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# Dominant Currency Paradigm: *Financial Dollarization View*

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# Dominant Currency Paradigm: *Financial Dollarization View**

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**Abstract**

This paper proposes an alternative view for the dominant currency paradigm. More specifically, the role of financial dollarization in exchange rate pass-through is analyzed. In highly dollarized countries, where domestic producers are unhedged, exchange rate depreciations against a dominant currency create additional pressures on inflation. In particular, depreciation increases unhedged borrowers' debt-service costs, which then push overall prices up. We use a panel of countries with highly dollarized economies to empirically estimate the impact of dominant currency exchange rates on inflation. On the theoretical front, we demonstrate this channel by a simple dynamic stochastic general equilibrium (DSGE) model to show how liability dollarization of domestic producers may change the optimal monetary policy reaction to USD exchange rate movements globally. These results provide an interesting insight for monetary policymakers, especially for countries with small open economies that are exposed to external shocks. The implications can help gauge the optimal monetary policy response to the US monetary policy-induced exchange rate movements for countries that may even not trade much with the US but have high financial dollarization.

**JEL Codes:** C33; E31; E37; E52; E58

**Keywords:** Dominant currency paradigm; Exchange rate pass-through; Dollarization; Monetary policy



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# I. Introduction

Understanding exchange rate pass-through plays a crucial role in monetary policymaking as it has an impact on both prices and output. From a policy perspective quantifying exchange rate pass-through helps gauge the relevant monetary policy response to exchange rate movements. It's even more important for central banks that operate monetary policy under forward-looking inflation targeting regime. In this case intermediate target for policy makers is an inflation forecast. More precise projections of exchange rate shocks' potential impact on inflation help avoid significant deviations from the target as monetary policy response will be more consistent.

Economic theories are usually based on purchasing power parity assumption meaning that prices of tradable goods expressed in one currency are the same across countries. If purchasing power parity condition holds then exchange rate pass-through should be complete on tradable goods. However, in reality this is not the case and increasing number of research papers empirically show incomplete exchange rate pass-through, possibly due to price and wage stickiness.

When discussing the exchange rate pass-through, most research papers concentrate on bilateral exchange rates. More recently though, dominant currency paradigm has gained in its importance. Recent research papers (Boz et al, 2017; Gopinath et al, 2010; Gopinath et al, 2008) claim that trade invoices are mostly denominated in a dominant currency, which is usually the US dollar. US dollar invoicing makes imported inflation more responsive to the exchange rate against the US dollar rather than bilateral exchange rate against any particular trading partner (different from the US).

However, this is not all. What is more, in some developing economies US dollar invoicing can actually be only a (potentially small) part of the picture where the effect of the exchange rate against the US dollar is strong. The reason for this is foreign currency borrowing on the part of domestic producers. This is the topic that we discuss here.

More specifically, this paper suggests another view about the role of a dominant currency in exchange rate pass-through. The central point of this view is built around the "liability dollarization" of domestic economy. In highly dollarized economies, the local producers are unhedged, their liabilities are denominated in a foreign currency while they receive revenues in a local currency; this exposes them to exchange rate shocks. Dollarized balance sheets of unhedged borrowers create additional pressures on inflation as well as on economic growth. On the one hand, in case of depreciation against the dominant currency, firms' wealth deteriorates, they invest less and this dampens aggregate demand and pushes inflation down. On the other hand, from the supply side, depreciation increases (foreign currency) debt-service costs, which then increase overall prices. Consequently, we get lower output but higher prices. Hence, even if the exchange rate depreciation can be a reflection of lower external demand, which should be deflationary in other cases, in case of dollarized economies it may actually become inflationary. This is the picture one would expect from a supply shock, yet the original shock could very well have been a (external) demand shock. This is the sense in which financial dollarization may be transforming demand shocks to supply shocks (see also Mkhatrishvili, 2017). Despite this, US dollar exchange rate pass-through in highly dollarized economies is frequently overlooked in the literature. And whenever discussed, only demand side channel is considered. This paper aims to shed some light on the supply side effects of dollarized balance sheets.

As for the results, we demonstrate the importance of US dollar exchange rate both empirically and theoretically. On the empirical front, in the first stage, this paper estimates effective exchange rate pass-through and shows incompleteness of it. Based on the dynamic panel regression, 1% depreciation (appreciation) of nominal effective exchange rate contemporaneously pushes inflation up (down) by 0.32 percentage points (pp). Cumulative response of 1% nominal effective exchange rate shock for one year equals to 0.21[1] pp. At the second stage, bilateral exchange rate against the dominant currency (which usually is USD) is introduced as an additional explanatory variable in the exchange rate pass-through analysis. Incorporating dominant currency reduces nominal effective exchange rate pass-through from 0.32 pp to 0.18 pp. Instead, the effect is absorbed by bilateral dominant currency exchange rate. Contemporaneous elasticity of dominant currency exchange rate is around 0.11 pp in all specifications. We also found that liability dollarization strengthens contemporaneous dominant currency pass-through.

On the theoretical front, we use a simple dynamic stochastic general equilibrium (DSGE) model to show how liability dollarization of domestic producers may change the optimal monetary policy reaction to global USD exchange rate movements. In particular, while non-dollarized small open economies (that don't trade with the US extensively) may stay put in terms of policy rates while

[1] Lower cumulative value may be the result of the temporary nature of exchange rate shock. In addition, it's the first lag that is statistically significant, not the subsequent ones.

seeing the USD exchange rate fluctuations, dollarized economies may be in a position where the needed reaction could be significant. For instance, increases in US interest rates may necessitate significant increases in interest rates of dollarized economies as well (could be almost one-for-one in the short term).

These results provide an interesting insight for monetary policymakers, especially for countries with small open economies that are exposed to external shocks. More specifically, they help gauge the optimal monetary policy response to the US monetary policy-induced exchange rate movements. This could mean a great deal for central banks in achieving their monetary policy mandates. Still, these results should be generalized with a grain of salt. The analysis only includes highly dollarized countries with similar macro characteristics and the results and policy recommendations could be relevant only for those types of economies.

The paper is organized as follows. Section II reviews the relevant literature. Section III describes data, estimation methodology and discusses the results, along with robustness checks. Section IV provides simple theoretical model that illustrates the case in point. As a case study, Section V shows that the linkages mentioned seem to have been at work in Georgia when it was hit by an external shock in 2014-2015. Concluding remarks and future work are summarized in Section V.

## II. Literature review

The reality does not seem to support either law of one price or complete exchange rate pass-through. Producers absorb part of exchange rate alignment by adjusting their markups (at least in the short-term), which causes incompleteness of exchange rate pass-through. There is an increasing number of empirical research papers that quantify the degree of exchange rate pass-through and theoretical research papers digging into the reasons for its incompleteness.

Exchange rate pass-through strongly depends on a currency choice in the price-setting strategy. In international economics a large branch of models considers prices to be set in a producer's currency. In the short-run, prices are sticky and 'producer currency pricing' implies complete exchange rate pass-through to imported inflation (Obstfeld et al, 1995). In contrast to this, several models are based on the assumption that prices are rigid in a local currency where the products are sold (consumer currency pricing). This causes zero exchange rate pass-through in the short-run. Both of them, producer currency pricing and local currency pricing have different implications for monetary and exchange rate policy issues.

Besides these, discussions about price stickiness in a dominant currency gained in its importance in recent years (Boz et al, 2017; Gopinath et al, 2010; Gopinath et al, 2008). Gopinath et al (2010) argue that producers prefer to set prices in a currency in which prices are the most stable. Based on the micro data, invoices are mostly denominated in a dominant currency, which usually is the US dollar (Boz et al, 2017). Empirical evidence shows that in the short-run USD exchange rate pass-through to inflation outweighs bilateral exchange rate pass-through. The currency choice and its impact on pass-though was also studied for Belgian data (Amiti et al, 2018). According to this research, on the one hand, invoicing currency plays a central role in exchange rate pass-through analysis, but simultaneously the choice of currency for invoice depends on import intensity of the production. Small-size firms with limited imported inputs in their production prefer to set prices in the local currency (euro in their case). In contrast, wherever production requires significant amount of imported goods, producers are setting prices in a dominant currency (USD). Deverux and Engel (2001) argue that it's just the countries with low exchange rate volatility and stable monetary policy that are characterized with low exchange rate pass-though as producers choose local currency for invoicing. Overall, these papers provide interesting monetary policy implications as they show that policymakers may need to take short-term outcomes coming from US dollar fluctuations into account.

Goldberg and Knetter (1996) suggested third-degree price discrimination as a major source for both incomplete exchange rate pass-through and deviation from the law of one price. They argue that goods markets are separated rather than integrated at the international level, which leads to country-specific changes in markups of exported goods. Dornbusch (1987) highlights imperfect competition as a primary reason of incomplete exchange rate pass-through. In response to exchange rate shocks firms partially change prices and absorb part of this shock though adjusting their markups.

Nevertheless, already incomplete exchange rate pass-through has been reduced even further over time. Taylor (2000) explains it by introducing inflation targeting regime. In particular, inflation targeting regime creates a low inflationary environment, where the long-run expectations are well anchored. Under persistent low inflationary expectations, producers are reluctant to change prices as they want to retain their competitiveness. Taylor's hypothesis has been supported by empirical evidence (Gagnon and Ihrig, 2004; Edwards, 2006; Mishkin and Schmidt-Hebbel, 2007). Mishkin (2007) also supports Taylor's idea and argues that credible monetary policy can prevent strong impact of exchange rate shocks on inflation. Even if exchange rate development is highly transmitted to import prices, credible monetary policy can prevent exchange rate shock's impact on general consumer prices.

