/126. 62Bobeica, E., M. Ciccarelli, and I. Vansteenkiste., "The link between labor cost and price inflation in the euro area," European Central Bank, 2019, WP 2235. of oil price innovations on the inflation dynamics63646566. They conclude that the fundamentals of oil prices are important determinant factors of inflation.

Choi et al., (2017) conclude **that domestic inflation** increases on average **by 0.4%** 106

when global oil prices rise 10%. The results are similar between advanced and transitional countries67. To extend the range of instruments available for the Central Bank of Montenegro, we have developed a set of models that make it possible for us to have a complementary toolset to forecast inflation: i) external variables, ii) internal variables, and iii) demand- pull and cost-push variables. 2.1.Approach to the analysis of inflation What is the optimal inflation rate in Montenegro? What determines the inflation equilibrium in Montenegro? What is the structure of inflation in Montenegro, and what instruments policymakers need to govern inflation? As long as prices are not unreasonable figures but reveal how people value things precisely, it is one of economics' most fundamental ideas68. In a competitive market, where each wage setter and firm are a small part of the market, real wage price-setting relation determines the market price and the unemployment rate. 63Kilian, L., "Not All Oil Price Shocks Are Alike: Disentangling Demand and Supply Shocks in the Crude Oil Market," American Economic Review, 2009, 99(3), 1053-1069. 64

Wei, Y., Y. Wang., and D. Huang., "Forecasting crude oil market volatility: Further evidence using GARCH-class models," Energy Economics, 2010, 32(6), 1477- 218

1484. 65Peersman, G., & Van Robays, I.,

Cross-country differences in the effects of oil shocks," Energy Economics, 2012, 34(5), 1532-1547. 174

66Baumeister, Ch., and G. Peersman., "Time-Varying Effects of Oil Supply Shocks on the US Economy," American Economic Journal: Macroeconomics, 2013, 5(4), 1-28. 67Choi, S.,

D. Furceri, P. Loungani, S. Mishra, and M. Poplawski-Ribeiro., "Oil Prices and Inflation Dynamics: Evidence from Advanced and Developing Economies," International 60

Monetary Fund, 2017, WP/17/196. 68

Varian, H.R., Intermediate Microeconomics: A Modern Approach, 9th ed. New York: W. W. Norton & Company, 2014. 41

In turn, wages are determined by the expected price level, unemployment rate, and positively correlated other factors. On the other hand, firms determine prices depending on wages and markups69. The expected inflation comprises of two variables: a constant (1 − α) and a last year's inflation coefficient α. πiW = (1 − α)π + $\alpha\pi i$−1 (4) At a constant inflation rate, firms and wage-setters' behavior is compatible, indicating a natural unemployment rate and output equal to potential. For output levels above potential, change in inflation increases. The positive change shows how the price and wage adjustment, in turn, affects production. Euroization in Montenegro anchored expectations. Since independence, 2006, economic reforms have been undertaken, and economic growth emerged in the market. Demand increased and led to growth, shifting inflation, consumption, and foreign direct investments (FDI) up. Since the Montenegrin economy is predominantly oriented in imports, it is of significant interest to see whether inflation is determined by core inflation (long term) or external shocks7071. Dimitrijevic et al. (2016) emphasize that: (i) administrative products (medicines, flour, electricity, fixed telephony), (ii) agricultural products, and (iii) oil products should be excluded as potential group products from core inflation. Oscillation of the above three groups are innovations that determine structural breaks, long term fluctuations, and seasonal inconsistency of inflation in Montenegro. The wave of FDI in 2007 and 2008 impacted, in 2012 and 2013, inflation by 37.2% and 129,4%, respectively, in the housing market in Montenegro72. In 2014, communication 69 Blanchard, O., Macroeconomics, 7th ed. Harlow, UK: Pearson, 2017. 70 Fabris, N., and I. Pejovic., Ekonomija. Savremena administracija: Beograd, 2015. 71 Dimitrijević, B., N. Fabris, Lj. Vladušić, M. Radović, and M. Jadrić., Economic Policy-Regional Aspects. Belgrade: Čugura, 2016. 72 Mijatovic-Mitrovic, M., and M. Ivanovic.

Inflation in a Fully-Euroised Economy: Could Inflation Differentials Threaten Competitiveness? De Gruyter. Journal of Central Banking Theory and Practice, 2017, 2, 101-124. 30

Maintaining price stability in Montenegro through governance of external and internal factors of inflation Table 1: CPI structure percentage by categories % to CPI

Av. 2011 Av. 2012 Av. 2013 Av. 2014 Av. 2015 Av. 2016 Av. 2017 197

FOOD AND NON-ALCOHOLIC BEVERAGES 42.0% 32.7% -34.8% -358.7% 84.3% 38.4% 24.6% ALCOHOLIC BEVERAGES AND TOBACCO 22.4% 18.0% 110.5% -84.2% 7.5% 3.5% 14.2% CLOTHING AND FOOTWEAR -4.9% -0.8% -7.4% -17.6% 27.1% -1.8% 8.8% HOUSING, WATER, ELEC., GAS & OTHER FUELS -4.9% 37.2% 129.4% 24.2% 25.2% 18.1% 10.5% FURNISHINGS, HOUS. EQ. & MAINTENANCE -1.2% 0.0% -12.2% 92.4% -1.8% 1.4% -2.0% HEALTH 17.0% 3.8% 24.3% -209.8% 11.5% 2.0% 4.7% TRANSPORT 28.7% 7.1% -107.6% 303.6% -69.3% 25.2% 31.7% COMMUNICATION 0.8% 2.5% -7.9% 265.7% 0.4% -0.4% 0.4% RECREATION AND CULTURE -4.8% 1.5% -31.9% 1.2% 5.7% 0.7% -0.6% EDUCATION -0.2% -0.1% 1.3% -0.2% 0.0% 0.0% 0.0% RESTAURANTS AND HOTELS 5.8% 4.0% -1.0% 26.1% 5.2% 6.7% 9.1% MISCELLANEOUS GOODS AND SER. 1.3% 0.0% 48.6% 44.6% -1.4% 2.6% 2.7% Source: Monstat, author's calculations, 2019. 37 and transport impacted inflation by 265.7% and 303.6%, respectively, which was counterbalanced by the negative shock of food and non-alcoholic beverages by -358.7%. Still, in 2016 and 2017: (i) import of food, tobacco and non-alcoholic beverages, (ii) housing, electricity and oil, (iii) and tourism industry and transport institute the cardinal impact on inflation in Montenegro. The CPI structure percentage by categories is represented in Table 1. The structure of Montenegrin inflation remains vulnerable to external shocks (imports of fuel especially), fiscal policy (excise tax on tobacco and accommodation services), and energy (tax and uncompetitive products), which harm Montenegro's economic stability and sustainable growth. Table 1 shows that in the pre- crisis period, food, alcoholic beverages and tobacco, and health and transport determined the inflation predominantly. Table 2: The impact of predominant internal and external factors on inflation Year Internal impact External impact 2017 Higher excise tax in Tobacco & Accom. Pass-through of oil and food in the world market 2016 Tobacco and Accom. services Deflation pass-through impact of oil and food 2015 Food & non-alc. beverages The deflationary impact of transport (decrease of the world oil market). An introductory tax of 7cents/lit for highway Bar-Bolare increased the oil price The inflationary effect of food price Decrease of world market oil price, and stagnation of Electricity price 2014 Weak growth of available income The deflationary trend of food prices and weak growth of effects income. 2013 Excise taxes on tobacco, VAT from 17% to 19%, deflationary of transport, electricity prices, medicine taxes, and accom. services The decrease in the cost of oil/transport 2012 Electricity, the excise tax on tobacco, alcohol, soft drinks, and coffee, tax on electricity counters and SIM cards Increase of world market price of oil 2011 Electricity, the excise tax on tobacco, alcohol, soft drinks and coffee, medecine taxes. Increase of Transport. Pass-through increase of oil and food prices Source: Economic Reform Programme for Montenegro, 2011-2018, pp. 17-26. The output gap in Montenegro is below potential. Bogetic et al. (2013) highlight that

Montenegro is not using the principal growth engine – exports – that has transformed many small countries, especially locations with significant geographical advantages. 13

The ratio of exports-to-GDP averaged only 39% in Montenegro for 2007-2011, while in Slovenia 68%, Estonia 78%, and Malta 85%73. 1,042,832689,321 1,457,350441,133 2,073,085 454,739 2,529,736 416,165 1,654,162 277,011 1,657,326 330,367 1,823,330 454,381 1,820,850 366,896 1,773,352 375,585 1,784,214 333,166 1,841,524 317,172 2,061,688 325,846 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 1 2 3 4 5 6 7 8 9 10 11 12 -673,506 -1,016,217 -1,618,346 -2,113,571 -1,377,152 -1,326,960 -1,368,949 -1,453,954 -1,397,767 -1,451,048 Import Export Trade ballance -1,524,353 -1,735,842 Figure 1: Import, export, and trade balance in Montenegro 2005-2016 Source: Monstat, author's calculations, 2019. Montenegro runs a trade deficit since 2005, implying that it accumulates debt, vis-à-vis the rest of the world, paying interest rates steadily. Increases in foreign demand, which would improve the trade balance, is a proper path. An increase in domestic demand, especially since the independence of Montenegro, has mostly increased imports, resulting in the trade deficit. To contribute to removing or reducing these obstacles, the ERP 2018 73 Edgardo, F.,

Small states, Smart Solutions: Increasing Connectivity and Effectiveness of Public Services, World Bank, Washington D.C., 13

2008. designed the

reform processes in each of the significant reform areas in line with the 76

European Commission's Guidance7475. The planned growth of the economic activity, in the time frame 2017-2030, is based on the priority development projects in the field of (i) energy production (hydropower plant - HPP, small HPPs, wind power plants, photovoltaic power stations, TPP Pljevlja II (changed to the ecological revitalization of TPP I) and energy efficiency programs; (ii) transportation (highway and other projects); (iii) industry (especially metal industry); (iv) tourism (tourist complexes and hotels); (v) and agriculture76. Exports are a fundamental economic problem in Montenegro. As Figure 2 shows, there is a too high concentration in aluminum, iron, and steel. It shows that this category accounts for 50% of exports on average from 2005-2016. It is planned to invest in the aluminum industry (KAP), BAT technology of 50 million euros until 2030, reducing the GHG by 82.76% and diversifying aluminum products 77. The technological sophistication of KAP would have multiplicative effects on the economic growth episodes. In 2013, Montenegro's technological export structure was mostly concentrated in semi-products 73.6%, primary products 16.3%, consumer goods 5.2%, capital equipment 4.7%, and high technology products 1.3%, implying low export sophistication, relatively little income potential78. 74 Djurovic, G., M. Muhadinovic, V. Djurovic,and M. M. Bojaj., "Agenda 2030: measuring progress in the Montenegro's national strategy for sustainable development," chapter 5 in the Book "Statistics, Growing data Sets and Growing Demand for Statistics," edited by Turkment Goksel, IntechOpen, UK, 2018. 75

Galli A., G. Djurovic, L. Hanscom, and J. Knezevic., "Think Globally, Act Locally: implementing the Sustainable Development Goals in Montenegro," Environmental Science and Policy, 317

2018, 84, 159-169. 76

Government of Montenegro, Economic Reform Programme for Montenegro, 2018-2020. 76

77 Djurovic, G., M. Bojaj., and M. Muhadinovic., Greenhouse Gas Emissions and Sustainable Growth in Montenegro; A SVAR Approach," Research, Faculty of Economics, 2020. 78 Halilbasic, M., S. Brkic., and V. Bosic., "Comparative Analysis of Export", EA, 2015, 48(1-2), 108- 129. Exports in Montenegro 500,000 400,000 300,000 200,000 100,000 0 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 Commodities and transactions not classified

elsewhere in the SITC Miscellaneous manufactured articles Machinery and transport equipment Manufactured goods 222

(aluminium, iron, and steel) Chemicals Animal oils and fats Mineral fuels, lubricants and related materials

Crude materials, inedible, except fuels Beverages and tobacco Food and live animals 331

Figure 2: Montenegro export concentration 2005-2016 Source: author's calculations. Halilbasic et al. 2015 highlight that the number of export products, greater than 100,000$ USD, for Montenegro ranges from 201-198, respectively, during 2006-2013. The Herfindahl - Hirschmann index of

geographic export concentration (HHI) ranges from 0.24-0.16, indicating a low export basket dispersion. Bogetic et al. (2013) find that

exported products for which Montenegro has revealed comparative advantage (RCA79 >1) are sparse in the product space (PS) methodology and often located in the difficult-to- reach periphery of the PS. 13

Three income potential groups are aluminum and iron, agriculture, and tourism. An increase in exports (mostly aluminum, iron, and steel) and its structural diversification helps stabilize the trade balance, debt/GDP, productivity growth, unemployment, output gap and consequently, limits external shocks to inflation in Montenegro, fixing price disparities and qualifying for the membership into European monetary union. Since there are many factors, we estimate three structural VAR and three BVAR identified inflation models. The first model identifies the fundamental external and 79 Revealed competitive advantage. independent determinants of the supply shocks (oil and London Metal Exchange aluminum prices). The second model examines primary internal and independent determinants of inflation, focusing on economic freedom and e-government. Model 3 incorporates cost-push and demand-pull variables. 2.2.External determinants of inflation in Montenegro It is vital for Montenegrin policymakers to examine and econometrically measure the external factors' impact on determining inflation. Thus, the Central Government of Montenegro is interested in seeing the dependency of inflation to changes in external factors. In the meantime, forecasting and causality are two other dimensions of high interest. Oil prices play a prominent role in the build-up of persistent inflationary pressures in advanced and transitional countries. Oscillations in oil prices are worldwide phenomena. The impact of oil prices in emerging economies that are not financially stable and not strong to absorb external shocks is highly influential in determining these economies. The inflation rate is the first to get impacted by oil price changes. Consequently, fluctuation in inflation further leads to economic changes80. Several research papers have examined the impact of oil prices on inflation since oil is a direct production input. Hooker (2002) examined the relationship between inflation and oil prices from

1962-1980 and 1981-2000: the results showed that the impact of oil 34

prices was noticed only in the first sample81. A great number of studies report a significant effect 80 Kozaric, K., and N. Fabris., „Monetary Policy at Crises Time," Journal of Central Banking Theory and Practice, 2012, 1, 5- 25. 81 Hooker, M., "Are oil price shocks inflationary? Asymmetric and nonlinear specifications versus changes in regime,"

Journal of Money, Credit and Banking, 2002, 34(2), 540- 561. of 131

oil prices on inflation828384.

Blanchard and Gali (2007) explain the strong relationship between oil prices and inflation in 34

two episodes: (i) low growth and high unemployment before 1970, and (ii) high growth and low unemployment after 198085. Table 3: Energy consumption in TJ energy units Energy 2018 % 2019 % 2020 % Electrical energy 12,492 20.13% 12,723 32.46% 13,015 30.88% Biomass 8,317 13.40% 8,089 20.64% 8,409 19.95% Coal 1,236 1.99% 1,289 3.29% 1,305 3.10% Oil and gas 35,984 57.98% 13,053 33.31% 15,372 36.48% Total 62065 100.00% 39192 100.00% 42141 100.00% Source: Decision of Energy Balance of Montenegro for 2020. Shocks coming from oil prices

can be viewed from three factors: (i) the source of shocks, (ii) the pass-through transmission mechanism of oil shocks, and (iii) the structure of 34

energy86. Table 3 shows energy consumption in terajoules (TJ) energy units of Montenegro. As seen from the table, oil consumption as an energy source is crucial for realizing planned economic and social activities in Montenegro. In 2018, oil was used 57.98% as an energy resource. Even though the percentage of oil consumption compared to the total energy sector is declining, oil usage increased from 330t, 347t, and 361t, respectively, from 2018- 202087. 82

Kiptui, M., "Oil price pass-through into inflation in Kenya," Kenya School of Monetary Studies Research Centre, 2009. 325

83 Misati, R. N., E. M. Nyamongo, and I. Mwangi., "Commodity price shocks and inflation in a net oil- importing economy," OPEC Energy Review, 2013, 37(2), 125-148. 84 Kargi, B., "The effects of oil prices on inflation and growth: time series analysis in Turkish economy for 1988:01 – 2013:04 period," MPRA paper, 2014, no. 55704. 85

Blanchard, O. J. and J. Gali., "The macroeconomic effects of oil price shocks: why are the 2000s so different from the 1970s?," National Bureau of Economic Research,Working Paper, 2007, no. 13368. 211

86

Lamazoshvili, B., "Effects of il price shocks on oil-importing developing economies: the case of Georgia and Armenia," Economics Education and Research Consortium, 2014, Working Paper no. E14/06. 34

87 Government of Montenegro, 2020., Decision of Energy Balance of Montenegro for 2020. The highway Bar-Boljare is expected to increase oil consumption usage, which is in the final stage of Section 1 construction. Thus, oil prices are an essential and dominant source of inflation, implying

that supply-side and demand-side innovations originated by external oil shocks are a source of variations in output and inflation in 4

Montenegro. 12 8 4.8 4 4.4 0 4.0 -4 3.6 3.2 06 07 08 09 10 11 12 13 14 15 16 17 I NF LOGOIL_SA Figure 3: Empirical relationship between inflation and oil prices Source: Author's calculations in EViews 11. Let us start by looking at the empirical relationship between oil prices and inflation in Figure 3. The blue line represents inflation, while the orange line shows the seasonally adjusted logarithmic of oil. It is noticeable that up to the end of 2008, the variables were co-moving together. The gap has widened just around the global financial crisis. While the world oil market price was still increasing, the inflation in Montenegro was declining until the middle of 2010. After 2010, they comove closely together till the end of 2014. The relationship between the two variables seems to have changed in the middle of 2014. Export potential is the primary productivity growth engine of Montenegro, based on the revealed competitive advantage 88. Policy misalignment (through debt, low investments, and bank guarantees) of KAP caused the leading Montenegrin exporter to shadow. Bogetic et al. (2013) highlight that countries with ensured cheap energy, BAT technology, and the traditional background of merchandise exports of aluminum, according to Product 88

Bogetić, Ž., I. **Pejović,** and **I. Osorio Roddarte.,** „Expanding and Diversifying Montenegro's Exports: A Product Space Analysis," **Journal of Central Banking Theory and Practice,** 64

2013, 2, 19-34. Space (PS) metrics methodology, could be large potential exporters with tourism and agricultural products. Aluminum application in cars, consumer goods, rail wagons, buses, aircraft, etc., has increased the demand for aluminum since aluminum is being used to reduce weight and fuel consumption.

International Trade Center (ITC), World Trade Organization (WTO), and the **United Nations (UN)** 296

are joint agencies89. The UN has set global goals of sustainable development, and the mission of ITC is to nurture them. The

Government of Montenegro nationalized the 2030 **Agenda on Sustainable Development by adopting the National Strategy for Sustainable Development (NSSD) in 2016** and **a corresponding Action Plan for its** implementation90. Restructuring of **the** 44

industrial sector in Montenegro, greening economy, and export promotion are parts of that process. This section focuses on export potential and product diversification since central policymakers are interested in designing proper measures to maintain stable and low inflation. What are the top products, sectors, and targeted markets that could potentially increase the exports of Montenegro, and how will they impact inflation? To answer these questions, we will focus on developing two measurable indicators: export potential and product diversification. There exists a necessity to know what Montenegro exports and what its potential is. Many sources can cause the gap. One of them can be a lack of knowledge of Montenegrin exporting companies about market regulations in the targeted markets. Another reason might be identifying potential partners in the targeted markets. Also, the economic freedom of Montenegro might be an internal factor. There exists a comprehensive list that assists in creating the gap between actual and potential exports in Montenegro. Therefore, economic experts need to identify this gray area and find which products have the highest chance to succeed in the targeted markets. Thus, this is where the export potential estimation methodology gets into action. First, we will find which products Montenegro can export. Second, we will identify markets that can bring the best for Montenegro and bring great results. The potential export assessment methodology 89 International Trade Centre (ITC), http://www.intracen.org/itc/about/, accessed, March 13, 2020. 90 Djurovic, G., Muhadinovic, M., Djurovic, V., and Bojaj, M., "Agenda 2030: measuring progress in the Montenegro's national strategy for sustainable development," chapter 5 in the Book "Statistics, Growing data Sets and Growing Demand for Statistics," edited by Turkment Goksel, IntechOpen, UK, 2018. points out profitable products, sectors, and target markets for trade development activities91. 2.2.1. Export potential indicator The first indicator that the methodology points out is Export Potential Indicator (EPI). Its purpose is to support already-established sectors and identify the products and industries that Montenegro has the highest potential to sell outside the country in specific target markets. Thus, EPI tries to find the products and sectors that Montenegro already succeeded in the past from the supply side. On the other hand, the indicator searches the countries on demand for such a product or sector with the best chance of success. The second indicator we will use is the Product Diversification Indicator (PDI). It aims to identify new products for export diversification. For Montenegrin policymakers, it would be exciting to know what products can be diversified further to the already established export sectors. We put together the supply and demand and the market access condition of the targeted markets to estimate how targeted markets the new diversified products would have the best potential for export success. These products are not yet exported, but we predict the potential success in targeted markets. EPI is composed of two sub-factors. The first one is the potential export value92. It measures the expected supply of a particular product from the exporter, the demand, and the exporter's accessibility. The second element of EPI is the difference between what is realized and what could have been realized. The margin is called the unrealized potential. Decreux and Spies (2016) show the following model: $Aiii = \alpha ii\ \alpha ii\ \alpha ii$ (5) and $Aiii$

measures the exports of country i, product k, and market j. For example, this would correspond to the Montenegrin exports of a product. While parameter αii, in this panel data, would measure the performance of Montenegro in exporting the product, αii 91

Decreux, Y., and J. **Spies., Export Potential Assessments, A methodology to identify export opportunities for developing countries, ITC,** 69

2016. 92 Ibid. shows the demand of the country (j) for our product, and αii corresponds to market access conditions from Montenegro to the country. Panel data econometrics could not give the expected results93, and therefore a different approach is given: $Aiii = \alpha ii\alpha iiAii = Wii\ dWiiiiW$) $Wi\ \Sigma i(di\ ii\ Aii$ (6) As Montenegro exports certain products, it reveals its sectors which make the country competitive, and this phenomenon in economics is known as Revealed Competitive Advantage (RCA), popularized by Balassa94: $AAAA = Wii\ \sum i\ Wii\ WWiii \approx AAAii \cdot i\ i\ \sum i\ Wii\ /\ \sum i\ \sum iWii$ & i (7) The ITC believes that a country's share of a product to its total exports can be written as its RCA times the percentage of the world demand (DShare). The ITC shares the following expression as the potential share of a product in a country's exports to a given market j: $[Wiii] = RCAiii \cdot iii\ ii$ (8) $Wii\ \Sigma i\ (RCAii \cdot ii\ i\ i\ )$ Expression (7) changes from (8); in fact, that expression (8) considers the demand of a market (MA) instead of the demand for the wealth. Thus, at the RCA ratio, we see the portion of a product's supply and the demand for that product by a specific country. Moreover, the final EPI is as follows: $AAAiii = AAii\ \sum iCAiiCCRxhiWWiiWiiiIAiii\ AAhArAiiAAiii$ (9) The first constituent on the right-hand side is the supply side. The supply side consists of RCA, RCA growth, X/M ratio, and global tariff conditions the export country faces. The second component is the demand indicator. The first part of the demand indicator deals with the proportion of a country's imports and the growth of that share. For example, this 93

Egger, P., An Econometric View of **the Estimation of Gravity Models and the** Calculation **of Trade Potentials, World Economy, 2002, 25(2), 297-312.** 53

94 Balassa, B.,

Trade Liberalization and Revealed Comparative Advantage, The **Manchester School, 1965, 33, 99-123.** 255

part would be the share of the country's imports from Montenegro and its growth. The second part of the demand would be the tariffs that the country applies to our products and the distance from Montenegro to the country. 2.3.2. The supply of Montenegrin products It is of valuable interest for policymakers of Montenegro to know the ingredients of the supply side and quantitatively reach a conclusion about the basket of exports of Montenegro. The ITC shows several sub-indicators of the supply side: $AAii = AAAii \cdot (RRCCAAririi{-}i31rr51) \cdot iii$ (1, $ixiiii$) $\cdot$ (α $1{+}Wi.iWiiWW\ {-}\sigma i\ i$) (10) $1{+}Wi.iWiiWWii$ By exporting products, Montenegro reveals its competitive products, the RCA. On the right-hand side, the first one, is RCA, where i stands for Montenegro (exporter) and k for aluminum (product). The next in line is the dynamic factor, the growth of RCA. It is followed by the trade surplus, xii , and the global tariff disadvantages of Montenegro iii faced in the world market. The RCA of a product such as aluminum in Montenegro represents the share of aluminum in Montenegro's exports to the share of aluminum in world exports. In the meantime, it can be interpreted in another way as the share of KAP in the aluminum's exports to the share of Montenegro in world exports: $IAP\ dwiirr\ IAP\ dwiirr\ AAAii = CwAiiirririiidrMiiidwrdiiidrdrri$, $AAAii = CCwwiiiirrrriiddMAiiirridiiidrdiri$, $AAAii$ = 00.1.28%% = 1,11 (11) $Wirid\ dwiirr\ Wirid\ dwiirr$ From this viewpoint, we can see the share of KAP in aluminum exports to the share of exports of Montenegro in world exports. In case the share of exports of KAP in Montenegro's exports is higher than the share of aluminum in world exports, we reveal that Montenegro has a comparative advantage in exporting aluminum. For example, the illustrative example in expression (11) shows that Montenegro is specialized in aluminum. RCA's growth is also remarkable to measure because we would like to know the RCA dynamics, how the

share of aluminum in Montenegro's exports has evolved to the change of the share of aluminum in the world exports. The ITC has done some econometric work about RCAs' dynamics, and the empirical results indicate that there is a continual progress of RCA. Based on the results, after five years of RCA growth, the growth discontinues its dynamics, but within five years, econometric work is reliable to predict the RCA growth range from 0.73% to 165%95. The third component of the supply side is the trade balance, export to import ratio of Montenegro. Why this component is included in the supply side of the expression. There are some products that, for example, Montenegro imports and re-exports the same to neighboring countries with almost no change at all and these products should not be considered in the expression whenever the imports are higher than exports. In this case, the RCA should be corrected, and usually, in recent years, the imports exceed exports in Montenegro. Thus, the RCA needs to be adjusted for cases when the export-to-import ratio is <1; otherwise, there is no need for correction. For example, if Montenegro imports bananas in value of 8.9 million euros and exports 8.3 million euros of bananas, then the ratio is 8.³⁄₈.9 = 0.9325, and the RCA should be multiplied in this case by 0.9325. The last component of the supply side is the global tariff disadvantage. This part of the expression compares the average tariff applied by the world to Montenegro of aluminum with the world's average tariff to all-aluminum suppliers. In case the ratio is <1, then RCA has to be downgraded, and for ratio >1, RCA should be upgraded. Why? Consider Montenegro. In case Montenegro faces higher average global tariffs than the average world and manages to export aluminum successfully, this implies that in a market with better tariff conditions, the RCA of Montenegro for aluminum would score higher. Therefore, an upgrade is necessary to balance the market access conditions. 2.3.2. The demand for Montenegrin products The demand for aluminum is a component of the EPI, and Montenegro needs to find out what is the demand for our products and who is in demand for them. The construction of the expression of the demand side of the EPI is as follows96: 95

Egger, P., An Econometric View of **the Estimation of Gravity Models and the** Calculation **of Trade Potentials, World Economy, 2002, 25(2), 297-312.** 53

96

Decreux, Y., and J. **Spies., Export Potential Assessments, A methodology to identify export opportunities for developing countries, ITC,** 69

2016. $AAhArAii \cdot AAiii = iiiii \cdot (RRhhWWiiWWiiiiWWWWiiWWiiWWriir{-}ii31rr51) \cdot (\alpha\ \sigma\ i\ 1{+}Wi.iWiiWWiii\ 1{+}Wi.iWiiWWii) \cdot A{-}|Wi.iiW\ WiiiWiWWii{-}iiW\ WiiiWiWWii|$ (12) The first component of expression (12) shows the share in market demand. For example, it shows the demand share of LME to the overall market demand for aluminum. It continues to show the growth of this share in demand over some period. For example, it would be interesting to know the growth rate of the share in demand of LME for 2008- 2010 and 2012-2014. Thus, it compares the demand share in 2012-2014 to the demand share in 2008-2010 while accounting for the pass-through of growth rates between two periods of time (within a specified interval). In case it is >1, then we have an increase in demand share, and for <1, we have a reduction in demand share. Next, we have an access indicator of the market, LME. This part of the expression shows the LME conditions of tariffs for Aluminum Plant Podgorica. This indicator compares the average tariff the LME applies to all-aluminum suppliers with the tariff the LME applies to Montenegro's exports of aluminum while accounting for the product's price sensitivity. In case the ratio is >1, then there is a tariff advantage for the Montenegrin market since the average tariff the LME applies to all suppliers of aluminum comparing to the tariff the LME applies to Montenegro is greater than >1. Thus, this would be advantageous for Montenegro; otherwise, it would be at a disadvantage compared to the other countries. Finally, we have a distance factor that captures the logarithmic distance of LME to the logarithmic range of KAP. In case the suppliers of aluminum to LME are located further than Montenegro, then Montenegro is located ideally, and no correction of the demand share is needed. It depends on the nature of the product because importing milk and aluminum changes the demand share drastically. 2.3.2. The bilateral trade relations The bilateral trade is based upon some expected trade between Montenegro and LME. The first component of expression (10) is the

current, actual, easiness of trade rii. The growth rate of economic activities of the exporter and the importer to the growth rate of the world is further considered as part of the expected bilateral trade of i and j, respectively KAP and LME: $Ari\ rii = rii \cdot \Delta GCPi\Delta r5GrC10Pw\Delta r5GrC10Pir5r10$, $AiiArArAiii = \Sigma iCAii \cdot CCxRihWxiiWiiiIAiii$ (13) In expression (13), we have the denominator that corrects complementarities in the trade structure between Montenegro and the United Kingdom. This part makes sure that easiness of business, for example, for aluminum between the two countries might be different for other products. Expression (13) helps us find the expected potential export value of aluminum from KAP to LME. The difference between actual and potential is unrealized or missed expected potential export value of aluminum between KAP and LME. The elaborate expression is as follows: $AAAiii = AAii\ AiiArArAiii\ AAhArAiiAAiii\ iii(xiii,CPIiii)\ AAArAA\ iA\ rirrAA\ iirAiriAiiii = 1 - CPIiii$ (14) (15) Thus, expressions (14) and (15) give us an expected value of trade that could happen. The difference between the realized and the potential will provide us with the unrealized, which is essential to find the reasons and policies that should be considered to get to Montenegro's full potential realization. The EPI for exporting aluminum not only to LME but to a region would be. $AAAIII = \Sigma i\in I,i\in IAAAiii$ (16) $AAArAA\ iA\ rirrAA\ iirAiriAiIII = 1 - \Sigma i\in I,i\Sigma\in Ii\in,iI\in,iI\in Ii,ii\in iI(xCiPiiIi,CiiPI\ iii)$ (17) $AAAiii = Ari.\ AAhArAii \sum iIRhWiWiiCxWiiiWiWiiIAiii\ Ari.\ AAiAiAiiAAiii$ (18) The market share is based on the current market share, while the growth of the exporter is explained relative to the world exports, and global tariff conditions are added as previously: $Ari.\ AAhArAii = A\ (xxiii\ , (\Delta AAAii), (\Delta\Delta GGCCPPwi)\ , x\ i\ rArii, AiiAAi\ rAriAA\ AiiAiriiir)$ (19) As far as the demand, we have total imports of a product, followed by the growth of the share and the importer's GDP growth. Tariff conditions remain unchanged from the previous representation: $Ari.\ AAi.ii\ AAiii = A(ii, (\Delta AAhArAiii), (\Delta AAAi), rAriAA\ Aii.\ , Air.\ AAA)$ (20) Graph 1: Export potential from Montenegro to the world Source: ITC, author's simulations, 2020. Graph 1 shows that aluminum not alloyed-unwrought, electrical energy, and wine of fresh grapes are the products with the most significant export potential from Montenegro to the World. Despite the utmost efforts to carefully check and process data through this methodology, the Montenegrin economy and country experts' in-depth knowledge remains to be further examined. Whole raw hides follow it, then split raw hides & skins, coniferous wood, housing for machinery, swine meat, whole raw hides and skins of bovine, bars and rods of alloyed steel, medicaments containing antibiotics, beech sawn, and beer made from malt. As we see from Table 4, the untapped potential (UP) of electrical energy in absolute terms is 91.4$ million. The supply capacity remains to be further developed, and the main demanders are Serbia, Bosnia and Hercegovina, and Hungary. The closest export links for electrical links are with Albania, while Italy remains the market with the highest demand potential for electrical energy. 140 90.00% 120 80.00% 100 70.00% 80 60.00% 50.00% 60 40.00% 40 30.00% 20 20.00% 0 10.00% 0.00% EP AE UP % of UP Figure 4: Montenegro export potential, actual export, and untapped potential Source: Author's calculations. Based on the expected calculations, Montenegro has an export potential of electrical energy towards Serbia of 39.5$ million, Bosnia and Herzegovina 13.1$, and Hungary 9.8$. We have included only 12 products in our representative study, Table 3, summing an untapped export potential of 186.9$ million. Graph 2: Sub-regional export potential of aluminum for Montenegro Source: ITC, author's simulations, 2020. This unused export potential should be considered by policymakers to analyze further what can be done to improve the trade balance of Montenegro, hence better control inflation. On average, the percentage of unused potential reaches 59.78%, and it is confirmed in Figure 4 as well that the UP (the purple line) is around 60%. East Europe and Asia's participation in the UP is 48.61% on average, while the unused export potential towards EU & West Europe reaches 77.70%. The percentage goes further for the Middle East, reaching 84.83% on average. We see, from Figure 4, that the highest EP products are the first couple of products. Aluminum is the product with the best combination of the supply and demand out of Montenegro's products. Thus, aluminum is a product that has the best production line to get offered to the world. In the meantime, the world is asking for aluminum. Germany is one of the most significant export potential destinations of aluminum for Montenegro (as seen from Graph 2), with an unused potential of 10.4$ million, followed by Turkey, with untapped potential for Montenegro of 4.9$ million. We can notice that from Graph 2, the sub-regions have an enormous potential to export aluminum for Montenegro. EU & west Europe is the most significant regional potential, followed by East Europe and Central Asia. Montenegro has closest export links with Bosnia and Herzegovina, Albania, and Serbia. The Middle East could be further used with 4.9$ million. The total unused export potential of aluminum is 35.6$ million, as seen in Table 4. Towards Belgium remains an unused export potential of aluminum of 2.2$ million. The total export potential for EU & West Europe of aluminum, not alloyed-unwrought sums up to 19.6$ million. As seen from Table 4, fresh grapes wine has a tremendous unused potential to be exported to neighboring countries such as Serbia, Bosnia and Herzegovina, and the United Kingdom. It is East Europe & Central Asia with a possibility of 2.8$ million, and EU and West Europe of 5.7$ million. Whole raw hides, split raw hides & skins of bovine or equine animals have an unused export potential of 14.4$ million. Just towards Serbia, there is an unused export potential worth 5 million dollars, Bosnia

and Herzegovina 2.2, and Italy 4.8. the closest export links are with Bosnia & Herzegovina. Coniferous wood sawn sums a total of 9$ million of unused export potential toward the world, specifically 4.6$ million toward EU & West Europe, and 1.6$ with an untapped export potential toward East Europe & Central Asia. Housings for machinery also have a high export potential for Montenegro, totaling 7.6$ million, out of which 2.5 would be possible towards Hungary and 982,000$ to Germany. Maintaining price stability in Montenegro through governance of external and internal factors of inflation Table 4: Export potential from Montenegro to the world World EE & Central Asia EU & West Europe Middle East Prod. Code 271600 760110 220421 4101XX 4407Xa 848330 21019 410150 722840 300420 440792 220300 Product description Electrical energy Aluminum, not alloyed Wine of fresh grapes Whole raw hides Coniferous wood sawn Swine meat, cured Wholeraw hides Bars & rods Medicaments Beech Beer made from malt Housings for machinery EP AE UP % of UP 116 26.7 91.4 78.79% 92.8 84.1 35.6 38.36% 21.1 15.2 9 42.65% 17.2 2.8 14.4 83.72% 13.7 6.8 9.9 10.4 7.2 3.9 6.7 1.7 6.4 7.8 5.5 4.9 5.3 5.3 4.6 3.3 9.1 66.42% 7.6 76.77% 3.4 47.22% 5 74.63% 2.7 42.19% 4.4 80.00% 2.4 45.28% 1.9 41.30% EP 0.9804 0.16 0.82 83.67% 1.6 4 0.71 44.68% 1.7 1.3 0.65 37.99% 3.7 2.7 1.2 32.43% AE UP % of UP 88.4 23.2 65.3 73.87% 15.1 20.1 13 12.2 10.1 2.8 6.1 6.6 1.8 0.2 5.1 3.9 3.3 1.6 4.2 27.81% 2.8 21.54% 7.3 72.28% 1.6 26.23% 1.6 88.89% 1.3 25.49% 1.6 48.48% EP AE UP % of UP 25.7 3.5 24.2 94.16% 56.2 54.4 19.6 34.88% 1.1 2.6 0.44 39.73% 0.7 0.46 0.59 84.27% 6.6 1 6.2 0.05 4.7 0.12 6.7 7.6 2 0 2.9 0.11 3.6 6.5 3.1 0.92 5.7 86.36% 6.2 100.00% 4.6 97.87% 4.8 71.64% 2 100.00% 2.8 96.55% 1.2 33.33% 2.9 93.55% EP AE UP % of UP 1.5 0 1.5 100.00% 14.5 9.6 4.9 33.79% 0.06 0 0.06 100.00% 0.19 0 0.19 100.00% 0.64 0 0.62 97.14% 0.46 0 0.42 89.71% 0 0 0 100.00% 0.08 0 0.08 100.00% 1.2 1.2 0.03 2.22% 0.09 0 0.09 100.00% 0.14 0 0.13 95.07% 0.01 0 0.01 100.00% Source: ITC, author's calculations, 2020. 55 In Figure 4, we can visually observe the gap between actual and unused export, potentially actualized. The purple line is close to the first two products, while for the rest of the products, the gap is rather broad. 2.2.2. Product diversification index in Montenegro What other products could Montenegro produce? How many products Montenegro currently produces, or what is its export basket? This section will deal with potential products or rank of a new product in a given target market. Since we deal with potential futuristic products, we rank them based on the Product Space (PS) methodology, invented by Hidalgo et al. (2007)97. They studied the network of relatedness between products, or 'product space,' finding that higher-income products are densely connected, while lower- income products occupy a less connected periphery. Hidalgo et al. (2007) show that nations tend to move to items similar to those they are already specialized, allowing countries located in more connected parts of the product space to upgrade their export basket more quickly. The demand and market access conditions variables will be calculated in the same manner as in the EPI. The supply-side changes from EPI, based on the PS methodology, establish connectivity between exported products by all countries worldwide. The identified potential products, based on PS, are filtered against the availability of natural resources in the countries under analysis. Furthermore, two filters are applied. The first filter identifies the relevant climatic zones to produce and export certain goods. In case the climatic zone is not available as a natural resource, the product(s) stops being analyzed further. The second filter deals with the status of a landlocked country. If a country is suggested to diversify into sea-related products, it is then taken off because no other landlocked country has successfully exported such products. $[xxiiiii]$ = $\Sigma i(RRCCAAiiii{\cdot}iii \cdot iiiii\,)$ (21) $i\ i$ 97

Hidalgo, C.A., B. Klinger, A.-L. Barabasi, and R. Hausmann., The Product Space Conditions the Development of Nations, Science, 2007, 317(5837), 482-487. 103

As far as the identification of the opportunities for diversification of new products, the linkage between the current export products to new potential products is analyzed. The linkage is the new supply measure to indicate supply capacities of Montenegro: 2.3.2. Product space methodology This section will show the product space methodology on which we base our supply capacity measure in product diversification. Productive factors, such as capital, labor, human capital, and institutions, and on the other hand, the technological differences create externalities that further lead to accelerated growth.98 Developed countries have shown that they have a continuum in production, advancing with a product slightly different or just a different one that moves countries forward. Countries that specialize in producing, for example, aluminum, such as Montenegro, have already invested in the broad sense in this industry and specialized in manufacturing aluminum. The underlying productive factors are relatively specific to producing aluminum. For example, making shoes would require a different set of environments. In common sense, providing an aluminum chocolate foil for a company from Switzerland might be more related between aluminum and aluminum foil then

specializing in another product as making shoes for Gucci in France. We will study this pattern to show this relatedness and how countries diversify to a related or approximate good. Each country has some predetermined dispositions that can potentially bring into existence some products. For example, Montenegro's capabilities to produce aluminum are different from Serbia, for a straightforward fact of natural resources. Thus, these capabilities refer to anything needed to export aluminum, such as the infrastructure, soil, climatic conditions, experts, specialists, human resources, legislation, institutions, chamber of commerce, and anything that the country possesses to export a given product. Coming back to our example of aluminum and aluminum foil for chocolates, it becomes common sense that if Montenegro specialized in exporting aluminum, the set of capabilities it possesses overlaps intensely with the onset of skills needed to export aluminum foil. Therefore, it already has many things to export and aluminum or other 98 Klenow, P.

J., and A. Rodriguez-Clare., Externalities and Growth, National Bureau of Economic Research, Working Paper 196

11009, 2004. types of aluminum products. Thus, Montenegro is much more likely to diversify into aluminum chocolate foil or wheel's rim than into shoes, for example. So, from aluminum, Montenegro can start exporting aerospace, medical, transportation, automotive, and marine industries. It is more likely to continue to do that than to begin shipping manufactured shoes, fish, or other unrelated products to aluminum. So, we can say that Montenegro has a high density around aluminum and has already developed a comparative advantage in exporting aluminum. Conditional probabilities measure density. Thus, conditional probabilities between each set of commodities estimate the probability to export product k with CA, knowing that product l is already exported with CA. $\varphi iii = A\ (CCAA'i'iii)$, & $AAirirrii = \Sigma iC\Sigma Aivi'iiviiiii$ (22) Density measure puts together conditional probabilities. That is a weighted average of the CA. Thus, the density measures a

country's supply capacities as the average approximation to a country' s new potential export product. 210

Nevertheless, a country might be in very close proximity to a given good. The PS would suggest that the country has excellent ease of diversifying into this new product. Still, these exports might never happen in real life because a) it is not possible to physically export the good, because as we have noticed earlier it is based only on trade statistics and there might be specific problems related to trade statistics, b) insufficient demand, and c) severe market access conditions. Even though the supply capacity for a new potential export product and the demand for such products is high, it is not enough to realize this new product because of the low accessibility of market conditions. Thus, all components must be considered to implement a new potential diversified product to a target market. 2.3.2. Supply-side of the product diversification index The supply side, the density, is the first component of the PDI. The density measures the average proximity of a product of Montenegro to a new export product. The average proximity shows the linkages between products based on how often they are jointly exported by countries, with corrected and RCA dynamic. We normalize the density measure because it has a different range than the comparative advantages used as the EPI supply indicator. That is why we normalize the density measure to ensure that the scope of densities between the first and the diversified product is in conformity between the first and the last product in the EPI: $iidCAii1 - iidCAiiM\ AAirirri'i = AAirirriiiid\ Cdirirw\ ii1 - iid\ CdirirwiiM$ (23) to ensure that $CCWWiiiiiiiixxi'i'iiM1 = CCAAiiiiM1$ where1,...N are product ranks. Even though the density measure for a feasible diversified product is passed through two filters, it is not enough unless we demand such a product and the market access conditions. $AAAiii = AAirirri'i \cdot AAhArAii \cdot AAiii \cdot AiiArArAiii$ (24) In this case, instead of supply, we use densities that are not equivalent to CAs, and that is why we need to rescale these densities to ensure that the PDI reveals the capacity of the total export capacity and the aggregate demand of the product. The process is necessary because the PDI is initially computed for all products (exported and non-exported). Eventually, only new products or products with marginal export potential (< 200,000$ and < top 95% cumulative EPI share) are kept in the PDI. The scaling is done in two steps: $AAirirri'i' = AAirirri'i \cdot \Sigma\Sigma iiiiCPxCiIxiiiiii\ ,\ ri\ rhAr\ AAAi' = Ari\ ri\ AAirirri'i" = AAirirri'i' \cdot \Sigma\Sigma iiiiCPxCiIxi'iiiii\ ,\ ri\ rhAr\ AAAi" = Ari\ ri$ (25) (26) where x-exports, m-imports, i-exporter, j-market, k-product for diversification, and l- exported product. Equation (25) shows how we rescale our initial densities so that the total PDI of Montenegro would correspond to the total export capacity. Moreover, we rescale the densities so that the PDI corresponds to the

aggregate demand, the projected demand for this product. Thus, the final PDI is calculated by the given current exports of this anticipated product into the GDP growth. Therefore, our final PDI ranks are assigned by an equation that uses these rescale densities combined with the demand side: $AAAi'i'i = AAirirri'i" \cdot AAhArAii \cdot AAiii \cdot AiiArArAiii$ (27) The PDI as EPI is always computed at the final level of aggregation, so we calculate it by the exporting country, product, and target market. But from here, we can aggregate to identify, for instance, diversification opportunities in a particular region. The total demand indicator in Graph 3 corresponds to the side of the bubble. The easiness to trade between country i and j, is represented by the width of the line in the analytical graph, and the length of the line shows the supply side (the growth and the expected growth of the exporter comparative to the world). Montenegro's best options for export diversification in the world are crude sunflower-seed or safflower oil, oilcake of sunflower seeds, and sheep cuts bone-in frozen, as it can be noticed in Graph 3 by the length of the line of the first three potential diversified products. Graph 3: Product Diversification Rank of Montenegro to World Source: ITC, author's calculations, 2020. Montenegro finds crude sunflower-seed or safflower oil easiest to reach as the line length reaches the outer circle. Wheat and meslin seed (excl. durum) is the product that faces the most energetic demand potential globally, confirmed by the size of the light-green bubble. The world's import value in US dollars reaches 35.5$ billion. Bosnia and Herzegovina imports 74$ million dollars of wheat and meslin, and the applied tariff to wheat & meslin from Montenegro is 0%. While Indonesia imports wheat & meslin 2.2$ billion, and the applied tariff from Montenegro is 2%. Table 5: Product diversification rank of Montenegro Pro code Product description World Europe Product's divers. potential rank in MNE Asia Americas Pacific 151211 Crude sunflower-seed/oil 230630 Oilcake of sunflower seeds 20442 Sheep cuts bone in, frozen 10410 Live sheep 20443 Sheep cuts boneless, frozen 1001Xb Wheat (excl durum) & meslin 310420 Potass chloride for use as fertil. 70700 Cucumbers & gherkins, fresh 420510 Skins of sheep or lambs 120600 Sunflower seeds 160250 Prepared meat 721420 Bars of iron or non-alloy st 940190 Parts of seats 30314 Trout frozen 160232 Meat or offal of fowls 720711 Semi-finished p. of iron or st. 440791 Oak, sawn/chipped lengthwise 230210 Bran, sharps & res. of maize 150710 Crude soya-bean oil 102 Live bovine animals 151219 Sunflower-seed or sunfl. oil 310230 Ammonium nitrate 410411 Grains of hides & skins of bo. 230220 Beet-pulp 760120 Aluminum alloys, unwrought 2204XX Wine of fresh grapes 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 28 1 2 4 3 5 6 12 7 8 9 10 11 13 15 14 28 17 16 27 20 19 18 21 22 24 25 1 2 3 7 6 5 4 8 14 11 21 23 13 12 19 9 15 25 10 16 22 27 18 30 29 49 1 8 2 11 4 7 3 5 22 27 9 10 6 16 21 36 14 44 17 18 13 25 43 26 23 1 28 7 40 20 5 2 14 3 10 6 30 9 45 11 41 22 21 8 47 29 23 15 Source: ITC, author's calculations, 2020. Turkey also is in high demand for wheat, amounting to 886.1$ million, but the tariff is 65% from Montenegro for this product. Greece, Albania, and North Macedonia are in high demand, 192.1$, 43.5$, and 15.3$ million, respectively, for this product, and the applied tariff is 0%. The policymakers of Montenegro might consider this fact for further analysis. As we can notice from Graph 3, aluminum is in high demand from the world (the green bubble, product number 25), but the readiness for potential export diversification from Montenegro is not high estimated by the length of the line. The total value that the world imports aluminum is 27.5$ billion (bn). Germany imports 3.7$ bn, and the applied tariffs are 0%, while the United States imports 4.4$ bn with the applied tariff of 1%. Great potential for the diversified aluminum alloys-unwrought is imports from Hungary, Serbia, and Slovenia with 385.8$ million, 41.6$ million, and 146.2$ million, respectively. Potassium chloride for use as fertilizer faces quite strong demand potential in the world, confirmed by the size of the purple bubble (product number 7 in the above Graph), reaching 12.4$ billion, and the length of the line is half-way, meaning the potential of potassium chloride supply to diversify further the product is quite ready. China, Brazil, and Indonesia are in high demand importing for potassium chloride, amounting to 1.8$ bn, 2.1$ bn, and 734.7% million, respectively. Product diversification rank of Montenegro to the world, Europe, Asia, America, and Pacific is shown in Table 5. Crude sunflower-seed or oil remains product number 1 ranked for all regions and the world, while the other products change ranks for different regions. The EPI and PDI both consider the aluminum products as a potential that policymakers might take for further in-depth analysis. Thus, the question is: what if aluminum is processed further by Montenegro, and how it would impact its economy. 2.3.Internal determinants of inflation in Montenegro The efficiency and effectiveness of monetary policy under the convergence criteria as the one proposed by the CBCG is based on appropriate forecasting performance and impulse responses (causality) of internal variables of inflation, assisting central policymakers in designing correct macroprudential actions. Technological progress is a variable affecting shadow economies and, consequently, the labor market. Shadow economies induce developing countries to present a broader set of tax basket, increasing the prices set by firms and wage setters, thus higher inflation. In the meantime, the structural change of technological progress affects the labor market's expectations and, consequently, inflation. Therefore, economic freedom is an essential variable in our further analysis and its impact on Montenegro's inflation. The economic freedom, e-government development index99 (EGDI), capital stock, human capital, employment, and GDP will be used as critical

internal factors contributing to anchor inflation in model 2. There are many different services that citizens and businesses seek from their governments, and it appears as though the number of functions available online grows annually. However, the most recent survey of those services deemed by the European Commission (EC), as the 20 basic services of e-government (eGov), had not been conducted since 2011.100 Table 6: 20 eGov services for citizens and businesses 20 Basic eGov services Services for Citizens Services for

Businesses Income Taxes Social Contribution for Employees Job Search Corporate Tax Social Security Benefits VAT Personal Documents Registration of a New Company Car Registration Submission of Data to the Statistical Office Application for Building Permission Custom Declaration Declaration to the Police Environment-related Permits Public Libraries Public Procurement Birth and Marriage Certificates Enrollment **in Higher Education Announcement of Moving Health-related Services** 27

Source: Blinn, 2014, pp. 2-3. Therefore, it was the primary goal to assess the current status of these basic services provided via the web portal www.euprava.me in Montenegro, because it was stated in the 2010 action plan that: "Electronic administration portal is a tool for government 99 United Nations, E-Government Knowledgebase, https://publicadministration.un.org, accessed, March 13, 2020. 100 European Commission, Digitizing Public Services in Europe: Putting ambition into action, eBook, 28, 2011 institutions and represents a single point where electronic public services offered by state administration authorities can be found."101 2.3.1. EGov benchmarking methodology One of the most often encountered issues when utilizing a benchmarking study is developing the scoring criteria and determining each question's weighting.102 The scoring metric of Blinn et al. (2008) was used to evaluate government to business (G2B) and government to citizens (G2C) services provided in Montenegro. 2.3.2. Rating Criteria This section analyzes the 20 basic eGov services across 17 criteria, sub-divided into four categories for investigation. Each measure was then assigned an associated weight depending on its perceived economic importance103 (Appendix 1 at the end of the dissertation gives elaborate scoring criteria, categories, and weighting). 2.3.3. Maturity of eGov services in Montenegro West (2004) developed a four-stage maturity model of eGov and included 1,813 United States (US)

government web sites in 2000, and a follow-up study of 1,680 government web sites in 170

2001104. This maturity model can be graphically portrayed as in Figure 5 below. Bill-board Partial-service Interactive Delivery One stop shop democracy Figure 5: EGov maturity model Source: Author's calculations. 101 Montenegro, Montenegro Action Plan: Open Government Partnership, 2104. 102 Blinn, N., F. Hogrebe, R. Lange, M. Nüttgens., "Benchmarking study on municipal portals: A Survey of G2B-Services in European capitals and large cities," Universität Hamburg, Arbeitsberichte zur Wirtschaftsinformatik, 2008, 4, 6. 103 Appendix 1: Evaluation Criteria of eGov services. 104

West, D. M., "E-Government and the Transformation of Service Delivery and Citizen Attitudes," **Public Administration Review, 2004, 64(1), 15–27.** 279

In Figure 5, we see that a web portal is mainly used for posting information during the first stage of maturation. The "one-stop-shop" stage marks full online availability and is characterized by the user's ability to accomplish tasks at a single location. The fourth and final stage is "interactive democracy." Notifications are pushed to the user based upon personal timelines, and feedback forms are utilized to continue to tailor the site to suit the user's needs. According to Fath-Allah et al., (2014), in their study on eGov maturity models, "many government agencies have mastered the first and second stage, while few government web sites have achieved the 3rd and 4th stage"105. 2.3.3.1. EGov portal of Montenegro The Ministry for Information Society and Telecommunications has opened one world wide web page, www.euprava.me106. The web page clearly shows the »Individual«, »Business«, and »Public Administration« services and sub-services for each category. 2.3.3.2. Calculation of values per

basic service With a valid model in hand, the research evaluates the web portal utilizing the Mystery Shopper approach.107 Each service represented a task the researcher needed to accomplish. The eGovernment web portal was utilized as if the researcher were an average user attempting to complete their assigned task. This exercise resulted in the assignment of points based on the above criteria to an evaluation matrix. These points were then multiplied by the weight factor to achieve the final score for each of the basic services. Following the calculation of individual scores, the average score for G2C and G2B services was calculated. 105

Fath-Allah, A., **L.** Chikhi, **R.E. Al-Qutaish, and A.** Indri., "E-Government Maturity Models: A Comparative Study," **International Journal of Software Engineering & Applications,** 182

2014, 5(3), 71-91. 106 Government of Montenegro, Ministry for Information Society and Telecommunications, 2019. 107 Mystery Shopper note. 2.3.3.3. Maturity of G2C and G2B services in Montenegro In Figure 6, it is noticed that G2C services in Montenegro are less mature than G2B. Furthermore, the distribution of G2C services is not equitable across the spectrum of services. The standard deviation among the group of G2C services is 21,53%. Clearly, this number is mostly affected by those areas which remain entirely undeveloped, such as the announcement of moving. While several services have achieved a degree of maturity that enables online activity, and it raises the question of why other services remain either significantly under-developed or completely undeveloped. It should be noted that there exist areas where scores reflect substantial investment on the part of the government to reach consumers. The more apparent regions are Income Taxes and Job Search. Income Taxes Public Procurement 80% Job Search Envir. Permits 70% 60% Social Security Ben. Custom Declaration 50% Pers. Documents 40% Subm of Data 30% 20% Car Registration 10% Reg. of a Company 0% Building Permission VAT Police Declaration Corporate Tax Public Libraries Soc. Contr. for Empl. Birth & Marr. Cert. Health Services Enr. in Higher Ed. Announ. of Moving Figure 6: Maturity level of G2B and G2C eGov services in Montenegro, 2017 Source: Author's calculations. Looking at G2B services, we again see a wide disparity between the maturities of services. Despite the conspicuous absence of an undeveloped category, the standard deviation for the data is 20,29%. Once again, services exist, such as VAT and Corporate Taxes, which have achieved maturity levels that suggest full interaction and the ability to complete a transaction online. However, other services such as Social Contribution and Customs Declarations make maturity levels that indicate they are still very much in the "read-only" phase. These facts might be taken elaborately into consideration by policymakers in relatedness with economic freedom, which will be one of the critical variables down the lines since economic freedom variable is measured based on 12 quantitative factors: a)

Rule of Law (property rights, government integrity, judicial effectiveness), b) **Government Size (government spending, tax burden, fiscal health),** c) **Regulatory Efficiency (business freedom,** labor **freedom, monetary freedom),** and d) **Open Markets (trade freedom, investment freedom, financial freedom)** 74

108. We will see the interconnectivity among eGov, economic freedom, and inflation later. It is interesting to note that those areas where the service involves financial transactions appear to be most developed. 2.3.4. Comparison of G2C and G2B services in Montenegro Observing the maturity of eGov services within the confines of G2B and G2C, it is no imperative to compare the findings of the research regarding the sophistication of these categories of services against each other. The study indicated that G2C services have a 40% maturity level, while G2B services demonstrated a 65% maturity level. The maturity level shows apparent favoritism towards the development of G2B services. The analysis includes additional data from Djurickovic (2013) study for comparative purposes.109 It is essential to emphasize that these studies were conducted utilizing different evaluation criteria and a different maturity model. The results should not be used to draw quantitative conclusions. Instead, these results are to be used to compare that regardless of the evaluation model utilized, the data still indicates that G2B and G2C services are in the same level of maturity and the difference in the maturity levels between G2B and G2C are relatively constant. However, this information runs contrary to the most recent United Nations eGovernment Survey 2018110, where Montenegro is ranked 58th and with a high 108 The Heritage Foundation, www.heritage.org, accessed, September 25, 2019. 109 Djurickovic, T., "Analyis of EGovernment Services

as a Tool for Measuring the Digital Development of Montenegro," Facta Universitatis - Series: Economics and Organization, 2013, 10(1), 65-76. 110

United Nations Department of Economic and Social Affairs, United Nations E-Government Survey 223

2018 Survey, Accessed Sep 25, 2019, 33-34. level of electronic government development index (EGDI). Further review of this same survey explicitly notes that the improvement in the EGDI of Montenegro primarily resulted from investments made in G2B services.111 The difference between the results of the two findings can most likely be attributed to the difference in the evaluation criteria. While both the research of this study and the Djurickovic (2013) study focused on providing the 20 basic eGov services, the United Nations survey incorporates many additional criteria in evaluating eGov maturity, including multiple approaches based on infrastructure.

