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Financial Stability Implications of Policy Mix in a Small Open Commodity-Exporting Economy

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Abstract

In this paper, we look at a commodity-exporting economy not fully isolated from commodity price volatility by fiscal policy. We study how systematic monetary policy under inflation targeting may contribute to financial instability by fueling the credit cycle when commodity prices increase or by amplifying the credit crunch when commodity prices decline. We report several empirical observations that illustrate the potential procyclicality (relative to credit developments) of inflation targeting policy where commodity price fluctuations are the main drivers of macroeconomic developments.

Namely, we find that relative prices in commodity-exporting economies are much more volatile than in other countries. The length of periods when relative prices grow or decline is comparable to the monetary policy horizon of most inflation targeters (2-3 years). Note that the central banks that target inflation, including those of the commodity-exporting countries, usually target the headline CPI. This index accommodates relative price changes by design.

We proceed with formal statistical testing using panel structural VARs and local projection models. The tests support the procyclicality of inflation targeting, but only in a group of emerging market economies. In practice, they have more procyclical fiscal policy than advanced economies: monetary policy eases in response to a higher price of an exported commodity while real credit grows. Counterfactual exercises show that endogenous monetary policy responses to commodity shocks explain around 20% on average of the real credit growth in a group of commodity exporting countries. The reaction of policy rates to commodity shocks in such countries is statistically significant. We review a collection of papers with estimated DSGE models and analyse impulse responses of real policy rates to commodity price changes to cross-check the empirical findings.

We also conduct a theoretical analysis and compare stabilisation properties (while accounting for financial stability risks) of the inflation-targeting policy rule and the 'leaning against the wind' policy rules. Notably, we do this exercise conditionally on the role of commodity price shocks for the economy. For this purpose, we use the DSGE with financial frictions and a banking sector estimated basing for the Russian economy. We measure the efficiency of policy results with different sensitivity to credit developments (the 'leaning against the wind' rules) under different variance of oil price shocks. This may also be interpreted as different efficiency of fiscal policy in insulating the economy from a given oil price volatility. The results show that when commodity price volatility is relatively high (fiscal policy is not countercyclical), leaning against the wind outperforms pure inflation targeting, thus supporting our empirical findings. Interestingly, even when the financial stability risks associated with the volatility of credit developments are negligible, a moderate leaning against the wind policy is still preferable. As policy implication, we point that a commodity-exporting economy should have countercyclical fiscal policy for inflation targeting to become countercyclical in a commodity cycle.

Key words: systematic monetary policy, optimal central bank policy, inflation targeting, macroprudential policy, relative prices, credit cycle, financial frictions, leaning against the wind, commodity prices
JEL codes: E31, E52, E58, F41, F47.

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Introduction

A crucial issue for a central bank of a commodity-exporting small open economy is how it should react to a commodity price shock,[1] which is the main source of volatility in such economies.[2] Such volatility is, in part, an efficient response of the economy to a shock. In this respect, the central bank should not react. Another part of the volatility is represented by an inefficient response caused by the presence of certain frictions/market imperfections.

Thus, asset market incompleteness (Mendoza, Oviedo (2006), Charnavoki (2010)), liquidity constraints (Bi, Kumhof (2011)), irrational consumers/optimism bias (Frankel (2011)) or political economy factors (Alesina et al. (2008)) are the imperfections that imply that commodity-exporting economies should have a fiscal rule/an oil stabilisation fund as the first line of defence[3] against inefficient volatility, caused by oil price changes.

Nominal price rigidity is the key friction in studies of optimal monetary policy response to commodity shocks. For the economy to demonstrate an efficient response to a terms-of-trade shock, quick relative price changes are required. As a result, commodity exporters are recommended to have flexible exchange rates to accommodate the shock. Instead of the exchange rate, they are advised to target domestic (non-tradable) inflation[4] as a nominal anchor. By targeting domestic inflation the central bank can differentiate the efficient response of import prices in the CPI basket from the inefficient and costly response of domestic rigid prices to the external shock (see Bergholt (2014, 2017), Charnavoki (2010), Allegret et al. (2015), Hamann et al. (2016)).[5] Targeting the whole CPI is not optimal as the central bank smoothes a part of the efficient variation in the economy.[6] The optimal monetary policy response to commodity price growth, therefore, is not procyclical (or is less so compared to whole CPI targeting). A central bank should see through inflation slowdown

[1] As emphasised by Kilian (2009) 'not all oil price shocks are alike.' Moreover, oil price changes may not be 'shocks' at all as purely exogenous changes. As a result, researchers and policy makers should carefully analyse the underlying sources of oil price volatility. Without doing so, the estimated impact of an oil price 'shock' on the economy would reflect some mixed effect of true oil shocks observed in the dataset, see Charnavoki and Dolado (2014).

[2] On the key role of commodity price shocks in macroeconomic variation, for example, in Chile, see Medina and Soto (2007a), in Norway see Bergholt et al. (2017), in Russia see Kreptsev and Seleznev (2017).

[3] Such defence is not ideal as oil price changes can spill into the economy even with a budget rule in place. The most commonly mentioned reasons are changes in country risk premium (see Hamann et al. (2016)) or the production links of industries (Bergholt et al. (2017)). Another option for commodity exporters is to use macro-hedging (Borensztein (2013)).

[4] The alternative is nominal GDP targeting, see Frankel (2014).

[5] The flipside is to consider the optimal monetary policy response for net oil importers. Kormilitsina (2011) considers the optimal monetary policy response for the case of oil importer and finds: *'One can notice that under an optimal monetary policy inflation rises more than in the baseline model. Therefore, the optimal policy planner focuses less on stabilising the inflation that results from high oil prices*.' Plante (2014) supports core inflation targeting (when wage flexibility is high, and even more inflation volatility if wages are sticky) but from the perspective of the different nature of oil shocks hitting the oil importing economy. Bodenstein et al. (2012) concludes: *'Among a wide range of rules, a rule that is easily implementable and that nearly maximizes U.S. welfare involves the Federal Reserve putting zero weight on the price of oil and responding to wage inflation without interest rate smoothing*.' See also Pesenti (2013).

[6] Hamman et al. (2016) mention regarding the case of oil price decline: *'An inflation-targeting central bank in an oil-exporting economy would face a policy dilemma: raising the policy rate to fight increased inflation coming from the exchange rate pass-through or lowering it to stimulate a slowing economy.'*

caused by the lower relative price of imports and avoid decreasing real interest rates in response to commodity price growth.[7]

Financial or credit market frictions (such as collateralised lending) are relatively new in studies of optimal policy in commodity-exporting small open economies (see Gonzales et al. (2016), Bejarano et al. (2016), Carvalho, F. A. et al (2017), Gourinchas (2018)). DSGE models estimated in some of these papers and empirical VAR models with credit variables (see Shousha (2016)), as well as event study analysis conducted by the IMF (2015), show that commodity price shocks are important drivers of a credit cycle in commodity-exporting economies, particularly due to the presence of such frictions.[8] To address financial frictions, the need arises for macroprudential policy as a complement to or substitute for monetary policy.[9]

In this paper, we focus not on frictions *per se*, but on systematic monetary policy under inflation targeting. It is viewed as a potential source of macroeconomic volatility and financial instability in commodity-exporting economies when fiscal policy is not smoothing effects of commodity price volatility on the economies.[10] The idea of our paper is close to those in Bernanke et al. (1997). Regarding the U.S. economy during 1970-1990s, they concluded that *'an important part of the effect of oil price shocks on the economy results not from the change in oil prices, per se, but from the resulting tightening of monetary policy*.' Our goal from the positive point of view is to study the role that monetary policy response to commodity price changes under an inflation targeting regime plays in driving *a credit cycle* in a commodity-exporting economy. Our goal from the normative point of view is to compare stabilisation properties of inflation targeting and 'leaning against the wind' monetary policy rules, which account for financial stability risks in countries with different exposure to commodity price volatility and different roles of credit volatility in predicting financial instability. The former may also be interpreted as different efficiency of fiscal policy in insulating the economy from oil price volatility. In this paper, we leave adding macroprudential policy out of consideration. We also do not search for the *optimal* policy mix (macroprudential in addition to monetary and fiscal

[7] In addition, Nakov and Pescatori (2010) and Plante (2014) stress that a central bank should not treat oil price shocks equally. It should respond differently to underlying causes of oil price fluctuations.

[8] Although empirical evidence shows that credit responds positively to higher commodity prices, theoretical mechanisms are not so conclusive. Better terms of trade mean higher income, which should reduce demand for credit, i.e. countries should pay off debt in good times and accumulate it in bad times according to the permanent income hypothesis, see Vegh (2013), Chapter 1. Existing DSGE models use different assumptions to account for the empirically observed growth of credit in good times. For example, Caballero (2018) mentions insufficient financial development amid high marginal productivity of capital and high demand for external liquidity in emerging market economies. Bejarano et al. (2016) assumes existence of overoptimistic agents. More on explanations are in Section 5 where we discuss a DSGE model for Russia.

[9] Research by Gourinchas (2018), Caballero (2018) and earlier Rey (2015) show that under some conditions small open emerging market economies cannot have independent monetary policy in response to some external shocks, justifying macroprudential policy/capital controls to become complementary to monetary policy in reaching macroeconomic stability.

[10] Financial stability is 'a condition in which the financial system – which comprises financial intermediaries, markets and market infrastructures – is capable of withstanding shocks and the unravelling of financial imbalances', the ECB. We follow Kockerols and Kok (ECB'2019), Aikman, et al. (BoE'2018) who consider time dimension:
Financial instability is high (comparing to a benchmark) expected macroeconomic volatility (employment, CPI, welfare). Factors of crisis probability and/or crisis severity are (i) endogenous build-up of financial imbalances, associated with a booming credit cycle; (ii) a large aggregate shock hitting the economy or the financial system.

policy), because our objective is different. At the current stage, we study under what conditions (exposure to commodity price volatility, which, among other factors, depends on fiscal rule procyclicality, and the role of credit-to-GDP volatility in generating financial instability) inflation targeting may be improved by way of monetary policy only (changing the policy rate) in an environment where a central bank can conduct independent monetary policy.[11]

Our main hypothesis is that systematic monetary policy is an important factor of a credit cycle in commodity-exporting inflation targeters.[12] Statistical testing of this hypothesis, which implies application of the methodology of Bernanke et al. (1997) and other methods, which appeared afterwards (local projections by Jorda (2005)), is the goal of our empirical analysis.

First, we empirically check the monetary policy response of inflation-targeting commodity exporters to episodes of commodity price changes. We expect to see the procyclicality of monetary policy, i.e. lower (higher) *real* interest rates in response to commodity price growth (decline). Such policy procyclicality, in our view, is a necessary element of creating or ending a credit cycle in such economies. To analyse monetary policy response to commodity price changes we review results of estimated DSGE models for the commodity-exporting inflation-targeting countries and undertake an event study exercise of real interest rate behaviour during commodity booms and busts.

Second, we proceed with formal statistical testing of our main hypothesis. For this purpose we use panel structural VAR models and local projections as in Jorda (2005) for inflation-targeting countries (and for emerging and developed economies that target inflation separately).[13, 14] As during the study we deal with empirics, we study inflation targeting *as it is implemented in practice*.

Two observations, in our view, rationalise the goal of our study and the hypothesis we are going to test.

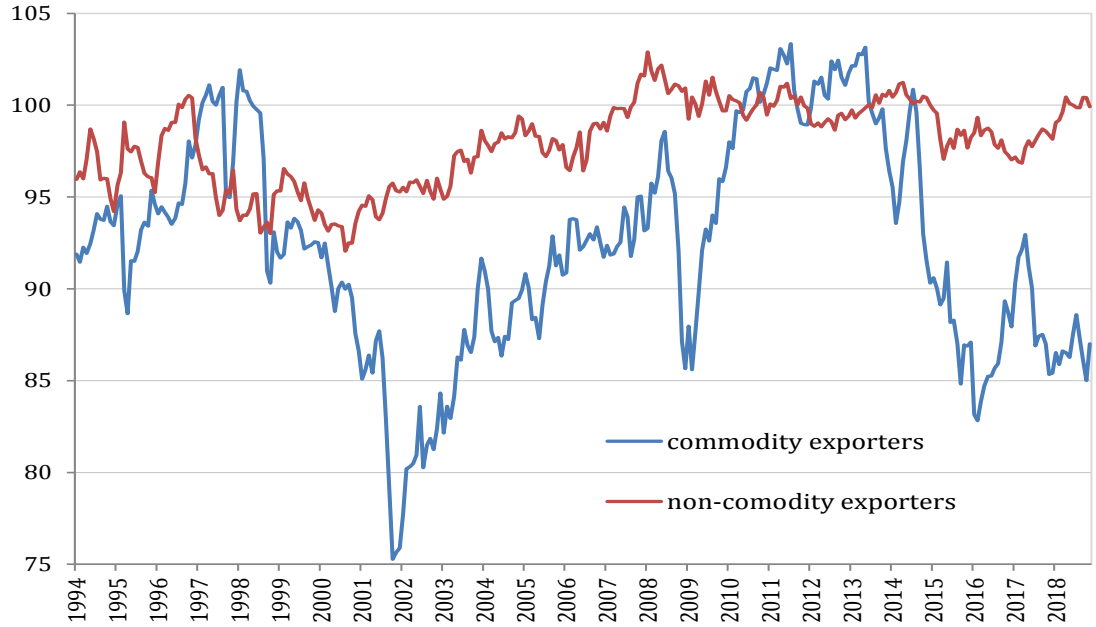
The first observation is that relative price changes in commodity exporters are extremely volatile. The phenomenon is known as *commodity currencies* (see Chen, Rogoff (2003), Cashin et al. (2004)). In Figure 1, we compare two medians of real exchange rates computed for certain commodity exporters and for other countries.[15]

From Figure 1 we can draw the conclusion that relative price changes in commodity-exporting economies are not only much more volatile than in other economies but that they are also persistent. The length of periods with relative price changes is larger than or comparable to the monetary policy

[11] The loss of such independence, or appearance of the 'Dilemma, not trilemma' as mentioned by Rey (2015) is an important rationale for adding macroprudential policy to central banks' policy toolkits. See footnote 9.
[12] In particular, we expect to find stronger effect for emerging market economies comparing to developed market economies, as emerging markets are expected to have more procyclical fiscal policy, higher procyclicality of country-risk premiums, narrower financial and currency markets, higher share of commodity sector.
[13] We also conduct event study analysis of real credit dynamics during episodes of commodity price growth and decline in the group of inflation-targeting countries.
[14] A list of inflation-targeting countries, including commodity exporters is in Appendix 1.
[15] Commodity exporters include Australia, Brazil, Canada, Chile, Colombia, Indonesia, Mexico, Norway, Peru, Russia, Saudi Arabia, South Africa, and Venezuela. Non-commodity exporters are the 48 countries in the BIS's dataset.

horizon of most central banks (2-3 years). As a result, the period of relative price changes in commodity exporters may be longer than the standard horizon of the monetary policy there.

Figure 1. Median real effective exchange rate indices for commodity and non-commodity exporters



Sources: BIS, authors' calculations.

The second observation is that central banks that target inflation,[16] including those of commodity-exporting countries, usually target the whole CPI. Therefore, inflation-targeting central banks of commodity-exporting economies do not follow theoretical prescriptions of optimality precisely. As this *measured* inflation includes prices of imported goods, the index is exposed to relative price changes by design. As a result, it is natural to expect that central banks, implementing inflation targeting, would react to a certain degree (generally speaking, depending on the persistence of the shock and efficiency of a fiscal rule in smoothing a commodity cycle) in the direction of such relative price changes. Thus, oil price growth leading to lower inflation results in easier monetary policy (in real terms) and vice versa. To reduce this dependence on relative price changes, in practice, central banks usually target future/expected CPI inflation at the end of the monetary policy horizon (i.e. when inflation caused by relative price changes disappears from CPI inflation), *or* implement so called *flexible* inflation targeting.[17] As the monetary policy horizon is usually restricted to two years, relative price changes of a shorter length than two years should not influence the expected inflation and the monetary policy at all in practice. In this sense, non-tradable

[16] We used the list from Hammond (2012) and from http://www.centralbanknews.info/p/inflation-targets.html l after 2012.
[17] In the latter case, a commodity boom may lead to a boom in the economy and thus to more restrictive monetary policy than under strict inflation targeting. But this is not the end of the story, as higher real rates may result in a stronger exchange rate and lower inflation, thus partly or fully (depending on elasticity values) weakening intentions to restrictive policy in case of this specific shock.

inflation targeting and expected whole inflation targeting become close substitutes. However, if real exchange rate changes take more than two years (such changes is expected to be especially strong under procyclical fiscal rule as shown by Soto, Medina (2007b)), can an outside observer be sure that the central bank would not react to systematic deviation of inflation from target even if such deviation is caused by purely *efficient* relative price changes? For example, such prolonged relative price changes may de-anchor inflation expectations, calling for monetary policy actions (easier monetary policy in times of prolonged commodity price growth).

Putting the first and the second observations together, we expect that inflation targeting *practice* in oil-exporting economies (especially those with procyclical fiscal policy) leads to a procyclical response of monetary policy to prolonged oil price changes. Thereby, it amplifies the credit cycle and generates risks for financial stability.

We need to check that a central bank would reduce real interest rates in response to higher oil prices. For this purpose, we review papers describing estimated DSGE models of commodity-exporting economies and analyse impulse responses of *real* policy rates to commodity price shocks presented in those papers. Our analysis finds strong support for the crucial role that relative price changes play in disinflation in commodity-exporting inflation-targeting economies facing terms of trade improvement. This is especially true when the improvement is permanent or when fiscal rule cannot perfectly insulate economy from commodity price changes. The analysis shows that in such cases inflation-targeting central banks pursue easier monetary policy, which contributes to a decline in real interest rates. Following a positive commodity price shock, real rates decline below the steady state and remain there for some time. Thus, the review of estimates of DSGE models for commodity-exporting inflation-targeting economies in general do not contradict our hypothesis that commodity price growth leads to looser monetary policy. Thereby, growth contributes to higher accumulation of credit in the economy and financial stability risks.

Impulse response analysis in panel VAR and local projections finds that not all commodity-exporting countries included in the estimation reduce interest rates in response to higher oil prices: only emerging market economies do. In all other inflation-targeting countries we observe higher policy rates after a positive commodity shock. For non-commodity-exporting economies the result looks natural – higher cost-pressure stemming from a commodity price shock stimulates tighter monetary policy response. For commodity-exporting developed economies (DEs), this result may be explained by several factors: low elasticity of their exchange rate to commodity prices due to presence of fiscal rules; high elasticity of domestic economic activity to commodity prices leading to high cost pressure even in the short term; low elasticity of capital flows; anchored inflation expectations and high monetary policy credibility.[18] Real credit grows after a positive shock in commodity exporting EMEs, but declines in all other countries' groups.

[18] Bergholt (2017) mentions the possibility of sensitive cost pressure due to expanding economic activity amid higher oil prices for the economy of Norway.

Calculations using the Sims and Zha (1995, 2006)[19] approach and (as a robustness check) that by Bernanke et al. (1997), show that endogenous real rate response under inflation targeting in commodity-exporting economies accounts for 20% of real credit increase on average after a positive commodity price shock. This is true for those countries where the policy rate significantly reacts to the shock and the real credit increases following the shock.

Turning to the normative analysis, we use the estimated DSGE model for Russia from Kreptsev and Seleznev (2017). This is a small open economy model with commodity-exporting sector (oil). It incorporates a friction similar to Bernanke et al. (1999) with banking sector as in Gerali et al. (2010) and a country risk-premium elastic to oil price changes as in Gonzales et al. (2016). Fiscal policy does not smooth the oil price volatility in the model, thus oil price shock is an important source of a business cycle in the model. Impulse responses from the model without countercyclical fiscal rule support the hypothesis that inflation targeting rule in the commodity-exporting economy similar to Russian is procyclical. The central bank in the model reduces the real rate in response to higher oil prices. For normative purposes, we compare an inflation targeting rule, when a central bank reacts to a deviation of inflation from the target, and 'leaning against the wind' monetary policy rules, which account for financial stability risks (Borio et al. (2003)). In this exercise we vary commodity price volatility (and thus indirectly vary fiscal policy procyclicality) and a parameter responsible for the weight of volatility of credit-to-GDP in the central bank's objective function.

The results show that when commodity price volatility is relatively high (fiscal policy is procyclical), leaning against the wind outperforms pure inflation targeting, thus supporting our empirical findings. Interestingly, even when financial stability risks associated with the volatility of credit developments are negligible, a moderate leaning against the wind policy is still preferable.

The article is organised as follows. In the first section, we describe our relationship with the literature. In the second section, we study the monetary policy response of inflation-targeting central banks to commodity price changes. For that purpose, we review the response we found in papers describing DSGE models estimated for inflation-targeting commodity exporters. In the third section, we use an estimated DSGE model with financial frictions for policy analysis. The last section concludes the paper. In one of the appendices we present results of an event study, which we did before turning to estimating econometric models.

[19] Originally 1995. Published as a vintage article in 2006.

1. Relationship with the literature

The papers motivating our research are Bernanke et al. (1997) and the discussion that followed on the role of systematic monetary policy in macroeconomic variation in the U.S. economy under oil shocks by Kilian et al. (2017), Bodenstein et al. (2012), Kilian and Lewis (2011), Carlstrom et al. (2006), Leduc et al. (2004). Our contribution to their agenda is that we focus on credit aggregates and financial stability in addition to price-output stability. Moreover, we apply the idea to a small commodity-exporting economy, where, as we believe, prolonged terms of trade change cause specific monetary policy reaction leading to a build-up of financial stability risks that should not appear (as a result of their monetary policy response to commodity price changes) in commodity importers.

Literature finds that real credit grows during commodity price booms, see IMF (2015), but with an unspecified contribution from monetary policy response to commodity prices.

We are not familiar with papers addressing the issue of how inflation-targeting policy in a commodity-exporting economy affects financial stability and how accounting for this impact can change the central bank's monetary response to commodity price changes (the optimal response may also include macroprudential policy). Most papers find that commodity price booms lead to a higher credit-to-GDP ratio or increase sectoral risks for financial stability (see Shousha (2016), Gonzales et al. (2016), Bejarano et al. (2016)) without a (careful) description of the role that monetary policy response to oil prices may play in the amplification of the credit cycle.

Shousha (2016) studies macroeconomic effects of commodity price booms and busts in a panel VAR of commodity exporters and in a DSGE model with four channels, through which financial frictions (in the form of banks' leverage constraint for foreign borrowing) can amplify the effect of oil prices on the economy and credit. DSGE models show the importance of the country risk-premium and the working capital channels as the most important amplifying mechanisms. Both mechanisms work through the domestic interest rate, but the paper deals with the natural rather than actual real interest rate. Thus, the issue of the role of monetary policy response to an oil price boom in generating credit cycles remains open. The author leaves the understanding of how monetary and fiscal policy may interact with the considered transmission channels for future research.

Gonzales et al. (2016) study the reaction of an oil-exporting economy to an abrupt reversal of an oil boom. The authors conduct an event study analysis and document the growth of total credit above normal during a boom and its reversal after the end of the boom, with significant sectoral heterogeneity: credit to the non-tradable sector expands while contracting to the tradable sector during the boom. The presence of financial frictions leads, through real exchange rate appreciation during the boom, to erosion of net worth in the tradable sector and its increase in the non-tradable sector, thus strengthening resource reallocation from tradable to non-tradable production. Real exchange rate appreciates due to lower country risk premium, which reacts to higher oil prices. The

paper does not address the role of monetary policy in exchange rate appreciation and in the build-up of credit, though impulse responses show that during a boom policy rate declines, which in general should have certain real effects. Macroprudential policy helps restrain credit growth in the boom but restrains resource reallocation after the bust.

Bejarano et al. (2016) consider macroeconomic dynamics during persistent changes of oil prices in an oil-exporting economy such as Colombia. They add financial and information frictions to the model. The financial friction in the form of restriction on foreign borrowing and informational frictions lead to overborrowing during the boom as overoptimistic agents extract more oil, which results in strong real appreciation and weakening of financial constraints in the economy. The paper leaves the question about the role of standard monetary policy in the process of accumulation of credit during the boom unanswered.

Our paper also relates to the extensive literature on 'leaning against the wind' (LAW), which Svensson (2017a) defines as '*a monetary policy that is somewhat tighter (that is, with a somewhat higher policy interest rate) than what is consistent with flexible inflation targeting without taking any effects on financial stability into account*.' Svensson (2017a) argues, that effectiveness of the policy can be characterised by elasticity of unemployment to real rate, by the role of credit booms in crisis prediction and by elasticity of real debt growth (credit boom) to real interest rates. Svensson (2013) challenges the notion that lower rates stimulate higher real credit (to GDP). The discussion continues in Andrian and Liang (2016) and Svensson (2017b), Agenor and Pereira da Silva (2019). Ajello et al. (2019) analyse optimal interest rate policy in an economy that can experience financial crisis and find rationale for the LAW under parameter uncertainty. We will contribute to this literature by comparing inflation targeting and the LAW in a commodity exporting in a DSGE model similar to Gerali et al. (2010). The estimated model for the Russian economy incorporates a friction similar to Bernanke, et al. (1999) and a country risk-premium elastic to oil-price changes as in Gonzales et al. (2016). If commodity price volatility is an important source of macroeconomic volatility and inflation targeting is procyclical regarding credit aggregates, it may provide additional rationale in favour of the LAW policy in these countries.

A strand of the LAW literature deals with complementarity or substitution between monetary policy and macroprudential policy when these policies used to deal with financial stability risks. The BIS annual economic report (2018) provides references on the subject and mentions: *'How far monetary policy should go in taking financial stability considerations into account is controversial. The answer depends on a range of factors, including the degree to which monetary policy affects risk-taking, debt and asset prices; the effectiveness of macroprudential actions; the particular nature of the risks; and the secondary effects of taking action.'* Kockerols and Kok (2019) assess the role of two policies and conclude, '*macroprudential policy is better suited to addressing risks to financial stability*' in the euro area. In this regard, an important objection to conducting the LAW in a small open economy is that higher interest rates may induce capital inflow, which thus substitutes

domestic credit and worsens the structure of private sector debt (external vs domestic debt) without significant impact on the volume of debt. As the BIS Annual economic report (2018) mentions, *'in more open economies, higher interest rates have the disadvantage of encouraging more capital inflows and exchange rate appreciation, which could offset at least in part their restraining influence on the build-up of financial imbalances. By contrast, macroprudential measures do not suffer from this limitation.'* Menna and Tobal (2018) find that optimal interest rate in an open economy with endogenous credit crises is lower than without such mechanism, thus opposing to the LAW.