The role of credible monetary policy explains a difference in the degree of pass-through between advanced and emerging economies (Taylor, 2000). Emerging economies have higher inflation environment and accordingly higher exchange rate pass-through. Gagnon et al (2004) tested 20 industrial economies and found relatively moderate impact of exchange rate on consumer prices in countries with low and stable inflation. Zorzi et al (2007) found emerging economies with single digit inflation having lower pass-through, similar to advanced economies. Caseli et al (2016) explains variations in the degree of exchange rate pass-through by the import intensity of the production. In emerging economies imported goods are intensively used as an input in the local production. Consequently, exchange rate shocks significantly impact cost of production and accordingly final impact on prices are stronger in emerging countries compared to advanced economies.

Another facet of this topic is that high level of dollarization can, in turn, create a possibility of stronger exchange rate pass-through (Reinhart et al, 2003). Many of developing and emerging economies suffer from financial dollarization and that could also drive the difference in the degree of pass-through between advanced and emerging economies. Carranza et al (2010) empirically found that dollarization intensifies exchange rate pass-though. Namely, per unit increase of dollarization index (dollarization measured by Reinhart et al, 2003) pushes exchange rate pass-through by 0.02-0.03 percentage points. Phiakeo (2017), in the case of Southeast Asian countries, found the degree of exchange rate pass-through increasing by 0.04 percentage points when dollarization increases by 1 percentage point. Sadeghli et al (2019) found intensified pass-through in emerging markets with dollarized economies. Yet, understanding of this phenomenon has been limited by the fact that economic literature mostly concentrated on trading partners' bilateral exchange rate pass-through to inflation (even though financial dollarization makes US dollar exchange rate more important). Hence, less is known about the role of US dollar exchange rate pass-through in highly dollarized countries.

As a result of the discussion above, the role of balance sheet effects in the exchange rate pass-through is mostly overlooked in the literature. Otherwise, if discussed, only demand side channel is analyzed. Exchange rate depreciation against US dollar deteriorates firms' wealth and reduces their investment. In contrast to Mundell-Fleming spirit, in highly dollarized countries exchange rate depreciation may have a contractionary effect (Carranza et al, 2010), since contractionary impact through balance sheet channel can outweigh the expansionary impact through competitiveness (net export) effect (Kim, 2016). This demand side is indeed important for understanding the exchange rate pass-through, but it is by no means sufficient. The supply side is also dependent on the balance sheet effects. With dollarized liabilities, in case of a domestic currency depreciation, for example, domestic producers face higher debt-servicing costs and this may push inflation up, even when the demand side is unchanged. The aim of this paper is to provide estimates of the supply side impact of dollarized balance sheets in terms of its implications for the exchange rate pass-through – something discussed in the next section.

## III. Empirical estimation

### i. Data

The primary interest in this empirical analysis lies in estimating the relationship between financial dollarization, on the one hand, and US dollar exchange rate pass-through to inflation, on the other. In particular, we attempt to test whether balance sheet effect creates additional pressure on inflation through dollarization channel. Since this analysis concentrates on potential supply-side effects of dollarization, only highly dollarized economies are included in the panel. Meanwhile, the priority goes to countries with similar macro fundamentals – like countries with inflation targeting and/or floating exchange rate (managed float and free float) regimes. With this consideration eight countries are selected for the estimation: Georgia, Armenia, Kyrgyzstan, Kazakhstan, Croatia, Albania, Serbia and Romania. The sample is from 2003Q1 to 2018Q4. The choice of the initial period is mainly driven by the availability of data. On top of the analysis of effective exchange rate and dominant currency exchange rate pass-though, we also want to identify whether dollarization plays a role. Therefore, at the next stage we extend panel data with non-dollarized small open economies like Czech Republic, Poland and Israel.

The final aim of the paper is to help monetary authorities in responding adequately to different exchange rate shocks. Therefore, this research is macro in its nature and all relevant macro variables should be included in the analysis. Headline CPI inflation is selected as a dependent variable. Nominal exchange rate in effective terms as well as bilateral exchange rate vis-à-vis a dominant currency are selected as explanatory variables. For countries with liabilities denominated in the US dollar (dollarization), exchange rate against the US dollar is selected; and for countries with liabilities denominated in euro (so called "euroization") bilateral exchange rate vis-à-vis euro is selected. Real GDP growth data is used as a control variable in order to catch demand side pressure on inflation. Also, food and oil price indices are used to capture supply side pressures on inflation. In addition, dollarization (foreign currency denominated loans as a share of total credit portfolio) is also included as an explanatory variable. All price indices (consumer price index, food price index, oil price index) and exchange rate variables included in the regressions are in annual log differences.

## ii. Estimation methodology

As a baseline model, at the first stage, we estimate the exchange rate pass-through based on the following form:

$$(1) \qquad \pi_{i,t} = \alpha_i + \alpha_0 \pi_{i,t-1} + \sum_{k=0}^{3} \beta_k \ \Delta neer_{i,t-k} + \ \delta' X_{i,t} + u_{i,t}$$

where $\pi_{i,t}$ is consumer price inflation of country $i$ at time $t$; $\Delta neer_{i,t}$ is the change in nominal effective exchange rate (increase means appreciation); and $X_{i,t}$ includes control variables: real GDP growth, food inflation and oil inflation.

At the second stage the baseline model is extended with bilateral exchange rate vis-à-vis the dominant currency:

$$(2) \qquad \pi_{i,t} = \alpha_i + \alpha_0 \pi_{i,t-1} + \sum_{k=0}^{3} \beta_k \ \Delta neer_{i,t-1} + \ \sum_{k=0}^{3} \gamma_k \ \Delta er_{i,t} + \ \delta' X_{i,t} + u_{i,t}$$

where $\Delta er_{i,t}$ is the change in exchange rate expressed in units of local currency per dominant currency (increase means depreciation).

At the third stage we extend the model with interaction term between dollarization level and change in exchange rate vis-à-vis dominant currency:

(3) $$\pi_{i,t} = \alpha_i + \alpha_0\pi_{i,t-1} + \sum_{k=0}^{3}\beta_k\ \Delta neer_{i,t-1} + \sum_{k=0}^{3}\gamma_k\ \Delta er_{i,t} + \\ + \sum_{k=0}^{3}\delta_k\ dol_{it}\Delta er_{i,t} + \delta'\ X_{i,t} + u_{i,t}$$

where $dol_{it}$ is the level of loan dollarization (foreign currency loans as a share total loans portfolio).

Those equations are estimated using dynamic panel regression with generalized method of moments (GMM). In particular, Arellano and Bover (1995) and Blundell and Bond (1998) methodology is applied. This approach has been widely accepted to deal with dynamic panel regression with endogenous explanatory variables. Generally, including lagged dependent variable creates dynamic panel bias (Nickell, 1981) as it is correlated with the fixed effects in error term. Arellano and Bover (1995) and Blundell and Bond (1998) deal with the endogeneity problem by using lags of dependent and endogenous variables, and their differences as instruments.

Various specifications have been applied to check the robustness of the estimated results. Standard fixed effect model with autoregressive term is also applied. Arellano and Bover (1995) and Blundell and Bond (1998) approach is mostly used with limited time periods and a high number of individuals. Using this methodology for large panel data with limited individuals can create overidentification problem. However, this issue is controlled with the ways suggested by Roodman (2008). Roodman (2008) also highlights that in standard fixed effect model dynamic panel bias diminishes with increasing number of time periods. For sufficiently large time periods, the size of the bias becomes negligible. Therefore, comparing the baseline results with fixed effect model is plausible.

## iii. Results

The baseline estimation shows that contemporaneous exchange rate pass-through to consumer prices is around 0.32 percent, while cumulative exchange rate pass-through for one year goes to 0.21 (see **Figure 1**). Nevertheless, the baseline specification shows insignificant second and third lags of nominal effective exchange rate, while short-term impact is strongly significant in all estimated regressions. These results are in line with other empirical investigations. Caseli et al (2016) find 0.22 exchange rate pass-through for one year and 0.25 exchange rate pass-through for two years after the initial shock is hit. Jasova et al (2016) tries various specifications for emerging markets and shows that the size of exchange rate pass-through varies in 0.22-0.25 range. Bussiere et al (2008) estimates the impact of import prices to exchange rate movement with 0.35 after one quarter. Mdivnishvili (2014) makes a similar analysis with Georgian data and estimates the degree of exchange rate pass-through equal to 0.42 (for Georgian case, see also Arevadze et al, 2020). As mentioned earlier, to control for demand-side pressures on prices, the real GDP growth rate is included in dynamic panel data regression. In all regressions applied during the analysis, real GDP shows significant positive impact on prices with the size of around 0.18 (see **Table A3**). Based on the economic theory demand needs time to have an impact on aggregate price level. Thus, four quarter lag of real GDP growth is incorporated in the baseline model. Despite this, shorter lags were also tried, but it did not provide significant and intuitive results.

On the other hand, to control for supply side pressures, world food price inflation and change in Brent crude oil prices are included together and separately. Food price inflation is significant in all specifications, while oil inflation is weakly significant and the sign of its coefficient is not intuitive. In the baseline estimation, consumer prices show moderate persistence of around 0.39.