Legal production of goods and services are hidden **from** government **authorities** to avoid payment **of** 146

taxes, social security contributions, minimum wages (safety standards), etc. The EGDI is a weighted average on three most important dimensions of e-government, namely: a) online services

scope and quality (Online Service Index, OSI), (2) telecommunication infrastructure **development status (Telecommunication Infrastructure Index, TII), and** (3) **inherent human capital (Human Capital Index, HCI):** 140

$AAAA$ = 3 ($AAAiiiiWiixWW$ + $AAAiiiiWiixWW$ + $AAAiiiiWiixWW$) 1 (28) Productivity growth has not increased in line with the expectations of firms. The workers in Montenegro ask for larger wages (high expectations). Still, the producers cannot afford it (productivity growth not in line with workers' expectations), increasing unemployment, and as a result affecting inflation. Technological progress is neglected so far, and its structural economic change should be considered to forecast and govern inflation through economic shadows and equilibrium in the labor market. 2.3.2. Economic freedom The Heritage Foundation (2019)

measures economic freedom based on 12 quantitative and qualitative factors, grouped into four broad categories, or pillars, of economic freedom112: **1. Rule of Law (property rights, government integrity, judicial effectiveness) 2. Government Size (government spending,** fiscal health, **tax burden)** 38

111 Ibid. 112 The Heritage Foundation, www.heritage.org, accessed, November 4, 2019.

3. Regulatory Efficiency (labor **freedom,** business **freedom, monetary freedom) 4. Open Markets** (investment **freedom,** trade **freedom, financial freedom)** Protection **of** 38

property rights, financial freedom, judicial effectiveness, fiscal health, and government spending remains the next institutional commitment step. Massive investments in infrastructure have created gaps in budgetary sustainability. .78 Business Freedom .76 .74 .72 .70 .68 .58 .60 .62 .64 Overall .56 Government Spending .52 .48 .44 .40 .36 .32 .28 .58 .60 .62 .64 Overall .84 Monetary Freedom .82 .80 .78 .76 .74 .72 .58 .60 .62 .64 Overall .66 Financial Freedom .53 .52 .51 .50 .49 .48 .47 .58 .66 Investment Freedom .8 .7 .6 .5 .4 .3 .58 .66 Property rights .60 .55 .50 .45 .40 .35

.58 .60 .62 Overall .64 .60 .62 Overall .64 .60 .62 Overall .64 .66 Fiscal Health .47 .46 .45 .44 .43 .42 .58 .66 Judical Effectivness .53 .52 .51 .50 .49 .48 .47 .58 .66 Tax Burden .94 .92 .90 .88 .86 .84 .82 .58 .60 .62 .64 Overall .60 .62 .64 Overall .60 .62 .64 Overall .48 .66 Government Integrity .44 .40 .36 .32 .58 .66 Labor Freedom 1.0 0.9 0.8 0.7 0.6 0.5 .58 .66 Trade Freedom .85 .84 .83 .82 .81 .80 .58 .60 .62 Overall .64 .60 .62 Overall .64 .60 .62 Overall .64 .66 .66 .66 Figure 7: Twelve quantitative and qualitative factors of economic freedom, 2009-2017 Source: Author's calculations in EViews 11. As we can observe from Figure 7, business freedom, government integrity, investment freedom, labor freedom, monetary freedom, tax burden, and trade freedom vs. overall economic freedom index have prospered since 2009. For instance, comparing business freedom vs. total economic freedom, significant progress can be observed. Arnason (1999) says: "property rights are fundamental to what is generally regarded as economic progress, and with well-defined and enforced property rights surplus production becomes possible.113" The higher quality of the property rights are, the more 113 Arnason, R., "Property Rights as a Means of Economic Organization," Conference Use of Property Rights in Fisheries Management, 1999. effective and efficient the economy will be. In a globalized world, trade can be almost unimaginable without the well-defined property rights of transferable goods and services114. For example, buying online shares of KAP should be well-defined for and by the KAP. Without clearly stated policies, economic activity is very limited. A free market will generate full economic efficiency and optimal economic growth115116. A free market without clearly defined property rights cannot function, making the property rights the core of a free market117. The characteristics of property rights are elaborated in Scott's article (1996), which presents the following four attributes of property rights118119120: ? Exclusivity – The right to utilize and a resource without interference. ? Duration – The length of time the owner can use the resource. ? Security – The strength of the entitlement. ? Transferability – The extent of the entitlement. The combination of the characteristics of property rights is multidimensional121. The relation of security and duration might be high, e.g., 1, but the relationship between security and transferability might be lower than 1. Scott (1988) constructed an aggregate numerical measure of the quality of property rights122. In our case, it can help 114

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Barro, R. X. Sala-i-Martin. Economic Growth. New York: McGraw-Hill, 1995. 239

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Smith, A. An Inquiry into the Nature and Causes of the Wealth of Nations. Edition by E. Cannan 1977. Chicago: University of Chicago Press, 7

1776. 122

Scott, A.D. Conceptual Origins of Rights Based Fishing. In Neher et al. (eds.) Rights Based Fishing. Kluwer Academic Publishers, Dordrecht, 7

1988. policymakers judge the economic efficiency of an institutional framework of Montenegro's activity. Scott (1988) came up with the following quality measure (Q): $A \equiv (\prod Ii{=}1\ riWi) \cdot (r1 + \sum Ii{=}I{+}1\ r2{,}i \cdot riWi)$ (29) Let us say, for example, that the security property right characteristic score for Montenegro is 0.95, exclusivity 0.95, duration 0.9, and transferability scores 0.1. Weights are as following: $r1$ = 0.5 $AiA\ r2$ = 0.5. What's the Q: $A \equiv A\alpha \cdot A\alpha \cdot A\alpha\ (r1 + r2 \cdot A\alpha)$ = 0.5130 (30) Even though the security, exclusivity, and duration score very high, the Q-value of the property rights scores only 51.3% of the 100% potential because of the low transferability. 2.3.6. Capital stock, human capital, and employment Capital stock denotes the

gross fixed capital formation (% of GDP). The gross fixed capital formation, 336

linked to the FDI drive model of economic growth, summarizes the demand side's impacts. The tourism, house sales, banking sector, and structural reforms mirror large FDI inflows in Montenegro. The just mentioned factors boosted domestic demand and increased bank deposits. Human capital time series comprises higher education employed, critical for keeping sustainable growth, while the employment to the labor force (vital for inclusive and sustainable development).

In contrast, human capital and employment are related to effects on 2

Montenegro's economy's supply side123.

We consider employment and human capital on the supply side. On the 2

other hand, we use capital stock to measure the demand side. Let's examine the human capital and employment/unemployment interconnectivity. 2.3.6.1. Unemployment and wage inequality in Montenegro Technological progress is a potential cost of unemployment for workers with inadequate skills, while it represents potential progress for those with the right skills. It leads to the 123

Fabris, N., "Impact of the Global Financial Crisis on the Labour Market and Citizens Social Status in Montenegro", **in the book The Social Consequences of the Global Economic Crisis in South East Europe, London School of Economics,** 25

2013, 131 – 143. inequality of wages. Let's see what happened in Montenegro's market since 2012, since that's the only available data for different sectors relative to education. accomodation_netincome 410 405 400 395 390 385 380 accomodation_netincome 410 405 400 395 390 385 380 accomodation_netincome 410 405 400 395 390 385 380 accomodation_netincome 410 405 400 395 390 385 380 2,850 2,950 3,050 3,150 1,300 1,500 1,700 1,900 160 200 240 280 320 5 10 15 20 25 30 Graduates Specialists masters of science Doctors of science Figure 8: Accommodation and food services net income to graduates, specialists, masters, and doctors of science. Source: Author's calculations in EViews 11. Figure 8 shows the evolution of net income for different education levels from 2012 to 2017. Each of the regression lines shows the evolution of Accommodation and food service activities' net income for a given level of education: graduates, specialists, masters of science, and doctors of science. We can notice that the average net income without taxes and the accommodation and food service activities sector's contributions is around 385€ from 2012 to 2017. For the first three levels of education, the regression line shows a downward slope, while only doctors of science for this sector show an upward trend. The demand for graduates, specialists, Master of Science has steadily fallen over time for this sector, whereas doctors of science have seen their net income rise consistently. 360 360 360 360 administrative_netincome 350 350 330 administrative_netincome 350 350 340 340 340 340 330 administrative_netincome 330 330 320 320 320 administrative_netincome 320 310 310 310 310 2,850 2,950 3,050 3,150 1,300 1,500 1,700 1,900 160 200 240 280 320 5 10 15 20 25 30 Graduates Specialists masters of science Doctors of science Figure 9: Administrative and support service activities net income to graduates, specialists, masters, and doctors of science. Source: Author's calculations in EViews 11. This specific sector's overall conclusion seems that Montenegro's demand relative to the education level is not upward. It implies that the sector of accommodation and food service activities does not have a high demand for education and that this sector is not related to net income inequality. If we turn to Figure 9, the only master of science has seen their wages rise steadily. The number of graduates, students who finished faculty, increased slowly from 2012 to 2017, averaging to 3000 graduates, whereas their demand in the market shows a negative relation to net wages. The labor market was in demand for masters of science, and the demand was higher than the supply, thus increasing the net wages. 480 480 480 480 construction_netincome 460 460 460 460 440 construction_netincome 440 420 construction_netincome 440 440 420 420 420 400 400 400 construction_netincome 400 380 380 380 380 2,850 2,950 3,050 3,150 1,300 1,500 1,700 1,900 160 200 240 280 320 5 10 15 20 25 30 Graduates Specialists masters of science Doctors of science Figure 10: Construction net income to graduates, specialists, masters, and doctors of science. Source: Author's calculations in EViews 11. Net income for construction graduates, specialists, and Ph.D.'s increased smoothly, but for masters of science, we see a smooth decrease in Figure 10. The highest proportion of increase belongs to graduates since large governmental projects were going on in Montenegro since 2012. financial_netincome 920 910 900 890 880 870 860 financial_netincome 920 910 900 890 880 870 860 financial_netincome 920 910 900 890 880 870 860 financial_netincome 920 910 900 890 880 870 860 2,850 2,950 3,050 3,150 1,300 1,500 1,700 1,900 160 200 240 280 320 5 10 15 20 25 30 Graduates Specialists masters of science Doctors of science Figure 11: Financial and insurance net income to graduates, specialists, masters, and doctors of science. Source: Author's calculations in EViews 11. The financial and insurance sector has seen an increase for specialists and Ph.D.'s and a smooth increase for graduates, while masters of science show a decrease in net wages. 520 520 520 520 total_emp_netincome 510 510 510 510 500 500 500 500 490 total_emp_netincome 490 total_emp_netincome 490 490 480 480 480 total_emp_netincome 480 470 470 470 470 2,850 2,950 3,050 3,150 1,300 1,500 1,700 1,900 160 200 240 280 320 5 10 15 20 25 30 Graduates Specialists masters of science Doctors of science Figure 12: Total net income to graduates, specialists, masters, and doctors of science. Source: Author's calculations in EViews 11. A lot of banks and insurance companies entered into the market of Montenegro, increasing the demand for specialists and Ph.D.'s averaging from 860€ to 920€. Figure 12

represents all sectors' total net income relative to graduates, specialists, masters, and PhDs. Only masters lack in the increase of demand in the labor market, signalizing the policymakers that this high-skilled group should be driven further in the market because the overall economy of Montenegro does not utilize their potential. 2.4.Demand-pull and cost-push ingredients of inflation One of the models that analyzes inflation determinants in this research will incorporate aggregate demand and aggregate supply factors: exchange rate, broad money (M2), wages, and productivity index124. The nominal exchange rate of euro

movements can influence Montenegro domestic prices through direct and indirect channels. In the direct channel, exchange rate movements can affect domestic prices through changes in the price of imported finished goods and imported inputs. In 10

the

indirect effect, the exchange rate depreciation affects the net exports, which in turn influences the domestic prices through the change in aggregate demand, putting upward pressure on domestic prices. 10

For example, Ikechukwu Kelikume et al., (2017) find that in Nigeria, the effect of innovation to the exchange rate in 12- month dynamics is: a) increases price level by 50%, b) depreciation increases the price 124

Bruno, M., Crises, Stabilisation, and Economic Reform: Therapy by Consensus. Oxford: Clarendon Press, 216

1993. level by 41%, and c) appreciation impacts the price level by 14%125. Hooper and Lowery

(1979) report that the various models they examined indicate that a 10% depreciation in the dollar, other things constant, produces a long-run increase in consumer prices in the order of 0.8% to 1.5% 70

126. Whitt, Koch, and Rosensweig (1986)

find that a 10% depreciation of the dollar produces a 1.6% increase in the price level after one year and a 4.6% increase after four 89

years127. Real appreciation adversely affects exports128129130131132. The fiscal policy of Montenegro and productivity growth are highly related to unemployment and inflation. Labor productivity determines the relative prices: the generosity of unemployment and antitrust legislation, on the other hand, refers to real wages and, consequently, to unemployment and inflation133. Differences between output and potential output are related to the deviation of unemployment from its natural rate and inflation change. In an enlarged Europe,

besides the catching-up process, the cyclical conditions and regulated prices are important determinants of the inflation 3

rate134. 125 Ikechukwu, K., F. Alabi, and A. Friday., "Nigeria Consumption Function – An Empirical Test of the Permanent Income Hypothesis," Journal of Global Economics, Management and Business Research, 2017, 9(1), 17-24. 126 Hooper, P., and B. Lowrey.,

Impact of the dollar depreciation on the U.S. price level: an analytical survey of empirical estimates, Washington **Board of Governors of the Federal Reserve System, International Finance Discussion Papers** 82

128, 1979. 127 Whitt, J. A., P. D. Koch and J. A. Rosensweig., "The dollar and Prices: An Empirical Analysis," Economic Review, 1986, 71, 4-18. 128

Chen, R., G. M. Milesi-Ferretti, and T. Tressel., "External Imbalances in the Euro Area," **IMF Working Paper,** 2 **/236,** 227

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Easterly, W., National Policies and Economic Growth: A Reappraisal. In Handbook of Economic Growth, ed. P. Aghion and S. Durlauf. Amsterdam: Elsevier, 3

1015– 56, 2005. 130 Coudert, V., C.

Couharde, and V. **Mignon.,** "On Currency Misalignments within the Euro Area," **Review of International Economics, 2013, 21(1), 35–48.** 253

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Égert, B. and A. **Morales-Zumaquero., Exchange rate regimes, foreign exchange volatility and export performance in Central and Eastern Europe: Just another blur project?, BOFIT Discussion Papers, No. 8.,** 3

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McKenzie, M. D., "The Impact of Exchange Rate Volatility in International Trade Flows," **Journal of Economic Surveys, 1999, 13(1), 71-106.** 248

133 Blanchard, O., Macroeconomics, 7th ed. Harlow, UK: Pearson, 2017. 134

Égert, B., Real Convergence, Price Level Convergence and Inflation Differentials in Europe, CESIFO Working Paper, No. 2127, 3

2007. Imported inflation through food and oil prices, the internal excise tax on alcoholic beverages and tobacco, and accommodation services' costs impacted inflation the most in 2017135. Our research will use the deposits to private sector and demand deposits to measure broad money (M2), as defined by the IMF136. The money supply (M2) is an exogenous variable, in this case, being formed through capital and current account. Since Montenegro is an open economy, it can impact inflation. Low-interest rates change the money supply, affecting the consumers, investments, and aggregate demand: output. The implication is that it increases economic activity and inflation. Moreover, we will use wages to measure their impact on inflation. First, if wages are more than productivity growth, they impact inflation: cost-push factor. Secondly, the purchasing power of clients affects aggregate demand through money expansion: demand-pull factor. 2.5.Maintaining price stability in Montenegro Recently, there has been a direction by researchers to consider financial stability as a central bank target. At the time being, only the Central Bank of Montenegro has explicitly stated financial stability as its primary goal, while many central banks have financial stability as a secondary goal. Therefore, we can state that Montenegro is ranked as a leader in implementing modern monetary policy solutions.137 In 2010, Montenegro achieved the EU candidate status, and since June 2012, has been in the process of negotiations. In the final phase of the negotiations, Montenegro's present use of the euro will be addressed. From accession as a Member State, Montenegro will participate in the economic and monetary union with a derogation. Following an 135

Government of Montenegro, Economic Reform Programme for Montenegro, 2018-2020. 76

136 International Monetary Fund (IMF)., Monetary and Financial Statistics Manual, 2010. 137 Zugic, R., and N. Fabris., "Financial Stability as the Goal of Central Banks," Current issues of the Montenegrin economy, 11-30. evaluation of its fulfillment of the necessary conditions and the Council decision to this effect, Montenegro shall join the euro area138. According to the Maastricht convergence criteria requirements for entering the EU (European Commission, Convergence Report, 2018),

the inflation rate must be stable and low **as a prerequisite to joining.** Article 87v of **the** 264

Law of the Central Bank of Montenegro says:" The primary goal of the Central Bank of Montenegro

is to maintain price stability, and that **without prejudice to the** achievement **of the** 51

objective referred to paragraph 1 of Article 87v, the Central Bank shall support the general economic objectives policy of the European Union, to contribute to the

achievement of the European Union **objectives set out in Article** 3 of **the** Treaty on **European** 143

Union.139" By opening Chapter 17 – Economic and monetary policy negotiations, the European Union cautiously monitors the advancement and implementation following the acquis throughout the negotiating process140. The benchmark for the chapter is: Montenegro has embraced

the required constitutional change. It has to ensure that the main **objective of price stability is defined in compliance with:** (i) **Articles 127 (1) and** 45

(ii) Article

282 (2) of the Treaty on the Functioning of the European Union141. Montenegro has to fit its 81

national legislation in line with the EU law to adopt the euro: meet price stability and ensure the country's economic convergence. Convergence criteria report that the government has to have

a price-performance that is sustainable, and the average inflation rate should not be higher than 1.5% of the three best performing Member 1

States142". We find there is still sufficient room for inflation examination, even though inflation has been analyzed to a great extent. The CBCG used the autoregressive integrated moving 138European Union, "General EU Position adopted by the Council," 2012, AD 23/12, CONF-ME-2, 13-14. 139 Central Bank of Montenegro, "Law of the Central Bank of Montenegro," Official Gazette of Montenegro, 2017, No. 40/10, 46/10, 6/13, 70/17. 140

European Commission, "Convergence Report. Institutional Paper 078," European Economy, 2018, ISSN 2443-8014. 156
141European Union, "Consolidated version of the Treaty on the functioning of the European Union," Official Journal of the European Union, 2012, C 326/47.

142European Commission, "Convergence Report. Institutional Paper 078," European Economy, 2018, ISSN 2443-8014. average (ARIMA) model (2,1,2), in 2018, for forecasting inflation in Montenegro143. This dissertation's novelty uses a combined prediction (VAR and Bayesian VAR) for the Montenegrin economy. This study employs high – dimensional dynamic models. It examines time-series data from 2006:1 – 2017:12. It examines and compares the performance of different forecasting combination puzzles of inflation144145. Since many factors affect Montenegro's inflationary pressures, we estimate recursively three VAR and three Bayesian VAR models. The Bayesian VAR models give a useful solution to the concerns of proliferation worries. Then, we combine the VARs and get two more RMSEs. We proceed to combine Bayesian VARs and get two more RMSEs. Moreover, we compare the combinations, using equal and MSE weights, and get the best RMSEs. In the meantime, we find causality among variables using impulse responses and variance decomposition. At the end of December 2017, the BVAR MSE combination inflation forecasting figures 2.661%, while the BVAR average combination inflation figures 2.822%. The average weights approach of standard VAR figures 1.537%, and the inverse of standard VAR MSE figures 1.516%. Standard VAR combination models, average and relative performance, show forecasting performances that are sustainable and fulfill the convergence criteria. The average rate of three best performing Member states

is 0.4 percentage points and, adding 1. 5 percentage points, the reference is 1.9 6

p.p. Even though BVAR combination models, average and relative performance, end up way off compared to the convergence EU criteria, incorporation of these Bayesian combination models is significant for the CBCG146. The above results enable forecasters to address, evaluate, compare, and exploit the strength of using the high-dimensional dynamic composite forecast models. 143 Central Bank of Montenegro, "Price Stability Report," Working Paper 2018. 144

Hendry, D. F., and M. P. Clements., "Pooling of Forecasts," **Econometrics Journal,** 2002, 5, **1-** 62

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A.S., J. Mitchell., and S. P. Vahey., "Combining forecast densities from VARs with uncertain instabilities, "Journal of Applied Econometrics, 2010, 250(4), **621–634.** 11

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Diebold, F. X. and P. Pauly., "The use of prior information in forecast combination," **International Journal of Forecasting,** 23

1990, 6, 503-508. 3. Data Methodology The recursive and non-recursive SVAR identification, panel data analysis, and forecast combination puzzle of inflation will be applied, using an equal and inverse MSE weights approach. Georgiev et al., (2017)147 highlight characteristically that

tests for stochastic trends or persistence have been based on ordinary least squares (OLS) estimation, achieving optimal power properties under normality. 138

Koutsoyiannis148 (1997) marks out that OLS is one of the most commonly used methods in estimating relationships in econometric models, and it produces the best, linear, unbiased estimates (BLUE). This need stems from the fact that if data from a time series is non -stationary, the OLS regression performed on variables with unit root would be "spurious"149 or "dubious."

A series is stationary if: i) **its mean and variance are constant over time, and** ii) **the value of covariance between** the **two time periods depends only on the distance or lag between the two periods and not the actual time,** where **the covariance is** 39

computed150. Several tests can be used to test stationarity 151. Kovacic152 (1995) accents that once the time series are identified as non-stationary series, they should be tested whether they are co-integrated. Moreover, Maddala and Kim153 (1998) punctuate that the variables are co-integrated if they satisfy the condition that there are at least (k-1) co-integrating equations, i.e., stationary linear combinations of individually non-stationary variables. Several diagnostic tests have to be performed after the model is estimated so that all needed 147

Georgiev, I., P.M.M. Rodrigues, and R **.A.M.** Taylor., "Unit Root Tests and Heavy-Tailed Innovations," **Journal of Time Series Analysis,** 249

2017, 38(5), 733-768. 148

Koutsoyiannis, A., Theory of Econometrics: Introductory to Exposition of Econometric Methods. London: Macmillan 275

Publishers, 1997. 149

Granger, C. S .W.J. and P. Newbold., "Spurious Regression in Econometrics," International Journal of Social Science, 1974, 130

5(1),

111-120. 150 Gujarati, D., Basic Econometrics. New York: The McGraw–Hill, 322

2004. 151 Mladenovic, Z., and A. Nojkovic., Primenjena analiza vremenskih serija. Beograd: Ekonomski fakultet, CID, 2012. 152 Kovacic, Z. J., Analiza vremenskih serija. Beograd: Ekonomski fakultet, 1995. 153 Maddala,

G. S., and I-M. Kim., Unit Root, Cointegration, and Structural Change. New York: Cambridge University Press, 1998. 176

corrections or even different estimators can be employed if necessary154. Many factors impact the internal and external shocks of inflation in Montenegro, and we will include variables with a significant impact on inflation in Montenegro. First, we will analyze three different SVAR models: a. INF = LOGECOFREEDOM + LOGEGDI + CAPSTOCK + LOGHUMAN_CAPITAL + EMPLOYMENT b. INF = LOGEXCH + LOGMLOGW + PROD_IND_GRWTH c. INF = LOGOIL + LOGALEUR + UN + GDP_GAP We proceed with a combination puzzle of inflation, using equal and inverse MSE weights: d. 1. LS INF C INF(-1) INF(-2) LOGECOFREEDOM_SA(-1) LOGECOFREEDOM_SA(-2) LOGEGDI(-1) LOGEGDI(-2) CAPSTOCK

_SA(- 1) CAPSTOCK _SA(-2) LOGHUMAN_CAPITAL _SA(-1) LOGHUMAN_CAPITAL _SA(-2) EMPLOYMENT _SA(-1) 126

EMPLOYMENT_SA(- 2) GDP_GAP(-1) GDP_GAP(-2) DUM2009 DUM2014 2. LS INF C INF(-1) INF(-2) INF(-3) LOGEXCH(-1) LOGEXCH(-2) LOGEXCH(-3) LOGM(-1) LOGM(-2) LOGM(-3) LOGW(-1) LOGW(-2) LOGW(-3) PROD_IND_GRWTH(-1) PROD_IND_GRWTH(-2) PROD_IND_GRWTH(-3) DUM2008 DUM_2009M06 DUM_2011M03 DUM_2013M10 3. LS INF C INF(-1) INF(-2) INF(-3) LOGOIL

_SA(-1) LOGOIL _SA(-2) LOGOIL _SA(-3) LOGALEUR _SA(-1) LOGALEUR _SA(-2) LOGALEUR _SA(-3) UN _SA(- 126

1) UN_SA(-2) UN_SA(-3) GDP_GAP(-1) GDP_GAP(-2) GDP_GAP(- 3) DUM_2009M06_AL DUM_2011M03_AL DUM_2013M07_AL DUM_2013M10_AL The final step is panel data analysis of Montenegro, Serbia, Croatia and Slovenia: e. D(INF) = INF(-1) + CAPITAL_STOCK(-1) + EMPLOY(-1) + LOGEF(-1) + LOGEGDI(-1) + GDP(-1) +

D(INF(-1)) + D(INF(-2)) + D(INF(-3)) + D(INF(- 4)) + D(INF(-5)) + D(INF(-6)) + D(INF(-7)) + D(CAPITAL_STOCK(-1)) + D(CAPITAL_STOCK(-2)) + D(CAPITAL_STOCK(-3)) + D(58

CAPITAL_STOCK(-4)) + D(CAPITAL_STOCK(-5)) + D(CAPITAL_STOCK(-6)) + D(CAPITAL_STOCK(-7)) + D(EMPLOY

(-1)) + D(EMPLOY (-2)) + D(EMPLOY (-3)) + D(EMPLOY (-4)) + D(EMPLOY (-5)) + D(EMPLOY (-6)) + D(EMPLOY (-7)) + D(58

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(-1)) + D(LOGEF (-2)) + D(LOGEF (-3)) + D(LOGEF (-4)) + D(LOGEF (-5)) + D(LOGEF (-6)) + D(LOGEF(-7)) + D(LOGEGDI (-1)) + D(LOGEGDI (-2)) + D(LOGEGDI (-3)) 158

+ 154 Jovicic, M., Ekonometrijski metodi. Beograd: CID, Ekonomski fakultet, 2002. D(LOGEGDI(-4)) + D(LOGEGDI(-5)) + D(LOGEGDI(-6)) + D(LOGEGDI(- 7)) +

D(GDP(-1)) + D(GDP(-2)) + D(GDP(-3)) + D(GDP(-4)) + D(GDP(-5)) + D(GDP(-6)) + D(GDP(-7)) 129

3.1.Empirical time series analysis We will look at the time series and analyze them. Asteriou and Hall155 (2007) point out that the

starting point is to exploit the information we can get from a variable 117

in the time series econometrics framework. Analyzing one variable at a time will give us a better understanding of the original time series properties. A systematized econometric knowledge will be used as a deductive way of understanding the time series's behavior. Moreover, intuition will be needed to compete for the scientific comprehension of the time series's behavior. The time series are actual data used to analyze the general – stochastic – process of the facts drawn from a specific period. We can think of the stochastic process as a distribution of all possible outcomes that can occur over time156. As we move across time, we collect the data, and that constitutes observations. Each observation, for example Ai, Ai+1, Ai+2, etc., has its probability density function, and it is usually represented as bell curves. As we move across time, for example, from Ai … Ai+i, what happens to the probability distribution function is very important. In case the probability distribution function changes over time, the time series is not stationary. The whole distribution does not change across time for a stationary process, but we will concentrate on the covariance- stationary process. A stochastic process {ri:

t=1, 2, …} with a finite second moment [$A(ri2) <\propto$] is covariance-stationary if: i) $A(ri)$ is constant; ii) $AAr(ri)$ is constant, and iii) for any r, $h \geq 1$, 16

$Air(ri,ri+h)$) depends on h and not on t157. The covariance is only dependent on the distance between two observations, and it is the distance that matters. The mean and variance are constant and time-independent. Therefore, at time t and time $r + h$, the mean and variance should hold constant: 155 Asteriou, D., and S. G. Hall., Applied econometrics, 3rd ed. Basingstoke, United Kingdom: Palgrave MacMillan, 2015. 156

International Monetary Fund (IMF), https://www.imf.org/en/Data, 323

accessed, October 3, 2019. 157

Wooldridge, J. M., Introductory Econometrics: A Modern Approach. Ohio: South-Western, 72

2013. $A(Ai) = A(Ai+h) = \lambda$; $AAr(Ai) = AAr(Ai+h)$, $Air(Ai, Ai+h) = Air(Ax, Ax+h)$ (34) Understanding the behavior of the variables will be of high importance for forecasting the variables. 3.1.1. Identification of covariance-stationarity of the time series “You can observe a lot simply just by watching,” says Lawrence Peter "Yogi" Berra158. The very first thing we will do is graph the data and observe their movement. Seeing the graphical behavior of the mean, variance, and covariance will familiarize us with the data and their potential breaks. In case the mean, variance, or covariance do not hold, the variable is nonstationary. From an economic perspective, if the deviation does not turn back to its long-run equilibrium, the variable is nonstationary. The equilibrium condition would get the variable to its mean in the long-run in case of stationarity (in case it diverges for a certain period). The variance of the time series depends on time. As time expands, the variance increases. If time series are nonstationary, the pattern of residual autocorrelations does not decay159. In stationarity cases, the trend of residual autocorrelations (the

autoregressive - AR), moving average (MA), or autoregressive moving average (ARMA), models display a 297

sharp cutoff in partial autocorrelation function (PACF) and the gradual decay in ACF. The right hint of non-stationarity would be a slow decay of ACF in the case of an AR model160. Nonstationary time series have a statistically detectable change over time – trend. The trend can be deterministic (a nonrandom function of time) and stochastic (random trend – random walk and random walk with a drift)161: $Ai = \lambda + \alpha * r + ri$ (35) 158

Lawrence Peter "Yogi" Berra (May 12, 1925 – September 22, 2015) was an American professional baseball catcher, who later took on the roles of manager and coach. 100

159 Ouliaris, S., A.

Pagan and J. Restrepo., Quantitative Macroeconomic Modeling with Structural Vector Autoregressions – An EViews Implementation. 15

Institute for Capacity Development, 2018. E-book, available at https://www.eviews.com/StructVAR/structvar.html. 160

Stock, J.H., and M. W. Watson., Introduction to Econometrics, 4th ed. Boston: Pearson, 130

2019. 161

Greene, W. H., Econometric Analysis. Upper Saddle River, NJ: Pearson **Prentice Hall,**	24

2012. $Ai = Ai{-}1 + ri$ (36) $Ai = \lambda + Ai{-}1 + ri$ (37) In Equation 35, the deterministic trend is a function of a constant λ, a constant of time value α, and innovations r (assumed to be independently, identically distributed-white noise-iid). Equation 36 is a particular AR case with an autoregressive coefficient 1, so- called random walk, which varies over time. Besides, equation 37 has a drift added to equation 36, depending on both on its own lagged value $Ai{-}1$. In estimating a stationary model, such as ARMA, on a nonstationary variable, the consequences are that the distribution is non-normal, shocks do not die out, and test statistics are flawed (biasedness in coefficients will be present), and confidence intervals are not valid162. An AR(1) model can be represented as an MA(q)163: $Ai = \alpha 1 Ai{-}1 + ri$ (38) $Ai = \alpha 1(\alpha 1 Ai{-}2 + ri{-}1 + ri$ (39) $Ai = \alpha 12(\alpha 1 Ai{-}3 + ri{-}2) + \alpha 1 ri{-}1 + ri$ (40) $Ai = \alpha 1 iA0 + ri + \alpha 1\ ri{-}1 + \alpha 12 ri{-}2 + \alpha 13 ri{-}3 + \ldots + \alpha 1 i{-}1 r1$ (41) Ai is a function of innovations ri, $ri{-}1$, $ri{-}2$, $ri{-}3$, … , $r1$ and the impact of shocks will depend on the values of $\alpha 1$. For values of $\alpha 1 < 1$ the effect of shocks phases out, and the variable is stationary, while for values $\alpha 1 = 1$ the impact of these innovations permanently do not diminish and have equal weight $Ai = A0 + \sum ii{=}{-}01\ ri{-}1$. Therefore, the variable has a stochastic trend, summing up all shocks. Thus, the variance of the variable Ai equals $r * \alpha 2$, which is not constant but depends on time r. As a consequence of not diminishing the shocks, it makes the variable nonstationary. There is one more case when $\alpha 1 > 1$, when the effects of shocks keep increasing, but this case in real life does not happen. The rational roots theorem states that it has a polynomial with rational roots164. We keep looking at the factors of the constant, the leading coefficient, and all possibilities. Taking 162 IMFx, Institute for Capacity Development, Macroeconometric Forecasting, 2018. 163 Mladenovic, Z., and P. Petrovic., Uvod u Ekonometriju. Beograd: Ekonomski Fakultet, 2011. 164 King, J. D., "Integer roots of polynomials," Mathematical Gazette, 2006, 90(519), 455-456. all possible combinations of the elements of the constant dividing by the leading coefficient factors gives all possible rational roots of the polynomial165. A root is a number, and if we plug into the polynomial equation, it should equal zero at the end. We check one by one if there are any of the factors that would bring the polynomial to zero166. If we have the polynomial roots, we can factor them in the opposite sign and multiply all of it, giving us the original polynomial back. Therefore, having a factor (root) equaling the polynomial to zero, we say the time series is nonstationary167. In our case, we can test the hypothesis of non-stationarity by $\alpha 1 = 1$, or equivalently take the differences $\Delta Ai = \alpha Ai{-}1 + ri$, where $\alpha = \alpha - 1 = 0$. Therefore, we test for the significance of the coefficient α, but we have to keep in mind that the t-test does not follow the standard distribution. The most successful tests of the

unit-roots are the Dickey-Fuller test (DF) and **the Augmented-Dickey-Fuller (ADF)**	230

test168. Adding a constant λ (intercept) and a constant and time trend, $\lambda + \alpha * r$ (intercept and trend), we get an extended DF test169. In case the $\alpha = 0$, we have a non-stationary economic time series. On the opposite, the series is stationary. As the error term is not likely to be white noise,

Dickey and Fuller extended their test procedure by suggesting an augmented version (augmented Dickey-Fuller ADF) of the test that includes additional **lagged terms of the dependent variable to**	88

remove autocorrelation170: $\Delta Ai{=}\alpha Ai{-}1{+}\ \sum ii{=}1 \alpha i \Delta Ai{-}1{+}\ ri$ (42) $\Delta Ai{=}\ A0{+}\ \alpha Ai{-}1{+}\ \sum ii{=}1 \alpha i \Delta Ai{-}1{+}\ ri$ (43) 165 Barrs, Sh., J. Braselton and L. Braselton, “A Rational Root Theorem for Imaginary Roots,” The College Mathematics Journal, 2003, 34(5), 380-382. 166

De Pillis, L. G., "Determinants and polynomial root structure," International Journal of Mathematical Education in Science and Technology, 2005, 36(5), 469-481. 183

167 Dickey, D.,

W. Bell, and R. Miller., "Unit Roots in Time Series Models: Tests and Implications," The American Statistician, 1986, 40(1), 12-26. 168 Mladenovic, Z., and 287

A. Nojkovic., Primenjena analiza vremenskih serija. Beograd: Ekonomski fakultet, CID, 2012. 169 Guiley, D. K., and P. Schmidt., "Extended tabulations for Dickey-Fuller tests," Economic Letters, 1989, 31(4), 355-357. 170 Asteriou, D., and S. G. Hall., Applied econometrics, 3rd ed. Basingstoke, United Kingdom: Palgrave MacMillan, 2015. $\Delta Ai = A0 + \alpha Ai{-}1 + A2r + \sum ii{=}1\ \alpha i \Delta Ai{-}1 + ri$ (44) The same as with the simple DF test, the difference between the above three regressions is the intercept $A0$ and intercept and trend $A0 + A2r$. As far as how many lags should be included in the ADF test, the Akaike171 information criterion (AIC), Schwarz Bayesian criterion172 (SBC), and general-to-specific criteria can be used. The null hypothesis for both tests, DF and ADF, is that $\alpha = 0$. Because DF and ADF lack some qualities, we are going to use additional tests. For example, the DF and ADF have low power to reject in case of near unit roots, such as between the stationary process ($\alpha 1 = 0.95$) and nonstationary process ($\alpha 1 = 1$). The conclusion could be that the time series is nonstationary when the time series truly is stationary. Trend stationary processes can barely be distinguished by DF and ADF tests173. Peter C. B. Phillips and Pierre Perron174 (1988) give a nonparametric approach concerning nuisance parameters and thereby allowing for an extensive class of weakly dependent and possibly heterogeneously distributed data: it is the AR(1) process $\Delta Ai = \lambda + \alpha r + \varphi Ai{-}1 + ri$. It has an intercept λ, time trend αr, and coefficient φ considering for heteroskedasticity and serial correlation of ri. It is also a unit root, testing for $\varphi = 0$. Therefore, the PP test neutralizes the innovations ri for any autocorrelation or heteroskedasticity.

Denis Kwiatkowski, Peter C.B. Phillips, Peter Schmidt, and Yongcheol Shin175 (KPSS) suggest a null hypothesis 220 test

that an observable series is stationary around a deterministic 171

Akaike, H., "A New Look at the Statistical Model Identification," IEEE Transactions on Automatic Control, 1974, 19, 716-723. 280

172 Schwarz, G. E., "Estimating the dimension of a model," Annals of Statistics, 1978, 6(2), 461–464. 173 Arltova, M., and D. Fedorova., "Selection of Unit Root Test on the Basis of Length of the Time Series and Value of AR(1)," Statistika - Statistics and Economics Journal, 2016, 96(3), 47-64. 174 Phillips, P. C. B. and P. Perron., "Testing for a Unit Root in Time Series Regression," Biometrika, 1988, 5(2), 335-346. 175

Kwiatkowski, D., P. C. B. Phillips, P. Schmidt, and Y. Shin., "Testing the null hypothesis of stationarity against the alternative of a unit root : How sure are we that economic time series have a unit root?," Journal of Econometrics, 1992, 54(173

1-3), 159-178.

trend: the series is represented as the sum of the deterministic trend, random walk, and stationary error. The test is a Lagrange Multiplier (LM) 176 test of the hypothesis that the random walk has zero variance. 46

Kwiatkowski et al., (1992) assume to

decompose the series into the sum of a deterministic trend, a random walk, and a stationary error: 46

$Ai = \epsilon r + ri + ri$ (45) Here ri, is a random walk: $ri = ri-1 + \alpha i$ (46) where the αi, is iid (0, $\alpha i2$). The ϵr contains deterministic components, grouping the intercept and time trends. Whereas, the ri denotes a random walk, and the hypothesis tests whether the variance equals zero, $\alpha i = 0$. In case the $\alpha i = 0$, then ri is merely a constant because, with mean zero, there is no variance. Therefore, Ai will have a trend and intercept, and it will be stationary since the innovations, αi, is white noise. The alternate hypothesis is that there is some variance in the disturbance term, in the ri, making the Ai nonstationary. A simple unified approach to testing in non-stationarity time series, again using the LM principle yielding test statistics, which also have Cramer-von Mises distributions under the null hypothesis, may be extended to multivariate models and models with structural breaks177. Bhargava (1986) continues that following Alok Bhargava178 (1986), Seiji Nabeya and Katsuto Tanaka179 (1990) and Peter Schmidt and Peter C. B. Phillips180 (1992) and setting up the unit test of $A0$: $\eta = 1$ against $A0$: $\eta < 1$, a unified expression can be represented: $Ai = \alpha + \alpha r + \lambda i$; $\lambda i = \eta \lambda i-1 + \varphi i$, $r = 1,\ldots,A$, (47) 176

Silvey, S. D., "The Lagrangian Multiplier Test," Annals of Mathematical Statistics, 1959, 30, 389-407. 288

177

Busetti, F., and A. Harvey., "Testing for the Presence of a Random Walk in Series with Structural Breaks," Journal of Time Series Analysis, 342

2001, 22(2), 127-150. 178 Bhargava, A., "On the Theory of Testing for Unit Roots in Observed Time Series," Review of Economic Studies, 1986, 53(3), 369-384. 179 Nabeya, S., and K. Tanaka., "Limiting power of unit-root tests in time-series regression," Journal of Econometrics, 1990, 46(3), 247-271. 180

Schmidt, P., and P. C. B. Phillips., "LM Tests for a Unit Root in the Presence of Deterministic Trends," Oxford Bulletin of Economics and Statistics, 213

1992, 54(3), 257-287. 12 8 4 0 -4 06 07 4.6 4.4 4.2 4.0 3.8 3.6 3.4 3.2 06 07 08 09 08 09 INF 10 11 12 13 LOGOIL_SA 10 11 12 13 GDP_GAP 14 15 14 15 16 17 16 17 1.0 0.8 0.6 0.4 0.2 0.0 06 07 08 09 24 22 20 18 16 14 12 10 06 07 08 09 LOGALEUR_SA 10 10 11 12 UN_SA 11 12 13 13 14 15 16 17 14 15 16 17 4 2 0 -2 -4 -6 -8 06 07 08 09 10 11 12 13 14 15 16 17 Figure 13: Inflation, aluminum, oil, GDP_GAP, and unemployment Source: Author's calculations in EViews 11. In case non-stationarity appears in Ai, then it should come from λi. Therefore, we can test the autoregressive coefficient η on λi. For $\eta = 1$, the time series is nonstationary and

has a unit root. Otherwise, for η < 1, the time series does not have a unit root, and the 207

polynomial does not equal zero. Behavior of the φi, in expression (47), will determine whether to use DF (in case φi is white noise) or ADF and PP (in case φi is $AAAAi,i$) tests. In practice, the above approach is applied by EViews181 testing for the autoregressive coefficient of the residual. Let us graph and observe the economic time series and try to assess stationarity or non-stationarity. 181 Statistical Software System Table 7: The summary of unit root and stationary tests Unit Root & Stationarity Tests

H0: Series has a unit root H0: Series is stationary Test ADF Tests PP Tests KPSS Variables None 28

I I & t I I & t I I & t Inflation Full sample Post crisis 0.25 0.52 0.22 0.07 0.00 0.05 0.28 0.39 0.34 0.49 0.01

<p<0. 05 0.01<p<0.05 p > 0. 10 0. 01 <p<0. 28

05 GDP_gap Full sample Post crisis 0.00 0.00 0.00 0.00 0.00 0.00 0.03 0.04 0.12 0.14 p > 0.10 p > 0.10 p > 0.10 p > 0.10 Logalu_sa Full sample Post crisis 0.21 0.02 0.53 0.24 0.10 0.65 0.10 0.39 0.37 0.81 0.05<p<0.10 p > 0.10 0.05<p<0.10 p<0.01 Logoil_sa Full sample Post crisis 0.65 0.04 0.53 0.05 0.43 0.58 0.27 0.71 0.58 0.66 p > 0.10 p<0.01 p<0.01 0.01<p<0.05 Unemployment Full sample Post crisis 0.70 0.70 0.89 0.82 0.16 0.15 0.90 0.92 0.39 0.39

p < 0.01 p < 0.01 p < 0. 01 p < 0. 311

01 *Full sample: 2006:1-2017:12 **Post-crisis sample: 2011:1-2017:12 Source: Author's calculations in EViews 11. We will use the output gap instead of the output level since it reduces the prize puzzle, and the coefficient is more likely to be constant182. The time series of inflation, aluminum, oil, GDP_GAP, and unemployment have sharp fluctuations, especially around 2008, corresponding to the global crisis. These intense steps can lead us to think that there might be a structural break. Not accounting for structural breaks would

cause worse forecasting performance in terms of the mean forecast, incorrectly estimated confidence bounds, 199

and forecast uncertainty183. The time series appear visually to be stationary except for these precipitous drops, and we are going to apply the unit root (ADF and PP) and KPSS tests. First, we will test the whole sample from January 2006 till December 2017, the post-crisis 182 Giordani, P., "An Alternative Explanation of the Price Puzzle," Journal of Monetary Economics, 2004, 51, 1271-1296. 183 De Gaetano, D., "Forecast Combinations for Structural Breaks in Volatility: Evidence from BRICS Countries,"

Journal of Risk and Financial Management, MDPI, Open Access Journal, 141

2018, 11(4), 1-13. period from January 2011 to December 2017, except for unemployment from January 2012 to December 2017. Observing Figure 14 and analyzing the test results will help us identify the study's time series' behavior. From the correlogram in Figure 14, we see from the

autocorrelation (AC) column that shocks' impact diminishes quickly, reminding us that the time series of inflation is most probably stationary.

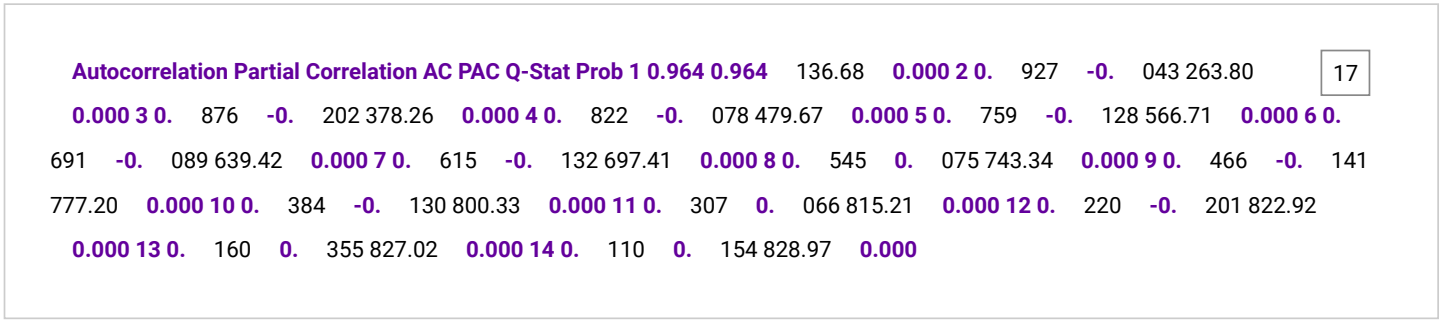


Figure 14: The correlogram of inflation Source: Author's calculations in EViews 11. Having specified the ADF test at 11 lags for the full sample, the inflation series becomes stationary, rejecting the null hypothesis of the unit root. Both trend and intercept are essential, having a t-statistic of -3.654 and 4.329, respectively. While the PP in the full sample fails to reject the unit root test, and KPSS rejects stationarity at the intercept, at 5% significance level, but fails to reject the null hypothesis of stationarity at intercept and trend because of having a statistic corresponding i > 0.10. The ADF and KPSS test conclusion is that the series of inflation is stationary, while PP not stationary. The post-crisis period from January 2011 till December 2017 gives us pretty much the same results, except the KPSS at intercept and trend. In the case of KPSS, EViews 11 does not provide us the i value directly, but it provides us with test statistics, and we compare it with the three critical values at 1%, 5%, and 10%. The sample size and correct specification is the key to testing for the unit-roots even though there is no guarantee that we may not end up with the wrong answer.184

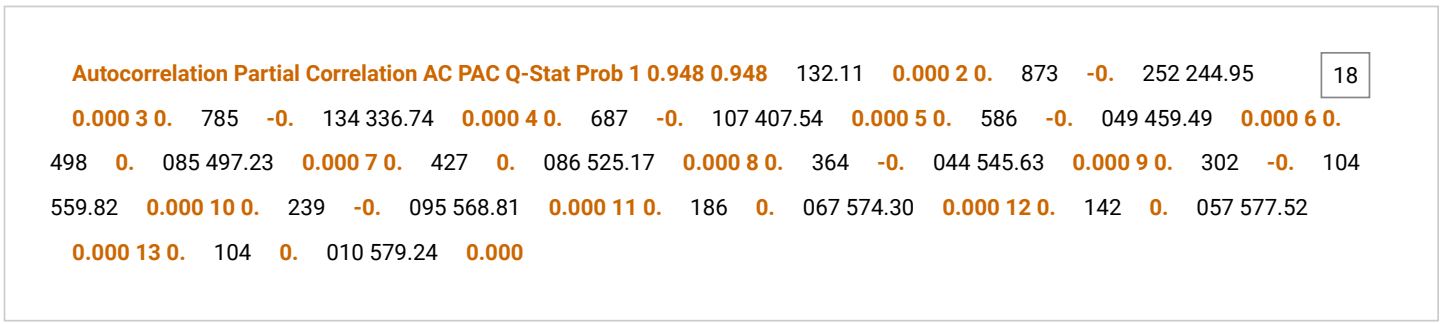
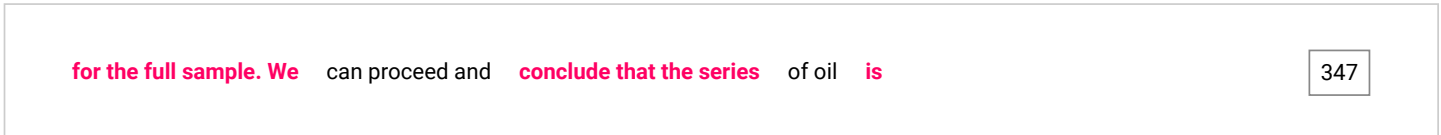


Figure 15: The correlogram of aluminum Source: Author's calculations in EViews 11. Having logged and adjusted the aluminum time series's seasonality, we will conduct the unit root and the stationarity tests. Observing Figure 15, the series has a constant mean (approx. 0.4) around which it oscillates except the period of crisis in 2008. Conducting the ADF unit root test, the series is stationary at the intercept, rejecting the null hypothesis of having a unit root. We can infer that the intercept is significant since it has a t-statistic of 2.985 (using Akaike Info Criterion) and i = 0.003. The trend statistic of i = 0.630 proves it as not significant. In the post-crisis sample, the KPSS test fails to reject the null hypothesis of stationarity having a value of 0.232 at the intercept, corresponding a i > 0.10. At lag length 35 and intercept specification, the ADF test of oil time series rejects the null hypothesis of unit root, corresponding a i = 0.044. The KPSS test fails to reject the null hypothesis at intercept with a test statistic of 0.247, corresponding i > 0.10. At the intercept and lag length 22, the ADF has i = 0.045 for the post-crisis period, thus rejecting the unit root test of non-stationarity. The t-statistic for the constant has a probability of i = 0.004. The ADF and KPSS tests provide enough proof rejecting the 184 Libanio, G. A. "Unit roots in macroeconomic time series: theory, implications, and evidence," Nova Economia, 2004, 15(3), 145-176. unit root and failing to reject stationarity



stationary. As observed in Figure 16, all tests confirm stationarity and

reject the null of unit root for the time series **of the** output gap. **The** 345

specified ADF at 3 lags, intercept and trend specification, the time series of unemployment shows a i = 0.105. Conducting a post- crisis ADF test, a sub-sample from January 2011 till Jun 2015, at 1 lag and including intercept and trend, we get a t-statistic of -3.436 with i = 0.0571, thus rejecting the null of unit root at 10% significance. 6 4 Quantiles of Normal 2 0 -2 -4 -6 -8 -6 -4 -2 0 2 4 Figure 16: Quantile GDP_GAP Source: Author's calculations in EViews 11. The same is confirmed from the PP test resulting in i = 0.071 and significant trend and constant. The KPSS, specified at trend and intercept, fails to reject stationarity at 5% significance. The properties of the time series included in our study reject unit root and fail to reject stationarity. 3.1.2. Identifying structural breaks As we can observe from the figures of (Air_rAi, iii_rAi, $iiAi$, AAi_AAii, ri_rAi), there is a potential structural change, especially around the global crisis. Our economic time series behaved in a predictable, ordinary fashion in the post-crisis period, but very volatile during 2008 – 2009.

In specifying a regression model, we assume that its assumptions apply to all sample observations 185. **The** 95

hypothesis that we put here is whether the same regression model applies to the prior and post-crisis period. The world oil prices, aluminum, and inflation have not been stable over the whole sample from January 2006 till December 2017. Intercept or slope parameters may change by α, and we notice abrupt changes in the setting parameters. Instead of having the following inflation model: $\pi i = A(Ai; \varphi) + \alpha i\ r = 1, \dots, A$ (48) We have an abrupt change in parameters: $\pi i = A(Ai; \varphi 1) + \alpha i\ Air\ r = 1, \dots, \bar{r}$ and $\pi i = A(Ai; \varphi 2) + \alpha i\ Air\ r = \bar{r}+1, \dots, A$ (49) Misspecification and not accounting for structural breaks would lead us to wrong conclusions, and consequently, the Central Bank of Montenegro would not be correct with policy decisions. The critical question here is whether the inflation model's actual parameters in Montenegro have changed during the estimation period! $\{\hat{r}i = \varphi 0,(1,R) + \varphi 1,(1,R)r1+. \dots +\varphi i,(1,R)ri + \alpha i\ \{\hat{r}i = \varphi 0,(1,ii+1) + \varphi 1,(1,ii+1)r1+. \dots +\varphi i,(1,ii+1)ri + \alpha i\ \{\hat{r}i = \varphi 0,(1,ii) + \varphi 1,(1,ii)r1+. \dots +\varphi i,(1,ii)ri + \alpha i\ [1. \dots (ri). \dots (ri+1). \dots A]$ If we estimate coefficients recursively, in small sub-samples, and there is no break in true parameters, we do not have structural breaks. Therefore, we start by applying recursive estimation186, expanding one more observation to the small sample. For each estimated sample, we get corresponding coefficients subsequently, as we expand the sample to time 185

Greene, W. H., Econometric Analysis. Upper Saddle River, NJ: Pearson **Prentice Hall,** 2012. 186 Bergman, **N.,** 261

"Recursive Bayesian Estimation: Navigation and Tracking Applications," 1999, Linköping Studies in Science and Technology. Dissertations No. 579. A. We proceed with Chow (1960) test187, which essentially breaks the sample into a restricted equation, allowing no breaks, and the unrestricted model with breaks: $[rr12] = [A1\ A2]\ [\alpha 1] + [\alpha\alpha 12]\ 0\ 0\ \alpha\ [rr12] = [A1]\ [\alpha] + [\alpha\alpha 12]\ 2\ A\ 2$ (50) (51) In case the SSR of different estimated equations fit the data well, then there is no structural break. The null assumption is that there is no break. Greene (2012) explains that the unrestricted least squares estimator is: $= (A'A)-1A'r = [rr12] = [A1'A1\ 0\ 0\ -1\ A2'\ A2\ ]\ [AA12"rr12] + [\alpha\alpha 12] = [\alpha\alpha 12]$ (52) continuing that the

total sum of squared residuals from this regression will be the sum of the two residual sums of squares from the two separate 120

regressions188: (53) $Ai'Ai = A1'iA1i + A2'iA2i\ A'A = A1'A1 + A2'A2$ (54) Equation (54) represents the restricted regression of the residual sum of squares. Greene (2012) computes the F statistic as follows189: $A[i2, i1 - A\ ] = (WrW'W1'rW1-/(Wi1'1W1-I)/)i2$ (55) In case $Ai'Ai \ll A'A$, making the F statistic larger than the critical value, then the restricted model accounts for breaks, and the null hypothesis of no breaks is rejected.

Another breakpoint test is the Quandt-Andrews test190191, where the sample is trimmed at the 187 Chow, G. C., "Tests of Equality Between Sets of Coefficients in Two Linear Regressions," Econometrica, 1960, 28(3), 591-605. 188

Spellman, F. R., and **Nancy E. Whiting., Handbook of Mathematics and Statistics for the Environment.** 195

Boca Raton: Taylor & Francis Group, 2014. 189

Greene, W. H., Econometric Analysis. Upper Saddle River, NJ: Pearson **Prentice Hall,** 24

2012. 190

Quandt, R. E., "The estimation of the parameters of a linear regression system obeying two separate regimes," **Journal of** 237 **the American Statistical Association, 1958, 53, 873-**

880. 191 Andrews, D. W. K., (1993) "Tests for parameter instability and structural change with unknown change point," Econometrica, 1993, 71, 395-397. beginning and the end. As in the Chow test, we calculate F statistics sequentially. Quandt192 (1958) finds that the switching point can be estimated most effectively by examining the appropriate likelihood function based on the F distribution, which is proposed for testing the hypothesis that no switch occurred against the single alternative of one switch. $A(r1)$ $A(r2)$ ˜7.5% ˜7.5% [1 $r1$ $r2$ A] Let's proceed to test

for multiple breaks in intercept and coefficients using Bai- Perron193 (2003) **to** test **sequentially the hypothesis of** 1 **L+1 vs. L determined breaks** sequentially. **The** Quandt-Andrews **test**

needs to be provided a sufficient number of observations after the break occurs; this is why we trim the estimation sample. For example, our break takes place in 2008m07, and we cannot detect it immediately. Instead, depending on a model specification and trimming parameters, we need several months after the break to pass and appear in our estimation sample. Such a scenario is difficult to avoid if we are entirely reliant on the statistical tests and do not use any prior information or judgment regarding a break. We may keep using a "broken" model (e.g., forecasting) for some time without realizing it is broken. Comparing the forecasting performance of, for example, two models – one that accounts for a structural break and one that does not, clearly shows that the model that does not account for the break performs worse in terms of root mean squared errors (RMSE) than the one that accounts for the break, allowing to reduce the forecast bias substantially194. 192 Ibid. 193 Bai, J., and P. Perron., "Critical values for multiple structural change tests," The Econometrics Journal, 2003, 6(1), 72-78. 194 Casini, A., and P. Perron., "Structural Breaks in Time Series,"

Boston University - Department of Economics - Working Papers Series, 2018, **WP2019-02.** 303

3.1.3. Modeling dichotomous variables If an observation belongs to a category or has an attribute, it can be represented by a binary value 0 or 1 as a useful device in a regression analysis195. A binary variable may represent significant strikes or policy happenings as 1 only for a specified period196. They are also known as indicator variables, as they will generally have a

value of 1 to indicate if an observation belongs to a category and 142

a 0 to note if not. Table 8: Multivariate regression of inflation Dependent Variable: INF Method: Least Squares Sample: 2006M01 2017M12

Included observations: 144 Variable Coefficient Std. Error t-Statistic Prob. 307

LOGALEUR_SA LOGOIL_SA UN_SA GDP_GAP C 8.271636 -0.161515 -0.385255 -0.779853 5.048492 1.003785 8.240446 0.583851 -0.276637 0.054475 -7.072198 0.089415 -8.721705 2.704927 1.866406 0.0000 0.7825 0.0000 0.0000 0.0641

R-squared Adjusted R-squared S.E. of regression Sum squared resid Log likelihood F-statistic Prob(F-statistic) 0. 518349 52 0. 504489 1.