Thus, applying the arguments to the case we are considering, of higher domestic interest rate in response to oil price growth, for LAW policy to be efficient, the exchange rate should change in the direction of reducing profitability of capital inflows according to the uncovered interest rate parity. Thus, our analysis of monetary policy alternatives, which would account for financial stability objectives, relates to the literature on independence of monetary policy, starting from Rey (2015). To study difficulties with monetary independence that arise due to financial frictions, Gourinchas (2018) introduces a debt ceiling in attracting foreign capital depending on the *level* of the exchange rate thus reducing the effectiveness of LAW. Diamond et al. (2018) stress the importance of the exchange rate appreciation in spillovers of foreign monetary policy. Caballero and Krishnamurthy (2002) introduce the *dual liquidity* concept, reducing substitutability of foreign and domestic credit (money) thus constraining efficiency of the LAW policy in reducing capital inflows. However, in this paper we neither consider macroprudential policy nor address the issue of its optimal policy mix with monetary policy, because our focus is different. Our focus is on the financial stability implications of inflation targeting and changes that may need to be introduced in inflation targeting under standard conditions of monetary policy Trilemma.

Last, our paper stresses the important role of relative prices in inflation dynamics in a commodity exporting economy and studies monetary policy response to relative price changes in such economies. In this regard, our paper relates to studies of inflation dynamics after commodity price changes, see Hooker (2002) and IMF (2015), and to studies of optimal policy response to such changes, see Bergholt (2014, 2017), Hamann et al. (2016), Bragoli et al.(2016), Allegret et al. (2015), Charnavoki (2010), Aoki (2001).

2. Monetary policy response to commodity prices in DSGE models of Commodity Exporters

In this section, we summarise impulse responses of *real* interest rates to commodity price shocks from articles describing estimated DSGEs of inflation-targeting commodity-exporting economies.

We paid attention, primarily, to the papers affiliated with the central banks of inflation-targeting commodity-exporting economies. Unfortunately, for some inflation-targeting countries, which are classified as commodity exporters,[20] we could not find any papers containing a description of a DSGE model with commodity export or terms of trade shocks. For the countries, for which we found estimated DSGE models, some papers address the issue of the optimal monetary policy and fail to provide the reader with an estimated policy rule to understand how the central bank reacts to commodity price shocks in the model. In many cases, the authors fail to provide the reader with a diagram describing the evolution of monetary policy stance (response of real interest rates) in the estimated model. In some cases, we could not find the response of nominal interest rates. In such cases, we could not make the inference. In those few cases when estimated policy responses are present, the authors do not describe the details of central banks' strategy for how they address commodity price growth or decline. Such description is especially important to understand the logic of central banks' actions when the response of policy rates is not monotonous. In all cases, we tried to provide quotations from the articles describing how the authors interpret the monetary policy responses. If we could not do this, we made our own short comments based on the diagrams describing the impulse responses. An additional challenge was the heterogeneity of commodity price shocks in the papers considered depending on their persistence (temporary or permanent oil price changes) and their origin (some papers distinguished between oil demand- and supply-side shocks). In all such cases, we mention the type of commodity shocks to which the results are applied. When we had such an option, we chose more persistent commodity shocks (as we expect that our hypothesis is relevant only for persistent oil price changes). Fiscal rules were another important feature, the presence of which in the models we tried to control.

The table in Appendix 2 summarises our findings. All results are presented for the case of commodity price increase. The summary of our findings is as follows:

- The most robust result is the reaction of GDP and inflation to a commodity price increase (with some differences due to persistence of the shock and its demand- or supply-side origin in the global commodity market). Following growth in commodity prices, the economic activity expands above the steady state. Inflation declines due to nominal appreciation. The persistence of the

[20] For the list of commodity exporters, see IMF (2015), footnote 20, and Appendix 1.

decline depends on the persistence of the shock. Inflation rises above the steady state after 3-7 quarters and remains above it on the convergence path to the steady state.

- In most cases, the nominal interest rate declines following commodity price growth but after 3-5 quarters returns and overshoots its steady state level. In few cases, the nominal interest rate increases on impact. This happens when the demand effect, raising cost pressure in the economy, outweighs the relative price changes effects. The resulting higher inflation justifies higher nominal interest rates.

- In the few papers where we have the opportunity to observe impulse responses of the real interest rate or find a description of its dynamics, we notice that the short-term dynamics of the real rate are not monotonous. In most cases, it rises on impact but after 2-5 quarters declines below the steady state and remains there until convergence. The increase immediately after the oil shock may be explained by significant disinflation due to nominal appreciation, which causes a shift in near-term inflation expectations. Since nominal interest rates in some cases contain the mechanism of interest rate smoothing, they cannot change quickly, but inflation and short-term expectations can.

To sum up, we found strong support for the crucial role that the relative price changes play in disinflation in commodity-exporting inflation-targeting economies facing terms of trade improvement. The analysis shows that inflation-targeting central banks pursue easier monetary policy in nominal terms, which contributes to the real interest rate decline. Real interest rates with a lag decline below the steady state and remain there for a prolonged time, following a positive commodity price shock.

Thus, the estimates of DSGEs for commodity exporting inflation targeting economies in general support our hypothesis that commodity price growth leads to looser monetary policy, which may contribute to higher accumulation of credit in the economy and the build-up of financial stability risks.

Additional evidence may be found in the literature that deals with the reverse situation – papers on the monetary policy response of *oil-importing* countries to an oil price increase. Kormilitsina (2011) finds that in response to an oil price shock, inflation increases and monetary policy is tightened in inflation-targeting countries.[21] Similar results with a rising real interest rate in response to higher oil price can be found for Chile as an oil-importing country in Medina and Soto (2005). We do not claim whether such a response is optimal or not; we only indicate it as a stylised fact or an observation. The existing evidence is not conclusive for the U.S., though. Kilian and Lewis (2011) find no systematic response of Fed policy to oil shocks and provide literature survey on the role that monetary policy plays in macroeconomic fluctuations in the US economy in response to oil price shocks. Later, Plante (2014) found significance of such systematic response for some identified structural shocks behind oil price increases at least.

[21] The paper by Kim et al. (2017) addresses the estimation of monetary policy response to oil price shocks for the Chinese economy. The results support the view that in the period when the PBC started paying more attention to inflation stabilisation it increased real rates in response to higher oil prices.

3. Policy interest rates and real credit during commodity booms and busts: Empirics

3.1 Panel Structural VAR and local projections

In this section, we empirically test the relevance of the hypothesis that systematic monetary policy response to commodity price changes in inflation targeting commodity-exporting countries is procyclical and amplifies the dynamics of credit aggregates in the economies. We estimate local projections as in Jorda (2005) and structural VAR models for a panel of inflation-targeting countries.[22] The data is described in Appendix 3.[23]

Six variables are included in the models: GGDP – Global GDP; ComPI – Commodity Price Index for non-exporting inflation-targeting countries, and prices of Oil, Metals, Cooper and Precious metals for exporting countries, depending on the commodity they export; GDP – Gross Domestic Product; Inflation – inflation in each country (derived from the consumer price index); $\mathrm{Policy\ rate}$ – Nominal policy rate of a central bank;[24] Credit – one of the credit variables mentioned in Appendix 3.

Panel vector autoregression model (PVAR) model is:

$$\mathrm{Y_{i,t}} = \alpha_i + \Phi_1 \mathrm{Y_{i,t-1}} + \cdots + \Phi_p \mathrm{Y_{i,t-p}} + \varepsilon_{i,t}$$

Where $t = 1, \dots, T$ denotes time, $i = 1, \dots, N$ denotes the country, $\mathrm{Y_{i,t}}$ is a $q \times 1$ vector of variables, Following Kilian and Lewis (2011) we choose a conventional ordering in a Cholesky decomposition: from external variables (global GDP and commodity prices) to domestic variables:

$$\mathrm{Y_{i,t}} = (\mathrm{GGDP_{i,t}}, \mathrm{ComPI_{i,t}}, \mathrm{GDP_{i,t}}, \mathrm{Inflation_{i,t}}, \mathrm{Policy\ rate_{i,t}}, \mathrm{Credit_{i,t}})'$$

$$\varepsilon_{i,t} \sim N(0, \Omega)$$

[22] Before conducting formal statistical testing, we made an event study analysis. We compare the dynamics of real interest rates (real credit) in commodity-exporting economies that target inflation with the dynamics of real interest rates (real credit) in non-exporting inflation-targeting countries in episodes of big commodity price booms and busts. We conducted the comparison similar to those in Gonzales et al. (2016) over a window covering 4-6 years around a price boom (or bust). We present it in Appendix 6. Our event study analysis on interest rates finds evidence that monetary policy of inflation-targeting central banks is different from that of other inflation-targeting central banks. The evidence, however, is more conclusive for episodes of commodity price busts rather than booms. During commodity price busts commodity-exporting inflation targeters more quickly raise real rates and more slowly reduce them afterwards. Our event study analysis on real credit cannot find meaningful difference of real credit dynamics in the two groups of countries, thus justifying more formal testing procedures, which could control for other factors affecting real credit in these groups.

[23] The most difficult task was to find a long enough series of nominal credits (at least covering the period of inflation targeting in a given country) which was rather homogeneous: we wanted it to be credit in one currency (for it not to be influenced by an exchange rate valuation effect). That is why for each country we used several alternative credit aggregates. However, we were not able to find data on credit in domestic or foreign currency for all inflation-targeting countries. There are BIS data in domestic currencies for almost all inflation-targeting countries. However, these data are subject to exchange rate valuation effect, which may result in counterintuitive growth of real credit during commodity price busts simply due to exchange rate depreciation. As the BIS data do not contain information on the share of local currency credit and foreign currency credit we are not able to correct for this effect. All variables are transformed into quarterly values. In addition, Credit with GDP are seasonally adjusted. All time-series included are transformed to a stationary form. In addition, data standardization is carried out

[24] To exclude uncertainty related to a definition of real policy rate, we use observed nominal policy rates, but include inflation into the models.

General method of moments (GMM) estimates of parameters in PVAR are consistent as shown in Sigmund and Ferstl (2019). According to the ordering of the variables in the VAR, commodity prices' innovations are endogenous, reflecting contemporary variation in global GDP.

Lag length selection performed by Bayesian information criterion. The confidence intervals are constructed by resampling residuals bootstrap scheme.

Local projection model (LPM), following Jorda (2005), is:

$$s = [0 : h]$$

In $s = 0$ evaluates:

$$y_{i,t+0} = \alpha_i + B_1^1 y_{i,t-1} + \cdots + B_p^1 y_{i,t-p} + C_0 X_{i,t} + u_{i,t+0}^0$$

$$IRF_0 = C_0 d_j$$

Where d_j represents the 'structural shock' to the j^{th} element in $y_{i,t}$.

In $s = 1:h$ evaluates:

$$y_{i,t+s} = \alpha_i + B_1^{s+1} y_{i,t-1} + \cdots + B_p^{s+1} y_{i,t-p} + u_{i,t+s}^s$$

We obtain

$$IRF_1 = B_1^1 C_0 d_j$$
$$\vdots$$
$$IRF_s = B_1^s C_0 d_j$$

where

$$y_{i,t+s} = (GGDP_{i,t+s}, ComPI_{i,t+s}, GDP_{i,t+s}, Inflation_{i,t+s}, Policy\ rate_{i,t+s}, Credit_{i,t+s})'$$

$$X_{i,t} = ComPI_{i,t}$$

and $t = 1, \dots, T$ denotes time, $i = 1, \dots, N$ denotes the country, $y_{i,t+s}$ is a $q \times 1$ vector of variables. $X_{i,t}$ is a variable of commodity price index.

As the first step, we estimate the models for each inflation targeting country in the sample (Kazakhstan and Russia were excluded due to a short data series under inflation targeting). In Appendix 4 we present the results of statistical testing of cumulative impulse responses to a positive oil price shock for each country and for each available credit series. Appendix 5 contains example figures of country specific impulse responses. It can be seen in Figures 5.5 – 5.16.

Then, for each country and the model, we choose those credit measures for which country-specific regressions produced statistically significant cumulative impulse responses for the longest time-horizon, irrespectively of the sign of the responses.

Third, we split the sample of inflation-targeting countries into four groups depending on their status as a commodity exporter and their status as a developed market economy – Table 1. We check the difference in the reaction of policy rates and real credit across these country groups.

Table 1. Inflation-targeting countries in the data sample

	Commodity exporters	Non-commodity exporters (importers)
Emerging market economies	Brazil Chile Colombia Indonesia Mexico Peru Philippines South Africa	Armenia Georgia Guatemala Poland Romania Serbia Turkey
Developed market economies	Australia Canada New Zealand Norway	Czech Republic Israel Sweden United Kingdom

Source: IMF for EME/DE status, for commodity exporting status see Appendix 1.

After choosing a credit measure and dividing the countries into groups, we estimate panel LP and VAR models for each group of countries. We present the results in Table 2.

Table 2. Results of testing for significance of impulse responses in panel LPMs and VARs to a positive commodity price shock (= growth of a commodity price)

		Commodity exporters	Non-commodity exporters (importers)
Emerging market economies	VAR	Interest rate: Decrease Q1 – Q4 Credit: Increase Q1 – Q8	Interest rate: Increase Q5 – Q8 Credit: Increase Q1 – Q8
	LPM	Interest rate: Decrease Q1 – Q3 Credit: Increase Q1	Interest rate: Increase Q5 – Q8 Credit: Insignificant (Increase)
Developed market economies	VAR	Interest rate: Increase Q1 – Q8 Credit: Decrease Q1	Interest rate: Increase Q1 – Q8 Credit: Decrease Q1 – Q4
	LPM	Interest rate: Increase Q3 – Q8 Credit: Insignificant (Decrease)	Interest rate: Increase Q1 – Q8 Credit: Decrease Q1 – Q3

Source: authors' calculations.

The summary of the results from Table 2 with the estimates of panel VARs and LPs in four groups of countries is the following:

- Commodity exporting EMEs in response to higher commodity prices reduce their policy rates (which start rising after approximately a year). In all other groups, we observe the opposite reaction of policy rates. For non-commodity exporting economies, EMEs as well as DEs, such a reaction may be explained by cost pressure coming from higher imported commodity prices. Commodity exporting DEs also tend to increase policy rates after the commodity price shock. This might be a consequence of higher elasticity of domestic economic activity to commodity prices in developed economies (even if fiscal rules are at work like in Norway, Bergholt (2017) mentions such a possibility), which leads to higher cost and wage pressure amid higher domestic share of spending and investment, thus counterbalancing the

disinflationary pressure due to exchange rate appreciation[25]. Moreover, the exchange rate appreciation may be less pronounced in DEs. DEs may have lower elasticity of their exchange rates to commodity price growth amid lower dependence of risk premiums and capital inflows, which lead to currency appreciations, on the dynamics of commodity prices. Furthermore, this may be the result of the credibility of their monetary policy. Even through inflation slows down due to exchange rate appreciation, anchored inflation expectations allow the central banks not to reduce policy rates.

- We observe that the reaction of real credit, which declines after a positive commodity price shock, is similar in DEs, irrespective of whether the countries export commodity or not. In both cases, central banks increase policy rates. This point to the possibility that the higher policy rates may contribute to a real credit decline after the shock, especially in a group of commodity exporting DEs, for which the terms of trade shock should stimulate economic and credit activity.
- The reaction of both policy rates and real credit in commodity exporting EMEs is almost the mirror image of that in non-commodity-exporting developed economies. In Figures 2 to 5 we plot impulse responses and their confidence bands for both methods in two groups: commodity exporting emerging market economies and non-commodity exporting developed market economies.

To estimate *the upper bound* of the contribution of an endogenous policy rate response to the dynamics of real credit we selected the cases in each group of countries:

- for which we observe statistically significant impulse responses of nominal rates to oil price shocks;

- where higher oil prices result in lower nominal rates and higher credit for commodity-exporters, and where for other inflation targeting economies higher oil prices cause higher interest rates and lower real credit.

The selection of countries is presented in Table 3.

[25] It may be also an effect of higher domestic fuel prices. For example, the direct weight of fuel in the CPI basket in Norway is around 10% (4pp. comes from fuel supply for housing and 6pp. - from operation of personal transport according to Statistics Norway). It doesn't account for an indirect effect through a supply chain, which makes the impact more evident. Our calculations using data since 2015 show that the pass-through of higher international oil prices (in USD) to retail fuel prices in Norway is around 10% (1% increase in Brent price leads to 0.1% increase in domestic energy prices). Similar calculations for Russia point to much lower pass-through of around 3%. How large the effect might be, empirical evidence presented in the literature on a reaction of total/headline inflation to a positive terms-of-trade shock in a developed commodity exporting economy point to an initial slowdown of total inflation due to an exchange rate appreciation, see Bergholt (2017) for Norway, Jääskelä, J.P., Nimark, K. (2011) for Australia, and Dorich et al. (2013) for Canada. But, further inflation dynamics is found to be governed by higher cost pressure in the economy.
Thus, changes in the tax regime of retail fuel sector may have important implication for the Bank of Russia policy when an international oil price persistently grows or declines.

Table 3. Inflation-targeting countries in the data sample and their selection in the estimation of the contribution of an endogenous policy rate response to the dynamics of real credit

	Commodity exporters	**Non-commodity exporters (importers)**
Emerging market economies	Brazil	Armenia
	Chile	Georgia
	Colombia	Guatemala
	Indonesia	Poland
	Mexico	Romania
	Peru	Serbia
	Philippines	Turkey
	South Africa	
Developed market economies	Australia	Czech Republic
	Canada	Israel
	New Zealand	Sweden
	Norway	United Kingdom

Note: Green – IRF for the policy rate is significant; in addition, the policy rate and real credit responses have expected signs (lower rates and higher real credit in response to higher commodity prices for commodity exporters, higher policy rates and lower real credit to higher commodity prices for non-commodity exporters), Red – either not significant or significant, but with the opposite sign to those in Green, Grey – mixed combinations of the IRF's signs.

Figure 2. Impulse response functions for nominal policy rate in LPM. The diagram shows commodity exporters from EMEs and non-commodity exporters from DEs.

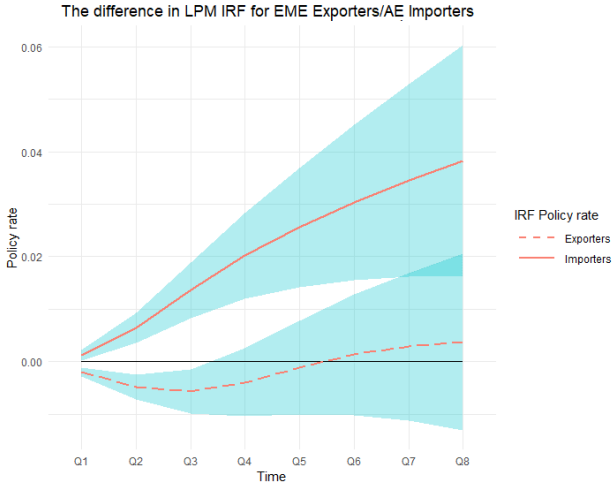


Figure 3. Impulse response functions for real credit in LPM. The diagram shows commodity exporters from EMEs and non-commodity exporters from DEs.

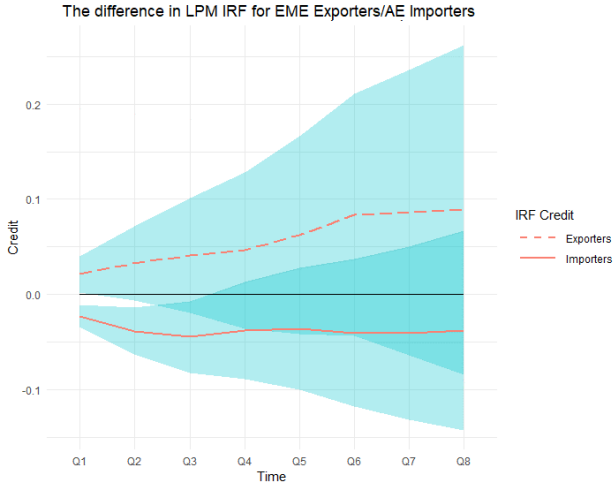


Figure 4. Impulse response functions for nominal policy rate in VAR. The diagram shows commodity exporters from EMEs and non-commodity exporters from DEs.

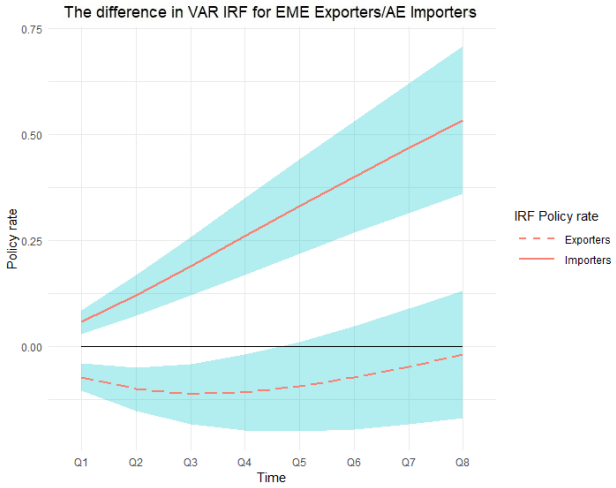
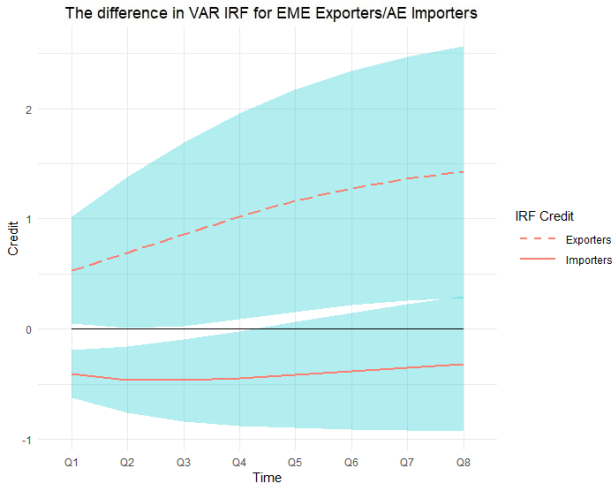


Figure 5. Impulse response functions for real credit in VAR. The diagram shows commodity exporters from EMEs and non-commodity exporters from DEs.



For selected countries (marked Green in Table 3) and previously selected credit measures, we repeat the exercise of Sims and Zha (2006)[26] as in Bernanke et al. (1997). For each country, we switch off the response of nominal rates to oil prices, compute counterfactual dynamics of real credit corresponding to the constant nominal rate path and compare it with the unrestricted response of real credit. Calculations using the Sims and Zha (1995) approach show that the endogenous nominal rates response under inflation targeting in commodity-exporting EMEs accounts for 20% of real credit increase on average after a positive oil price shock (Table 4).[27]

We also find that the systematic monetary policy effect on real credit in response to commodity price growth is rather small in the sample of non-commodity-exporting IT countries. It is the strongest for Poland where real credit is 15% higher when a central bank does not react to higher oil prices by counterfactually keeping monetary policy the same compared to the case when it reacts. It is positive for the United Kingdom, Sweden and the Czech Republic.

[26] Originally 1995. Published as a vintage article in 2006.
[27] The average contribution of systematic monetary policy to real credit volatility after commodity shocks in a group of commodity-exporting inflation-targeting countries becomes around 15% after excluding the developed economies of Norway and Canada.

Table 4. Results of counterfactual procedure by Sims and Zha (2006) for a sub-sample of inflation-targeting countries

Inflation-targeting country	**Counterfactual level of credit relative to actual, %**
Commodity exporters	
Brazil	- 3.1
Chile	- 17.5
Colombia	- 2.6
Indonesia	- 58.6
Peru	- 2.2
Average	**-20.2**
Other inflation-targeting (non-commodity-exporting) countries	
Czech Republic	+ 0.4
Israel	- 18.8
Sweden	+ 4.1
United Kingdom	+7.3
Guatemala	- 21.6
Poland	+ 14.2
Serbia	- 12.8
Average	**-3.9**

Note: Russia is absent in the sample due to a short time series (inflation targeting started only in 2015).

As a robustness check, to further replicate Bernanke et al. (1997) we add two additional variables to the VARs and LPM specifications: 10 year and 3 month government bond yields – Table 5.1 in Appendix 5. Therefore, we consider impulse response functions for the nominal policy rate and credit in the next specification (ordering) of the above presented model:

$$\mathrm{Y_{i,t}} = (\mathrm{GGDP_{i,t}}, \mathrm{ComPI_{i,t}}, \mathrm{GDP_{i,t}}, \mathrm{Inflation_{i,t}}, \mathrm{Policy\ rate_{i,t}}, \mathrm{3M\ rate_{i,t}}, \mathrm{10Y\ rate_{i,t}}, \mathrm{Credit_{i,t}})'$$

$$\mathrm{y_{i,t+s}} = (\mathrm{GGDP_{i,t+s}}, \mathrm{ComPI_{i,t+s}}, \mathrm{GDP_{i,t+s}}, \mathrm{Inflation_{i,t+s}}, \mathrm{Policy\ rate_{i,t+s}}, \mathrm{3M\ rate_{i,t+s}}, \mathrm{10Y\ rate_{i,t+s}}, \mathrm{Credit_{i,t+s}})'.$$

Adding interest rates with other maturities does not improve the significance of impulse responses as well as their signs – Appendix 5, Figures 5.1-5.4.

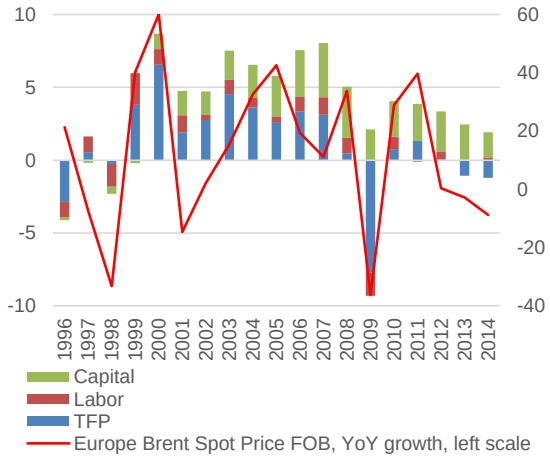
We will consider Russia's case in more detail in the next section.