**Figure 1: Exchange rate pass-through (baseline)**

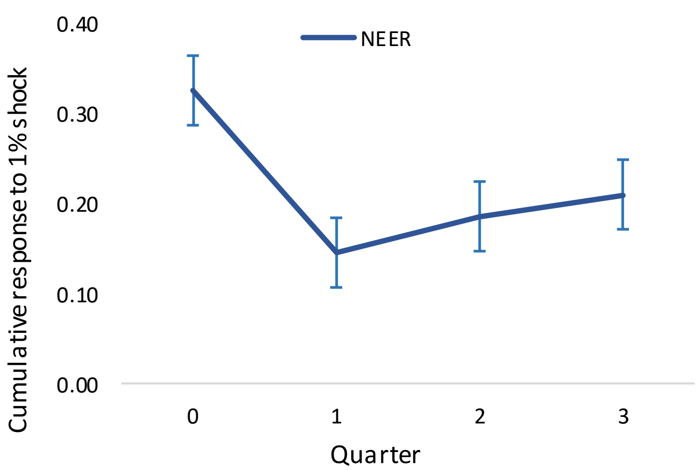
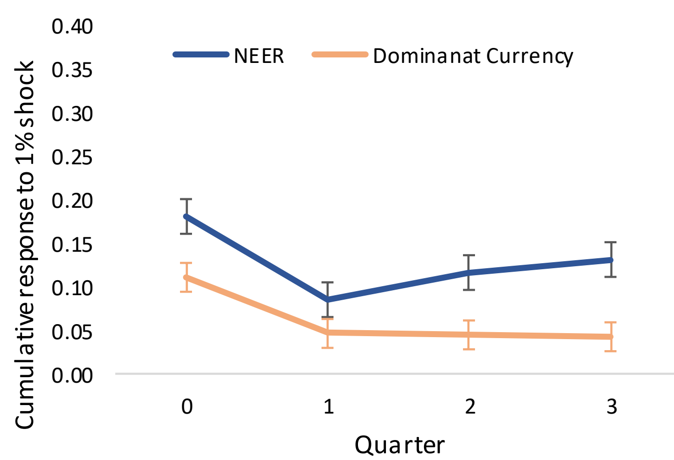



**Figure 2: Exchange rate pass-through (extended with exchange rate against the dominanat currency)**




*Source: authors' estimates*

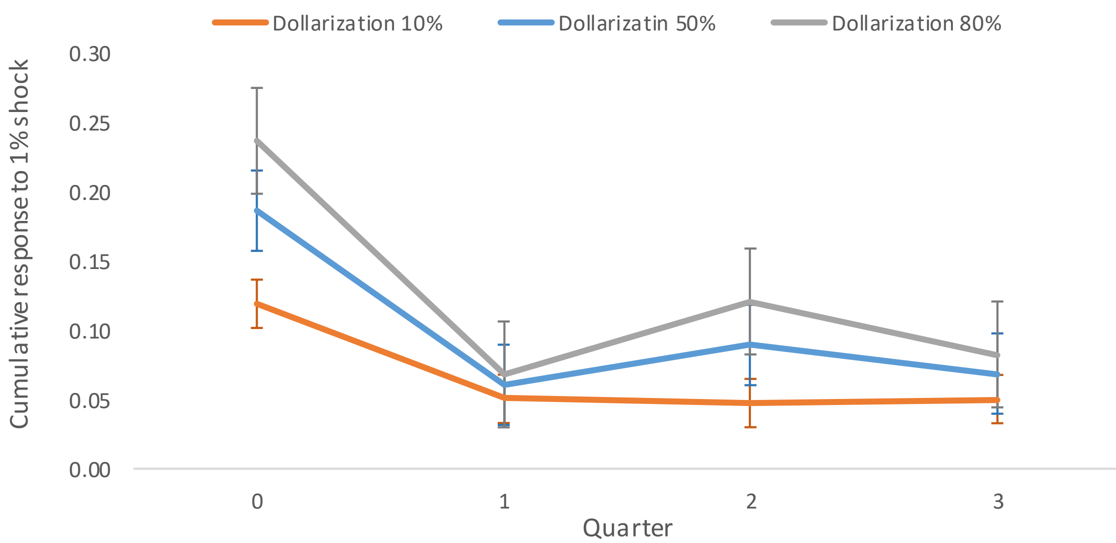
At the second stage, the model is extended with bilateral exchange rate vis-à-vis dominant currency. As **Figure 2** depicts, including a dominant currency exchange rate reduces the size of contemporaneous nominal effective exchange rate pass-through from 0.32 to 0.18 and cumulative yearly pass-through from 0.21 to 0.13. Instead, the effect is absorbed by the dominant currency exchange rate. The contemporaneous effect of the dominant currency equals to 0.11; while cumulative response to 1% shock goes to 0.05. As in the previous case, the second and third lags of both effective and bilateral exchange rate are not statistically significant, while contemporaneous and first lag are strongly significant.

In the extended specification the coefficients of real GDP growth and food inflation change only slightly and are strongly significant (see

**Table A4**). Once again, oil inflation provides neither significant result nor is its size big enough (0.05). Headline inflation still shows moderate persistence with the size of around 0.41.

At the next stage, we attempt to test whether exchange rate pass-through of dominant currency comes from the loans' dollarization channel. For that reason, we add interaction term between dominant currency exchange rate and the level of dollarization (equation 3). Our interest is to estimate $\delta_k$ and tests its significance. In this case dominant currency exchange rate pass-through for the non-dollarized countries would be $\gamma_k$, while for the dollarized countries it would be $(\gamma_k + \delta_k * dol)$. In order to catch the difference between non-dollarized and highly dollarized economies we extend the panel data with non-dollarized countries. At this stage, we add small open economies with inflation targeting and floating exchange rate regimes like Czech Republic, Poland and Israel. Firstly, we run the same estimations like equation (1) and equation (2) and check whether the degree of exchange rate pass-through changes. The coefficient has slightly changed. The contemporaneous effect of nominal exchange rate pass-through slightly increased (by 0.01). While contemporaneous effect of dominant currency exchange rate decreased by 0.01 (see **Table A5**). Then we estimated extended model with interaction term and found the positive sign of its coefficient. Based on our estimates, dollarization strengthens contemporaneous exchange rate pass-through of the dominant currency by 0.16 (see **Figure 3**), while dollarization intensifies dominant currency cumulative pass-through by around 0.05 (see **Table A5**) – meaning that in fully dollarized economies (100% of dollarization) short term dominant currency exchange rate pass-through stands at around 0.26, while the cumulative one would be 0.1. However, again, only contemporaneous and first lags are significant, while longer term lags are insignificant. Interestingly, adding interaction term between dollarization and dominant currency exchange rate further dampens degree of contemporaneous effective exchange rate pass-through. Also, short term effective exchange rate pass-through became insignificant while longer term are strongly significant and the cumulative effect stands at around 0.13. **Figure 3** illustrates dominant currency pass-through for three cases of dollarization. As we can see, an increase in the degree of dollarization intensifies the role of dominant currency for the exchange rate pass-through.

**Figure 3: Dominant currency exchange rate pass-through under different degrees of dollarization**




*Source: authors' estimates*

## iv. Robustness checks

The abovementioned results remain robust to the changes of empirical estimation techniques. The baseline specification is based on the dynamic panel regression with generalized method of moments. Alternatively, fixed effect estimation with autoregressive term is applied. Generally, fixed effect model with lag dependent and endogenous variables provides biased results. However, with increasing number of time periods the size of the bias diminishes. The degree of exchange rate pass-through for both nominal effective and dominant currency exchange rates are in line with above given results (see **Table A6** and **Table A7**).

Firstly, the baseline specification is estimated and it shows similar nominal effective exchange rate pass-through with contemporaneous effect varying in the 0.26-0.29 range. Real GDP growth and food inflation are strongly significant. On the other hand, the coefficient of food inflation increases significantly. In almost all specifications, oil inflation is weakly significant.

Secondly, the model is extended with the dominant currency exchange rate. Similar to the previous case, the degree of contemporaneous nominal effective exchange pass-through diminishes to around 0.14, while dominant currency contemporaneous effect is around 0.07-0.08. Food inflation and real GDP have a significant positive impact on consumer prices. Oil inflation is weakly significant in extended model as well.

Thirdly, the model is extended with the interaction term between dollarization and change in dominant currency exchange rate. At this stage, non-dollarized countries (Czech Republic, Poland, Israel) are added in the analysis. Various specifications support that dollarization strengthens contemporaneous dominant currency exchange rate pass-through by around 0.05-0.1 (see **Table A8**). Interaction terms between dollarization and lags of a change in dominant currency exchange rate pass-through are insignificant and outweigh the positive sign of contemporaneous effect. In this regression, dominant currency still shows a significant impact on consumer price inflation by around 0.11-0.15, while nominal effective exchange rate became insignificant.

## IV. Model simulations

In this section we show that the reduced-form estimates shown above can very well be a reflection of a structural feature related to liability dollarization. Namely, we use a very simple dynamic stochastic general equilibrium (DSGE) model somewhat similar to Gali and Monaccelli (2005). The difference with their model is that we also incorporate price indexation (as in Christiano et al. 2005) and external habit formation (as in Smets and Wouters, 2003). An additional, and crucial, difference is the presence of pay-in-advance constraint in companies' production process. This makes domestic good producers dependent on bank credit to pay their wage bills (since in our model labor is the only production factor). This makes it possible to analyze, in a very simple way, what happens when the companies borrow in one currency or the other. In other words, this is simply a reflection of the fact that companies in real world rely heavily on borrowing while planning their production process – what matters is in which currency they do so.