820747 460.8019 -288.0743 37.39768 0.000000

Mean dependent var S.D. dependent var Akaike info criterion Schwarz criterion Hannan-Quinn criter. Durbin-Watson stat 116

2.684028 2. 586562 4. 070476 4. 173595 4. 112378 0.

185680 Source: Author's calculations in EViews 11. Binary variables are also called dummy variables since they are not real, and we create them to represent something else197. Therefore, quantifying qualitative information in a regression model is very important. 195 Suits, D., "Use of Dummy Variables in Regression Equations,"

Journal of the American Statistical Association, 1957, 52(280), 548-551. 290

196 Gujarati, D., Basic Econometrics. New York: The McGraw–Hill, 2004. 197 Asparoukhov, O. K., and A. Stam., "Mathematical programming formulations for two-group classification with binary variables," Annals of Operations Research, 1997, 74, 89-112. Either it is shifted, or the underlying elasticities have moved around. From around the second half of 2014 onwards, the upward trend in inflation reflects the increase in food, alcoholic and non-alcoholic beverages and tobacco prices in Montenegro. After the crash in the United States' housing market in 2015, the economy recovered, and oil prices decreased. The direction we are following here is that the relationship between inflation and oil changed around 2008 and 2014, indicating that we need to consider bringing in multiple structural breaks around these periods. 12 8 6 4 4 2 0 0 -4 -2 -4 06 07 08 09 10 11 12 13 14 15 16 17 Residual Actual Fitted Figure 17: Actual, fitted, and residuals Source: Author's calculations in EViews 11. Confirming whether this is necessary, we are going to run a simple regression model between inflation, constant, and logarithmic oil prices, an elasticity expression. Including all variables inflation, oil, aluminum, unemployment, and GDP gap into a multivariate regression model, we get Table 8. The first notable thing is the R-squared ($A2$)198 of 51.83% but in the meantime low Durbin-Watson of 0.18 indicating positive autocorrelation. The autocorrelation is confirmed in Figure 17. Once again, the global financial crisis period shows positive residuals passing the upper border 2 and reaching 198

Wooldridge, J. M., Introductory econometrics: a modern approach. Ohio: South-Western, 72

2009. even the level of 4 and above. Around 2011, we notice negative residuals crossing the - 2, and in 2013 soaring to around 3. 60 20 40 15 20 10 0 5 -20 0 -40 -5 -60 -10 -80 06 07 08 09 10 11 12 13 14 Recursive C(1) Estimates ± 2 S.E. 15 16 17 -15 06 07 08 09 10 11 12 13 14 Recursive C(2) Estimates ± 2 S.E. 20 2 15 1 10 5 0 0 -1 -5 -10 06 07 08 09 10 11 12 13 14 15 16 17 -2 06 07 08 09 10 11 12 13 14 Recursive C(3) Estimates

Recursive C(4) Estimates ± 2 S.E. ± **2 S.E.** 1 **.5** 1 **.0 0.5** 0 **.0** -0 **.5** -1 **.0** 12

-1.5 06 07 08 09 10 11 12 13 14

Recursive C(5) **Estimates ± 2 S.E.** 15 16 17 **Figure** 18: **Recursive** coefficient **estimates of** 340

inflation Source: Author's calculations in EViews 11 15 16 17 15 16 17 It can be explained from the increase in housing, water, electricity, gas, and other fuel category prices in Montenegro, impacting the inflation in 2012 by 37.2% and in 2013 by 129.4%. Also, alcoholic beverages and tobacco impacted inflation by 110, 5% in 2013. We see negative autocorrelation in 2014, which comes from a) communication with a shock of 265.7% into inflation, b) health category of -209.8% and c) furnishings - house equipment and maintenance of 92.4%. Food and non-alcoholic beverages impacted oscillations of inflation by 38.4% and 24.6% in 2016 and 2017, respectively. Figure 17 shows the positive autocorrelation. Proceeding with the recursive ordering stability test, the results of Figure 18 put to consideration breaks in coefficients $A1$, $A2$, $A3$, $A4$, AiA $A5$. Multiple breaks appear to be in each coefficient, confirmed by Bai-Perron multiple breakpoint test, as seen in Table 9. Intercept and slope coefficients propose breaks in June 2009, March 2011, October 2013, and March 2016. Quandt-Andrews breakpoint test suggests Jun 2009 as a breaking point.

Table 9: Multiple **Bai-Perron test Sequential F-statistic determined breaks:** 4 **Break Test F-statistic** Scaled **F-statistic** Critical **Value** 0 vs. 1** 145

*

1 vs. 2 * 2 vs. 3 * 3 vs. 4 * 4 vs. 5 241

29.88617 26.67427 9.725133 9.194913 0.000000 149.4308 133.3713 48.62566 45.97456 0.000000 18.23 19.91 20.99 21.71 22.37 * Significant at the 0.05 level. Break dates: Sequential Repartition 1 2009M06 2 2013M10 3 2011M03 4 2016M03 2008M11 2011M03 2014M01 2016M03 Source: Author's calculations in EViews 11. We need to consider the specifics of the above residuals described above to model dichotomous variables: ? ? Dum_2008m06 – takes account of the pre-crisis period. Dum_2009m06 – takes account of the global financial crisis. It has value 1 from June 2009 till February 2011. ? Dum_2011m03 – represents an increase in prices of alcoholic beverages and tobacco, and it has a value of 1 from March 2011 till May 2013. ? Dum_2013m07 – takes into account the increase of VAT from 17% to 19% in July 2013. It takes the value of 1 from July 2013 till September 2013. ? Dum_2013m10 – reflects an increase in prices of housing, water, electricity, gas, and other fuels. It takes the value of 1 from October 2013 till February 2016. ? Dum_2016m03 – accounts for the increase in prices of food & non-alcoholic beverages. It takes the value of 1 from March 2016 till December 2017. The role of food prices and oil are very deterministic in inflation199. A large part of shifting in inflation appears to come from food, imported mostly and to some degree from domestic agricultural products, and products subject to high excise tax such as tobacco and oil. In the pre-crisis period, the economy was overheated due to increased foreign direct investments (FDI), impacting housing prices. Table 10: Inflation model with dummy variables Dependent Variable: INF Sample: 2006M01 2017M12

Included observations: 144 **Coefficie Variable nt Std. Error t-Statistic Prob. C** 295

4.177093 3.085924 LOGALEUR_SA 2.996166 1.330477 LOGOIL_SA 1.163165 0.692608 UN_SA -0.416524 0.106706 GDP_GAP -0.398906 0.092200 DUM_2009M06_AL -3.376320 0.530496 DUM_2011M03_AL -1.745908 0.540293 DUM_2013M07_AL -1.917639 1.109249 DUM_2013M10_AL -3.439219 0.585772 DUM_2016M03 -0.373596 0.917691 1.353596 2.251948 1.679398 -3.903482 -4.326546 -6.364458 -3.231409 -1.728773 -5.871263 -0.407104 0.1781 0.0260 0.0954 0.0001 0.0000 0.0000 0.0016 0.0862 0.0000 0.6846

R-squared Adjusted R-squared S.E. of regression Sum squared resid Log likelihood F-statistic Prob(F-statistic) 0. 690179 52 **0.** 669371 **1.**

487283 296.4095 -256.3060 33.16759 0.000000

Mean dependent var S.D. dependent var Akaike info criterion Schwarz criterion Hannan-Quinn criter. Durbin-Watson stat 123

2.684028 **2.** 586562 **3.** 698695 3.904932 **3.** 782498 **0.**

269650 Source: Author's calculations in EViews 11. Thus, the equilibrium of wage-setting and price-setting decreased the labor market's unemployment rate, corresponding to April 2009. The impact of increasing VAT, from 17% to 19%, pushed prices up, increasing the markups in the price-setting relation and lowering the employment rate: the markup is associated with the shadow economy. 199 Mohanty, M. S., and M. Klau, "What determines inflation in emerging market economies?,"

BIS Papers chapters,in: Bank for International Settlements (ed.), Modelling aspects of the inflation process and the monetary transmission mechanism in emerging market countries, 105

2001, 8, 1-38. Including the dummy variables in the inflation model, the $A2$ increases significantly, and the F statistic remains stable. In the meantime, the Durbin – Watson statistic still is very low 0.27, indicating residual autocorrelation, which can and will be corrected by incorporating the lagged values. We never know the true slope αi instead, we calculate the sample slopes Ai and make inferences about the αi. We estimated four slope coefficients and five dichotomous variables. Each time we will make inferences about population slope values, we can never know what they are200. Our sample slope values will allow us to make inferences for the population values. Are our sample coefficients far away enough from zero that we can suggest that the population coefficients are nonzero201? And, how much variation is there on inflation in Montenegro? How much explaining is this model doing? The sum of squares $AA = \sum (ri - \bar{r})2$ calculates the whole deviation from the mean202. We subtract all observations from the mean and square, each getting the amount the variation in inflation203. The $A2$ tells that 69.01% of the variation in inflation is being explained by ri variables. Still, there are residuals of 30.99% going unexplained (keeping in mind that we did not incorporate the lagged values yet to fix the positive autocorrelation). Is this model with the above explanatory variables better than a model with 0 explanatory variables? The joint hypothesis is that all

$\alpha 1 = \alpha 2 = \alpha 3 = \alpha 4 = \alpha 5 = \alpha 6 = \alpha 7 = \alpha 8 = \alpha 9 = \alpha 10$ 335

= 0204. If we can not reject this, then our model is useless. Reminding the statistics,

if the p-value is less **than the level** of significance **5%,** we reject **the** $A0$. Even **if** 274

we use a 1% level of significance, we will

reject the null hypothesis. In our case, **the F-statistic** (33.167) **is less than the critical** 258

value ($AriA\{A - rrArirriA$ = 0.000}). It indicates that it is in the rejection region. 200 Kim, J. H., and A. P. Robinson., "Interval-Based Hypothesis Testing and Its Applications to Economics and Finance," Econometrics, 2019, 7(21). 201 Gauss, C. F., "Bestimmung der Genauigkeit der Beobachtungen," Zeitschrift für Astronomie und Verwandte Wissenschaften, 1816, 1, 187–197. 202 Pearson, K., "On the dissection of asymmetrical frequency curves," Philosophical Transactions of the Royal Society A., 1894, 185, 71–110. 203 Ghahramani, S., Fundamentals of Probability, 2nd ed. New Jersey: Prentice Hall, 2000. 204

Barreto, H., and **F. M.** Howland., **Introductory Econometrics: Using Monte Carlo Simulation with Microsoft Excel. Cambridge, England: Cambridge University Press,** 164

2010. If we were to write the estimated regression equation, it would be like the one following equation 56. For example, its interpretation would be for every additional percentage of the aluminum price at the LME, the expected percentage of inflation increases by 2.996% on average, holding all other variables constant. The same logic of interpretation follows for the other variables. $\hat{AiA}$ = 4.177 + 2.996 ∗ $AiAAiArri\ A$ + 1.163 ∗ $AiAAiii\ A$ − 0.398 ∗ $AAAW\ Ai$ − 0.416 Ai_rA − 3.376 ∗ $Ari\_2009i06$ − 1.745 ∗ $Ari\_2011i03$ − 1.917 ∗ $Ari\_2013i03$ − 3.439 ∗ $Ari\_2013i10$ − 0.373 ∗ $Ari\_2016i03$ (56) In addition to using the coefficients for interpretation, we can also predict inflation for a month. For example, for January 2011, the values of the model variables are logaleur_sa=0.5982, logoil_sa=4.3311, gdp_gap=2.6376, un_sa=13.7299, and dum_2009m06 is 1. Substituting the above values to the model, we get: $\hat{AiA}$ = 4.177 + 2.996 ∗ (0.5982) + 1.163 ∗ (4.3311) − 0.398 ∗ (2.6376) − 0.416 ∗ (13.7299) − 3.376 ∗ (1) = −2.7155 (57) The actual inflation, for January, is 1.1%, and the error is (1.1 − (-2.7155)) = + 3.81. 2.2519 0 2.2519 Figure 19: Theoretical t-distribution of logaleur_sa Source: Author's simulations. Standard deviation gives us a typical variation of a coefficient, average expected error term from the sample value205. Dividing the coefficient with the standard error, we get the t- statistic, and the higher the t-statistic206 in magnitude, the more significant the 205 Gurland, J., and T. Ram C. "A Simple Approximation for Unbiased Estimation of the Standard Deviation," The American Statistician, 1971, 25(4), 30–32. 206 Gosset, W. S., "On the error of counting with haemacytometer," Biometrika, 1907, 5(3), 351–360. variable is. We rarely or ever conduct inference in the constant term. The p-value will help us determine whether the coefficient is significant or not. So, the $r1$ = 2.$^{996166}/_{1}$.330477 = 2.2519 is the standardized coefficient, and the p- value indicates how extreme this coefficient is if indeed the population coefficient was zero. The initial hypothesis is that each of these coefficients at the population level is zero207. We start with the assumption that there is no effect of these variables into inflation, and on the other side, we get the sample values. The p-value tells us approximately how likely it is to be zero208. Let's have a look at a simple theoretical diagram in Figure 19. If the null hypothesis were zero, we would expect a t-statistic zero, but it could be any around zero due to the random selection. The t-distribution shows us the distribution of potential t value209. The standardized t value for the logarithmic value of seasonally adjusted aluminum expressed in euros is 2.2519, while the p-value tells us the value beyond the curves. The two-tailed areas equal to 0.026=2.6%. If the null hypothesis is $A1$ = 0, the chance of getting a sample as extreme as we did, $A1$ = 2.9961 is 2.6%. We are happy to infer that $A1$is not zero, and more than 95% of $A1$ is under the bell curve in Figure 19. In other words, the logarithmic value of aluminum is related to inflation in Montenegro. This methodology would apply to other variables in the model. More examination should be done in the specification, but allowing structural breaks and including appropriate dichotomous variables solved some fundamental residual problems. Therefore, this is a reasonable starting point to develop a forecasting model. 3.2.Vector autoregressive model of inflation in Montenegro Christopher Sims (1980) says:

"Large-scale do perform useful forecasting and policy- analysis functions despite their incredible identification; the restrictions imposed in the usual style of identification are neither essential to constructing a model which can 49

207 Johnson N. L., K. Samuel.

N. Balakrishnan., Continuous Univariate Distributions, Volume 1, 2nd ed. United Kingdom: John Wiley & Sons, 24

1994. 208 Lüroth, J., "Vergleichung von zwei Werten des wahrscheinlichen Fehlers," Astron. Nachr., 1876, 87(14), 209–20. 209 Helmert, F. R., "Über die Berechnung des wahrscheinlichen Fehlers aus einer endlichen Anzahl wahrer Beobachtungsfehler," Z. Math. U. Physik, 1875, 20, 300–3.

perform these functions nor innocuous; an alternative style of identification is available and practical." 49

210 Models being used

from the 1960s, because the latter imposed many restrictions, were mostly not consistent with the notion that today's choices take into account the effect of 40

tomorrow's utility by economic agents211. Sims (1980) continues arguing that the identification of the previous models is inappropriate and cannot be taken seriously, which became known as Sim's Critique212.

Since then, VARs have been used for macroeconomic forecasting and policy analysis to investigate the sources of business- cycle fluctuations and provide a benchmark against which modern dynamic macroeconomic theories can be 78

evaluated213. The

VARs are linear time-series models designed to capture the joint dynamics of multiple time 184

series214. Since no variable can be deemed as exogenous from forward-looking agents, all endogenous variables

in the system are treated as a function of lagged values of all endogenous variables. 234

215 According to Sims, macroeconomic models could be designed without imposing strong restrictions and pretending to have a priori theory216. The VARs make theoretical identifying restrictions much more precise than models that were prevalent until the '60s217. The goal of the VARs is forecasting and policy projections218. 210 Sims, C. A., "Macroeconomics and Reality," Econometrica, 1980, 48(4), 1–48. 211 Pecican, E. St.,

Forecasting Based on Open VAR Model," Romanian journal of economic forecasting, 291

2010, 13(1), 59-69. 212 Christiano, L. J., "Christopher A. Sims and Vector Autoregressions," Scand. J. of Economics, 2012, 114(4), 1082–1104. 213

Del Negro, M. and F. Schorfheide., "Priors from Equilibrium Models for VARs," International Economic Review 2004, 45, 643–673. 128

214 Del Negro, M. and F. Schorfheide., "Monetary Policy with Potentially Misspecified Models," American Economic Review, 2009, 99(4), 1415-1450. 215 Sims, C. A., "Comparison of Interwar and Postwar Business Cycles: Monetarism Reconsidered," American Economic Review, 1980, 70

(2), 250–257. 216 Sims, C. A., "Are Forecasting Models Usable for Policy Analysis?," Federal Reserve Bank of Minneapolis Quarterly Review, 232

1986, 10 (1), 2–16. 217

Sims, C. A., "Models and Their Uses," American Journal of Agricultural Economics, 1989, 71, 489– 494. 328

218

Stock, J. and M. Watson., "Vector Autoregressions," Journal of Economic Perspectives, 2001, 15, 101– 254

115.

Forecasts obtained from VAR models are, in most cases, better than those obtained from the far more complex simultaneous equation models219. Asteriou and Hall 119

(2016)220 take two stationary simultaneous time series, ri and ri, affected by current and past values and respective white noise error terms rxi and rxi: $ri = \alpha 10 - \alpha 12ri + \alpha 11ri{-}1 + \alpha 12ri{-}1 + rxi$ $ri = \alpha 20 - \alpha 21ri + \alpha 21ri{-}1 + \alpha 22ri{-}1 + rxi$ (58) (59) Equations (58) and (59) have a contemporaneous impact on each other. The matrix algebra of the above two equations would look like: [1 $\alpha 12$] [$rrii$] = [$\alpha\alpha 1200$] + [$\alpha 11$ $\alpha 12$ $ri{-}1$ rxi $\alpha 21$ 1 $\alpha 21$ $\alpha 22$] [$ri{-}1$] + [rxi] (60) or: A = [1 $\alpha 21$ $\mathbf{A}\boldsymbol{z}i = \boldsymbol{B}0 + \boldsymbol{B}1\boldsymbol{z}i{-}1 + \boldsymbol{t}i$ $\alpha 112$], $\boldsymbol{z}i$ = [$rrii$], $\boldsymbol{B}0$ = [$\alpha\alpha 1200$], $\boldsymbol{B}1$ = [$\alpha\alpha 1211$ $\alpha\alpha 1222$] , $\boldsymbol{z}i{-}1$ = [$ri{-}1$ $ri{-}1$] and $\boldsymbol{t}i$ = [$rrxxii$] Multiplying equation (61) by $A{-}1$ we get: (61) (62) $ri = A0 + A1ri{-}1 + Ai$ (63) following $A0 = A{-}1A0$, $A1 = A{-}1A1$, and $Ai = A{-}1ri$. $A0$ is $(i * 1)$ vector of constants, $A1$ is $(i * i)$ vector of coefficients, Ai is $(i * 1)$ vector of white noise221 innovations. The rewritten VAR model looks as: $ri = A10 + A11ri{-}1 + A12\ ri{-}1 + A1i$ (64) $ri = A20 + A21ri{-}1 + A22\ ri{-}1 + A2i$ (65) Equations (58) and (59) are structural VAR (SVAR), while (64) and (65) are reduced form VAR. Because we did not impose any restrictions and that residuals are not 219

Brooks, C., Introductory econometrics for finance. Cambridge: Cambridge University Press, 2002. 220 Asteriou, D., and 217

S. G. Hall., Applied econometrics, 3rd ed. Basingstoke, United Kingdom: Palgrave MacMillan, 2015. 221

The best-known generalized process is white noise, which can be thought of as a continuous time analogue to a sequence of 93 independent and identically distributed observations.

orthogonal, equations (64) and (65) are reduced-form VAR222. Since Ai = A−1ri, errors $A1i$ and $A2i$, in equations (64) and (65), are made up of two innovations rxi and rxi. White noise means that error terms are uncorrelated, so $A[Ai]$ = 0 and finite variance223. An equation error term can be contemporaneously correlated with other equations' residuals but not correlated with their own lagged values and independent variables224 (as in any specified regression). Therefore, the reduced-form innovations are not orthogonal, completely uncorrelated. The structure of the contemporaneous variance-covariance matrix is as follows: $A[Ai\ Ai']$ = [$\alpha W21$ $\alpha A1A2$ $\alpha A1A2$ $\alpha W22$] (66) where $\alpha W21$ is the variance of the first variable, $\alpha W22$ the variance of the second variable, and $\alpha A1A2$ denotes the contemporaneous covariance. For time $r0$ and $r1$ (not contemporaneous), however, the innovations need to be uncorrelated, and the variance- covariance matrix should be zero225: $A[Ai0\ Ai'1]$ = [00 0 0] (67) All equations have identical regressors, and estimates are consistent and efficient. The model we will estimate is parsimonious226, meaning that we will include the lowest possible number of parameters in the VAR model because VARs are very parametrized227. 222

Hamilton, J. D., Time Series Analysis. Princeton, New Jersey: Princeton University Press, 1994. 209

223 Stein,

M. L., Interpolation of Spatial Data: Some Theory for Kriging. Springer Series in Statistics. New York: Springer, 1999. 19

224 Watson, M., "[Vector Autoregressions and Reality]: Comment," Journal of Business and Economic Statistics, 1987, 5, 451–453. 225

Bernanke, B. and I. Mihov., "Measuring Monetary Policy," Quarterly Journal of Economics, 1998, 113, 869–902. 37

226 Daganzo, C.

F., V.

V. Gayah, and E. J. Gonzales., "The potential of parsimonious models for understanding large scale transportation 245 systems and answering big picture questions," EURO Journal on Transportation and Logistics, 2012, 1(

1-2), 47-65. 227

Blanchard, O. and R. Perotti, R., "An Empirical Characterization of the Dynamic Effects of Changes in Government Spending and Taxes on Output," Quarterly Journal of Economics, 2002, 117, 1329– 304

1368. 3.2.1. Estimation of the VAR model for the Montenegrin economy Five variables will constitute our VAR model, as follows: Ai = (Air_rAi, iii_rAi, $iiAi$, AAi_AAii, ri_rAi, $Ari\_2009i06$ − $Ari\_2011i03$, $Ari\_2013i03$, $Ari\_2013i10$, $Ari\_2016i03$) (68) The Ai is the vector, $Airi$ is the seasonally adjusted logarithmic aluminum price in euros, $iiii$ is the seasonally adjusted oil price in euros in logarithmic form, $iiAi$ is the inflation expressed in percentage, $AAi\_AAii228$ is the gap of gross domestic product, obtained by HP filtering log GDP, and rii is the unemployment expressed in percentage and seasonally adjusted as well. As far as the dichotomous variables are described in the previous section. Key variables are oil and aluminum prices, which are included as exogenous variables to measure econometrically the impact of these shocks on inflation and the economy. Unemployment and gdp_gap will show the effect of corresponding shocks on other variables. The sample period for the VAR will be starting from January 2006 till December 2017. Still, for estimation purposes, we will go from January 2006 till December 2015, and we will use the model to forecast inflation from January 2016 to December 2017. The onset will be our tool to assess whether our model can predict the actual inflation from 2016:01 onwards. The gdp_gap, inflation, and unemployment will capture the long-run path of inflation. At the same time, aluminum and oil prices, including dummy variables, will potentially explain the external short-run dynamic movements of inflation. Each column corresponds to one equation in the VAR. For example, the first equation is inflation, which is expressed

as a function of its own 4 lags, the lags of 305

logaleur_sa, logoil_sa, gdp_gap, un_sa, constant, and dummy variables. The process is applied to the other endogenous variables in the model. EViews calculates the coefficients, standard errors, and t statistics in brackets for each regressor. The coefficient of determination (R2) is relatively high, but it is typical for VAR in levels229. We need to decide the number of lags that we want to use. Therefore, the specification issue is where we focus on in the 228 Lipsey, R. G., K. A. Chrystal., Economics, 11th ed. Oxford, UK: Oxford University Press, 2007. 229

Frost, J., Regression Analysis: An Intuitive Guide for Using and Interpreting Linear Models, ebook. 192

next paragraphs. Looking at the t-statistics of individual coefficients (in square brackets), it turns out that most coefficients are not statistically significant (one can use 2 as an approximate threshold for the 95% significance level). The phenomenon is also typical for VARs and should not cause concern. Usually, only the coefficients of the first own lag of each variable and maybe a few others are significant230. None of these results automatically implies that the VAR is good or bad, either from a statistical perspective or from an economic perspective231. More analysis needs to be done on checking the residuals' properties to find a statistically well-specified reduced form VAR232. Moreover, further investigation is also required to assess whether the VAR has meaningful implications from an economic perspective. 3.2.1.1. Stationarity of the VAR system Establishing covariance-stationarity is vital in a VAR system233. It has important implications, such that the response to shocks gradually dies down, tending to zero in the long run. A vector process is said to be covariance-stationary if its first and second moments, $A[ri]$ and respectively $A[ri\ ri'-i]$, are independent of the time t:234 $ri = A + \emptyset 1ri-1 + \epsilon i\ r1i = A1 + \emptyset 11\ r1i-1 + \emptyset 12\ r2i-1+. . . +\emptyset 1I\ rIi-1 + \epsilon 1i\ ri = A + \Phi 1[A + \Phi 1ri-2 + \epsilon i-1\ ] + \epsilon i\ ri = A + \Phi 1A + \Phi 21ri-2 + \epsilon i + \Phi 1\epsilon i-1\ ri = . .. ri = A + \Phi 1A +. . . +\Phi 1i-1A + \Phi 1iri-i + \epsilon i + \Phi 1\epsilon i-1 + . . . +\Phi 1i-1\epsilon i-i+1\ A[ri] = \sum ii=-01\ \Phi 1i\ A + \Phi 1iA[ri-i]$ (69) (70) (71) (72) (73) (74) (75) 230

Blanchard, O. and D. Quah., "The Dynamic Effects of Aggregate Demand and Supply Disturbances," American Economic Review, 1989, 79 (4), 655–673. 215

231

Chari, V. V., P. Kehoe, and E. McGrattan., "A Critique of Structural VARs Using Real Business Cycle Theory," Federal Reserve Bank of Minneapolis Working Paper 631. 98

232 Luetkepohl, H., "Vector Autoregressive Models," EUI Working Paper ECO 2011/30. 233

Pagan, A. R., and G. W. Schwert., "Testing for covariance stationarity in stock market data," Economics Letters, 1990, 33(2), 165- 294

170. 234 Rossi, E., and P. S. de Magistris., "Estimation of Long Memory in Integrated Variance," Econometric Reviews, 2014, 33(7), 785-814. The value of this sum depends on the behavior of Φ1i as j increases. The expected value of the dependent variable does not depend on time. Moreover, the covariance of two expected values, let's say ri and ri+i, depends on the time lapsed j. In other words, a VAR system is stationary if the mean and variance of its variables are measurable and do not depend on time. If the VAR is stationary, all its components are stationary235. Rossi (2011) highlights that the VAR can be expressed in the following form236: [AI − Φ1A−...−ΦiAi]ri= A+ ϵi Φ(A)ri= A+ ϵi (76) (77) with Φ(A)= [AI − Φ1A−...−ΦiAi] (78) Φ(A) (A r A) matrix polynomial in L. Where ri−1 = Ari, ri−2 = $A2ri$, ArA, and AI stands for the identity matrix. The polynomial in the lag operator, Φ of (A), must be invertible for the VAR to be stationary. Setting the polynomial to 0 and replacing the lag operator L by g, we get: [AI − Φ1A−...−Φiri] (79) The characteristic polynomial is defined as: Φ(A)= [AI − Φ1A−...−Φiri] = 0 (80) Therefore, the VAR

is stationary if all the np roots of the polynomial are outside the unit imaginary circle, 250

greater than 1 in absolute value237. If one of the values, e.g., g = 1 or - 1, then the VAR is integrated of higher-order, 1 or above238. We should notice that 235 Brooks, Ch.,

Introductory Econometrics for Finance, 3rd ed. Cambridge, United Kingdom: Cambridge University Press, 252

2014. 236 Rossi, E., and P. S. de Magistris., "Indirect inference with time series observed with error," Journal of Applied Econometrics, 2018, 33, 874-89. 237

Pankratz, A., Forecasting with Dynamic Regression Models. Hoboken, NJ: John Wiley & Sons, 1991. 24

238 Glaister, S., Mathematical Methods for Economists, 3rd ed. Oxford, UK: Blackwell, Oxford, 1984. EViews calculates the inverse roots of the characteristic polynomial (λ = 1), for W example, based on the equation: [$Ai\lambda i$ − Φ1λi−1 − . . . −Φi] = 0 (81) lying within the unit imaginary circle. Any mean zero covariance-stationary process ri can be represented as a sum of all the past white noise shocks239: ri = ∑∞i=0 $\eta i\epsilon i$−i + ηi (82) and η is the matrix of coefficients, describing the responses over time of each endogenous variable to the sequence of shocks ϵi. 3.2.1.2. Lag length specification of the VAR The lag specification is crucial in a VAR system. The determination of the lag length is a critical element in the

specification of VAR models240. Braun and Mittnik (1993) emphasize the inconsistency of a misspecification VAR model241. Lütkepohl (1993) indicates that overfitting causes an increase in the VAR's mean-squared forecast errors

and that underfitting the lag length often generates autocorrelated errors242. Hafer and Sheehan (1987) find that the accuracy of forecasts from VAR models varies substantially for alternative lag 96

lengths243. Overfitting is very problematic because, as we estimate many coefficients, it might, for example, just like in our case with a moderate range of data, be that the coefficients are quite poorly estimated. Meanwhile, we have to be careful 239 Cochrane, J. H., Time Series for Macroeconomics and Finance. UK: Spring, 1997, 2005. 240 Ozcicek, O., and D. McMillin., "Lag length selection in vector autoregressive models: symmetric and asymmetric lags," Applied Economics, 1999, 31(4), 517-524. 241

Braun, P. A. and S. Mittnik., "Misspecifications in Vector Autoregressions and Their Effects on Impulse Responses and Variance Decompositions," Journal of Econometrics, 1993, 319-41. 98

242

Lütkepohl, H., "Testing for causation between two variables in higher dimensional VAR models," in H. Schneeweis & K. F. Zimmermann (eds), Studies in Applied Econometrics, Physica, Heidelberg, pp. 75–91. 32

243 Hafer, R. W., and R.

G. Sheehan., "On the Sensitivity of VAR Forecasts to Alternative Lag Structures," Federal Reserve Bank of St. Louis Working Paper 1987- 329

004A. since this might lead us to omit important variables and consequently miss essential dynamics of Montenegro's inflation model. Thus, we have to find the golden middle. In the process of selecting the appropriate

number of lags in a VAR model, the Akaike information criterion (AIC), Schwarz information criterion 221

(SC), and Hanna-Quinn information criterion (HQC) are employed in the following model244: $AAA(i) = ii|\sum\hat{i}| + R2\ i2i$ (83) $AA(i) = ii|\sum\hat{i}| + iiR\ i2i\ R$ (84) $AAA(i) = ii|\sum\hat{i}| + 2ii(iiR)\ i2i\ R$ (85) Hayashi (2000) highlights that the number of lags, minimizing the values of these criteria, can be assumed as the optimum, conditioned that the model is free of autocorrelation and that residuals are typically spread out245. Practitioner's advice (as a guide to assist in deciding for the optimum number of lags (variables) in a VAR), is to use 12 lags when working with monthly data and as a practical constraint $ii < R$: T representing the sample 3

size, n the number of variables, and p number of lags of the 299

VAR. Inverse Roots of AR Characteristic Polynomial 1.5 1.0 0.5 0.0 -0.5 -1.0 -1.5 -1 0 1 50

Figure 20:

Inverse roots of AR characteristic polynomial Source: Author's calculations 341

in EViews 11. 244

Hendry, D. F., Dynamic Econometrics. Oxford: Oxford University Press, 1995. 245 Hayashi, F., 23

Econometrics. Princeton: Princeton University Press, 2000. Table 11:

VAR lag order selection criteria Endogenous variables: LOGOIL _SA LOGALEUR _SA UN _SA 50

GDP_GAP INF Exogenous variables: C DUM_2009M06_AL DUM_2011M03_AL DUM_2013M07_AL DUM_2013M10_AL Sample: 2006M01

2015M12 Included observations: 108 Lag LogL LR FPE AIC SC HQ 0 -374.4466 NA 50

1 181.1858 1008.370 2 263.8264 142.3254 3 289.2848 41.48773 4 303.5246 21.88715 5 318.3429 21.40423 6 344.8121 35.78236 7 358.1235 16.76251 8 391.0807 38.45012 9 412.5043 23.01050 10 454.8210 41.53302 11 483.1948 25.22121 12 0.001123 7.397160 6.08e-08 -2.429367 2.10e-08* -3.496786 2.11e-08 -3.505274 2.63e-08 -3.306012 3.28e-08 -3.117462 3.35e-08 -3.144668 4.43e-08 -2.928213 4.16e-08 -3.075569 4.97e-08 -3.009339 4.16e-08 -3.330018 4.70e-08 -3.392497 563.8971 64.26288* 2.12e-08 -4.424020* 8.018024 7.648898 -1.187640 -1.925892 -1.634194* -2.741572* -1.021819 -2.498323 -0.201693 -2.047323 0.607720 -1.607036 1.201378 -1.382505 2.038697 -0.914311 2.512204 -0.809930 3.199298 -0.491962 3.499483 -0.560904 4.057867 -0.371645 3.647209 -1.151430 *

indicates lag order selected by the criterion LR: sequential modified LR test statistic (each test at 5% level) FPE: Final prediction error AIC: Akaike information criterion SC: Schwarz information criterion HQ: Hannan-Quinn information criterion Source: Author's calculations in EViews 35

11. Our model has 144 monthly observations suggesting that the number of variables in the VAR should not be larger than 4; in fact, 3 in case we used 12 lags. Let us see the behavior of the stationarity of our VAR (2) inflation model. As we can see in Figure 20,

all the inverse roots of the characteristic polynomial lie within the unit circle, confirming the 84

VAR model's stationarity.

We have reached significant results: based on the stationarity tests assessed so far, we can infer the validity of impulse response standard 1

errors246247. The largest inverse root of our VAR model's characteristic polynomial is 0.960867, accrediting our assessment of the stationarity of the VAR model. Having included 12 lags in the lag exclusion test

about deciding the maximum number of lags to be employed in our VAR (2) model, we get 1

Table 11. For each of the criteria, an appropriate lag length is denoted by an asterisk (*). In our VAR (2) model, the FPE, SC, and HQ suggest 2 lags as the fitting lag length, while AIC and likelihood ratio (LR) select 12 lags. Consistency is missing between different criteria, which might indicate the right number of lags. The dispersion of the results is too broad, and some criteria are allowing for more dynamics in the system, while the others are not suggesting such a wide gap of dynamics. Nevertheless, we keep proceeding with 2 lags, like the appropriate lag length for our VAR (2) model. Thus, we re-estimate the model. 3.2.1.3. Residual diagnostic checks of the VAR model We emphasized earlier that ri (residuals) must not be correlated (white noise) for a stationary VAR to be correctly specified248. In case errors are autocorrelated $A\{\alpha i'\alpha i-i\} \neq 0$ for some r, the estimator $\alpha 1$ îs unbiased, $A\{\alpha 1\} = \alpha 1$(but not in case if we include a lagged dependent variable), but the estimator of the coefficient standard error is no longer consistently, resulting in an unreliable t-statistic249. Table 12: VAR (2) residual covariance matrix INF LOGAL LOGOIL UN_SA GDP_GAP INF LOGAL LOGOIL UN GDP_GAP 0.4863 0.0029 0.0072 -0.0457 0.0148 0.0029 0.0072 -0.0457 0.0148 0.0022 0.0012 -0.0017 0.0005 0.0012 0.0049 -0.0011 -0.0002 -0.0017 -0.0011 0.087 0.0044 0.0005 -0.0002 0.0044 0.0277 246 Lütkepohl, H., “Asymptotic distributions of impulse response functions and forecast error variance decompositions of vector autoregressive models,”

Review of Economics and Statistics, 72: 116–125. 247 Lütkepohl, H., and D. S. Poskitt., “Estimating orthogonal impulse responses via vector autoregressive models,” Econometric Theory, 185

1991, 7, 487–496. 248

Granger, C. W. J., “Some properties of time series data and their use in econometric model specification,” Journal of Econometrics, 1981, 16, 121–130. 269

249

Poskitt, D. S., and Lütkepohl, H., “Consistent specification of cointegrated autoregressive moving average systems,” Discussion Paper 54, SFB 373, Humboldt-Universität zu Berlin, 32

1995. .3 .2 .1 .0 -.1 -.2 -.3 06 07 1.6 1.2 0.8 0.4 0.0 -0.4 -0.8 -1.2 -1.6 06 07 2 1 0 -1 -2 06 07 08 08 08 Source: Author’s calculations in EViews 11. VAR Residuals LOGOIL_SA Residuals 09 10 11 12 UN_SA Residuals 09 10 11 12 INF Residuals 09 10 11 12 13 14 13 14 13 14 .2 .1 .0 -.1 -.2 15 -.3 06 1.2 0.8 0.4 0.0 -0.4 -0.8 15 06 15 LOGALEUR_SA Residuals 07 08 09 10 11 12 13 GDP_GAP Residuals 07 08 09 10 11 12 13 Figure 21: VAR (2) residuals Source: Author’s calculations in EViews 11. 14 15 14 15 Mean forecasting performance will worsen with the presence of autocorrelation of errors, and confidence bounds will be either too wide or too narrow250. Plotting the residuals in EViews 11, we get Figure 21. The first

noticeable thing is that some residuals vary above and below the mean in specific periods, especially around the crisis episodes in 2008. The attributes inherent in and communicated by these residuals are valuable to us, and we have to keep them in mind since they produce specific effects251. Proceeding with the analysis, we get the covariance matrix of the residuals in Table 12. As long as the off diagonals are not zeros, there is autocorrelation among 250

Box, G. E. P., and G. M. Jenkins., Time Series Analysis: Forecasting and Control, San Francisco: Holden-Day, 1976. 151

251

Jarque, C. M., and A. K. Bera., "A test for normality of observations and regression residuals," **International Statistical Review, 1987, 55, 163–** 219

172. residuals252. Since we have not defined the shocks yet (which is the problematic issue, identifying the structural model), it is still expected to have errors correlated253. Exploring the properties of our VAR model's residuals, we get the correlogram of residuals of our VAR model, Figure 22. Table 13: VAR residual serial correlation LM tests with 2 and 3 lags VAR with 2 lags VAR with 3 lags Lags LM-Stat Prob LM-Stat Prob 1 34.08133 0.1062 21.59529 2 40.58314 0.0254 21.72868 3 18.75179 0.8089 27.85776 4 18.15730 0.8356 18.23873 5 26.71583 0.3702 26.35556 6 22.76041 0.5916 18.15460 7 34.42207 0.0992 35.18603 8 26.38435 0.3873 34.28241 9 19.58194 0.7684 16.74204 10 20.38099 0.7266 26.95871 11 25.48733 0.4353 16.67007 12 69.78283 0.0000 53.05919 0.6590 0.6514 0.3144 0.8321 0.3888 0.8358 0.0849 0.1020 0.8909 0.3580 0.8934 0.0009

Probs from chi-square with 25 df. Source: Author's calculations in **EViews** 35

11. Specified at 12 lags and with 2 standard error bounds, it shows the correlations of each variable with the others. For instance, in the first row, we see the autocorrelation of residuals among inf and the other variables, and so on. Looking at short term error correlations of the estimated VAR (2), practically at 1st lags, all the lines lie within the 2 standard error bounds suggesting no autocorrelation. Another back up

to the suggestion of missing autocorrelation is **non-noticeable continual wave sinusoidal.** 1

Continuing testing for residuals autocorrelation in our VAR model, we get Table 13. 252 Del Negro, M., and F. Schorfheide., "Montetary Policy Analysis with Potentially Misspecified Models," American Economic Review, 99, 1415-1450. 253 Den Haan, W. J., and Th. Drechsel., "Misspecification in Macroeconomics: Difficult but Not Impossible to deal with," Centre for Macroeconomics and London School of Economics and Political Science, 2019. Based on the

95% significance level, the null hypothesis that **there is no autocorrelation of residuals in our estimated** 1

VAR (2) model can be rejected with 2 lags, with p=2.54% for lag orders up to 2. But still, for orders up to 1,

there is no indication based on the LM test **that there is** a correlation **of errors.** 1

This finding suggests we should amend our VAR model with more lags, as indicated by AIC and LR. The estimated VAR (3) model with 3 lags suggests no autocorrelation based on the LM test, as seen in panel B of Table 13. We choose to proceed with the VAR (3) model, as suggested by the LM test panel B in Table 13. The test indicates no autocorrelation of residuals for lag orders up to 11. The VAR (3)

fitted to this data would have the form: $ri = A111ri$ **−1** $+ A112\pi i$ **−1** $+ A113rii$ **−1** $+ A114Airi$ **−1** $+ A115iiii$ **−1** 9

$+ A211ri{-}2 + A122\pi i{-}2 + A123rii{-}2 + A124Airi{-}2 + A125iiii{-}2 + A131ri{-}3 + A132\pi i{-}3 + A133rii{-}3 + A134Airi{-}3 + A135iiii{-}3 + A1i$ (86) $\pi i = A121ri{-}1 + A122\pi i{-}1 + A123rii{-}1 + A124Airi{-}1 + A125iiii{-}1 + A221ri{-}2 + A222\pi i{-}2 + A223rii{-}2 + A224Airi{-}2 + A225iiii{-}2 + A231ri{-}3 + A322\pi i{-}3 + A233rii{-}3 + A324Airi{-}3 + A235iiii{-}3 + A2i$ (87) $rii = A131ri{-}1 + A132\pi i{-}1 + A133rii{-}1 + A134Airi{-}1 + A135iiii{-}1 + A231ri{-}2 + A322\pi i{-}2 + A233rii{-}2 + A324Airi{-}2 + A325iiii{-}2 + A331ri{-}3 + A332\pi i{-}3 + A333rii{-}3 + A334Airi{-}3 + A335iiii{-}3 + A3i$ (88) $Airi = A141ri{-}1 + A142\pi i{-}1 + A143rii{-}1 + A144Airi{-}1 + A145iiii{-}1 + A241ri{-}2 + A422\pi i{-}2 + A243rii{-}2 + A424Airi{-}2 + A425iiii{-}2 + A431ri{-}3 + A432\pi i{-}3 + A343rii{-}3 + A434Airi{-}3 + A435iiii{-}3 + A4i$ (89) $iiii = A151ri{-}1 + A152\pi i{-}1 + A153rii{-}1 + A154Airi{-}1 + A155iiii{-}1 + A251ri{-}2 + A522\pi i{-}2 + A253rii{-}2 + A524Airi{-}2 + A525iiii{-}2 + A531ri{-}3 + A532\pi i{-}3 + A353rii{-}3 + A534Airi{-}3 + A535iiii{-}3 + A5i$ (90) Maintaining price stability in Montenegro through governance of external and internal factors of inflation Cor(INF,INF

(-i)) .4 .0 -.4 2 4 6 8 10 12 Cor(LOGALEUR_SA,INF **(-i)) .4 .0 -.4 2 4 6 8 10 12 Cor(** LOGOIL_SA,INF **(-i)) .4 .0 -.4 2 4 6 8 10 12 Cor(** UN_SA,INF **(-i)) .4 .0 -.4 2 4 6 8 10 12 Cor(** GDP_GAP,INF **(-i)) .4 .0 -.4 2 4 6 8 10 12** 12

Autocorrelations with Approximate 2 Std.Err. Bounds Cor(INF,LOGALEUR_SA(-i)) Cor(INF,LOGOIL_SA(-i)) Cor(INF,UN_SA(-i)) .4 .0 -.4 2 4 6 8 10 12 Cor(LOGALEUR_SA,LOGALEUR_SA(-i)) .4 .0 -.4 2 4 6 8 10 12 Cor(LOGOIL_SA,LOGALEUR_SA(-i)) .4 .0 -.4 2 4 6 8 10 12 Cor(UN_SA,LOGALEUR_SA(-i)) .4 .0 -.4 2 4 6 8 10 12 Cor(GDP_GAP,LOGALEUR_SA(-i)) .4 .0 -.4 2 4 6 8 10 12 .4 .0 -.4 2 4 6 8 10 12 Cor(LOGALEUR_SA,LOGOIL_SA(-i)) .4 .0 -.4 2 4 6 8 10 12 Cor(LOGOIL_SA,LOGOIL_SA(-i)) .4 .0 -.4 2 4 6 8 10 12 Cor(UN_SA,LOGOIL_SA(-i)) .4 .0 -.4 2 4 6 8 10 12 Cor(GDP_GAP,LOGOIL_SA(-i)) .4 .0 -.4 2 4 6 8 10 12 .4 .0 -.4 2 4 6 8 10 12 Cor(LOGALEUR_SA,UN_SA(-i)) .4 .0 -.4 2 4 6 8 10 12 Cor(LOGOIL_SA,UN_SA(-i)) .4 .0 -.4 2 4 6 8 10 12 Cor(UN_SA,UN_SA(-i)) .4 .0 -.4 2 4 6 8 10 12 Cor(GDP_GAP,UN_SA

(-i)) .4 .0 -.4 2 4 6 8 10 12 Cor(INF,GDP_GAP **(-i)) .4 .0 -.4 2 4 6 8 10 12 Cor(** 12

LOGALEUR_SA,GDP_GAP(-i)) .4 .0 -.4 2 4 6 8 10 12 Cor(LOGOIL_SA,GDP_GAP(-i)) .4 .0 -.4 2 4 6 8 10 12 Cor(UN_SA,GDP_GAP(-i)) .4 .0 -.4 2 4 6 8 10 12 Cor(GDP_GAP,GDP_GAP(-i)) .4 .0 -.4 2 4 6 8 10 12 Figure 22: Correlogram specification-autocorrelations with 2 std.err. bounds Source: Author's calculations in EViews 11. 116 Thus, from the New Keynesian perspective, we have chosen in the above model VAR (3) ri, πi, rii, $Airi$, and $iiii$ to analyze in-depth the above variables that might help macroprudential policymakers of Montenegro to understand better macroeconomic stabilization and outcomes by the government (using fiscal policy) and the central bank (using monetary policy). 3.2.1.4. VAR residual heteroskedasticity tests The assumption of homoskedasticity states

that the variance of **the** unobserved **error, u, conditional on the explanatory variables, is** 16

constant254. Wooldridge (2013) explains that

> **homoskedasticity fails whenever the** variation **of the** unobserved factors change **across different** population **segments,** where **the population segments are determined by the different values of the explanatory variables:** 16

if the errors are time-dependent, $\sigma i2$, then we deal with heteroskedasticity. Let us consider a straightforward model of inflation in Montenegro with one lag to see heteroskedasticity's consequences in forecasting performance. For simplicity reasons, we will estimate a wrong model assuming the variance is constant. Still, in reality, it is heteroskedastic and a simple inflation model in Montenegro with generalized autoregressive conditional heteroskedasticity (GARCH) errors, which takes into account the time variance. Table 14: One period ahead forecast assessment Forecast evaluation h=1 Correct (DGP) Model Incorrect Model RMSE 0.596938 0.607497 Bias -0.106341 -0.105529 S.E. 0.616060 0.627461 *Forecasting period: 2017:2 2017:12 Source: Author's calculations in EViews 11. Moreover, we will compare the wrong and correct model in terms of forecasting performance. Based on the above results, we see RMSEs of the correct (0.5969) and incorrect model (0.6074) in one period ahead. The forecasting performances are not 254

> **Wooldridge, J. M., Introductory Econometrics: A Modern Approach. Ohio: South-Western,** 72

2013. different a lot. While for the multiperiod ahead forecasting performance of our simple model, we can observe that the forecast standard error of the GARCH model is lower than the model that estimates the forecasting performance without considering the time varianceFdoerpeecnadsetnscytd.. errors: Incorrect (OLS) vs. Correct (GARCH) regression .5 .4 .3 .2 .1 I II III IV 2017 INF_GARCH_SE INF_OLS_SE Figure 23: Multiperiod ahead forecasting performance of simple inflation model Source: Author's calculations in EViews. The estimates of confidence bounds in Figure 23 show that the model, which includes the GARCH errors, is more inclusive, tending to stabilize the interval of uncertainty. In contrast, the incorrect model tends to have confidence bounds to infinity, worsening forecasting performance uncertainty. The presence of heteroskedasticity does not impact the mean forecast255. Turning to our true VAR (3) model, there is one test that we will apply to test whether the residuals are heteroskedastic or not. Table 15:

> **VAR residual heteroskedasticity tests: no cross-terms Chi-sq. df Prob.** 628.3370 510 **0.** 257

0003 Source: Author's calculations in EViews 11. Since the p=0.0003, we can reject the null hypothesis of homoskedasticity. Heteroskedasticity does not affect model forecasting performance in terms of the mean forecast, as seen in Figure 24. However, if we decide to account for heteroskedasticity, 255 Park, R.E., "Estimation with Heteroscedastic Error Terms," Econometrica, 1966, 34(4), 888. we would need to reformulate our model as a system and use multivariate GARCH specification to model the variance-covariance matrix. Mean forecast and 95% confidence intervals: Incorrect (OLS) vs. Correct (GARCH) 3.0 2.5 2.0 1.5 I II III IV 2017 INF INF_OLS_F INF_OLS_F+1.96*INF_OLS_SE INF_OLS_F-1.96*INF_OLS_SE 2.8 2.6 2.4 2.2 2.0 1.8 1.6 I II III IV 2017 INF INF_GARCH_F INF_GARCH_F+1.96*INF_GARCH_SE INF_GARCH_F-1.96*INF_GARCH_SE Figure 24: Mean forecast and 95% confidence intervals: Incorrect (OLS) vs. Correct (GARCH) Source: Author's calculations in EViews 11. 3.2.1.5. VAR residual normality test The presence of heteroskedasticity in our residuals from the previous findings may lead us to anticipate that there might be problems with the normality of residuals. Normality means no skewness, and expected residuals are not leptokurtic256. $\alpha\hat{\imath} = ri - \alpha 0 - \hat{}\alpha 1\hat{r}1i - \ldots - \alpha i\hat{r}ii$ (91) $A\hat{} = 1R \sum Ri=1 (\alpha\sigma r)\hat{}3$ and $A = \hat{}1R \sum Ri=1 (\alpha\sigma r)\hat{}4$ (92) $AA = (A^{\hat{}} + (I - \hat{}3)^{2} R 6 4)$ (93) No skewness means S is close to 0. No excess of kurtosis means – K is close to 3, leading Jarque- Berra test to 0. The skewness of logaleur_sa and

un_sa seem to reject the normality hypothesis, and the kurtosis of logaleur_sa, un_sa, and gdp_gap as well. The joint statistic of the Jarque-Berra test is relatively high 966 with a p-value smaller than 5%; thus, we can

reject the hypothesis that the residuals of our VAR model are normally distributed	142

jointly. We notice an excess of K, but this is not the only cause. The skewness is also present. 256 Thode, H. J., Testing for normality. New York: Marcel Dekker, 2002. 3.2.2. Forecasting performance of the estimated VAR (3) model So far, we assigned, in the above cases, some numbers to the forecast performance, such as RMSE, Bias, and SE. To understand where they come from and how to interpret these statistics, we need to elaborate on these statistics to evaluate our estimated VAR model's forecasting performance. As seen previously, we estimated the model using the data from 2006:1 till 2015:12, while the remaining data from 2016:1 till 2017:12 will be used to evaluate out-of-sample forecast performance. We can never know the future, but we can use different econometric strategies and analyze the performance afterward. For example, we can never know if tomorrow the sun will rise, but we can use the past to forecast, inductively, that tomorrow the sun will rise in the morning. Our uncertainty forecast performance will be very low because we know with high certainty the time interval, the sun will rise in Montenegro. Another question here that raises is if we would like to see the temperature when the sun rises tomorrow in Montenegro. If we are close to the actual performance, then our forecast performance will be unbiased257. The time of rewriting this dissertation is November 2020, and to make good forecasting for the temperature when the sun rises in Montenegro, one needs to repeat often forecasting from the same model to draw sound reasonable conclusions. To make proper forecasting performance evaluation, we need to make daily forecasts for each day of March and then assess and evaluate the forecasting performance. Each of our time series in the VAR model has a probability distribution, a random process. This randomness makes the prediction closely impossible to fit the actual outcome. We can assess the actual outcome and calculate the outcome number ratio to the total number of possible outcomes as a result of study and analysis. All our variables have a probability density function as long as they have an underlying data generating process (DGP)258. There can be different types of density functions, so econometricians do not deal with density functions but with models. The meaning of linearity is straight forward: a one- 257 Dées, S. and J. Güntner., "Forecasting Inflation Across Euro Area Countries and Sectors: A Panel VAR Approach," Journal of Forecasting, 2016, 36, 431-453. 258 Çınlar, E., Probability and stochastics. New York: Springer, 2011. unit increase in variable x, $A\{r|r\}$, changes the conditional mean (the expected value) of y by α1259. The distribution of y is centered about $A(r|r)$, as shown in Graph 4. $A(r|r)$ = α0 + α1A + αi (94) t Graph 4: Normal probability distribution Source: Author's simulations. The conditional means are used more frequently for modeling than density functions. The latter is more burdensome in terms of data. Even if we know all the proper variables that should be included to estimate the inflation in Montenegro, the errors should be white noise, meaning 0 mean, which in practice is not the case. The conditional mean and the error term determine the performance of the forecast to actual data260. The difference between the real data (actual) and the forecast is attributed to the distribution of true error terms. To the best of our knowledge capabilities, we cannot know the distribution of true error terms. As we expand the sample to infinity hypothetically, our best guess (even if we know all the required variables to estimate the inflation in Montenegro) is that the forecast errors are 0. Each of the explanatory variables in our VAR model has its parameters, coefficients. These variables might probably have their explanatory variables within an equation, 259 Draper N. R., and H. Smith., Applied Regression Analysis, 3rd ed.