3.2 Focusing on Russia

The Russian economy is a small open economy with exports comprising almost 30% of real GDP and the export of fuels (oil, gas, refined oil), metals, coal and wood making up 75% of total exports (data for 2016). That is why the Russian economy is greatly exposed to terms of trade shocks – these shocks indeed are a major source of macroeconomic variation in Russia, especially that of TFP variation (Figure 6). In its quest for macroeconomic stability, Russia introduced a fiscal rule in a form of the Stabilisation Fund in 2004 (a new, more orthodox rule-based version of the rule was introduced in 2017). To increase relative price adjustment in times of big terms of trade movements, the Bank of Russia adopted a floating exchange rate in late 2015 and started inflation targeting in 2015 as a nominal anchoring.

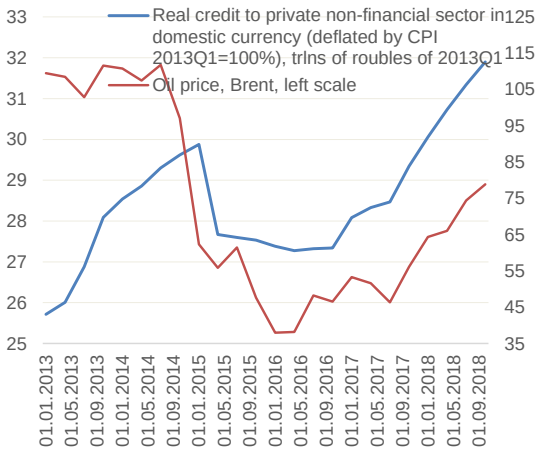
Rapid private sector debt growth in Russia before the global financial crisis coincided with oil price growth. This is true for both domestic credit and net external debt of the private sector. The dynamics of domestic ruble credit in Russia is procyclical – real domestic banks credit to the private non-financial sector in the domestic currency (excluding FX valuation effect) positively correlates with the oil price (Figure 7). As Figures 8-9 show the level of net external private sector debt (in U.S. dollars) is procyclical too (correlation of the oil price level with the level of debt is 0.6, and just 0.1 with net debt to GDP. However, the correlation of net external debt with a lag of oil price is 0.4).

Figure 6. Decomposition of the value added growth on KLEMS data for Russia and oil price growth



Sources: Russia KLEMS. National Research University Higher School of Economics and Groningen Growth and Development Centre. March 2017, EIA.

Figure 7. Real credit to private non-financial sector in domestic currency and oil price



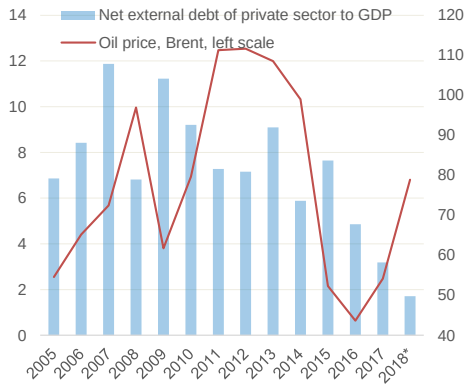
Source: Bank of Russia.

Figure 8. Net external debt of private non-financial sector and oil price, $ bln

Sources: Bank of Russia, EIA.

Note: * - end of the third quarter.

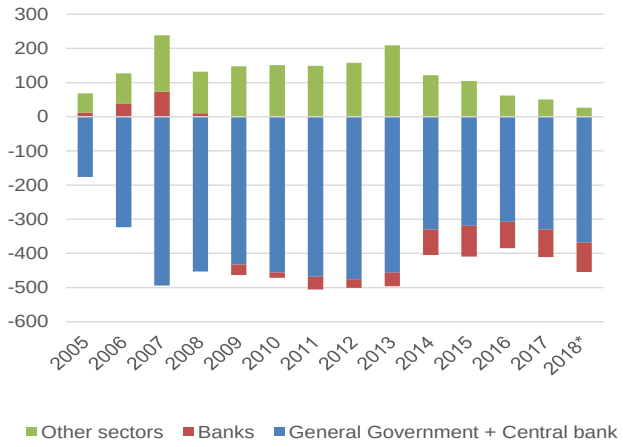
Figure 9. Net external debt of private non-financial sector and oil price, % of GDP



Sources: Bank of Russia, EIA.

Note: * - end of the third quarter.

Figure 10. Net external debt by institutional sectors, $ bln, positive means net external debt



Source: Bank of Russia.

Note: * - end of the third quarter.

Figures 11-14. Cumulative impulse responses of real rates and real credit in Russia to an exogenous oil price increase in a structural VAR and local projections

Figure 11. Policy rate response in VAR

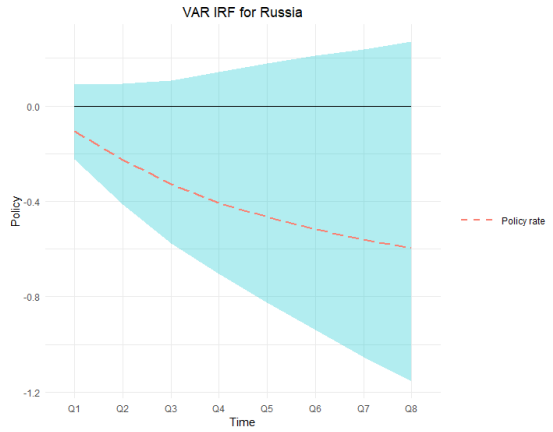


Figure 12. Real credit response in VAR

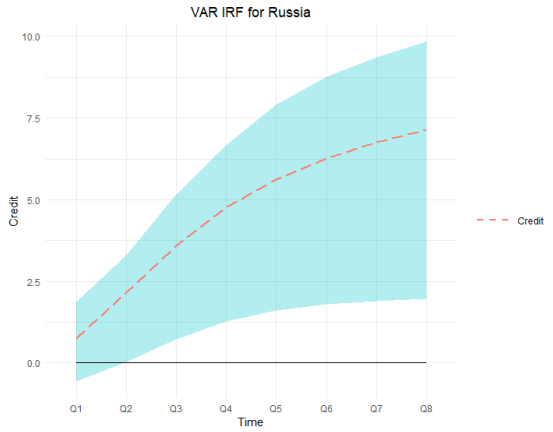


Figure 13. Policy rate response in LPM

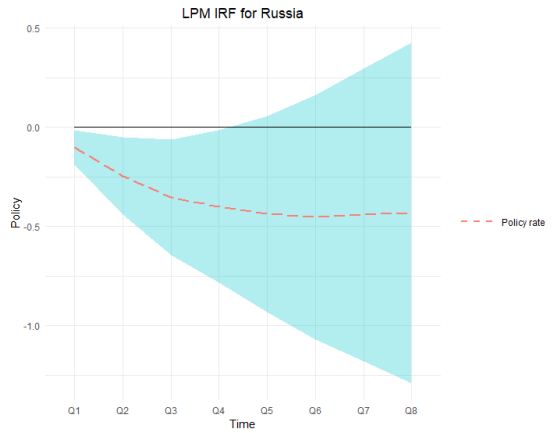
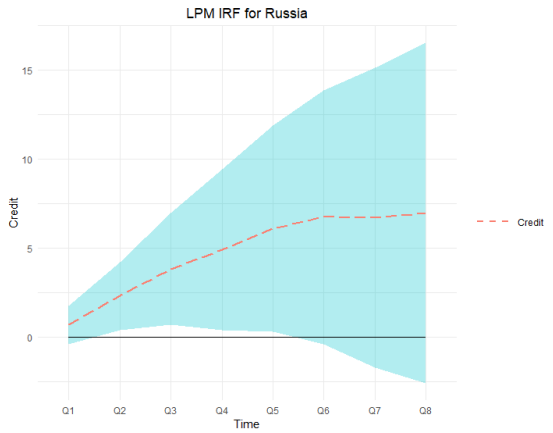


Figure 14. Real credit response in LPM



Note: VAR results are significant on 95% CI, constructed from bootstrap distribution with 100 runs. LPM results are significant on 95% CI, constructed from New-West estimator.

Turning to rigorous econometric analysis, we estimated a structural VAR (with ordering as in cases above) and local projection, Jorda (2005), on Russian data. As inflation targeting in Russia only started in 2015, we were not able to use Russia's case in testing our main hypothesis that inflation targeting may have unpleasant financial stability implications through influencing credit growth. However, given the widely accepted point of view that, before the introduction of inflation targeting, the Bank of Russia had conducted a more procyclical monetary policy (using exchange rate as a nominal anchor) it is interesting to test such a view. We test the reaction of credit and real rates using data given over a long period (since 2000). Computed impulse responses show that oil price shocks have a significant positive effect on real credit and a negative effect on real rates in Russia (Figures 11-14).

Thus, Russian households and corporates accumulate debt during good times. There may be several explanations for this behaviour from a theoretical point of view: liquidity constraints (higher net worth or income flows weaken the constraint) as in Shousha (2016) or Caballero (2018), myopia,

irrational expectations (overoptimism) and adaptive behaviour, when agents consider a short-term oil price change as a persistent one, see, Bejarano et al. (2016).

An important observation is that growing oil prices coincide with not only real domestic credit growth but also with foreign debt growth. Again, economic agents seem not to reduce foreign debt in good times. The sectoral distribution of foreign debt in Russia points to an explanation. Sectoral distribution of external debt is extremely heterogeneous and higher oil prices make it even more heterogeneous. When corporates and households accumulate debt, governments and central banks accumulate net foreign assets (Figure 10). Caballero (2018) provides a survey on the explanation of observed precautionary (excessive) accumulation of international reserves – it is another side of the underinsurance by the private sector. As a result, the private sector may consider a central bank growing international reserves a hedge against possible unpleasant future oil dynamics. This implies that the private sector expects the central bank to step in and rescue and thus borrows even more (moral hazard). Such behaviour is rational under a fixed/managed exchange rate regime, which the Bank of Russia applied before it started inflation targeting. However, even under inflation targeting, the Bank of Russia has the ability and instruments (like currency swaps) to step in with FX interventions (liquidity provision) like it did in 2014-2015. Other explanations for the growing external debt of the private sector in good times are similar to those applied to domestic debt (credit): overoptimism and myopia. Structural estimated DSGE models should incorporate some of these mechanisms (liquidity constraints, overoptimism or myopia) to be able to reproduce the empirically observed regularities.

The role of monetary policy during the considered period is another possible explanation for the reaction of real credit to oil price fluctuations. As Figure 11 and Figure 13 show, real interest rates decline when the oil price grows, and real rates increase when the oil price decline.

In the next section, we use a DSGE model with financial frictions and banking (credit) to compare inflation targeting with LAW in different environments: varying the economy's exposure to oil price volatility and the role played by credit-to-GDP in predicting/amplifying risks to financial stability.

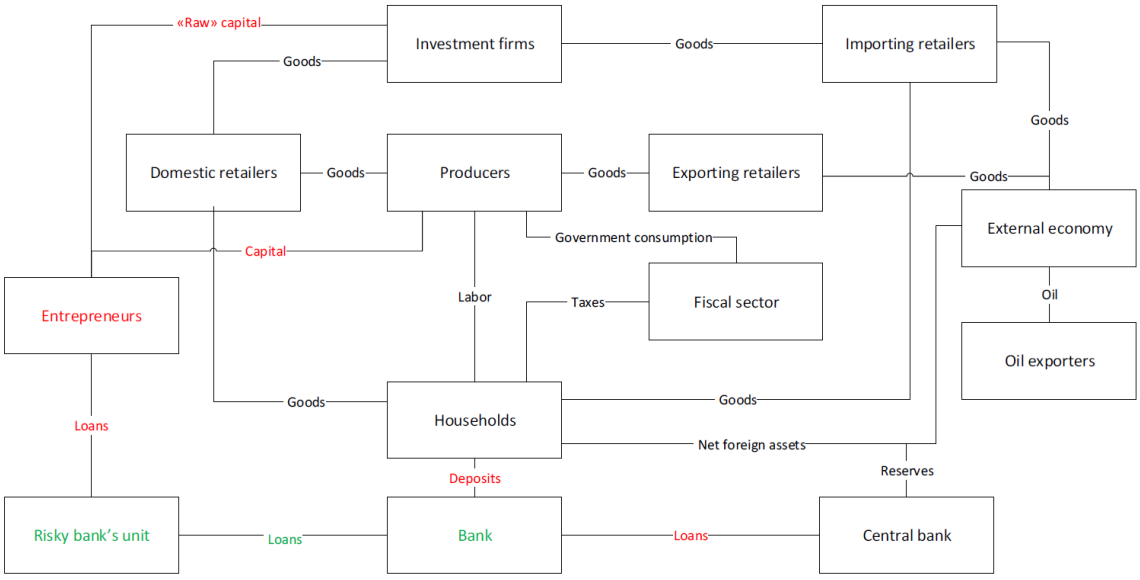
4. Oil prices, real credit, financial stability: comparing inflation targeting and leaning against the wind in a DSGE model for Russia

In this section, we rely on an estimated DSGE model for Russia from Kreptsev, Seleznev (2017). It is a small open economy model with a commodity-exporting sector (oil as endowment) following Cristoffel et al. (2008) with the banking sector as in Gerali et al. (2010). The economy is composed of households, firms (different sectors for tradable and non-tradable domestic goods, retail firms, etc.), fiscal and monetary authorities, external economy and the banking sector. Fiscal

policy in the model does not smooth transitory commodity price changes. There are free frictions in the model for Russia that call into question a central bank's response: one is standard price rigidity, another is interest rate rigidity in the banking sector,[28] the third – a financial friction in the spirit of Bernanke, et al. (1999) but with mutual funds replaced with commercial banks optimising their objective function as in Gerali et al. (2010). [29] The block scheme of the economy is presented in Figure 15. For our analysis, we use the calibrated parameters of the DSGE model presented in Kreptsev, Seleznev (2017).[30]

We apply the model to compare inflation targeting with leaning against the wind for different values of oil price volatility and the role played by credit-to-GDP in generating financial instability. Changing oil price volatility allows us to analyse economies that are more (with high oil price volatility) or less (with low volatility) dependent on oil price dynamics. Financial stability risks stemming from volatility of credit-to-GDP also may be high or low, depending on the level of financial development (level of credit-to-GDP), comovement of the credit cycle and business cycle (commodity prices) and sensitivity of economic and financial conditions to external shocks.

Figure 15. The block scheme of the model with the banking sector (from Kreptsev, Seleznev (2017))



Source: Kreptsev, Seleznev (2017).

[28]As maturity of all credit in the economy is just one period (all debt is refinanced each period), such interest rate rigidity helps reduce monetary transmission of the central bank's interest rate changes and make it more realistic. At the same time, interest rate rigidity introduces additional inefficiency in the economy.

[29] Authors of the DSGE model for Russia did not introduce LTV restrictions as in Gerali et al. (2010) due to the technical difficulties of solving a version of the original model extended to open economy with LTV restrictions. Following Bernanke et al. (1999) banks offer a menu of credit in the form of 'interest rate volume of credit.' Thus, credit constraints are accounted for indirectly in the model.

[30] As authors of the DSGE model mention in their original paper, estimates of the rule do not change much in calibrated and estimated versions of the model – see Table 3 in Appendix B in Kreptsev, Seleznev (2017). The rule was estimated for period 2006 Q1-2017 Q4. It covers inflation targeting, which *de jure* started in 2015, but *de facto* in 2013.

The DSGE model for Russia reproduces similar responses of policy rates and real credit to an oil price shock to those found in the empirical analysis of Section 3 – see Figures 16-21. Systematic monetary policy response to oil shocks under inflation targeting (in a model with estimated policy rule) is procyclical – the central bank reduces the real interest rate three quarters after the shock.[31] Higher oil prices lead to higher GDP, lower inflation and lower real interest rates (except initial two quarters). Positive real rates in the first two quarters are the result of a quick exchange rate pass-through from stronger national currency to consumer prices. Thus, easier monetary policy additionally stimulates economic activity. Real credit increases because of a positive oil shock. These results highlight the problem of potential procyclicality of monetary policy response to an oil price shock. It justifies analysis of the modified Taylor rule, including the reaction to credit changes (the LAW), to achieve more stable dynamics of the economy.

Several features of the model lead to a procyclical reaction of credit demand and supply to oil price changes:

First, there is no countercyclical fiscal policy in the model;

Second, the model contains the inflation targeting monetary policy rule, which prescribes the central bank to react to headline inflation.

Third, the CPI basket in the model consists of tradable and non-tradable goods. Thus, the model accounts for the possibility of terms of trade changes to influence inflation through their effect on the exchange rate (relative prices) and exchange rate pass-through.

Figures 16-21. Impulse responses of GDP, inflation, real policy rate and real credit in Russia to an exogenous oil price increase in a DSGE model under alternative policy rules.

Figure 16. Profile of the oil price

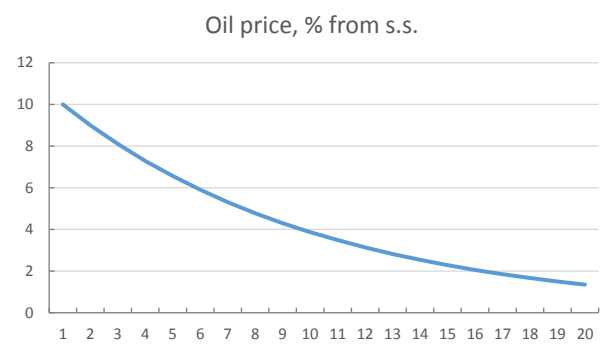
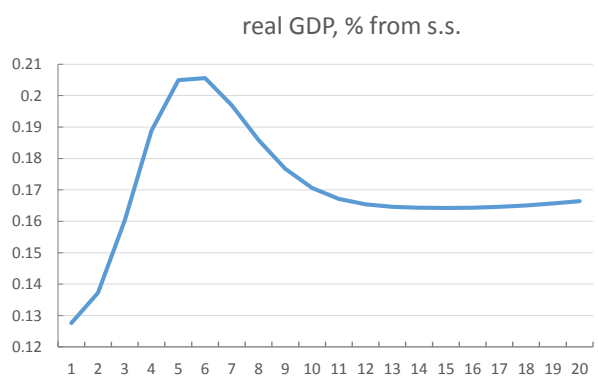


Figure 17. Response of GDP



[31] Kreptsev, Seleznev (2017) show for the benchmark that 68% confidence intervals are different from zero, so we do not include confidence intervals for the benchmark.

Figure 18. Response of the nominal policy rate

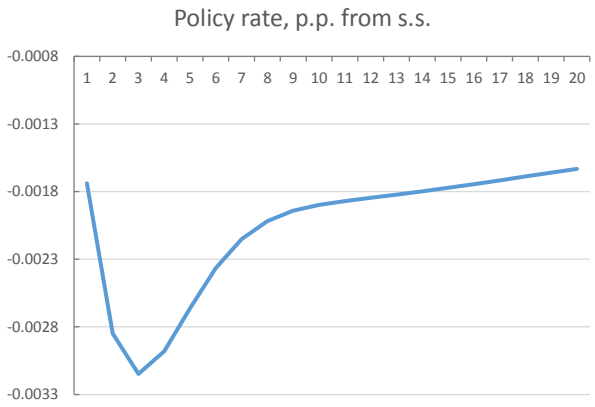


Figure 19. Response of inflation

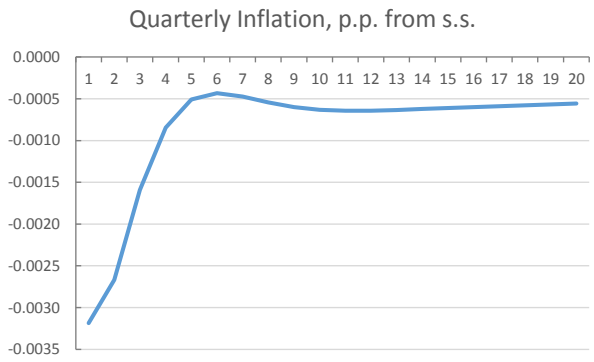


Figure 20. Response of real credit

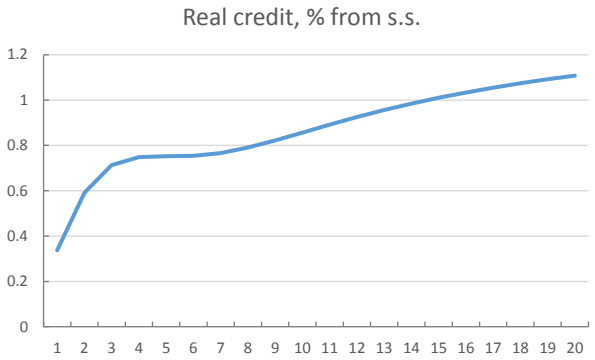
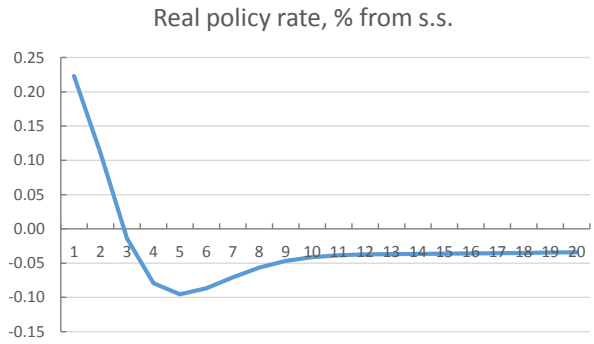


Figure 21. Response of the real policy rate



Source: authors' calculations based on the model by Kreptcev, Seleznev (2017).

Fourth, the model contains financial frictions constraining supply of liquidity.

Fifths, in the spirit of Gonzales et al. (2016) a country risk-premium is sensitive to oil price changes and to a level of net foreign liabilities. The risk premium dependence on oil prices reflects the variation of the credit risks in the economy in the oil cycle.

Entrepreneurs in the model benefit from higher oil prices as their net worth increases (lower probability of default in a more friendly macroeconomic environment). As a result, profit maximisation makes them demand more credit to leverage profits they earn in good times. The credit supply increases due to higher net worth.

To compare the baseline version of inflation targeting rule with some alternative leaning against the wind rules, we introduced several changes to the basic DSGE model.

1. To understand whether the policy is effective we should provide some criteria. We follow the idea given by Verona et al. (2017) and consider the loss function presented as a weighted average of variances in inflation, output and credit-to-GDP. The last term is included to consider a financial stability purpose as one of the goals for monetary policy authorities. Loss function has the following form:

$$L = var(\pi) + var(Y) + \alpha_{cr} var(Cr)$$

Where: $var(\pi)$ – variance of inflation, $var(Y)$ – variance of GDP, $var(Cr)$ – variance of credit to GDP ratio, α_{cr} – weight of credit variance on the loss function.

By adding volatility of credit-to-GDP to the loss function we indirectly account for the possibility of financial instability in the model economy (which in the DSGE, as in many others, only temporarily deviates from the steady state), which may result in a structural shift in volatilities of inflation and GDP in a direction considered unpleasant for the regulator (a crisis). By varying its weight in the loss function, we try to replicate economies with different exposure to financial stability risks stemming from credit-to-GDP volatility to check how recommendations in favour of inflation targeting change depending on the volatility.

2. We add a credit variable to the policy rule. We consider two measures of the credit cycle: a change in credit volume and a change in the credit-to-GDP level. The modified monetary policy rule is the following:

$$\frac{R_t}{R^*} = \left(\frac{R_{t-1}}{R^*}\right)^{\phi_R} \left(\frac{\pi_t}{\pi^*}\right)^{(1-\phi_R)\phi_\pi} \left(\frac{Cr_t}{Cr_{t-1}}\right)^{\phi_{cr}} e^{e_t^R}$$

Where: R_t – policy interest rate at t, π_t – inflation rate at t, Cr_t – credit cycle variable, e_t^R – monetary policy shock, $\phi_R, \phi_\pi, \phi_{cr}$ – interest rate inertia, inflation weight and credit cycle weight coefficients respectively. Variables with an asterisk are for the steady state levels.

3. The last important change in the baseline model involves considering the different oil price shock volatilities. This will help us compare the influence of including credit cycle variables in the monetary policy rule in exporting and non-exporting countries. A country with small variance in commodity price can be seen as non-exporting country in comparison with a country with great shocks since the oil price shock will be less relevant for the whole economy in the former case. In fact, we will see the difference in optimal policy rule for exporting countries with larger or smaller changes in commodity price. Another interpretation is procyclicality of fiscal policy. Countercyclical fiscal rule should reduce role of oil price shock volatility relative to other sources of volatility in the economy[32].

To address the main problem of this paper we evaluate in the DSGE model the variance of output, inflation and the credit-to-GDP ratio for different weights of credit cycle variable for both credit growth rate and credit-to-GDP growth rate for different values of oil price shock volatility. Weights changed from zero to one with 0.1 step. Oil price shocks were 2, 5, 10, 20, 50 and 100 times higher than in the baseline model. Then we find the value of loss function and calculate the relative loss function as the ratio of losses with the LAW part in the rule to the losses without it for the same shock size. If this ratio is smaller than one we can conclude, that monetary policy benefits from considering credit cycle.

[32] Thus, even though fiscal rule is absent in the DSGE model we can indirectly account for its effectiveness in smoothing oil price cycles

As we can see from the figures below (see Figures 22-23), countries with greater volatility in commodity prices (more procyclical fiscal policy) benefit more from LAW policy for both measures of credit cycle. In case of credit growth rate in monetary policy rule, countries with small variance in the oil price have higher losses when they implement LAW approach.

Then we compare loss functions for different weights of credit volatility (see Figures 24-29 below). We can see that the smaller the weight, the higher the losses, the sooner the benefits of the LAW policy disappear. If we introduce credit-to-GDP ratio growth in the monetary policy rule, we can see a considerable difference in the reaction of the loss function to the change in the weight of credit. If commodity price volatility is relatively small, change in weight has insufficient influence on the optimal policy level. However if there is a huge variance the difference is considerable: the less the weight of credit volatility in the loss function, the smaller the optimal coefficient in monetary rule for credits and the greater the pace of loss change. If we compare the graphs of loss functions with zero and non-zero weight of the credit cycle variable, we can see the following. When the coefficient ϕ_{cr} in monetary policy rule is small (less than approximately 0.3) the losses are much smaller than when $\phi_{cr} = 0$. This means that the credit cycle variable in the rule will not negatively impact economic welfare despite the fact that we use the irrelevant variable in monetary policy decision. This conclusion is not valid for credit growth as the loss function with zero credit cycle weight in always higher.