Here we show the most important part for our analyses (in log-linearized form). The domestic inflation equation (hybrid Phillips curve) has the following form:

(4) $$\pi_t^H = \frac{\beta}{1+\beta} E_t\pi_{t+1}^H + \frac{1}{1+\beta} \pi_{t-1}^H + \frac{\beta}{1+\beta}\frac{(1-\beta\theta)(1-\theta)}{\theta} (mc_t - mc_{ss})$$

where $\pi_t^H$ is domestic (home) inflation, $E_t$ represents expectations operator with information available at time-$t$, $mc_t$ is the real marginal cost, while $mc_{ss}$ denotes its steady state level. Parameters have the usual meaning: $\beta$ – discount factor and $\theta$ – degree of price stickiness. The difference with a simple DSGE model (Gali and Monaccelli, 2005) is that here we have a persistent inflation, which is a more realistic case (and supported by the empirical evidence presented above). Including the persistence of inflation allows for some lags between marginal cost and inflation.

For our exercise, the crucial part is the marginal costs, which will include the cost of debt-servicing for producers. In addition to real wage we have interest rate cost in the marginal cost equation. Namely, when domestic producers borrow in domestic currency their marginal cost is the following:

(5) $$mc_t = i_t + (w_t - p_t - a_t)$$

where $w_t - p_t$ stands for real wages (nominal wage minus price level), $a_t$ represents the technology (or productivity), while the term $i_t$ reflects the cost of borrowing for the firm. Hence, in this case, it is the interest rate on domestic currency loans (something tightly controlled by the domestic central bank). On the other hand, if the companies borrow in US dollars, then their marginal costs become:

(6) $$mc_t = \left(i_t^{usd} + E_t s_{t+1} - s_t\right) + (w_t - p_t - a_t)$$

In this case the cost of borrowing becomes dependent on the US interest rates ($i_t^{usd}$) and exchange rate of the domestic currency relative to the US dollar ($s_t$). Hence, through marginal costs, exchange rate movements may spill over to the domestic inflation, even if we do not consider the direct impact from imported inflation. Representing marginal cost in such a way implies the possible incipient instability in inflation dynamics coming from exchange rates that requires monetary policy to anchor the system, in other words to have a reaction to it.

The rest of the model equations are pretty standard except for the exchange rate equation where, instead of pure Uncovered Interest Parity (UIP), we follow a much more realistic approach of Bacchetta and Wincoop (2019)[2]. The standard UIP condition assumes that interest rate differential should compensate for the expected depreciation. This implies initial exchange rate depreciation as

[2] Their approach seems to resolve six puzzles regarding the exchange rate dynamics, something that pure UIP has a hard time doing.

a response to foreign interest rate hike. Initially investors fully adjust their portfolios and increase foreign currency holding as it becomes more preferable. If pure UIP holds, initial exchange rate deprecation will be followed by an appreciation in order to compensate for a foreign interest rate hike. Bacchetta and Wincoop (2019) suggest modified UIP condition that roots on the idea of "delayed portfolio adjustment". In reality, investors do not respond to a change in the interest rate differential instantaneously. Rather, portfolio adjustment is more gradual (Froot and Thaler, 1990). Following this idea, Bacchetta and Wincoop (2019) show that a foreign interest rate hike causes exchange rate depreciation which is followed by long lasting depreciationary pressures as investors are gradually increasing their position in a foreign currency. Modified UIP has the following form:

(7) $$(i_t - \pi_t) - (i_t^{us} - \pi_t^{us}) = E_t e_{t+1} - \mu e_t + b\varphi e_{t-1}$$

where $i_t^{us}$ stands for US interest rate, $e_t$ - for real US dollar exchange rate and $\pi_t^{us}$- for US inflation.

The monetary policy reaction function of the domestic central bank has the following form:

(8) $$i_t = r + \pi + \tau[E_t \pi_{t+1} - \pi]$$

where, neutral interest rate is the sum of real interest rate $(r)$ and headline inflation target $(\pi)$ and policy reacts to future annual headline inflation $\pi_{t+1}$ deviations from its target. The reaction function and the coefficient of inflation deviation from its target satisfy the basic principle of monetary policy that is to adjust the policy rate sufficiently aggressively to anchor inflation and inflationary expectations. Appendix 2 lists all the model equations.

Calibration of the model is also standard. We calibrate the model parameters according to Gali and Monaccelli (2005), where available. For the degree of habit formation we assume the degree of one, while exchange rate equation is calibrated according to Bacchetta and Wincoop (2019).

What we do next with the calibrated model at hand is simulating impulse responses to the US interest rate shock. This helps us show what happens when US dollar borrowing costs and the US dollar exchange rate change. As we want to isolate pure financial dollarization impact on marginal cost and its implications, we assume that real exchange rate against major trading partners (excluding the USA) does not change. Meanwhile, USA is assumed to have a small share in total trade flows (like in Georgia). More specifically, we assume that real effective exchange rate consists of 5% of the USD and 95% of other major trading partners' currencies. Under such assumptions, the US interest rate shock, as shown below for dollarized economies, becomes the supply side shock where US dollar is strengthening globally. In this case, trade channel could not help much absorbing the exchange rate shock (as effective exchange rate changes only a little), while headline inflation would be slightly affected by the direct imported inflation.

**Figure 4** shows impulse responses to a 2 percentage points[3] (pp) positive shock to US interest rate in two cases: when domestic producers borrow in a domestic currency (non-dollarized case) and when they borrow in a foreign currency (dollarized case). Blue solid line indicates a financially dollarized economy where unhedged producers have liabilities in US dollars (where marginal cost function is represented by equation 6) while a non-dollarized case is shown by the red dashed line (where the marginal cost equation is represented by equation 5).

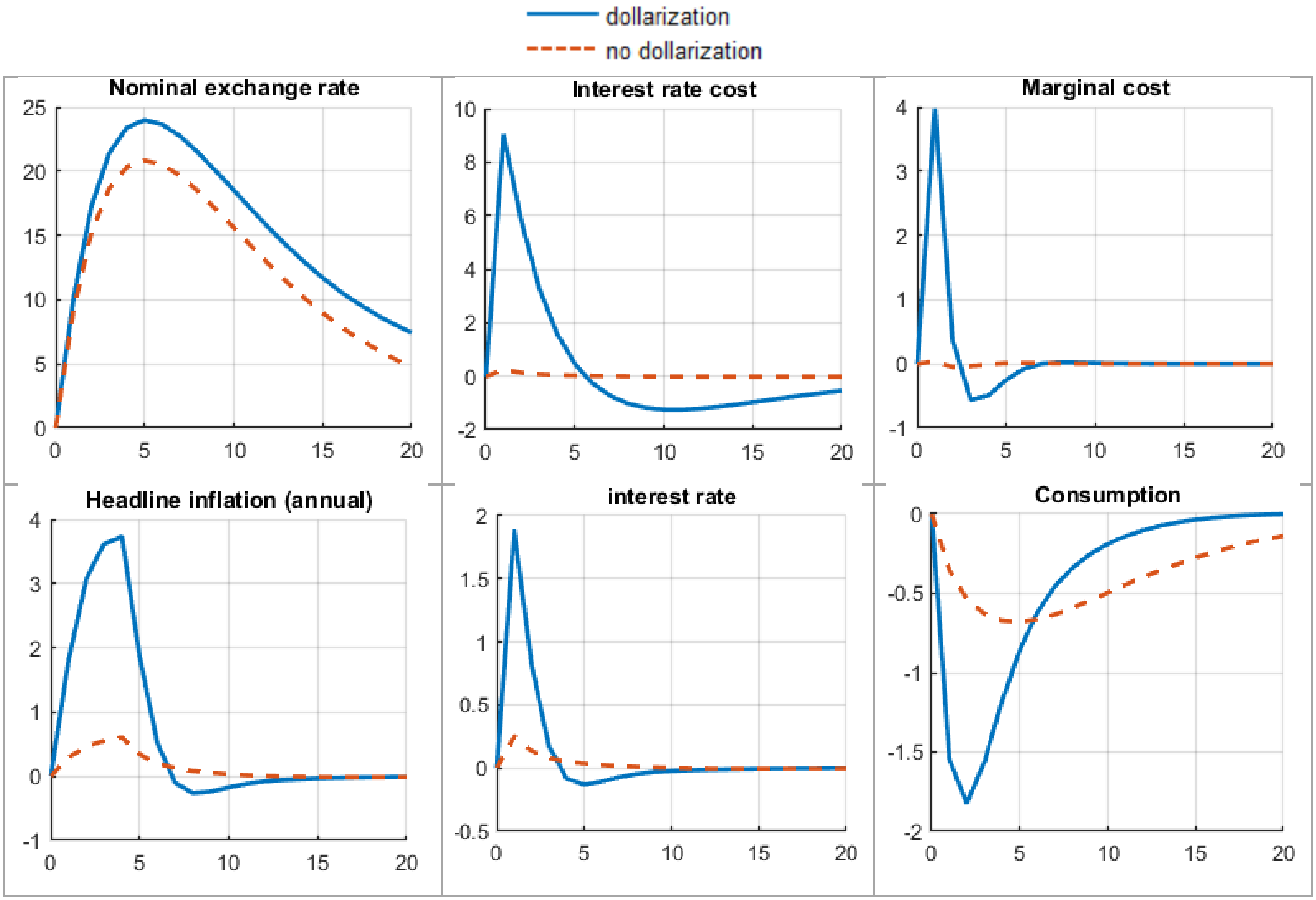
In the highly dollarized country when the US interest rate shock hits the economy, the nominal exchange rate depreciates as a response. Following the modified uncovered interest parity condition (equation 7), US interest rate hike implies long-lasting depreciationary pressure (for about a year) for both real as well as nominal exchange rates. As producers have their liabilities in US dollars in the dollarized economy, US interest rate shock, and a resulting depreciationary pressure, increases their debt service burden. US interest rate shock coupled with an increase in expected depreciation pushes interest rate (debt service) cost by almost 9 pp (which is far higher than an increase in US interest rates, clearly, due to exchange rate). It leads to an increase in marginal costs by 4 pp. Interest rate cost is only a part of the marginal cost and decrease in real wages partially neutralizes its impact, however not fully. Higher marginal cost pushes domestic inflation up by more than 3 pp. In response to this shock, monetary policy tightens and the policy rate increases by nearly 1.6 pp. tightened monetary policy makes consumption drop, which is followed by a decline in aggregate output and employment.