Wiley Series in Probability and Statistics. Hoboken, NJ: John Wiley & Sons,	282

1998. 260 Tofallis, Ch., "A better measure of relative prediction accuracy for model selection and model estimation,"

Journal of the Operational Research Society, 2015, 66, 1352–1362.	332

including the error term. This phenomenon deduces to conclude that each of the variables increases the probability of uncertainty and widens the confidence interval in forecasting performance. In our case study, not only do we not know precisely the variables that should be included in the VAR in absolute terms, but there is time series for Montenegro that we cannot collect, such as real effective exchange rate, etc. Therefore, it is expected that the missing data will increase the uncertainty in our model261. The estimation of coefficients is based on random variables contributing to forecast error and uncertainty. Another source of forecast uncertainty is structural breaks262. Even though we included a fitting number of dummy variables, we proved that there are some areas left that could not be covered absolutely, increasing forecast uncertainty. Since the consumer price index (CPI) for Montenegro is available only from 2010, this increases forecast uncertainty due to not being able to manipulate with adequate ratios in the labor market, such as unit labor cost (ULC). Since labor productivity is not available, it is not possible to get to the ULC. So, we do not tempt to calculate ULC, but instead, we include unemployment coming due to price-setting and wage-setting relations. Because the random

error is the difference between the actual value, ri, **and the** estimation **(the** 309

conditional mean), $\alpha 0 + \alpha 1A$, the uncertainty is present in forecast error. Moreover, the unknown coefficients add to the forecast error together with the functional form. To conclude, there are many forecast uncertainty sources in our model that contribute to the forecast error. It is impossible to make a perfect prediction of inflation, and even if we do, we would be lucky. However, we need to quantify the forecast uncertainty of inflation. There is a set of econometric measures we will refer to evaluate our forecast performance. A forecast test can be computed to test that the model's structure has not been changed, but also the forecast quality of the model can be examined with measures of accuracy263. Bias is the first quantitative measure we will use, and it measures the difference between the actual results and the forecast. For example, if our true inflation rate is 2.2% and the forecasting 261 Little, R., and R. Donald.,

Statistical Analysis with Missing Data. Hoboken: John Wiley & Sons, 2014. 324

262 Tian, J., and Anderson, H. M., "Forecasting Under Structural Break Uncertainty," International Journal of Forecasting, 2014, 30(1), 161-175.
263

Vogelvang, E., Econometrics: Theory and Applications with EViews. Instructor's Manual. Harlow, England: FT Prentice Hall (Pearson Education), 165

2005. outcome is 2.7%, the difference of 0.5% is the bias as we can see in Graph 5. Standard forecast error measures the forecasting bands. If we say that, for example, the variance is narrow, varying from 2.6 – 2.8%, then the interval of error is not extensive, and the variation is acceptable. $\frown AiAr \frown ArAiAArA\ AirAAArr\ Arrir$ ..... 2.2% (actual) ..... 2.6% 2.7% 2.8% ..... (forecast) Graph 5: Bias and variance in forecasting outcome Source: Author's simulations. If the error variance were from 2.5% to 2.9%, the forecast error variance would be broader, lowering accuracy. As we can notice it from Graph 5, the bias and variance overlap. A combination of the two gives us the third measure, mean squared forecast error264 (MSFE). We will see down the lines that the MSE mathematically assumes both sides of the forecast symmetrically, and we must be careful in this case because we deal with inflation. The negative side of inflation means deflation, which is not symmetrical. In a large number of cases, it is more costly for a country than inflation. The

most frequently used estimator for $\sigma 2$ **is:** 265 $r2 =$ $\sum i=1(xi - \bar{x})2$ (95) i **−1** 95

$AAr[r2]$ = 2σ4 $AAA(r2|\sigma2)$ (96) i−1 Later, we will see when we perform the forecasting strategies that RMSE is very sensitive to data that jump out of its mean. For calculating the bias, it uses the average difference between the actual and the forecasting outcome. The calculation is seen in the other 264 Wackerly, D.,

W. Mendenhall and R. L. Scheaffer., Mathematical Statistics with Applications, 7th ed. Belmont, CA, USA: Thomson Higher Education, 2008. 163

265

Cho, E., and M. J. Cho., "Variance of Sample Variance with Replacement," International Journal of Pure and Applied Mathematics, 286

2009, 52(1), 43–47. forecast evaluation statistics. However, EViews 11 uses

root mean squared error (RMSE), the mean absolute error (MAE), and Theil's U 256

statistics266: $AAAA$ = $\sqrt{i}$11 ii=+ii+11$(Ai - AW,\hat{i})$ ² $\sum$ (97) AAA = $\sum ii$=+ii+11$|Ai - AW,\hat{i}|$ 1 i1 (98) 1 A = $\sqrt{i}$1 i1 $\sum ir$=+ii+11 Wr2 $\sum ir$=+ii+11$(Wr-Wd,\hat{r})$² 1 (99) We do not see Bias, MSE, SE, mean percentage error (MPE), and Theil's U2 statistics in EViews. They might be treasured to draw correct conclusions about the meaning that stands behind the economic variables. The RMSE is particularly vulnerable to atypical calculations, but MAE is not susceptible to the outliers267. After we calculate our forecasting statistics, we need to compare it to a benchmark model. An ideal model that econometricians use is the naïve model or the so-called random walk model268. It assumes the variable will remain the same as the last period. If our model statistics are worse than that of the naïve model, it is a signal that our model forecast accuracy is poor. Besides, there is a tradeoff between the number of parameters and forecast accuracy. EViews adds two more statistics: $AAAA$ = 1 i1 $\sum ii$=+ii+11 $|Wr-WWrd,\hat{r}|$ (100) $AAAAA$ A1 = 1 $\sqrt{}$ i 1 $\sum ir$=+ii+11$(Wr-Wd,\hat{r})$² i11 $\sum ir$=+ii+11 Wr2 + $\sqrt{i}$11 $\sum ir$=+ii+11 Wd2,r $\sqrt{}$ (101) We need to emphasize one thing here when calculating the MAPE in case of inflation in Montenegro. The MAPE forecast evaluation statistic can't be calculated in case the inflation is expressed as a percentage. Usually, the lower the error, the better the model, 266 EViews,

http://www.eviews.com/help/helpintro.html#page/content/ series-Forecast_Evaluation .html, accessed, 278

October 18, 2019. 267

Kim, E., and B. H. S. Kim., Quantitative Regional Economic and Environmental Analysis for Sustainability in Korea. Singapore: Springer 162

Nature, 2016. 268

Clements, M. P., and D. F. Hendry., "Forecasting economic processes," International Journal of Forecasting, 1998, 14, 226

111–131. considering all other facts and logical representation. The U1 statistic has the RMSE as the numerator, normalized by the actual and forecasted series' dispersion. The statistic of U1 lies between 0 and 1, 1 being the worst. There can be cases where U1 is smaller than its benchmark model but does not mean that it is better, making it not useful. In economic policy and forecast, Theil proposes the following formulae as a measure of forecast accuracy269: √ 1 i1 ∑ ir=+ii+11(YrY−rY−d1,r̂)² $AAAAA$ A2 = √ 1 (102) i 1 ∑ir=+ii+11(YrY−rY−r1−1)² The U1 measures the forecast accuracy while the U2 measures the forecast quality. It compares the forecast to a naïve forecast, which is not reported by the EViews: it is a ratio of RMSEs. The smaller U2, the better forecast model, meaning the forecast method applied, is accepted since it beats the most straightforward no-change extrapolation of the naïve model. In the case of the U2=0, it means a perfect forecast. It can be shown that270: AAA = AA2 + $AiAr$2 (103) AA2 = (rx − rx)̂2 + 2(1 − r)$rxrx$̂(104) where rx denotes the standard deviation of actual data, rx̂denotes the standard deviation of forecasted time series, and r is the correlation coefficient between actual and forecasted series. This break down is essential to be able to track the reason if MSE is high. From the above, we can get the bias proportion ($AiAr$²/AAA) telling us the distance of the mean forecast to the actual data mean. While the variance proportion (((rx − rx)̂/AAA)) 2 tells us how far the forecasted variance is from the original series variance. The (2(1 − r)$rxrx$̂/AAA), in equation (104), measures the covariance proportion. A right prediction has a small bias, and variance proportion with most of the error is concentrated 269

Bliemel, F., "Theil's Forecast Accuracy Coefficient: A Clarification," **Journal of Marketing Research, 1973, 10(4), 444-446.** 289

270 DeGroot, M. H., Probability and Statistics, 2nd ed. Boston, United States: Addison-Wesley, 1980. in the covariance proportion, all summing to 1271. The above ratios are very valuable since they show us the measures and error concentration. The dispersion between bias and variance proportion can be crucial in determining the forecast's accuracy and structure for policy analysis since it pinpoints straight forward to the error. For example, if we find that a large proportion is concentrated in bias, it signals the gap between the forecast and the actual series. EViews uses observations from 1 to T to estimate a model and from T+1 to T+k to evaluate forecast performance. For each period T+1 till T+k, we get forecasts, and EViews averages these statistics, not letting us know precisely the prediction for each horizon. Based on average predictions, we can't evaluate the short-run or long-run performance of our VAR (3) model. To be more precise, we need measurements for each forecasting horizon to assess the performance. As long as the environment changes over time and economic stability cannot be guaranteed, we need different strategies to help us have measurements for different horizons. Two mechanisms to evaluate prediction horizons are rolling and expanding strategies272. The rolling window keeps rolling using a fixed size. The expanding approach expands the sample size. In case the forecast parameters change at some point during the sample, these strategies should capture the instability through RMSE, Bias, or SE. The time series is split into two subsamples. Table 16: Rolling window forecast for $iiAi$ = α0 + $iiAi$−1 + αi

HORIZON h=1 h=2 h=3 h=4 h=5 h=6 h=7 h=8 28

Bias MSE RMSE SE MAE MAPE -0.023 -0.019 -0.031 -0.055 -0.097 -0.121 -0.118 -0.112 0.680 1.369 2.060 2.970 0.825 1.170 1.435 1.723 0.825 1.170 1.435 1.722 0.625 0.901 1.161 1.405 0.630 0.774 1.008 1.165 4.064 2.016 2.014 1.703 1.571 5.310 6.325 6.991 2.304 2.515 2.644 2.301 2.512 2.642 1.908 2.106 2.267 1.816 2.087 2.486 Source: Author's calculations in EViews 11. The first is from 1 to T, and h-step ahead forecasts are made till T+k enabling forecasting errors. The starting sample is then either expanded or rolled forward by an increase, and 271 Sharma, N. K., and M. Bicchal., "The properties of inflation expectations: Evidence for India," EconomiA, 2018, 19(1), 74-89. 272

Levy, H., Levy, M. S. **Solomon., Microscopic simulation of financial markets: From investor behavior to market phenomena. Orlando: Academic Press,** 153

2000. the sample is re-estimated until we reach the point of not being able to make more forecasts273. The approach brings us real error measurements of h-step ahead predictions274. These two strategies are not embedded in EViews. In Tables 15 and 16, we regress inflation on its first lag, applying rolling and expanding strategies to show the forecasting performance of an 8-step ahead forecast for 50 repeating samples. As the time horizon expands from 1 to 8, we notice that the error forecast performance of Bias, MSE, RMSE, SE, MAE, and MAPE gets worse. It is to be expected that the prediction accuracy will worsen since we are exposed to higher uncertainty in time. At some point, the conditional mean of this simple regression will stabilize. The second thing we notice is that rolling strategy has higher errors than expanding strategy, especially RMSE. The RMSE for the expanding strategy is 0.787, for h=1, while the rolling technique is 0.825. The expanding window uses more observations than the rolling or fixed window strategy, leading to a higher forecasting precision. Table 17: Expanding window forecast for $iiAi = \alpha 0 + iiAi{-}1 + \alpha i$

HORIZON h=1 h=2 h=3 h=4 h=5 h=6 h=7 h=8 28

Bias MSE RMSE SE MAE MAPE -0.131 -0.210 -0.298 -0.391 -0.496 -0.578 -0.627 -0.669 0.619 0.787 0.776 0.583 0.596 1.152 1.073 1.053 0.808 0.680 1.610 2.215 2.962 1.269 1.488 1.721 1.233 1.436 1.648 1.007 1.177 1.385 0.874 1.009 1.384 3.865 1.966 1.879 1.583 1.625 4.572 5.006 2.138 2.237 2.044 2.135 1.728 1.842 1.870 2.252 Source: Author's calculations in EViews 11. 273 Pesaran, M. H., and A. Timmermann., "Market Timing and Return Prediction under Model Instability," Economic & Social Research Council, 2002, Discussion Paper 412. 274

Hyndman, R.J., and G, **Athanasopoulos., Forecasting: principles and practice, 2nd ed. Melbourne, Australia: OTexts,** 194

2018. 3.2.2.1. Evolution of confidence interval – fan charts To make a graphical representation of the evolution of confidence interval throughout the forecasting period, we will use a technique used by England's bank in their monthly inflation report – fan charts (Bank of England 2018). In a simple AR(1) model: $ri = \alpha 0 + \alpha 1 ri{-}1 + \alpha i$ $\alpha i \sim i.i.W.(0,\sigma 2)$ (105) the forecast for one period ahead conditional on data up to t is: $r\hat{i}+1 = \alpha 0 + \alpha 1 ri$ (106) and the forecasting error is: $AA1 = r\hat{i}+1 - ri{-}1 = \alpha i+1$ and variance of forecast error $AAr(AA1) = \sigma 2$. The confidence bounds at 2 standard errors, corresponding to a 95% confidence interval (1.s.e. corresponds ≈ 60% confidence interval), is $\alpha 0 + \alpha 1 ri \pm 1.96\sigma$. As we proceed with forecasting periods ahead, the FE and $AAr(AA1)$ will get more significant than for one period ahead. It is expected to proceed into a more profound uncertainty of time, but the forecast error and its variance will stabilize after some periods. Therefore, the confidence bounds will expand as we move from period to the next. Usually, errors are not normally distributed, and we deal with bootstrapped errors, leading to an asymmetrical fan chart. 3.2.3. Forecasting the VAR model Now, we turn to our VAR model moving ahead, describing the dynamic behavior of economic variables included in the model and forecasting.

We will proceed with our VAR model **for** policy analysis and **structural inference. One** 1

of our VAR model' s primary objectives **is** predicting, **and it has common characteristics as a univariate AR model.** 1
Zivot and Wang (2006) **emphasize:**

"forecasting future values of a matrix Ai when the Π parameters are assumed to be known, and there are no deterministic terms or exogenous variables, the best linear forecaster, in terms of minimum mean squared error (MSE), of $Ai+1$ or one-step forecast" is275: 275 Zivot, E. and J. Wang., "Vector Autoregressive Models for Multivariate Time Series. In: Modelling Financial Time Series with S-PLUS," Springer Science, 2006, 385-429. $A(A + 1|A) = A + \Pi 1 AR + \ldots + \Pi iAR{-}i+1$ (107) and predictions

for longer horizons h (h-step forecasts) are obtained using the chain-rule of forecasting as: $A(A+$ $h|$ 172

$A) = A + \Pi 1 A(A + h - 1|A) + \ldots + \Pi i A(A + h - i|A)$ (108) Zivot and Wang (2006) proceed with providing the h-step forecast error, which may be expressed as276: $AR+h - A(A + h|A) = \sum hi=-01\ \Psi i \alpha R+h-i$ (109) where the matrices Ψi are determined by recursive substitution277: $\Psi i = \sum ii=-11\ \Psi i-i \Pi i$ (110) with $\Psi 0 = Ai$ and $\Pi i = 0$ for j>p. Before continuing further, we need to mention

that there are two ways of doing forecasting. The first is within the sample, which cuts the sample into two parts. The first part of the sample is used to make an estimation. The second part of the data that hasn't been included in the regression is employed for forecasting. The second option is to use all the data available and do out-of-sample forecasting. To make a forecast, we can employ known values or forecasted ones. Using the known values for prediction is static forecasting. We go back to the original data, ignore the previous forecast, and use actual value to generate the next prediction. This technique ignores any forecasting errors. In case we proceed using the forecasted values from regression, then it is dynamic forecasting. Here, if we continue to keep using the predicted values, 2

we allow forecasted errors to increment. Under fit forecasting, it becomes relevant when we have more than 276

Shephard, N., "Statistical Aspects of ARCH and Stochastic Volatility," in Cox D. R., D. V. Hinkley and O. E. Barndorff-Nielsen (eds), Time Series Models: In Econometrics, Finance and Other Fields. London: Chapman & Hall, 23

1996. 277

Waggoner, D. F., and T. Zha., "Conditional Forecasts in Dynamic Multivariate Models," Review of Economics and Statistics, 9

1999, 81(4), 639-651. one equation in a model, where each equation is treated individually without any interaction when generating a forecast. Now, let us return to our preferred specification VAR (3) model. We can proceed with the equation object to do the dynamic and static forecasting, but it is limited, and we will use the model simulator. 6 4 2 0 -2 -4 IV I 2015 .8 .7 .6 .5 .4 .3 .2 IV I 2015 24 22 20 18 16 14 12 10 IV I 2015 GDP_GAP II III IV I II III 2016 2017 Actual GDP_GAP (Baseline) LOGALEUR_SA II III IV I II III 2016 2017 Actual LOGALEUR_SA (Baseline) UN_SA II III IV I II III 2016 2017 Actual UN_SA (Baseline) IV 8 6 4 2 0 -2 IV IV 4.4 4.2 4.0 3.8 3.6 3.4 3.2 2015 IV 2015 IV I I INF II III IV I II III 2016 2017 Actual INF (Baseline) LOGOIL_SA II III 2016 IV I II III 2017 Actual LOGOIL_SA (Baseline) Figure 25: Dynamic solution – deterministic simulation Source: Author's calculations in EViews 11. IV IV

There are two types of simulation processes. One is a 1

deterministic simulation. We obtain only one value for the solution, which does not respond to shocks (yielding a single forecast rather than a distribution of possible values). It estimates under the current set of assumptions, without any innovations introduced, called the baseline. We can 2

add an alternative scenario where we change the premises of the forecast. For example, we might shock unemployment or aluminum by a 15% increase then see what happens to the forecast. The model object, or the solver, is a generalized forecasting mechanism. The model is solved for the forecast period of January 2016 till December 2017 for all endogenous variables. GDP_GAP ± 2 S.E. 10 5 0 -5 -10

IV I II III IV I II III 2015 2016 2017 29

Actual GDP_GAP (Baseline Mean) LOGALEUR_SA ± 2 S.E. 1.2 1.0 0.8 0.6 0.4 0.2 0.0 -0.2

IV I II III IV I II III 2015 2016 2017 29

Actual LOGALEUR_SA (Baseline Mean) UN_SA ± 2 S.E. 24 20

16 12 8 4 IV 2015 I II III IV 2016 I II III 267

2017 Actual UN_SA (Baseline Mean) 15 10 5 0 IV -5 IV 2015 5.5 5.0 4.5 4.0 3.5 3.0 IV 2.5 IV 2015 IV INF ± 2 S.E. I II III IV 2016 I II III 2017 Actual INF (Baseline Mean) LOGOIL_SA ± 2 S.E. I II III IV I II III 2016 2017 Actual LOGOIL_SA (Baseline Mean) Figure 26: Dynamic solution – stochastic simulation Source: Author's calculations in EViews 11. IV IV Therefore, we now have one more baseline variable helping us to analyze the actual and forecasted values. Under dynamic solution – deterministic simulation, Figure 25 plots the actual values of all endogenous series and forecasts in light green. The first and imposing thing that we can notice is that, even under the dynamic solution of the VAR model, inflation, aluminum, and oil have a right prediction, while gdp_gap and unemployment in the first quarter are doing well. Still, after that, the horizon of uncertainty expands. They start to deteriorate over time quite significantly. The model is not able to forecast unemployment, particularly. A key consideration is that it should have the price-setting and wage-setting equations that determine Montenegro's natural unemployment rate. We have a dynamic solution, which uses only the endogenous variables' actual values before the forecast sample when producing the forecast. It uses the forecasted lagged values of the endogenous variables to solve forward for the forecast period; it deteriorates over time. It is not surprising that the forecast performance deteriorates at unemployment over time as well. While this initial forecast is deterministic, it assumes that our stochastic equations would hold "determined" over the period predicted. Because of random disturbances and estimated coefficients, the

deterministic simulation ignores the fact that these relationships do not hold exactly. 1

We should account for these uncertainty sources by using stochastic simulations. As seen in Figure 1

26, confidence bands are plotted in red. The first eye- catching thing is that the GDP gap, inflation, oil, and aluminum are within the confidence bands, taking into account the coefficient uncertainty, increased repetitions to 10,000, and bootstrap innovation generation. Figure 27 is the stochastic simulation for the static solution model simulator for the period 2016m01 till 2017m12. To view the forecast with confidence bands, we propose to make a graphical representation. What can be noticed from Figure 27? The static solution performs better than the dynamic solution,

both in terms of the fit and smaller **standard error bounds.** It comes **as a result of de facto one period ahead forecast.** 1 **It uses actual instead of forecasted lagged values over the forecast period. The**

whole picture has taken a better perspective with one period ahead forecast instead of a multi-period ahead forecast (dynamic). To have a better view of the differences between simulation scenarios and solution types, we created Figure 28. What can be noticed? We can observe from Figure 28 that the stochastic-static model predicts way better the actual inflation than stochastic-dynamic because it uses the actual lagged values to forecast one-step ahead. The stochastic- dynamic uses lagged forecasted values to forecast one-step ahead, accumulating errors and creating a gap widening deeper for each forecasted period ahead. The blue line represents the actual inflation, the black line shows the stochastic-static model's predicted values, and the smooth dark green line displays the stochastic-dynamic model. Until the middle of the second quarter of 2017, both models comove with actual inflation, and after that period, the gap starts to widen. But still, by the end of 2017, the confidence bands normalize and stabilize, as shown previously in the theoretical section of forecasting. 1.2 0.8 0.4 0.0 -0.4 -0.8 -1.2 IV 2015 1.0 0.8 0.6 0.4 0.2 0.0 IV 2015 24 22 20 18 16 14 IV 2015 GDP_GAP ± 2 S.E. I II III IV I II III 2016 2017 Actual GDP_GAP (Baseline Mean) LOGALEUR_SA ± 2 S.E. I II III IV I II III 2016 2017 Actual LOGALEUR_SA (Baseline Mean) UN_SA ± 2 S.E. I II III IV 2016 I II III 2017 Actual UN_SA (Baseline Mean) IV IV IV 6 4 2 0 -2 -4 IV 2015 4.4 4.2 4.0 3.8 3.6 3.4 3.2 3.0 IV 2015 INF ± 2 S.E. I II III IV 2016 I II III 2017 Actual INF (Baseline Mean) LOGOIL_SA ± 2 S.E. I II III IV I II III 2016 2017 Actual LOGOIL_SA (Baseline Mean) Figure 27: Static solution – stochastic simulation Source: Author's calculations in EViews 11. IV IV Figure 28 has included bootstrapped errors and coefficient uncertainty. In EViews, innovation generation controls how the errors are generated or re-sampled. It gives us the option of doing normal random numbers, in which case it draws from the normal distribution with mean zero and a particular variance one can set. 8 6 4 2 0 -2 -4

IV 2015 I II 2016 **III IV I II** 2017 **III IV I IV 2018** 29

INF INF (Scenario 3 Lower) INF (INF_3M) INF (Scenario 3 Upper) INF (Scenario 3 Mean) Figure 28: Stochastic-static and stochastic-dynamic of actual and forecasted values Source: Author's calculations in EViews 11. 3.3.Alternative scenarios The CBCG and the Ministry of Finance would be interested to hypothetically see the reaction of inflation in different scenarios, such as an increase in the price of oil, aluminum, or growth of gdp_gap into inflation. Why? Even though this is not the determinate solution to the model, at this stage, we are interested in seeing the results of alternative forecasting scenarios. Let us observe how inflation changes when we change one of our variables' assumptions by some amount. We have created an alternative scenario solution to assess the increase of unemployment shock to inflation in Montenegro. The alternative scenario starts altering data from January 2016 till December 2017. Hypothetically, we increase unemployment from 1 point to 3.3, corresponding from 6.03% to 30.30%. In Figure 29, we compare the new alternative scenario in green, the baseline scenario in red, and the historical data in blue. Notice that unemployment is higher than before, as have specified it, and inflation is closer to the actual data. 6 4 2 0 -2 -4 IV I 2015 .8 .7 .6 .5 .4 .3 .2 IV I 2015 GDP_GAP II III IV I II III 2016 2017 Actual GDP_GAP (Scenario 1) GDP_GAP (Baseline) LOGALEUR_SA II III IV I II III 2016 2017 Actual LOGALEUR_SA (Scenario 1) LOGALEUR_SA (Baseline) UN_SA IV 8 6 4 2 0 -2 IV IV 4.4 4.2 4.0 3.8 3.6 3.4 3.2 2015 IV 2015 INF I II III IV I 2016 Actual INF (Scenario 1) INF (Baseline) LOGOIL_SA

I II III IV I 2016 **II III IV** 2017 **II III IV 2017** 29

Actual LOGOIL_SA (Scenario 1) LOGOIL_SA (Baseline) 24 22 20 18 16 14 12 10

IV I II III IV I II III IV 2015 2016 2017 Actual 43

UN_SA (Scenario 1) UN_SA (Baseline) Figure 29: Deterministic – dynamic alternative scenario of unemployment increase Source: Author's calculations in EViews 11. One of the many reasons for higher unemployment might be, for example, higher unemployment benefits, as was the case in 2017 with early pensioned women with three children. People who have more income are less interested in searching for a job, directly increasing wages and unemployment. The other factors that might affect the unemployment equilibrium are the shadow economy, letting firms have a higher potential impact on the market, and increasing prices. Furthermore, this means that the real wages paid by firms would decrease, consequently increasing unemployment. The facts in Figure 29 are consistent with the economic theory and real data, but it still does not say anything about causality. Usually, the VAR coefficient interpretation is not an easy process because there is no theoretical concept in economics that interprets them. It is recommended to move one step ahead and estimate impulse responses, giving us the causality. Higher unemployment, meaning that the actual unemployment is higher than the natural rate, the output is below potential, and the output is negative278: $A - Ai = -A(r - ri)$ (111) In our case, as unemployment increased in an alternative scenario, the output gap in the alternative scene, in the green line, is below the baseline line in red for the whole year of 2016. After the first quarter of 2017, the output gap gets higher. Once more, this does not show the causality of the relationship between inflation and unemployment. We need to move to impulse responses, which shows the response of inflation, the VAR's dependent variable, to shocks in the errors. As a potential external factor, we have embedded an alternative scenario of the oil price increase. The reasons for such an increase are different, and it is beyond the scope of this study. In 2008, the global financial crisis led to a drop in demand and decreased oil prices. The

Organization of Petroleum Exporting Countries (OPEC) 279, **in the 1970s,** controlled the **oil** 131

industry and increased oil prices, while in 2000, China increased the oil demand. As a result, oil prices increased280. Causes for price increase might be many in the future, 278 Ball, L., D. Leigh, and P. Loungani., "Okun's Law: Fit at 50?," IMF Working Paper, 2013, WP/13/10. 279 The Organization of the Petroleum Exporting Countries (OPEC), https

://www.opec.org/opec_web/en/about_us/24.htm, accessed, 283

October 22, 2019. 280

Baffes, J., M. A. Kose, F. Ohnsorge, and M. Stocker., "The Great Plunge in Oil Prices: Causes, Consequences, and Policy Responses," World Bank Group, **Policy Research Note, /15/01,** 60

2015. as oil is the primary energy source for production. The logical question is:

What would be the impact of an increase in **oil price on the** 315

Montenegrin economy? 6 4 2 0 -2 -4 -6 IV I 2015 1.0 0.8 0.6 0.4 0.2 IV 2015 I 24 22 20 18 16 14 12 10 IV 2015 I $AAA = WWWWi\ IWWiii\ PiiWiWiiiiix$ GDP_GAP II III IV I II III 2016 2017 Actual GDP_GAP (Scenario 2) GDP_GAP (Baseline) LOGALEUR_SA II III IV I II III 2016 2017 Actual LOGALEUR_SA (Scenario 2) LOGALEUR_SA (Baseline) UN_SA II III IV I II III 2016 2017 Actual UN_SA (Scenario 2) UN_SA (Baseline) IV 10 8 6 4 2 0 -2 IV IV 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2015 IV 2015 IV I I (112) INF

II III IV I II III IV 2016 2017 Actual 43

INF (Scenario 2) INF (Baseline) LOGOIL_SA

II III IV I II III IV 2016 2017 Actual 43

LOGOIL_SA (Scenario 2) LOGOIL_SA (Baseline) Figure 30: Deterministic – dynamic alternative scenario of oil price increase Source: Author's calculations in EWiews 11. A better way would have been as if we had the productivity price index and then see the effect of such an increase in the productivity price set by Montenegro's companies. The result comes as a lack of time series of ULC as a determinant of unemployment rather than wages. The labor productivity at the time of writing is not available for Montenegro. Therefore, we consider the labor market equilibrium as the effect of the price-setting set by firms and wage-setting set by wage setters, which is unemployment281. The impact of oil price is multidimensional in Montenegro. It affects the production, consumers, government, investors, Tax Administration of Montenegro (TAM) through excise and taxes. The innovation of an increase in oil prices might come endogenously from fiscal policies due to fiscal consolidation. We can observe this from the side of firms that set prices on the relation with unemployment. The increase in oil prices increases production cost, pushing companies to raise rates to keep in an existing profit margin. The alternative scenario starts altering data from January 2016 till December 2017. Hypothetically, we increase oil prices from 0.5 points to 1.65, corresponding from 14.01% to 40.0%. As Figure 30 demonstrates, in the case of oil price increases, consumers do not have the same real value of money anymore. Real wages

1/1+ m A PS 1/1+ m' A' A'' PS' WS' WS u n u'n u'n' Unemployment rate, u 167

Graph 6: Increase in oil price and unemployment Source: Author's simulations. Their real wages decrease, leading to a rise in unemployment because workers must accept this reality. GDP gap would decrease three-four months, and inflation would 281 Blanchard, O., Macroeconomics, 7th ed. Harlow, UK: Pearson, 2017. increase. In case we would like to characterize the behavior of unemployment, GDP gap, and inflation, it would be great to show their interconnectivity in a graphical format. When confronted with a macroeconomic question about a shock or a policy, the income- spending, monetary - policy, and Phillips curve (IS-LM-PC) is a typical model to start the analysis and implications282. The horizontal line, PS, in Graph 6, represents the price- setting relation: W 1 P = 1+i (113) An increase in oil prices (markup m) pushes firms to increase prices, and consequently, real wages decrease. Suppose that the Ministry of Finance of Montenegro increases excise tax in oil prices, driving the market to increase its prices to maintain the marginal profit. The nominal wage we get paid does not change, but the power of our money in the market has changed since we can't buy the same consumption basket we could have purchased prior to the change. The higher the excise tax, the lower our real wages. The scheme is the interpretation of economic movement from PS to PS'. The simplifying assumption that labor returns are constant in production makes the PS line flat, but if the returns were decreasing, we would have a downward sloping curve. The opposite happened, for example, when the Government of Montenegro pensioned women with three kids in 2017. It increased the WS in Graph 6, moving the economy along the PS', shifting from WS to WS' – A'', increasing the natural rate of unemployment. In case we analyze from a different perspective, labor market, we get labor supply and labor demand. Having not in control the market of wages, it brings to scene a situation of a competitive market283. In this case, no cartels control the market, but everyone in the labor market participates individually, determining the market price, equilibrium284. Equilibrium means that all labor force in the market selects freely. For any other wage different from 282 Ibid. 283

Leonard, J., "Wage Expectations in the Labor Market: Survey Evidence on Rationality," Review of Economics and Statistics, 1982, 64, 157– 334

161. 284

Staiger, D. O., J. Spetz, and C. S. Phibbs., "Is There Monopsony in the Labor Market? Evidence from a Natural Experiment," Journal of Labor Economics, 2010, 28, 211–236. 181

the equilibrium, some labor force would alter their behavior. It can't keep continuing for a long time because workers in the market are motivated to change their behavior. The compatibility of the labor supply and demand is the optimal point. For wages that are lower than the equilibrium, firms' demand is higher than the workforce willing to offer work. It implies a labor force ready to offer work at a higher wage to the firms demanding the labor force. The dynamics will end up to the point where demand and supply are equal. For wages higher than the optimum, companies are unwilling to pay, driving down to the equilibrium. The competitive market will be at equilibrium only when the labor force equals the supply force. IS AA" rn' LM' rn AA' LM Yn' Yn GDP PC' PC π - π t -1 A' 0 A" A GDP Graph 7: IS-LM-PC equilibrium Source: Author's simulations. Increase of oil price, because excise tax, for instance, shifts the PS to PS' lowering the real wage from (W/P) to (W/P)' (because firms must pay a higher excise tax and thus reducing wages) pushing an increase in unemployment. Having assumed the proportion of units produced to the number of workers involved, then output decreases. Let us start from the optimum point A in Graph 7, where the market is in equilibrium. Hypothetically, having decided with fiscal consolidation policy and increasing the excise tax, the output gap decreases to Ai', leading firms to increase their prices, causing inflation to increase from PC to PC'285. It moves the economy from A to A'. It is the turn of the CBCG to increase the interest rate to slow down the heating of inflation, driving the economy to A". The dynamic mechanism of decreasing output correlated with increasing inflation is known as stagflation286. When the output is shrinking, inflation keeps growing until the CBCG intervenes with economic policies and turns the equilibrium in the medium run. Most probably, the Government of Montenegro, in this case, would have placed the fiscal policy into action, shifting the IS curve to the left through many budgetary mechanisms. In this case, the oil producers, for example, in the Middle East, would have a higher demand for their goods since they have more income, profiting from the price increase. Consequently, this would be reflected in less market demand for the European Union and Montenegro. The role of expectations explains the margin of inflation in the 1970s and 2000 in the United States. In case changes in the oil price (excise tax or stock market) in Montenegro are not associated with changes in inflation expectations, then they will remain constant, and the Government of Montenegro will have a much easier job. Is it to be expected that inflation expectations will remain constant? What determines inflation expectations? Suppose people have a strong belief in the stability of the macroeconomic environment. In that case, it is to be expected that they believe that the Government is making the right move to benefit Montenegro's future. But suppose some agents are motivating and promoting instability, especially in a small country in transition. In that case, expectations might change, and potential investors might expect inflation to continue increasing287. Prospects of a lower inflation rate in the future and stable expanding growth shifts the demand up to increasing spending and output. Thus, although a straight impact of excise tax on unemployment, production, and inflation is limited, 285 Dornbusch, R., S. Fischer and C. Kearney., Macroeconomics. Sydney: The Mc-Graw-Hill Companies, Inc., 1996. 286

Gokal, V., and S. Hanif., "Relationship between inflation and economic growth," Reserve Bank of Fiji, Working Paper, 2004/04. 224

287 Todaro, M.P. Economic Development. New York: Addison Wesley Longman, Inc., 2000. changes in expectations are to be taken seriously by the policymakers of Montenegro, especially in front of accessing the European Union. Political stability plays an important role, as well. The effects of macroeconomic policies depend fundamentally on its impact on expectations. Therefore, if the inflation expectations remain unchanged because of higher excise tax and citizens believe this is for their current and future benefit, the effects of such an increase will be much limited in inflation and output growth288. In opposite, it could get the country into e deep recession. If expectations play such an important

role, the logical question is whether macroeconomists can bring forward any valuable forecasting about the future. The answer is yes. People form their expectations based on the era of information and knowledge, starting from the internet to brokers, news, banks, and other agents in the market worldwide289. Thus, these futuristic expectations are very logical, so-called rational expectations. Let us turn back to Figure 30. We notice that unemployment in this scenario is expected to be lower than predicted by the baseline, making us think that unemployment equilibrium might be affected by some other factors. The aluminum price changes drastically, which is expected since its production depends on the energy of oil. The GDP gap stays close to the baseline for three quarters of 2016, and after that starts to decline as explained previously. Inflation systematically follows the dynamic vibes of the benchmark, increasing as expected. By the second quarter of 2017, it stabilizes and starts to decline following the decline of the GDP gap, which signifies that the citizens' expectations remained constant, and the Government of Montenegro anchored its expectations. We can stipulate here that the unemployment curve might be very steep, inelastic to changes in the price-setting curve to oil changes, even though we should include adequate time series as mentioned previously that are related to unemployment. Nevertheless, we might think that unemployment insurance and employment protection 288

Bank for International Settlements., Inflation mechanisms, expectations and monetary policy. 141

Monetary and Economic Department, Papers No 89, 2016. 289 Giacomini, R., “Economic theory and forecasting: lessons from the literature”, Econometrics Journal, 2015, 18, C22–C41. are two potential variables associated with wages and unemployment elasticity. It remains to be further examined in other researches. 6 4 2 0 -2 -4 -6 IV I 2015 1.0 0.8 0.6 0.4 0.2 IV 2015 I 24 22 20 18 16 14 12 10 IV 2015 I GDP_GAP II III IV I II III 2016 2017 Actual GDP_GAP (Scenario 5) GDP_GAP (Baseline) LOGALEUR_SA II III IV I II III 2016 2017 Actual LOGALEUR_SA (Scenario 5) LOGALEUR_SA (Baseline) UN_SA II III IV I II III 2016 2017 Actual UN_SA (Scenario 5) UN_SA (Baseline) IV 10 8 6 4 2 0 -2 IV IV 4.4 4.2 4.0 3.8 3.6 3.4 3.2 2015 IV 2015 IV INF I II III IV I 2016 Actual INF (Scenario 5) INF (Baseline) LOGOIL_SA

I II III IV I 2016 **II III IV** 2017 **II III IV 2017** 29

Actual LOGOIL_SA (Scenario 5) LOGOIL_SA (Baseline) Figure 31: Deterministic – dynamic alternative scenario of aluminum LME price Source: Author’s calculations in EViews 11. It would be interesting to see one of the last alternative scenarios of our VAR(3) model in case we change the price of aluminum. A hypothetical change of aluminum price from 0.01 to 0.24 points, respectively, from 3.1%% to 57.3% is applied to observe the potential ability to predict such shocks to Montenegrin economy from outside, exogenous, meaning out of our direct control. The first noticeable thing is that the model predicts inflation higher than the baseline model but closer to the baseline than in the oil price increase. The same behavior is observed with the GDP gap. It stays more relative to the baseline than in the case of oil price alternative scenarios. Note, however, that so far, we have not been able to say anything about causality. This topic will be taken up in the following session. 3.4.Structural vector autoregressive model There is no conceptual background that interprets VAR coefficients like multivariate regression models290. Sims was one of the first to interpret the VAR coefficients through impulse responses, a fascinating macroeconomics development291. What does the impulse response do? It observes the response of the dependent variable to shocks in the errors. The whole problem here is to identify these shocks, and once defined; we can observe the response of inflation and other variables in the VAR model292. Thus, interpretation then becomes easy. However, at the time being, we can observe only the composed reduced form errors, and we need them separate – individual – to know relation shock – error – dependent variable. Thus, the reduced form contains errors that are made up of a combination of structural errors that need to be identified293. Without SVAR analysis, one could reach wrong conclusions because of not individualizing errors in the structural VAR model. For example, suppose we anticipate that unemployment will increase. The macroprudential policymakers of the Government of Montenegro control to the best of knowledge the markups (m), the shadow economy, 290

Akaike, H., "Fitting autoregressive models for prediction," **Annals of the institute of Statistical Mathematics, 1969, 21(2), 243-247.** 193

291 Sims, C. A., "Macroeconomics and reality," Econometrica, 1980, 48(1), 1-48. 292 Caldara, D., and C. Kamps., "What are the effects of fiscal policy shocks? A VAR-based comparative analysis," European Central Bank working paper series, 2008, 877. 293

Lütkepohl, H., New Introduction to Multiple Time Series Analysis. Berlin: Springer, 2005. 24

and the unemployment gap continues to widen. In that case, we cannot conclude that controlling better the markups led to a rise in unemployment. The markup control was endogenous to the anticipated unemployment. The markups-policy reacted to the expected unemployment. One could say that the unemployment would have been higher had the policymakers not taken any action or that it takes time for the markups-policy to impact reducing unemployment in Montenegro. Thus, the policymakers' reaction was not exogenous, and this is not what we would like to calculate. In the meantime,

we would like to measure and **know the impact the policy** has on **the** 146

GDP gap and inflation in Montenegro. Based on this structure, we cannot tell apart the effect of the markups-policy into the other variables of the VAR model. From the perspective of fiscal policy, let us consider that the policymakers of Montenegro are expecting e decrease in demand, and then decrease the excise tax of oil, making higher the deficit. However, still, the output gap continues to widen. We might conclude incorrectly that reducing the excise tax of oil caused the output to decline. As in the example before, the same inference might be reached by deducing logically that the fiscal authorities' reaction was endogenous to the expected reduction in consumption, demand. We can not measure the impact of markups or excise tax while unemployment and market are reacting to other variables' movements. If many variables affect unemployment contemporaneously, we should aim to measure only the impact of the variable we are interested in examining. Thus, to trace the dynamics of policy, we need to identify solely exogenous shocks, autonomous activities to observe the Montenegrin economic reaction. This reaction is called an impulse response. We would like to know completely exogenous shocks to markups and excise tax, for example. The mechanism drives us to the identification of the

structural model, which **isolates purely exogenous shocks and gets the responses of the endogenous variables after** these shocks hit **the** 48

economy294. After identifying the structural errors, we can compute the responses of dependent variables and make predictions, for example, what will happen to inflation in Montenegro if fiscal authorities decrease the excise tax or control the shadow economy. 294 Christiano, L. J., "Christopher A. Sims and Vector Autoregressions," Scand. J. of Economics, 2012, 114(4), 1082–1104. It is time to note that the error terms in the reduced VAR form are composed of two or more shocks, and if the error terms of the reduced form are white noises, then the error terms of the structural error terms will be white noise processes too. Asteriou and Hall (2016) take two stationary simultaneous time series, ri and ri affected by current and past values and errors terms rxi and rxiwhite noise295: $ri = \alpha 10 - \alpha 12ri + \alpha 11ri{-}1 + \alpha 12ri{-}1 + rxi\ ri = \alpha 20 - \alpha 21ri + \alpha 21ri{-}1 + \alpha 22ri{-}1 + rxi$ (114) (115) Equations (114) and (115) have a contemporaneous impact on each other. The matrix algebra of the above two equations would look like: [1 α21 A=[1 α21 α12] [$rrii$] = [$\alpha\alpha$1200] + [α11 α12 $ri{-}1$ rxi 1 α21 α22] [$ri{-}1$] + [rxi] (116) Ari = $A0$+ $A1ri{-}1 + ri$ (117) α112], ri = [$rrii$], $A0$ = [$\alpha\alpha$1200], $A1$ = [α11 α22] , $ri{-}1$ = [$ri{-}1$] α12 $ri{-}1$ α21 and ri = [$rrxxii$] It is crucial to note here that ri error terms (shocks)

are independent. Matrix A is essential in the process of identification. The 1s in the diagonal of matrix A express the contemporaneous impact between endogenous variables. Coefficients α12 and α21 represent contemporaneous relations between ri and α12ri, and ri and α21ri, and we see them in matrix A296. Having a matrix, A, in front of ri, emphasizes that we have two or more variables at time t, α12ri and α21ri. The identification is the structural model. Multiplying equation (117) by the inverse of A, A−1, we get: A−1Ari = A−1A0+ A−1A1ri−1 + A−1ri (118) ri = A0+ A1ri−1 + Ai (119) following A0 = A−1A0, A1 = A−1A1, and Ai = A−1ri. We find it essential to take a pause here and recall what the inverse of a matrix is. For example, let us get an inverse 295 Asteriou, D., and S. G. Hall., Applied econometrics, 3rd ed. Basingstoke, United Kingdom: Palgrave MacMillan, 2015. 296 Lanne, M., and H. Luetkepohl., "Structural Vector Autoregressions with Nonnormal Residuals," Economics Working Papers, 2005, ECO2005/25, European University Institute. of a matrix A 3x3, and we are going to do this by using cofactors and determinants. For instance, we have the following matrix: 0 A = [2 1 0 −1 1 1 3] (120) 4 Proceeding with this example, we need to find the determinant of A, |A| = $AArA$: |A| = $AArA$ = 0 [−1 3] − 0 [2 3] − 1 [2 −1] (121) = 0[(−1 · 4) − (1 · 3)] − 0[(2 · 4) − (1 · 3)] + 1[(2 · 1) − (1 · (−1))] 1 4 1 4 1 1 = 0 − 0 + 1(2 + 1) = 3 the next thing we are going to use is cofactors: + |−1 3| 1 − | 0 1 4 1 4 | [+ | 0 1 −1 3 | − |2 3| 1 4 + |0 1 | 1 4 − |0 1| 2 3 + |2 −1| 1 0 0 1 −7 − |1 1 | = [1 + |0 2 −1|] 0 1 −5 −1 2 3 0] (122) 0 the diagonal number stay where they are at, while the other elements about the diagonal are transposed: −7 [−5 3 1 1 −1 2] (123) 0 0 the 1 and -5 will switch places, the 1 and 3 switch places, and likewise, the 2 and 0 will switch places. The last thing we do is multiply every entry by ⅓, and this will be our inverse matrix: 1 −7 1 1 |A| $AAiA$ = 13 [−5 −1 2] = A−1 −7 1 3 1 0 0 3 3 3 [−5 −1 2] = A−1 3 3 3 1 0 0 and we have found the inverse matrix A−1 of A. (124) (125) In equation (119), A0 is (i ∗ 1) vector of constants, A1 is (i ∗ i) vector of coefficients, Ai is (i ∗ 1) vector of white noise innovations, and it can be rewritten as: ri = A10 + A11ri−1 + A12 ri−1 + A1i (126) ri = A20 + A21ri−1 + A22 ri−1 + A2i (127) Equations (114) and (115) are structural VAR while (126) and (127) are reduced form VAR. Because we did not impose any restrictions and that residuals are not orthogonal, equations (126) and (127) are reduced-form VAR. Since Ai = A−1ri, errors A1i and A2i, in equations (126) and (127), are made up of two innovations rxi and rxi297. Let's recall that multiplying any matrix by its inverse provides us with the identity matrix298: A−1A = A (128) White noise means that error terms are uncorrelated, so A[Ai] = 0 and finite variance299. An equation error term can be contemporaneously correlated with other equations' residuals but not correlated with their own lagged values and independent variables (as in any specified regression)300. Therefore, the reduced-form innovations are not orthogonal, completely uncorrelated. The structure of the contemporaneous variance-covariance matrix is as follows: A[Ai Ai'] = [αW21 αA1A2 αA1A2 αW22] (129) As we can notice from above, multiplying structural shocks by the inverse matrix gives us forecast errors: Ai = A−1ri (130) 297 Brüggemann, R., H. Lütkepohl, and M. Marcellino., "Forecasting euro area variables with German pre-EMU data," Journal of Forecasting, 2008, 27(6), 465-481. 298

Lütkepohl, H., New Introduction to Multiple Time Series Analysis. Berlin: Springer, 2005. 24

299 Carter, B., Op Amps for Everyone, 4th ed. Oxford, UK: Elsevier, 2013. 300 Beenstock, M., and D. Felsenstein., "Spatial Vector Autoregressions," Spatial Economic Analysis, 2007, 2(2), 167-196. which are linear combinations of the structural shocks. Asteriou and Hall (2015) obtain A1i and A2i301: A1i = (i(1w−r+$\alpha\alpha$1212αi21w)r) , AiA A2i = (iwr+α21iwr) (1−α12α21) (131) When there is a surprise in inflation, for instance, we usually do not know what happened. A combination of factors, structural shocks, at the same time, could be affecting inflation in Montenegro. Fiscal policy, labor market, international innovations could be affecting all together in the meantime, and we would like to disentangle those factors by getting the structural model. The problem is that the SVAR can't be estimated directly, and it is a theoretical construct.

It is non-observable. As Sims (1992) said, **it is an** interpretation **of historical** data302. **We have** only **the evolution of the** 48

economic time series. According to Sims (1992), all variables should be treated equally, as endogenous, and no distinction should be made between endogenous and exogenous. The reduced VAR model has the same package of regressors. Thus, we start from a reduced-form VAR model, aiming towards the structural model, which

isolates the exogenous shocks and measures these shocks' **impact on the variables included in the** VAR **model.** 48

Consequently, we need to get matrix A, the so-called identification. Ai = $A0$+ $A1Ai$−1 + Ai (132) We start from the reduced-form VAR model, and we pre-multiply it with matrix A and get the following results303: AAi = $AA0$+ $AA1Ai$−1 + AAi (133) following $A0$ = A−1$A0$, $A1$ = A−1$A1$, and Ai = A−1ri, and that identity matrix is A−1A = A: AAi = AA−1$A0$ + AA−1$A1Ai$−1 + AA−1ri (134) AAi = $AA0$ + $AA1Ai$−1 + Ari (135) 301 Asteriou, D., and S. G. Hall., Applied econometrics, 3rd ed. Basingstoke, United Kingdom: Palgrave MacMillan, 2015. 302 Sims, Ch., "Interpreting the macroeconomic time series facts: The effects of monetary policy," European Economic Review, 1992, 36(5), 975-1000. 303

Amisano, G., and C. **Giannini., Topics in Structural VAR Econometrics, second, revised and enlarged** ed. Berlin Heidelberg: **Springer,** 202

2012. AAi = $A0$ + $A1Ai$−1 + ri (136) Equation (136) uncovers the structural model, the structural shocks, and the contemporaneous relations among variables. It is the way we can observe what happens to the economy of Montenegro once a shock hits the marketplace. This section deals with the VAR model, the structural VAR specification and identification, impulse response analysis, and forecast-error variance decomposition. Once the reduced VAR form is estimated, we get the reduced form residuals $A1i$ and $A2i$. The information we get from the estimation is consisted of $A1$0, $A2$0, $A1$1, $A1$2, $A2$1, and $A2$2, and we get a 2x2 symmetric variance-covariance matrix of the residuals. It sums up to nine coefficients: 6 coefficients, 2 variances, and 1 covariance. The number of coefficients, in the structural VAR, equations (114) and (115), is: α12, α21, α10, α20, α11, α12, α21, and α22, summing up to 8. Besides, we have the variances, but the structural shocks are independent, resulting in the covariance of 0. We have more unknowns than equations since the only information we have is the 9 parameters of the estimated reduced-form VAR model. How to solve the problem? The only solution is to impose a restriction on one of the structural parameters. It makes

the number of unknown **parameters in the** structural **model** equal to **the number of** parameters known from **the** 281

standard reduced-form VAR estimation model. Where should we impose the restriction? The usual approach is to impose one restriction in matrix A, the so-called identification. We are limiting the relations of endogenous variables occurring during the same time (contemporaneous) of the structural model in matrix A304. The matrix A has two possibilities to be restricted: coefficient α12 or α21. Let's say that we set α12 = 0, making matrix A look as follows: [1 0 α21 1] (137) How could we determine what coefficient to set to zero? The answer is that based on economic intuition, we can impose a restriction on matrix A. 304 Ouliaris, S., A.

Pagan and J. Restrepo., Quantitative Macroeconomic Modeling with Structural Vector Autoregressions – An EViews Implementation. 15

Institute for Capacity Development, 2018. E-book, available at https://www.eviews.com/StructVAR/structvar.html. ri + 0 = α10+α11ri−1 + α12ri−1 + rxi α21ri + ri = α20 − +α21ri−1 + α22ri−1 + rxi (138) (139) If α12, (α12ri), = 0, then the contemporaneous effect of ri on ri is restricted to zero. Thus, a shock to ri will have 0 effects contemporaneously to ri, and only the lagged value of ri, α12ri−1, will affect ri. On the other hand, equation (139) results differently because we have not imposed any contemporaneous restrictions. Shocks to ri affect contemporaneously variable ri (α21 coefficient). Imposing restrictions in matrix A, we also impose restrictions in the inverse of matrix A, A−1305. [$rrii$] = [−α21 01] [$\alpha\alpha$1200] + [−α21 01] [$\alpha\alpha$1211 $\alpha\alpha$1222] [$rrii$−−11] + [−α21 01] [$rrxxii$] 1 1 1 [1 0 −α21 1] = A−1 (140) (141) The zero in the last

matrix, equation (141), is the restriction between the reduced-form residuals, the forecast errors, and the structural shocks. Forecast errors of y equal structural shocks to y: $Axi = rxi$. The product of the matrices results in the reduced-form VAR expressed in terms of the structural parameters as follows306: $ri\ \alpha 10\ \alpha 11\ \alpha 12\ rxi\ [ri] = [-\alpha 21\alpha 10 + \alpha 20] + [-\alpha 21\alpha 11 + \alpha 12\ -\alpha 21\alpha 12 + \alpha 22]\ [ri-1] + [-\alpha 21rxi + rxi]\ ri-1$ (142) Using the coefficients, g, obtained with the reduced -form estimation, we can build all the equations that will allow us to resolve the structural parameters: $ri\ A10\ A11\ A12\ ri-1\ Axi\ [ri] = [A20] + [A21\ A22]\ [ri-1] + [Axi]$ (143) based on: $A10 = \alpha 10$, $A20 = -\alpha 21\alpha 10 + \alpha 20$, $A11 = \alpha 11$, $A12 = \alpha 12$, $A21 = -\alpha 21\alpha 11 + \alpha 12$, $A22 = -\alpha 21\alpha 12 + \alpha 22$. Since $Axi = rxi$ then, $rAr(Axi) = \sigma i2x$, $rAr(Axi) = \sigma i2x + \alpha 221\sigma i2x$, and $Air(AxiAxi) = A(Axi)(rxi - \alpha 21rxi) = -\alpha 21\sigma i2x$. Substitute the estimated values for these 9 parameters $A10$, $A11$, $A12$, $A20$, $A21$, $A22$, $\sigma W2x$, $\sigma Wx-Wi$ in the 9 equations, to solve for: $\alpha 21$, $\alpha 10$, $\alpha 20$, $\alpha 11$, $\alpha 12$, $\alpha 21$, $\alpha 22$, $\sigma v2x$, $AiA\ \sigma v2x$. Note that the structural shocks 305 Vargas-Silva, C. “Monetary Policy and US Housing: A VAR Imposing Sign Restrictions,” Journal of Macroeconomics, 2008, 30, 977-990. 306

Arias, J. E., J. F. Rubio-Ramírez and D. F. Waggoner., “Inference based on SVARs identified with sign and zero restrictions: theory and applications,” **Econometrica,** 9

2018, 86, 685-720. can be recovered because we imposed that structural shocks to y are equal to y forecast errors, which are obtained from the reduced-form estimation307. Once we get coefficient $\alpha 21$ from the system of nine equations, we can compute u, given that $rxi = Axi + \alpha 21rxi$. But we know that $rxi = Axi$ because of the restriction we just imposed. Thus, $rxi = Axi + \alpha 21Axi$308. It is how we use the reduced-form residuals to get the structural shocks. As Sims (1980) says: “SVAR is useful because it isolates structural shocks and allows tracing out the VAR variable dynamics after one of those shocks hits the economy.”309 Therefore, imposing restrictions in matrix A identifies the SVAR. It is all about restrictions. The difference between the unknown and known elements is the number of restrictions required to identify the structural model. Let n be the variable number in the VAR so that we can count the unknown elements. We know that the diagonal of matrix A are 1s. Thus, the unknown elements in matrix A are $i2 - i$, but we need to add the n number of unknown variances of structural shocks u. Therefore, the total number of unknown elements would be $i2 - i + i = i2$. As far as the known elements, the estimation of the reduced-form VAR model allows us to get $(i2 + i)/2$ distinct elements contained in the symmetric variance-covariance matrix of the errors: $AAiAi' = \sum W$310. How to get to know the known elements? There are n distinct known elements from the diagonal plus $(i2 - i)/2$ elements are found off the diagonal, summing up to the total known elements: $i + (i2 - i)/2 = (i2 + i)/2$. Thus, we need to impose $i2 - (i2 + i)/2$ restrictions which equal $(i2 - i)/2$. In our case, we have 5 variables, and the number of restrictions that should be imposed is: $(i2 - i)/2 = (52 - 5)/2 = 10$. 307 Dungey, M. and R. A. Fry., “Identifying Fiscal and Monetary Policy in a Structural VAR,” Economic Modelling, 2009, 26, 1147-1160. 308

Sims, C. “A nine-variable probabilistic macroeconomic forecasting model,” **In J. Stock and M. Watson, eds., Business Cycles, Indicators and Forecasting. University of Chicago Press for the NBER,** 1993. 309 **Sims, C.,** 9

“Macroeconomics and Reality,” Econometrica, 1980, 48(4), 1-48. 310 Ouliaris, S., A.

Pagan and J. Restrepo., Quantitative Macroeconomic Modeling with Structural Vector Autoregressions – An EViews Implementation. 15

Institute for Capacity Development, 2018. E-book, available at https://www.eviews.com/StructVAR/structvar.html. 3.4.1. Impulse responses After elaborating and analyzing the reduced-form VAR model, we come to impulse responses, showing

us the variance **in endogenous variables for each structural** innovation **at t, t+1, and so** 1

on311. It requires us to transform our structural autoregressive vector312: Ari = $A0$+ $A1ri$−1 + ri (144) and after successive iterations, we get313: Ai = $A0$+ $A1$($A0$ + $A1$($A0$ + $A1Ai$−3 + Ai−2) + Ai−1) + Ai (145) Ai = (A + $A1$ + $A12$+. . . +$A1\infty$)$A0$ + Ai + ∑∞i=1 $A1i$ Ai−i + $A1iAi$−i−i (146) As $i \rightarrow \infty$ x reduces to a sum of errors or into a sum of shocks, which is called the Wold Representation (1951) of X314: Ai = λ + ∑i+=∞1 $A1i$ Ai−i + Ai (147) and assume φi = $A1i$ then: Ai = λ + ∑i+=∞1 φi Ai−i + Ai (148) If X has a Wold representation, then X is stable. The condition that guarantees stability is that G has eigenvalues smaller than 1 in modulus, and it is a prevalent result valid for any VAR(p)315. Since the VAR is stationary, the estimated reduced-form VAR has a moving average: Ai = λ + ∑∞i=1 φi Ai−i (149) 311 Pesaran,

M. H. and **Y. Shin.,** "Generalized Impulse Response Analysis in Linear Multivariate Models," **Economics Letters,** 1998, 58, **17-29.** 312 Sims, **C.,** "Macroeconomics and Reality," **Econometrica,** 39

1980, 48(4), 1-48. 313 Ouliaris, S., A.

Pagan and J. Restrepo., Quantitative Macroeconomic Modeling with Structural Vector Autoregressions – An EViews Implementation. 15

Institute for Capacity Development, 2018. E-book, available at https://www.eviews.com/StructVAR/structvar.html. 314 Wold, H. O. A. "Dynamic Systems of the Recursive Type - Economic and Statistical Aspects," Sankhya, 1951, 11, 205-17. 315 Beneš, J., and D. Vávra., "Eigenvalue filtering in VAR models with application to the Czech business cycle," European Central Bank, Working Paper Series 549, 2005. Using the same old relation between the forecast errors and structural shocks, we find316: Ai = λ + A−1ri + ∑∞i=1 φi A−1ri−i (150) or more compactly: Ai = λ + ∑∞i=1 Ai ri−i (151) $A11,i$ and $A12,i$ are the responses of y and x to a change in rxi and rxi respectively. Note that $A11,0$ is the effect at impact, $A11,1$ is the effect of rxi on y on t+1, and so on in succession: $\partial\partial xirw$+ri = $A11,i$ (152) also, the cumulative effect is ∑∞i=0 $A11,i$. It is the expression (152), the partial derivative, that we are interested in examining.