Figure 22. Relative loss function in case of the credit-to-GDP ratio in monetary policy for equal weights of output, inflation and credits in loss function

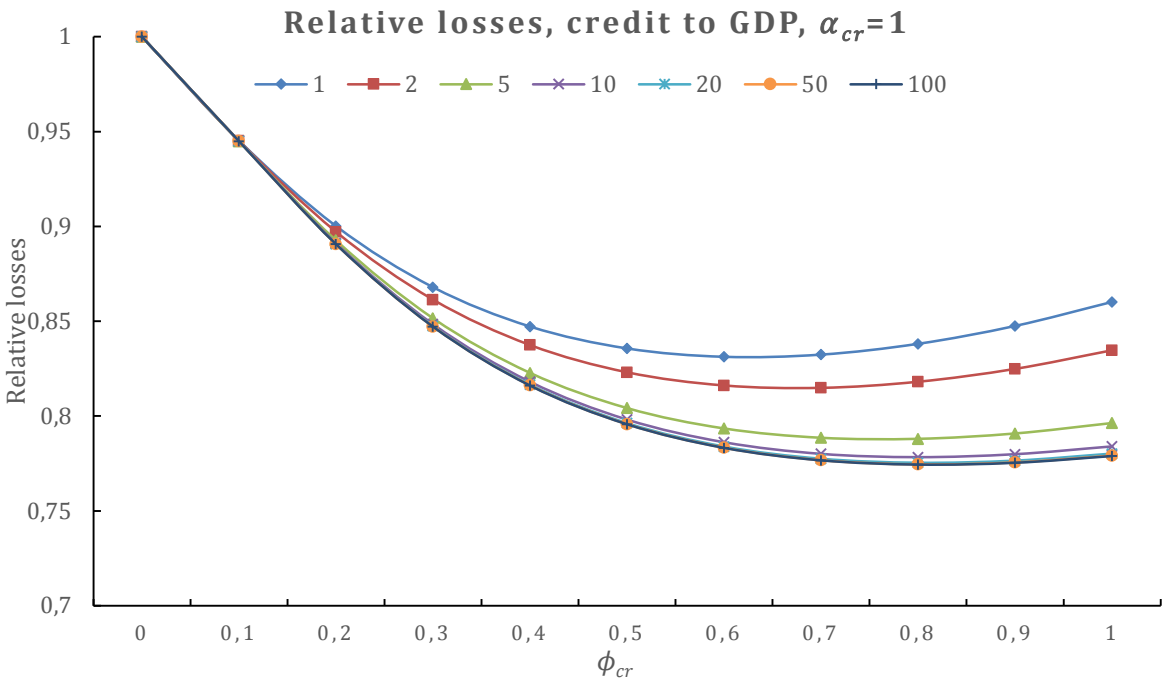


Figure 23. Relative loss function in case of the credit-to-GDP ratio in monetary policy for equal weights of output, inflation and credits in loss function

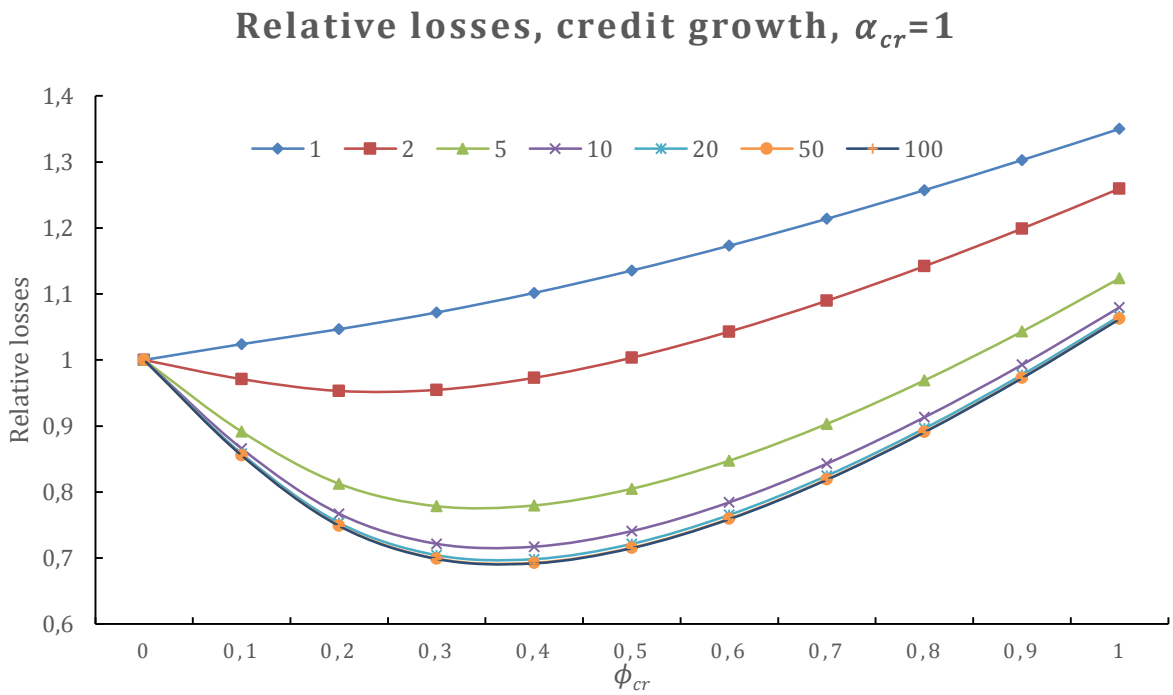


Figure 24. Comparison of relative loss functions for different weights of credits in loss function, **credit growth**, baseline volume of shock

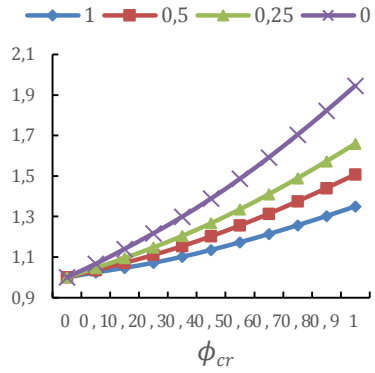


Figure 25. Comparison of relative loss functions for different weights of credits in loss function, **credit growth**, 2 times higher shock

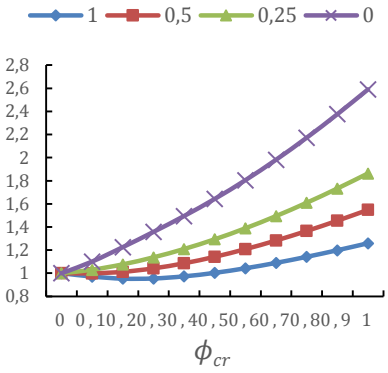


Figure 26. Comparison of relative loss functions for different weights of credits in loss function, **credit growth**, 50 times higher shock

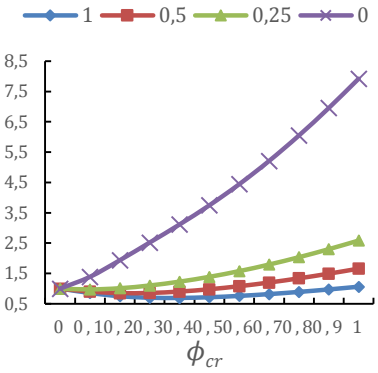


Figure 27. Comparison of relative loss functions for different weights of credit in loss function, **credit-to-GDP**, baseline volume of shock

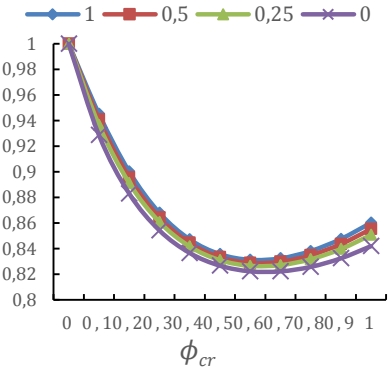


Figure 28. Comparison of relative loss functions for different weights of credit in loss function, **credit-to-GDP**, 2 times higher shock

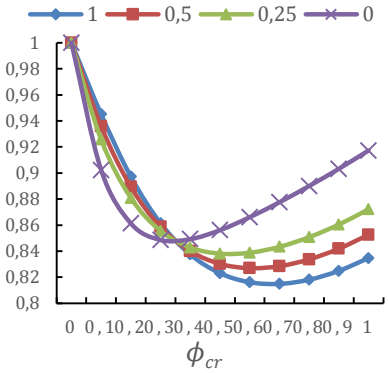
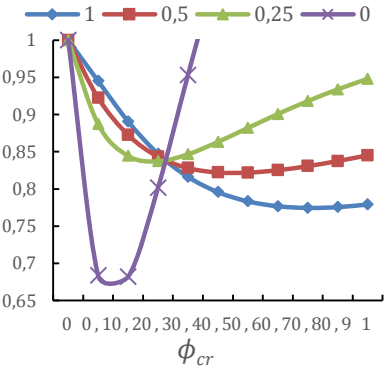


Figure 29. Comparison of relative loss functions for different weights of credit in loss function, **credit-to-GDP**, 50 times higher shock



Finally, we compare the impulse response function of policy rate and real credit given different policy measures (Figures 30-33). These graphs support our previous conclusion of using the credit-to-GDP measure in the monetary policy rule. In case of looser monetary policy in terms of credit cycle, we can see that credit growth does not affect the interest rate very much but credit becomes higher than in the baseline model. A more restrictive monetary policy including credit growth in the monetary rule makes the interest rate go up, which leads to a faster slowdown in real credit. For both low and high ϕ_{cr} when we are using credit-to-GDP in the monetary rule, we see a more countercyclical policy rate and less volatile real credit.

Figure 30. Response of interest rate, $\phi_{cr} = 0.1$

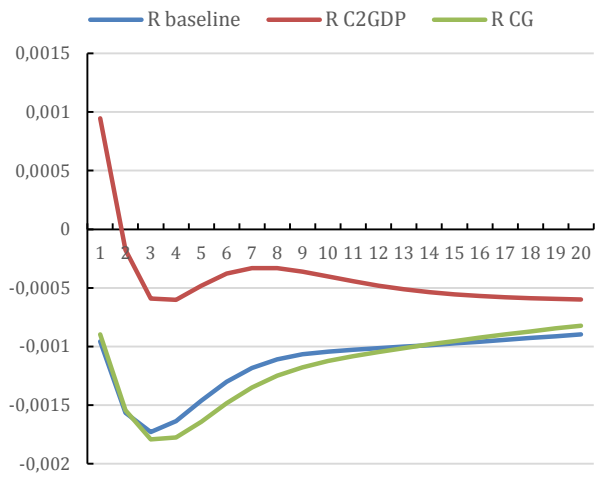


Figure 31. Response of real credit, $\phi_{cr} = 0.1$

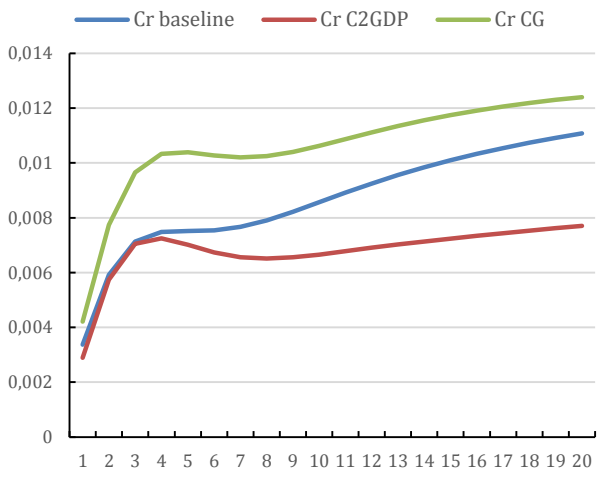


Figure 32. Response of interest rate, $\phi_{cr} = 0.5$

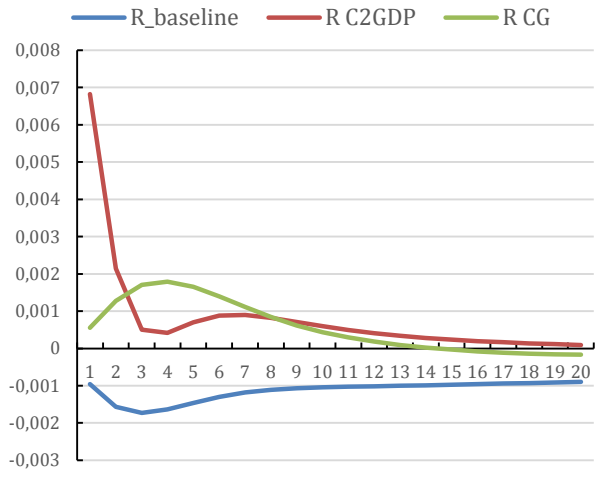
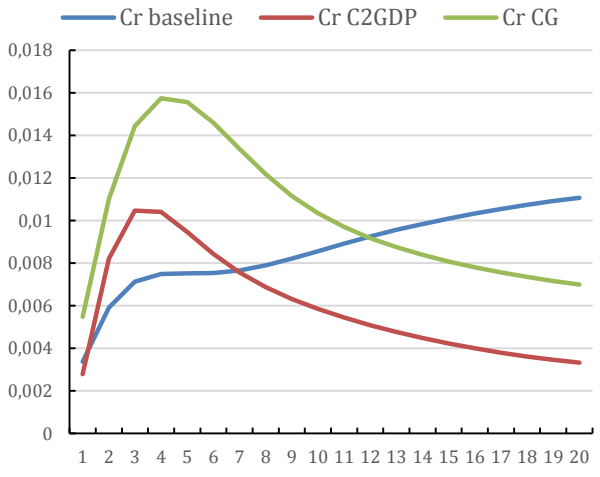


Figure 33. Response of real credit, $\phi_{cr} = 0.5$



Conclusion

The main research question of this paper is how a central bank in a commodity-exporting economy should react to commodity price changes. There is a consensus in the literature that fiscal rule is a necessary element of policy ammunition. Regarding the central bank's policy, inflation targeting (of domestic inflation) and a flexible exchange rate are two other necessary elements for such countries.

Our contribution to the literature raises the issue of financial stability implications of inflation targeting in commodity-exporting countries. Our research starts with two observations. The first is that relative prices are extremely volatile in commodity-exporting economies. As commodity price cycles have long periods, relative prices change in one direction over a long period of time. The second observation is that all inflation targeters in commodity-exporting countries target the headline consumer price index, which includes prices of imported goods. Therefore, relative price changes impact the dynamics of the CPI. Usually, central banks try to see through relative price changes and prefer not to react. Taking the first and second observations together, we assert that persistent relative price changes (especially strong with a procyclical fiscal rule) may make it extremely challenging for the inflation-targeting central bank not to react. Moreover, we expect that in such situations central banks would loosen their monetary policy. Afterwards, if the commodity price persistently rises and the central bank reacts by reducing the real interest rate (not just keeping the real rate at the same level when inflation declines), such a procyclical policy may lead to the accumulation of financial stability risks in the form of a higher credit-to-GDP ratio. Accumulation of debt when oil prices are booming is especially dangerous, as booms tend to end with busts. Therefore, the economy would enter into 'the bad times' with higher debt, which is not good for the reduction of macroeconomic volatility. Thus, procyclical fiscal rule under inflation targeting policy may have important negative implications for financial stability as well.

We formulate a hypothesis that monetary policy response under inflation targeting in commodity-exporting countries significantly amplifies the credit cycle in such economies, more so for more persistent commodity price changes or for less prudent fiscal frameworks. In this paper, we take the preliminary steps to test this hypothesis by studying monetary policy response under inflation targeting. We use two sources of data to study whether inflation-targeting central banks loosen monetary policy in response to higher commodity prices (especially to their persistent growth).

First, we reviewed papers describing DSGE models estimated for inflation-targeting commodity exporters in order to extract impulse responses of real interest rates to oil price shocks. To sum up, we found strong support for the crucial role that relative price changes play in disinflation in commodity-exporting inflation-targeting economies facing terms of trade improvements when the improvement is permanent or when fiscal rule cannot perfectly insulate economy from commodity

price changes. The review shows that in such cases inflation-targeting central banks pursue easier monetary policy, which contributes to a decline in real interest rates. Following positive commodity price shocks, real rates decline below the steady state and remain there for some time. Thus, the estimates of DSGE models for commodity-exporting inflation-targeting economies in general support our hypothesis that commodity price growth leads to looser monetary policy. This may contribute to higher accumulation of credit in the economy and the build-up of financial stability risks.

Second, we undertook an event study analysis by comparing the median response of real interest rates and real credit in two groups of inflation-targeting central banks to oil price booms and busts since 1999. These two groups of inflation targeters include commodity exporters and other inflation targeters. The event study analysis demonstrates that monetary policy of inflation-targeting central banks is different from that of other inflation-targeting central banks. Moreover, the evidence is in favour of the hypothesis that during episodes of prolonged commodity price changes the inflation-targeting central bank in a commodity-exporting economy changes its monetary policy stance (real interest rates) in the opposite direction to the movement of the commodity price. Regarding real credit dynamics, we have not found any meaningful differences between the groups, which justifies more formal statistical tests (local projections as in Jorda (2005) or Panel SVARs).

Impulse response analysis in panel VAR and local projections finds that not all commodity-exporting countries included in the estimation reduce interest rates in response to higher oil prices: only emerging market economies do. Policy rates in these economies start rising after approximately a year. In all other inflation-targeting countries we observe higher policy rates after a positive commodity shock. For non-commodity-exporting economies the result looks natural – higher cost-pressure stemming from commodity prices stimulates tighter monetary policy response. For commodity-exporting developed economies (DEs), this result may be explained by several factors: low elasticity of their exchange rate to commodity prices due to presence of fiscal rules; high elasticity of domestic economic activity to commodity prices leading to high cost pressure even in the short term; low elasticity of capital flows; anchored inflation expectations and high monetary policy credibility. Real credit grows after a positive shock in commodity-exporting EMEs, but declines in all other country groups.

Calculations using the Sims and Zha (1995, 2006)[33] approach and (as a robustness check) that by Bernanke et al. (1997) show that endogenous real rates response under inflation targeting in commodity-exporting economies accounts for 20% of real credit increase on average. This comes as a result of a positive oil price shock in those countries where policy rate significantly reacts and the real credit increases following an oil price increase.

We also conduct a theoretical analysis and compare stabilisation properties (while accounting for financial stability risks) of the inflation-targeting policy rule and the ‘leaning against the wind’

[33] Originally 1995. Published as a vintage article in 2006.

policy rules. Notably, we do this exercise conditionally on the role of commodity price shocks for the economy. For this purpose, we use the DSGE with financial frictions and a banking sector estimated basing for the Russian economy and measure the efficiency of policy results with different sensitivity to credit developments (the 'leaning against the wind' rules) under different variance of oil price shocks. This may also be interpreted as different efficiency of fiscal policy in insulating the economy from a given oil price volatility. The results show that when commodity price volatility is relatively high (fiscal policy is not countercyclical), leaning against the wind outperforms pure inflation targeting, thus supporting our empirical findings. Interestingly, even when the financial stability risks associated with the volatility of credit developments are negligible, a moderate leaning against the wind policy is still preferable.

As policy implications, we may conclude:

First, when commodity price shocks become a relatively (to other shocks hitting the economy) important source of macroeconomic volatility, which is the case with a procyclical fiscal policy, inflation targeting becomes procyclical regarding credit variables as well. Thus, procyclical fiscal policy coupled with inflation targeting may contribute to build-up of financial instability in the economy. By inflation targeting we mean a central bank's commitment to price stability – low and stable inflation in the medium-term.

Second, the 'leaning against the wind'[34] reaction of monetary policy (policy rate) to credit developments outperforms inflation targeting. This is true in case of procyclical fiscal policy in a commodity-exporting economy under standard monetary policy trilemma conditions. LAW lets the central bank compensate for the procyclicality of fiscal policy, especially in situations with persistent changes in commodity prices that lead to persistent changes in relative prices and measured inflation. However, as shown in the literature, which we review in the paper, LAW policy may have serious constraints as well. This is especially the case when a small open economy loses monetary policy independence (Dilemma, not trilemma) or elasticity of economic activity to interest rate is very high.

Third, with countercyclical fiscal policy, which reduces the role of commodity price volatility in the economy, inflation targeting tends to close its efficiency gap with LAW in addressing the goal of macroeconomic stabilisation. This also applies to cases when the goal is expressed in terms of not only inflation and output volatility but also credit variables volatility, so the policy accounts for financial stability. Thus, for the inflation targeting not to become procyclical and not to contribute to financial stability risks it should be combined with a countercyclical fiscal rule.

[34] Which is 'a monetary policy that is somewhat tighter (that is, with a somewhat higher policy interest rate) than what is consistent with flexible inflation targeting without taking any effects on financial stability into account' (definition by Svensson).

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APPENDIX 1

Table 1.1. List of inflation-targeting economies (including commodity-exporting economies)

	Target measure	Target 2012	Target horizon	Commodity exporter?
Armenia	H CPI	4% ± 1.5 pp	Medium term	No
Australia	H CPI	2% – 3%	Medium term	Yes
Brazil	H CPI	4.5% ± 2 pp	Yearly target	Yes
Canada	H CPI	2% (mid-point of 1% – 3%)	Six-eight quarters	Yes
Chile	H CPI	3% ± 1 pp	Around 2 years	Yes
Colombia	H CPI	2% – 4%	Medium term	Yes
Czech Republic	H CPI	2% ± 1 pp	Medium term, 12-18 month	No
Georgia	CPI	3%	Medium term	No
Ghana	H CPI	8.7% ± 2 pp	18-24 month	No
Guatemala	H CPI	4.5% ± 1 pp	End of year	No
Hungary	H CPI	3%	Medium term	No
Iceland	H CPI	2.5%	On average	No
India	CPI	4% ± 2 pp	Three consecutive quarters	No
Indonesia	H CPI	4.5% ± 1 pp	Medium term	Yes
Israel	H CPI	1% – 3%	Within two years	No
Japan	CCPI	2%	Within two years	No
Kazakhstan, Republic of	CPI	5% – 7%	Medium term	Yes
Mexico	H CPI	3% ± 1 pp	Medium term	Yes
New Zealand	H CPI	1% – 3%	Medium term	Yes
Norway	H CPI	2.5%	Medium term	Yes
Peru	H CPI	2% ± 1 pp	At all times	Yes
Philippines	H CPI	4% ± 1 pp	Medium term (from 2012-2014)	Yes (Not on the IMF list)
Poland	H CPI	2.5% ± 1 pp	Medium term	No
Romania	H CPI	3% ± 1 pp	Medium-term target from 2013	No
Russian Federation	CPI	4%	Medium term	Yes
Serbia	H CPI	4% ± 1.5 pp	Medium term	No
South Africa	H CPI	3% – 6%	On a continuous basis	Yes (Not on the IMF list)
South Korea	H CPI	3% ± 1 pp	Three years	No
Sweden	H CPI	2%	Normally two years	No
Thailand	H CPI (since 2012)	3% ± 1.5 pp	Eight quarters	No
Turkey	H CPI	5% ± 2 pp	Multiyear (Three years)	No
United Kingdom	H CPI	2%	At all times	No

Source: Hammond (2012) for countries that introduced inflation targeting before 2012. For those that introduced inflation targeting after 2012 – national central banks. Data on the status of a commodity exporter are from IMF (2015), footnote 20, and authors' calculations of commodity export shares based on WTO data.

APPENDIX 2

Table 2.1. Summary of estimated DSGE models of some[35] inflation-targeting commodity-exporting economies: Impulse responses of inflation, GDP, nominal and real interest rates to a commodity price **increase.**

	Paper	Commodity-exporting inflation-targeting country[36]	Data coverage[37]	Response of inflation	Response of GDP	Response of **nominal** interest rates	Response of **real** interest rates (as a deviation from the steady state[38])
1	Bergholt et al. (2017)[39]	Norway	1995 Q1-2015 Q4	'We get a substantial strengthening of the real exchange rate and an initial drop in inflation. The appreciation passes through to consumer prices. CPI inflation is affected both directly through imported inflation and indirectly through the effect on domestic prices.'	'Real wages, investment and consumption increase along with output after the international oil productivity shock.'	'Monetary authorities, trying to bring inflation back to target, respond by lowering policy rates.'	'These developments are associated with a downward shift in the real interest rate path, further supporting aggregate demand.'
2	Gerdrup, K. R. et al. (2017)[40]	Norway	From 1994 Q1	Negative oil supply shock: 'Inflation is first reduced due to a stronger NOK exchange rate, but increases after around a year due to higher domestic demand.' Positive oil demand: 'The appreciation of	Negative oil supply shock: Overall, 'a positive oil price shock has an expansionary effect on activity in Norway. Real wages and household consumption increase.'	Negative oil supply shock: 'The central bank increases the key policy rate somewhat.' Positive oil demand: 'The key policy rate is increased much more.'	Not present in the paper Our comment: According to Figure 6. Real interest rate seems to be increasing on impacts, but after approx. 5 quarters dives below the steady state.

[35] We were not able to find DSGE papers containing the commodity sector for the following inflation-targeting economies: Mexico, South Africa, Peru, Kazakhstan, and the Philippines.

[36] The list of inflation targeters is from http://www.centralbanknews.info/p/inflation-targets.html commodity exporters is taken from IMF (2015).

[37] In most cases, data samples coincide with the inflation-targeting samples by design.

[38] Kormilitsina (2011) shows that the natural interest rate increases in commodity-importing countries when the oil price increases. The higher rate should stimulate the substitution of capital with cheaper, due to higher inflation, labour. Plane (2014) supports the evidence.

[39] The authors consider two oil shocks: 'shocks to oil extraction productivity and Norwegian oil investment efficiency.' We cite results for the drop in international oil productivity, which results in a smaller oil price increase. As the authors mention: 'We emphasize that the responses in the mainland economy are qualitatively similar following the two shocks despite the very different implications for the global economy.'