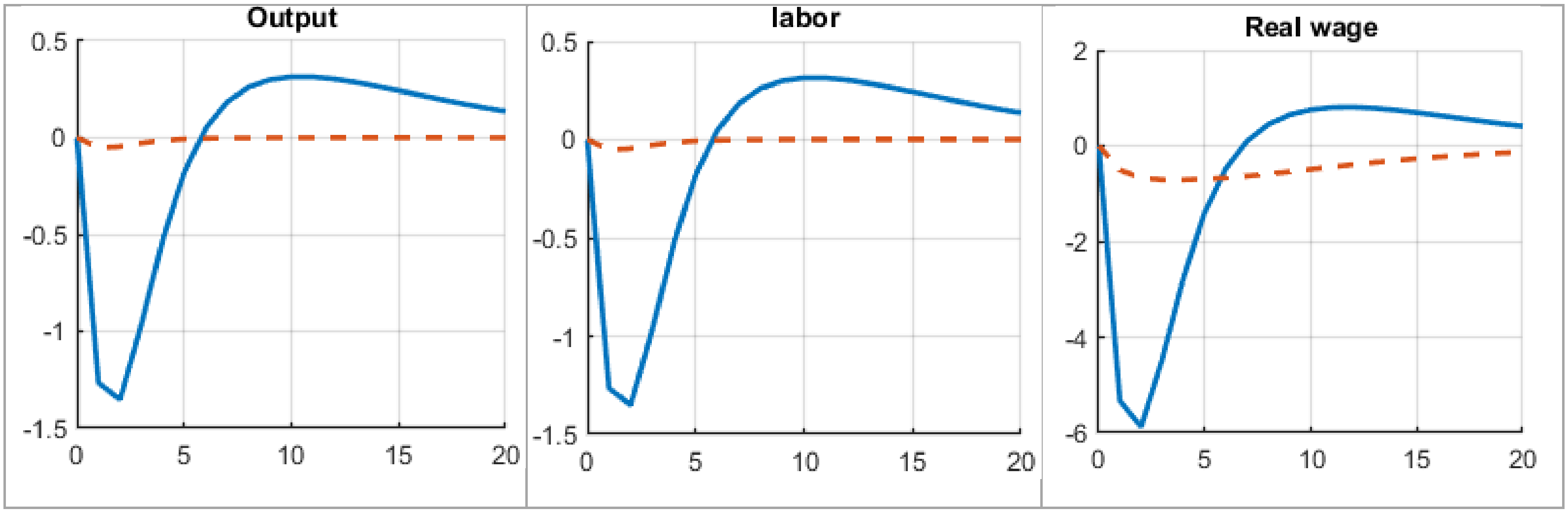
**Figure 4** also illustrates that in an economy without financial dollarization US interest rate shock leads to nominal and real exchange rate depreciation vis-à-vis US dollar, but, interestingly, the size of the depreciation is slightly smaller. Once again, if we assume that real exchange rate against the trading partners remains the same, we get only slight changes in the economy. In other words, while

[3] We consider such a size of the shock so as to make it look like a taper tantrum episode of 2013-2014 years, when increase in long-term US interest rates was almost 2 pp. US dollar back then appreciated globally by around 20% and, interestingly, this is also the number that we get with our model endogenously.

non-dollarized economies barely move, dollarized economies face a picture similar to a supply side shock – where inflation is increasing but the output and employment are declining.

**Figure 4: Impulse responses to a 2 pp shock to the US policy rate (dollarized VS non-dollarized)**






*Source: Authors' estimates*

This analysis provides interesting insights for monetary policymakers. Whenever the Fed tightens the monetary policy stance and increases interest rates, the US dollar strengthens globally. The currencies of small open economies depreciate vis-à-vis the US dollar while their currencies against trading partners remain stable. The traditional approach incorporates effective exchange rate's impact on inflation and, therefore, US interest rate shock's impact on inflation is believed to be muted. In reality, this is not the case and the dominant currency like the US dollar exchange rate has an important impact on the domestic inflation. We suggest liability dollarization as the way to resolve this puzzle. Based on our analysis in dollarized economies central banks are forced to respond to US interest rate shocks as they suffer from balance sheet effects through liability dollarization channel.

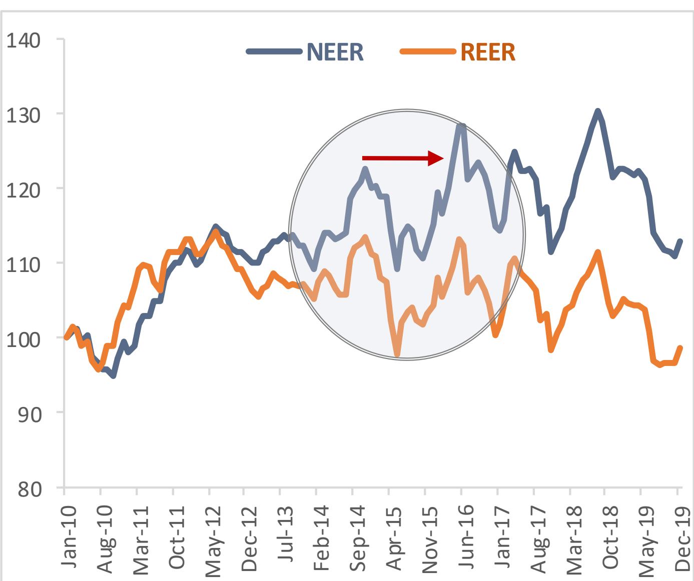
To sum up, while dominant currency paradigm and our approach both explain how US dollar exchange rates may have a significant impact on inflation, they differ in an important way – dominant currency paradigm (invoicing in a dominant currency) says that depreciation against the USD would increase imported inflation, while our approach says that the same depreciation would increase domestic inflation (due to higher FX debt-service costs in domestic production). This is an important way to differentiate the two effects.

# V. Case study: 2014-2015 external shock in Georgia

The channel described above, both econometrically and theoretically, has been something the National Bank of Georgia experienced firsthand. In 2014-2015 Georgia faced a major external shock: its trading partners where depreciating at a high rate. The natural reaction of the domestic market was to put a depreciationary pressure on Georgian lari as well – after all if trading partners depreciate against the US dollar and if you stand still, this means loss of competitiveness against your trading partners and a current account deficit problems in the future. Hence, lari started a big depreciation cycle as well. As a result, nominal effective exchange rate returned to its pre-2014 level, making sure the competitiveness against the trading partners remained intact. However, even though this meant that net export and imported inflation wouldn't change much going forward, Georgia started experiencing inflationary pressures, despite the fact that aggregate demand seemed pretty weak. Against the backdrop of weak demand as well as unchanged effective exchange rate, increasing inflation was a puzzle to some.

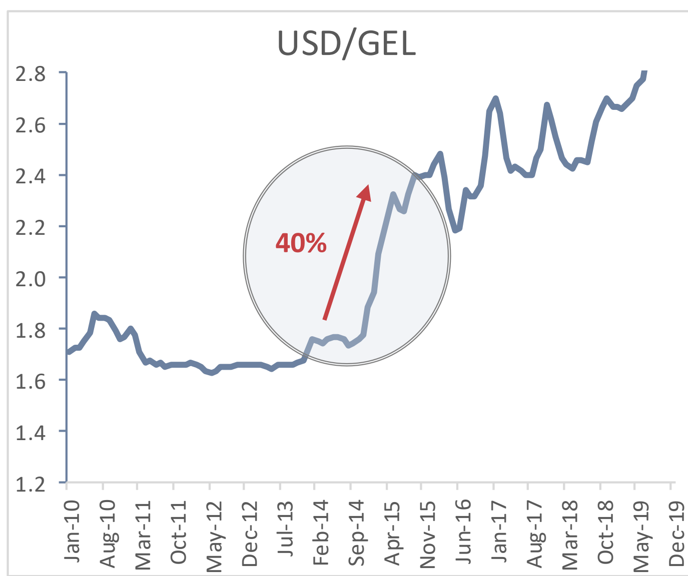
**Figure 5: Main indicators of the Georgian economy (external shock of 2014-2015)**

*Escalating regional tension in Georgia's main trading partners, and oil price shock negatively affected Georgia's economy and NEER as well REER depreciated after earlier appreciation.*