These partial derivatives are **called impulse responses since they** show **the response of the variable** is the riA **periods ahead from t to a temporary one unit change in** 9

rxi. We are primarily interested in the dynamic response of inflation to an exogenous shock that hits the Montenegrin economy. In our example, we need to identify a structural VAR(3) model and structural shocks using a recursive ordering. Our goal is to follow the footprints of internal and external shocks on the Montenegrin economy, specifically inflation. Since the Phillips relation changed across countries, we are interested in seeing the Montenegrin economy's case from an empirical perspective about inflation. Why? Montenegro's government must identify the shocks and measure their effect for policy reasons, especially in the dawn of entering the European Union. Based on this model, we are interested in generating forecasts and, for policy analysis, using our economic intuition to set restrictions. Since Montenegro's specifics as 316

Watson, M.W., Vector Autoregressions and Cointegration, in R. Engle and D. McFadden (eds.), Handbook of Econometrics, Vol IV. Amsterdam: **Elsevier,** 144

1994. a small euroized economy are crucial, we would like to see empirical results from this VAR model. Following Breitung et at., (2004), the SVAR model is as follows317: AAi = $A1Ai$−1 + $A2Ai$−2+. . . +$AiAi$−i + αi (153) and Ai is a (nx1) vector of endogenous variables: Ai =

(*iii,iiW,rii,AAi_AAii,πi*) (154) The matrix A is invertible, and it has (n x n)

coefficients of contemporaneous relations on the endogenous variables. *A'* *ir* are matrices **(n** 321

x n) capturing the dynamics of variables, and αi is a (n x 1) structural shock vector. Our VAR(3) model, with three lags, was found to be not autocorrelated. It is confirmed by Wooldridge (2013) as the best model when it is from one to three lags318. The oil variable *iii*, will be placed first. Why? Our economic intuition is that a shock to the oil price, either increased through excise tax or world market, affects all other variables contemporaneously. Oil and aluminum prices are vital variables that we are interested in tracing out their dynamics. Why? Because they are exogenously determined. These will point out the shocks that penetrate the global market to the Montenegrin economy. We are interested in tracing the endogenous variables such as GDP and unemployment to capture the effect these shocks have on inflation. The variables in our VAR(3) model are ordered recursively. The first variable is the oil price, assuming it is contemporaneously exogenous to the other variables. It implies that the price of aluminum, unemployment, gdp_gap, and inflation do not determine the oil price at period t. Meanwhile, the price of aluminum is ordered second, while unemployment is third. The fourth is gdp_gap, and the last one is inflation, which is affected by all other variables. Overall, the first two variables represent exogenous shocks coming due to the world economy, impacting the Montenegrin market. The unemployment rate represents the labor market. The GDP gap represents the goods market, and inflation represents the behavior of the price-setting in Montenegro. Thus, we have internal and external shocks impacting the whole Montenegrin economy. First, 317

Breitung, J., BrÄuggemann, **R.** & LÄutkepohl, **H. (2004). Structural vector** autoregressivemodeling **and impulse responses, in H.** LÄutkepohl & **M.** KrÄatzig **(eds), Applied Time Series Econometrics, Cambridge University Press, Cambridge, pp. 159 - 196.** 318 Wooldridge, **J.** 32

M., Introductory Econometrics: A Modern Approach. Ohio: South-Western, 2013. we use

Sims' (1980) orthogonalized impulse responses319. **We will trace out the** SVAR **responses of the dependent variables** to shocks **in** 1

our model. Figure 32 contains macroeconomic variables and impulse responses to shocks. Each chart traces the response to Cholesky one standard deviation (d.f. adjusted) innovations ± 2S.E. Each column represents responses of variables to a shock coming from a variable. For example, the first column represents all variables' responses to

one-unit standard deviation shock in the oil prices. **Response** of LOGOIL_SA **to** 4

LOGOIL_SA .08 .04 .00 -.04 5 10 15 20 25 30 35 40 45 Response of LOGALEUR_SA to LOGOIL_SA .04 .02 .00 -.02 5 10 15 20 25 30 35 40 45 Response of UN_SA to LOGOIL_SA .3 .2 .1 .0 -.1 5 10 15 20 25 30 35 40 45 Response of GDP_GAP to LOGOIL_SA .4

Response to Cholesky One S.D. (d.f. adjusted) Innovations ± 2 S.E. Response of LOGOIL_SA **to** LOGALEUR_SA **Response of** LOGOIL_SA **to** UN_SA **Response of** LOGOIL_SA **to** 20

GDP_GAP .08 .04 .00 -.04 5 10 15 20 25 30 35 40 45 Response of LOGALEUR_SA to LOGALEUR_SA .04 .02 .00 -.02 5 10 15 20 25 30 35 40 45 Response of UN_SA to LOGALEUR_SA .3 .2 .1 .0 -.1 5 10 15 20 25 30 35 40 45 Response of GDP_GAP to LOGALEUR_SA .4 .08 .04 .00 -.04 5 10 15 20 25 30 35 40 45 Response of LOGALEUR_SA to UN_SA .04 .02 .00 -.02 5 10 15 20 25 30 35 40 45 Response of UN_SA to UN_SA .3 .2 .1 .0 -.1 5 10 15 20 25 30 35 40 45 Response of GDP_GAP to UN_SA .4 .08 .04 .00 -.04 5 10 15 20 25 30 35 40 45 Response of LOGALEUR_SA to GDP_GAP .04 .02 .00 -.02 5 10 15 20 25 30 35 40 45 Response of UN_SA to GDP_GAP .3 .2 .1 .0 -.1 5 10 15 20 25 30 35 40 45 Response of GDP_GAP to GDP_GAP .4 Response of LOGOIL_SA to INF .08 .04 .00 -.04 5 10 15 20 25 30 35 40 45 Response of LOGALEUR_SA to INF .04 .02 .00 -.02 5 10 15 20 25 30 35 40 45 Response of UN_SA to INF .3 .2 .1 .0 -.1 5 10 15 20 25 30 35 40 45 Response of GDP_GAP to INF .4 .0 .0 .0 .0 .0 -.4 -.4 -.4 -.4 -.4 5 10 15 20 25 30 35 40 45 5 10 15 20 25 30 35 40 45 5 10 15 20 25 30 35 40 45 5 10 15 20 25 30 35 40 45 5 10 15 20 25 30 35 40 45

Response of INF to LOGOIL_SA **Response of INF to** LOGALEUR_SA **Response of INF to** UN_SA **Response of INF to** GDP_GAP **Response of INF to** INF .4 **.0** .4 **.0** .4 **.0** .4 .4 .0 **.0** 109

5 10 15 20 25 30 35 40 45 5 10 15 20 25 30 35 40 45 5 10 15 20 25 30 35 40 45 5 10 15 20 25 30 35 40 45 5 10 15 20 25 30 35 40 45 Figure 32: Impulse responses Source: Author's calculations in EViews 11. The impulse response to the oil price shock shows that aluminum price increases immediately, reaching the highest peak in the fourth month 0.035566 and then declining sharply and after 11 months becoming negative -0.001231. After 16 months it reaches the lowest point -0.012431. After this, the response of aluminum price starts to increase, reaching 0.007704 after 30 months. After that, it keeps declining with smoother oscillations and again becoming negative after 39 months. We can conclude that based 319 Sims, C., "Macroeconomics and Reality," Econometrica, 1980, 48(4), 1-48. on the above results, aluminum price response to oil price shocks has significant swings, from positive to negative, with a permanent negative impact on the price of aluminum. The pass-through from oil to aluminum is relatively quick, occurring only after a couple of months touching the peak. The persistence continues to drop drastically after precisely 12 months, from the time reaching the summit. The reason might be that after the economy is hit with the

one-unit standard deviation shock in the oil price, the 4

aluminum production cost decreased the markups (m) in price-setting in the labor market. Thus firms increased the prices to maintain the marginal profit. After 4 months, due to the lower demand for aluminum in the goods market equilibrium, the aluminum price declined sharply, becoming negative. Another reason could be that investments fell, and as a result, the aluminum price ended up contrary due

to a one-unit standard deviation shock in the oil price. Let us turn **to the** 4

response of unemployment to Cholesky

one-unit standard deviation shock in the oil price. For **the** first five months, **the** 4

response of unemployment has no movements almost at all. It might happen because of the drop in registered employees. Also, the number of registered unemployed has slightly increased, especially from 2014 to 2016 (Monstat 2018)320. The informal sector of employment must be considered, which reaches approximately 30% of the registered employment. The unemployment rate to the unemployment ranges from 3.87 to 3.6, respectively, from 2006 till 2017. Based on Monstat (2018), the growth rate of registered employment ranges from 4.5% to 1.1%, showing a decline, while unemployment shows an increase in growth rate from -10% to 24%, respectively, from 2006 to 2017. In 2010, the employment

growth rate showed a negative -7.13 growth rate. We need to emphasize that the relation between registered employment to registered unemployment and pensioners is around 1.1%. The aging of the Montenegrin population increased from 32.4 in the 1991 Census to 37.7 years, according to the Census data of 2011321. The aging index showing the relationship between the number of older people (65 years and over) and the number of young people (under 15) has significantly increased between the two censuses. In 1991 it was 32.55, 320 Monstat, https://www.monstat.me, accessed, October 25, 2019. 321

United Nations, Department of Economic and Social Affairs, Population Division. World Population Ageing 2017 - Highlights (ST/ESA/SER.A/397), 2017. 134

while in 2003, it rose to 58.18, and in 2011 it reached 66.81 (Monstat, 2014)322. As seen from Figure 31, after the seventh month, the response of unemployment to oil shock increases as expected. Proceeding with the analysis further, we notice that the GDP gap keeps slightly positive for the first five months, decreasing to -0.300301 just after 13 months. The output significantly responded to the Cholesky one standard deviation oil price shock, meaning that the Montenegrin economy heavily depends on oil supplies. The transmission takes about 13 months, hitting the deep bottom. Subsequently, it takes 7 months to reach 0, attaining a peak level of 0.170036 after 2 years and 3 months. After that, it starts declining slowly, reaching 0 again 34 months. This oil price innovation implication is that GDP_gap decreases quickly for a transitional economy as Montenegro, taking more than a year to recover. It suggests that the response of the output gap to the Cholesky one standard deviation oil price shock could

reduce the supply of intermediate goods market and the demand for the final goods 4

market in Montenegro, causing much damage to industrial production323. Inflation impulse response function to Cholesky one standard oil price shocks gradually increases after a lag of four months. After that, it declines to reach deflation of -0.002386 after 15 months, hitting the bottom of -0.089678 after 21 months. The transmission is evident since the economy slowed down, output hitting bottom after 13 months, while inflation after 21, a gap of 8 months between output and inflation hitting bottom. Only after 30 months, inflation becomes positive 0.004767. The increase in oil price makes the Central Bank and fiscal policymakers intervene to lower inflation. As the output decreases, inflation increases slowly. Output has reached the lowest level, while inflation keeps decreasing. After 13 months, while the output gap keeps increasing, inflation is still falling until the dynamic gap between output and inflation reaches, after 24 months, at - 0.2111, the so-called stagflation. The increase in the oil prices affected demand in the 322 Ibid. 323

Lee, K., and Sh. Ni., On the dynamic effects of oil price shocks: a study using industry level data," Journal of Monetary Economics, 2002, 49, 823–852. 37

Montenegrin market, leading firms to change their investments, canceling projects. Notice that until output decreases within 12 months, inflation continues to increase, even for some months, keeping the same level and pushing inflation to a higher level than before the increase in oil price. In this case, the macroprudential fiscal policymakers in Montenegro intervened, adjusting the inflation with output. This whole adjustment process makes the economy go through a recession, with partial recovery. The adjustment process is mainly coordinated through the Montenegrin Government's expectations process seems to do well. While still there are some gaps, while output decreases inflation increases, most of the time, they comove. It proves the crucial point of expectation formation in the Montenegrin market and the dynamic effects of shocks. These economic fluctuations are a product of continuous innovations, either to aggregate supply or demand. That is why we need to identify these shocks and react to them with a proper policy; otherwise, they may lead to a recession. Although we will later have the nominal exchange

rate examined in another model, we would like to observe what happens if we add to the original VAR(3) model the nominal exchange rate! Will the impulse responses of the Montenegrin economy change? As expected, the Montenegrin economy's performance did not vary if we added the nominal exchange rate. If we compare the results, they are identical. The impulse responses of the variables in both cases have a similar impact on the innovations. Lastly, it confirms that the original model is a good one.

Response to Cholesky One S.D. (d.f. adjusted) Innovations ± 2 S.E. Response of GDP_ GAP **to** LOGOIL_SA 124
Response of INF **to** LOGOIL_SA .4 **.6** .2 .4 **.0**

.2 -.2 .0 -.4 -.2 -.6 -.4 5 10 15 20 25 30 35 40 45 5 10 15 20 25 30 35 40 45 Figure 33: Impulse responses with exchange rate added to the VAR model Source: Author's calculations in EViews 11. We might keep adding, for instance, wages because they directly impact the price-setting and wage-setting relation in the labor market in Montenegro. They confirm, once more, that the original model with 3 lags is stable. The added variable does add any change to the impulse responses of innovations in the Montenegrin economy. It confirms that our original VAR(3) model is not misspecified. Thus, the exogenous oil price shocks' exogenous movements are exogenous as expected, which was approved by adding some intuitive economic potential variables. Therefore, exogenous shocks were adequately identified. Including nominal exchange to better isolate the oil price innovations did not prove to add any new information based on evidence from Figure 33. 3.4.2. Forecast error

variance decomposition Knowledge about the **forecast errors is useful** to analyze **the** relationships among 175
variables. The **variance decomposition gives** us a **proportion of the** variances **of**

the forecast errors for $rii{+}h$ into a percentage, explained by each of the shocks324. Thus, finding shocks ri brings the question about the importance of one innovation versus another in explaining ri. The forecast error variance decomposition has been used as an argument in discussing the origin of business cycles. Montenegrin policymakers need to know whether oil and aluminum price shocks are the primary external sources of inflation forecast errors at long horizons? Or, are demand shocks the primary internal sources of inflation forecast errors in Montenegro? In our recursive ordering for y and x, all the one period forecast-error variance of y is due to shocks rxi to itself, by construction. It is so because y was placed first in the ordering, and shocks to x do not affect y contemporaneously. At longer horizons, the explanatory share of shocks to y will diminish. Thus, the variance of the forecast errors should increase with the horizon. As seen in the forecasting section, the further we move into horizons, the higher the chance for uncertainty bands. 324

Anderson, T., An Introduction to Multivariate Statistical Analysis, 3rd ed. New York: John Wiley, 186

2003. In our two-variable conceptual example, the forecast errors take on a recursive ordering, meaning a sequential change. One could think of it as a timeline of events, with shocks hitting y first and then affecting the interest rate325. [1 0 $rxi\ Axi$ $-\alpha 21$ 1] $[rxi]$ = $[Axi]$ (155) [1 · (rxi) + 0 · (rxi)]=[$rxi\ Axi$ $-\alpha 21(rxi)$ + 1 · (rxi) $-\alpha 21rxi$ + rxi] = $[Axi\ ]$ (156) Shocks to ri do not affect contemporaneously (within the period) ri. On the contrary, both shocks have a contemporaneously impact on ri, as seen from equation (156). How much will be the effect of ri on ri? It depends on the size of $\alpha 21$. Structural shocks, ri $r$ill only be adequately identified if there is economic support for the restriction imposed to identify the VAR326. In our case, the restriction imposed is that $\alpha 12$ = 0. It should be justified based on economic intuition. It does have to make sense; otherwise, the effect might result in bringing wrong policies about the economic dynamics of Montenegro. Finding matrix $A{-}1$ and A, when one has a recursive ordering, is not hard, and with $A{-}1$ we get the impulse responses. Any invertible matrix may be broken into two lower triangular factors – Cholesky factors327. It is a numerical technique to estimate a recursive ordering easily. To obtain the inverse of matrix A, we can get the Cholesky factor of the variance-covariance matrix of the forecast errors. It is a mathematical concept, and it does not have anything to do with

economics. But the restrictions we make are purely economic intuition, which is reflected in the upper side of the matrix A and on its inverse $A-1$. Based on those 0s, EViews will get the impulse response calculations. It is a combination of mathematics, 325 Lütkepohl, H., "Asymptotic distributions of impulse response functions and forecast error variance decompositions of vector autoregressive models," Review of Economics and Statistics, 1990, 72, 116– 25. 326

Forni, M., M. Hallin, M. Lippi, and L. Reichlin., "The generalized dynamic factor model: identification and estimation," **Review of Economics and Statistics,** 2000, 82, **540–** 37

52. 327 Higham, N. J. "Cholesky Factorization," Manchester Institute for Mathematical Sciences School of Mathematics, EPrint 2008.116. artistic judgment, and economic intuition. Why intuition? It is often challenging to justify the economics of recursive ordering. Ouliaris et al. (2018) continue arguing that when one has a recursive ordering, the inverse of A, $A-1$, is the Cholesky factor of $\sum W$, the variance-covariance matrix328. In case we substitute expression that relates the forecast errors with structural shocks into the variance-covariance matrix of the forecast errors, it results like the following329: $AWrWr' = \sum W$ (157) $A(A-1rir i'A-1') = \sum W$ (158) Assuming

that the variance-covariance matrix of the structural shocks **is the identity matrix:** 298

$Airir' = \sum i = A$ we get precisely that the variance-covariance matrix: (159) the same as: $A-1AA-1' = \sum W$ (160) $(A-1A-1') = \sum W$ (161) which is the product of two Cholesky factors, the inverse of A, $A-1$, times its transpose $A-1'$330. The inverse of A, $A-1$, is the lower triangular, which is consistent with the recursive ordering. Note that when you normalize the variance-covariance matrix of the structural shocks, $\sum i = A$, assuming that it is equal to the identity matrix, our matrix A will not have 1s on the diagonal as we expected at the beginning. It only has to do with how we normalize our VAR. Either we have 1s on the diagonal of A, or we impose that the variance of the structural shocks is 1. 328 Ouliaris, S., A.

Pagan and J. Restrepo., Quantitative Macroeconomic Modeling with Structural Vector Autoregressions – An EViews Implementation. 15

Institute for Capacity Development, 2018. E-book, available at https://www.eviews.com/StructVAR/structvar.html. 329

Nicholas J. Higham. Functions of Matrices: Theory and Computation. Philadelphia, PA, USA: Society for Industrial and Applied Mathematics, 2008. 154

330

Brezinski, C., The life and work of André **Cholesky. Numer. Algorithms, 2006, 43, 279–288.** 203

If correlations between the errors are low, the order is irrelevant. But usually, correlations are strong, and the order matters. Deciding the ordering (restrictions) to be imposed is crucial, and we need to use economic intuition to resolve it. It is impractical to try all possible orders. With 4 variables, there are 4!=24 possible orderings—too many. If we are sure that there is a recursive ordering or sequential chain, we must then know in what order the variables are recursive. The IMFx (2018) continues emphasizing that knowledge of the prediction errors can be precious in

examining the relationships among the variables331. Assume that we know the coefficients $A0$ and $A1$and wish to project the values of Ai+1 conditional on the observed values of Ai. If the equation: Ai = $A0$+ $A1Ai$−1 + Ai is advanced one period, we obtain: (162) Ai+1 = $A0$+ $A1Ai$−1 + Ai+1 and the prediction error will be: (163) Ai+1 − AAi+1 = Ai+1 For innovation in r + 1. (164) Ai+3 = $A0$+ $A1$($A0$ + $A1$($A0$ + $A1Ai$ + Ai+1) + Ai+2) + Ai+3 Ai+3 − AAi+3 = $A12Ai$+1 + $A1Ai$+2 + Ai+3 AAi+i = (A + $A1$ + $A12$+. . . +$A1i$−1)$A0$ + $A1iAi$+i (165) (166) (167) It might also be expressed in structural error terms: Ai+i − AAi+i = Ai+i + $A1Ai$+i+1 + $A12Ai$+i−2+. . . +$A1i$−1Ai+1 The prediction error only for r and n steps ahead forward will be: (168) i i Ai+i = λ + ∑ $A1i$ A−1ri+i−i Ai+i = λ + ∑ φi A−1r =

i+i−i = i=0 i i=0 Ai +i = λ + ∑ Ai ri +i−i (169) i=0 214

331 IMFx, Institute for Capacity Development, Macroeconometric Forecasting, 2018. The variance of this prediction error is332: Ai+i − AAi+i = $A11$,0rxi+i + $A11$,1rxi+i−1 + ⋯ + $A11$,i−1rxi+1 + $A12$,0rxi+i + $A12$,1rxi+i−1+. . . +$A12$,i−1rxi+i (170) $\sigma x2$,i = $\sigma x2$[$A121$,0 + $A121$,1+. . . +$A121$,i−1] + $\sigma x2$[$A122$,0 + $A122$,1+. . . +$A122$,i−1] (171) The error variance increases as the projection horizon increases since the values of $A121$,0 are necessarily positive. It is doable to decompose the prediction error n periods forward by contributing two shocks in our example333. The proportions of $\sigma x2$,i attributable to each structural shock are334335: $\sigma w2$[$W121$,0+$W121$,1+...+$W121$,i−1] $\sigma w2$[$W122$,0+$W122$,1+...+$W122$,i−1] $\sigma w2$,i $\sigma w2$,i (172) Expression (172)

shows the proportion of the changes **of** one **variable** attributable **to shocks** to itself **and shocks to** another variable. **The** 233

latter is exogenous if rxi−i fails to explain any changes in y. The restriction imposed above requires that the entire variance in the prediction error for y one-period forward be attributable to rxi−i. Now, let us turn to our empirical results of variance decomposition. The first part of Table 18 represents the forecast error variance of the oil price variable, which is exogenous and comes due to itself. As seen, we have set the horizons to be from 1 to 10 months forecast error variance. At short horizons, at month 1, the forecast error variance of oil price is due to itself 100%, as we see that in the column of LOGOIL_SA, month 1. Why? Since the oil price was placed first in the ordering, no other shocks affect it contemporaneously. As we see it from the columns of LOGALERU_SA, UN_SA, GDP_GAP, and INF, the first month has no impact contemporaneously at the LOGOIL_SA, and thus containing zeros. It comes from the fact that we first ordered the oil price as an independent variable from other variables. As horizons increase, for instance, from 1 to 2, we notice each variable's 332

Hamilton, J., Time Series Analysis. Princeton, New Jersey: Princeton University Press, 1994. 333 Favero, **C.,** 212

Applied Macroeconometrics. Oxford, UK: Oxford University Press, 2001. 334 Eichenbaum, M., 1992. "'Interpreting the macroeconomic time series facts: The effects of monetary policy' : by Christopher Sims," European Economic Review, 1992, 36(5), 1001-1011. 335

Enders, W., Applied econometric time series. Hoboken, New Jersey: Wiley, 333

3rd ed, 2010. contribution and its corresponding shocks to the movements,

forecast error variance, of oil **price.** Table 18: **Forecast error variance decomposition** Variance Decomposition **of** 312

LOGOIL: Period S.E. LOGOIL LOGAL UN GDP_GAP INF 1 0.070473 100.0000 2 0.104573 96.43955 3 0.132607 94.05346 4 0.152519 92.63005 5 0.167123 91.38196 6 0.177492 89.96724 7 0.185245 88.04492 8 0.191537 85.58960 9 0.197071 82.64439 10 0.202276 79.34028 0.000000 0.000000 1.196515 0.216567 1.776276 0.800118 3.007427 0.888716 4.501467 0.932818 6.018904 1.083848 7.709810 1.300352 9.572234 1.496169 11.61932 1.635543 13.81909 1.717064 0.000000 0.001241 0.031466 0.041664 0.109911 0.204564 0.300350 0.391146 0.474784 0.545365 0.000000 2.146128 3.338682 3.432143 3.073848 2.725448 2.644569 2.950851 3.625957 4.578195 Variance Decomposition of LOGAL: Period S.E. LOGOIL LOGAL UN GDP_GAP INF 1 0.047188 11.51427 2 0.067800 16.56238 3 0.084746 27.39790 4 0.097061 34.31334 5 0.105637 38.44080 6 0.111196 40.73391 7 0.114663 41.71547 8 0.116891 41.75111 9 0.118490 41.18286 10 0.119913 40.29248 88.48573 0.000000 82.44847 2.15E-06 70.90762 0.051217 63.09712 0.082194 57.95108 0.107956 54.73329 0.114156 52.65233 0.112071 51.19895 0.108410 50.00745 0.107710 48.85325 0.127219 0.000000 0.073329 0.168616 0.547865 1.301009 2.318738 3.541224 4.821430 5.999951 6.964410 0.000000 0.915817 1.474643 1.959488 2.199155 2.099909 1.978902 2.120098 2.702032 3.762645 Variance Decomposition of UN: Period S.E. LOGOIL LOGAL UN GDP_GAP INF 1 0.285312 0.531419 2 0.414072 0.425844 3 0.471512 0.645777 4 0.514320 0.802195 5 0.556393 0.715748 6 0.595461 0.625222 7 0.628560 0.584043 8 0.656999 0.597446 9 0.682113 0.661382 10 0.704237 0.753692 0.721276 98.74731 0.385049 95.08352 0.493189 91.39653 0.533792 88.17241 0.702572 85.52381 1.093605 82.74026 1.761715 79.83687 2.602862 77.14465 3.569315 74.74631 4.643408 72.62948 0.000000 4.061299 7.158790 9.070631 10.68561 12.26270 13.69768 14.81835 15.66656 16.29175 0.000000 0.044283 0.305711 1.420967 2.372258 3.278214 4.119695 4.836698 5.356429 5.681672 Variance Decomposition of GDP_GAP: Period S.E. LOGOIL LOGAL UN GDP_GAP INF 1 0.159984 0.153992 2 0.317459 0.746123 3 0.468198 0.606668 4 0.610431 0.421050 5 0.738905 0.357724 6 0.855572 0.877097 7 0.961903 2.275946 8 1.060773 4.558784 9 1.154226 7.514745 10 1.242685 10.82717 0.910271 1.317503 2.431321 0.676292 1.163761 1.617849 0.840535 2.050569 1.217938 1.979867 1.927946 1.793235 2.811741 1.552434 3.773445 1.296115 4.723474 1.104663 5.608961 1.063248 97.61823 95.87789 96.47122 96.31289 95.18390 92.26277 87.33575 80.77912 73.31718 65.78529 0.000000 0.268376 0.140505 0.374955 1.260574 3.138957 6.024126 9.592533 13.33994 16.71534 Variance Decomposition of INF: Period S.E. LOGOIL LOGAL UN GDP_GAP INF 1 0.685676 2.506486 2 0.883497 5.712231 3 1.059628 8.752622 4 1.172512 11.41066 5 1.262393 12.88109 6 1.334657 14.31063 7 1.394508 15.59593 8 1.445952 16.60511 9 1.488882 17.30248 10 1.522646 17.72630 0.041461 3.108327 0.435832 2.313356 0.304302 1.617544 0.930138 1.696993 2.165884 2.703656 3.891369 4.085677 5.764598 5.499089 7.526025 7.020830 8.938035 8.548189 9.912354 9.936654 1.159379 0.734785 0.647839 0.721727 0.646343 0.578561 0.544452 0.534670 0.547631 0.574743 93.18435 90.80380 88.67769 85.24049 81.60303 77.13376 72.59593 68.31337 64.66367 61.84995 Cholesky Ordering: LOGOIL LOGAL UN GDP_GAP INF Source: Author's calculations in EViews 11. For instance, at the horizons of 2 months, the contribution of aluminum, unemployment, and inflation shocks to the movements of oil price increases from 0% to 1.19%, 0.21%, and 2.14%, respectively. And at longer horizons, for example, 10 horizons, the contribution of corresponding shocks increases to 13.81%, 1.71%, and 4.57%. Moving further, the forecast error variance of unemployment is mostly the result of shocks to itself at short horizons 98.74%. In contrast, at horizons of 10 months, the contribution of oil, aluminum, gdp_gap, and inflation is 0.75%, 4.64%, 16.29%, and 5.68%, respectively. At 24 moth horizons, the contribution is as follows: oil 1%, aluminum 15.50%, gdp_gap 15.74%, and inflation 5.13%, while at horizons of 48 months, the respective contribution is: oil 1%, aluminum 20.37%, gdp_gap 14.55%, and inflation 5.24%. Thus, we notice here that gdp_gap and inflation contribute to increasing forecast error variance (movements). Still, aluminum is the leading shock contributing to the movement of unemployment in the Montenegrin labor market. Next is the GDP gap in the line to see the variance, from 1 to 10

periods ahead forecast error, explained by the system's **first orthogonal shock.** 9

At short horizons, month 1, most of the movements come from itself 97.61%. Still, at 10 months, shocks' impact increases: oil shock contributes at 10.82%, aluminum at 5.60%, unemployment at 1.06%, and inflation at 16.71%. At 24-month horizons, we have: oil 23.35%, aluminum 8.31%, unemployment at 9,31%, and inflation at 23.34%. The oil price impact increased from 10.82% to 23.35%, aluminum from 5.60% to 8.31%, unemployment from 1.06% to 9.91%, and inflation from 16.71% to 23.34%, at horizons from 10 to 24 months. We notice that each shock

continues to have a greater impact as horizons increase. At the variance decomposition of inflation, most of the variance at month 1 comes from itself 93.18%, but unemployment contributes with 3.10% even at the beginning and oil price wHitihst2o.5r0i%ca.l Decomposition using Cholesky (d.f. adjusted) Weights Figure 34: Historical inDfleatcioonmdpecoosmitpioosnitioonf uINsinFg Cholesky weights 6 4 2 0 -2 -4 -6 06 07 08 09 10 11 12 13 14 15 Total stochastic LOGOIL_SA LOGALEUR_SA UN_SA GDP_GAP INF Source: Author's calculations in EViews 11. At 10-month horizon, contribution of oil is 17.72%, aluminum 9.91%, unemployment with 9.93%, and gdp_gap with 0.57%. If we increase the horizon to 24 months, then the impact of shocks are as follows: oil 17.82%, aluminum price (11.41%), unemployment with 13.62%, and gdp_gap 1.14%. We notice that the impact of oil price shock increases rapidly at the beginning, especially the first 6 months from 2.50%, 5.71%, 8.75%, 11.41%, 12.88%, and 14.31%, respectively. Figure 34 shows historical inflation decomposition, decomposing forecast errors to elements associated with structural shocks. The empirical evidence follows the IS-LM-PC model, but not precisely, and the reasons that it does not follow it come from the fact that the Montenegrin economy is in transition, unemployment statistics are incomplete concerning registered and unregistered, and the presence of a shadow economy. 3.5.Non-recursive identification For the following identification, the imposition of restrictions on the contemporaneous structural parameters in the short-run and long-run are as follows: 1 α21 A = α31 α41 [α51 1 0 1 α32 α42 α52 α12 0 0 0 0 1 α34 α43 1 α53 α54 α13 α14 0 α i 0 α W 0 α i 0 α W 1] [α π] α15 = ri rW ri & rW [$r\pi$] A = α21 α31 α41 1 α32 α42 α23 1 α43 α24 α34 1 α25 α35 0 1] [α π] α i α W α i α W = [$r\pi$] ri rW ri rW (173) [α51 α52 α53 α54 totaling the number of restrictions to 10, based on (i2 − i)/2 = (52 − 5)/2 = 10. The first equation in (173) assumes that oil price is exogenous to the other variables. The second equation in (173) assumes that oil price is affected only by aluminum price innovations. Equation 3 assumes that unemployment is not affected by innovations in inflation, α35 = 0. Equation 4 assumes that neither in the short-run nor the long-run GDP gap is affected by inflation; as a result, we restricted in EViews 11, α45= 0. Finally, inflation gets impacted by contemporaneous shocks of all variables in the system. We have combined restrictions in the short and long run, which is done by doing restrictions in S and F matrices, totaling 10 restrictions. Specifying long-run restrictions in F is equivalent to imposing more complicated linear restrictions on S. Table 19: Restricted VAR identification

Coefficient Std. Error z-Statistic Prob. C(1) C(2) C(3) C(4) C(5) C(6) C(7) C(8) C(9) C(10) C(11) C(12) C(13) C(14) C(15) 63

-0.227213 0.171102 0.156133 -1.468896 0.545882 -0.379222 0.095350 -0.064769 0.456635 -0.467079 0.070473 0.044389 0.283520 0.158067 5.869842 0.007349 0.049899 0.027842 1.036117 0.074521 0.041698 1.557152 0.006505 0.243175 0.433262 0.000581 0.000366 0.002339 0.001304 0.049206 -30.91833 3.428967 5.607894 -1.417692 7.325250 -9.094498 0.061233 -9.957373 1.877799 -1.078052 121.2130 121.2131 121.2130 121.2130 119.2919 0.0000 0.0006 0.0000 0.1563 0.0000 0.0000 0.9512 0.0000 0.0604 0.2810 0.0000 0.0000 0.0000 0.0000 0.0000 Log-likelihood 3685.137

LR test for over-identification: Chi-square(10) 395.1863 **Probability 0.0000 Estimated A matrix: 1.000000 0.000000** 114
-0. 227213 1 **.000000 0.** 171102 **0.** 545882 0.156133 **-0.** 379222 -1.468896 **0.**

095350

Estimated B matrix: 0. 070473 **0.000000 0.000000 0.** 044389 **0.000000 0.** 000000 **0.000000 0.000000** 147
0.000000 0.000000

Estimated S matrix: 0. 070473 **0.000000 0.** 016012 **0.** 044389 **-0.** 020799 **-0.** 024231 **-0.** 006278 99
0. 015264 **0.** 108555 **0.** 013962 0.000000 **0.**

000000 1.000000 -0.064769 0.456635 0.000000 0.000000 0.283520 0.000000 0.000000 0.000000 0.000000 0.283520 0.018363 -0.120888 0.000000 0.000000 0.000000 1.000000 -0.467079 0.000000 0.000000 0.000000 0.158067 0.000000 0.000000 0.000000 0.000000 0.158067 0.073830 0.000000 0.000000 0.000000 0.000000 1.000000 0.000000 0.000000 0.000000 0.000000 5.869842 0.000000 0.000000 0.000000 0.000000 5.869842 Estimated F matrix: 0.559932 -1.078073 0.171231 0.300597 0.320679 3.381867 -1.849607 0.384114 1.610320 0.196131 -0.212509 0.216527 4.250110 1.913083 -3.166156 -0.007564 0.168855 2.048638 3.147017 -0.796151 -2.333817 -0.123108 11.75292 -7.860592 17.70660 Source: Author's calculations in EViews 11. Table 19 reports the contemporaneous coefficient estimates of

oil price innovations **based on the SVAR** non-recursive **model. These coefficients provide baseline intuition of the basic relationship that exists among the variables.** 4

4. Forecast Combination Puzzle of Inflation In advance, policymakers need to know the potential movements of inflation to prepare appropriate policy measures. Cecchetti et al., (2000), among other factors, highlight the impulse responses of the real economy to inflation336. Dées and Güntner (2016) disentangle the role of profit margins and unit labor costs

as the primary **determinants of price dynamics on the supply side** 59

across euro area countries and sectors using a panel VAR approach337. Even though inflation

has been examined **to a** great **extent** in **the** previous sections, **we find there is still sufficient space for enhancement. The** 1

novelty of this section is that it uses a combined prediction for the economy of Montenegro. This section uses high – dimensional dynamic models using a combination approach. It examines and compares the empirical results of various forecast combination puzzles of inflation338339. The theory of combining different models of forecasts recommends

that methods that weigh **better forecasts more heavily will** show a **better** performance **than** the **simple combination** forecast (Stock **and** 85

Watson, 2004; Smith and Wallis, 2009)340341. Our main statement, ceteris paribus, is that we should include aggregate determinants of inflation into the macro-econometric examination. Forecast combination puzzles are essential in the light of Montenegrin efforts to join the EU. First, conceptual specification, based on which empirical estimations of inflation determinants are examined, is not prevailing, combining empirical analysis and theory. Second, we identify three structural VAR and BVAR models recursively and combine them employing an equal and inverse MSE 336

Cecchetti, S.G. R.S. Chu, **and** Ch. **Steindel.,** "The unreliability of inflation indicators," **Current Issues in Economics and Finance,** 2000, **6,** 80

1-6. 337 Dées, S. and J. Güntner., “Forecasting Inflation Across Euro Area Countries and Sectors: A Panel VAR Approach,” Journal of Forecasting, 2016, 36, 431-453. 338

Hendry, D. F., and M. P. Clements., “Pooling of Forecasts,” **Econometrics Journal,** 2002, 5, **1-**	62

26. 339 Jore,

A.S., J. Mitchell., and S. P. Vahey., “Combining forecast densities from VARs with uncertain instabilities, ”Journal of Applied Econometrics, 2010, 250(4), **621–634.**	11

340

Stock, J. H., and M. W. Watson., “Combination Forecasts of Output Growth in a Seven-Country Data Set,” **Journal of Forecasting, 2004, 23(6), 405-430.**	179

341

Smith, J., and K. F. Wallis., “A Simple Explanation of the Forecast Combination Puzzle,” **Oxford Bulletin of Economics and Statistics, 2009, 71(3), 331-355.**	62

weighting approach. VARs are critical

empirical tools in modern macroeconomics, and they allow one to model macroeconomic data	1

informatively342. We present here parameter estimates and the main characteristics of two more model examinations. The second identified SVAR model is as follows: πi = α0 + α1log(AA)i + α2log($AAAA$)i + α3$AAriAii$ + α4log(A)t + α5$Aiii$ + α6AAA_AAAi + ri (174) where πi- denotes the inflation rate, log -

natural logarithm so that the	inflation	**function has a constant price elasticity,**	log(AA)i	16

– denotes the natural logarithm of economic freedom, log($AAAA$)i – denotes the logarithmic state of technology, $AAriAii$ – denotes the capital stock rate, log(A)t – denotes the natural logarithm of human capital, $Aiii$ – denotes the labor force, AAA_AAAi – indicates the GDP gap. We will extend the growth model, which is shown in expression (174). As long as Montenegro

has set its national development	strategy,	**it is valuable to examine how**	1

this set of variables that determine economic growth dynamics will impact inflation343. There is a debate among academics about the proxy for the state of technological progress344345. We will proxy it by e- government development index (EGDI). Model 3, in this section, examines how changes in money supply, exchange rates, productivity, and wages affect inflation in the Montenegrin economy. A complete European monetary union is a fundamental step toward political union346. $\pi i = \alpha 0 + \alpha 1 \log(AA)i + \alpha 2 \log(A2)i + \alpha 3 \log(A)i + \alpha 4 AriAi + ri$ (175) 342

Del Negro, M., **and** F. **Schorfheide., Bayesian Macroeconometrics. In Handbook of Bayesian Econometrics, Chapter 7, 293-387. Oxford University Press,** 40

2011. 343 Government of Montenegro, Economic Reform Programme for Montenegro (ERP), 2018-2020. 344

Clarke, G. R. G., and S. J. **Wallsten.,** "Has the Internet Increased Trade? Evidence from Industrial and Developing Countries," **World Bank Policy Research Working Paper 3215,** 191

2004. 345 Meijers, H., "Does the internet generate economic growth, international trade, or both?,"

International Economics and Economic Policy, 2014, 11(1), 137-163. 330

346 Alesina, A., and V. Grilli., "The European Central Bank: Reshaping Monetary Policy in Europe." National Bureau of Economic Research, Working Paper 7927, 2000. where $\log(AA)i$ - denotes the US dollar to euro logarithmic form of the nominal exchange rate, $\log(A2)i$ - represents

broad money as defined by the International **Monetary** Fund (IMF), Monetary **and Financial Statistics Manual** 3

(2017), $\log(A)i$ - logarithmic form of wages, and $AriAi$ - denotes industrial production growth. Equation (175) incorporates both demand-pull and cost-push ingredients, starting from a balance between aggregate demand and aggregate supply. How can we pool or combine these forecast puzzles into an optimal forecasting performance? Multiple forecasting performances are available to decision-makers before they confirm a macroprudential policy decision. Given the relative uncertainty associated with identifying the true DGP, should a single forecasting performance be employed? Or should we average over all the available forecasting performances? It is not convincing that one econometric model would be statistically preferable to others at all points of the forecast horizon. Combining individual forecasts offers a simple way of creating a sophisticated, more flexible forecasting model to explain inflation phenomena. An integrated combined forecast is a weighted average of Z forecasts347348: $W\ r\hat{R}W+h = \sum rR,h,irR,h,i$ (176) i=1 and choosing weights as denoted in expression (176) rR,h,i, minimizes the risk related to the loss from making a forecasting error. The optimal weight for $rR,h,1$ is: $r* = \sigma R2+h,1 + \sigma\sigma R2R2++hh,,23+-\sigma\sigma R2R++hh,3,1-,2,33\sigma R+h,1,2,3$ (177) more considerable weight is assigned to the more precise model and the vector of optimal weights r' with Z forecasts is: 347

Bates, J. and C. W. J. Granger., "The Combination of Forecasts," **Operations Research Quarterly,** 1969, 20, **451-468.** 266

348 Zhang, B., "Real-time inflation forecast combination for time-varying coefficients models," Journal of Forecasting, 2019, 38(3), 175-191. $r' = r'\sum --R11,h\ r'\sum R,hr$ (178) The estimator squared bias and the forecast variance estimator of the MSE loss function of a forecast is: $W\ W\ A\ [(rR+h - rR,h,i)2] = \sum rR2,h,i\ AiAr2R,h,i + \sigma x2 + \sum rR2,h,i\ AArR2,h,i$ (179) $i\ i$ The recursive MSE of an individual forecast is: $AAAR,h,i = A - h - 1\ \sum(ri+h -$

ri,h,i) 1 $R-h$ 2 (180) i=1 and MSE weights, relative performance weights, are: 1 $\varphi R,h,i$ = $\sum Yi{=}M1SMCSSC,h1S,i,h,i$ (181) Computing relative performance weights - inverse MSE - employing either rolling or discounting windows allows more attention to be paid to the recent performance. Combining forecast puzzles implies diversification of risk. There are

a few methods for aggregating **forecasts** that **have been developed** on **the forecast combination,** 300

but we will employ the averaging and the inverse MSE. Furthermore, we provide an

out-of-sample methodology, which **can be used to construct tests that evaluate a time-series model's ability to predict** 150

(West, 1999)349. Before we proceed further with the examination of the combination forecast methodology, we see it reasonable to describe the structure of the economic freedom variable. 4.1.Empirical results Based on the

ADF and PP unit root tests and KPSS stationarity test, 319

all variables are stationary, I(0). Visual inspection of the time series and statistical correlograms confirm 349 West, K. D., "Asymptotic inference about predictive ability," Econometrica, 1996, 64, 1067-1084. stationarity as well. Moreover,

t-statistics and p-values test results **reject the null hypothesis of unit-** 1

roots. Inverse Roots of AR Characteristic PolynInovmeriasel Roots of AR Characteristic PolynInovmeriasle Roots of AR Characteristic Polynomial Model 1 Model 2 Model 3 1.5 1.5 1.5 1.0 1.0 1.0 0.5 0.5 0.5 0.0 0.0 0.0 -0.5 -0.5 -0.5 -1.0 -1.0 -1.0 -1.5 -1 0 1 -1.5 -1 0 1 -1.5 -1 0 1 Figure 35: Inverse roots of AR characteristic polynomial for models 1, 2, and 3 Source: Author's calculations in EViews 11. Testing for structural breaks is crucial for confidence bounds and forecasting purposes as well. Stability diagnostics (recursive estimates, Chow breakpoint test, Quandt-Andrews, and Bai-Perron) denote a parameter switch at a 5% significance level. Therefore, we include dichotomous variables. Recursively, we identify and estimate three SVAR and three BVAR models. A fitting lag is recommended for each of the lag length criteria (AIC, LR, FPE, SC, and HQ)350. As seen from Figure 35, all the inverse roots of the AR characteristic polynomial of models 1, 2, and 3 lie within the unit circles, confirming the stationarity of the VARs. The fan charts, in Figures 36-38, show the forecasts for each model. We portray ten confidence intervals: from 90% to the mode. Visual inspection displays that the first model, in Figure 36, fits into a 9% confidence band the best (from 1.6% to 2.0% inflation). It reveals

a sustainable forecasting **performance and** an **average inflation** rate **not** higher **than 1.5% above the three best performing** EU **Member states'** 65

inflation rate. The average rate of

Cyprus (0.2%), Ireland (0.3%), and Finland (0.8%), as the 6

best three performing 350 Clark,

T.E., and F. Ravazzolo., "Macroeconomic forecasting performance under alternative specifications of time-varying volatility," Journal of Applied Econometrics, 2015, 300(4), 551–575. 11

Member states,

is 0.4% and, adding 11/2 percentage points, the reference is 1.9% 6

351. Model 2, in Figure 37, has more vibrations around the mode line than model 1. 12% 8% 4% 0% -4% -8% IV I II III IV 2016 2017 Figure 36: Fan chart of model 1 Source: Author's calculations in EViews 11. Still, model 2 has valuable information to be considered for combined forecasts. As expected, model 3, in Fig. 33, having the external shocks (oil and aluminum LME prices), creates more fluctuations as horizons increase. As expected, model 3, in Figure 38, having the exogenous shocks (oil and aluminum LME prices), creates more fluctuations as horizons increase. The confidence bands increase with time and do not stop till 2017:12. Model 3 fits into 72-81% confidence bands in the second half of 2017. We include a certain number of variables within a forecasting model because adding more regressors to the examined model exacerbates the size problems352. We estimated three different SVAR models and 351 European Commission. "Convergence Report. Institutional Paper 078," European Economy, 2018, ISSN 2443-8014. 352 Clark, T.

E. and K. D. West., "Using out-of-sample mean squared prediction errors to test the martingale difference hypothesis," Journal of Econometrics, 2006, 135, 155-186. 272

then compared their forecasting performance based on RMSEs. Besides, we computed combined predictions with these models. 10% 8% 6% 4% 2% 0% -2% -4% IV I II III IV 2016 2017 Figure 37: Fan chart of model 2 Source: Author's calculations in EViews 11. Are our combined puzzle forecasts better or worse than the weighted aggregate of its parts? Each of the SVAR models has its interpretative and explanatory variables. 6% 4% 2% 0% -2% -4% -6% -8% -10% IV I II III IV 2016 2017 Figure 38: Fan chart of model 3 Source: Author's calculations in EViews 11. The three SVAR models have been identified, estimated, and examined, predicting inflation the best. We set the sample from January 2006 to December 2016. We evaluate each using least squares (LS). The forecasting out-of-sample is from 2017:1 to 2017:12. We examine the forecasting performances based on the RMSEs. The first model has the lowest RMSE (0.69), while the second model equals (2.35). As seen in Table 20, the third model appears to perform the worst according to RMSE, having a value of (3.71). Table 20: Forecast evaluation statistics of model 1, 2, and 3 Forecast: INFF_1, INFF_2, INFF_3 Actual: INF Forecast sample: 2017M01 2017M12 Included observations: 12 Model 1 Model 2 Model 3

Root Mean Squared Error Mean Absolute Error Mean Absolute Percentage Error Theil Inequality Coefficient 0. 6884 0. 6175 25.8427 0. 169

1647 2.3466 2.0865 90.341 0.3364 3.7081 3.4428 145.0751 0.9071 Source: Author's calculations in EViews 11. Based on inverse MSE, the numerators of relative weights, are as follows: r1 = 2.11, r2 = 0.18, and r3 = 0.07. While the value of the denominator is rt = 2.36. The weights are to sum up to 1 by construction, and the relative weights are: w1 = 0.89244, w2 = 0.076802, and w3 = 0.030758. Figure 39 shows our two new forecast combinations: equal and relative performance weights. On average, both combinations underpredict the actual inflation during the whole year of 2017. For the first three months - forecast horizon, the equal weights perform better than the inverse MSE weights, reaching inflation of

1.89%. After this period, the INFF_MSE performs much better than the equal weights. The RMSE of equal weights (RMSE_C = 0.864771) is way better than the second and the third SVAR models, and the RMSE of relative performance (RMSE_MSE = 0.577499) is better than any of the SVAR models. Why are these results worthly of being noticed? They denote that considering all determinants of inflation reveals essential information for the CBCG: better forecasting. 3.00% 2.75% 2.50% 2.25% 2.00% 1.75% 1.50% 1.25% 1.00%

M1 M2 M3 M4 M5 M6 M7 M8 M9 M10 M11 M12 14

2017 Inf INFF_C INFF_MSE Figure 39: Combination forecasts: equal and inverse MSE weights Source: Author's calculations in EViews 11. Although the relative RMSE weights of model 2 and model 3 are relatively weak, upon combining into relative and average weights, they reveal robust knowledge for the policymakers: a lower RMSE. Using SVAR models, adding different variables continually increases the combined forecasting performance, resulting in a lower RMSE. We conclude that including appropriate SVAR forecasts in the forecast combination puzzle consistently reduces the RMSE of the combination forecasts. Suitably constructed forecasting combinations should replace traditional judgemental inflation forecasts. Thus, we find that a simple average combination outperforms all performances in the first quarter. The relative weight performance stays very close even in the first quarter and is the least sensitive until the end of December 2017. Traditionally in Montenegro, inflation forecasting has mainly been judgemental, making it difficult to replicate and justify. Noticeably, low-dimensional models omit essential information contained in the other variables. Thus, combination forecast puzzles that pool individual-predictor forecasting performances is the optimal solution for the Central Bank of Montenegro. Figure 40 portrays forecast comparison of i) the actual inflation (inf), ii) inflation combined forecasts based on inverse MSE (inff_mse), iii) combined forecasts using equal weights (inff_c), iv) combined forecast using MSE-averaging of 5 forecasts (inf_f01_all), v) forecast using model 1 (inff_1), vi) forecast using model 2 (inff_2), and vii) forecast using model 3 (inff_3). Forecast Comparison Graph 6 4 2

0 -2 -4 M3 M4 M5 M6 M7 M8 M9 M10 M11 M12 M1 M2 M3 M4 M5 M6 M7 M8 M9 M10 M11 M12 14

2016 2017 Inf INFF_3 INF_F01_ALL INFF_1 INFF_C INFF_2 INFF_MSE Figure 40: Forecast comparison Source: Author's calculations in EViews 11. The results are noticeable because the simple arithmetic average combination forecast (equal weights) outperforms the more sophisticated "optimal" forecast composites for the first three months. Afterward, from April to December 2017, the inverse MSE forecasting performance is the optimal linear composite since it minimizes the RMSE. The performance of model 1 keeps up with the inverse MSE very near to the end of December 2017. Still, the simple average combination performs way better than both model 2 and model 3. The actual inflation results in (1.9%), the inverse MSE at (1.5%), the averaging (1.4%), model 1 at (1.3%), model 2 at (5.8%), and model 3 at (-3.0%) at the end of December 2017. Models 1-3 show forecasts that are

sustainable and average inflation rate **not more than 1.5% above the three best performing Member States'** 1

inflation rate: Although models 2 and 3 are way-off compared to the actual inflation, including these variables is significant to the CBCG353. The above results enable macroprudential policymakers to address, evaluate, compare, and implement the strength of using the dynamic composites of high-dimensional combination puzzles. 353

Diebold, F. X. and P. Pauly., "The use of prior information in forecast combination," **International Journal of Forecasting,** 23

1990, 6, 503-508. 4.1.1. Sensitivity analysis The policymakers of CBCG are highly interested to hypothetically see the responses of inflation in different sensitive scenarios, such as an increase in economic freedom index- internal innovations354. We consider it a leading indicator for inflation to which macroprudential policymakers should conIsnidfer in Montenegro. 50 0 0% -50 -1,000% -100 -2,000% -150 -3,000% -200 -4,000% 10 11 12 01 02 03 04 05 06 07 08 09 10 11 12 16 17 Inf Inf (Scenario 1) Inf (Baseline) Percent Deviation Figure 41: Economic freedom alternative scenario Source: Author's calculations in EViews 11. The impact of the economic freedom variable is multidimensional in Montenegro. The sensitive case scenario, in Figure 41, hypothetically increases the economic freedom index from 20% to 40% from 2017:1 till 2017:12. The dynamic effects can be traced out to inflation, as seen in Figure 41. We have to remind the reader that this is a deterministic simulation and dynamic solution performance. It employs predicted lagged values to bring a multi-period ahead forecasting. If we visually inspect inflation, in Figure 41, the alternative sensitive scenario could deflate the prices from 0% to -2020%. 354 Groen,

J. J. J., Paap, **R., and F. Ravazzolo.,** "Real-time inflation forecasting in a changing world," **Journal of Business and Economic Statistics,** 2013, 310(1), **29–44.** 11

Economic freedom appears to be crucial, and here we analyze the impulse responses and variance decomposition (Chan and Jeliazkov, 2009; Chan, 2013)355356. In Figure 42, inflation directly starts to decline, especially in the first year, and then slowly increases.

How can we describe **the above results? The** great **news** is **that** Montenegro **is moving ahead towards the** 1

European Union, being a NATO member. Meanwhile, seeing progressive economic reforms

in the real market can **be** anticipated **from a** forward- looking **society to have a** positive **perspective.** It **implies a correction of price expectations** *AW* **in relation to the** 1

curRreesnptopnrsiecoeflleNvFetlo*A*LO.GECOFREEDOM_SA Innovation

using Cholesky (d.f. adjusted) Factors .6 .4 .2 .0 -.2 -.4 -.6 229

-.8 5 10 15 20 25 30 35 40 45 Figure 42: Response of inflation to economic freedom innovation Source: Author's calculations in EViews 11. As expected, the decomposition of forecast error variance of inflation to the economic freedom shocks is mostly the result of innovations to itself at short horizons, 96.53%. The contribution of economic freedom shocks to the inflation rate movement increases to 9.13% after six months. The economic freedom contribution and its corresponding innovations to inflation's movement go up to 24.94%, at 12-month horizons. At 24-month horizons, the proportion of inflation movement due to economic freedom shocks reaches 35.89%. 355 Chan,

J. C. C., and I. Jeliazkov., "Efficient simulation and integrated likelihood estimation in state- space models," **International Journal of Mathematical Modelling and Numerical Optimisation,** 2009, **1, 101–120.** 168

356 Chan, J.C.C., "Moving average stochastic volatility models with application to inflation forecast," Journal of Econometrics, 2013, 1760(2), 162–172.

MHaiinsttaionirnigcaprlicDeestcaboimlitypinoMsiotnitoennegurositnhrgouCghhgoolveersnkaync(edo.ffe.xtaedrnjaulsantdeidnt)erWnaelfiagchtotrss of inflation Inf from LOGECOFREEDOM_SA 4 3 2 1 0 -1 -2 -3 -4 -5 06 07 08 09 10 11 12 13 14 15 16 Total stochastic LOGECOFREEDOM_SA Figure 43: Historical inflation decomposition from economic freedom Source: Author's calculations in EViews 11. Finally, policymakers of CBCG could be interested in knowing how the nominal exchange rate shock would impact inflation. Figure 44 shows that two periods ahead, inflation response to the nominal exchange rate innovation increases to 0.06, and after six periods decreases to 0.00. Given the high increase in meeting the Maastricht convergence criteria and the lack of methodological uniformity, we believe that the results shown here would

appeal to policymakers. Although a few **previous research papers have identified** some **methods that could be** employed **in forecasting** inflation, **such as internal and external variables,** those **methodologies** 1

had restrictions and difficulties in implementing

on a national level. Thus, **our results allow** the **policymakers to** comprehend **the** factors incorporated **in identifying the** set **of** inflation dynamics **and** its expectations better **and** 2

design

more effective and efficient **policy measures that can be used in** Montenegro. **We** reveal **that** 1

among the individual-predictor forecasts, model 1 performs optimally, based on the RMSE. Model 1 performs even better than equal weights. Nevertheless, equal weights perform better than model 2 and model 3. This vital evidence indicates that economic freedom is

critical in promoting and pushing **sustainable growth. The main implications suggest that** 1

economic freedom is crucial in governing internal inflation and

Response to Cholesky One S.D. (d.f. adjusted) Innovations ± 2 S.E. 20

sustainable growth in Montenegro. Alternatively, we increased oil prices in the previous section and economic freedoRmeinspthoisnssecetioonf. INF to LOGEXCH .6 .4 .2 .0 -.2 5 10 15 20 25 30 35 40 45 Figure 44: Inflation response to the nominal exchange rate innovation Source: Author's calculations in EViews 11. The inflation forecasting performance increases and sharply drops down, implying that Montenegrin economic government regulations are crucial. The impulse response results reveal that inflation responses to innovation on oil prices and economic freedom are essential. The forecast error variance decomposition of inflation is moved mainly from economic freedom and oil prices. In conclusion, the empirical findings provide macroprudential policymakers with an in-depth examination and understanding of the forecast combination models. 4.2.Bayesian VARs What is the probability that a global economic shock will hit Montenegro in the upcoming month, March 2020, given that we know that a global economic crisis has already hit a country? We can estimate this probability using Bayes' theorem.

A regression model with unknown coefficients α, **the variance-covariance matrix** $\sum W$, **and** $Ai{\sim}iiA\ A$ **(0,** $\sum W$**),** 2
Bayes' theorem is employed to combine the prior distribution of the parameters with the likelihood data **function to produce a posterior distribution of coefficients** α, viz357358: 357 **Ouliaris,**

S., A.