[40] The authors also distinguish oil demand shock and oil supply shock; both tend to increase oil prices.

				the NOK exchange rate contributes to lower inflation in the first couple of quarters, but inflation eventually becomes higher as the effect of lower imported inflation is phased out and higher domestic inflation becomes dominant.'	Positive oil demand: Our comment: Economic activity is more volatile.		
3	Soto, Medina (2007b)[41]	Chile	Model is calibrated	'There would be a slight decrease in inflation. This last effect occurs due to a real appreciation of the exchange that compensates a slight increase in domestic goods inflation.'	'Output and employment increase, as well as real wages and marginal costs.'	Our comment: The nominal interest rate declines slightly.	Our comment: With fiscal rule, the real rate first increases a little but after two quarters decreases below the steady state.
4	Fornero et al. (2014, 2016)[42]	Chile	2001 Q3-2012 Q4	Our comment: The results show that in both cases the shock generates lower inflation in the short run and higher inflation after some periods.	Our comment: The results show that in both cases the shock generates an expansion of real GDP and investment in all sectors.	Our comment: The nominal rate decreases on impact and after 10 quarters overshoots the steady state.	No information
5	Dorich et al. (2013)	Canada	1980 Q1-2012 Q2	'In ToTEM II the response of inflation is nearly zero.' Our comment: but negative.	'Regardless of the source of the commodity-price shock, the effects are, on net, positive.'	No information	No information
6	Rees et al. (2015)	Australia	1992 Q1-2013 Q4	'A temporary increase in resource prices has almost no effect on CPI inflation, although the error bands around this response are	'Higher resource prices raise domestic income, causing a sustained expansion in domestic demand.'	Our comment: Increases with a peak after four quarters.	No information

[41] We considered the case 'Ricardian and non-Ricardian households' as less extreme and fiscal rule C – actually implemented in Chile.

[42] The authors consider extended version of Medina and Soto (2007a) and two copper price shocks (transitory and persistent). We cite results for a persistent shock.

				wide.' [43] The aggregate responses conceal sizeable changes in relative prices, however.			
7	Jääskelä, J.P., Nimark, K. (2011)	Australia	1993 Q2-2007 Q3	'We also find that the initial impact on inflation of an increase in demand for Australian commodities is negative, because of an improvement in the real exchange rate, although there is a persistent positive effect on inflation that dominates at longer horizons,' 'After about seven quarters although, the response of inflation is positive and quite persistently so.'	'An increase in commodity demand generates an output expansion, an increase in employment.'	Our comment: Cash rate declines on impact and stays below the steady state for 10 quarters.	No information
8	De Castro, M. et al (2011)[44]	Brazil	1999 Q3-2010 Q2	Our comment: CPI inflation decreases amid a decline of imported goods inflation.	Our comment: GDP increases.	Our comment: The nominal interest rate increases and remains above the steady state for eight quarters.	No information
9	Hamann et al. (2016)[45]	Colombia	1921-2013	The authors consider a negative oil price shock: 'the nominal depreciation drives total inflation off the target. The pass-through of this change to inflation is significant. It raises temporally but persistently annual inflation	The authors consider a negative oil price shock: 'the permanent fall of oil revenues causes a permanent fall in consumption and GDP.'	The authors consider a negative oil price shock: 'the model delivers a nominal exchange rate depreciation, which passes to total inflation. The pass-through of this change to inflation may be significant. It raises temporally but	The authors consider a negative oil price shock: 'the permanent fall of oil revenues …drives total inflation off the target, calling the bank for a tighter policy stance.'

[43] Also in the paper: "Downes, Hanslow and Tulip (2014) find that an increase in resource prices may have a small (possibly negative, at least in the short run) effect on Australian CPI inflation".

[44] Authors do not consider a ToT shock; the results in the table are for an export demand shock.

[45] The authors consider permanent and transitory oil price decline. We cite the results for permanent shocks.

				well above target.'		persistently annual inflation well above target, calling the model's strict-inflation-targeting central bank to tighten monetary policy to keep inflation in control.'	
10	Oktyianto, F. et al. (2014)[46]	Indonesia	2001 Q1-2012 Q4	Our comment: CPI inflation declines and returns to the steady state after 10 quarters.	Our comment: GDP increases.	No information	No information
11	Kreptsev D., Seleznev S. (2017)[47]	Russia	2006 Q1-2016 Q3	Our comment based on table 5a: Sequential CPI declines for four quarters.	Our comment: GDP increases.	Our comment: The nominal interest rate declines and slowly returns to the steady state.	Our comment:[48] The real rate increases on impact, but after the third quarter declines below the steady state.
12	Andreyev M.Yu., Polbin A.V. (2017) (in Russian)	Russia	Model is calibrated	Our comment: Inflation declines due to cheaper imported goods.	Our comment: GDP increases.	Our comment: The nominal interest rate declines.	No information

Source: corresponding papers mentioned in column 1.

[46] The authors do not consider a ToT shock; the results in the table are for a positive world GDP shock.

[47] The authors build a DSGE model of a commodity-exporting economy with banking sector as in Gerali et al. (2010). The oil price shock dies out after 20 quarters.

[48] The response of the real interest rate is absent in the paper but authors calculated it upon our request.

APPENDIX 3

Table 3.1. List of data by countries with the source.

№	Country	Variable in model	Source and variable name
1	Armenia	Nominal interest rate	CEIC, Table AM.IMF.IFS: Money market and Policy Rates: Central bank policy rate: End of Period
		Nominal GDP	CEIC, Table AM.IMF.IFS: Gross Domestic Product: by Expenditure: Quarterly, Gross Domestic Product
		CPI	CEIC, Table AM.IMF.IFS: Consumer and Producer Price Index, Consumer Price Index (2010 = 100)
		Nominal credit	CEIC, SR code 4465189: Money Supply: M2X: M2
			CEIC, SR code 3570285: Commercial Banks Credit: Residents: Households: in AMD
			CEIC, SR code 3570256: Commercial Banks Credit: Residents: Non-Financial Corporations: in AMD: Private
2	Australia	Nominal interest rate	BIS, Central bank policy rate (average for 3 month)
		Nominal GDP	CEIC, Table AU.IMF.IFS: Gross Domestic Product: by Expenditure: Quarterly, Gross Domestic Product
		CPI	BIS, Consumer Price Statistics, Index (2010 = 100), end of the period
		Nominal credit	CEIC, SR code 3062019: Money Supply: Broad Money
			CEIC, SR code 3062794: Money Supply: M3
			CEIC, SR code 3062353: Bank Lending: Credit Incl. Securitisations
			CEIC, SR code 3062850: Bank Lending: Credit Incl. Securitisations: ow: Other Personal
			CEIC, SR code 3062309: Bank Lending: Loans & Advances: AFIs
3	Brazil	Nominal interest rate	BIS, Central bank policy rate (average for 3 month)
		Nominal GDP	CEIC, Table BR.IMF.IFS: Gross Domestic Product: by Expenditure: Quarterly, Gross Domestic Product
		CPI	BIS, Consumer Price Statistics, Index (2010 = 100), end of the period
		Nominal credit	CEIC, SR code 116523877: Broad Money Supply: M2
			CEIC, SR code 6640530: (DC)Loans: Outstanding: FS: By Activity: Private Sector: Households
			CEIC, SR code 90228997: Financial System Credit: Balance: Total
			CEIC, SR code 90228937: Financial System Credit: Balance: Private Sector: Households
4	Canada	Nominal interest rate	BIS, Central bank policy rate (average for 3 month)
		Nominal GDP	CEIC, Table CA.IMF.IFS: Gross Domestic Product: by Expenditure: Quarterly, Gross Domestic Product
		CPI	BIS, Consumer Price Statistics, Index (2010 = 100), end of the period
		Nominal credit	CEIC, SR code 3549925: Money Supply: M3: M2: Gross
			CEIC, SR code 3549956: Household Credit
5	Chile	Nominal interest rate	BIS, Central bank policy rate (average for 3 month)
		Nominal GDP	CEIC, Table CL.IMF.IFS: Gross Domestic Product: by Expenditure: Quarterly, Gross Domestic Product
		CPI	BIS, Consumer Price Statistics, Index (2010 = 100), end of the period
		Nominal credit	CEIC, SR code 1921372: MA: Average: Private: M2
			CEIC, SR code 89941557: Banking System: Loans: Consumer Credit
			CEIC, SR code 89941317: Banking System: Loans
			CEIC, SR code 90480807: BS: Assets: LR: Individuals: Consumer Loans
6	Colombia	Nominal interest rate	BIS, Central bank policy rate (average for 3 month)

		Nominal GDP	CEIC, Table CO.IMF.IFS: Gross Domestic Product: by Expenditure: Seasonally Adjusted: Quarterly, Gross Domestic Product (GDP): Seasonally Adjusted
		CPI	CEIC, Table CO.IMF.IFS: Consumer and Producer Price index: Quarterly, Consumer Price Index
		Nominal credit	BIS, Credit to the non-financial sector, Credit to Private Sector from All sectors at Market value: Domestic currency: Adjusted for breaks
			CEIC, SR code 4538022: Credit institutions: Credit Balance Including Leasing: Gross
			CEIC, SR code 4538017: Credit institutions: Credit Balance Including Leasing: Consumer: Gross
			CEIC, SR code 5038515: Money Supply: M2
7	Czech Republic	Nominal interest rate	BIS, Central bank policy rate (average for 3 month)
		Nominal GDP	CEIC, Table CZ.IMF.IFS: Gross Domestic Product: by Expenditure: Quarterly, Gross Domestic Product
		CPI	BIS, Consumer Price Statistics, Index (2010 = 100), end of the period
		Nominal credit	CEIC, SR code 1119338: Money Supply: Stock: M3: M2
			CEIC, SR code 1408508: Commercial Banks Deposits: CZK: RE: Household
			CEIC, SR code 5562646: Commercial Banks Loans: CZK and FC: Classified: RN: Residents: Households
8	Georgia	Nominal interest rate	CEIC, Central bank policy rate: End of Period
		Nominal GDP	CEIC, Table GE.IMF.IFS: Gross Domestic Product: by Expenditure: Quarterly, Gross Domestic Product
		CPI	CEIC, Table GE.IMF.IFS: Consumer and Producer Price index: Quarterly, Consumer Price Index
		Nominal credit	CEIC, SR code 3578069: Money Supply: M2
			CEIC, SR code 4495420: Term Loans: Households: ow Consumer Loans
			CEIC, SR code 4495418: Term Loans: Households
9	Guatemala	Nominal interest rate	CEIC, Central bank policy rate: End of Period
		Nominal GDP	CEIC, Table GT.IMF.IFS: Gross Domestic Product: by Expenditure: Quarterly, Gross Domestic Product
		CPI	CEIC, Table GT.IMF.IFS: Consumer and Producer Price index: Quarterly, Consumer Price Index
		Nominal credit	CEIC, SR code 2877126: GT: Money Supply: M2
			CEIC, SR code 110466217: GT: Deposit Takers: Assets: Financial: Loans: Gross: Non Interbank: Other Domestic Sectors
10	Indonesia	Nominal interest rate	BIS, Central bank policy rate (average for 3 month)
		Nominal GDP	CEIC, Table ID.IMF.IFS: Gross Domestic Product: by Expenditure: Quarterly, Gross Domestic Product
		CPI	BIS, Consumer Price Statistics, Index (2010 = 100), end of the period
		Nominal credit	CEIC, SR code 3180660: ID: Money Supply: M2
			CEIC, SR code 4187944: Comm Banks: Credit: Consumption
11	Israel	Nominal interest rate	BIS, Central bank policy rate (average for 3 month)
		Nominal GDP	CEIC, Table IL.IMF.IFS: Gross Domestic Product: by Expenditure: Quarterly, Gross Domestic Product
		CPI	BIS, Consumer Price Statistics, Index (2010 = 100), end of the period
		Nominal credit	CEIC, SR code 4531683: Credits: Outstanding: by Borrowers, Credits: Outstanding: Borrowers: Households and Others
			CEIC, SR code 4531750: Credits: Outstanding: by Borrowers, Credits: Outstanding: Borrowers: Households
			CEIC, SR code 3530629: Money Supply: M2: Avg
12	Mexico	Nominal interest rate	BIS, Central bank policy rate (average for 3 month)

		Nominal GDP	CEIC, Table MX.IMF.IFS: Gross Domestic Product: by Expenditure: Quarterly, Gross Domestic Product
		CPI	BIS, Consumer Price Statistics, Index (2010 = 100), end of the period
		Nominal credit	CEIC, SR code SR113211957: Money Supply M2
			CEIC, SR code SR113217727: Commercial Banks: Financing: Private Sector
			CEIC, SR code SR113217747: Commercial Banks: Financing: Private: Direct: Consumer Credit
			CEIC, SR code SR113219997: Commercial Banks: Credits: Consumption
			CEIC, SR code SR113219967: Commercial Banks: Credits: Mortgage
			CEIC, SR code SR113219847: Commercial Banks: Credits
13	New Zealand	Nominal interest rate	BIS, Central bank policy rate (average for 3 month)
		Nominal GDP	CEIC, Table NZ.IMF.IFS: Gross Domestic Product: by Expenditure: Quarterly, Gross Domestic Product
		CPI	BIS, Consumer Price Statistics, Index (2010 = 100), end of the period
		Nominal credit	CEIC, SR code SR105553577: Depository Corp: Money Supply: Broad Money
			CEIC, SR code SR105553297: Housing and Personal Consumer Loans
14	Norway	Nominal interest rate	BIS, Central bank policy rate (average for 3 month)
		Nominal GDP	CEIC, Table NO.IMF.IFS: Gross Domestic Product: by Expenditure: Quarterly, Gross Domestic Product
		CPI	BIS, Consumer Price Statistics, Index (2010 = 100), end of the period
		Nominal credit	CEIC, SR code SR5176706: Domestic Debt C2: Household: in Foreign Exchange
			CEIC, SR code SR1292048: Domestic Debt C2
			CEIC, SR code SR1290586: Domestic Debt C2: in NOK
			CEIC, SR code SR5176704: Domestic Debt C2: Household
			CEIC, SR code SR5176705: Domestic Debt C2: Household: in NOK
			CEIC, SR code SR1289973: Monetary Aggregates: M3: M2
15	Peru	Nominal interest rate	BIS, Central bank policy rate (average for 3 month)
		Nominal GDP	CEIC, Table PE.IMF.IFS: Gross Domestic Product: by Expenditure: Quarterly, Gross Domestic Product
		CPI	BIS, Consumer Price Statistics, Index (2010 = 100), end of the period
		Nominal credit	CEIC, SR code SR5217606: Household Debt
			CEIC, SR code SR1508413: Financial System: Credit: Private
			CEIC, SR code SR1508187: Financial System: Credit: Private: Domestic Currency
			CEIC, SR code SR2180783: Banking System: Credit: Private
			CEIC, SR code SR1508637: Financial System: Broad Money: Domestic Currency
16	Philippines	Nominal interest rate	BIS, Central bank policy rate (average for 3 month)
		Nominal GDP	CEIC, Table PH.IMF.IFS: Gross Domestic Product: by Expenditure: Quarterly, Gross Domestic Product
		CPI	BIS, Consumer Price Statistics, Index (2010 = 100), end of the period
		Nominal credit	CEIC, SR code SR6875977: DCS: LA: M4: M3: M2
			CEIC, SR code SR4712336: Consumer Loans (CL): Philippine Banking System (PBS)
17	Poland	Nominal interest rate	BIS, Central bank policy rate (average for 3 month)

		Nominal GDP	CEIC, Table PL.IMF.IFS: Gross Domestic Product: by Expenditure: Quarterly, Gross Domestic Product
		CPI	BIS, Consumer Price Statistics, Index (2010 = 100), end of the period
		Nominal credit	CEIC, SR code SR1117470: Money Supply: M3: M2
			CEIC, SR code SR5157401: Banking Sector Claims: NF: Households: PLN
18	Romania	Nominal interest rate	BIS, Central bank policy rate (average for 3 month)
		Nominal GDP	CEIC, Table RO.IMF.IFS: Gross Domestic Product: by Expenditure: Quarterly, Gross Domestic Product
		CPI	BIS, Consumer Price Statistics, Index (2010 = 100), end of the period
		Nominal credit	CEIC, SR code SR1760726: Broad Money: M2
			CEIC, SR code SR3210441: Loans: Residents: Household: RON
19	Serbia	Nominal interest rate	BIS, Central bank policy rate (average for 3 month)
		Nominal GDP	CEIC, Table RS.IMF.IFS: Gross Domestic Product: by Expenditure: Quarterly, Gross Domestic Product
		CPI	BIS, Consumer Price Statistics, Index (2010 = 100), end of the period
		Nominal credit	CEIC, SR code SR1645799: Money Supply M2
			CEIC, SR code SR3518858: Banking System: Cons: Assets: DC: Non Govt Sectors: Households
			CEIC, SR code SR3518831: Banking System: Cons: Assets: DC: Non Govt Sectors
20	South Africa	Nominal interest rate	BIS, Central bank policy rate (average for 3 month)
		Nominal GDP	CEIC, Table ZA.IMF.IFS: Gross Domestic Product: by Expenditure: Quarterly, Gross Domestic Product
		CPI	BIS, Consumer Price Statistics, Index (2010 = 100), end of the period
		Nominal credit	CEIC, SR code SR1355572: Domestic Credit
			CEIC, SR code SR1359123: Domestic Credit: Private Sector
			CEIC, SR code SR3207284: Domestic Credit: Private Sector: Loans and Advances
			CEIC, SR code SR3207241: Domestic Credit: Private Sector: Loans and Advances: ow to Households
			CEIC, SR code SR1356689: Money Supply M3: M2
21	Sweden	Nominal interest rate	BIS, Central bank policy rate (average for 3 month)
		Nominal GDP	CEIC, Table SE.IMF.IFS: Gross Domestic Product: by Expenditure: Quarterly, Gross Domestic Product
		CPI	BIS, Consumer Price Statistics, Index (2010 = 100), end of the period
		Nominal credit	CEIC, SR code SR86068547: Bank Loans: Non MFIs: Domestic: Households
			CEIC, SR code SR86068507: Bank Loans: Non MFIs: Domestic
			CEIC, SR code SR86068527: Bank Loans: Non MFIs: Domestic: Non-Financial Corp
			CEIC, SR code SR86068147: MFI Loans: Non MFIs: Domestic: Households
			CEIC, SR code SR86067787: Money Supply: M3: M2
22	Turkey	Nominal interest rate	BIS, Central bank policy rate (average for 3 month)
		Nominal GDP	CEIC, Table TR.IMF.IFS: Gross Domestic Product: by Expenditure: Quarterly, Gross Domestic Product
		CPI	BIS, Consumer Price Statistics, Index (2010 = 100), end of the period
		Nominal credit	CEIC, SR code SR717568: Money Supply: M2
			CEIC, SR code SR2087627: Loan Distribution: BS: Consumer Loan
			CEIC, SR code SR1374825: Consumer Loan: in TRY

23	United Kingdom	Nominal interest rate	BIS, Central bank policy rate (average for 3 month)
		Nominal GDP	CEIC, Table UK.IMF.IFS: Gross Domestic Product: by Expenditure: Quarterly, Gross Domestic Product
		CPI	BIS, Consumer Price Statistics, Index (2010 = 100), end of the period
		Nominal credit	CEIC, SR code SR6919331: MFIs: Assets: Loans: Private: Households: Foreign Currency
			CEIC, SR code SR529461: MFIs: Assets: Loans: Private: Foreign Currency
			CEIC, SR code SR529465: MFIs: Assets: Loans: Private: Households: GBP
			CEIC, SR code SR529460: MFIs: Assets: Loans: Private: GBP
			CEIC, SR code SR4351331: UK: Banking Institutions: Claims on Private Sector
			CEIC, SR code SR352894: Money Supply M2

Table 3.2. Commodity prices and global GDP

№	Country	Indicator	Source of Data, Indicator
1	South Africa	Gold price	CEIC: Table World Bank.Pink Sheet: Commodity Price: Precious Metals, Commodity Price: Precious Metals: Gold
2	Chile	Copper price	CEIC: Table World Bank.Pink Sheet: Commodity Price: Metals and Minerals, Commodity Price: Nominal: Metals and Minerals: Copper
3	Australia, Peru	Metals price index	CEIC: Table World Bank.Pink Sheet: Commodity Price Index, Commodity Price Index: Non-Energy: Metals and Minerals: Base metals (Ex. Iron Ore)
4	New Zealand	Agriculture price index	CEIC: Table World Bank.Pink Sheet: Commodity Price Index, Commodity Price Index: Non-Energy: Agriculture
5	Colombia, Norway, Canada, Brazil, Mexico, Philippines, Indonesia, Russian Federation, Republic of Kazakhstan	Oil price	U.S. Energy Information Administration, Crude Oil Prices: West Texas Intermediate (WTI) – Cushing, Oklahoma [DCOILWTICO], retrieves from FRED, Federal Reserve Bank of St. Louis
6	Other inflation-targeting countries	Commodity Price Index	IMF Commodity Price Index (2010 = 100)
7	All countries	Global GDP growth rate	CEIC, Table WD.IMF.IFS: Gross Domestic Product: Deflator and Volume Index: Quarterly, WD: GDP: Volume Index: YoY

Appendix 4

Table 4.1. Comparison analysis different types of credits reaction on commodity price shock.

Commodity Exporters						
Country	Method	Credits				
Australia		**Money Supply: Broad Money**	**Money Supply: M3**	**Bank Lending: Credit Incl. Securitisations**	**Bank Lending: Credit Incl. Securitisations: ow: Other Personal**	**Bank Lending: Loans & Advances: AFIs**
	VAR	Interest rate: Increase Q1-Q8 Credit: Decrease Q1	Interest rate: Increase Q1-Q5 Credit: Insignificant	Interest rate: Increase Q1-Q5 Credit: Insignificant	Interest rate: Increase Q1-Q5 Credit: Insignificant	Interest rate: Increase Q1-Q5 Credit: Insignificant
	LPM	Interest rate: Increase Q1-Q8 Credit: Decrease Q1-Q2	Interest rate: Increase Q1-Q5 Credit: Decrease Q1	Interest rate: Increase Q1-Q5 Credit: Insignificant	Interest rate: Increase Q1-Q5 Credit: Insignificant	Interest rate: Increase Q1-Q5 Credit: Insignificant
Brazil		**Broad Money Supply: M2**	**(DC)Loans: Outstanding: FS: By Activity: Private Sector: Households**	**Financial System Credit: Balance: Total**		**Financial System Credit: Balance: Private Sector: Households**
	VAR	Interest rate: Insignificant Credit: Increase Q5-Q8	Interest rate: Insignificant Credit: Insignificant	Interest rate: Insignificant Credit: Insignificant		Interest rate: Insignificant Credit: Insignificant
	LPM	Interest rate: Insignificant Credit: Increase Q2-Q8	Interest rate: Decrease Q1-Q2 Credit: Increase Q1-Q6	Interest rate: Insignificant Credit: Insignificant		Interest rate: Decrease Q1 Credit: Insignificant
Canada		**Money Supply: M3: M2: Gross**		**Household Credit**		
	VAR	Interest rate: Increase Q4-Q8 Credit: Decrease Q2-Q7		Interest rate: Increase Q5-Q8 Credit: Insignificant		
	LPM	Interest rate: Insignificant Credit: Insignificant		Interest rate: Insignificant Credit: Insignificant		
Chile		**MA: Average: Private: M2**	**Banking System: Loans: Consumer Credit**	**Banking System: Loans**		**BS: Assets: LR: Individuals: Consumer Loans**
	VAR	Interest rate: Increase Q3-Q8 Credit: Insignificant	Interest rate: Insignificant Credit: Insignificant	Interest rate: Insignificant Credit: Insignificant		Interest rate: Insignificant Credit: Insignificant
	LPM	Interest rate: Insignificant Credit: Insignificant	Interest rate: Decrease Q1-Q8 Credit: Increase Q1-Q6	Interest rate: Insignificant Credit: Insignificant		Interest rate: Insignificant Credit: Increase Q5-Q8
Colombia		**Credits Institutions: Credit Balance Including Leasing: Gross**	**Credit Institutions: Credit Balance Including Leasing: Consumer: Gross**	**Money Supply: M2**		**Credit to Private Sector from All sectors at Market value: Domestic currency: Adjusted for breaks**
	VAR	Interest rate: Insignificant Credit: Insignificant	Interest rate: Insignificant Credit: Insignificant	Interest rate: Insignificant Credit: Insignificant		Interest rate: Insignificant Credit: Increase Q1
	LPM	Interest rate: Insignificant Credit: Insignificant	Interest rate: Decrease Q1 Credit: Increase Q2-Q4	Interest rate: Insignificant Credit: Insignificant		Interest rate: Decrease Q1 Credit: Increase Q1-Q2
Indonesia		**ID: Money Supply: M2**		**Comm Banks: Credit: Consumption**		
	VAR	Interest rate: Decrease Q1 Credit: Insignificant		Interest rate: Decrease Q1 Credit: Insignificant		
	LPM	Interest rate: Decrease Q1-Q4		Interest rate: Decrease Q1-Q4		