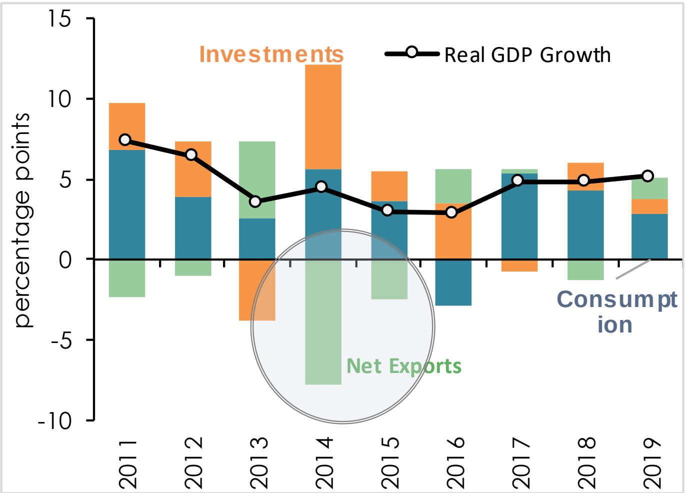

*Source: National Bank of Georgia*

*Meanwhile, US dollar started to strengthen globally and Georgian lari sharply depreciated and remained at a depreciated level relative to the USD.*



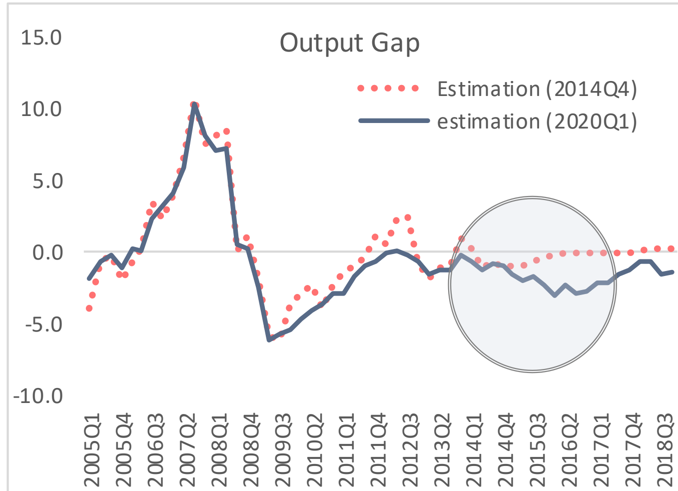

*Source: National Bank of Georgia*

*Due to the negative external demand shock, real GDP growth slowed.*



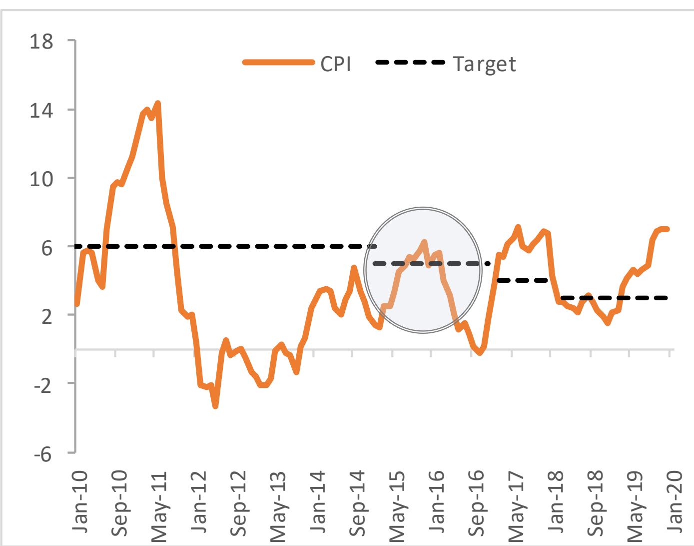

*Source: Geostat; National Bank of Georgia*

*The negative output gap widened – signaling to a negative demand side pressures on headline inflation.*



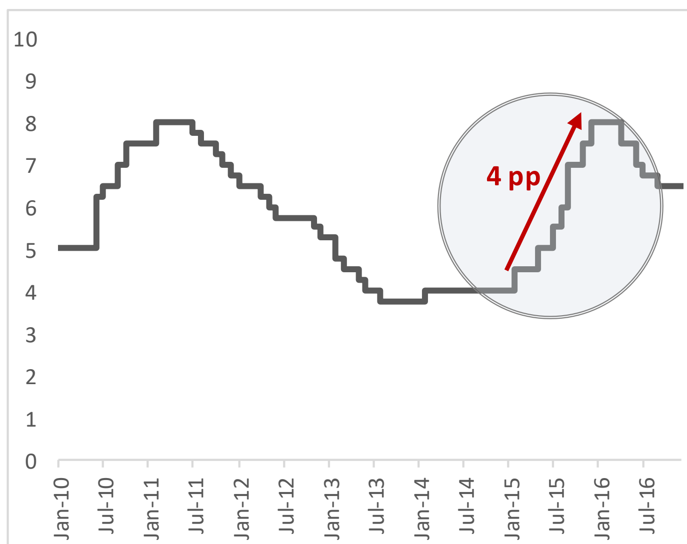

*Source: National Bank of Georgia*

*Exchange rate depreciation pushed inflation up from very low levels and it increased slightly more than the target (which at that time was 5%).*




*Source: Geostat; National Bank of Georgia*

*As a response, the NBG tightened monetary policy stance, which stemmed further increases in inflation.*




*Source: National Bank of Georgia*

The way the NBG resolved this puzzle was through the channel described above – liability dollarization on the part of domestic producers. Exchange rate depreciation increased producers' marginal costs and pushed inflation up. As described above, depreciation had a persistent impact on domestic inflation. Under such circumstances, the NBG's optimal reaction should be to tighten monetary policy stance and contain inflationary pressures. Nevertheless, fundamental factors do not show the necessity of the tightening, as exchange rate depreciation in effective terms were moderate and weak aggregate demand had a downward impact on prices. However, the NBG took into account the possible impact of financial dollarization on inflation. Accordingly, during 2014-2016 the NBG gradually raised monetary policy rate by 4 percentage points, which was even somewhat modest relative to peer countries. Initially, before 2014 the Georgian monetary policy stance was loose. The policy rate was approximately 2.5 pp lower than neutral. Meaning that overall the monetary policy stance was tightened somewhat moderately. Meanwhile, the NBG maintained floating exchange rate regime and were intervening in the FX market only to mitigate excessive volatility. As a result, after a brief overshoot, inflation rate was maintained around the target level, while the exchange rate floated freely to adjust to the new fundamentals. This case study is broadly consistent with impulse responses shown above – demonstrating the importance of the balance sheet channel working on the supply side in real cases as well.

## VI. Conclusions

This paper supports the dominant currency paradigm, in terms of its final impact, as it shows US dollar exchange rate having a significant effect on overall consumer prices. Nonetheless, this paper suggests another approach to thinking how dominant currency may affect domestic inflation, instead of impacting imported inflation. In particular, this paper highlights the importance of liability dollarization, which was either frequently overlooked in economic literature or discussed through only the demand-side channel. In highly dollarized countries, where producers' liabilities are denominated in a foreign currency (mostly in the US dollar), exchange rate movements change their debt-servicing costs. Therefore, producers may respond strongly to US dollar exchange rate movements by changing prices of their products produced mostly domestically. The same conclusion can be extended to other dominant currencies, e.g. euro: countries with liabilities dominated in euro suffering from high degree of pass-through of exchange rate vis-à-vis euro.

The major policy implications that can be drawn from our empirical and theoretical analyses is that monetary policymakers in dollarized economies should not underestimate US monetary policy induced exchange rate fluctuations, even if they have no financial stability implications and don't trade with the US. In particular, when US dollar is strengthening (weakening) globally it has a spillover effect to the rest of the world. Most interestingly small and open economies with highly dollarized balance sheets experience additional upward (downward) pressures on inflation. Under such circumstances even if bilateral exchange rate with main trading partners is stable, monetary policy may be forced to also look at US dollar exchange rates, as long as balance sheets are extensively dollarized.

**Future work**

Something that may complicate the analysis is that there can be nonlinear linkages between exchange rates and consumer prices, especially in highly dollarized countries with floating exchange rate regime. Producers and importers most probably incorporate exchange rate volatility in their price setting strategy to avoid potential losses in case of exchange rate depreciation. Under such circumstances, the magnitude of exchange rate movement can have nonlinear transmission to consumer prices. In case of small-size movements in exchange rates, pass-though could be smaller, while after some threshold, exchange rate depreciation could start having a proportionally larger effect.

In the future work, nonlinear linkages between exchange rate and inflation can be tested. There are some papers trying to find nonlinear linkages between exchange rate and prices. Caseli et al (2016) tested and found nonlinear exchange rate pass-through for 28 emerging countries. In particular, when linear case was tested the degree of exchange rate pass-through was 6 percent, while for the depreciation greater than 10 percent and 20 percent the size of pass-through increased to 18 percent and 25 percent, respectively. Bussiere (2013), on the basis of G7 countries, also finds nonlinear linkages between the exchange rate and import and export prices. Frankel et al (2012) found that depreciations above 25 percent have a proportionally larger pass-through effect. Those research papers tested non-linear linkages based on the nominal effective exchange rate or bilateral exchange rate with trading partners. We think that the same logic would be relevant in the analysis of the dominant currency exchange rate pass-through. Producers could incorporate possible exchange rate volatility in advance. In such a case, producers would absorb small-size depreciations by adjusting their markups. However, after some threshold, exchange rate impact on prices could be larger.