Pagan and J. Restrepo., Quantitative Macroeconomic Modeling with Structural Vector Autoregressions – An EViews Implementation. 15

Institute for Capacity Development, 2018. E-book, available at https://www.eviews.com/StructVAR/structvar.html. 358 K-H. Chin, X. Li., "Bayesian Forecast Combination in VAR-DSGE Models," Journal of Macroeconomics, 2018, 59, 278-298. $i(\alpha \mid \sum W, A) = I(W|\alpha,\sum id()Wi)(\alpha|\sum d)$ (184) and consequently, we get

that the posterior distribution is the likelihood function times the prior distribution: 9

$i(\alpha \mid \sum W, A) \propto A(A \mid \alpha, \sum W)\ i(\alpha \mid \sum W)$ (185) In our case, the simplification would like $i(AAA \mid rhiAi) = I(ihiWi|IIC)\ i(IIC)$. The $i(ihiWi)$

Bayes' theorem allows us to update our opinion based on new information. Yesterday's **posterior beliefs (updated opinion) are today's prior (opinion to be updated). The idea about updating beliefs is core to Bayesian econometrics and can be used to test the hypothesis. We start with some idea or opinion, based on econometric inference, about how something works. Simulation methods of different types of priors get us different posteriors. In the case of the normal distribution of the prior** α, 2
normal distribution will have the posterior as well, and the matrix weighted average of the OLS estimates of the mode and mean of the prior

α is: $A = \bar{}[A{-}1 + \sum{-}W1 \otimes (A'A)]{-}1[A{-}1\ A + (\sum{-}W1 \otimes A')r]$ (186) The above expression (186) shows that the

Bayesian methods tend to shrink the VAR estimated coefficients towards **the prior mean,** distant **from the OLS estimates. Forecasting gains are exactly** the **just mentioned characteristic: shrinking the VAR estimates** towards **the prior mean. VARs often end up with the** over-fitting **problem, which can result in imprecise forecasts. VARs have many parameters to estimate n(np+1), often inaccurately because of limited data,** and **consequently, response** functions **and forecasts are not well-determined; thus, the number of coefficients easily** proliferates359. **Standard error bands tend to not account for parameter uncertainty, making forecasts to look more** prices **than they are really. The Bayesian method introduces prior distributions, including,** inter alia, **parameter** 2

359 Rummel, O., "Economic Modeling and Forecasting," Centre for Central Banking Studies, Bank of England, 2015, 1-54. uncertainty360. Having a parsimonious model is the idea, a restricted number of parameters being estimated. Literature has emerged with

practical solutions to omit some lagged values p in some 2

equations,

usually referred to as "best sub-set VARs." This section will apply Bayesian methods that set valuable prior distributions on the VAR coefficients' whole structure 2

to get a parsimonious onset. 4.2.1. Forecasting with Bayesian vector autoregressions

Relative to our previous three VAR models, we estimated BVAR prior type of Litterman/Minnesota, Normal-Flat, Independent Normal-Wishart, Sims-Zha (normal- Wishart), and Giannone-Lenza-Primiceri to perform out-of-sample forecasting from January 2017 to December 2017. Our primary variable of interest is inflation (inf). Table 21 shows the results. There is an improvement in the forecasts. The 2

lowest RMSE for model 1 has BVAR, Normal-Flat prior type, and the values of hyperparameters are set to $\lambda 1 = 0$, since

we have proven that the VAR(2) is stationary, and 2

$\lambda 1 = 0.1$, implying a strong

prior for α. Standard deviations of the first variables in each equation are controlled through $\lambda 1$, shrinking the first-lag coefficients. Relative to the VAR parameter estimates, the lagged coefficients have shrunk. Compared to the standard VAR estimates, the 2

BVAR of prior Litterman/Minnesota shows to have the lowest RMSEs for model 2 (0.48967) and model 3 (1.27483), given the setting $\lambda 1 = 0$, $\lambda 1 = 0.1$, $\lambda 2 = 0.99$, $\lambda 3 = 1$, and $\lambda 4 = 10$. A discernible difference is that the Litterman/Minnesota estimates are significantly smaller for each variable's first lag. We set $\lambda 2 = 0.99$ so that cross-lag variables play a significant role in each equation. Lambda 3 is set as $\lambda 3 = 1$, denoting no lag decay via $\eta\lambda 3$. Finally, $\lambda 4 = 10$ denotes parameter associated with exogenous variables. Minnesota assumes that the mean of coefficients $\alpha i1$ $i = 1, \ldots, i$ are unity, while the mean of all other coefficients are zero. Besides, we also assumed the covariance of errors is diagonal. In the Minnesota case, the distribution of α shows as a random walk behavior, since random 360

Sims, C.A. and T. Zha., "Bayesian Methods for Dynamic Multivariate Models," International Economic Review, 1998, 39, 949-968. 128

walks are perceived to be right macroeconomic forecasters361. The primary advantage of Minnesota prior is that the posterior is a normal distribution. Table 21:

Forecasting using Bayesian estimation methods 2017 :1- 2017 :12 Prior Variable RMSE MAE Standard Model 1 205

Inf 1.876233 1.493975 VAR Model 2 Inf 0.924197 0.80918 Model 3 Inf 2.224169 1.997501 Model 1 Inf 3.902768 3.793592 Minnesota Model 2 Inf 0.48967 0.39565 Model 3 Inf 1.27483 1.095986 Model 1 Inf 0.9913 0.924781 Normal-Flat Model 2 Inf 1.108264 0.967861 Model 3 Inf 1.749179 1.57831 Normal- Model 1 Inf 0.99558 0.928842 Wishart Model 2 Inf 0.79153 0.688589 Model 3 Inf 1.749503 1.577475 Model 1 Inf 1.365351 1.178597 Indep. N-W Model 2 Inf 0.749201 0.6695 Model 3 Inf 2.110446 1.892409 Sims-Zha (N- Model 1 Inf 2.97381 2.342177 W) Model 2 Inf 0.660882 0.584204 Model 3 Inf 1.642633 1.425595 Giannone, L Model 1 Inf 1.789615 1.762234 & P Model 2 Inf 1.320379 1.056946 Model 3 Inf 1.654359 1.563016 Source: Author's calculations in EViews 11. Let us see the forecasting performance of the best BVARs based on the RMSEs. Visual inspection shows that the first model, in Figure 45, fits the best into a 5% confidence band. It offers a sustainable forecasting performance, even within the 5% confidence band, and the average inflation rate is

not more than 1.5% above the three best performing EU Member States' 1

inflation rate. 361

Del Negro, M., and F. Schorfheide., Bayesian Macroeconometrics. Handbook of Bayesian Econometrics, 2010. 225

INF 6 5 4 3 2 1 0 -1 1 2 3 4 5 6 7 8 9 INF

Median 35% 10% 5% Figure 45: Forecasting performance of inflation model 1 using Bayesian Normal- Flat prior, 2

2017:4-2017:12 Source: Author's calculations in EViews 11. INF 6 5 4 3 2 1 0 -1 -2 1 2 3 4 INF 10% 5 6 8 9 7 Median 35% 5% Figure 46: Forecasting performance of inflation model 2 using Bayesian Minnesota prior, 2017:4 2017:12 Source: Author's calculations in EViews 11. Model 2, in Figure 46, has little oscillations around the mode, and it has valuable information sets to be considered by policymakers of Montenegro. As expected, model 3, in Figure 47, having the external shocks (oil and aluminum LME prices), creates more fluctuations than model 1 and 2. It fits into a 10% confidence band for the first six periods. After that, it converges into a 5% confidence band. Even though model 3 shows higher oscillations around the mean, it has valuable information sets. They are essential for Bayesian forecasting combination in SVAR models with many predictors. INF 6 5 4 3 2 1 0 -1 -2 1 2 3 4 I NF 10% 5 6 7 8 9 Median 35% 5% Figure 47: Forecasting performance of inflation model 3 using Bayesian Minnesota prior, 2017:4 2017:12 Source: Author's calculations in EViews 11. 4.2.2. Bayesian forecasting combination This section is motivated by our previous combination findings' results, forecasting SVAR models, based on averaging and relative performance MSE weights. We extend the forecast combination in this section and consider Bayesian vector autoregressive priors to compare and examine their forecast performance. We test the hypothesis of whether Bayesian averaging, trimmed, and inverse MSE outperforms our previous findings, based on the RMSEs. The relative weight numerators, based on inverse MSE, are as follows: r1 = 1.017634, r2 = 4.170555, and r3 = 0.615317, and the value of the denominator is rt = 5.803507. By construction, the relative weights should sum up to 1, and the relative weights are: w1 = 0.175348, w2 = 0.718627, and w3 = 0.106025. Figure 48 shows our three new forecast combinations: equal and relative performance MSE weights. On average, the average weight combination underpredicts the actual inflation until October 2017. The inverse MSE approach performs better than the average combination, as seen in Figure 48. 3.00 2.75 2.50 2.25 2.00 1.75 1.50 1.25 1.00

M1 M2 M3 M4 M5 M6 M7 M8 M9 M10 M11 M12 2017 I nf I 189

NFF_C I NFF_MSE Figure 48: Bayesian combination forecasts: equal and inverse MSE weights Source: Author's calculations in EViews 11. The RMSE of equal combined Bayesian approach equals 0.804415, and the RMSE of the inverse MSE Bayesian approach equals 0.586937. We can conclude that the Bayesian combination produced two RMSEs better than the RMSEs of model 1 and model 2. Still, the RMSE of model 2 remains to be the lowest RMSE of all individual and combined Bayesian approaches. 4.3.Forecast comparison Considering all determinants of inflation in Montenegro's market reveals crucial information for the CBCG: better prediction. Even though the relative weights of Bayesian VAR model 1 and model 3 are low, when combining into relative weights, they reveal robust information for the policymakers: a lower RMSE. Evidence shows that adding variables through different Bayesian prior models systematically increases the forecasting performance, lowering the RMSE. Table 22 shows forecast comparison combinations, Bayesian and standard VAR, and the results show that standard VAR combination has a lower RMSE (0.577499) upon using the inverse MSE than the BVAR. On the other hand, the average combination of Bayesian combination has a lower RMSE (0.804415) than the average weight standard VAR combination in terms of root mean square error. Table 22: Comparison of BVAR and VAR combinations for 2017:1-2017:12 Combinations Approach RMSE Standard VAR Combination Average weights Inverse MSE 0.864771 0.577499 Bayesian VAR combination Average weights Inverse MSE 0.804415 0.586937 Source: Author's calculations in EViews 11. We conclude that including adequate Bayesian VAR forecasts in the forecast combination consistently reduces the combination forecasts' root mean square error. Both combinations are a critical tool for the policymakers of the Central Bank of Montenegro. The Bayesian VAR combination results confirm the standard VAR combination results that both the averaging and the relative performance weight approach lower RMSE. 3.00 2.75 2.50 2.25 2.00 1.75 1.50 1.25 1.00

M1 M2 M3 M4 M5 M6 M7 M8 M9 M10 M11 M12 14

2017 Inf VAR_INFF_C VAR_INFF_MSE BVAR_INFF_C BVAR_INFF_MSE Figure 49: Forecast comparison of BVAR and VAR combinations Source: Author's calculations in EViews 11. Let us see the comparison of standard VAR and the Bayesian VAR forecast combinations from 2017:1-2017:12 graphically. For the first three months, the simple VAR arithmetic average combination forecast outperforms all sophisticated "optimal" forecast composites (2.045%). From April to June 2017, the inverse VAR MSE, the green line, is the optimal linear composite forecast, being the closest to the actual inflation, the blue line (2.127%). The Bayesian inverse MSE takes over the leadership from July until December 2017, converging the best to the actual inflation (2.661%). We have reached a critical conclusion that both combinations have to be considered by the Government of Montenegro: the standard VAR combination performs the best forecasting for quarter I and II of 2017, while Bayesian VAR combination shows the best forecasting performance for quarters III and IV of 2017. At the end of December 2017, the BVAR MSE combination inflation figures 2.661%. The BVAR average combination inflation figures 2.822%, the average weights approach of standard VAR figures 1.537%, and the inverse of standard VAR MSE figures 1.516%. Standard VAR combination models, average and relative performance, show forecasts that are

sustainable and average inflation rate not more than 1.5% above the inflation rate of the three best performing EU 1
Member states. The average rate of the

three best performing EU Member states

is 0.4% and, adding 11/2 percentage points, the reference is 1.9%. 6

Even though BVAR combination models, average and relative performance, end up way off compared to the convergence EU criteria, incorporating these Bayesian combination models is essential for the CBCG362. The BVAR high-dimensional dynamic composite models empower forecasters. 362

Diebold, F. X. and P. Pauly., "The use of prior information in forecast combination," **International Journal of Forecasting,** 23

1990, 6, 503-508. 5. Panel Data Econometrics This section deals with cross country growth and inflation. The objective is not only to compare two subgroups: i) Montenegro (ME) and Serbia (SR) as candidate countries for the EU membership and ii) Croatia (CR) and Slovenia (SI), already in EU, but to highlight the Montenegrin case. Since the above two subgroups have set their national development strategies, it is worthy of analyzing how this onset of factors that determine economic growth dynamics affects inflation363. Robert M. Solow (1956) and Trevor Winchester Swan (1956) stress that government intervention is crucial in the sustainable economic growth process364365. On the other hand, Paul M. Romer (1993) and Robert E. Lucas (1988) highlighted endogenous growth, focusing on knowledge, R&D, human capital, and technological progress366367. The nexus between economic freedom (EF) and the endogenous growth model (EGM) has been shown in several studies368369. Richard Cebula (2011) shows a positive relationship between EF and EGM by using panel data370. Klaus Friesenbichler (2018) uses a macroeconomic panel of OECD countries, which 363 Medic, R., "Econometric Analysis Of Inflation Determinants In Central And Eastern European Countries Based On Panel Models," Ministry of Finance, Belgrade, Serbia, 1-6/2009. 364

Solow, R. M., "A Contribution to the Theory of Economic Growth." The **Quarterly Journal of Economics, 1956, 70(1), 65-94.** 365 **Swan, T.** W., "Economic Growth and Capital Accumulation." The **Economic Record, 1956, 32(2), 334-361.** 133

366

Romer, Paul M., "Two Strategies for Economic Development: Using Ideas and Producing Ideas." **In Supplement to the World Bank Economic Review and the World Bank Research Observer, ed. Lawrence H. Summers and Shekhar Shah, 63-91. Washington, DC: World Bank,** 26

1993. 367 Lucas, Robert

E., "On the Mechanics of Economic Development." **Journal of Monetary Economics, 1988, 22(1), 3-42.** 122

368 Berggren, Niclas., "The Benefits of Economic Freedom: A Survey." The Independent Review, 2003, 8(2), 193-211. 369

Gwartney, J., R. Holcombe and R. Lawson., "Economic Freedom, Institutional Quality, and Cross- Country Differences in Income and Growth," **Cato Journal,** 2004, 24(3), **205-** 308

233. 370 Cebula, Richard., "Economic Growth, Ten Forms of Economic Freedom, and Political Stability," Journal of Private Enterprise, 2011, 26(2), 61-82. replicates and expands previous estimates by Myung Hoon Yi and Changkyu Choi (2005), that broadband internet lowers transaction

costs, thereby inflation. He studied 207 countries from 1991-2007 and showed

that when the internet penetration rate increases by 1%, **the inflation** rate **drops by 0.04%-**	101

0.13%371. 5.1.Methodology of panel econometrics The cross-sectional data range will be from 2006:1 to 2017:12, thus increasing the number of observations.

To control for time trends in further examinations, **we** will **include dummy variables.** In our case, **the**	1

sample set consists of a fixed period **for all cross- sectional units,**	117

making the combined panel data matrix set balanced. Our econometric model, production function, is remodeled as follows: rii = αii + α1 $\sum ii$=1 $AAAAii$ + α2 $\sum ii$=1 $AAiirAiii$ + α3 $\sum ii$=1 $Aiiiirii$ + α4 $\sum ii$=1 $AArAAii$ + α5 $\sum ii$=1 $iiAii$ + αii (187) 5.1.1. The fixed, random effects and cross-sectional dependence The fixed-effects method treats the constant Ai specifically within each section N, as we can see in the following model: Aii = Ai + α1$A1ii$ + α2$A2ii$+. . . +$\alpha iAiii$ + rii (188) $\boldsymbol{X}$ = $\boldsymbol{G\alpha}$ + $\boldsymbol{X\alpha}$' + $\boldsymbol{t}$ $A1$ iR 0 . 0 $r11$ $r12$. $r1i$ (189) $A2$ 0 iR . 0 $r21$ $r22$. $r2i$ A= . A = ... A = ... (AI)IR x 1 (0 0 . iR)IR x I ($rI1$ $rI2$ rIi)IR x i . $A1$ $A2$ $\alpha 1$ α 1 α = . . . α' = . (190) . . (AI)I x 1 (α1)i x 1 371 Friesenbichler, Klaus., “Inflation and Broadband Revisited: Evidence from an OECD Panel. A replication study of Yi and Choi (Journal of Policy Modeling, 2005).”

International Journal for Re-Views in Empirical Economics, 2018, 2: 2018-	284

1. For different cross-sections, we get different constant estimates because of the dummy inclusion in the model. Contrary to the fixed effects method, the constant varies in the random process within each sub-section. The Wald test, comparing the above methods, proposes to reject the null hypothesis that the pooled regression method is more appropriate than the fixed effects method, which outperforms the random effects method: Table 23: Wald test Test Statistic Value df Prob. F-statistic 103.3570 Chi-square 1136.927 (11, 559) 11 0.0000 0.0000 Source: Author’s calculations in EViews 11. The null hypothesis assumes that the series are independent of each other, as M. Hashem Pesaran (2004) proposes372: $AAWWi$ = $\sqrt{I}$($I2R$−1) ($\sum Ii$=−i1 $\sum iI$=i+1 [$\pi i2i$ (R−I−σ1)$S\pi iiii$−λSii]) → A(0,1) (191) Table 24: Residual cross-section dependence test Test Statistic d.f. Prob.

Breusch-Pagan LM Pesaran scaled LM Bias-corrected scaled LM Pesaran CD	251

230.6607 6 0.0000 64.85395 0.0000 64.83996 0.0000 7.742262 0.0000 Source: Author’s calculations in EViews 11. Since N=4 and T=144 in our study, we use the LM test. The assumption is

that the errors for different cross-sectional units are uncorrelated, and **the**	21

results are as Table 24.

The first line shows results for the Breusch-Pagan LM test. 99

In this case, the value of the test statistic (230.66) is well into the upper tail of a φ62, and strongly we reject the null hypothesis of no correlation at conventional significance levels. The next two lines 73

372 Pesaran, Hashem M., “General Diagnostic Tests for Cross Section Dependence in Panels”, IZA Discussion Paper 2004, No. 1240.

present results for the two scaled Pesaran tests. The Pesaran scaled and Breusch-Pagan 21

LM tests are asymptotically standard normal, and the test statistic results of 64.85 and 64.83, respectively, strongly reject the null at conventional levels. 21

While the test statistic value of 7.74 is significantly below the scaled LM tests. The Pesaran CD test still rejects the null at the conventional significance levels. 21

5.1.2. Panel unit roots In the literature of panel unit root tests, there are a couple of standardized methods such as In Choi (2001); Jörg Breitung (2002);

Andrew Levin, Chien-Fu Lin and Chia-Shang James Chu (2002); Kyung So Im, M. Pesaran and Yongcheol Shin (2003); 26

and Nicholas Apergis and James Payne (2009)373374375376377. We will utilize individual and standard unit root processes to test the unit root and stationarity for Montenegro, Serbia, Croatia, and Slovenia. All variables in the model are tested on both levels and first differences. The

results of panel unit root tests are presented in Table 25. Based on the results of the panel unit root 262

at level, capital stock contains unit roots according to PP and Kaddour Hadri (2000) up to 10% significance level378. The ADF, PP, and Hadri confirm non- stationarity for employment at the level. 373

Choi, I., “Unit Root Tests for Panel Data,” Journal of International Money and Finance, 2001, 20(2), 249-272. 115

374 Breitung, J., “Nonparametric Tests for Unit Roots and Cointegration,” Journal of Econometrics, 2002, 108(2), 343-363. 375

Levin, A., Ch .-F. Lin and Ch.-Sh. J. Chu., "Unit Root Tests in Panel Data: Asymptotics and Finite- Sample Properties," Journal of Econometrics, 2002, 108(1), 238

1-24. 376

Im, K. S., H. M. Pesaran, and Y. Shin., "Testing for unit roots in heterogeneous panels," Journal of Economics, 2003, 115(1), 53-74. 122

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Apergis, N. and J. Payne., "Energy Consumption and Economic Growth in Central America: Evidence from a Panel Cointegration and Error Correction Model," Energy Economics, 2009, 31(2), 211-216. 316

378

Hadri, K., "Testing for Stationarity in Heterogeneous Panel Data", The Econometrics Journal, 2000, 3(2), 148-161. 115

Maintaining price stability in Montenegro through governance of external and internal factors of inflation Table 25: Panel unit root test results Null: UR Methods Levin, Breitung Im, Pesan ADF Lin and Chu t-stat

and Shin Fisher Chi- sq PP Fisher Chi- sq Null: 339

Stationary Hadri Z-stat Test in: Variables Level GDP -4.90*** CAP. ST. -3.24*** EMP -2.57*** LOGEF -1.63** LOGEGDI -3.03*** INF -3.05*** First Diff. GDP -6.46*** CAP. ST. -4.09*** EMP -2.90*** LOGEF -4.15*** LOGEGDI -3.28*** INF -19.69*** -2.01*** -1.40* -2.21** 0.4 0.05 -2.56*** -5.37*** -2.18** -2.27** -1.81** -1.70*** -16.56*** -2.90*** -1.76** -1.46* -0.76 -0.05 -2.26*** -3.84*** -1.79** -4.92*** -1.67** -5.24*** -20.07*** 33.63*** 14.62* 12.35 9.56 13.78* 17.29** 51.64*** 26.55*** 20.59*** 26.95*** 57.16*** 804.54*** 20.03*** 3.08 2.78 31.44*** 26.56*** 18.95** 46.90*** 27.89*** 58.03*** 27.22*** 60.78*** 822.83*** 1.77 9.02 2.88 13.24 9.22 0.07*** -0.31*** 0.37*** 0.77*** 0.77*** 1.27*** -1.11*** Notes: ***, **, * implies 1%, 5%, and 10% significance levels. Source: Author's calculation in EViews 11. 197 The logarithm of the economic freedom variable has a unit root at a level based on Breitung, IPS, ADF, and Hadri. The LOGEGDI is suggested to have unit roots based on Breitung, IPS, and Hadri. The D(CS), D(EMP), and D(LOGEF) reject the null hypothesis of IPS unit root at specified lag length 5, with probabilities of (0.0417), (0.000), and (0.0469), respectively. Stationarity is accepted at the first difference for all panel unit tests. The series are integrated of order I (1). 5.1.3. Panel cointegration test We will now develop a panel cointegration model, and the precondition for running such a model is that variables at 1st difference become stationary. In case they cointegrate, then we have

a long-run relationship between the dependent and the independent variables. 26

We will apply Peter Pedroni (2004), Chihwa Kao (1999), and Soren Johansen's (1988) methodologies to test panel cointegration379380381. Table 26: Pedroni, Kao, and Johansen panel cointegration test results Stat Weigh. St t-Stat. F. Trace F. (max-eigen)

Panel v-Stat Panel rho-Stat Panel PP-Stat Panel ADF-Stat Group rho-Stat Group PP-Stat Group ADF-Stat 132

ADF None At most 1 At most 2 2.29** -0.49 -0.78 -3.53*** 0.60 0.06 -1.95** 1.73** -0.06 -0.06 -1.10 -2.20** 58.69*** 32.60*** 30.68*** 20.62***
Notes: ***, **, * implies

1%, 5%, and 10% significance levels. Source: Author's calculations 310

in Eviews 11. 379

Pedroni, P., "Panel Cointegration: Asymptotic and Finite Sample Properties of Pooled Time Series Tests with an Application 160 to the PPP Hypothesis," **Econometric Theory, 2004, 20(3), 597-625** 380 **Kao,** Ch., "Spurious Regression and Residual-Based Tests for Cointegration in Panel Data." **Journal of Econometrics, 1999, 90(1), 1-44.**

381

Johansen, S., "Statistical Analysis of Cointegration Vectors," **Journal of** Economics Dynamic **and Control, 1988, 12(2-3), 231-254.** 242

Table 26 provides

panel cointegration test statistics which evaluate the null against both the homogeneous and the heterogeneous alternatives. In the **case of** Pedroni, four of **the eleven statistics reject the null hypothesis of no cointegration at the conventional size of** 67

5%. Kao's residual test statistics reject the null hypothesis.

Johansen's maximum likelihood cointegration approach confirms **the** results by **Kao. Test results** 314

suggest that the variables have

a long-run relationship since **the** p **-value is less than** 5%. **The** 337

unrestricted cointegration rank test, maximum Eigenvalue, reject the hypothesis

that there is no cointegration among the variables. Meanwhile, **the Trace** 320

test estimates three cointegration equations. Individual cross-sectional results of Trace test statistics for Montenegro, Serbia, Croatia, and Slovenia reject the null hypothesis of no cointegration. Maximum Eigenvalue test statistics reject the null hypothesis at 0.1 significance for all countries; for Montenegro and Croatia at the 0.05 conventional level, they reject the null of no cointegration. 5.2.Panel VECM of Montenegro, Serbia, Croatia, and Slovenia The following variables constitute our VECM model, as follows: $AiAii$ = $AAiii$, $AAiirAi\_rriAiii$, $AiiiiriAirii$, $iiAAAAiii$, $iiAAAiArAAAiiii$, Ari2006, Ari2007, Ari2008, Ari2009, Ari2010, Ari2011, Ari2012, Ari2013, Ari2014 (192) Key variables are e-government and economic freedom, which are included to measure econometrically the impact of these shocks on Montenegro's inflation, Serbia, Croatia, and Slovenia and its economies. The sample period will be from January 2006 to December 2017, but for estimation purposes, the VECM model goes from January 2006 till December 2015. We will utilize the out-of-sample model to forecast variables from January 2016 till December 2017. It will be our tool to assess whether our model can predict actual inflation from 2016:01 onwards. Including 8

lags in the test of **lag exclusion or lag length criteria** pertaining to **deciding the number of lags to be** applied **in our** 1

VECM model, the Final predictor error FPE (7.03),

Akaike information criterion AIC (-24.77), **Schwarz information criterion SC** (-23.61) **and Hannan-Quinn information criterion HQ** 187

(-24.31) suggest 2 lags as the fitting lag length. In comparison, only sequential modified LR test statistic LR (98.95) suggests 8 lags. We select 8 lags, as we will see that any other number of lags is not enough for stationarity, like the appropriate lag length for our model.

All the inverse roots of the AR **characteristic polynomial lie within the unit circle,** confirming **the** 84

model's stationarity.

The largest inverse root of the AR polynomial is 0. 45

999859, accrediting our assessment of the VAR model's stationarity. Looking at notably 1st lags short-term error correlations), all the lines lie within the 2 standard error bounds suggesting no autocorrelation. Another back up

to the suggestion of missing autocorrelation is **non-noticeable continual wave sinusoidal** 1

and p=66.83% for lag orders up to 11. Moreover, since the p=0.1182, we cannot reject the null hypothesis of homoskedasticity. The coefficients of unrestricted VECM are statistically significant for LOGEF and LOGEGDI since the corresponding t-statistic is 5.2741 and 5.7675, respectively.

While for capital stock, employment and GDP are not significant estimates in the long run since the t-stats are less than 2. Imposing restrictions on the VECM, we test for weak exogeneity of employment and GDP by imposing A (3,1) = 0, A (6,1) = 0 on the fitted model (Table 27). We will treat inflation as the dependent variable in the long-run equation, B (1,1) =

1. The p-value of the test statistic for weak exogeneity is 344

0.2935. Thus, we can accept the null hypothesis that employment and GDP can be treated as exogenous. We will, therefore, continue to use this restriction in our baseline specification of the

model. The coefficient of the ECM (Cointeq1) is negative (-0.092578) and significant 318

(- 5.22849) concerning inflation. The ECM coefficients of capital stock, LOGEF, and LOGEGDI are negative (-0.007126), (-4.23E-05), and (-0.000270), respectively, and statistically significant, (-3.35276), (-3.71723), and (-5.18872), respectively. In contrast, the insignificance of the ECM coefficients of employment and GDP equations suggests that these variables are weakly exogenous to inflation. We argue that these results are reasonable since inflation, capital stock, economic freedom, and EGDI are endogenous (flow) variables dependent on each other. Employment and GDP take time to react to disequilibria in inflation relative to its long-run path. The ECM coefficient (- 0.092578) implies that the mechanism corrects its previous period disequilibrium at an average speed of 9.25% monthly. Maintaining price stability in Montenegro through governance of external and internal factors of inflation Table 27:

Vector error correction estimates with restrictions Cointegration Restrictions: B(1,1)=1, A(3,1)=0, A(6,1)=0 268

Chi-square(2) 2.451771 Probability 0.293498 CointEq: INF(-1) CAP_ST(-1) EMP(-1) LOGEF(-1) LOGEGDI(-1) GDP(-1) C INF(-1) 1.0000 0.0601 (0.1566) [0.3838] 0.0252 (0.0197) [1.2763] 62.2855 (12.4490) [5.0032] 1.04522 (0.1838) [5.6867] 0.3128 (0.1572) [1.9893] -262.2420 Error Corr.: D(INF) D(C_ST) D(EMP) D(LOGEF) D(LOGEGDI) D(GDP) CointEq1 -0.0925 (0.017) [-5.228] -0.0071 (0.0021) [-3.3527] 0.0000 (0.0000) [NA] -4.23E-0 (1.1E-0) [-3.7172] -0.0002 (5.2E-05) [-5.18872] 0.0000 (0.0000) [NA] Source: Author's calculations in Eviews 11. 201 Maintaining price stability in Montenegro through governance of external and internal factors of inflation Table 28:

Granger causality results based on VECM - φ^2 independent variables statistics of lagged 1st differenced term/(p-value) 56

Dep. Var. ΔINF ΔCAP_ST. ΔEMP ΔLOGEF ΔLOGEGDI ΔGDP ECTt-1 ΔINF -- 10.161 (0.179) 2.350 (0.937) 15.522 (0.029)** 23.064 (0.001)*** 14.381 -0.092 (0.044)** [-5.22] ΔCAP_ST. (0.0025)*** (0.224) (0.999) (0.399) (0.297) 22.018 -- 9.404 0.446 7.290 8.415 - 0.007** [-3.35] ΔEMP 4.578 1.859 -- 3.395 4.886 5.185 (0.711) (0.967) (0.846) (0.673) (0.637) 0.000 [NA] ΔLOGEF 16.127 (0.024)** 12.356 (0.089)* 0.830 -- 1.847 (0.997) (0.967) 10.562 (0.158) - 4.23E** [-3.717] ΔLOGEGDI 11.708 (0.110) 7.580 (0.371) 1.418 (0.985) 3.438 (0.841) -- 7.649 (0.364) - 0.000** [-5.188] ΔGDP 13.647 (0.057)* 1.133 (0.992) 3.095 (0.876) 7.896 (0.341) 2.786 -0.904 -- 0.000 [NA]

Note: ***, ** and ** denotes significant at 1%, 5%, and 10% significance level, respectively. The figure in the parenthesis (…) represent as p-value and the figure in the squared brackets […] denote as t-statistic. Source: 56

Author's calculations in Eviews 11. 202 It also implies that, on average, 9.25% of deviation from the long-run equilibrium is smoothed in one month. In line with reasonable prior expectations, the sign of the ECM (Cointeq1) coefficient is significant and negative, indicating there is a long-run causality from economic freedom and EGDI to inflation. We must negate the sign of the coefficients shown in Table 27 because of how the equation is represented; it is normalized with all the variables on the left-hand side. The above results lie on a continuum with the new growth theory, which states that government regulation reduces inflation through increased efficiency, resource allocation, and increased FDI. The long-run equation looks as follows: iiA = 262.24 − 62.28 $iiA(AAiiiiiA\ ArAAAii)$ − 1.05 $iiA(AAAA)$ (193) We can notice from the long-run equation that employment is weakly exogenous since its impact is more concentrated in the short run. It happens to be our recommended model for forecasting. In front of every equation, there are ECM coefficients, which are taken literally from the estimated model. We can notice that for employment and GDP, the error correction term is set to zero. Nicholas Apergis and James Payne (2010) emphasize that given the variables are cointegrated, a panel VECM is estimated to perform Granger-causality tests382. Next, having defined the lagged residuals

as the error correction term, the following inflation **dynamic error correction model is estimated** 108

(as well for the other variables): $\Delta AAAii = \alpha 1i + \sum ii{=}1\ \epsilon 11ii\Delta AAAii{-}i + \sum ii{=}1\ \epsilon 12ii\Delta AAiArii{-}i + \sum ii{=}1\ \epsilon 13ii\ \Delta Aiii{-}i + \sum ii{=}1\ \epsilon 14ii\ \Delta AAAAii{-}i + \sum ii{=}1\ \epsilon 15ii\ \Delta AAiArAAii{-}i + \sum ii{=}1\ \epsilon 16ii\ \Delta AiAii{-}i + \varphi 1i\ \alpha ii{-}1 + r1ii$ (194) where i denotes countries, t period, k

lag length set at eight **based on likelihood ratio tests,** Δ **is the** 108

first-difference operator, and u is the serially uncorrelated error term.

The statistical significance of the partial F-statistics, associated with the corresponding right- hand side variables, 148
determine the Short **-run causality. The**

causality, for instance, running from capital stock to GDP, is tested by restricting $\epsilon 62ii$ = 0. The null hypothesis 382 Apergis, Nicholas and James Payne., "Energy consumption and growth in South America: Evidence from a panel error correction model," Energy Economics, 2010, 32(6), 1421-1426. is that the lagged coefficients = 0, while the alternative hypothesis is that the lagged coefficients ≠ 0, and the direction

is to reject the null **hypothesis if the** p **-value of the** $Ahi2$ **-statistic** is ≤ **0.** 259

05. Thus, we can estimate

both long-run and short-run causality, respectively, on the $\varphi 2$ − **test of the lagged first differenced terms for each right-** 71
hand side variable and the t-test of the error correction term. The

test results are presented in Table 28. At the significance of 5%, 1%, and 5% level, respectively, we notice the Granger causality of LOGEF, LOGEGDI, and ΔGDP on ΔINF. 5.2.1. Panel dynamic forecasts Data from 2016:1 until 2017:12 will be used to evaluate out-of-sample forecasting performance. Forecasting evaluation statistics are shown in Table 29. Notice that the ECM model can predict the actual behavior of inflation

rather well. This result provides further evidence that the significant driving internal force behind the movement of inflation for ME, SR, CR, and SI, is innovations to economic freedom and EGDI. Table 29: Forecasting evaluation statistics for ME, SR, HR, and SI Fore. Eval. St. ME SR HK SI Bias MSE RMSE SE MAE MPE MAPE Theil's U1 Theil's U2

Bias proportion Variance proportion Covariance proportion 0. 13 **0.** 84 **0.** 25 4.12 **0.** 50 2.03 **0.** 265

24 3.41 0.42 1.73 8.25 -83.86 72.19 398.04 0.19 0.53 1.01 3.47 0.06 0.17 0.364 0.163 0.568 0.666 -2.58 10.71 3.27 4.03 2.66 -137.23 233.56 0.96 1.59 0.62 0.046 0.331 -0.73 1.14 1.07 0.60 0.85 -75.55 92.15 0.31 0.85 0.47 0.217 0.306 Source: Author's calculations in Eviews 11. 205 theories that government regulations of economic activities reduce inflation through its inflation in all countries. This substantial literary evidence is in line with new growth Slovenia and Croatia. Sensitive forecasting scenario 2 reveals a very sharp decline in wages, lowered prices, and restructured the markets in terms of competitiveness for 1st quarter. It implies that the growth in technological progress has increased the real sharply based on the alternative forecasting scenario 1 for Croatia and Slovenia after the aggressively from 10% to 56%, for the period 2016:1 to 2017:12. Inflation drops down We increased e-government – scenario 1 and economic freedom – scenario 2, variance proportion and Serbian to both bias and variance proportion. and Slovenian covariance proportion goes to bias proportion, while Montenegrin to strategies were used as benchmarking: DD and DS. As seen in Table 29, a lot of Croatian (DD) proves to be the most appropriate forecasting performance. Two forecasting Montenegro and Slovenia. While for Serbia and Croatia, the deterministic – dynamic The deterministic – static (DS) shows the best strategic forecasting performance for Source: Author's calculations in Eviews 11. Figure 50: Panel fan chart 2016:1 – 2017:01 1 - 15M07 1 - 15M10 1 - 16M01 1 - 16M04 1 - 16M07 1 - 16M10 1 - 17M01 2 - 15M08 2 - 15M11 2 - 16M02 2 - 16M05 2 - 16M08 2 - 16M11 2 - 17M02 3 - 15M09 3 - 15M12 3 - 16M03 3 - 16M06 3 - 16M09 3 - 16M12 4 - 15M07 4 - 15M10 4 - 16M01 4 - 16M04 4 - 16M07 4 - 16M10 4 - 17M01 -15 -10 -5 0 5 10 15 20 impact on GDP, by and large through increased efficiency, better allocation of resources, enhanced capacity utilization, and increased FDI. 5.2.2. Panel impulse response functions The impulse response of inflation to the economic freedom shock shows that inflation decreases slowly in the first two quarters, reaching -0.061304 and increasing gradually up to 0.003734 after 11 months. Carefully, we have to observe how productivity and labor market expectations are formed in Figure 51.

Response to Cholesky One S.D. (d.f. adjusted) Innovations ± 2 S.E. Response of INF **to** LOGEGDI **Response of** INF **to** 20

LOGEF .8 .8 .6 .6 .4 .4 .2 .2 .0 .0 -.2 -.2 1 2 3 4 5 6 7 8 9 10 1 2 3 4 5 6 7 8 9 10 Figure 51: Panel impulse response functions Source: Author's calculations in Eviews 11. Since the examined countries are converging rapidly, this implies a correction of price expectations AW regarding the current price level P. If society expects that the price level will decrease, then the real wages in PS relation should increase, shifting up the PS relation. The WS relation will change as well based on AW, unemployment r, and institutional factors. The shift of the WS curve depends on the expected level of productivity. Hypothetically, if workers' expectations of productivity increase are higher than what firms expect, WS will shift more than the PS, increasing unemployment. 5.2.3. Panel variance decomposition Now, let's turn to our empirical results of panel variance decomposition. Figure 52 represents the panel forecast error variance of inflation. We have set the horizons to be from 1 to 48 months forecast error variance. At short horizons (1 month), the forecast error variance of inflation is due to itself 100%. Why? Since the inflation was placed first in the recursive ordering, no other shocks affect it contemporaneously.

Variance Decomposition using Cholesky (d.f. adjusted) Factors Variance Decomposition of 276

INF 100 80 60 40 20 0 5 10 15 20 25 30 35 40 45 INF CAPITAL_STOCK EMPLOY LOGEF LOGEGDI GDP Figure 52: Panel variance decomposition of inflation Source: Author's calculations in Eviews 11. As horizons increase, we notice each variable's contribution and its corresponding shocks to the movements, forecast error variance, of inflation increases. For instance, at the horizons of 2 months, the contribution of capital stock, employment, LOGEF, LOGEGDI, and GDP to the movements of inflation increases from 0% to 0.023%, 0.1326%, 0.2791%, 0.5838%, and 6.21%, respectively. At longer horizons, for example, 10 months, the contribution of corresponding shocks increases to 3.2946, 0.7194, 6.7446, 1.8280, and 0.4376, respectively. In case we increase the horizon to 24 months, we notice that the contribution of economic freedom and its corresponding shocks to the movement of inflation increases to 21.1981%, being the greatest in contributing to the evolution of inflation, graphically notice that from Figure 52. At short horizons, 1 month, economic freedom movements account for 73.2899%, and capital stock accounts for 26.5084%, even in the 1st month. At horizons of 10 months, shocks' impact increases: inflation contributes to 2.6475%, EGDI 0.2743 %, GDP 2.4458%, and employment at 0.8950%. At 24-month horizons, the contribution of inflation and its corresponding shocks to the movement of economic freedom increases to 26.6067%, but capital stock decreases to 9.4318%. Moving further, the forecast error variance of EGDI is mostly the result of shocks to itself at short horizons 95.15613%. However, still, shocks of economic freedom contribute to the movement with 0.4012%, employment 1.1064%, capital stock 2.9291%, and inflation 0.0017%. At horizons of 10 months, the contribution of inflation increases to 9.5589%. At 24 moth horizons, the contribution of inflation and its corresponding shocks to the movement of EGDI increases to 31.5340%. This section has examined both the short-run and long-run effects of economic freedom and e-government on inflation, employing a panel data set for Montenegro, Serbia, Croatia, and Slovenia for the time span 2006:1 – 2017:12. Pedroni, Kao, and Johansen's heterogeneous panel cointegration tests disclose the long-run relationship between inflation, economic freedom, and e-government. The VECM suggests that a 1% increase in economic freedom and e-government reduces inflation by 62.28% and 1.05%, respectively. Besides, the Granger causality test is utilized to reveal the direction of the causal relationship. The PVECM is applied to forecast inflation using deterministic- stochastic simulation and dynamic-static solutions. Forecasted measures such as bias proportion, variance proportion, SE, RMSE, covariance proportion, and Theil's U1 and Theil's U2 are used, confirming the forecasting performance strategies' results.

The impulse response findings reveal that the response **of inflation to a shock on economic** 1

freedom and e-government is essential. The forecast error variance decomposition of the inflation rate is moved mainly from economic freedom. This section's empirical results provide policymakers with a more in-depth examination of the impact of economic freedom, e-government, and expectations on inflation. Furthermore, while governing price stability endogenously, as one of the Maastricht criteria, i.e., the euro convergence criteria, policymakers need to recognize and forecast the consequences of unlined government regulations

in the design and implementation of a national **sustainable** growth **that ensures future economic** 247

perspective. The macroprudential policymakers should proceed to improve economic freedom and e- government in the business ecosystems of the countries. Conclusions Montenegro is lined as a leader in the implementation process of modern monetary policy solutions, and many researchers have considered financial stability as a central bank target. Currently, only the Central Bank of Montenegro has explicitly stated financial stability as its primary goal, while many central banks have financial stability as a secondary goal. Montenegro achieved the EU candidate status in 2010, and since June 2012, it has been in the process of negotiations. The euro Montenegro's present use will

be addressed in the final phase **of the negotiations.** The country **will participate in** the **economic and monetary** 31 **union** with a derogation **from accession as a Member State.**

Following

an evaluation of its fulfillment of the necessary conditions and the Council decision to this	306

effect, Montenegro shall join the euro area. As a prerequisite to joining, the inflation rate must be stable and low according to the Maastricht convergence criteria requirements for entering the EU. Explicitly, article 87v of the Law of the Central Bank of Montenegro says:" The primary goal of the Central Bank of Montenegro

is to maintain price stability, and that without prejudice to the achievement of the	51

objective referred to paragraph 1 of Article 87v, the Central Bank shall support the general economic objectives policy of the European Union, to contribute to the

achievement of the European Union objectives set out in Article 3 of the Treaty on European	143

Union." By opening Chapter 17 – Economic and monetary policy negotiations, the European Union carefully monitors the progress and implementation according to the acquis throughout the negotiating process. The main

objective of price stability should be defined in compliance with: (i) Articles 127 (1) and	1

(ii) Article

282 (2) of the Treaty on the Functioning of the European Union. The Government of Montenegro has to adapt its	81

legislation in line with the EU law to adopt the euro:

meet price stability and ensure economic convergence of the country. Convergence criteria report that	1

the country has to

have a sustainable price-performance, and the average rate of inflation should not be higher than 1.5% of the three best performing Member States.	65

Given the struggle macroprudential policymakers in Montenegro have had to define proper criteria to diagnose and examine the onset of inflation indicators, we felt compelled to identify and investigate a methodological approach that the central Government of Montenegro can apply in designing anti-inflation

and overall development strategy. Given the high increase of interest in meeting the 1

Maastricht convergence criteria and the deficiency

of any homogeneous methodology, we believe that the findings revealed in this doctoral dissertation will appeal 54
to policymakers. Although previous researches have shown a few methods that could be applied in the
forecasting inflation rate, such as external and internal variables, the methodologies revealed from those findings
have been relatively restricted and not easy to administer on a national level

in Montenegro. Thus,

our results allow the policymakers to recognize the factors involved in identifying and knowing the onset of 2
inflation dynamics and

its expectations in Montenegro correctly

and develop more efficient and effective policy measures that can be used nationally. In so doing, we hope that the 113
doctoral dissertation advances the toolset required to combat many central policymakers' concerns

in Montenegro, especially the CBCG. Forecasting inflation phenomena implicates social, economic, and political interconnectivity, not just in Montenegro but worldwide. The interconnectivity and interdependence of countries are more than ever emphasized, and thus the consideration for sustainable development of Montenegro. Since Montenegro is headed towards integration into the European Union, it is of high importance for monetary authorities to reduce, maintain, and stabilize inflation to an acceptable level, or the target level, thus ensuring an age of sustainable development in the wave of globalization. Even though inflation determinants have

been analyzed to a great extent, we find there is still sufficient room for 1

inflation examination. In 2018, the CBCG used the autoregressive integrated moving average (ARIMA) model (2,1,2) to forecast inflation. This dissertation's novelty is that it uses a combined prediction for the Montenegrin economy, using VAR and Bayesian VAR. This research employs high–dimensional dynamic models. It examines time-series data from 2006:1 – 2017:12. Systematically, it examines and compares the performance of different forecasting combination puzzles of inflation. The reduced issue of time inconsistency, stabilization appears to be anchored. Montenegro, in 2002, stabilized the exchange rate through the euroization mechanism, which was the first step towards stabilizing inflation in Montenegro. Nevertheless, if we go to the roots of inflation in Montenegro, we could identify internal and external factors. One of the potential problems might be the fiscal deficit. The authorities need to increase the revenues and reduce the expenditures or go financing, leading to inflation. Stabilization requires to fix the fiscal deficit. Another potential root might appear through the inflationary inertia, which comes from referring to the last period adjustment of wages and looking forward. Thus, it deals straight forward with the expectations formation and how much citizens believe in the prosperity of the future of Montenegro. This issue, as well, appears to be cut off in its roots since Montenegro's government has well-anchored its citizens' expectations. The ongoing case of global macroeconomic impacts of COVID- 19 in the Montenegrin

economy implicates that its citizens' expectations are well anchored. In case the policymakers keep adjusting the last period's inflation, it will exactly create the inflationary inertia. To implement the above mentioned so far, the government needs to have well-grounded institutions. Well-oriented macroprudential strategic policymakers should not only rely on the benevolent authority who will do the proper thing. Institutions are the last longing fundamentals that move forward, in the right direction, implementing the policies. A government might reach its targeted inflation, but the question is the efficiency of the stabilization cost. There is a cost of reducing inflation to a targeted level. One of the measures used is the ratio of the accumulated excess of unemployment above the natural level to inflation reduction. For example, suppose the accumulated excess of unemployment above the natural level is 9%, and the inflation is 3%. In that case, the sacrifice ratio is 3%, meaning that for every single percentage point of reduction in inflation, the unemployment rate is 3% points above the natural rate of unemployment. If this is the case, then in 2017, it would mean 182,368 unemployed x 3% = 5,471. Thus, 5,471 more unemployed would be the cost of reducing 1% inflation in Montenegro. Thus, stabilization is not painless. The lower the level of the sacrifice ratio, the more efficient the stabilization mechanism. The sacrifice could be measured in terms of the euro cost of production loss to the percentage change in the inflation rate. The authorities should fight the cost of maintaining price stability in Montenegro to reach the balance. As mentioned previously, even with the fiscal deficit in equilibrium, there might be some pressure coming from certain groups of workers or the authorities' lack of credibility, creating inflationary inertia. Since Montenegro gave up its monetary instruments, its central policy role stays in the fiscal institutions. However, still, the CBCG, as one of the chain institutions in the stability process, must be autonomous. The chairman of the Central Bank's mandate is set by the law and thus autonomous, avoiding direct response to the executive power. The gained credibility for a stabilization program is the product of an independent central bank. It appears to be a high linkage between the index of autonomy of the Central Bank with the inflation rate:

the more autonomous **the central bank, the lower is the inflation rate.** 111

An independent Central Bank will convince foreign investors, so inflation will not burn their profits. The so far mentioned policies come from the demand side and institutions. Holding the above in mind, one of the key research questions in this thesis is the analysis and determination of the optimal inflation rate, in fact, the study of the determinants that influence the achievement and maintenance of price stability in the country. Moreover, the next research question is analyzing the main factors of inflation in Montenegro and what instruments policymakers need to govern the inflation. The first critical research assumption and hypotheses made to draw out and test its logical and empirical results is structured as follows: H1: Achieving and maintaining price stability in Montenegro, as one of the goals of the central monetary authority in the country (and its instruments) on its path to the European Union and the European Monetary Union, is significantly contributed by the measurement of the impact of critical factors that determine the level of inflation in the country. It is important to emphasize that this is one of the main Montenegro's goals in fulfilling the criterion of being a functioning market economy, which is precisely defined in the set of closing benchmarks for the EU negotiation chapter 17, European and monetary union (opened on June 26, 2018). Montenegro is also obliged to adopt the required constitutional change to ensure that the primary objective of price stability is defined in accordance with Articles 127(1) and 282(2) of the Treaty on the Functioning of the European Union. To prove this hypothesis, since many factors affect Montenegro's inflationary pressures, we examine three individual-predictive recursive and non-recursive structural vector autoregressive (SVAR) and three Bayesian SVAR models to investigate and forecast inflation determinants of Montenegro. We continue employing the average and inverse MSE combinations approach, and the data are examined from January 2006 to December 2016. Additionally, out-of-sample 12-month horizon forecasting is performed from January 2017 to December 2017. Model 1 examines external determinants. Model 2 examines the internal determinants of inflation. Model 3 relates to demand-pull and cost- push variables. Combining the above three forecasts, using an equal and inverse MSE weighting approach, we disclose four more RMSEs: two VAR equal and inverse MSE weights and two Bayesian VAR equal and inverse MSE weights. Besides, we use

impulse responses to **trace the effects of structural shocks on the endogenous variables** and **forecast error variance** 1
decomposition of shocks **to**

variables. Moreover, we use the panel vector error correction model (VECM) approach to forecast inflation dynamics and inflation expectations in Montenegro, Serbia, Croatia, and Slovenia from January 2006 to December 2015 out-of-sample 24-month horizon forecasting from January 2016 to December 2017. The objective of the panel cointegration approach is not only to compare two subgroups: i) Montenegro (ME) and Serbia (SR) as candidate countries for the EU membership and ii) Croatia (CR) and Slovenia (SI), already in EU, but to highlight the Montenegrin case. We employ alternative forecasting scenarios since the Central Bank of Montenegro wants to hypothetically have a forward-looking forecasting reaction of inflation in different sensitive scenarios, such as an increase in the oil price (external innovations) and economic freedom index-internal innovations. This doctoral dissertation reveals and documents

a significantly wider knowledge gap: both theoretical and empirical. We identified recursively 1

and non-recursively three VAR and three Bayesian VAR

models. Each model aggregates essential **macroeconomic variables to forecast** inflation **in** Montenegro. At **the** 1

end of December 2017, the BVAR MSE combination inflation figures 2.661%: the BVAR average combination inflation figures 2.822%. The average VAR combination weights approach figures 1.537%, and the inverse of standard VAR MSE figures 1.516%. The standard VAR combination models, average and relative performance, show a predicting

performance that is sustainable. The **average inflation** performs **not more than 1.5% above the three best performing** 1

Member States rate: **Cyprus (0.2%), Ireland (0.3%), and Finland (0.8%). The average rate is 0.4% and, adding 1.** 5%, **the reference is 1.9%.** 6

We have reached a critical conclusion that both combinations have to be considered by the Government of Montenegro. The standard VAR combination performs the best forecasting for the quarter I and II of 2017, while the Bayesian VAR combination shows the best forecasting performance for quarters III and IV of 2017. Even though BVAR combination models, average and relative performance, end up way off compared to the convergence EU criteria, incorporating these Bayesian combination models is significant for comparison purposes. The above results enable policymakers to address, evaluate, exploit, and compare the strength of using the high-dimensional dynamic composite forecast models. The second critical research assumption and hypotheses made to draw out and test its logical and empirical results is structured as follows: H2: Factors of inflation in the area of external demand that are crucial to maintaining price stability in the country, such as the Montenegrin economy and in the proposed model, are the price of energy and aluminum prices. In other words, the changes in the price of oil in the international market, expressed by the level of energy prices on the domestic market, as one of the key inputs for economic activities in the country, significantly determine the level of inflation. Montenegro's forward-looking and knowing the oil markets allows estimating the oil supply distribution, considering worldwide geographical and political events, and thus its consequences. Simultaneously, the price of aluminum affects the Montenegrin economy, which is also a stock market product. The more advancement of technological sophistication of KAP and its product diversification of aluminum (as the principal industrial export growth engine) – the greater assistance to policymakers to stabilize the trade balance, debt/GDP ratio, productivity growth, unemployment reduction, output gap, and consequently, limit external shocks to inflation in Montenegro, fixing price disparities and qualifying for the membership into the EU/EMU. In other words, this research is focused on the measurement of the impact of oil prices and aluminum export growth on the average inflation rate in Montenegro. Supply Shocks: Oil and

Aluminum Prices On the other hand, we have supply shocks, external disturbances to the Montenegrin economy. Governing external shocks is not directly into Montenegrin policy authorities' control and thus much more difficult to keep inflation stabilized. Usually, such shocks do not happen consistently, but they appear to be one-off shocks. The structure of the supply shocks comparing with the demand shocks are different. The following is suggested to absorb better external potential shocks: ? Montenegro needs to diversify some products further. Two indicators could assist the policymakers: Export Potential Indicator (EPI) and Product Diversification Indicator (PDI). By exporting products, Montenegro reveals its competitive products, the RCA. The EPI index indicates that electrical energy, aluminum not alloyed-unwrought, and wine of fresh grapes are the products with the most significant export potential from Montenegro to the world. The untapped potential (UP) of electrical energy, aluminum, and wine is 91.4$, 35.6$, and 8.5$ million, respectively. In our representative study, the untapped export potential sums up to 186.9$ million. This unused export potential should be considered by policymakers to see what can be done to improve the trade balance of Montenegro. On average, the percentage of untapped potential (UP) reaches 59.78%. Aluminum is the product with the best combination of the supply and demand out of Montenegro's products. ? be that investments fell, but as a result, the aluminum price ended up contrary. ? For the first five months, the response of unemployment has no movements almost at all to oil price shocks. It occurs because of the drop in registered employees, even though the number of registered unemployed has slightly increased, especially from 2014 till 2016. The informal structure must be considered as well, which reaches approximately 30% of the registered employment. The employment rate to unemployment ranges from 3.9 to 3.6 in the period from 2006 to 2017, respectively. Based on Monstat (2018), the registered employment growth rate ranges from 4.5% to 1.1%, showing a decline, while the unemployment shows an increase in growth rate from -10% to 24%, respectively, from 2006 to 2017. In 2010, employment showed a negative -7.13 growth rate. We need to emphasize that the relation between registered employment to registered unemployment and pensioners is around 1.1%. The aging of the Montenegrin population increased from 32.4 in the 1991 Census to 37.7 years, ? The aluminum price response to oil price shocks has prominent oscillations, from positive to negative, with a permanent negative impact on aluminum's price. The pass-through from oil to aluminum is relatively quick, occurring after a couple of months, touching the peak. The persistence will continue to drop it drastically after 12 months, from the time reaching the peak. The reason is that after the economy is hit with the

one-unit standard deviation shock in the oil price, the 4

aluminum production cost lowered the price-setting (PS) curve in the labor market. Thus firms increase the prices to maintain the marginal profit. Only after four months, due to the lower demand for aluminum in the goods market equilibrium, the price declined sharply, becoming negative. It could be another reason, according to the Census data of 2011. The aging index, showing the relationship between the number of older people (65 years and over) and the number of young people (under 15), has significantly increased between the two censuses. In 1991 it was 32.55, while in 2003, it grew to 58.18, and in 2011 it amounted to 66.81. Finally, after the seventh month, the response of unemployment to oil shock increases as expected. ? The output significantly responds to the Cholesky one standard deviation oil price shock, meaning that the Montenegrin economy heavily depends on oil supplies. The transmission takes about 13 months, hitting the deep bottom. Subsequently, it takes 21 months to reach 0, attaining a peak level of 0.17% after two years and three months. In words: the oil price shock implication is that output declines rapidly for a transitional economy as Montenegro and gets more than a year to get back. It suggests that the response of the output gap to the Cholesky one standard deviation oil price shock could

reduce the supply of intermediate goods market **and the demand for** the **final goods** 4

market in Montenegro, causing

much damage to industrial production. ? The impulse **response of** inflation **to** Cholesky one standard **oil price** 4

innovations starts increasing after a lag of four months, increasing gradually. After that, it declines, reaching deflation of -0.0023% after 15 months, hitting the bottom of - 0.09% after 21 months. The transmission is evident since the economy slowed down, output hitting bottom after 13 months, while inflation after 21, a gap of 8 months between output and inflation hitting bottom. The broadest dynamic gap between output and inflation is reached after 24 months at -0.2111%, the so-called stagflation. Nevertheless, the dynamic gap has reached that stage since the increase in oil price affected Montenegrin market demand, leading firms to alter their investments, canceling projects. We notice that until output decreases within 12 months, inflation continues to increase, even for some months, keeping the same level and pushing inflation to a higher level than before the increase in oil price. In this case, the fiscal policymakers should intervene, adjusting the inflation and output. This whole adjustment process makes the economy go through a recession, with partial recovery. The adjustment process is mainly achieved through the expectations process, which in Montenegro seems to be well done. While still there are some gaps, while output decreases, inflation increases, most of the time, they comove. It proves the crucial point of expectation formation in the Montenegrin market and the dynamic effects of shocks. The exogenous movements of oil price shocks are exogenous as expected to be, and this was confirmed by adding some intuitive economic potential variables such as wages and exchange rates. Therefore, exogenous shocks are adequately identified. Including nominal exchange to better isolate the oil price innovations did not prove to add any new information to the model. ? Contrary to oil price shock, the response of unemployment to aluminum's shock is marked by a faster rate of dynamics. The labor market in Montenegro reacts faster to shocks in aluminum than innovations in oil prices. Since the Aluminum Plant in Podgorica is one of the leading growth engines, the transmission channels reflected in the labor market are directly portrayed. ? The dynamics of the GDP response to aluminum shocks compared with oil price shocks are very identical, but still, in the case of aluminum shock, GDP's response is faster. After four months, it reached to become negative, while at the oil price shock, it took to become negative five months. After this, the dynamics are identical. ? The inflation response to aluminum shock takes eight months to reach the peak, while at the oil price shock, inflation gets a peek at four months. It takes 16 months to hit bottom, while the oil price reached 0 at 15 months. Aluminum remains a crucial export commodity for the industry of Montenegro. However, the strategic plans for KAP's future development depend on technological investments and investments in environmental protection. Meanwhile, within the EU accession process, Montenegro is committed to fulfilling all requirements of the ecological acquis and continues producing aluminum in line with the EU standards. Only, in that case, aluminum and all its components will continue to be the main export commodity of Montenegro. Besides, price fluctuations of oil market prices and aluminum stock prices at LME are the primary external factors that affect inflation and its stability in Montenegro. The third critical research assumption and hypotheses made to draw out and test its logical and empirical results is structured as follows: H3: Strengthening of the measures and state administration policies towards the development of e-services contributes to more effective and efficient public services provision, which affects GDP, productivity growth, unemployment, production gap and therefore stabilizes internal inflation shocks in Montenegro. Namely, one of the internal factors determining the inflation rate in Montenegro, in this survey, will be the level of developed e-services, included in the VAR and Bayesian VAR models, such as the EGDI index. Another important factor included in the VAR and BVAR models will be economic freedom since it is fundamental to what is regarded as economic progress. By testing the hypothesis in the models, the correlation between the selected variables will be evaluated. Demand shocks: expectations, EGDI, and economic freedom in Montenegro We track

the change in endogenous variables for each structural shock at t, t+1… 1

t+k, from demand shocks: EGDI and economic freedom, combined with expectations.