		Credit: Insignificant			Credit: Increase Q1-Q5		
Mexico		**Money Supply M2**	**Commercial Banks: Financing: Private Sector**	**Commercial Banks: Financing: Private: Direct: Consumer Credit**	**Commercial Banks: Credits: Consumption**	**Commercial Banks: Credits: Mortgage**	**Commercial Banks: Credits**
	VAR	Interest rate: Insignificant Credit: Increase Q6-Q8	Interest rate: Insignificant Credit: Insignificant	Interest rate: Insignificant Credit: Insignificant	Interest rate: Insignificant Credit: Insignificant	Interest rate: Insignificant Credit: Insignificant	Interest rate: Insignificant Credit: Insignificant
	LPM	Interest rate: Insignificant Credit: Insignificant	Interest rate: Insignificant Credit: Insignificant	Interest rate: Insignificant Credit: Increase Q1	Interest rate: Insignificant Credit: Insignificant	Interest rate: Insignificant Credit: Insignificant	Interest rate: Insignificant Credit: Insignificant
New Zealand		**Depository Corp: Money Supply: Broad Money**			**Housing and Personal Consumer Loans**		
	VAR	Interest rate: Insignificant Credit: Insignificant			Interest rate: Increase Q4-Q6 Credit: Insignificant		
	LPM	Interest rate: Increase Q1-Q3 Credit: Insignificant			Interest rate: Increase Q1-Q3 Credit: Insignificant		
Norway		**Domestic Debt C2**	**Domestic Debt C2: in NOK**	**Domestic Debt C2: Household**	**Domestic Debt C2: Household: in NOK**	**Monetary Aggregates: M3: M2**	**Domestic Debt C2: Household: in Foreign Exchange**
	VAR	Interest rate: Insignificant Credit: Insignificant	Interest rate: Insignificant Credit: Insignificant	Interest rate: Insignificant Credit: Insignificant	Interest rate: Insignificant Credit: Insignificant	Interest rate: Increase Q6-Q8 Credit: Insignificant	Interest rate: Increase Q3-Q8 Credit: Decrease Q1-Q5
	LPM	Interest rate: Insignificant Credit: Insignificant	Interest rate: Insignificant Credit: Increase Q1	Interest rate: Insignificant Credit: Insignificant	Interest rate: Insignificant Credit: Insignificant	Interest rate: Insignificant Credit: Insignificant	Interest rate: Increase Q1-Q8 Credit: Decrease Q1-Q3
Peru		**Banking System: Credit: Private**	**Broad Money: Domestic Currency**	**Credit: Private: Domestic Currency**	**Household Debt**		**Net Domestic Credit : Private Sector**
	VAR	Interest rate: Insignificant Credit: Insignificant	Interest rate: Decrease Q1 Credit: Increase Q1	Interest rate: Insignificant Credit: Insignificant	Interest rate: Insignificant Credit: Insignificant		Interest rate: Decrease Q1 Credit: Insignificant
	LPM	Interest rate: Decrease Q1 Credit: Decrease Q1	Interest rate: Decrease Q1 Credit: Increase Q1	Interest rate: Decrease Q1 Credit: Decrease Q1	Interest rate: Decrease Q1 Credit: Insignificant		Interest rate: Decrease Q1 Credit: Insignificant
Philippines		**DCS: LA: M4: M3: M2**			**Consumer Loans (CL): Philippine Banking System (PBS)**		
	VAR	Interest rate: Insignificant Credit: Insignificant			Interest rate: Insignificant Credit: Decrease Q2 - Q6		
	LPM	Interest rate: Decrease Q1 Credit: Decrease Q1-Q4			Interest rate: Insignificant Credit: Decrease Q1-Q8		
South Africa		**Domestic Credit**	**Domestic Credit: Private Sector**	**Domestic Credit: Private Sector: Loans and Advances: to Households**	**Domestic Credit: Private Sector: Loans and Advances**		**Money Supply: M3: M2**
	VAR	Interest rate: Insignificant Credit: Insignificant	Interest rate: Insignificant Credit: Insignificant	Interest rate: Insignificant Credit: Insignificant	Interest rate: Insignificant Credit: Insignificant		Interest rate: Insignificant Credit: Insignificant
	LPM	Interest rate: Insignificant Credit: Insignificant	Interest rate: Insignificant Credit: Insignificant	Interest rate: Insignificant Credit: Insignificant	Interest rate: Insignificant Credit: Insignificant		Interest rate: Insignificant Credit: Insignificant
Non-Commodity Exporters							

Armenia		**Money Supply: M2X: M2**	**Commercial Banks Credit: Residents: Households: in AMD**	**Commercial Banks Credit: Residents: Non-Financial Corporations: in AMD: Private**
	VAR	Interest rate: Insignificant Credit: Increase Q1-Q8	Interest rate: Insignificant Credit: Insignificant	Interest rate: Insignificant Credit: Insignificant
	LPM	Interest rate: Decrease Q1 Credit: Increase Q1-Q2	Interest rate: Insignificant Credit: Insignificant	Interest rate: Insignificant Credit: Insignificant
Czech Republic		**Money Supply: Stock: M3: M2**	**Commercial Banks Deposits: CZK: RE: Household**	**Commercial Banks Loans: CZK and FC: Classified: RN: Residents: Households**
	VAR	Interest rate: Increase Q4-Q8 Credit: Decrease Q1-Q5	Interest rate: Increase Q7-Q8 Credit: Decrease Q2-Q6	Interest rate: Increase Q3-Q8 Credit: Insignificant
	LPM	Interest rate: Increase Q1-Q8 Credit: Decrease Q1-Q2	Interest rate: Insignificant Credit: Decrease Q1	Interest rate: Increase Q1-Q5 Credit: Insignificant
Georgia		**Money Supply: M2**	**Term Loans: Households: ow Consumer Loans**	**Term Loans: Households**
	VAR	Interest rate: Insignificant Credit: Insignificant	Interest rate: Insignificant Credit: Insignificant	Interest rate: Insignificant Credit: Decrease Q1-Q2
	LPM	Interest rate: Insignificant Credit: Insignificant	Interest rate: Insignificant Credit: Insignificant	Interest rate: Insignificant Credit: Insignificant
Guatemala		**GT: Money Supply: M2**	**GT: Deposit Takers: Assets: Financial: Loans: Gross: Non Interbank: Other Domestic Sectors**	
	VAR	Interest rate: Increase Q1-Q8 Credit: Decrease Q2-Q3	Interest rate: Insignificant Credit: Insignificant	
	LPM	Interest rate: Increase Q1-Q8 Credit: Decrease Q1-Q2	Interest rate: Increase Q5-Q8 Credit: Insignificant	
Israel		**Money Supply: M2: Avg**	**Credits: Outstanding: Borrowers: Households and Others**	**Credits: Outstanding: Borrowers: Households (HO)**
	VAR	Interest rate: Insignificant Credit: Decrease Q1 – Q2	Interest rate: Increase Q1 – Q8 Credit: Insignificant	Interest rate: Increase Q2 – Q8 Credit: Insignificant
	LPM	Interest rate: Increase Q1 – Q5 Credit: Decrease Q1 – Q4	Interest rate: Increase Q1 – Q3 Credit: Insignificant	Interest rate: Increase Q1 – Q5 Credit: Decrease Q1
Poland		**Money Supply: M3: M2**	**Banking Sector Claims: NF: Households: PLN**	
	VAR	Interest rate: Increase Q4-Q8 Credit: Decrease Q1	Interest rate: Insignificant Credit: Insignificant	
	LPM	Interest rate: Increase Q1-Q3 Credit: Decrease Q1	Interest rate: Increase Q1-Q8 Credit: Decrease Q1-Q3	
Romania		**Broad Money: M2**	**Loans: Residents: Household: RON**	
	VAR	Interest rate: Insignificant Credit: Insignificant	Interest rate: Insignificant Credit: Insignificant	
	LPM	Interest rate: Insignificant Credit: Insignificant	Interest rate: Insignificant Credit: Insignificant	
Serbia		**Money Supply M2**	**Banking System: Cons: Assets: DC: Non Govt Sectors: Households**	**Banking System: Cons: Assets: DC: Non Govt Sectors**
	VAR	Interest rate: Insignificant Credit: Insignificant	Interest rate: Insignificant Credit: Insignificant	Interest rate: Insignificant Credit: Insignificant
	LPM	Interest rate: Insignificant Credit: Insignificant	Interest rate: Increase Q1-Q2 Credit: Decrease Q1	Interest rate: Increase Q1 Credit: Insignificant

Sweden		**Money Supply: M3: M2**	**Banks Loans: Non MFIs: Domestic: Households**	**Banks Loans: Non MFIs: Domestic**	**Banks Loans: Non MFIs: Domestic: Non-Financial Corp**	**MFIs Loans: Non MFIs: Domestic: Households**
	VAR	Interest rate: Increase Q1-Q8 Credit: Insignificant	Interest rate: Increase Q1-Q8 Credit: Insignificant	Interest rate: Increase Q1-Q8 Credit: Insignificant	Interest rate: Increase Q1- Q8 Credit: Insignificant	Interest rate: Increase Q2-Q8 Credit: Insignificant
	LPM	Interest rate: Increase Q1-Q3 Credit: Insignificant	Interest rate: Increase Q1-Q3 Credit: Insignificant	Interest rate: Increase Q1-Q3 Credit: Insignificant	Interest rate: Increase Q1- Q3 Credit: Insignificant	Interest rate: Increase Q1-Q3 Credit: Insignificant

Turkey		**Money Supply: M2**		**Loan Distribution: BS: Consumer Loan**		**Consumer Loan: in TRY**	
		Interest rate: Insignificant Credit: Insignificant		Interest rate: Insignificant Credit: Increase Q1-Q8		Interest rate: Insignificant Credit: Increase Q1-Q2	
		Interest rate: Insignificant Credit: Insignificant		Interest rate: Insignificant Credit: Increase Q1-Q3		Interest rate: Insignificant Credit: Increase Q1	
United Kingdom		**Money Supply M2**	**UK: Banking Institutions: Claims on Private Sector**	**MFIs: Assets: Loans: Private: GBP**	**MFIs: Assets: Loans: Private: Households: GBP**	**MFIs: Assets: Loans: Private: Foreign Currency**	**MFIs: Assets: Loans: Private: Households : Foreign Currency**
	VAR	Interest rate: Increase Q2-Q8 Credit: Insignificant	Interest rate: Insignificant Credit: Insignificant	Interest rate: Increase Q1 - Q4 Credit: Decrease Q1	Interest rate: Insignificant Credit: Insignificant	Interest rate: Insignificant Credit: Insignificant	Interest rate: Insignificant Credit: Insignificant
	LPM	Interest rate: Increase Q1-Q4 Credit: Decrease Q1	Interest rate: Insignificant Credit: Insignificant	Interest rate: Increase Q1 - Q3 Credit: Decrease Q1 - Q2	Interest rate: Insignificant Credit: Insignificant	Interest rate: Insignificant Credit: Insignificant	Interest rate: Insignificant Credit: Insignificant
Note: VAR results are significant on a 95% CI, constructed from bootstrap distribution. LPM results are significant on a 95% CI, constructed from New-West estimator.							

Appendix 5

Selected impulse responses of real interest rates (left) and real credit (right) to a positive oil price shock.

VAR results are significant on a 95% CI, constructed from bootstrap distribution. LPM results are significant on a 95% CI, constructed from New-West estimator.

Credits: Australia – Money Supply: Broad Money; Brazil – Financial System Credit: Balance: Private Sector: Households; Canada – Money Supply: M3: M2: Gross; Chile – BS: Assets: LR: Individuals: Consumer Loans; Colombia – Credit Institutions: Credit Balance Including Leasing: Consumer: Gross; Indonesia – Comm Banks: Credit: Consumption; Mexico – Commercial Banks: Credits: Consumption; New Zealand – Housing and Personal Consumer Loans; Norway – Domestic Debt C2: Household: in Foreign Exchange; Peru – Broad Money: Domestic Currency; Philippines – Consumer Loans (CL): Philippine Banking System (PBS); South Africa – Domestic Credit: Private Sector; Armenia – Money Supply: M2X: M2; Czech Republic – Commercial Banks Deposits: CZK: RE: Household; Georgia – Money Supply: M2; Guatemala – GT: Money Supply: M2; Israel – Money Supply: M2: Avg; Poland – Banking Sector Claims: NF: Households: PLN; Romania – Broad Money: M2; Serbia – Banking System: Cons: Assets: DC: Non Govt Sectors; Sweden – MFIs Loans: Non MFIs: Domestic: Households; Turkey – Loan Distribution: BS: Consumer Loan; United Kingdom – MFIs: Assets: Loans: Private: GBP.

Table 5.1. Results of testing for significance of impulse responses in panel LPMs and VARs to a positive commodity price shock. Specification with 10-year and 3-month government bonds yield.

		Exporters	Non-Exporters
Emerging Countries	VAR	Interest rate: Decrease Q1 – Q3 Credit: Insignificant (Increase)	Interest rate: Insignificant Credit: Insignificant
	LPM	Interest rate: Decrease Q1 – Q3 Credit: Increase Q1	Interest rate: Insignificant Credit: Insignificant
Developed Countries	VAR	Interest rate: Insignificant Credit: Insignificant	Interest rate: Increase Q1 – Q8 Credit: Decrease Q1 – Q6
	LPM	Interest rate: Insignificant Credit: Insignificant	Interest rate: Increase Q1 – Q8 Credit: Decrease Q1 – Q3

Figure 5.1. Impulse response functions for a nominal policy rate in LPM. The diagram shows commodity exporters from EMEs and non-commodity exporters from DEs. Specification with 10-year and 3-month government bonds.

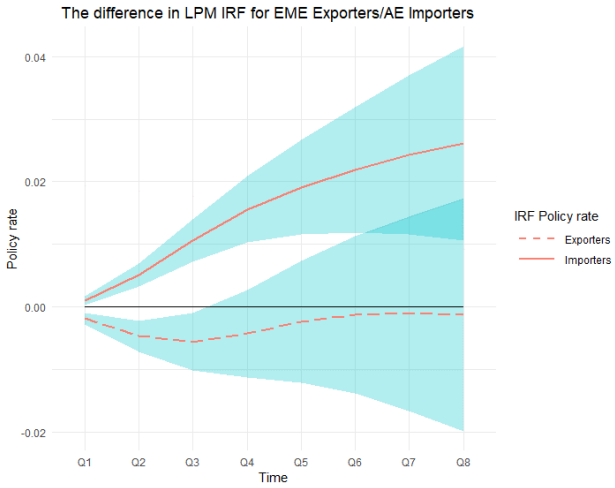


Figure 5.2 Impulse response functions for real credit in LPM. The diagram shows commodity exporters from EMEs and non-commodity exporters from DEs. Specification with 10-year and 3-month government bonds.

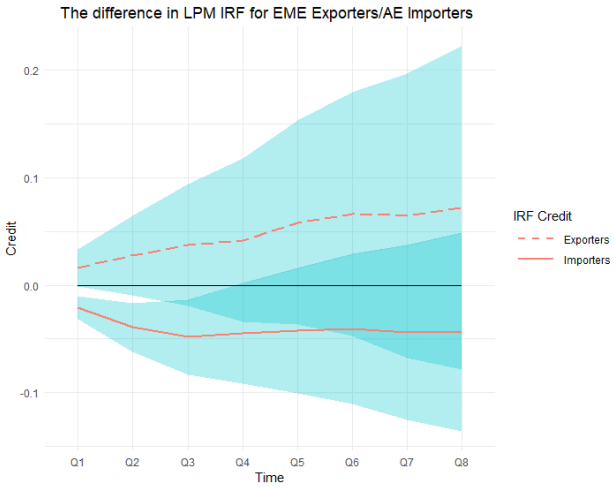


Figure 5.3 Impulse response functions for a nominal policy rate in VAR. The diagram shows commodity exporters from EMEs and non-commodity exporters from DEs. Specification with 10-year and 3-month government bonds.

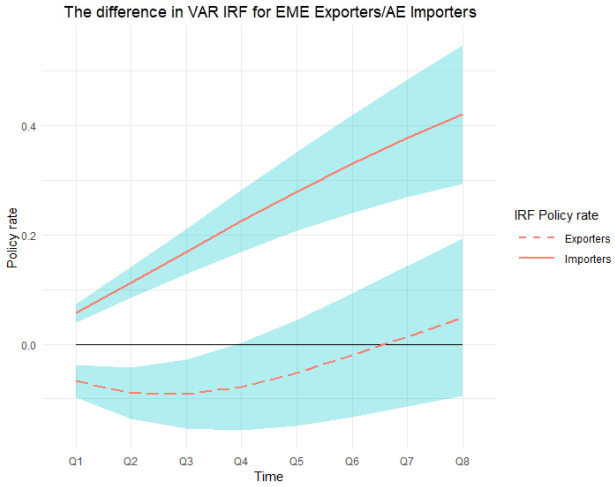


Figure 5.4 Impulse response functions for real credit in VAR. The diagram shows commodity exporters from EMEs and non-commodity exporters from DEs. Specification with 10-year and 3-month government bonds.

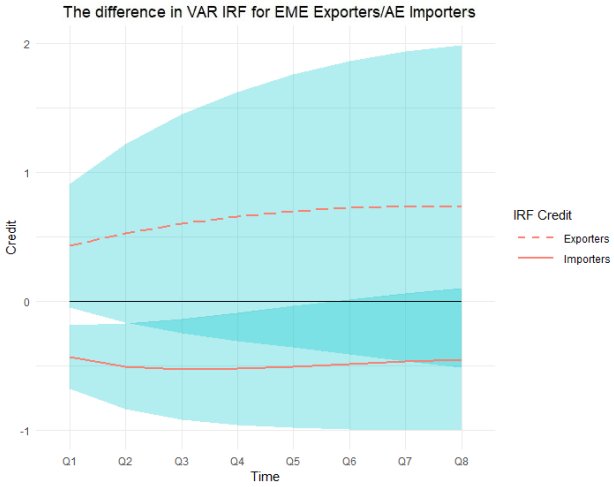


Figure 5.5 Impulse response function for a nominal policy rate in LPM for Indonesia.

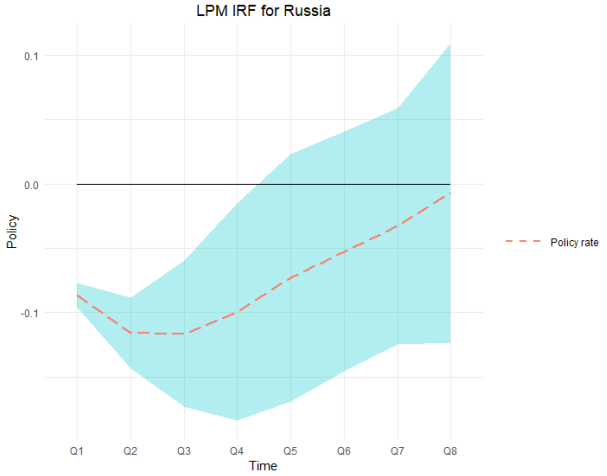


Figure 5.6 Impulse response function for real credit in LPM for Indonesia.

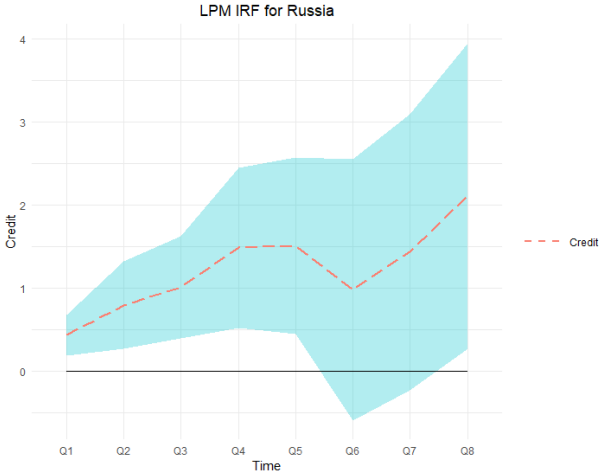


Figure 5.7 Impulse response function for a nominal policy rate in LPM for Colombia.

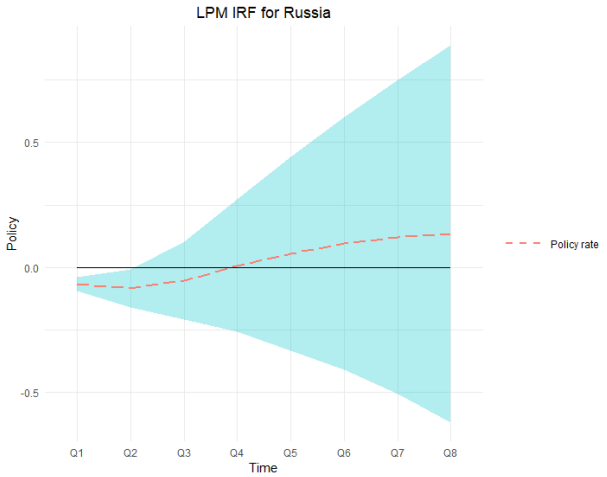


Figure 5.8 Impulse response function for real credit in LPM for Colombia.

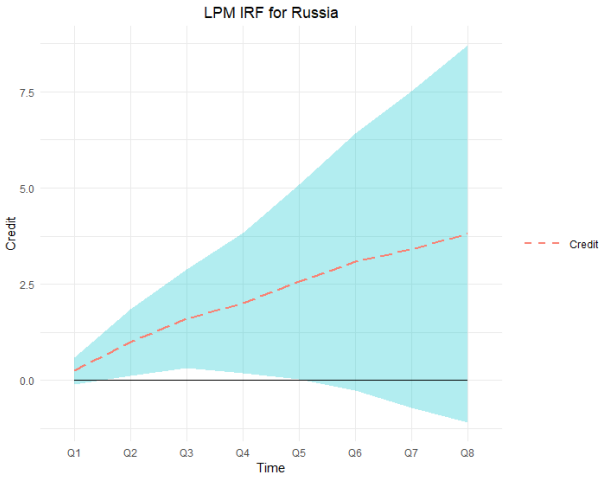


Figure 5.9 Impulse response function for a nominal policy rate in LPM for Czech Republic.

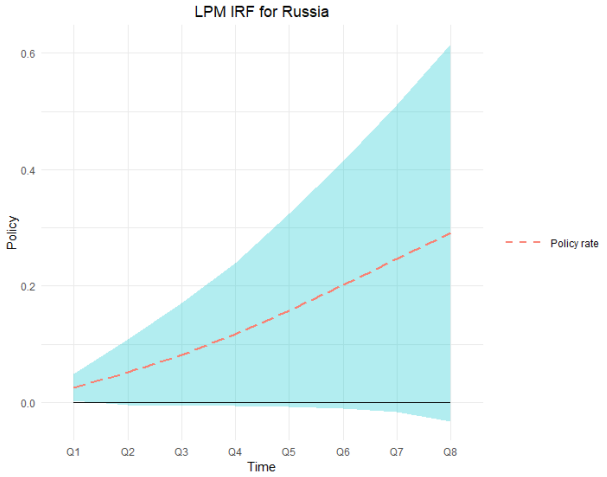


Figure 5.10 Impulse response function for real credit in LPM for Czech Republic.

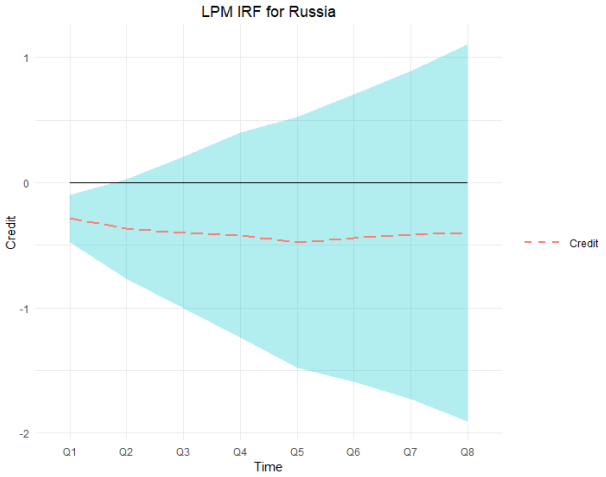


Figure 5.11 Impulse response function for a nominal policy rate in LPM for Israel.

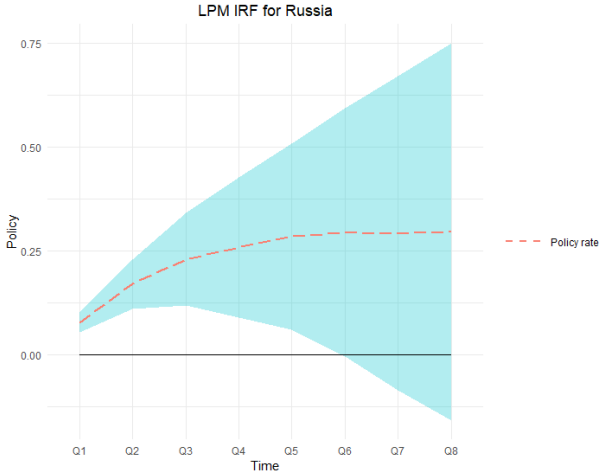


Figure 5.12 Impulse response function for real credit in LPM for Israel.

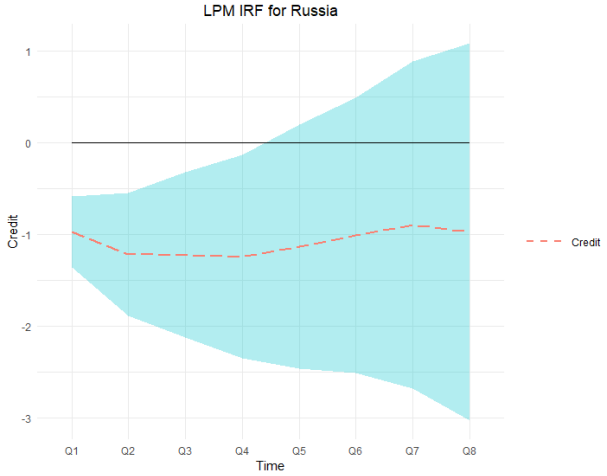


Figure 5.13 Impulse response function for a nominal policy rate in VAR for United Kingdom.

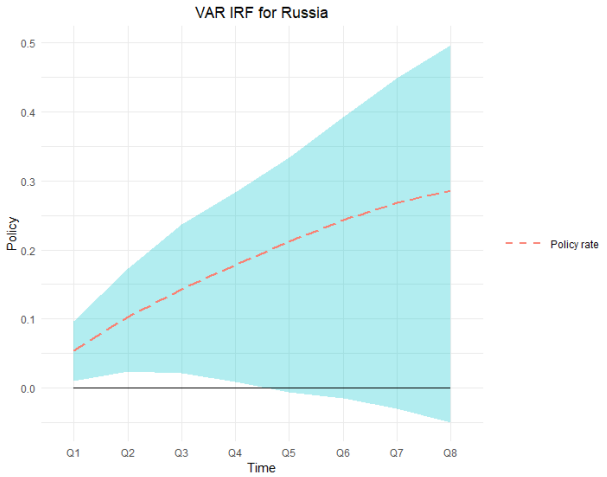


Figure 5.14 Impulse response function for real credit in VAR for United Kingdom.

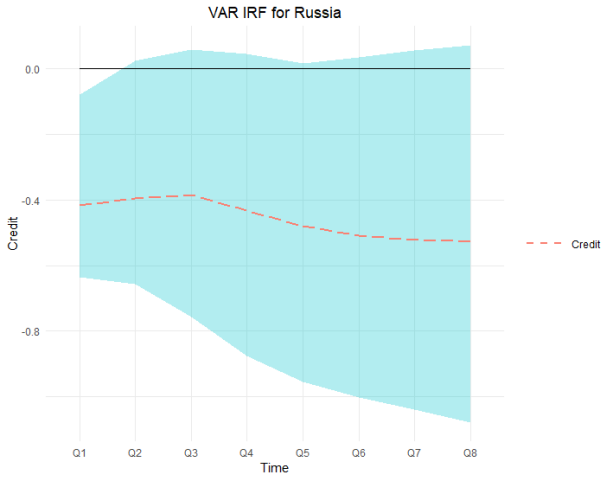


Figure 5.15 Impulse response function for a nominal policy rate in LPM for United Kingdom.