Incorporating nonlinear behavior of exchange rate pass-through in Phillips curve would improve forecast accuracy. However, modeling nonlinearities has been a challenge, since existing solution methods for non-linear models are either quite resource-intensive or not sufficiently accurate. Yet there is some work on this front (e.g. see Mkhatrishvili et al, 2019). If non-linear modeling becomes easier in the future, those strong non-linear linkages could very well become standard features of macroeconomic models used in practice.

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# Appendix A – details of the empirical exercise

**Table A1: List of the countries**

| | |
|---|---|
| **Albania** | ALB |
| **Armenia** | ARM |
| **Georgia** | GEO |
| **Croatia** | HRV |
| **Kazakhstan** | KAZ |
| **Kyrgyzstan** | KRG |
| **Romania** | ROU |
| **Serbia** | SRB |
| **Czech Republic** | CZK |
| **Poland** | PLN |
| **Israel** | IL |

**Table A2: Data sources**

| | |
|---|---|
| **Consumer Price Inflation (CPI)** | Central banks and statistics offices |
| **Nominal Effective Exchange Rate** | Bruegel |
| **Exchange rate vis-s-vis dominant currency** | Central banks |
| **Food Price Index** | FAO |
| **Oil Price (Brent Crude Oil)** | Bloomberg |
| **Real GDP growth** | IMF and statistics offices |
| **Dollarization (FX loans as a share of total credit portfolio)** | Central banks |

**Table A3: Baseline model**

| | ***Equation 1*** | | |
|---|---|---|---|
| | ***Consumer Price Inflation (CPI)*** | | |
| **$CPI_{t-1}$** | **0.3920*** | **0.3872*** | **0.3921*** |
| | (0.0207) | (0.0206) | (0.0219) |
| **$NEER_t$** | **-0.3210*** | **-0.3253*** | **-0.3240*** |
| | (0.0387) | (0.0387) | (0.0410) |
| **$NEER_{t-1}$** | **0.1794*** | **0.1801*** | **0.1773*** |
| | (0.0471) | (0.0472) | (0.0499) |
| **$NEER_{t-2}$** | **-0.0439** | **-0.0402** | **-0.0351** |
| | (0.0466) | (0.0467) | (0.0494) |
| **$NEER_{t-3}$** | **-0.0210** | **-0.0243** | **-0.0273** |
| | (0.0311) | (0.0311) | (0.0329) |
| **Food $Inflation_t$** | **0.2136*** | **0.1702*** | |
| | (0.0263) | (0.0151) | |
| **Real GDP $Growth_{t-4}$** | **0.1476*** | **0.1552*** | **0.0614*** |
| | (0.0518) | (0.0518) | (0.0081) |
| **Oil $Inflation_t$** | **-0.0266*** | | **0.1734**** |

| | | | |
|---|---|---|---|
| | (0.0132) | | (0.0548) |
| **Constant** | **0.0136** | **0.0135** | **0.0144** |
| **Observations** | **455** | **455** | **455** |
| **Number of countries** | **8** | **8** | **8** |
| **AR(2) p value** | **0.6269** | **0.7050** | **0.9787** |
| **Sargan p value** | **0.7312** | **0.7290** | **0.7475** |

***** P<0.01 ** P<0.05 * P<0.1**

**AR(2) –** Arellano and Bond autocorrelation tests the null hypothesis that errors terms in the first difference have no second order serial correlation serially uncorrelated

**Sargan** – Instruments overidentification test. Tests the null hypothesis that the instruments used are not correlated with the residuals.

*NEER increase means appreciation*

**Source: authors' estimates**

**Table A4: Baseline extended with exchange rate against a dominant currency**

| | ***Equation 2*** | | |
|---|---|---|---|
| | ***Consumer Price Inflation (CPI)*** | | |
| **$CPI_{t-1}$** | **0.4110***** | **0.4072***** | **0.4149***** |
| | (0.0214) | (0.0213) | (0.0226) |
| **$NEER_{t}$** | **-0.1788***** | **-0.1803***** | **-0.1765***** |
| | (0.0421) | (0.0422) | (0.0445) |
| **$NEER_{t-1}$** | **0.0957**** | **0.0954*** | **0.0880*** |
| | (0.0500) | (0.0501) | (0.0528) |
| **$NEER_{t-2}$** | **-0.0325** | **-0.0311** | **-0.0264** |
| | (0.0515) | (0.0516) | (0.0544) |
| **$NEER_{t-3}$** | **-0.0143** | **-0.0149** | **-0.0176** |
| | (0.0348) | (0.0348) | (0.0367) |
| **$ER_{t}$** | **0.1094***** | **0.1105***** | **0.1133***** |
| | (0.0126) | (0.0126) | (0.0133) |
| **$ER_{t-1}$** | **-0.0641***** | **-0.0643***** | **-0.0691***** |
| | (0.0130) | (0.0131) | (0.0138) |
| **$ER_{t-2}$** | **-0.0014** | **-0.0017** | **-0.0024** |
| | (0.0130) | (0.0130) | (0.0137) |
| **$ER_{t-3}$** | **-0.0024** | **-0.0022** | **-0.0015** |
| | (0.0086) | (-0.0022) | (0.0091) |
| **Food $Inflation_{t}$** | **0.1981**** | **0.1650***** | |
| | (0.0247) | (0.0145) | |
| **Real GDP $Growth_{t-4}$** | **0.1414***** | **0.1450***** | **0.1550***** |
| | (0.0487) | (0.0488) | (0.0514) |
| **Oil $Inflation_{t}$** | **-0.0201*** | | **0.0593***** |
| | (0.0122) | | (0.0075) |
| **Constant** | **0.0125** | **0.0125** | **0.0136**** |

| | | | |
|---|---|---|---|
| **Observations** | **455** | **455** | **455** |
| **Number of countries** | **8** | **8** | **8** |
| **AR(2) p value** | **0.9895** | **0.9898** | **0.9892** |
| **Sargan p value** | **0.3342** | **0.3759** | **0.5872** |

***** P<0.01 ** P<0.05 * P<0.1**

**AR(2) –** Arellano and Bond autocorrelation tests the null hypothesis that errors terms in the first difference have no second order serial correlation serially uncorrelated

**Sargan** – Instruments overidentification test. Tests the null hypothesis that the instruments used are not correlated with the residuals.

*NEER increase means appreciation; ER (exchange rate vis-à-vis dominant currency) increase means depreciation*

**Source: authors' estimates**

**Table A5: Baseline extended with exchange rate against a dominant currency and interaction term between dollarization and dominant currency exchange rate**

| | *Equation 3* | | | | |
|---|---|---|---|---|---|
| | *Consumer Price Inflation (CPI)* | | | | |
| **$CPI_{t-1}$** | **0.4319***** | **0.4028***** | **0.4689***** | **0.4665***** | |
| | (0.0180) | (0.0174) | (0.0202) | (0.0215) | |
| **$NEER_t$** | **-0.2651***** | **-0.1935***** | **-0.0391** | **-0.0391** | **-0.0245** |
| | (0.0333) | (0.0338) | (0.0663) | (0.0669) | (0.0421) |
| **$NEER_{t-1}$** | **0.1237***** | **0.0909***** | **-0.1201** | **-0.1208** | **-0.1514** |
| | (0.0401) | (0.0396) | (0.1562) | (0.1561) | (0.0616) |
| **$NEER_{t-2}$** | **-0.0256** | **-0.0212***** | **0.1270** | **0.1312** | **0.1576***** |
| | (0.0401) | (0.0398) | (0.1234) | (0.1258) | (0.0609) |
| **$NEER_{t-3}$** | **-0.0145** | **-0.0149** | **-0.1267***** | **-0.1299***** | **-0.1482***** |
| | (0.0272) | (0.0269) | (0.0727) | (0.0745) | (0.0386) |
| **$ER_t$** | | **0.0977***** | **0.1006***** | **0.1023***** | 0**.0937***** |
| | | (0.0119) | (0.0372) | (0.0363) | (0.0194) |
| **$ER_{t-1}$** | | **-0.0563***** | **-0.0542***** | **-0.0543***** | **-0.0560***** |
| | | 0.0122 | (0.0315) | ( 0.0315) | (0.0187) |
| **$ER_{t-2}$** | | **0.0065** | **-0.0105***** | **-0.0110** | **-0.0150** |
| | | (0.0122) | (0.0228) | (0.0231) | (0.0189) |
| **$ER_{t-3}$** | | **-0.0042** | **0.0084** | **0.0088** | **0.0124** |
| | | (0.0080) | (0.0110) | (0.0113) | (0.0130) |
| **$Dol_t*ER_t$** | | | **0.1676***** | **0.1681***** | **0.1855** |
| | | | (0.0902) | (0.0896) | (0.0381) |

| | | | | | |
|---|---|---|---|---|---|
| **$Dol_{t-1}$*$ER_{t-1}$** | | | **-0.1427***** | **-0.1429 ***** | **-0.1604***** |
| | | | (0.0382) | (0.0375) | (0.0424) |
| **$Dol_{t-2}$*$ER_{t-2}$** | | | **0.0778** | **0.0796** | **0.0937** |
| | | | (0.0745) | ( 0.0762) | (0.0434) |
| **$Dol_{t-3}$*$ER_{t-3}$** | | | **-0.0574** | **-0.0587** | **-0.0688** |
| | | | (0.0387) | (0.0397) | (0.0288) |
| **Food Inflation$_t$** | **0.1791***** | **0.1723***** | **0.1475***** | **0.1290***** | |
| | (0.0200) | (0.0177) | (0.0451) | (0.0320) | |
| **Real GDP Growth$_{t-4}$** | **0.1466** | **0.1499***** | **0.1549***** | **0.1568***** | **0.1581***** |
| | (0.0446) | (0.0420) | (0.0173) | ( 0.0183) | ( 0.0312) |
| **Oil Inflation$_t$** | **-0.0192** | **-0.0110** | **-0.0111** | | **0.0450***** |
| | (0.0100) | (0.0088) | (0.0103) | | (0.0042 ) |
| **Constant** | **0.0102***** | **0.0029***** | **0.0015***** | **0.0079 ***** | **0.0084***** |
| **Observations** | **638** | **638** | **638** | **638** | **638** |
| **Number of countries** | **11** | **11** | **11** | **11** | **11** |
| **AR(2) p value** | **0.1465** | **0.1370** | **0.3146** | **0.3099** | **0.3181** |
| **Sargan p value** | **0.7348** | **0.8122** | **0.1038** | **0.1031** | **0.1004** |

***** P<0.01 ** P<0.05 * P<0.1**

**AR(2) –** Arellano and Bond autocorrelation tests the null hypothesis that errors terms in the first difference have no second order serial correlation serially uncorrelated

**Sargan** – Instruments overidentification test. Tests the null hypothesis that the instruments used are not correlated with the residuals.