Our goal is to trace the effects of internal shocks to the 1

economy of Montenegro, inflation. It is essential to emphasize the dynamics since they show a precise cause and effect relation between the shock and the variable that responds. ? The impulse response of EGDI to the economic freedom shock has significant oscillations, from negative

to positive, with a permanent positive impact in the e- government development index. The pass-through from economic freedom to EGDI is relatively quick. The reason is that after the economy is hit with the one- unit standard deviation shock in the economic freedom, the expectations of productivity increase more than the real productivity, creating an unfavorable gap in the labor market. Workers expect higher wages than firms can afford. After four months, the expectations of citizens adjust to the new reality, that is until $AAAAW$ and $AAAA$ are again equal. Another reason is that new technology investments took a while until the provider and the user functionalized and got used to the new system. ? As the capital stock variable is composed of FDI, it is no surprise that the real capital investors suspect the advancement of economic freedom. As a consequence, the investments are withdrawn. The capital stock responded negatively until 20 months, reaching -0.6. After this period, it starts to increase but slowly. It takes a while to convince foreign investors to bring their machinery and start production. Even though the GDP increases from the very start, the FDI decreases more, resulting in lower capital stock. In words: it implies that the government has to observe how foreign investors create and change their expectations. ? The response of human capital to Cholesky one-unit standard deviation shock in economic freedom starts to increase from the very beginning. It unfolds a critical perspective for students of Montenegro. Economic freedom hikes their expectations and views for a better future. ? The response of employment to economic freedom shock shows a smooth decline of employment, reaching -0.0003 after 22 months. After hitting bottom, it starts to increase slowly, reaching 0 after only 40 months. The labor market, society, and workers expected that the economy grows faster, which does not, creating an unfavorable gap in employment, increasing unemployment. The wage-setting (WS)

relation will shift up by more than the price **-setting** (PC) **relation,** increasing unemployment's **natural rate. The** 231

unadjusted gap remains higher for 20 months until expectations of productivity have adjusted to the new reality. Workers ask for a higher wage, and firms could not afford it. It leads to an increase in unemployment. After some period, workers and society will realize that firms have not increased their productivity, lowering their expectations, and accepting lower wages-increasing employment. The above fact suggests the policymakers should have an in-depth understanding of the adjusting mechanism of expectations. ? The response of GDP

to the economic freedom shock keeps increasing until the 19th month to 0. 25%. In **the** 1

first and second quarters, it increases than for the upcoming two quarters it remains pretty much the same level, steady. Thus, after the fourth quarter, it starts again to rise. This critical fact implies that economic freedom prospers when government authorities adequately anchor expectations. The mechanism of economic freedom is not strong enough to upgrade the economy alone. The citizens need to have a strong belief in the hands of macroprudential policymakers. In words: anchoring expectations with economic freedom brings prosperity.

Having the good news that the country **is moving ahead towards the EU** 1

implies a correction of price expectations AW, relating **to the current price level P:** increasing **the** 1

real wages in price-setting relation. The wage-setting relation will change, as well, based on AW, unemployment r, and institutional factors captured by variable r: equilibrium of workers and firms' expectations of productivity. The adjustment process will occur until the equilibrium is reached in the free market: until workers and firms' expectations adjust to the new reality. We have examined comparative inflation analysis of actuals, baseline, scenario 1 – an increase of EGDI, and scenario 2 – an increase of economic freedom. When economic activity is hit with positive economic freedom, inflation decreases drastically. The measures of economic freedom

are based on 12 quantitative and qualitative factors, grouped into four broad categories, or pillars, of economic freedom: 42
a) Rule of Law (property rights, government integrity, judicial effectiveness), b) Government Size (government spending, tax burden, fiscal health), c) Regulatory Efficiency (business freedom, labor freedom, monetary freedom), and Open Markets (trade freedom, investment freedom, financial freedom). The

future thesis should examine each of the above components of economic freedom. Property rights are fundamental to what is generally regarded as economic progress, and

with well-defined and enforced property rights, surplus production becomes a potential. The higher quality and more 7
extensive the property rights are, the more efficient and productive the economy will be.

In a globalized world, trade can be almost unimaginable without the well-defined property rights of transferable goods and services. The forecasting performance shows that the economic freedom alternative scenario would increase human capital sharply compared to the scene of EGDI increase. The marginal impact of scenario 1 vs. scenario 2 is critical. This fact is significant for policymakers to increase the number of students: knowledge. The introduction of the EGDI has changed the structure of the Montenegrin economy. The structural contour of the market changes due to introducing new technologies making the old ones obsolete. The early skills are less useful, while the new ones are in higher request. The old skilled generation is willing to work at least for the same wage, even accepting a lower salary. Still, the newly qualified generation has high expectations about the introduction of the new technological process. This process will shift the WS relation to the right if the new skilled generation outbalances the old skilled ones. As the modern age requires higher-skilled people, it is to be expected that higher education is a potential variable. This wage inequality comes from the educational level as well. The decrease in employment in our case might arise from the fact that the demand for high-skilled workers is high, but the supply of the higher-skilled is low, resulting in a decrease in employment. As the adjustment process takes place in the labor market, we notice inflation adjusts as well. The more Montenegro closes to the EU, the higher will be demand for high-skilled workers. Still, in the meantime, some companies will keep demanding low skilled workers to stay competitive in the global market as the economic borders keep narrowing. It even increases the expectations of workers in the labor market. The co-movement of employment and inflation is rather close, which is under our explanation of the adjustment of AW ~ P and AW ~ A. Policymakers might consider it to balance the supply and demand of workers by specific sectors to balance wage inequality, which impacts further the economic activity and governing internal and external inflation factors in Montenegro. Only holders of masters' degrees lack an increase of demand in the average labor market, signalizing the policymakers that this high-skilled group should be motivated further because the overall economy of Montenegro does not utilize their potential. ? On the other hand, the inflation response to EGDI shock shows an increase

in the first half of the year, then decreasing until the end of the second 273

year, reaching zero. Thus, again, here we deal with the expectation mechanism. The adjustment process might take up to 24 months. ? The response of GDP to the EGDI shock is negative. It happens when productivity growth increases more slowly, but the expectations of workers keep growing. It is fascinating for Montenegro because this confirms the forward-looking, futuristic, reflected in the GDP, inflation, and employment. Thus, this specific mechanism leads to increasing employment (the high skilled outbalance the low- skilled) and, hence inflation. The adjustment mechanism of GDP is negative for the first six months then starts increasing. To conclude, the impact of EGDI on employment is high, which is one of the significant macroeconomic cornerstones of Montenegro. We obtained impressive results from the panel dataset containing data for Montenegro, Serbia, Croatia, and Slovenia. The inflation variance decomposition is moved mostly from economic freedom. The empirical results clearly show the contribution of capital stock, economic freedom, and the corresponding shocks to the movements, forecast error variance of

GDP. ? Under the alternative panel scenario, 1 – EGDI, GDP for Montenegro and Serbia predicts the economic growth even lower than the baseline, primarily for Montenegro, which shows how expectations of technological progress adjust slowly. This equilibrium happens only after 21 months for Montenegro, while for Serbia, after 14 months. While for Croatia and Slovenia, we see a very high increase in the GDP, leading us to conclude that the workers' expectations were absorbed very well from the markets. Moreover, inflation drops sharply based on the alternative forecasting scenario 1 for Croatia and Slovenia after the 1st quarter. It happens because the growth in technological progress has increased the real wages. In reality, it has lowered prices and restructured the market in terms of competitiveness for Slovenia and Croatia. While for Montenegro and Serbia, we see no significant oscillations. In words: institutional changes are suggested to synchronize the speed of the expectations in Montenegro and Serbia. ? As a potential factor, we have embedded an alternative scenario when economic freedom increases in the panel dataset: scenario 2. The channel of economic freedom is multidimensional. It affects production, government, consumers, investors, and revenues. The GDP increases enormously for all countries, forecasting a rapid growth for Montenegrin, Serbian, Croatian, and Slovenian economies of 4,826%, 4,644%, 5,983%, and 7,293%, respectively, in the period from January 2016 to December 2017. If we look at inflation, from January 2016 to December 2017, the alternative scenario could deflate the prices from 0% to - 3,650%. It is significant for the CBCG to consider that through economic freedom, the CBCG could control the internal and external shocks to Montenegro's economic activity. Employment goes through the adjustment mechanism, especially Montenegro goes through a drastic drop – reaching -1,124% in the second quarter. It implies that the adjustment process goes through a very dynamic oscillation within the first year. It coincides with some countries that entered the EU, such as Rumania, Bulgaria, and Croatia. There was a high flow of employment outside of their countries. Moreover, capital stock drops down, which comes from the fact that foreign investors wait until they get convinced that it is not a bubble, but it comes from the markets' internal restructure. ? We can notice that EGDI goes through the adjustment process, as well. At the very beginning, we see a drop in the EGDI. At the same time, after six months, it starts to increase and then keeps rising even more after the 1st year comparing to the initial year of the forecasting period, January 2016. The above scenarios reveal which of the panel dataset alternative scenarios do impact more substantially inflation and economic activity in Montenegro, Serbia, Croatia, and Slovenia. The dynamic impact of economic freedom on inflation and GDP is enormous. The EGDI is noticeable in Croatia and Slovenia as a positive impact, while economic freedom appears throughout the countries. Remarkably, this hypothetical assumption's impact hits all countries more or less with the same tide, except for Montenegro, in case of inflation, which is profoundly impacted by economic freedom. GDP increases enormously for all cross-sectional panel countries in case of the hit by economic freedom, but far more significant for Croatia and Slovenia when hit by EGDI innovation. The inelasticity of the labor market, determined by these tensions, brings creative destruction. In words: the Government of Montenegro is recommended to take an in- depth look. There are more declining sectors, low in demand, than increasing ones, high in demand. The strategy should go towards that the computers should become more comfortable to use even for those low in high-skill jobs and take advantage of low-wage workers. Demand-pull and cost-push variables Model 2 has cost-push variables and demand-pull and: the nominal exchange rate, broad money (M2), wages, productivity growth, and inflation. The macroprudential policymakers and the CBCG are interested in examining and measuring shocks that originate abroad, precisely the exchange rate. Since the nominal exchange rate volatility is often associated with significant disruptive effects, we have analyzed the impulse response of the euro nominal exchange rate to the Montenegrin economy. ? The

impulse response to the positive nominal exchange **shock indicates that initially,** M2 falls **immediately, followed by** 4 nominal exchange **shock,** until **the**

second month. After a 9-month interval, the response of M2 reaches 0.001%. After that, it keeps increasing until the 19th month, reaching a peak of 0.009%. In words: after the euro appreciates, exports decrease, output decreases, and the trade deficit increases in Montenegro. To avoid a reduction in output, the Government must induce government spending to shift up the demand. ? The impulse response of wages to the nominal exchange rate shock has considerable oscillations, resulting in negative. ? As expected, productivity growth decreases from 2.5% to 0.9% in the first

3- month interval. After that, **the response of** productivity growth **starts accelerating, and the maximum impact is reached at around** 8 **to** 9 **months,** grasping 1.7%. **After** this, **it** keeps falling **slowly and,** 4

after a 39-40 month interval, it reaches 0. ? The

impulse response to the positive nominal exchange **shock indicates that** inflation **initially** increases **immediately, followed by** nominal exchange **shock** 4

until the second month. It starts at -0.1%, and in the second month, it increases inflation to 0.06%. After this, inflation falls immediately to 0.01 in the 3rd month. In 48 months, inflation does not show prominent oscillations and keeps close to 0. ? The

impulse response to the positive M2 **shock indicates that initially,** wages fall **immediately, followed by** 4

the M2 until the third month, reaching -0.006%. Just after the 6-month interval, wages reach 0, and after 15 months, they increase to 0.008%. In words: as money penetrated the Montenegrin market, the expectations of the market and workers increased, but the real productivity did not improve. Consequently, the adjustment mechanism regulates the labor market in Montenegro, and workers accept lower wages. From the month of 15 to 38, wages fall slowly, confirming the about conclusion and implication. ? Inflation impulse response to the positive M2 shock indicates identical movements to wages. First, inflation falls from 0.02% to -0.04% within the first two months, then increases to 0.18% after eight months. After this, inflation

starts declining slowly and remains negative (-0.02) **for the rest of the period.** 4

Based on the above model, we can conclude that the Montenegrin macroprudential policymakers have to carefully pay attention to money supply and exchange rates to combine with fiscal policies. The Montenegrin government has to use fiscal policy to balance potential shocks that originate from abroad. Stabilization policy in the wake of exogenous innovations, such as COVID-19, is the first- order concern for Montenegro's monetary and fiscal authorities. This dissertation documented that strengthening Montenegro's institutions, public administration, and using principal growth engine – exports – and product diversification makes Montenegro stronger to absorb global economic shocks. Another substantial documentation is that the Montenegrin economy is

vulnerable to external shocks, as it heavily **relies upon capital inflows.** 2

Moreover, preserving human capital and keeping it in the country amounts to vital support and growth engine for macroeconomic stability and structural reforms in Montenegro. As the foreign investments will be very fragile after the outbreak of COVID-19, the stock market needs to be closely monitored by macroprudential policymakers. Since the structural reforms of supply shocks in Montenegro, through human capital and employment, trigger oscillations in aggregate demand more extensive than the shocks themselves, the policymakers are to make sure of not allowing firms to exit and create job destruction. In words: the series of effects

would cause a recession in case intervention **of conventional and non-conventional policies** 2

lacks. Inducing a high economic growth rate, leveraging the country's comparative advantages, has been documented in the thesis, and it can be achieved through securing law and order and appropriate subsidies. The upcoming central economic challenge for the policymakers of the Government of Montenegro and the CBCG is to manage the fiscal basket, lowering the public debt carefully. Considering all the 2020 uncertainties, a full rebound to pre-COVID 19 GDP levels will take a few years. Even though a new synthesis, more harmonization of contemporary macroeconomists, regarding the recovery, appears to be in-sight and feel that they have the toolset needed to have an in-depth understanding of macroeconomics and designing policies, the health crisis has started in January 2020 and is continuing worldwide. Montenegro, as a small and open economy, has to reassess carefully daily future economic and development policies since a relatively small shock could lead to a macroeconomic crisis. In these circumstances, the CBCG independence position is crucial, which could influence the avoidance of more serious consequences with its instruments. Insufficient focus on financial institutions could be a source of failure. By and large, the role of an independent CBCG provision could avoid the problem. Thus, a combination of integrated factors is substantially documented in this thesis to be a consistent role model for maintaining price stability. In words: poor understanding of the interacted factors by a central bank and having the factors absent from macroeconomic models combines and creates a crisis. Large macroeconomic integrated models are lessons documented from this thesis to design macroprudential tools to keep stable and low inflation and avoid significant risks to the level of high public debt dangers. If history is any reference, starting from the recent economic history, modern economic systems will be hit yet by another source of shocks the macroeconomists have not analyzed so far in combination puzzles. Thus, for example, the adjustment mechanism of the 2008 Financial liquidity trap crisis of lowering interest rates did not prove to be operational in response to low output: the decline in total economic activity or production trends. Be it fiscal or monetary policy, the room is much more limited than thought previously, especially in Montenegro. In the upcoming recovery period, general fiscal stimulus will be less effective than usual since the Keynesian multiplier feedback is muted due to some sectors' shutdown. Monetary policy may have magnified effects by restricting company exits, as long as it is unimpeded by the zero nominal lower bound. At the time being of rewriting this doctoral thesis, the documented findings, withdrawn from the empirical combination puzzles in chapters 3, 4, and 5, will appeal to macroeconomic policymakers and bring closer arguments to understand better what is happening to use monetary and fiscal policy tools: to steer the economy back gradually to its growth and refocus on the path of growth. The combination puzzle findings of integrated factors, the so-called combination puzzle recommend policymakers to take the combined position of new Keynesians and new growth theorists: the economic return to its natural level in the medium run, and the use of technological progress determinants. The combination policy tool, monetary and fiscal, addresses the best this question in our VAR and BVAR combined models. In addition to the above, our documented results have some other interesting macroprudential policy implications. Firstly, it is crucial to investigate further why economic freedom increases positively affect GDP, and in particular, to analyze the growth of economic freedom in correlation with the reduction of the shadow economy and the attraction of investments. It may be a mixture of a combination of the following: a) increases of shadow economies, b) crowds out of selected private investments, and c)increases of debt burden for the benefit of a few groups. Secondly, the policymakers should consider the institutional improvements and control mechanisms to simultaneously reduce the impact of public debt growth on future development dynamics. Finally, evaluation of public sector expenditure, such as public sector bureaucracy, is to be examined with a continuous reduction of administrative barriers to business. In words: appropriate investments would not increase the public debt and normalize the economic freedom shock impact. Another essential implication of this research is the assessment that Montenegro should effectively lead and end as soon as possible (reasonable medium-term). Another fundamental implication of this research is the assessment that Montenegro should effectively lead and end as soon as possible (reasonable medium-term) the already opened chapters and overall negotiation process with the EU. Achieving full-fledged membership will strongly contribute to the country in raising the economy's competitiveness, overall economic outlook, and benefit from the EU budget to maintain price stability and protect the country against any other financial or health shocks. Besides, unemployment is an issue of serious concern in Montenegro and the need for structural reforms in that area. The unemployment level is too high, put another way - the output is lower than the natural level (potential), and the economy has a trade deficit. An increase in exports and their diversification will help on both the trade and output fronts. Having shown all of the above, future research avenues should include a factor-

augmented VARX and sign restrictions approach to a better and more complete picture of future shocks. This research has used SVAR parameter estimation methods that impose parametric restrictions on structure or impulse responses. Sign restrictions utilize information to generate many sets of impulse responses for uncorrelated shocks αi that satisfy the signs. The range of possible impulse responses, the compatibility of the data, the shape of responses in choosing a parametric model, and the isolation of specific shocks are the benefits of sign restrictions. A desirable combination of sign restrictions and parametric would bring the best results. In conclusion, this doctoral dissertation's empirical findings provide macroprudential policymakers with an in-depth understanding of the role endogenous and exogenous determinants play in governing inflation with standard VAR and Bayesian combination models. Although previous research has identified several

methods that could be used to predict inflation, **such as internal and external variables, the methodologies developed from** these studies **have been** limited **and difficult to** apply at the **national level.** 1

Therefore, we value that the results of this research will enable

policymakers to better **understand the factors involved in** recognizing **the** dynamics **of** inflation **and** inflation **expectations in** 1

Montenegro and develop more effective measures and policies, which can be used at the national level. By doing so, we hope that our research work improves the set of tools needed to effectively address the challenges of managing external and internal inflation factors, which is crucial for maintaining price stability for macroprudential policymakers in Montenegro, especially the Central Bank of Montenegro. References 1. Acemoglu, D., and J. A. Robinson., Economic Origins of Dictatorship and Democracy. Cambridge, UK: Cambridge University Press, 2005. 2. Acemoglu, D., Introduction to Modern Economic Growth, New Jersey: Princeton University Press, 2009. 3. Acemoglu, D., S. Naidu, P. Restrepo, and J. A. Robinson., Democracy, Redistribution and Inequality. National Bureau of Economic Research Working Paper 19746, 2013. 4. Aghion, Ph. And P. Howitt., The Economics of Growth. Cambridge, MA: MIT Press, 2008. 5. Akaike, H., "A New Look at the Statistical Model Identification," IEEE Transactions on Automatic Control, 1974, 19, 716-723. 6. Akaike, H., "Fitting autoregressive models for prediction," Annals of the institute of Statistical Mathematics, 1969, 21(2), 243-247. 7. Alesina, A., and A. Wagner., "Choosing (and Reneging on) Exchange Rate Regimes," Journal of the European Economic Association, 2006, 4(4), 770- 799. 8. Alesina, A., and R. J. Barro., "Currency Unions," The Quarterly Journal of Economics, 2002, 117(2), 409-36. 9. Alesina, A., and V. Grilli., "The European Central Bank: Reshaping Monetary Policy in Europe." National Bureau of Economic Research, Working Paper 7927, 2000. 10. Amisano, G., and C. Giannini., Topics in Structural VAR Econometrics, second, revised and enlarged ed. Berlin Heidelberg: Springer, 2012. 11. Anderson, T., An Introduction to Multivariate Statistical Analysis, 3rd ed. New York: John Wiley, 2003. 12. Andrews, D. W. K., (1993) "Tests for parameter instability and structural change with unknown change point," Econometrica, 1993, 71, 395-397. 13. Apergis, N. and J. Payne., "Energy Consumption and Economic Growth in Central America: Evidence from a Panel Cointegration and Error Correction Model," Energy Economics, 2009, 31(2), 211-216. 14. Apergis, Nicholas and James Payne., "Energy consumption and growth in South America: Evidence from a panel error correction model," Energy Economics, 2010, 32(6), 1421-1426. 15. Apostolov, M., and D. Josevski., "Aggregate Demand–Inflation Adjustment Model Applied to Southeast European Economies," Journal of Central Banking Theory and Practice, 2016, 5(1), 141-157. 16. Arias, J. E., J. F. Rubio-Ramírez and D. F. Waggoner., "Inference based on SVARs identified with sign and zero restrictions: theory and applications," Econometrica, 2018, 86, 685-720. 17. Arltova, M., and D. Fedorova., "Selection of Unit Root Test on the Basis of Length of the Time Series and Value of AR(1)," Statistika - Statistics and Economics Journal, 2016, 96(3), 47-64. 18. Arnason, R., "Property Rights as a Means of Economic Organization," Conference Use of Property Rights in Fisheries Management, 1999. 19. Asparoukhov, O. K., and A. Stam., "Mathematical programming formulations for two-group classification with binary variables," Annals of Operations Research, 1997, 74, 89-112. 20. Asteriou, D., and S. G. Hall., Applied econometrics, 3rd ed. Basingstoke, United Kingdom: Palgrave MacMillan, 2015. 21. Baffes, J., M. A. Kose, F. Ohnsorge, and M. Stocker., "The Great Plunge in Oil Prices: Causes, Consequences, and Policy Responses," World Bank Group, Policy Research

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191. 317. Zugic, R. and N. Fabris., “Framework for Preserving Financial Stability in Montenegro,” Journal of Central Banking Theory and Practice, 2014, 3(1), 27 – 41. 318. The Heritage Foundation, https://www.heritage.org, accessed, October 31, 2019. 319. Trading Economics , https://tradingeconomics.com/, accessed, October 17, 2019. 320. Zivot, E. and J. Wang., “Vector Autoregressive Models for Multivariate Time Series. In: Modelling Financial Time Series with S-PLUS,” Springer Science, 2006, 385-429. PROŠIRENI APSTRAKT Inflacija je jedan od centralnih odnosno osnovnih makroekonomskih pokazatelja koji se temeljno ispituje od strane kreatora makroprudencijalne politike i makroekonomskih istraživača. Vlade je veoma zainteresovana za pouzdane prognoze inflacije. Prognoza inflacije je izazovno istraživanje. Značajan broj istraživača procijenio je i predvidio svojstva vremenskih serija inflacije. Opšta saglasnost ovih studioznih ispitivanja je da se osnovni trend i volatilnost inflacije tokom vremena znatno mijenjaju; međutim, još uvijek ne postoji konsenzus o najboljem načinu predviđanja dinamike inflacije. Prognoze inflacije bez grešaka od značaja su i za ostale subjekte u ekonomiji. Ekonomski akteri cé donijeti svoje odluke o platama i cijenama na osnovu inflacionih očekivanja koje se formiraju i oslanjaju na tačnost prognoze inflacije. Sa druge strane, nivo zavisnosti jedne male i otvorene ekonomije, poput Crne Gore, kao i dinamika njenih makroekonomskih indikatora, prošli su kroz značajne razvojne promjene poslednjih decenija. Neke od ovih promjena se ogledaju u obnovi nezavisnosti Crne Gore, dok se druge pripisuju ekonomskoj i političkoj orijentaciji ka Evropskoj uniji. Ove velike promjene donijele su značajno smanjenje volatilnosti makroekonomskog okruženja u Crnoj Gori: inflacija je ključni pokazatelj. Dakle, Vlada i makroprudencijalni kreatori politike Crne Gore preuzeli su dužnost i obavezu da kreiraju jasne makroekonomske politike sa namjerom da stabilizuju i učvrste inflaciju. Istovremeno, Evropska komisija eksplicitno izvještava o kriterijumima konvergencije u kojima performanse cijena moraju biti održive i prosječna stopa inflacije ne viša od 1,5 procentnih poena iznad stope inflacije tri države članice sa najboljim rezultatima. Ova disertacija koristi širok spektar ekonometrijskih modela, od kojih svaki nosi robustne vremenske serije, i procenjuje i ocijenjuje njihove prognozne performanse kroz vrijeme i modele. Različite studije su vršile poređenja predviđanja na jednom određenom modelu. Međutim, ova disertacija fokusira se na objedinjavanje ključnih internih i eksternih faktora inflacije i izvođenje kombinacije predviđanja za isti događaj: budući da nema pojedinačno “najboljeg” modela. Bez obzira na postojanje mnogih visoko rafiniranih kombinacionih metoda, tačnost predviđanja je često najbolja kada se primijenjuje jednostavno prosiječno korišcénje na svim modelima. Mi koristimo pristup jednakih i relativnih težina performansi (inverzni MSE). Ovo je prvi put da je za ekonomiju Crne Gore dobijeno kombinovano predviđanje, sugerišucí višedimenzionalne dinamičke modele. Ceteris paribus, naš glavni cilj je otkrivanje eksternih i internih determinanti inflacije u Crnoj Gori. Otkrivamo značajno širi jaz znanja: prvo, teorijska specifikacija, na osnovu koje se analiziraju empirijski determinante inflacije, koja kombinuje teoriju i empirijsku analizu, još uvijek nije opšteprihvaćena; drugo, izvođenjem identifikujemo tri strukturna VAR modela i kombinujemo ih sa jednakim i inverznim MSE pristupom ponderisanja. Ovaj pristup u dosadašnjim istraživanjima nije primijenjen na podatke o inflaciji u Crnoj Gori. Cilj ove doktorske disertacije je empirijski istražiti i prognozirati determinante inflacije Crne Gore, koristecí kombinacione metode prognoze, od januara 2006. do decembra 2016. godine, i van uzorka 12 – mjesečnog predviđanja horizonta od januara 2017. do decembra 2017. godine. S obzirom da kreatori politike moraju da definišu odgovarajucé kriterijume za dijagnozu, odnosno prepoznavanje indikatora inflacije, glavni izazov kod ovog istraživanja je bila potreba da se razvije pristup i metodologija koju Vlada Crne Gore može koristiti, u istraživanju determinanti inflacije, a uskladu sa postepenim prilagođavanjem standardima koje je neophodno uvoditi u makroekonomskom upravljanju, a na putu pristupanja EU, odnosno Evropskoj monetarnoj uniji. U radu se isputuju tri pojedinačna – prediktora SVAR modela za predviđanje inflacije. Takođe, koristimo pristup panel-vektorskog modela korekcije grešaka (VECM) za predviđanje dinamike inflacije i očekivanja inflacije u Crnoj Gori, Srbiji, Hrvatskoj i Sloveniji. Cilj pristupa panel kointegracije nije samo poređenje dvije podgrupe: i) Crna Gora (ME) i Srbija (SR) kao zemlje kandidati za članstvo u EU i ii) Hrvatska (CR) i Slovenija (SI), već u EU, već da istaknemo slučaj Crne Gore. Model 1 ispituje unutrašnje determinante inflacije. Model 2 odnosi se na potražnju i rast troškova varijable. Model 3 ispituje spoljne determinante. Kombinujucí navedena tri VAR i tri Bayesian VAR (BVAR) modela, otkrivamo još četri RMSE-a: (i) dvije VAR jednake i inverzne MSE težine, i (ii) još dva BVAR RMSE-a. Oni pokazuju performanse prognoziranja koja su održiva: prosječna inflacija ne viša od 1,5 p.p. iznad prosječne stope tri države članice sa najboljim performansama. Standardna VAR kombinacija daje najbolje predviđanje za I i II kvartal 2017. godine, dok Bayesian VAR kombinacija pokazuje najbolje performanse predviđanja za III i IV kvartal za 2017. Naši rezultati omogucávaju kreatorima politika Crne Gore da bolje razumiju faktore koji su uključeni u prepoznavanje dinamike inflacije i inflacionih očekivanja i razviju efikasnije regualtivu i mjere. Na navedeni način, ovo istraživanje unaprjeđuje i preporučuje potrebne metodološke alate, kombinujući prognoze, kako bi se kreatori markoprudencijalnih politika u Crnoj Gori efikasnije borili sa izazovima održavanja stabilnosti cijena. Kao što je prethodno istaknuto, determinante inflacije su jedno od ključnih pitanja sa kojim su se kreatori makroekonomskih politika u

Crnoj Gori neprekidno suočavali tokom proteklih decenija, a posebno od 2002. godine, nakon usvajanja eura kao zvanične valute. Država je status kandidata za Evropsku uniju postigla 2010. godine i u procesu je pregovora od juna 2012. godine. Kako je i navedeno u pregovaračkoj poziciji Unije, prilikom otvaranja pregovora, posebno otvaranja poglavlja o Evropskoj monetarnoj uniji, korišćenje eura kao zvaničnog sredstva plaćaja u Crnoj Gori bicé razmotreno tokom završne faze pregovora o pristupanju Uniji. Okvirni scenario podrazumijevao bi da Crna Gora od pristupanja učestvuje u Ekonomskoj i monetarnoj uniji kao država članica sa izuzecém i formalno se pridružuje eurozoni nakon odluke Savjetaa u tom smislu, na osnovu procjene ispunjenosti potrebnih uslova (EU General Position, 2012). Na osnovu zahtjeva tzv. Mastrihtskih kriterijuma za ulazak u EU (European Commission, Convergence Report, 2018), stopa inflacije mora biti stabilizovana kao preduslov za pridruživanje odnosno pristupanje Uniji. Otvaranjem pregovora o Poglavlju 17 - Ekonomska i monetarna politika, Unija pažljivo prati napredak u usklađivanju i primijeni pravne tekovine EU tokom čitavog procesa pregovora. Jedno od mjerila za ovo poglavlje je: Crna Gora je usvojila potrebne ustavne promjene. Ona mora da obezbijedi

da se primarni cilj stabilnosti cijena definiše u skladu sa članovima **127(1) i 282 (2) Ugovora o funkcionisanju Evropske unije** (Article **143** 135

of the Constitution, 2012). Da bi usvojila odnosno koristila euro u skladu sa svim kriterijumima, Crna Gora mora uskladiti svoje nacionalno zakonodavstvo sa propisima EU i ispuniti preduslov stabilnosti cijena, kako bi osigurala ekonomsku konvergenciju. Kriterijumi konvergencije izričito izvještavaju: „Performanse cijena koja su održive i prosiječna inflacija ne vecá od 1,5 p.p. iznad prosječne stope inflacije tri države članice sa najboljim učinkom (European Commission, 2018)“. Iako je inflacija u velikoj mjeri analizirana, saznajemo da još ima dovoljno prostora za istraživanje. Novina ovog rada je u tome što koristi kombinovano predviđanje za ekonomiju Crne Gore. Ovaj rad predlaže upotrebu visokodimenzionalnih dinamičkih modela, ispitivanje podataka vremenskih serija za Crnu Goru od januara 2006. do decembra 2017. godine. Procjenjuje i upoređuje empirijske performanse različitih prognoziranih kombinacija inflacije (Hendry and Clements, 2001; Jore et al., 2010). Cilj je otkriti determinante inflacije u Crnoj Gori u navedenom periodu i predvidjeti dinamiku inflacije, koristecí kombinovani pristup. Da bismo postigli taj cilj, rekurzivno procjenjujemo tri strukturna VAR identifikovana modela inflacije. Prvi model identifikuje primarne unutrašnje i nezavisne determinante inflacije (ekonomska sloboda i e-uprava). Model 2 ima varijable povlačenja potražnje i potiskivanja troškova (nominalni kurs, tražnja i depoziti privatnog sektora kao mjera širokog novca, zarade i rast industrijske proizvodnje), dok model 3 identifikuje osnovne spoljne i nezavisne determinante šokove ponude (cijene nafte i LME cijene aluminijuma). Teorija kombinovanja prognoza sugeriše da cé metode koje koriste bolje prognozne performanse i različite pondere, imati bolji učinak od jednostavnih modela kombinacije prognoza. Ceteris paribus, naše glavno stanovište je da bismo trebali uključiti agregatne determinante inflacije u makroekonometrijsku procjenu. Kombinacije prognoza su od suštinskog značaja u svjetlu crnogorskih napora da se ispuni ekonomske kriterijume pristupanja Evropskoj uniji. Empirijske determinante inflacije su od suštinskog značaja. Faktori koji određuju inflaciju u naprednim i tranzicionim zemljama bili su tema mnogih empirijskih i teorijskih studija (Golinelli and Orsi, 2001; Egert, 2007; Blanchard et al., 2010; Koop and Korobilis, 2012; Apostolov and Josevski, 2016; Obradovic et al., 2017). Sa druge strane, radovi koji se bave istraživanjem determinanti i analizom inflacije u Crnoj Gori su ograničeni. Članci koji su ispitivali inflaciju u našoj zemlji istakli su da bi samo strukturni višedimenzionalni modeli mogli tačno prognozirati inflaciju u Crnoj Gori (Lipovina – Bozovic et al., 2015; Mitrovic – Mijatovic and Ivanovic, 2017). Lipovina – Bozovic et al., (2015) zaključili su da ARIMA modeli predviđanja ne mogu adekvatno predvidjeti inflaciju, zbog postojanja mnogih spoljnih faktora koji utiču na kretanje cijena u Crnoj Gori. Mitrović - Mijatović i Ivanovic, (2017) utvrdili su da otvorenost Crne Gore pregrijava tražnju na tržištu nekretnina. Nadalje, novačana masa, akcize i spoljni šokovi takođe značajno utiču na inflaciju. Takođe, Međunarodni monetarni fond, u svom izvještaju Montenegro-Article IV Consultation, (2018) naglašava da 2 p.p. povecánja PDV-a i povecánje akciza dodaje otprilike 1 p.p. na inflaciju. Buducí da postoji relativno mali broj istraživačkih radova koji ispituju inflaciju u Crnoj Gori, razmotrili smo veliki broj empirijskih studija o determinantama inflacije. Za predviđanje inflacije predlažu se različite metodologije i indikatori. Cecchetti et al., (2000), između ostalih faktora, ističu impulsne reakcije realne ekonomije na inflaciju. Dées i Güntner (2016), koristecí panel VAR pristup, razdvajaju ulogu jediničnih troškova rada i profitnih marži kao osnovnih determinanta dinamike cijena u zemljama evrozone. Yi i Choi (2005) su proučavali 207 zemalja od 1991-2007 i otkrili su da kada se stopa penetracije interneta povecá za 1%, inflacija opada za 0,04% -0,13%.

Czernich et al., (2011) utvrdili su pozitivnu i značajnu vezu između širokopojasne veze i rasta za OECD: od 1996-2007. Acemoglu (2009) tvrdi da postoji uvjerljiva empirijska podrška hipotezi da razlike u ekonomskim institucijama, a ne srecá, geografija ili kultura, uzrokuju razlike u prihodima po stanovniku, pa otuda i inflaciju. Heritage Foundation (2019) naglašava: „U ekonomski slobodnom društvu, pojedinci su slobodni da rade, proizvode, troše i ulažu na bilo koji način, uz tu slobodu, koju država ujedno štiti i ne ograničava“. Pozitivnu veza između ekonomske slobode (ES) i endogenog modela rasta (EMR) pokazalo je nekoliko studija (Berggren, 2003; Gwartney et al., 2004). Cebula (2011) gdje se potencira pozitivna veza između ES i EMR koristecí podatke iz panela. Hammermann i Flanagan (2007) zaključuju da bi vecá liberalizacija pomogla da se smanje podsticaji rasta inflacije, a što je zasnovanu na istraživanju ekonomija u tranziciji sa 19 panela. Pored navedenog, brzina tehnološkog napretka (AW) i dinamički tempo očekivanja, koje društvo i radnici formiraju, presudni su i za oblikovanje očekivanja cijena (AW), a mehanizam prilagođavanja može se veoma zakomplikovati (Blanchard, 2017). Inovativne tehnologije mijenjaju strukturu tržišta, činecí staru tehnologiju zastarelom (Aghion i Hovitt, 2008). Takodje, smanjenje zaposlenosti u slučaju Crne Gore, može proizací iz činjenice da je potražnja za visokokvalifikovanim radnicima značajna, ali je ponuda adekvatnih profila kadrova, koje tržište traži, nedovoljna: povecánje nezaposlenosti, svih obrazovnih nivoa, utiče na inflaciju. U radu se takodje istražuju posljedice odricanja Crne Gore od nezavisne monetarne politike odnosno njenih ključnih instrumenata, što je dovelo do smirivanja inflatornih trendova. Polazeći i od iskustava nekih zemalja u razvoju, inflacija može postati niža i do 4%, kada se centralne banke i de jure obavezuju i de facto fiksiraju devizni kurs, u odnosu na slučajeve kada se samo de facto obavezuju (Ghosh et al., 2014). Euroizovane zemlje treba da imaju vrlo nisku prolaznu inflaciju, jer su njihove valute povezane sa valutom njihovih glavnih trgovinskih partnera (Del Cristo et al., 2012). U tom kontekstu, novačana masa očigledno ulazi u kratkoročne determinante inflacije (Lissovolik, 2003). Bobeica et al., (2019), što ukazuje da je verovatnije da se troškovi rada prenose na inflaciju cijena šokovima potražnje nego šokovima ponude. Još jedan dio literature izučavan je u ovom radu, i to onaj koji istražuje vremenski - različite efekte šokova cijena nafte na dinamiku inflacije, što su istraživali Kilian (2009), Peersman i Van Robays (2012), te Baumeister i Peersman (2013). Oni pokazuju da su osnovni izvori cijena nafte ključne determinante inflacije. Choi et al., (2017) otkrivaju da povecánje globalnih cijena nafte od 10%, povecáva domacú inflaciju za oko 0,4%, slično i kod razvijenih i kod zemalja u razvoju. Sve vecí značaj upravljanja inflacijom na pragu pristupanja EU motiviše autora da konceptualno i empirijski istražuje i predviđa determinante inflacije. Iako su determinante inflacije u velikoj mjeri proučavane, otkrivamo znatno širi jaz u znanju. Prvo, konceptualna specifikacija, na osnovu koje se analiziraju empirijska ispitivanja determinanti inflacije, ne prevladava kombinovanjem teorije i empirijske analize. Drugo, identifikujemo rekurzivno tri strukturna VAR i tri BVAR modela i kombinujemo ih sa jednakim i inverznim MSE pristupom ponderisanja. Navedene metode nisu primijenjene na crnogorske podatke o inflaciji. VAR se pokazalo jednim od ključnih empirijskih alata u savremenoj makroekonomiji i omogucávaju informativno modeliranje makroekonomskih podataka (Del Negro i Schorfheide, 2011). Kritičke pretpostavke istraživanja i hipoteze iznjete da bi testirali njihov logički i empirijski rezultat strukturirane su na sljedecí način: H1: Postizanju i održavanju stabilnosti cijena u Crnoj Gori, kao jednom od ciljeva centralne monetarne vlasti u zemlji (i njenim instrumentima), na putu ka Evropskoj uniji i Evropskoj monetarnoj uniji, značajno doprinosi i mjerenje uticaja ključnih faktora koje opredjeljuju nivo inflacije u zemlji. Važno je naglasiti da je ovo jedan od glavnih ciljeva Crne Gore u ispunjavanju kriterijuma uspostavljanja funkcionalne tržišne ekonomije, koja je precizno definisana u nizu zatvarajućih mjerila za pregovore sa EU u pregovaračkom poglavlju 17 - Evropska i monetarna unija (koje je otvoreno 26. juna 2018. godine). Crna Gora je takođe obavezna da usvoji neophodne ustavne promjene kako bi se osiguralo da se primarni cilj stabilnosti cijena definiše u skladu s članom 127(1) i 282(2) Ugovora o funkcionisanju Evropske unije. H2: Faktori inflacije u zoni eksterne tražnje, koji ključno opredjeljuju održavanje stabilnosti cijena u zemlji, na primjeru crnogorske ekonomije i u predloženom modelu, su cijena energenata i cijena aluminijuma. Drugim riječima, promjene cijene nafte na međunarodnom tržištu, izražena nivoom cijena energenata na domaćem tržištu, kao jedan od ključnih inputa za ekonomske aktivnosti u zemlji, značajno opredjeljuju nivo inflacije. Istovremeno, na taj nivo utiče i cijena aluminijuma, koja je takođe berzanski prozvod. Što je naprednija tehnološka sofisticiranost KAP-a i što je veća diverzifikacija proizvoda od aluminijuma (kao glavnog motora rasta industrijskog izvoza), to je veća podrška kreatorima politika u cilju stabilizacije trgovinskog bilansa, odnosa duga/BDP-a, rasta produktivnosti, smanjenja nezaposlenosti, smanjenja proizvodnog jaza, i poslijedično, ograničavanja eksternih šokova inflacije u Crnoj Gori, smanjenja cjenovne nejednakosti i kvalifikovanja zemlje za članstvo u EU/EMU. Drugim riječima, ovo istraživanje e se fokusira na mjerenje uticaja izvoza aluminijuma na prosječnu stopu inflacije u Crnoj Gori, kao i analizu efekata promjene cijena energenata na svjetskom tržištu. H3: Jačanje mjera i politika državne uprave ka razvoju e-usluga doprinosi efektivnijem i efikasnijem pružanju javnih usluga, što utiče na BDP, rast produktivnosti, nivo nezaposlenosti, proizvodni jaz i stoga stabilizuje interne šokove

inflacije u Crnoj Gori. Naime, jedan od unutrašnjih faktora koji određuju stopu inflacije u Crnoj Gori u ovom istraživanju bicé nivo razvijenih e-usluga, uključen u model regresije OLS, kao što je EGDI indeks. Testiranjem hipoteze u navedenom modelu, ocjeniće se postojanje korelacije između izabraih varijabli. Da bi dokazali ove hipoteze, ovdje predstavljamo procjene parametara i glavne karakteristike tri modela. Prvi identifikovani rekurzivni SVAR model je sledecí: πi = α0 + α1log(AA)i + α2log($AAAA$)i + α3$AAriAii$ +α4log(A)t + α5$Aiii$ + α6AAA_AAAi + ri (1) gdje πi označava stopu inflacije, log prirodni logaritam, tako da funkcija inflacije ima konstantnu elastičnost cijena, iiA(AA)i prirodni logaritam ekonomske slobode, iiA($AAAA$)i logaritamsko stanje tehnologije, $AAriAii$ stopa zaliha kapitala, $Aiii$ prirodni logaritam ljudskog kapitala, $Aiii$ radna snaga, AAA_AAAi označava jaz bruto domacég proizvoda. Proširujemo model rasta, koji je predstavljen u izrazu (1). Buducí da je Crna Gora postavila nacionalnu strategiju razvoja, dragocjeno je analizirati kako ovaj skup faktora, koji određuju dinamiku ekonomskog rasta, utiče na inflaciju (ERP, 2018-2020). Debata među istraživačima je šta bi trebalo predstavljati potvrdu stanja tehnološkog napretka u određenoj ekonomiji (Clarke i Wallsten, 2004; Meijers, 2014). U tom istraživanju,m možemo poći od indeksa razvoja e-uprave (EGDI) u modelu 1. EGDI uključuje karakteristike pristupa, kao što su infrastruktura i nivo obrazovanja, kako bi se odražavao kako zemlja koristi informacione tehnologije za unapređenje pristupa i uključivanje svojih ljudi (UN E-Government, 2019) . Model 2 cé ispitati kako promjene deviznog kursa, novčane mase, zarada i produktivnosti utiču na inflaciju u Crnoj Gori, koristecí rekurzivni strukturni VAR pristup. Ovdje posebno ističemo istraživanja koja procjenjuju da je evropska monetarna integracija, kompletna Evropska monetarna unija, istovremeno i suštinski, posredni korak, ka političkoj uniji (Alesina i Grilli, 2000): πi = α0 + α1log(AA)i + α2log($A2$)i + α3log(A)i + α4$AriAi$ + ri (2) gdje iiA(AA)i označava logaritamski oblik nominalnog kursa američki dolar za evro, iiA($A2$)i mjera novčane mase definisana u Međunarodnom monetarnom fondu (MMF, Monetary and Financial Statistics Manual 2017), iiA(A)i logaritamski oblik zarada, i $AriAi$ označava rast industrijske proizvodnje. Jednačina (2) uključuje sastojke privlačenja potražnje i potiskivanja troškova, polazecí od ravnoteže između agregatne tražnje i agregatne ponude. Cijene nafte i aluminijuma su kritične promijenljive u modelu 3 i mi smo zainteresovani za pracénje njihove dinamike. Zašto? Jer su egzogeno određene. To cé ukazati na šokove koji sa globalnog tržišta dolaze u crnogorsku ekonomiju. Motor rasta produktivnosti Crne Gore u velikoj mjeri zavisi od izvoznog potencijala (Bogetić et al., 2013). Neusklađenost politike Kombinata aluminijuma Podgorica (KAP) prouzrokovala je pad vodecég crnogorskog izvoznika. Bogetić et al., (2013) ističu da Crna Gora ne koristi glavni pokretač rasta - izvoz. Izvoz je transformisao mnoge male zemlje, posebno one sa značajnim prednostima u pogledu lokacije. Za period od 2007. do 2011. godine, odnos izvoza prema BDP-u u prosjeku je iznosio samo 39% u Crnoj Gori, dok je u Sloveniji 68%, Estoniji 78% i Malti 85% (Edgardo, 2008). Predviđa se da cé BAT tehnologija biti uložena u iznosu od 50 miliona eura u aluminijumsku industriju do 2030. godine. Smanjila bi efekat staklene bašte (GHG) za 82,76% (što utiče na zdravlje i poljoprivredu) i diverzifikovala proizvode od aluminijuma (ERP, 2018-2020). Stoga su cijene nafte i aluminijuma predstavljaju značajne determinante koje treba uzeti u obzir u makroekonometrijskom predviđanju crnogorske ekonomije. πi = α0 + α1log(Aii)i + α2log(Air)i + α3Aii + α4AAA_AAAi + ri (3) gdje iiA(Aii)i označava logaritamski oblik cijena nafte, iiA(Air)i logaritam cijena LME aluminijuma i Aii zarade. Ovaj model procijenjuje spoljne inovacije putem cijena nafte i aluminijuma. Kako možemo objediniti ili kombinirati ove prognoze u optimalnu prognozu? Uopšteno govorecí, višestruke prognoze su dostupne donosiocima odluka prije nego što donesu odluku o politici. S obzirom na neizvesnost povezanu sa identifikovanjem optimalnog GDP-a, da li treba koristiti jednu (najbolju) prognozu? Ili bismo trebali (nekako) da prosiječimo sve dostupne prognoze? Nije vjerovatno očekivati da bi jedan statistički model bio poželjniji od drugih u svim tačkama horizonta prognoze. Kombinovanje predviđanja pojedinačnih prediktora nudi jednostavan način izgradnje sofisticiranog, fleksibilnijeg modela predviđanja za objašnjavanje podataka. Objedinjena - kombinovana prognoza je ponderisani prosek Z prognoza (Zhang, 2019): W rRW+h = ∑ rR,h,irR,h,i (4) i=1 a odabirom pondere rR,h,i, minimalizuje se rizik povezan sa gubitkom zbog pravljenja greške u prognozi. Optimalana ponder za rR,h,1 je: $r*$ = σR2+h,1 + σR2+h,2 + σR2+h,3 − 3σR+h,1,2,3 σR2+h,3 − σR+h,1,2,3 (5) a preciznijem modelu dodeljuje se značajniji ponder. Vektor optimalnih težina r' sa Z prognozama je: r' = r'∑−−R1,1h r'∑R,hr (6) Kvadratna pristrasnost i prognoza varijanse funkcije MSE gubitka prognoze je: A [(rR+h − rR,h,i)] 2 W W = ∑ rR2,h,i $AiArR$2,h,i + σx2 + ∑ rR2,h,i $AArR$2,h,i i i Rekurzivni MSE pojedinačnih prognoza je: 1 R−h $AAAR$,h,i = A − h − 1 ∑(ri+h − ri,h,i) 2 i=1 MSE ponderi, relativne težine performansi, su: 1 φR,h,i = ∑YiM=1$SMCSSC$,h1S,i,h,i (7) (8) (9) Računanje relativnih pondera performansi (inverzni MSE) koristecí “rolling” prozore ili “discounting” omogucáva da se više pažnje posveti nedavnim performansama. Kombinovane prognoze podrazumevaju diverzifikaciju rizika. Sve variable su stacionarne, I (0), na osnovu jedinstvenih testova korjena ADF, PP i KPSS testa stacionarnosti. Vizuelni pregled i statistički korelogrami takođe prikazuju i potvrđuju stacionarnost. Rezultati testa t-statistike i p-vrijednosti odbacuju nultu hipotezu o jediničnim korijenima. Testiranje potencijalnih strukturnih lomova je presudno za utvrđivanje u svrhu predviđanja, kao i granica povjerenja.

Dijagnostika stabilnosti, pod rekurzivnim procjenama – Chow breakpoint test – Quandt-Andrews – Bai-Perron, ukazuje na to da postoji promjena parametara na nivou značajnosti od 5%. Dakle, dodajemo dihotomne varijable. Rekurzivno identifikujemo i procjenjujemo tri VAR i tri BVAR modela inflacije. Za svaki od kriterijuma (AIC, LR, FPE, SC i HK) predlaže se odgovarajucá dužina docnje. Odabrali smo dvije docnje kao odgovarajucú dužinu docnje za naš VAR model 1 i tri docnje za modele 2 i 3 (Clark i Ravazzolo, 2015). Svi inverzni korijeni karakterističnog polinoma nalaze se unutar jediničnih krugova, što potvrđuje stacionarnost VAR modela 1, 2 i 3. Otkrivamo da se prvi model najbolje uklapa u opseg pouzdanosti od 9% (od 1,6% do 2,0% inflacije). Pokazuje performansu predviđanja koji je održiv i prosječna inflacija ne vecá od 1,5% iznad stope tri države članice sa najboljim učinkom: Kipar (0,2%), Irska (0,3%) i Finska (0,8%). Prosječna stopa je 0,4%, a dodajucí 11/2 procentnih poena, referenca je 1,9% (EC, 2018). Model 2 ima više oscilacija oko "mode" nego model 1. Ipak, model 2 ima značajne skupove informacija koje treba uzeti u obzir za kombinovane prognoze. Kao što se i očekivalo, model 3 koji ima spoljne šokove (berzanske cijene nafte i aluminijuma), stvara vecé fluktuacije kako se horizonti povecávaju. U drugoj polovini 2017. godine, model 3 uklapa se u opsege pouzdanosti od 72-81%. Uključujemo određeni broj varijabli u model, jer dodavanje više regresora modelu predviđanja pogoršava probleme sa veličinom (Clark i West, 2006). Procijenili smo tri različita modela, a zatim uporedili njihove prognozne performanse na osnovu greške srednjeg kvadrata. Pored toga, izračunali smo kombinovane prognoze sa ovim modelima. Da li su naše kombinovane prognoze bolje od ponderisanog zbira njegovih dijelova? Svaki od SVAR modela ima svoje objašnjenja varijable i jednu y varijablu. Tri SVAR modela su precizirana, procijenjena i ispitana koja mogu najbolje predvidjeti inflaciju. Postavljamo uzorak na osnovu kojeg želimo da procijenimo modele, od januara 2006. do decembra 2016. Svaki od njih procijenjujemo pomocú najmanjih kvadrata. Uzorak predviđanja je od januara 2017. do decembra 2017. Pored toga, naredba "forecast" daje nam statistiku procijene za svaki model, čuvajucí matrice. Pokretanje ovog dijela programa (koda) omogucáva nam upoređivanje sposobnosti predviđanja svakog modela. Na osnovu RMSE, ispitujemo prognoze performansi. Prvi model ima najmanju grešku srednjeg kvadrata (0,69), dok je RMSE drugog modela (2,35). Izgleda da RMSE trecég modela ima najlošije rezultate, imajucí vrijednost (3,71), kao što se vidi u tabeli 19 u radu. Možemo li napravi dodatni korak u istraživanju? Kombinovanjem gornje tri prognoze, sa jednakim ponderima i relativnim ponderima performansi (inverzni ponderi MSE), otkrivaju se još dva RMSE. Zašto su ovi rezultati izuzetno značajni? Oni pokazuju da uzimanje u obzir svih determinanti inflacije na tržištu Crne Gore otkriva ključne informacije za CBCG: bolje predviđanje. Iako su relativni ponderi modela 2 i modela 3 relativno niski, kada se kombinuju u relativne pondere, oni otkrivaju vitalne i robusne informacije za kreatore makroprudencijalne politike: niži RMSE. Dokaz je da dodavanje varijabli, kroz SVAR modele, sistematski povecáva performansu predviđanja, snižavajucí RMSE. Zaključujemo da uključivanje adekvatnih SVAR prognoza u kombinaciju predviđanja dosljedno smanjuje osnovnu kvadratnu grešku prognoza kombinacije. Drugim riječima, adekvatno konstruisane kombinacije prognoza u Crnoj Gori trebale bi zamijeniti tradicionalne prognoze inflacije koje su se pokazale nedovoljno pouzdane. Štaviše, otkrivamo da, u prvoj četvrtini posmatrane godine, jednostavna prosječna kombinacija nadmašuje sve performanse. Pored toga, performansa relativnih pondera ostaje vrlo blizu, čak i za performanse u prvom kvartalu i najmanje je osetljiva do decembra 2017. godine. Jednostavniji, odnosno tzv. nisko-dimenzionalni modeli izostavljaju informacije sadržane u ostalim promijenljivim. Stoga su kombinacione prognoze, koje udružuju pojedinačne prediktorske prognoze, optimalno rješenje za Centralnu banku Crne Gore. Upoređujemo prognoze stvarne inflacije, kombinovane prognoze inflacije koristecí relativne pondere na osnovu inverznog MSE, kombinovane prognoze koristecí jednake pondere, kombinovanu prognozu koristecí srednje kvadratne greške, prognoze pomocú modela 1, prognoze pomocú modela 2 i prognoze pomocú modela 3. Na bazi sprovedenog istraživanja može se zaključiti da u početku posmatranog perioda (2017. godina), tokom prva tri mjeseca, jednostavna aritmetička prosječna prognoza kombinacije, nadmašuje sofisticiranije „optimalne" kompozitne prognoze. Od aprila do decembra 2017. godine, inverzni MSE je optimalna linearna kompozitna prognoza, minimizirajucí srednju kvadratnu grešku (MSE). Model 1 prati inverzni MSE do kraja, ali ipak, prosječna kombinacija ima bolje rezultate od Modela 2 i Modela 3. Na kraju decembra 2017. stvarna inflacija iznosi 1,9%, dok inverzni MSE 1,5%, u prosijeku 1,4 %, model 1 (1,3%), model 2 (5,8%) i model 3 (-3,0%). Modeli 1-3 pokazuju performanse predviđanja koje su održive i prosječna inflacija nije vecá od 1,5% iznad stope tri države članice sa najboljim učinkom: Kipar (0,2%), Irska (0,3%) i Finska (0,8%). Prosječna stopa je 0,4%, a dodajucí 11/2 procentnih poena, referenca je 1,9% (EC, 2018). Na kraju decembra 2017. kombinovana inflacija BVAR MSE iznosi 2,661%: BVAR prosječna kombinovana inflacija iznosi 2,822%. Prosječne težine kombinacije VAR približavaju se 1,537%, a obrnuto od standardnih VAR MSE 1,516%. Standardni modeli kombinacije VAR, prosječne i relativne performanse, pokazuju predviđanje performansi koje su održive. Iako su modeli 2 i 3 daleko u poređenju sa stvarnom inflacijom, inkorporiranje ovih varijabli je značajno za Centralnu banku Crne Gore (CBCG). Gornji rezultati omogucávaju prognozerima da analiziraju, procijene, uporede i iskoriste snagu korišcénja visokodimenzionalnih dinamičkih kompozitnih