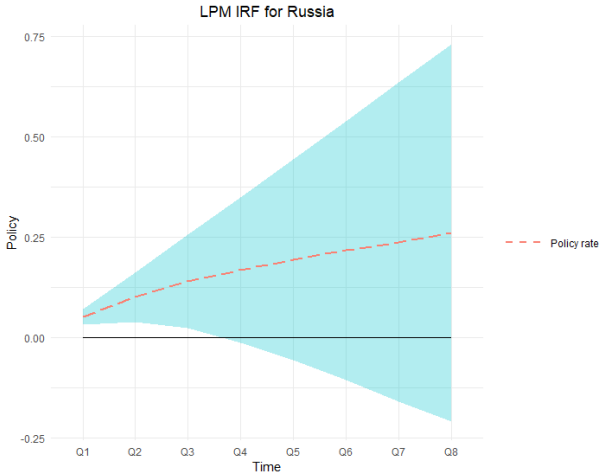
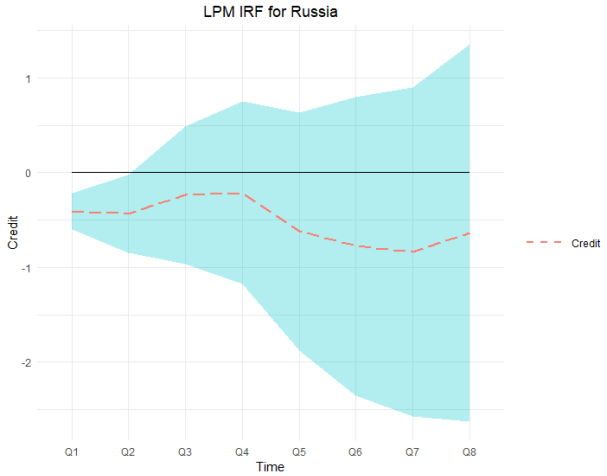


Figure 5.16 Impulse response function for real credit in LPM for United Kingdom.



APPENDIX 6

A.6.1. Real interest rates during commodity boom and bust in Inflation-targeting countries: event study analysis

In this section, we present the results of the event study analysis similar to Gonzales et al. (2016) or IMF (2015) we undertook in the panel of inflation-targeting economies. The goal of the analysis is to check whether there is a systematic difference in dynamics of real interest rates during commodity booms and busts across a group of commodity-exporting inflation-targeting small open economies and a group of other inflation-targeting small open economies. Our hypothesis is that commodity-exporting inflation-targeting economies reduce real interest rates during commodity booms and raise them following commodity price busts compared to the dynamics of real interest rates in the group of non-commodity-exporting inflation targeters.

For the analysis we considered the period of 1999 M1-2018 M11. We decided not to take a longer period as there were only a few inflation targeters before 1999 (the first was New Zealand in 1989). Another reason is that the dynamics of commodity prices during the 1990s did not demonstrate much volatility. We split the whole sample into 5 subsamples according to the dynamics of '*All Commodity Price Index, 2005 = 100, includes both Fuel and Non-Fuel Price Indices'*:[49] three with commodity price growth and two with commodity price decline – see Figure 6.1.

Three periods of rapid commodity price growth are:

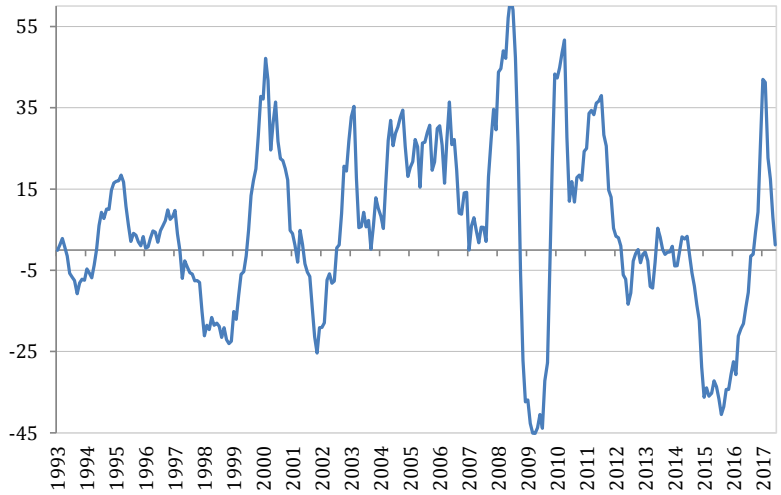
- 1999M1-2008M9. In this subsample of almost ten years there was only one year, 2001, and 2 months after that when the yearly growth rate of commodity prices was below zero.
- 2009M2-2012M3. This three-year subsample covers the period when commodity prices were recovering from the global financial crisis.
- 2015M8-2018M9. This three-year sample covers the period when commodity prices (mostly oil) were recovering from the decline at the end of 2014.

The two periods of commodity price busts are:

- 2008M10-2009M1. This three-month period was marked by the minimum yearly growth rate of commodity prices at -45%.
- 2012M4-2015M7. This three-year period was marked by the minimum yearly growth rate of commodity prices at -40%.

[49] The index is calculated by the IMF. It was discontinued in 2017M4. After that date we used the dynamics of the Bloomberg Commodity Index.

Figure 6.1. Annual growth rate of *All Commodity Price Index, %*



Sources: IMF, authors' calculations.

In our calculations, we consider the following sample of countries (the sample is unbalanced and depends on the year when a country joined the club of inflation-targeting countries):

- Commodity-exporting inflation-targeting small open economies:

For 1999-2008 – Australia, Brazil, Canada, Chile, Colombia, Mexico, Norway, the Philippines, South Africa, and Peru.

In 2014 we added Indonesia, in 2015 – Russia.

- Other inflation-targeting small open economies:

For 1999-2008 – Czech Republic, Israel, New Zealand, Poland, Sweden, and Great Britain. For 2009-2014 we added Romania, Serbia, and Turkey. In 2015 – Argentina and India.

To calculate real interest rates we used BIS statistics on nominal policy rates and inflation rates. A real interest rate is calculated using the Fisher equation: $(1 + r_t) = \frac{1+i_t}{1+\pi_t}$, where r_t is real interest rate, i_t is nominal interest rate, π_t is current CPI inflation rate.

The real interest rates for each country were normalised to have zero average and unit variance. For each country and each period we calculated real interest rates. Then we computed two medians across the countries in each of the two groups. We tried several options of calculating real interest rates from nominal rates:

1. subtracting current 1-year annual inflation from nominal rates;

2. subtracting the average inflation for the 2 previous years (difference of logs of CPI at t and t-24);

3. subtracting the average inflation for the 3 previous years (difference of logs of CPI at t and t-36);

4. subtracting future 1-year annual inflation from nominal rates;

5. subtracting the average future inflation for the 2 years;

6. subtracting the average future inflation for the 3 years (this way we tried to account for long-term inflation expectations);

7. subtracting the average of 1 year ahead inflation and 2 years back;

8. subtracting the average of 2 years ahead inflation and 1 years back.

Thus, in total we constructed 5 (samples) * 8 (ways to calculate real rates) = 40 diagrams[50] comparing real rate dynamics in commodity-exporting and non-commodity-exporting inflation targeters. The results of our calculations are below.

The following can be summarised:

- For the first and most prolonged period of oil price growth in 1999-2008, we find no systematic difference in the behaviour of real interest rates across the two groups of countries regardless of the measure of inflation we use to compute real interest rates. The only exception during this long period is the behaviour of real rates during the rapid recovery of oil prices in 1999-2000 after the 1997 crisis. The calculations of real rates based on past inflation show that commodity exporters were rapidly reducing real interest rates during these two boom years while other inflation-targeting economies were raising them. However, this might be just a result of high inflation in the past years.

- In the period of the commodity price bust in 2008, commodity exporters were rapidly increasing real interest rates, while other inflation targeters already had their rates at a high level by the time of the Lehman crash. During the crisis, non-commodity exporters quickly reduced real rates but commodity-exporting inflation targeters acted with a lag of 2 to 4 months (depending on the measure of the real interest rate). These differences are in favour of the view that instead of supporting the economy by quickly reducing rates, commodity exporters supported exchange rates to contain inflationary pressure of depreciations (or, according to Gourinchas (2018), higher rates might have been used to avoid risks to financial stability arising amid high levels of external debt). Leaving aside the intentions of commodity-exporting central banks, the analysis shows that their monetary policy stance was probably tighter than that of non-commodity-exporting inflation targeters during this period.

- In the period during the recovery of commodity prices after the global financial crisis in 2009M2-2012M3, it was only in one measure of real interest rates (based on 1-year ahead and 2-years back inflation) that we observed a significant divergence of real rates in the two groups of countries. In commodity-exporting countries, real rates started to decline in early 2012 while those in other inflation-targeting economies started to rise. However, the result was not robust for other measures of real rates.

[50] Less those for the last episode when we cannot compute real rates for some forward-looking measures.

- During the second episode of commodity price decline in 2012M4-2015M7 commodity exporters increased real rates and held them at the higher level during the period both for long-term (3-year) backward-looking measures of inflation expectations and for long-term (3-year) forward-looking measures. Thus, for this second episode of commodity price decline, we observe the same reaction of real interest rates in commodity-exporting inflation targeters as in the first episode of commodity price decline.

- During the last episode of oil price growth in 2015M8-2018M9 real rates in commodity exporters for most of the indicators (especially backward-looking, as construction of forward-looking is constrained by the end of the sample) were at higher levels. For only one measure (based on one-year ahead inflation) the median real rate was declining and closing the gap from above with real rates in non-commodity-exporting inflation targeters. Only in this case commodity exporters were 'normalising' their tight monetary policy by decreasing real rates during the last phase of commodity price growth.

To summarise, we mention below the most robust results of the event study analysis.

First, for two episodes of commodity price decline we found that monetary policy of commodity-exporting inflation targeters was, probably, tighter in real terms than that of other inflation-targeting economies. The level of real interest rates in commodity exporters was either higher (as in the episode of 2012M4-2015M7) than that of other inflation targeters or similar to other inflation targeters, but did not decrease immediately after the boom ended (as, probably, in the episode of the global financial crisis).

Second, surprisingly, during the longest commodity price boom we found no systematic differences in real interest rates in the two groups and only specific evidence during other booms. Monetary policy of all inflation targeters in the longest episode was very similar and synchronised. One possible explanation of this is the extremely strong common global business cycle in 2002-2008 which dominated monetary policy response across inflation targeters. In such circumstances, our analysis may not be granular enough to differentiate the policy reaction in the two groups of countries, especially when monetary policy decisions were not concentrated but made over a very long period of time and not synchronous inside the groups. The crisis episodes, on the contrary, are characterised by monetary policy decisions concentrated over a short period of time, which helps identify any differences if they exist.

The event study analysis finds some, though not robust, evidence that monetary policy of certain inflation-targeting central banks is different from that of other inflation-targeting central banks. Moreover, this evidence is in favour of the hypothesis that during episodes of prolonged commodity price changes an inflation-targeting central bank in a commodity-exporting economy changes its monetary policy stance (real interest rates) in the opposite direction to the movement of the commodity price. This strategy may have important implications for the credit cycle in commodity exporters and for financial stability.

Figures 6.2 – 6.9. Dynamics of median real interest rate for commodity-exporting countries (red line) and for other inflation-targeting countries (blue line). **Upswing, 1999 – 2008**

Figure 6.2. Inflation is calculated as average CPI growth rate for one previous year.

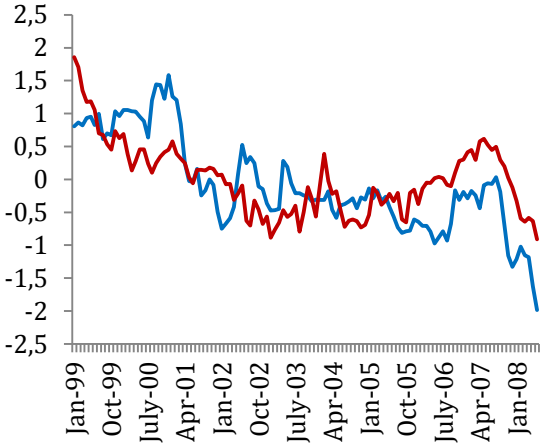


Figure 6.3. Inflation is calculated as average CPI growth rate for two previous years.

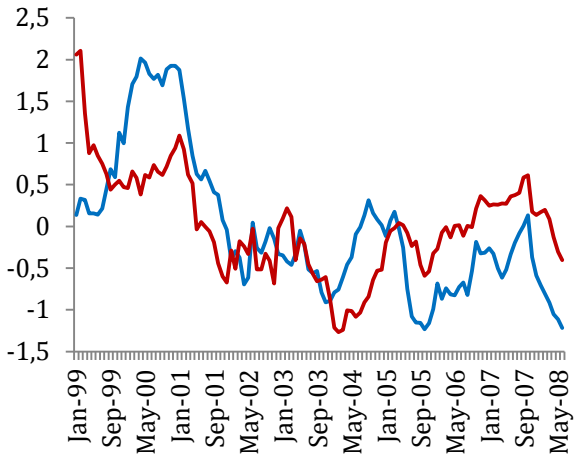


Figure 6.4. Inflation is calculated as average CPI growth rate for three previous years.

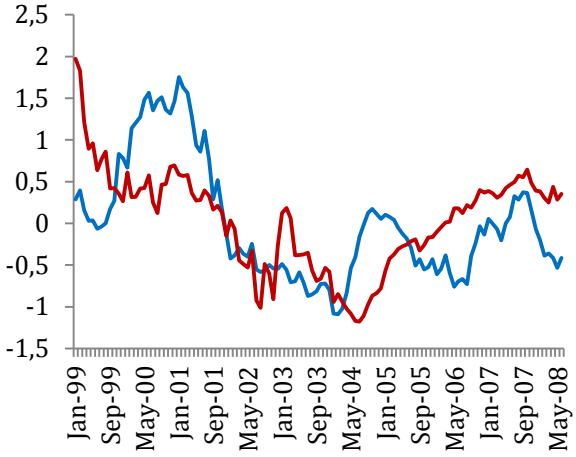


Figure 6.5. Inflation is calculated as CPI growth rate for one following year.

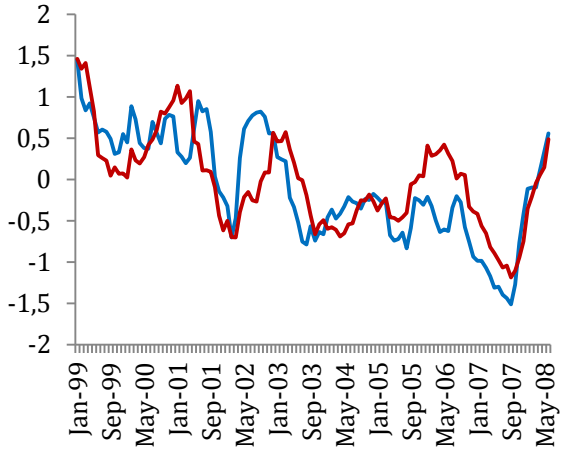


Figure 6.6. Inflation is calculated as average CPI growth rate for two following years.

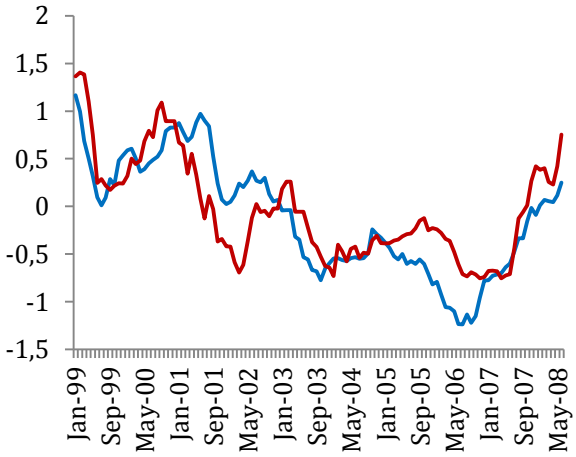


Figure 6.7. Inflation is calculated as average CPI growth rate for three following years.

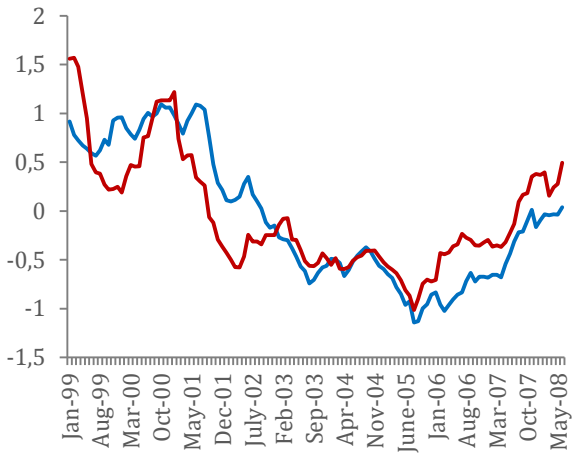


Figure 6.8. Inflation is calculated as average CPI growth rate for two previous years and one following year.

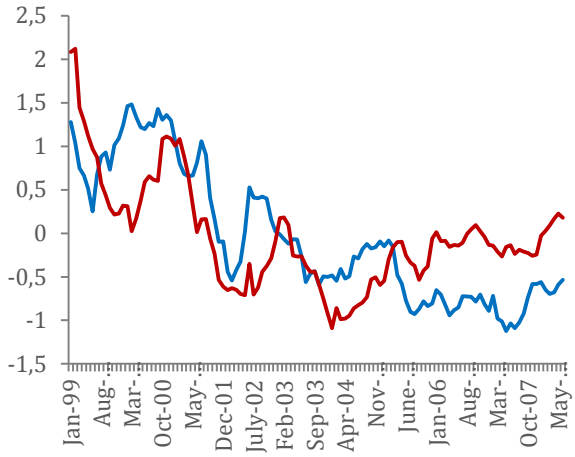
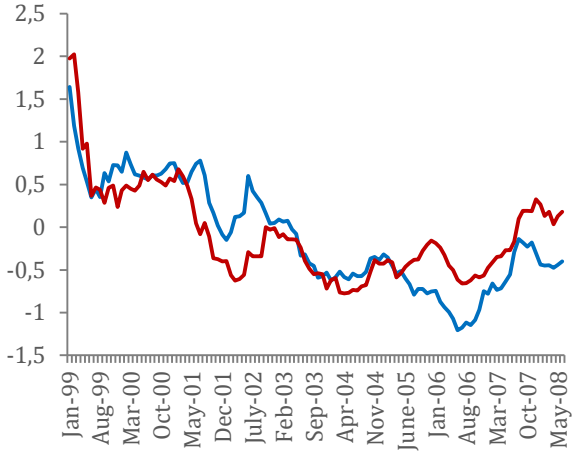


Figure 6.9. Inflation is calculated as average CPI growth rate for one previous year and two following years.



Figures 6.10 – 6.17. Dynamics of median real interest rate for commodity-exporting countries (red line) and for other inflation-targeting countries (blue line). **Upswing, 2009 – 2012**

Figure 6.10. Inflation is calculated as average CPI growth rate for one previous year.

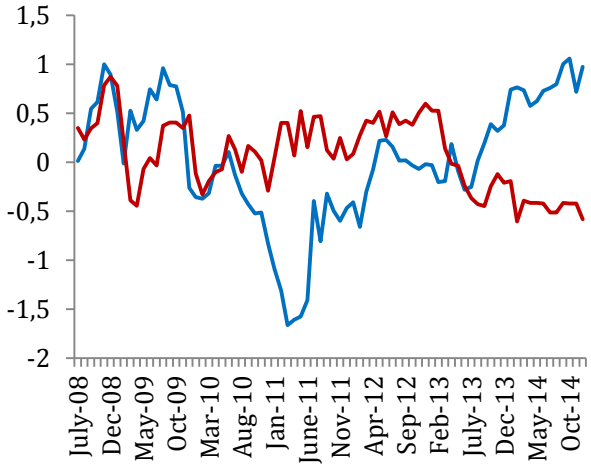


Figure 6.11. Inflation is calculated as average CPI growth rate for two previous years.

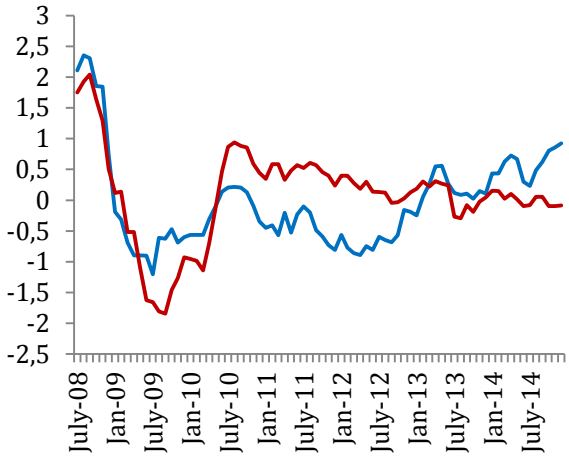


Figure 6.12. Inflation is calculated as average CPI growth rate for three previous years.

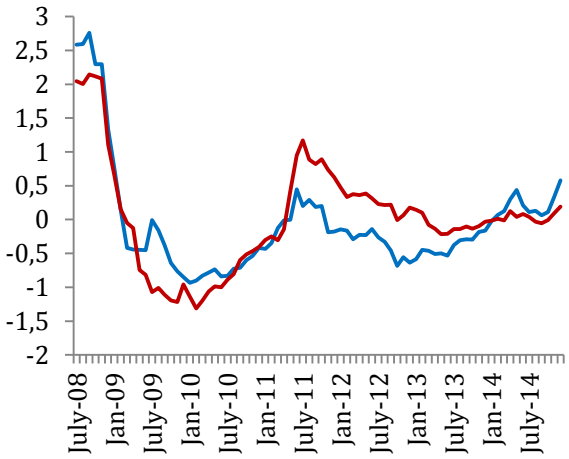


Figure 6.13. Inflation is calculated as CPI growth rate for one following year.

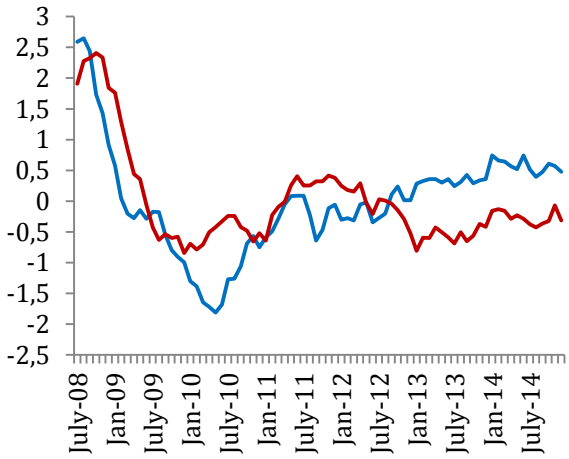


Figure 6.14. Inflation is calculated as average CPI growth rate for two following years.

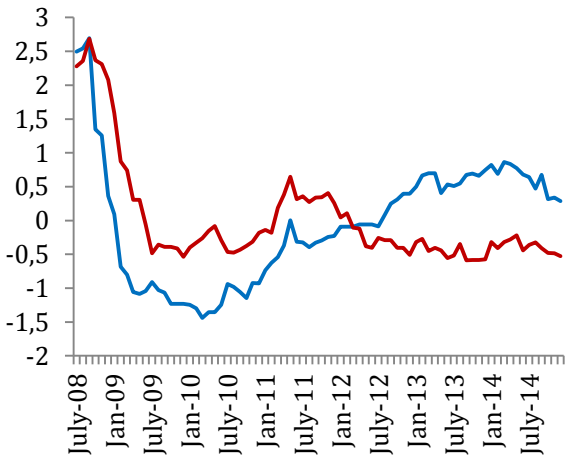


Figure 6.15. Inflation is calculated as average CPI growth rate for three following years.

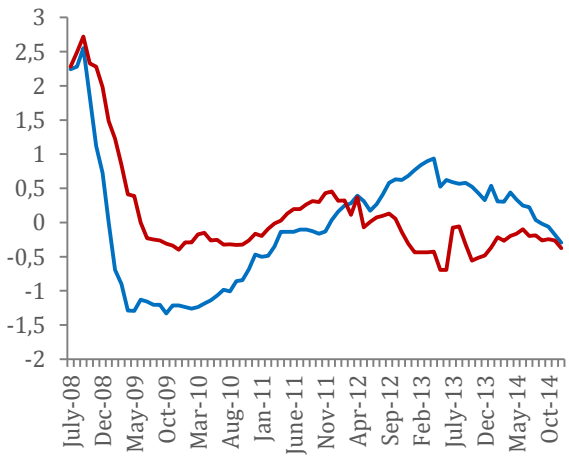


Figure 6.16. Inflation is calculated as average CPI growth rate for two previous years and one following year.

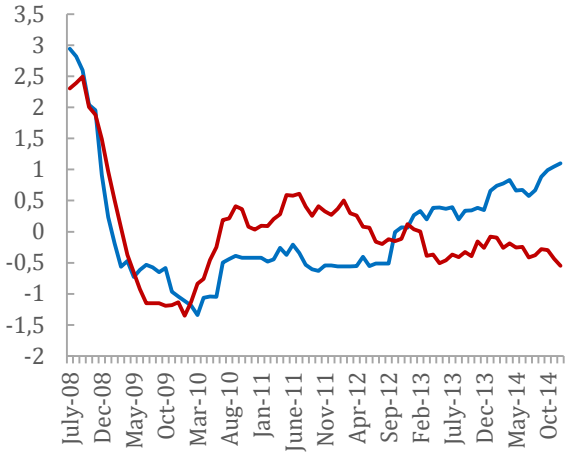
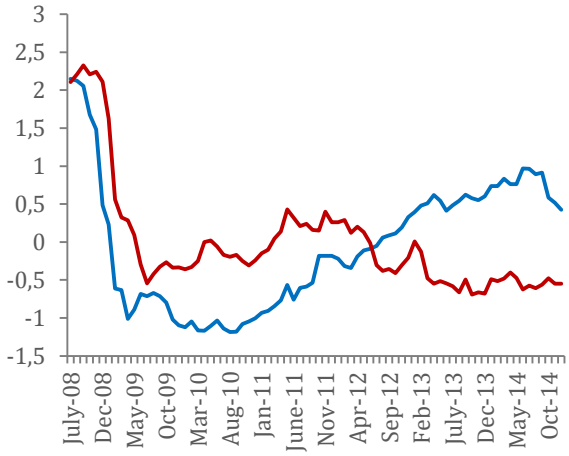


Figure 6.17. Inflation is calculated as average CPI growth rate for one previous year and two following years.