modela prognoze. U poređenju sa standardnim procjenama VAR, BVAR Litterman / Minnesota pokazuje da ima najniže RMSE za model 2 (0,48967) i model 3 (1,27483), s obzirom na $\lambda 1 = 0$, $\lambda 1 = 0.1$, $\lambda 2 = 0.99$, $\lambda 3 = 1$, and $\lambda 4 = 10$, dok je za model 1 BVAR Normal-Flat , RMSE = 0.9913. Osetljiva razlika je u tome što su procjene Litterman / Minnesota znatno manje za prvo zaostajanje svake promjenljive. Standardna VAR kombinacija ima niži RMSE (0,577499) pri korišcénju inverznog MSE od BVAR-a (0.586937). S druge strane, prosječna Bayesian VAR kombinacija ima niži RMSE (0,804415) od prosječne težine standardne VAR kombinacije u smislu ygreške srednjeg kvadrata (0.864771). Kao što smo već istakli, za prva tri mjeseca, jednostavna VAR aritmetička prosječna prognoza kombinacije nadmašuje sve sofisticirane „optimalne“ kompozitne prognoze (2.045%). Od aprila do juna 2017. godine, inverzna VAR MSE, optimalna je linearna kompozitna prognoza, koja je najbliža stvarnoj inflaciji (2,127%). Bayesian inverzni MSE preuzima vođstvo od jula do decembra 2017. godine, konvergirajucí najbolje u stvarnu inflaciju (2,661%). Došli smo do kritičnog zaključka da Vlada Crne Gore mora da uzme u obzir obe kombinacije: standardna VAR kombinacija najbolje prognozira za I i II kvartal 2017. godine, dok Bayesian VAR kombinacija pokazuje najbolje prognozne performanse za kvartale III i IV 2017. Zaključujemo da uključivanje adekvatnih Bayesian VAR prognoza u kombinaciju prognoza, suštinski smanjuje osnovnu srednju kvadratnu grešku predviđanja kombinacije. Obje kombinacije su kritično sredstvo za kreatore politike Centralne banke Crne Gore. Panel ekonometrija je ispitivala i kratkoročne i dugoročne efekte ekonomskih sloboda i e-uprave na inflaciju, primijenom skupa podataka za Crnu Goru, Srbiju, Hrvatsku i Sloveniju za vremenski raspon 2006: 1 - 2017: 12. Heterogeni testovi kointegracije panela Pedroni, Kao i Johansena otkrivaju dugoročnu vezu između inflacije, ekonomskih sloboda i e-uprave. VECM predlaže da povecánje ekonomskih sloboda od 1% i e-uprave smanjuju inflaciju za 62,28%, odnosno 1,05%. Pored toga, koristi se Granger-ov test uzročnosti da bi se otkrio pravac uzročno-posljedične veze. PVECM se primenjuje za predviđanje inflacije pomocú determinističko-stohastičke simulacije i dinamičko- statičkih riješenja. Koriste se predviđene mjere kao što su proporcija pristrasnosti, proporcija varijanse, SE, RMSE, proporcija kovarijanse i Theil U1 i Theil U2, što potvrđuje rezultate predviđanja strategija učinaka. Nalazi impulsnog odgovora otkrivaju da je odgovor inflacije na šok za ekonomske slobode i e-vladu od suštinske važnosti. Razlaganje varijanse greške u prognozi stope inflacije proizilazi uglavnom iz indikatora nivoa ekonomskih sloboda. CBCG je zainteresovana da hipotetički sagleda reakciju inflacije u različitim osetljivim scenarijima, poput povecánja cijene nafte (spoljne inovacije) i indeksa ekonomskih sloboda - interne inovacije (Groen et al., 2012). Smatramo ih vodecím pokazateljima inflacije na koje bi kreatori makroprudencijalne politike trebalo da reaguju u Crnoj Gori. Alternativni scenario počinje da utiče, odnosno da mijenja podatke od januara 2016. do decembra 2017. Hipotetički, povecávamo cijene nafte sa 0,5 na 2 poena, sa 14,01% na 48,43%. Istražujemo kakav bi bio uticaj povecánja cijena nafte u crnogorskoj ekonomiji, s obzirom da je kanal cijene nafte je u Crnoj Gori višedimenzionala, te utiče na proizvodnju, potrošače, investitore, kao i na politiku Vlade, posebno u domenu fiskalne politike. Šok rasta cijena nafte mogao bi docí endogeno kao rezultat fiskalne konsolidacije. Troškovi proizvodnje povecávaju se rastom cijena nafte, što primorava kompanije da povecáju cijene, kako bi zadržale postojecú marginu profita. U slučaju porasta cijena nafte, potrošači više nemaju istu stvarnu vrijednost novca. Realne zarade im se smanjuju, što dovodi do povecánja nezaposlenosti. Odlukom o fiskalnoj konsolidaciji i povecánjem akciza, proizvodni jaz se smanjuje. To navodi preduzecá da povecáju cijene, što dovodi do povecánja inflacije. Na redu je monetarna politika, preko CBCG, da povecá/utiče na kamatnu stopu, kako bi usporila rast inflacije. Dinamika smanjenja proizvodnje povezana sa porastom inflacije poznata je kao stagflacija. U slučaju da promjene cijena nafte (promjena akciza ili promjena cijena na berzi) u Crnoj Gori ne budu pracéne promjenama očekivanja inflacije, tada cé očekivanja ostati konstantna, a Vlada cé imati mnogo lakši posao u makroekonomskom upravljanju. Da li je realno da cé očekivanja ostati konstantna? Šta određuje ova očekivanja? Ako čvrsto veruju u stabilnost makroekonomskog okruženja, tada se njihova očekivanja necé promjeniti. Naime, kompanije svoja očekivanja formiraju u vremenu velike dostupnosti informacija i razvoja društva znanja, počev od Interneta do brokera, vijesti, banaka i drugih agenata na tržištu širom svijeta (Giacomini, 2015). Sprovedeno istraživanje takođe ukazuje na zaključak da je u Crnoj Gori i kanal ekonomskih sloboda višedimenzionalan. Osjetljivi scenario slučaja, u našem istraživanju, hipotetički povecáva indeks ekonomskih sloboda sa 20% na 44% tokom cijele 2017. godine. Moramo imati na umu da je ovo deterministička simulacija – performansa predviđanja dinamičkog rešenja, koja koristi već predviđene docnje vrijednosti, da bi napravila predviđanje za više perioda unaprijed. Dakle, ovaj model automatski povecáva šansu za povecánje vjerovatnocé za reziduale. Ako pogledamo inflaciju, alternativni osjetljivi scenario mogao bi da utiče na smanjenje nivoa cijena, čak i sa 0% na -207%. Važno je pojasniti i zašto su se u istraživanju koristili strukturni VAR-ovi. Polazi se od činjenice da je CBCG zainteresovana za pracénje efekata šoka na inflaciju. Razmatramo događaj kada Crna Gora predviđa porast inflacije. CBCG povecáva, odnosno utiče na kamatnu stopu, ali inflacija i dalje raste, kako se očekivalo. Moglo bi se pogrešno zaključiti da je povecánje kamatne stope dovelo do porasta inflacije. Međutim, reakcija je bila endogena za očekivanu inflaciju. Stoga, u

istraživanju moramo identifikovati čisto egzogeni (politički ili drugi tip) šoka, da bismo mogli da pronađemo njegove dinamičke efekte: identifikujemo strukturni VAR. Impulsni odgovori prate efekte strukturnih šokova na endogene varijable. Funkcija impulsnog odziva cé nam recí promjenu endogenih varijabli za svaki strukturni šok pri t, t + 1 i tako dalje (Inoue i Kilian, 2016). Koristecí isti, ranije korišćen, odnos između prognoziranih grešaka i strukturnih šokova, Guerron- Quintana et al., (2017) naglašavaju: $Ai = \lambda + A-1ri + \sum\infty i=1\ \varphi i\ A-1ri-i$ (10) ili kompaktnije: $Ai = \lambda + \sum\infty i=1\ Ai\ ri-i$ (11) $A11,i$ i $A12,i$ su odgovori y i x na promijenu rxi i rxi, respektivno. Takođe, treba imati u vidu da je $A11,0$ efekat pri impakta, $A11,1$ je efekat rxi na y i tako redom: $\partial\partial xirw+ri = A11,i$ (12) takođe, kumulativni efekat je $\sum\infty i=0\ A11,i$. Pošto smo ispitali tri SVAR i tri BVAR modela, tragamo za prihvatljivim nivoom inflacije, odnosnom održivim nivoom u odnosu na šokove cijena nafte od jedne standardne jedinice devijacije. Reakcija impulsa na inflaciju, od jedne jedinice tzv. Cholesky standardne inovacije cijena nafte - počinje da se postepeno povecáva nakon docnje od četiri mjeseca. Poslije toga, opada, dostižucí deflaciju od -0,002 nakon 15 mjeseci. Dostiže dno od -0,09 nakon 21 mjeseca. Prenos šoka cijene nafte je evidentan. Treba imati na umu da porast cijena nafte ne može biti reakcija na ono što se dešava sa ostalim varijablama. To mora biti egzogeno. U ovom slučaju, „egzogeni" koraci Centralne banke Crne Gore, čine je zaista nezavisnom institucijom. Dakle, egzogeni šokovi su pravilno identifikovani. Riječima: s obzirom da je ekonomija usporila, proizvodnja je dosegla dno nakon 13 mjeseci, dok je inflacija dostigla najniži nivo poslije 21 mjeseca (jaz od 8 mjeseci između proizvodnje i inflacije). Već nakon 30 mjeseci inflacija postaje pozitivna, 0,0047. Dakle, povecánje cijene nafte tjera CBCG i kreatore fiskalne politike da intervenišu u cilju smanjenja inflacije. Povecánje cijene nafte uticalo je na potražnju na crnogorskom tržištu, navodecí kompanije da promijene svoja ulaganja i otkažu planirane projekte. U roku od 12 mjeseci, dok se proizvodnja smanjuje, inflacija nastavlja da raste. U ovom slučaju intervenisali su kreatori fiskalne politike u Crnoj Gori, prilagođavajucí inflaciju i proizvodnju. Ovaj proces prilagođavanja uglavnom se koordinira kroz proces očekivanja, koji je u Crnoj Gori solidno postavljen. Ovo prikazuje ključnu tačku: formiranje očekivanja u Crnoj Gori i dinamičke efekte šokova. Implikacija ovog šoka sa cijenama nafte je da proizvodnja brzo opada za tranzicionu ekonomiju kao što je Crna Gora, i treba joj više od godinu dana da se oporavi. Pri dekompoziciji varijanse inflacije na naftne šokove, vecína promjena, u prvom mjesecu, dolazi sama po sebi na nivo od 93,18%. Ovo ne bi trebalo da bude iznenađenje za kreatore ekonomske politike. Rezultat je našeg sistemskog pristupa u analizi navedenih varijabli. U dužim horizontima - 24 mjeseca, doprinos šokova varijablama kretanju ili prognozi varijanse greške inflacije povecáva se na sledecí način: nafta (17,82%), cijena aluminijuma (11,41%), nezaposlenost (13,62%) i gdp_gap 1,14%. Učinak šoka cijena nafte se naglo povecáva na početku, posebno u prvih šest mjeseci, sa 2,50%, 5,71%, 8,75%, 11,41%, 12,88% i 14,31%, respektivno. U modelu 1 primijetili smo da su ekonomske slobode od presudnog značaja, pa stoga i ovdje analiziramo detektovane impulse i dekompoziciju varijanse (Chan i Jeliazkov, 2009; Chan, 2013). Inflacija odmah počinje da opada, posebno u prvoj godini, a zatim počinje vrlo sporo da raste. Kako možemo da protumačimo navedeno kretanje, tj. rezultate? Navedena istraživanja upućuju na zaključak da je Crna Gora izuzetno izložena dejstvu spoljnih determinanti inflacije, posebno promjenama cijena nafte, kao berzanske robe. Da nagle promjene ove varijable, imaju izuzetno izražen uticaj kako na nivo prozvodnje, tako i na zaposlenost, te na samu antiflacionu politiku. Na putu pristupanja EU, Crna Gora mora uzimati u obzir dejstvo ovih determinanti inflacije, koje dolaze sa medjunarodnog tržišta, te efikasnom i fleksibilnom makroprudencijalnom, i ukupnom makroekonomskom politikom, blagovremeno se prilagođavati promjenama eksterne tražnje i šokovima cijena nafte. Istovremeno, neophodno je ekonomskim i sturkturnim reformama, smanjivati ranjivost, odnosno povećavati otpornost na eksterne šokove. To podrazumeva korekciju očekivanja cijena AW u odnosu na trenutni nivo cena A. Konačno, očekivano, Choleski-jeva dekompozicija varijanse prognoze greške inflacije na inovacijama ekonomskih sloboda uglavnom je rezultat šokova per se u kratkim horizontima, do nivoa od 96,53%. Posle šestomjesečnog horizonta, doprinos šokova ekonomskih sloboda kretanju inflacije povecáva se na 9,13% u ukupnoj kompoziciji. U 12-mjesečnim horizontima, doprinos ekonomskih sloboda i odgovarajucíh šokova evoluciji inflacije iznosi 24,94%. U 24-mjesečnim horizontima, udio kretanja inflacije usled šokova uzrokovanim ekonomskim slobodama dostiže 35,89%. Zaključno, doprinos ekonomskih sloboda kretanju inflacije je izuzetno značajan. Drugim riječima: u ekonomski slobodnom društvu pojedinci mogu slobodno raditi, proizvoditi, trošiti i ulagati. Kumulativno, takav ambijent pogoduje očuvanju cjenovne stabilnosti i kvalitetu prognoza ključnih makroekonomskih indikatora. S obzirom na to da su kreatori politike morali da definišu odgovarajucé kriterijume za dijagnozu nastupa indikatora inflacije, cijenimo da je dodata vrijednost ovog istraživanja napor na identifikaciji posebnog pristupa i same metodologije prognoziranja nivoa inflacije, koju bi Vlada Crne Gore mogla koristiti u razvoju antiinflacione i ukupne strategije razvoja. S obzirom na veliki porast interesa za ispunjavanje kriterijuma konvergencije odnosno kriterijuma iz Mastrihta, kao i nedostatak ujednačene metodologije prognoziranja nivoa inflacije, vijerujemo da cé zaključci predstavljeni u ovom istraživanju koristiti kreatorima makroprudencijalne politike u sprovođenju jedne od ključih fukcija upravljanja ekonomskim sistemom, a

to je održavanje cjenovne stabilnosti i posticanje rasta. Savremeni uslovi iznenadne zdravstvene i narastajuće ekonomske krize, u uslovima rastuće sistemske neizvjesnosti, takođe potvrđuju značaj istraživanja poput ovoga. Drugim riječima, stabilizaciona politika u toku egzogenih šokova, kao što je pandemija COVID-19, prvo je pitanje za monetarne i fiskalne vlasti Crne Gore. Ova disertacija je dokumentovala da jačanje crnogorskih institucija, javne uprave i korišćénje glavnog pokretača rasta - izvoza - i diverzifikacije proizvoda u smislu jačanja izvoznog potencijala naše ekonomije, čini Crnu Goru snažnijom u apsorbovanju globalnih ekonomskih šokova. Druga važan zaključak koji se može izvući na bazi sprovedenih istraživanja jeste da je crnogorska ekonomija (kao izrazito servisno orjentisana ekonomija) posebno osetljiva na spoljne šokove, jer se u velikoj mjeri oslanja na prilive kapitala i promjene eksterne tražnje. Štaviše, očuvanje ljudskog kapitala i njegovo zadržavanje u zemlji predstavljaju vitalnu podršku i pokretač rasta, ne samo za neophodnu makroekonomsku stabilnost, već i za jednako značajne i neophodne - strukturne reforme u Crnoj Gori. Budući da su strane investicije značajno smanjene uslijed izbijanja pandemije COVID-19, makrobonitetni kreatori politike moraju pažljivo nadgledati berzu i kretanja na međunarodnom tržištu. Budući da strukturne reforme šokova ponude u Crnoj Gori, kroz ljudski kapital i zapošljavanje, pokrecú oscilacije agregatne tražnje opsežnije od samih šokova, kreatori politike moraju osigurati da firmama ne dozvole relativno lak izlazak iz sektora, koji bi povlačio i značajnija kolebanja na tržištu rada i gubitak značajnog broja radnih mjesta. Drugim riječima: niz efekata mogao bi prouzrokovati recesiju u slučaju da nedostaje intervencija, kako konvencionalnih, tako i značajnog broja nekonvencionalnih politika i mjera. Podsticanje visoke stope ekonomskog rasta, iskorišćávajucí komparativne i konkurentske prednosti zemlje, dokumentovano je u tezi, a to se, između ostalog, može posticí obezbjeđivanjem reda i zakona, striktne primjene jednakih normi za sve, snažnijih institucija, ali i državng intervencionizma balansiranog kroz odgovarajuće subvencije i druge oblike podrške privredi (posebno u uslovima kriza). Sve navedeno dobija posebno na težini, ako uzimamo u obzir turbulentne faktore sprege zdravstveno-ekonomske krize, kada instrumenti fisklane polilike i politike upravljanja javnim dugom, postaju od presudne važnosti za stabilizaciju ekonomije i poboljšanje razvojne perspektive. Uzimajucí u obzir sve neizvesnosti koje je sa sobom donijela 2020. godina, kao i sagledavanje realnog oporavka ekonomije u srednjem roku, potpuni oporavak nivoa BDP-a, na nivo iz 2019. godine, prije COVID 19, svakako da može potrajati i nekoliko godina. Iako se čini da se nazire nova sinteza odnosno više usaglašenosti stavova savremenih makroekonomista po pitanju modela oporavka, te da oni cijene da posjeduju set alata potreban za dublje razumijevanje makroekonomije i dizajniranje budućih politika - dubina zdravstvene kriza koja je započela u januaru 2020. godine i nastavlja se širom svijeta, ipak tjera na oprez i dalja istraživanja. Crna Gora, kao mala i otvorena ekonomija, svakodnevno mora pažljivo preispitivati svoju buduću ekonomsku i razvojnu politiku, jer relativno mali šok može dovesti do ozbiljne makroekonomske krize. Nedovoljni fokus na finansijskim institucijama mogao bi biti izvor neuspjeha. U navedenim okolnostima, od presudnog je značaja pozicija nezavisnosti CBCG, koja bi svojim instrumentima mogla uticati na izbjegavanje ozbiljnijih posljedica. Kombinacija integrisanih faktora je u velikoj mjeri dokumentovana u ovoj tezi kao dosljedan uzor za održavanje stabilnosti cijena. Sažeto rečeno: loše razumijevanje međufaktorskih indikatora od strane centralne banke i nepostojanje faktora iz makroekonomskih modela, kombinuje i stvara krizu. Lekcije velikih integrisanih makroekonomskih modela su dokumentovane u ovoj tezi, uz dizajniranje makrobonitetnih alata kako bi se održala stabilna i niska inflacija i izbjegli značajni rizici u odnosu na nivo javnog duga. Polazeći od novije ekonomske istorije, savremene privredne sisteme će pogađati još izvora različitih šokova koje makroekonomisti do sada nisu analizirali u kombinovanim zagonetkama. Tako se, na primjer, mehanizam prilagođavanja krize zamkama finansijske likvidnosti iz 2008. godine, uz snižavanje kamatnih stopa, nije pokazao operativnim kao odgovor na pad ukupne ekonomske aktivnosti odnosno kretanje proizvodnje. Bilo da je riječ o fiskalnoj ili monetarnoj politici, prostor je mnogo ograničeniji nego što se ranije mislilo, posebno u Crnoj Gori. U predstojecém periodu oporavka, opšti fiskalni podsticaj bicé manje efikasan nego obično, jer su kejnzijanski multiplikatori prigušeni zbog gašenja nekih sektora. Monetarna politika može imati povecáne efekte ograničavanjem izlaza preduzecá, sve dok je neometana nultom nominalnom donjom granicom. U trenutku pisanja ove doktorske teze, dokumentovani nalazi, povučeni iz empirijskih kombinacija zagonetki u poglavljima 3, 4 i 5, privucí cé kreatore makroekonomskih politika i približiti argumente da bolje razumiju šta se dešava sa upotrebom alata monetarne i fiskalne politike: da se ekonomija postepeno oporavlja i usmjeri ponovo na putanju rasta. Nalazi komibinacije integrisanih faktora, tzv. kombinovane slagalice (combination puzzle) preporučuju kreatorima politike da zauzmu kombinovani stav novih kejnzijanaca i teoretičara novog rasta: ekonomski povratak na prirodni nivo u srednjem roku i upotreba determinanti tehnološkog napretka. Alat kombinovane politike, monetarni i fiskalni, najbolje se bavi ovim pitanjem u našim kombinovanim modelima VAR i BVAR. Pored navedenih, dokumentovani rezultati ovog istraživanja obuhvataju i dodatne implikacije na makrobonitetnu politiku. Prvo, veoma je važno dalje ispitivati zašto povecánje ekonomskih sloboda ima tako pozitivan efekat na BDP, te posebno analizirati rast ekonomskih sloboda u korelaciji sa smanjenjem sive ekonomije i

privlačenjem investicija. Drugo, kreatori politike treba da razmotre institucionalna poboljšanja i mehanizme kontrole, kako bi istovremeno težili da smanje uticaj rasta javnog duga na buduću razvojnu dinamiku. Na kraju, treba ispitati procjenu rashoda javnog sektora, odnosno strukturu ukupne javne potrošnje, uz kontinuirano smanjenje administrativnih barijera poslovanju. Drugim riječima: odgovarajućom kombinacijom investicija i okvira ukupne razvojne politike zemlje, mogao bi se kontrolisati njihov uticaj na rast javnog duga, čime bi se i normalizovali uticaji šoka ekonomskih sloboda. Otkrili smo da među performansama predviđanja pojedinačnih prediktora model 1 ima najbolje rezultate na osnovu greške osnovnog kvadrata. Zavisi od trenutnih ekonomskih šokova i ekonomske slobode. Model 1 ima čak i bolje rezultate od kombinovanih jednakih pondera, ali usrednjavanje ima bolji učinak od pojedinačnog modela 2 i modela 3. Ovaj osnovni dokaz pokazuje da su ekonomske slobode od presudnog značaja za promociju održivog rasta. Glavne implikacije ove studije sugerišu da su ekonomske slobode izuzetno značajne u upravljanju inflacijom i održivim rastom u Crnoj Gori. Alternativno, povecáli smo cijene nafte i ekonomsku slobodu, a predviđena inflacija se povecáva, odnosno naglo opada: dakle, implicirajucí da su vladini propisi o ekonomskim aktivnostima presudni. Rezultati impulsnog odgovora otkrivaju da su odgovori inflacije na šok naftom i ekonomsku slobodu značajni. Dekompozicija varijanse inflacije premiješta se uglavnom iz ekonomskih sloboda i cijena nafte. Zaključno, empirijski rezultati ove doktorske disertacije rada pružaju kreatorima makroprudencijalnih politika detaljno razumijevanje modela kombinacije prognoza. Još jedna suštinska implikacija ovog istraživanja je ocjena da Crna Gora treba u što kraćem (razumnom srednjem roku) efikasno vodi i okonča pregovarački proces sa EU. Postizanje punopravnog članstva snažno cé doprinijeti zemlji u podizanju konkurentnosti privrede i ukupnoj ekonomskoj perspektivi. Crna Gora, kao neto korisnica značajnih sredstava iz strukturnih i investicionih fondova EU, istovremeno dobija značajnu podršku u očuvanju stabilnosti cijena i zaštiti od mnogih (budućih) ekonomskih ili zdravstvenih šokova. Pored toga, nezaposlenost je pitanje koje ozbiljno zabrinjava sve ekonomske aktere u Crnoj Gori, zajedno sa potrebom za strukturnim reformama u toj oblasti. Nivo nezaposlenosti je visok, odnosno proizvodnja je niža od prirodne (potencijalne), uz visok trgovinski deficit. Povecánje izvoza i njihova diverzifikacija pomocí cé i na trgovinskom i na proizvodnom frontu. Polazeći od svega navedenog, budući putevi istraživanja trebalo bi da uključuju faktorski uvecáni VARX i pristup ograničenja znakova, radi bolje i potpunije slike buducíh šokova. Ovo istraživanje koristilo je metode za procjenu parametara SVAR koje namecú parametarska ograničenja na strukturu ili impulsne odzive. Ograničenja znakova koriste informacije za generisanje mnogih skupova impulsnih odgovora za nekorelirane šokove αi koji zadovoljavaju znakove. Opseg mogucíh impulsnih odgovora, kompatibilnost podataka, oblik odgovora pri izboru parametarskog modela i izolacija specifičnih šokova su prednosti ograničenja znakova. Poželjna kombinacija ograničenja znakova i parametra donijela bi najbolje rezultate. Iako su prethodni istraživački radovi identifikovali nekoliko metoda koje bi se mogle koristiti za predviđanje inflacije, poput internih i eksternih varijabli, metodologije razvijene iz tih studija bile su ograničene i teško ih je primijenjivati na nacionalnom nivou. Stoga cijenimo da će rezultati ovog istraživanja omogucíti kreatorima politike da bolje razumiju faktore koji su uključeni u prepoznavanje nastupa dinamike inflacije i inflacionih očekivanja u Crnoj Gori i razviju efikasnije mjere odnosno politike, koje se mogu koristiti na nacionalnom nivou. Radecí tako, nadamo se da naš istraživački rad unapređuje set alata potrebnih za učinkovito suočavanje sa izazovima upravljanja spoljnim i unutrašnjim faktorima inflacije, što je od ključnog značaja za održavanje stabilnosti cijena odnosno za kreatore makroprudencijalne politike u Crnoj Gori, posebno Centralnu Banku Crne Gore. Ključne riječi: Makroekonometrijsko predviđanje; Inflacija; VAR i BVAR kombinacije prognoza; Panel ekonometrija; Funkcije impulsnog odziva; BIOGRAFIJA Martin M. Bojaj je rođen 29.08.1976. godine u Mannheimu, Njemačkoj, gdje počinje prve korake školovanja. Osnovnu i srednju školu završava u Tuzima, Podgorici. Osnovne studije završio na Fakultetu za poslovnu administraciju, School of Business Administration, Wayne State University, Detroit, Michigan, USA, 2001. godine sa prosječnom ocjenom A (GPA 3.73). Magistarske studije (MSc) završio na Ekonomskom fakultetu u Podgorici u maju 2016. godine sa prosječnom ocjenom A (10.00). Magistarsku tezu, pod nazivom “Uticaj razvijenosti modela G2B i G2C na ekonomski rast Crne Gore“,

pod mentorstvom prof.dr Maje Baćović **(redovnog profesora Ekonomskog fakulteta u** Podgorici). Doktorske studije **na Ekonomskom fakultetu u Podgorici** 198

upisuje 2016. godine. Na Oakland Community College, Michigan, bio je angažovan kao istraživač 1999. godine. Na Wayne State University bio je angažovan kao saradnik za oblast Accounting od 2000 do 2001. godine, i to na predmetima: Advanced accounting theory 5100, Managerial

accounting 5160, Taxes on income 5170, i Auditing, assurance, and attestation 5996. Angažovan je u Hellenic Petroleum, Kotor, 2001. godine kao menadžer plana budžeta i analitičar. Od 2006. godine vodi filijalu NLB banke AD Podgorica u Tuzima. U cilju usavršavanja pohađao je IMF Macroeconometric forecasting studije. Takođe, dobitnik je brojnih nagrada tokom studiranja, između ostalog i Phi Theta Kappa međunarodnu skolastičku dekoraciju. Autor je većeg broja naučnih radova iz oblasti makroekonomije. Aktivno učestvuje u mnogim međunarodnim aktivnostima kao i u izradi značajnih projekata.

IZJAVA O AUTORSTVU Potpisani: Martin M. Bojaj **Broj indeksa:** 1/16 **Izjavljujem da je doktorska disertacija pod naslovom** 208

“Maintaining Price Stability in Montenegro through Governance of External and Internal Factors of Inflation” ?

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Maintaining Price Stability in Montenegro through Governance of External and Internal Factors of Inflation Mentor: Prof.dr Gordana Đurović Potpisani: Martin M. Bojaj

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“Maintaining Price Stability in Montenegro through Governance of External and Internal Factors of Inflation”

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1. Autorstvo 2. Autorstvo – nekomercijalno 3. Autorstvo – nekomercijalno – bez prerade 4. Autorstvo – nekomercijalno – dijeliti pod istim uslovima 5. Autorstvo – bez prerade 6. Autorstvo – dijeliti pod istim uslovima Podgorica, 10.11.2020. godine Potpis doktoranda _____ Inzinerine Ekonomika-Engineering Economics, 2020, 31(2), 145–154 Forecasting Inflation: A Combination Approach Martin M. Bojaj[1]*, Gordana Djurovic[2] University of Montenegro, Faculty of Economics Boulevard Jovana Tomasevica 37, 81000, Podgorica, Montenegro E-mail. [1]*bmmbojaj@gmail.com (corresponding author); [2]gordana@t-com.me http://dx.doi.org/10.5755/j01.ee.31.2.24609 The objective of this paper is to investigate and forecast the determinants of Montenegrin inflation empirically, using forecast combination methods, from January 2006 to December 2016, and out-of-sample 12-month horizon forecasting from January 2017 to December 2017. The main research problem is that given the struggle policymakers have had to define proper criteria to

diagnose the onset of inflation **indicators, we** felt compelled to **identify an approach and methodology that the government of Montenegro can use** in **the** 2

threshold to accessing the European Union. We examine three individual-predictor SVAR models to forecast inflation. Model 1 examines the internal determinants of inflation. Model 2 relates to demand-pull and cost-push variables. Model 3 examines external determinants. Combining the above three forecasts, we disclose two more RMSEs: equal and inverse MSE weights. Model 1 predicts inflation at 1.3 %, the inverse MSE at 1.5 %, and the weighted average at 1.4 %. They show forecasting performances that are

sustainable and average inflation not more than 1.5 % above the rate of the three best performing Member states: 1

Cyprus (0.2 %), Ireland (0.3 %), and Finland (0.8 %) over **the** 6

12 months covering April 2017-March 2018.

Our findings allow the policymakers to understand the factors involved in identifying the onset of inflation **dynamics and** inflation **expectations in** Montenegro **better and develop more effective** government regulations **that can be** employed **nationally. In so doing,** 1

this research advances and recommends

the toolset needed, combining forecasts, **to combat the concerns of many macroprudential policymakers in** Montenegro, especially **the** 206

Central Bank of Montenegro. Keywords: Macroeconometric Forecasting; Inflation; Forecast Combination; Impulse Response Functions; Inverse MSE Approach. Introduction The determinants of inflation are

a critical question that macroeconomic policymakers **in** Montenegro **have faced** continually **over the past** 10

decade, and particularly since 2002, following the adoption of the euro as Montenegro's formal currency. The country achieved the European Union candidate status in 2010 and has been in the process of negotiations since June 2012. Montenegro's present use of the euro will be addressed in the course of the final phase

of the negotiations. Montenegro will participate in the economic and monetary union from accession as a Member State with a derogation and shall join the euro area following the Council decision to this effect based on an evaluation of its fulfillment of the necessary conditions 31

(EU General Position, 2012).

Based on the requirements of the Maastricht criteria for entering the EU 1

(European Commission, Convergence Report, 2018),

the inflation rate must be stabilized as a prerequisite to joining. By opening the 236

negotiations on Chapter 17 – Economic and monetary policy,

the Union carefully monitors the progress in the alignment with and implementation of the acquis throughout the process of negotiating. One of the 1

benchmarks for the chapter is: Montenegro

has adopted the required constitutional change. It has to ensure that the primary objective of price stability is defined in compliance with Articles 127 (1) and 282 (2) of the Treaty on the Functioning of the European Union (Article 143 of the Constitution, 1

2012). To adopt the euro, Montenegro

has to bring its national legislation in line with the EU law and meet price stability to ensure economic convergence. Convergence criteria explicitly report: 1

"A price-performance that is sustainable and average inflation not more than 1.5 % above the rate of the three best performing Member States (European Commission, 2018)". Even though inflation

has been analyzed to a great extent, we find there is still sufficient space for enhancement. The 1

novelty of this paper is that it uses a combined prediction for the economy of Montenegro. This paper suggests using high – dimensional dynamic models,

examining time-series data from January 2006 to December 2017 for Montenegro. It evaluates and compares the empirical performance of various forecast combinations of inflation	1

(Hendry & Clements, 2001; Jore et al., 2010). The objective is to reveal the determinants of inflation in Montenegro

in the specified period and forecast the inflation dynamics, using a combination approach.	1

To achieve that objective, we estimate recursively three structural VAR identified models of inflation. The	1

first model identifies the primary internal and independent determinants of inflation (economic freedom and e- government). Model 2 has demand-pull and cost-push variables (the nominal exchange rate, the demand, and private sector deposits as a measure of broad money, wages, and industrial production growth), while model 3 identifies the fundamental external and independent determinants of the supply shocks (oil and London Metal Exchange aluminum prices). We find that only one forecast -145- Martin M. Bojaj, Gordana Djurovic. Forecasting Inflation: A Combination Approach combinations, the inverse MSE, outperforms all SVAR models. The theory of combining forecasts

suggests that methods that weigh better-performing forecasts more heavily will perform better than the simple combination	85

forecast (Stock & Watson, 2004; Smith & Wallis, 2009). Ceteris paribus, our main statement is that we should incorporate aggregate determinants of inflation into the macro-econometric estimation. Forecast combinations are essential

in the light of Montenegrin efforts to join the European Union.	343

Literature Review Empirical inflation determinants are essential. Factors that determine inflation in advanced and transitional countries have been a topic of many empirical and theoretical studies (Golinelli & Orsi, 2001; Egert, 2007; Blanchard et al., 2010; Koop & Korobilis, 2012; Apostolov & Josevski, 2016; Obradovic et al., 2017). Papers that investigate Montenegrin inflation are limited. Articles that examined Montenegrin inflation highlighted that only the structural multidimensional models would accurately forecast inflation in Montenegro (Lipovina – Bozovic et al., 2015; Mitrovic – Mijatovic & Ivanovic, 2017). Lipovina – Bozovic et al., (2015) concluded that ARIMA forecasting models could not adequately predict inflation

because of the existence of many external factors that influence the price movement in Montenegro.	190

Mitrovic – Mijatovic and Ivanovic, (2017) found that

openness of Montenegro, overheated demand in house prices, broad money, 3

excise tax, and external shocks have a positive impact on inflation. International Monetary Fund, Montenegro-Article IV Consultation, (2018) emphasizes that a 2 p.p. VAT increase and excise increases adds approximately 1 p.p. to inflation. Since there are only a small number of research papers that examine Montenegrin inflation, we have considered a large number of empirical studies on inflation determinants. Different methodologies and indicators are suggested to forecast inflation. Cecchetti et al., (2000), among other factors, highlights the impulse responses of the real economy to inflation. Dées and Güntner (2016), using a panel VAR approach,

disentangle the role of unit labor **costs and profit margins as the fundamental determinants of price dynamics** 59

across euro area countries. Yi and Choi (2005) studied 207 countries from 1991- 2007 and revealed

that when internet penetration rate increases by 1 %, **the inflation drops by 0.04** 101

%–0.13 %. Czernich et al., (2011) found a positive and significant relationship between broadband nexus and growth for OECD: from 1996–2007.

Acemoglu (2009) argues that **there is convincing empirical support for the hypothesis that differences in economic institutions,** rather **than luck, geography, or culture, cause differences in incomes per-capita,** 92

hence inflation. The Heritage Foundation (2019) emphasizes: “In an economically free society, individuals are free to work, produce, consume, and invest in any way they please, with that freedom both protected by the state and unconstrained by the state.” The positive relation between economic freedom (EF) and the endogenous growth model (EGM) have shown several studies (Berggren, 2003; Gwartney et al., 2004). Cebula (2011) showed a positive relationship between EF and EGM by using panel data. Hammermann and Flanagan (2007) conclude that greater liberalization would help reduce incentives for higher inflation based on 19-panel transition economies. The technological progress speed (Ae) and the dynamic pace of expectations that society and workers form is crucial with the shaping of price expectations (Oe) as well, and the adjustment mechanism might get very complicated (Blanchard, 2017). Innovative technologies change the structure of the market, making old technology obsolete (Aghion & Howitt, 2008). The decrease in employment in Montenegro’s case might come from the fact that the demand for high-skilled workers is high, but the supply is low: increasing unemployment, impacting inflation. Montenegro gave up the independent monetary policy.

Inflation is indeed lower, especially in emerging markets, by some 4% when the central banks **both de jure commits and de facto pegs the exchange rate** rather **than when it de facto pegs alone** 47

(Ghosh et al., 2014). Euroized

countries should have very low pass-through inflation **as their currencies are anchored to that of their principal trade** 61

partners (Del Cristo et al., 2012). Broad money clearly enters short-term inflation determinants (Lissovolik, 2003). Bobeica et al., (2019)

show that it is more likely that labor costs are passed on to price inflation with demand shocks than with supply shocks. 118

Another strand of the

literature that examines the time- varying effects of oil price shocks on the inflation dynamics 57

are

Kilian, (2009), Peersman and Van Robays, (2012), and Baumeister and Peersman, (2013). They show that the 57

underlying sources of oil

prices are critical determinants of inflation.

Choi et al., (2017) find that a 10 % increase in global oil prices, increases domestic inflation by about 0.4 166

%, being similar between advanced and developing countries. The rising importance of governing inflation at the threshold of accessing the EU motivates the authors to conceptually and empirically research and predict inflation determinants. Methodology Even though inflation determinants have

been studied to a great extent, we reveal a significantly wider knowledge gap. First, conceptual specification, based on which empirical examinations of inflation determinants are analyzed, is not prevailing combining theory and empirical analysis. Second, we identify recursively three structural VAR models 1

and combine them with an equal and inverse MSE weighting approach.

It has not been applied to Montenegrin inflation data. VARs turn out to be one of the key empirical tools in modern macroeconomics, and they allow one to model macroeconomic data informatively 1

(Del Negro & Schorfheide, 2011).

Here, we present parameter estimates and the main characteristics of the models. The first identified recursive SVAR model is as follows: 1

πt = β0 + β1log(CC)t + β2log($CCCC$)t + β3$CSrkakt$ +β4log(C)t + β5$Ckkt$ + β6CCO_CAOt + rt (1) Inzinerine Ekonomika-Engineering Economics, 2020, 31(2), 145–154 where πt denotes the inflation rate, log

natural logarithm so that the inflation **function has a constant price elasticity,** 16

log(CC)t the natural logarithm of economic freedom, log($CCCC$)t the logarithmic state of technology, $CSrkakt$ the capital stock rate, log(C)t the natural logarithm of human capital, $Ckkt$ the labor force, CCO_CAOt denotes the gross domestic product gap. We will augment the growth model, which is represented in expression (1). Since Montenegro

has set its national development strategy, **it is valuable to** analyze **how** 1

this set of factors that determine economic growth dynamics impact inflation (ERP, 2018– 2020). The debate among academics is what would be a proxy for the state of technological progress (Clarke & Wallsten, 2004; Meijers, 2014). We will proxy it by e- government development index (EGDI) in model 1. The EGDI

incorporates the access characteristics, such as the infrastructure and educational levels, to reflect how a country is using information technologies to promote access and inclusion of its people (UN **E-Government,** 79

2019). Model 2 will examine how changes in exchange rates, money supply, wages, and productivity impact inflation in Montenegro, using a recursive structural VAR approach. A complete monetary union in Europe is an essential intermediate step toward political union (Alesina and Grilli, 2000): πt = β0 + β1log(CS)t + β2log($M2$)t + β3log(S)t + β4$Orkat$ + rt (2) where log(CS)t denotes the logarithmic form of the nominal exchange rate US dollar to euro, log($M2$)t

a measure of broad money defined by the International **Monetary** Fund (IMF), Monetary **and Financial Statistics Manual** 3

(2017), log(S)t logarithmic form of wages, and $Orkat$ denotes industrial production growth. Equation (2) incorporates both demand-pull and cost-push ingredients, starting from a balance between aggregate demand and aggregate supply. Oil and aluminum prices are critical variables in model 3, and we are interested in tracing their dynamics. Why? Because they are determined exogenously. These will indicate the shocks that come from the global market to the Montenegrin economy. The productivity growth engine of Montenegro substantially depends on export potential (Bogetic et al., 2013). Policy misalignment of Aluminum Plant Podgorica (KAP), caused the leading Montenegrin exporter to suffer. Bogetic et al., (2013) emphasize that

Montenegro is not using the principal growth engine – exports. Exports have **transformed many small countries, especially those with significant location advantages.** 13

For 2007–2011, the exports-to-GDP ratio averaged only 39 % in Montenegro, while in Slovenia 68%, Estonia 78 %, and Malta 85 % (Edgardo, 2008). It is projected that BAT technology will be invested in the amount of 50 million euros in the aluminum industry until 2030. It would reduce the

greenhouse gas (GHG) by 82.76 % (impacting health and agriculture), and diversify products of aluminum (ERP, 2018–2020). Thus, oil and aluminum prices are significant determinants to be considered in the macro-econometric forecasting of the Montenegrin economy. πt = β0 + β1log(Oik)t + β2log(Akr)t + β3Skt +β4CCO_CAOt + rt (3) where log(Oik)t denotes the logarithmic form of the oil prices, log(Akr)t the logarithm of LME aluminum prices, and Skt wages. This model estimates external innovations through oil and aluminum prices. How can we pool, or combine these forecasts into an optimal forecast? Generally speaking, multiple forecasts are available to decision-makers before they make a policy decision. Given the uncertainty associated with identifying the true DGP, should a single (best) forecast be used? Or should we (somehow) average over all the available forecasts? It is implausible that one statistical model would be preferable to others at all forecast horizon points. Combining individual-predictor forecasts offers a simple way of building a sophisticated, more flexible forecasting model to explain the data. A pooled - combined forecast is a weighted average of Z forecasts (Zhang, 2019): Z wcT+h = ∑ wT,h,$i$$wT$,$h$,$i$ (4) i=1 and choosing weights wT,h,i, minimizes the risk associated with the loss from making a forecast error. The optimal weight for wT,h,1 is: w∗ = σT2+h,3 − σT+h,1,2,3 σT2+h,1 + σT2+h,2 + σT2+h,3 − 3σT+h,1,2,3 (5) and more significant weight is assigned to the more precise model. The vector of optimal weights w' with Z forecasts is: w' = rr'∑'∑−TT−1,h,1hr (6) The squared bias and the forecast variance of the MSE loss function of a forecast is: C [(wT+h − wT,h,i)] 2 Z Z = ∑ wT2,h,i $aiarT$2,h,i + σx2 + ∑ wT2,h,i $SarT$2,h,i (7) The recursive MSE of individual forecasts is: i i $MSCT$,h,i = 1 T−h ∑(wt+h − wt,h,i) 2 (8) S − h − 1 t=1 Moreover, the MSE weights, relative performance weights, are: 1 ψT,h,i = $ZMSES$,h1,i (9) ∑i=1$MSES$,h,i Computing relative performance weights (inverse MSE) using either rolling windows or discounting allows more attention to be paid to recent performance. Combined forecasts imply diversification of risk. Empirical Results and Discussion

All variables are stationary, I(0), **based on unit root tests of ADF, PP, and KPSS** stationarity **test. Visual inspection and statistical correlograms portray and confirm stationarity** as well. **Test results of t-statistics and p-values reject the null hypothesis of unit-** 1

roots.

Testing for potential structural breaks is **crucial to identify for forecasting purposes as well as confidence bounds. Stability diagnostics, under recursive estimates** 1

– Chow breakpoint test – Quandt-Andrews – Bai- Perron, indicate there is a switch of parameters at a 5 % 10% significance level. Thus, we add dichotomous variables. Recursively, we identify and estimate three SVAR 8% models of inflation. For each of the criteria (AIC, LR, FPE, 6% SC, and HQ), a fitting lag length is suggested. We select two 4% lags as the appropriate lag length for our VAR model 1 and three lags for models 2 and 3 (Clark and Ravazzolo, 2015). 2% As we can see from Figure 1, all the

inverse roots of the 0% **characteristic polynomial** lie **within the unit** circles, -2% **confirming the** stationarity **of the** VAR **model** 106

1, 2, and 3. -4% Model 1 Model 2 Model 3 1.5 1.5 1.5 1.0 1.0 1.0 0.5 0.5 0.5 0.0 0.0 0.0 -0.5 -0.5 -0.5 -1.0 -1.0 -1.0 -1.5 -1.5 -1.5 -1.5 -1.0 -0.5 0.0 0.5 1.0 1.5 -1.5 -1.0 -0.5 0.0 0.5 1.0 1.5 -1.5 -1.0 -0.5 0.0 0.5 1.0 1.5 -1.5 -1.0 -0.5 0.0 0.5 1.0 1.5 Figure 1. Inverse Roots of AR Characteristic Polynomials Source: Authors' estimates The fan charts, in Figures 2–4, show the forecasting performance of each model. We portray results, showing ten confidence intervals: from 90 % to the mode. 12% 8% 4% 0% -4% -8%

M10 M11 M12 M1 M2 M3 M4 M5 M6 M7 M8 M9 M10 M11 M12 2016 2017 36

Figure 2. Fan Chart of Model 1 – Stochastic Simulator Source: Authors' estimates

Visual inspection reveals that the first **model, in** Figure **2,** fits **the best**	2

into a 9 % confidence band (from 1.6 % to 2.0 % inflation). It shows a forecasting

performance that is sustainable and average inflation not more than 1.5 % above the rate of the three best performing	1

Member states: Cyprus (0.2 %), Ireland (0.3 %), and Finland (0.8 %). The average rate is 0.4 % and, adding 11/2 **percentage points, the reference is 1.9**	6

% (EC, 2018). Model 2, in Figure 3, has more oscillations around the mode than model 1. Still, model 2 has valuable information sets to be considered for combined forecasts. As expected, model 3, in Fig. 4, having the external shocks (oil and aluminum LME prices), creates more fluctuations as horizons increase.

M10 M11 M12 M1 M2 M3 M4 M5 M6 M7 M8 M9 M10 M11 M12 2016 2017	36

Figure 3. Fan Chart of Model 2 – Stochastic Simulator Source: Authors' estimates In the second half of 2017, model 3 in Figure 4 fits into 72-81% confidence bands. We incorporate a certain number of variables within a model because

adding more regressors to the forecasting model exacerbates the size problems	302

(Clark & West, 2006). 6% 4% 2% 0% -2% -4% -6% -8% -10%

M10 M11 M12 M1 M2 M3 M4 M5 M6 M7 M8 M9 M10 M11 M12 2016 2017	36

Figure 4. Fan Chart of Model 3 - Stochastic Simulator Source: Authors' estimates We estimated three different models and then compared their forecast performance, based on root mean square error. Besides, we computed combined forecasts with these models. Are our combined forecasts better than the weighted sum of its parts? Each of the SVAR models has its explanatory variables and a y variable. The three SVAR models have been specified, estimated, and examined which can forecast inflation the best. We set the sample over which we want to estimate the models, from January 2006 to December 2016. We estimate each using least squares. The forecasting sample is from January 2017 to December 2017. Besides, the command of forecast(e) gives us evaluation statistics for each model, saving matrices. Running this part of the program (code), enables us to compare the forecasting ability of each model. Based on the RMSEs, we examine the forecast performances. The first model has the lowest root mean squared error (0.69), while the RMSE of the second model is (2.35). The RMSE of the third model appears to perform the worst, having a value of (3.71), as seen in Table 1. Can we do better? Combining the above three forecasts, with equal weighting and

relative performance weights (inverse MSE weights), reveals two more RMSEs. Table 1 Why are these results remarkable? They show that Forecast Evaluation Statistics of Model 1, 2, and 3 taking into consideration all determinants of inflation in the market of Montenegro reveals crucial information for the Included observations: 12 M1 M 2 M 3 CBCG: better prediction. Even though the relative weights of model 2 and model 3 are relatively low, when combining

Root Mean Squared Error Mean Absolute Error Mean Absolute P. **Error Theil Inequality Coefficient 0.** 6884 2.3466 178
3.

7081 into relative weights, they reveal vital and robust 0.6175 2.0865 3.4428 information for the macroprudential policymakers: a lower 25.842 90.341 145.0751 RMSE. Evidence is that adding variables, through SVAR 0.1647 0.3364 0.9071 models, systematically increases the forecasting Source: Authors' estimates The numerators of relative weights, based on inverse MSE, are as follows: r_1 = 2.11, r_2 = 0.18, and r_3 = 0.07. While the value of the denominator is r_t = 2.36. By construction, the weights should sum up to 1, and the relative weights are: w_1 = 0.89244, w_2 = 0.076802, and w_3 = 0.030758. 3.00% 2.75% 2.50% 2.25% 2.00% 1.75% 1.50% 1.25% 1.00%

M1 M2 M3 M4 M5 M6 M7 M8 M9 M10 M11 M12 14

2017 Inf INFF_C INFF_MSE Source: Authors' estimates performance, lowering the RMSE. We conclude that including adequate SVAR forecasts in the forecast combination consistently reduces the root mean square error of the combination forecasts. Suitably constructed forecast combinations in Montenegro should replace traditional judgemental inflation forecasts. Moreover, we find that in the first quarter, a simple average combination outperforms all performances. Besides, the performance of the relative weight stays very close even for the first quarter performance and is the least sensitive till December 2017. Traditionally, so far, inflation predictions have mainly been judgemental in Montenegro, making them difficult to replicate and justify. Low-dimensional models omit information contained in the other variables. Thus, combination forecasts, that pool individual-predictor forecasts, is the optimal solution for the Central Bank of Montenegro. Figure 5. Combination Forecasts: Equal Weights and Inverse MSE Weights Forecast Comparison Graph 6% 4% 2%

0% -2% -4% M3 M4 M5 M6 M7 M8 M9 M10 M11 M12 M1 M2 M3 M4 M5 M6 M7 M8 M9 M10 M11 M12 14

2016 2017 Inf INFF_1 INFF_2 INFF_3 INFF_C INFF_MSE INF_F01_ALL Figure 6. Forecast Comparison Source: Authors' estimates Figure 6 shows forecast comparison of the actual inflation (inf), inflation combined forecasts using relative weights based on inverse MSE (inff_mse), combined forecasts using equal weights (inff_c), combined forecast using mean square error-averaging of 5 forecasts (inf_f01_all), forecast using model 1 (inff_1), forecast using model 2 (inff_2), and forecast using model 3 (inff_3). The results are highlighting because, in the beginning, for the first three months, the simple arithmetic average combination forecast outperforms the more sophisticated "optimal" forecast composites. From April to December 2017, the inverse MSE is the optimal linear composite forecast, minimizing the mean-squared-error (MSE). Model 1 follows the inverse MSE closely to the end, but still, the average combination performs better than Model 2 and Model 3. At the end of December 2017, the actual inflation figures 1.9 %, while the inverse MSE 1.5 %, the averaging 1.4 %, model 1 (1.3 %), model 2 (5.8 %), and model 3 (-3.0 %). Models 1-3 show a forecasting

performance that is sustainable and average inflation not more than 1.5 % above the rate of the three best performing 1

Member states: Cyprus (0.2 %), Ireland (0.3%), and Finland (0.8 %). The average rate is 0.4 % and, adding percentage points, the reference is 1.9 11/2 6

% (EC, 2018). Even though models 2 and 3 are way off compared to the actual inflation, incorporation of these variables is significant for the Central Bank of Montenegro (CBCG). The above results enable forecasters to address, evaluate, compare, and exploit the strength of using the high- dimensional dynamic composite forecast models. Sensitivity Analysis The CBCG is interested to hypothetically see the reaction of inflation in different sensitive scenarios, such as an increase in the price of oil (external innovations) and economic freedom index-internal innovations (Groen et al., 2012). We consider them as leading indicators for inflation to which macroprudential policymakers should react in Montenegro. The alternative scene starts altering data from January 2016 till December 2017. Hypothetically, we increase oil prices from 0.5 to 2 points, respectively, from 14.01 % to 48.43 %. What would be the impact of an increase in oil prices in the Montenegrin economy? The channel of oil price is multidimensional in Montenegro. It affects the production, consumers, government, investors, and Tax Administration of MoInNFtenegro (TAM). 12% 10% 8% 6% 4% 2% 0% -2%

I II III IV I II III IV I II III IV 2015 2016 2017 Actual 43

INF (Scenario 1) INF (Baseline) Figure 7. Inflation Deterministic – Dynamic Alternative Scenario of oil Price Increase Source: Authors' estimates The shock of an increase in oil prices might come endogenously as a result of fiscal consolidation. The cost of production increases by the increase of oil prices pushing companies to increase prices to keep in an existing margin of profit. In the case of oil prices increase, consumers do not have the same real value of money anymore. Their real wages decrease, leading to an increase in unemployment. Having decided with fiscal consolidation and increasing the excise tax, the output gap decreases. It leads firms to increase their prices, causing inflation to increase. It is the turn of monetary policy through the CBCG to increase the interest rate to slow down the heating of inflation. The dynamics of decreasing output associated with increasing inflation is known as stagflation. In case the changes in oil prices (excise tax or stock market) in Montenegro are not accompanied by changes in expectations of inflation, then expectations will remain constant, and the Government will have a much easier job. Is it to be anticipated that expectations will remain constant? What determines these expectations? If they have a strong belief in the stability of the macroeconomic environment, then their expectations will not swing. People form their expectations based on the era of information and knowledge, starting from the internet to brokers, news, banks, and other agents in the market worldwide (Giacomini, 2015). The channel of economic freedom is multidimensional in Montenegro. The sensitive case scenario, in Figure 8, hypothetically increases the economic freedom index from 20 % to 44 % during the whole year of 2017. The dynamic effects can be traced to inflation, as seen in Figure 8. We have to keep in mind that this is a deterministic simulation – dynamic solution forecasting performance, which uses forecasted lagged values to make a multi-period ahead forecasting. Thus, it automatically increases the chance of widening the probability for residuals. If we look at inflation, in Figure 9, the alternative sensitive scenario could deflate the prices from 0 % to -2In0f7 %. 50% 0%

-50% -100% -150% -200% -250% **I II III IV I II III IV** 277

2016 2017 Inf Inf (Scenario 2) Inf (Baseline) Figure 8: Deterministic Simulation – Dynamic Solution of Economic Freedom Alternative Scenario Source: Authors' estimates Why did we use structural VARs? The CBCG is interested in tracing the effects of a shock to inflation. consider the event when Montenegro anticipates a rise in inflation. The CBCG increases the monetary policy interest rate, but inflation still rises, as expected. One could incorrectly conclude that the increase in interest rate led to a rise in inflation. The reaction was endogenous to the expected inflation.

We must identify purely exogenous (policy or another type) shock to be able to trace out its dynamic effects: identify the structural VAR. Impulse responses trace the effects of structural shocks on the endogenous variables. 1

Impulse response function will tell us the change in endogenous variables for each structural shock at t, t+1, and so on 1

(Inoue & Kilian, 2016). Using the same old relation between the forecast errors and structural shocks, Guerron-Quintana et al., (2017) emphasizes: $St = \mu + A-1rt + \sum\infty i=1\ \psi i\ A-1rt-i$ or more compactly: $St = \mu + \sum\infty i=1\ Ci\ rt-i$ (10) (11) $a11,i$ and $a12,i$are the responses of y and x to a change in rxt and rxt, respectively. Note that $a11,0$ is the effect at impact, $a11,1$ is the effect of rxt on y and so on in succession: $\partial\partial xtty+tk = C11,k$ (12) also, the cumulative effect is $\sum\infty i=0\ C11,i$. Since we examined three SVAR models, we will trace out the responses of inflation to one-unit standard deviation shRoescpkosnosef tooilCphroilceessk.y One S.D. (d.f. adjusted)

Innovations ± 2 S.E. Response of INF **to** LOGOIL_SA **.4 .3 .2 .1 .0 -.1 -.2 -.3 5 10 15 20 25 30** 139

35 40 45 Figure 9. Impulse Responses to Oil Shocks Source: Authors' estimates The inflation impulse response to Cholesky one standard oil price innovations starts increasing gradually after a lag of four months. Besides, it declines, reaching deflation of -0.002 after 15 months. It hits the bottom of - 0.09 after 21 months. The transmission is evident. We should remember that an increase in oil prices cannot be a reaction to what is happening to the other variables. It must be exogenous. In this case, the "exogenous" movements of the Central Bank of Montenegro are exogenous. Thus, exogenous shocks were properly identified. In words: since the economy slowed down, output hits bottom after 13 months, while inflation after 21 months – a gap of 8 months between output and inflation hitting bottom. After only 30 months, inflation becomes positive, 0.0047. The increase in the price of oil makes the CBCG and fiscal policymakers to intervene to lower inflation. The oil price increase affected demand in the Montenegrin market, leading firms to change their investments and cancel projects. Within 12 months, while output decreases, inflation continues to increase. In this case, the fiscal policymakers in Montenegro intervened, adjusting the inflation and output. This adjustment process is mainly coordinated through the expectations process, which in Montenegro seems to be well done. This portrays a crucial point: the formation of expectations in Montenegro and the dynamic effects of shocks. The implication from this oil price shock is that output declines quickly for a transitional economy as Montenegro and takes more than a year to recover. At the variance decomposition of inflation to oil shocks, most of the variance, in the first month, comes from itself 93.18 %. This is not a surprise. It results from our recursive ordering. At longer horizons-24 months, the contribution of shocks to variables to the movement, or forecast error variance, of the inflation increases as follows: oil (17.82 %), aluminum price (11.41 %), unemployment (13.62 %), and gdp_gap 1.14 %. The impact of oil price shock increases rapidly at the beginning, especially the first six months from 2.50 %, 5.71 %, 8.75 %, 11.41 %, 12.88 %, and 14.31 %, respectively. In model 1, we noticed that economic freedom appears to be of crucial importance, and here we analyze the impulse responses and variance decomposition (Chan & Jeliazkov, 2009; Chan, 2013). In Figure 10, inflation immediately starts to decline, especially in the first year, then somehow begins very slowly to increase.

How can we interpret the above results? The good news is **that the** country **is moving ahead towards the EU,** 1

being a member of NATO. Meanwhile, seeing economic reforms

in the real market, it is to be expected from a forward-looking society to have a positive perspective. This implies a correction of price expectations Oe in relation to the current price level 1

O. Finally, as expected, the Cholesky decomposition of forecast error variance of inflation to the economic freedom innovations is mostly the result of shocks to itself at short horizons 96.53 %. After six month-horizons, the contribution of economic freedom shocks to the movement of inflation increases to 9.13 %. At 12-month horizons, the contribution of economic freedom and its corresponding shocks to the evolution of inflation goes to 24.94 %. At 24- month horizons, the proportion of the movement of inflation due to shocks to economic freedom reaches 35.89 %.

Response to Cholesky One S.D. (d.f. adjusted) Innovations ± 2 S.E. .4 Response of INF to 20

LOGECOFREEDOM_SA .2 .0 -.2 -.4 -.6 5 10 15 20 25 30 35 40 45 Figure 10. Impulse Responses to Economic Freedom Shocks Source: Authors' estimates In conclusion, the contribution of economic freedom to the movements of inflation is powerful. In other words:

in an economically free society, individuals are free to work, produce, consume, and invest. 188

Conclusions and Implications Given the struggle policymakers have had to define proper criteria to diagnose the onset of inflation indicators,

we felt compelled to identify an approach and methodology that the Government of Montenegro can use in developing anti-inflation and overall development strategy. Given the high increase in the interest of fulfilling the Maastricht convergence criteria and the lack of any uniform methodology, we believe that the findings presented in our paper will appeal to macroprudential policymakers. Although previous research papers have identified a few methods that could be used in forecasting inflation, such as internal and external variables, the methodologies developed from those findings have been restricted and difficult to administer on a national level. 1

Thus, our findings will allow the policymakers to understand the factors involved in identifying the onset of inflation dynamics and inflation expectations in Montenegro better and develop more effective policy measures that can be used nationally. In so doing, we hope that our research paper advances the toolset needed to combat the concerns of many macroprudential policymakers in Montenegro, especially the 1

Central Bank of Montenegro.

This paper reveals a significantly wider knowledge gap: both theoretical and empirical. We identified recursively three SVAR models. Each model aggregates critical macroeconomic variables to forecast inflation in Montenegro. The 1

forecasting performance of model 1 predicts inflation at 1.3 %, the inverse MSE at 1.5 %, and the average weights at 1.4 %. They show a forecasting inflation

performance that is sustainable and average inflation not more than 1.5 % above the rate of the three best performing References 1

Member states: Cyprus (0.2 %), Ireland (0.3 %), and Finland (0.8 %). The average rate is 0.4 % and, adding percentage points, the reference is 1.9 11/2 6

%.

We find that among the performance of the individual- predictor forecasts, 1

model 1 performs the best, based on the root mean square error. It depends on current economic shocks and economic freedom. Model 1 performs even better than the combined equal weights, but the averaging performs better than individual model 2 and model 3. This essential evidence shows that economic freedom is

critical in promoting sustainable growth. The main implications of this study suggest that 1

economic freedom is crucial in governing inflation and sustainable growth in Montenegro. Alternatively, we increased oil and economic freedom, and the forecasted inflation increases and sharply drops down, respectively: thus, implying that government regulations of economic activities are crucial.

The impulse response findings reveal that the responses of inflation to a shock on oil and **economic** freedom **are significant. The** variance decomposition **of** 1

inflation is moved mostly from economic freedom and oil prices. In conclusion, the

empirical findings of this paper **provide** macroprudential **policymakers with an in-depth understanding of the** 2

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