Figures 6.18 – 6.22. Dynamics of median real interest rate for commodity-exporting countries (red line) and for other inflation-targeting countries (blue line). **Upswing, 2015 – 2018**

Figure 6.18. Inflation is calculated as average CPI growth rate for one previous year.

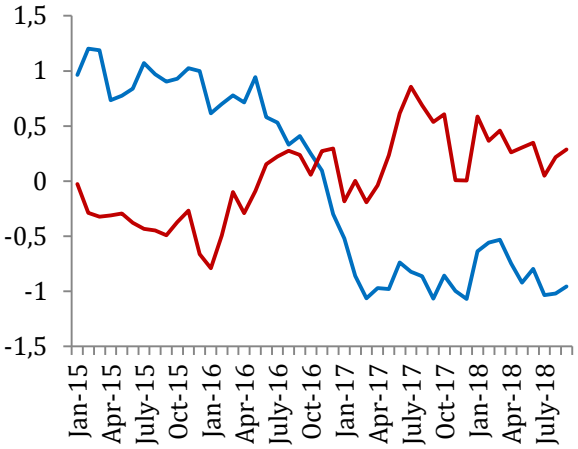


Figure 6.19. Inflation is calculated as average CPI growth rate for two previous years.

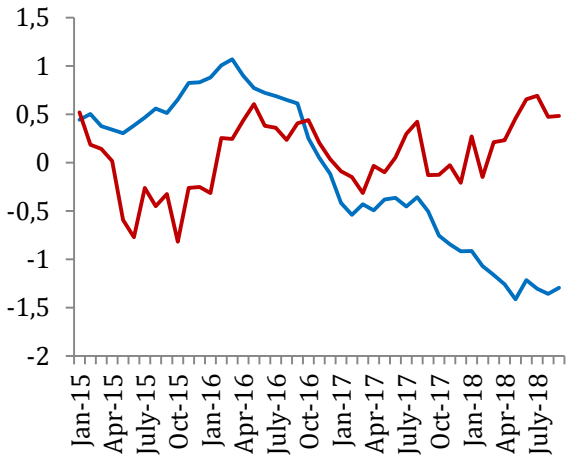


Figure 6.20. Inflation is calculated as average CPI growth rate for three previous years.

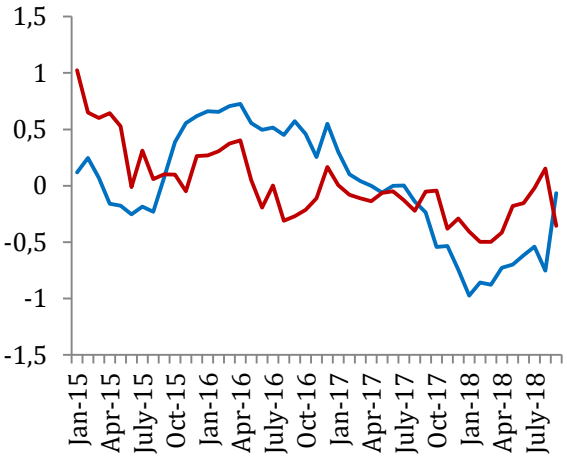


Figure 6.21. Inflation is calculated as CPI growth rate for one following year.

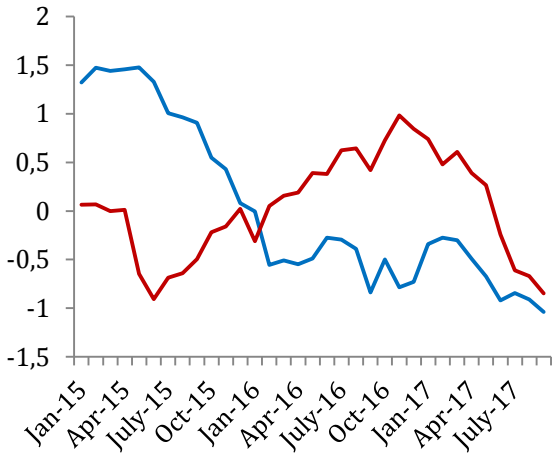
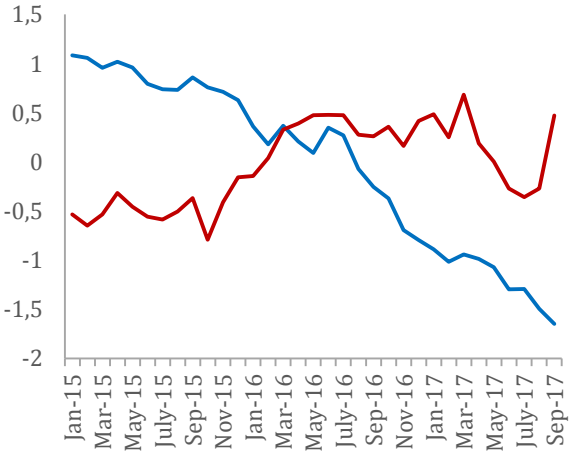


Figure 6.22. Inflation is calculated as average CPI growth rate for two previous years and one following year.



Figures 6.23 – 6.30. Dynamics of median real interest rate for commodity-exporting countries (red line) and for other inflation-targeting countries (blue line). **Downswing, 2008 – 2009**

Figure 6.23. Inflation is calculated as average CPI growth rate for one previous year.

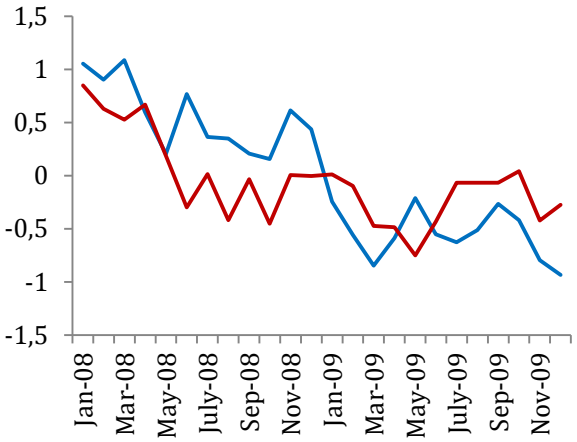


Figure 6.24. Inflation is calculated as average CPI growth rate for two previous years.

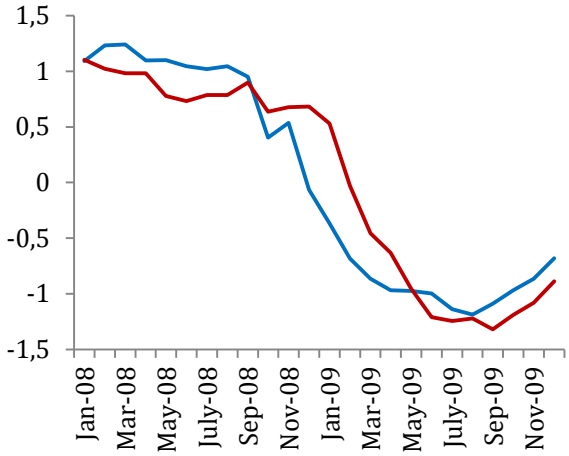


Figure 6.25. Inflation is calculated as average CPI growth rate for three previous years.

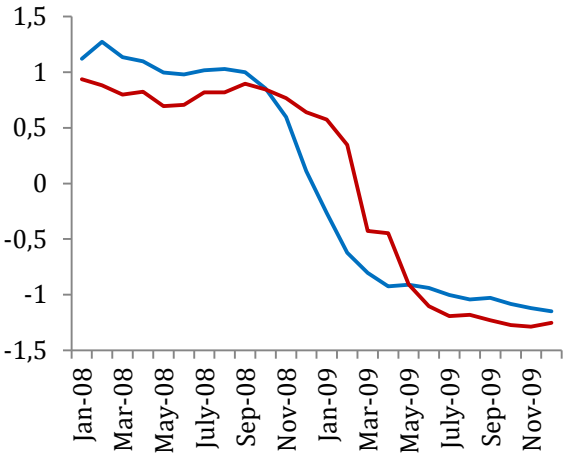


Figure 6.26. Inflation is calculated as CPI growth rate for one following year.

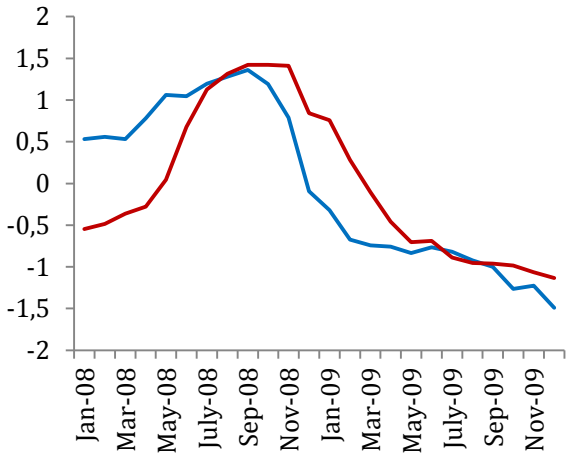


Figure 6.27. Inflation is calculated as average CPI growth rate for two following years.

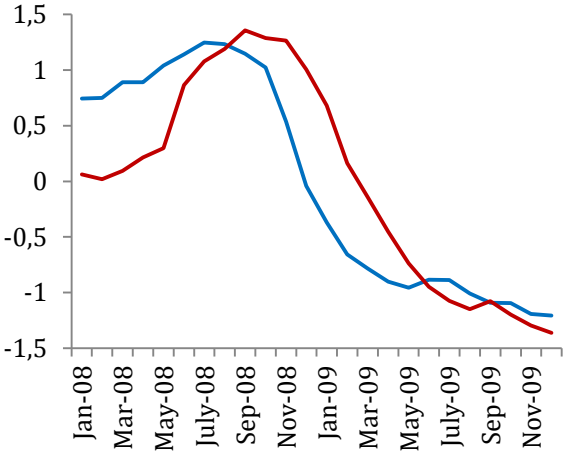


Figure 6.28. Inflation is calculated as average CPI growth rate for three following years.

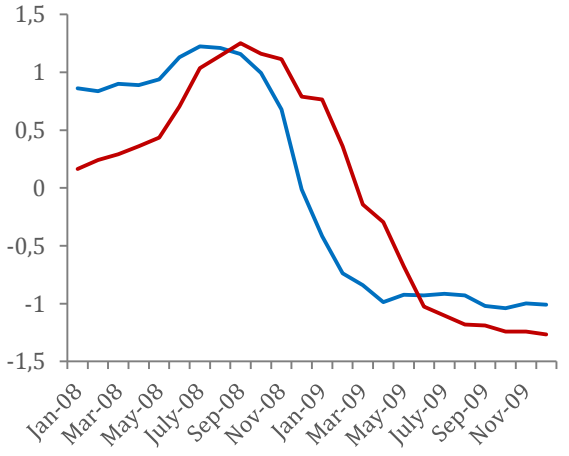


Figure 6.29. Inflation is calculated as average CPI growth rate for two previous years and one following year.

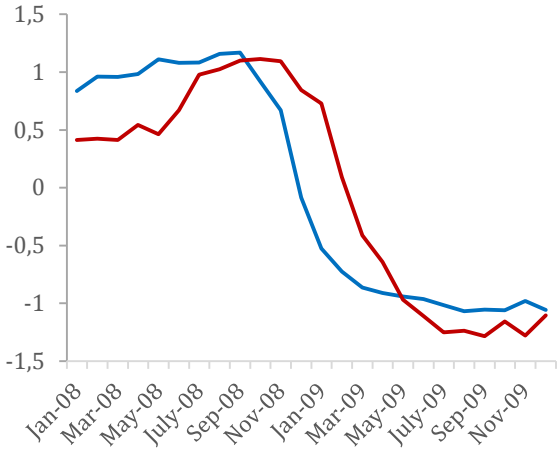
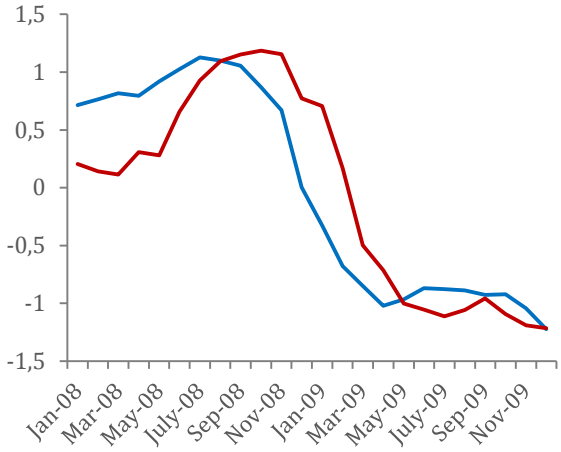


Figure 6.30. Inflation is calculated as average CPI growth rate for one previous year and two following years.



Figures 6.31 – 6.36. Dynamics of median real interest rate for commodity-exporting countries (red line) and for other inflation-targeting countries (blue line). **Downswing, 2012 – 2015**

Figure 6.31. Inflation is calculated as average CPI growth rate for one previous year.

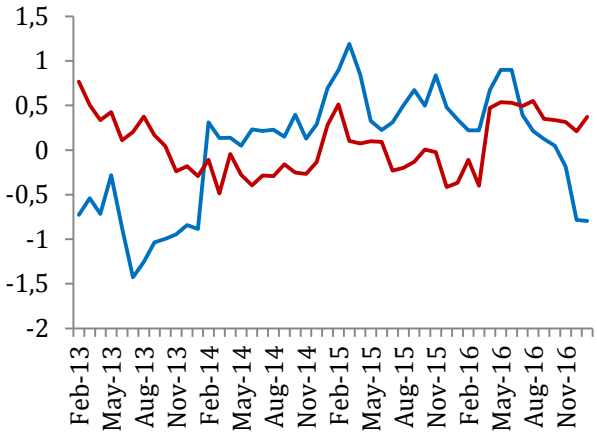


Figure 6.32. Inflation is calculated as average CPI growth rate for two previous years.

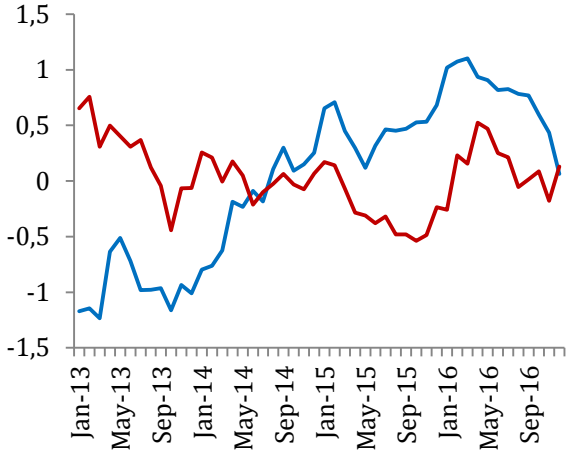


Figure 6.33. Inflation is calculated as average CPI growth rate for three previous years.

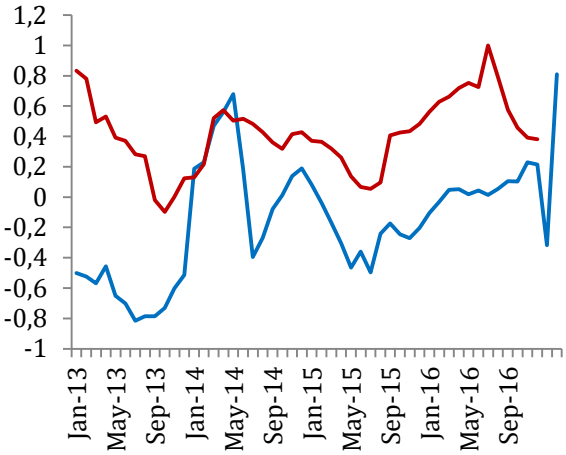


Figure 6.34. Inflation is calculated as CPI growth rate for one following year.

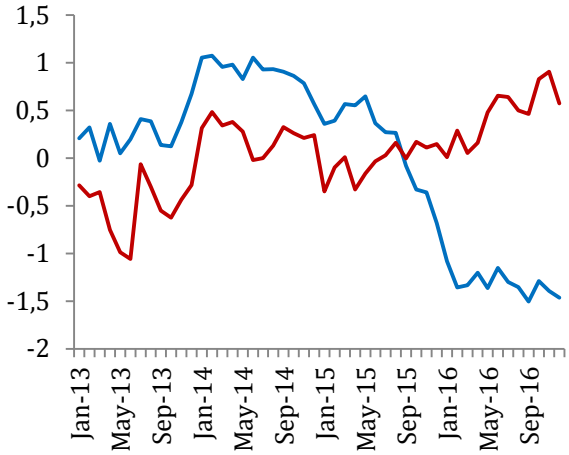


Figure 6.35. Inflation is calculated as average CPI growth rate for two following years.

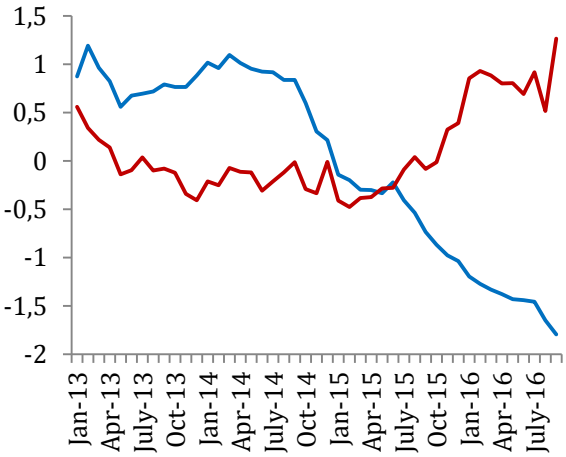


Figure 6.36. Inflation is calculated as average CPI growth rate for three following years.

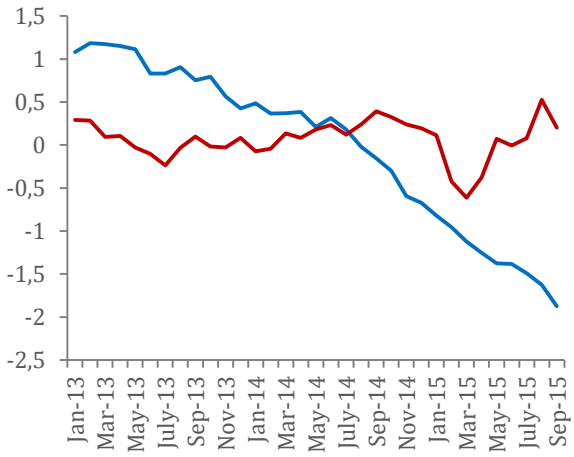


Figure 6.37. Inflation is calculated as average CPI growth rate for two previous years and one following year.

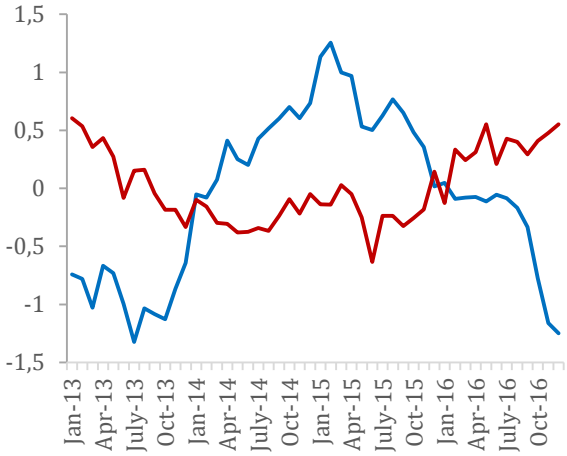
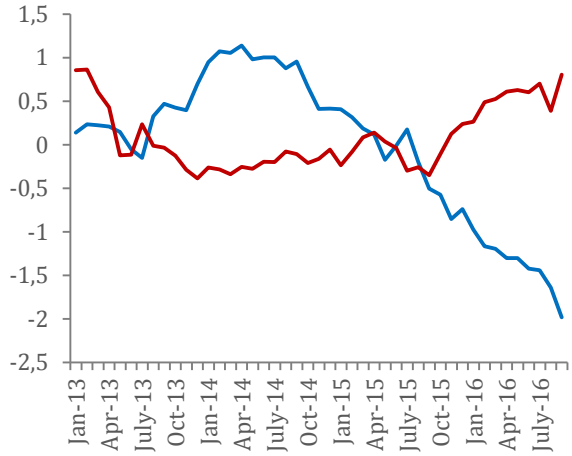


Figure 6.38. Inflation is calculated as average CPI growth rate for one previous year and two following years.



A.6.2. Real credit during commodity booms and busts in Inflation-targeting economies: event study analysis

In this section we make the second preliminary step in testing the relevance of the hypothesis that inflation targeting may contribute to real credit variation in commodity-exporting inflation targeters. We conduct an event study analysis of the real credit in commodity-exporting economies during commodity booms and busts and compare it with those in remaining inflation-targeting economies. As the two groups of countries face the same global environment except for the dynamics of commodity prices, the difference of credit in the groups would reflect the difference in the monetary and fiscal policy central banks undertake in these economies in response to changing external conditions.[51]

The event study, conducted by the IMF (2015) finds that commodity price boom in a commodity-exporting country leads to twice as higher real credit growth rate compared to the episodes of commodity price decline. In our study we compare dynamics of real credit for two groups of inflation-targeting countries: commodity-exporting economies and other inflation-targeting countries.

For the analysis we considered the period of 1999M1-2018M11. Data for nominal credit are taken from the Bank of International Settlements. We used the 'Credit to Private non-financial sector from All sectors at Market value - Domestic currency - Adjusted for breaks' category.[52] We deflated nominal credit by CPI using data on CPI indexes from the CEIC.

We present the results for episodes of commodity price growths and declines since 1999 in Appendix 5. As the diagrams show, we do not find any visible differences in the dynamics of real credit in the two groups of countries considered. This is true in particular for the longest period of commodity price growth, in 2000-2008, for which different reaction of monetary policy responses to commodity price changes might have had a significant effect on real credit.

As in the event study we cannot control for some other factors that may influence the dynamics of real credit except for differences in monetary policies in these countries. In the next section we will turn our attention to using formal statistical tests based on impulse responses in panel VARs and local projections.

[51] We speak about external conditions as we believe that averaging across two groups cancels out the impact of country-specific factors.
[52] For some countries (Peru, Philippines, Romania, Serbia, Kazakhstan, Guatemala, Ghana, the Republic of Georgia, and the Republic of Armenia) we used the IMF database on 'Claims on private sector' from the Depository corporation survey.

Figures 6.39 – 6.43. Dynamics of median real credit in deviations from country-specific average for each period for commodity-exporting inflation-targeting countries (red line) and for other inflation-targeting countries (blue line), percentage points

Figure 6.39. Upswing, 1999-2008

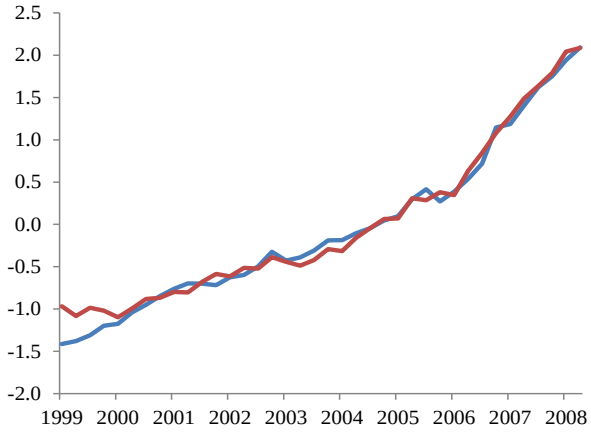


Figure 6.40. Upswing, 2009-2012

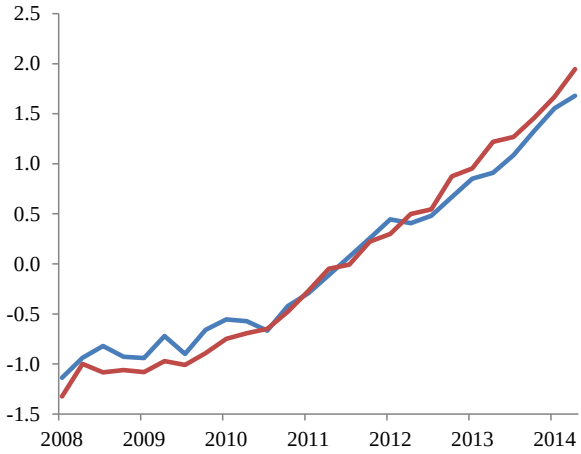


Figure 6.41. Downswing, 2008-2009

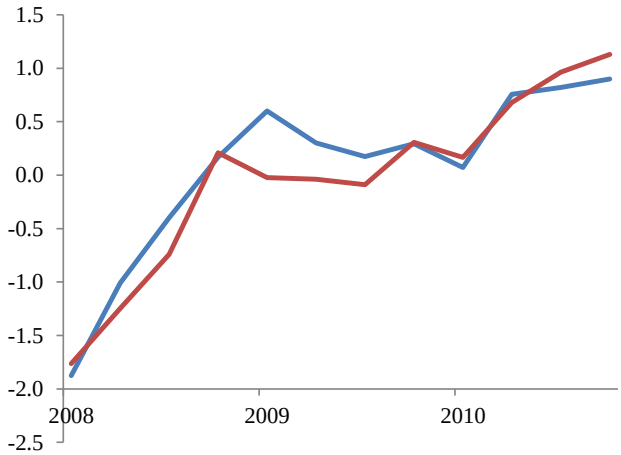


Figure 6.42. Downswing, 2012-2015

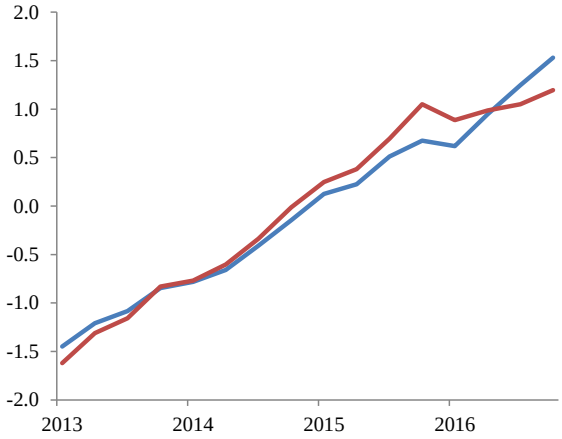


Figure 6.43. Upswing, 2016-2018