*NEER increase means appreciation; ER (exchange rate vis-à-vis dominant currency) increase means depreciation*

**Source: authors' estimates**

**Table A6: Fixed effect model (baseline)**

| | *Consumer Price Inflation (CPI)* | | | | | |
|---|---|---|---|---|---|---|
| **AR (1)** | **0.8641** | **0.8645** | **0.8642** | **0.8640** | **0.8603** | **0.8593** |
| | | | | | | |
| **NEER$_t$** | **-0.2593***** | **-0.2631***** | **-0.2635***** | **-0.2688***** | **-0.2703***** | **-0.2908***** |
| | (0.0407) | (0.0413) | (0.0413) | (0.4159) | (0.0418) | (0.0461) |
| **NEER$_{t-1}$** | **0.1785** | **0.0177** | **0.0190** | **0.0190** | **0.0204** | **0.0198** |
| | (0.0305) | (0.0305) | (0.0308) | (0.0308) | (0.0309) | (0.0341) |
| **NEER$_{t-2}$** | | | **-0.0124** | **-0.0085** | **-0.0057** | **-0.0032** |
| | | | (0.0304) | (0.0306) | (0.0307) | (0.0340) |
| **NEER$_{t-3}$** | | | | **-0.0349** | **-0.0354** | **-0.0434** |
| | | | | (0.0305) | (0.0307) | (0.0339) |
| **Food Inflation$_t$** | **0.5356***** | **0.5357***** | **0.5359***** | **0.5342***** | **0.4418***** | |
| | (0.0407) | (0.0516) | (0.0516) | (0.0516) | (0.0304) | |
| **Real GDP Growth$_{t-4}$** | **0.1785**** | **0.1789**** | **0.1804**** | **0.1762**** | **0.1832**** | **0.1861**** |
| | (0.0852) | (0.0853) | (0.0854) | (0.0855) | (0.0858) | (0.0949) |
| **Oil Inflation$_t$** | **-0.0541**** | **-0.0538**** | **-0.0541**** | **-0.0539**** | | **0.1523***** |

| | | | | | | |
|---|---|---|---|---|---|---|
| | (0.0246) | (0.0246) | (0.0246) | (0.0246) | | (0.0160) |
| **Constant** | **0.0463** | **0.0464** | **0.0462*** ** | **0.0462*** ** | **0.0446*** ** | **0.0528*** ** |
| **Number of countries** | **8** | **8** | **8** | **8** | **8** | **8** |
| **R Squared** | **0.4249** | **0.424** | **0.425** | **0.4273** | **0.4372** | **0.3552** |
| ***** P<0.01 ** P<0.05 * P<0.1** | | | | | | |
| *NEER increase means appreciation* | | | | | | |

**Source: authors' estimates**

**Table A7: Fixed effect model (extended with bilateral exchange rate vis-à-vis a dominant currency)**

| | *Consumer Price Inflation (CPI)* | | | | | |
|---|---|---|---|---|---|---|
| **AR (1)** | **0.8748** | **0.8743** | **0.8741** | **0.8740** | **0.8713** | **0.8714** |
| | | | | | | |
| **$NEER_t$** | **-0.1434*** ** | **-0.1390*** ** | **-0.1384*** ** | **-0.1391*** ** | **-0.1374*** ** | **-0.1347*** ** |
| | (0.0459) | (0.0463) | (0.0463) | (0.0463) | (0.0465) | (0.0512) |
| **$NEER_{t-1}$** | **0.0156** | **0.0016** | **0.0038** | **0.0039** | **0.0032** | **-0.0060** |
| | (0.0297) | (0.0346) | (0.0347) | (0.0347) | (0.0348) | (0.0383) |
| **$NEER_{t-2}$** | **-0.0061** | **-0.0055** | **-0.0194** | **-0.0173** | **-0.0151** | **-0.0150** |
| | (0.0296) | (0.0296) | (0.0344) | (0.0345) | (0.0346) | (0.0381) |
| **$NEER_{t-3}$** | **-0.0233** | **-0.0238** | **-0.0231** | **-0.0357** | **-0.0369** | **-0.0488** |
| | (0.0296) | (0.0296) | (0.0297) | (0.0343) | (0.0344) | (0.0379) |
| **$ER_t$** | **0.0682*** ** | **0.0692*** ** | **0.0697*** ** | **0.0697*** ** | **0.0712*** ** | **0.0826*** ** |
| | (0.0121) | (0.0121) | (0.0122) | (0.0122) | (0.0122) | (0.0134) |
| **$ER_{t-1}$** | | **-0.0063** | **-0.0060** | **-0.0059** | **-0.0068** | **-0.0106** |
| | | (0.0079) | (0.0079) | (0.0079) | (0.0079) | (0.0087) |
| **$ER_{t-2}$** | | | **-0.0063** | **-0.0059** | **-0.0061** | **-0.0079** |
| | | | (0.0079) | (0.0079) | (0.0079) | (0.0087) |
| **$ER_{t-3}$** | | | | **-0.0057** | **-0.0062** | **-0.0090** |
| | | | | (0.0078) | (0.0079) | (0.0086) |
| **Food $Inflation_t$** | **0.5111*** ** | **0.5085*** ** | **0.5073*** ** | **0.5058*** ** | **0.4268*** ** | |
| | (0.0502) | (0.0503) | (0.0504) | (0.0504) | (0.0296) | |
| **Real GDP $Growth_{t-4}$** | **0.1746** ** | **0.1795** ** | **0.1844** ** | **0.1846** ** | **0.1912** ** | **0.1989** ** |
| | (0.0827) | (0.0829) | (0.0832) | (0.0833) | (0.0834) | (0.0919) |
| **Oil $Inflation_t$** | **-0.0478** ** | **-0.0467** ** | **-0.0465* ** | **-0.0460** ** | | **0.1488*** ** |
| | (0.0239) | (0.0239) | (0.0239) | (0.0240) | | (0.0155) |
| **Constant** | **0.0474*** ** | **0.0471** | **0.0469** | **0.0469** | **0.0455** | **0.0536** |
| **Number of countries** | **8** | **8** | **8** | **8** | **8** | **8** |
| **R Squared** | **0.4058** | **0.4119** | **0.4155** | **0.4166** | **0.4235** | **0.3249** |
| ***** P<0.01 ** P<0.05 * P<0.1** | | | | | | |
| *NEER increase means appreciation; ER increase means depreciation.* | | | | | | |

**Source: authors' estimates**

**Table A8: Fixed effect model (extended with bilateral exchange rate vis-à-vis a dominant currency and interaction term between dollarization and dominant currency exchange rate)**

| | *Consumer Price Inflation (CPI)* | | | | | |
|---|---|---|---|---|---|---|
| **AR(1)** | **0.7612** | **0.7542** | **0.7501** | **0.7437** | **0.7435** | **0.7240** |
| | | | | | | |
| **$NEER_t$** | **-0.0271** | **0.0002** | **0.0038** | **-0.0057** | **-0.0032** | **-0.0134** |
| | (0.0471) | (0.0505) | (0.0512) | (0.0519) | (0.0519) | (0.0549) |
| **$NEER_{t-1}$** | **-0.0157** | **-0.0502** | **-0.0489** | **-0.0564** | **-0.0581** | **-0.1012** |
| | (0.0402) | (0.0487) | (0.0524) | (0.0529) | (0.0529) | (0.0555) |
| **$NEER_{t-2}$** | **-0.0074** | **0.0087** | **0.0140** | **0.0340** | **0.0401** | **0.0532** |
| | (0.0389) | (0.0406) | (0.0501) | (0.0528) | (0.0525) | (0.0556) |
| **$NEER_{t-3}$** | **-0.0504*** | **-0.0422** | **-0.0409** | **-0.0769** | **-0.0799**** | **-0.1250** |
| | (0.0384) | (0.0387) | (0.0407) | (0.0485) | (0.0484) | (0.0504) |
| **$ER_t$** | **0.1168***** | **0.1232***** | **0.1252***** | **0.1376***** | **0.1408***** | **0.1426***** |
| | (0.0235) | (0.0242) | (0.0255) | (0.0282) | (0.0280) | (0.0314) |
| **$ER_{t-1}$** | **-0.0195*** | **0.0082** | **0.0098** | **0.0170** | **0.0179** | **0.0031** |
| | (0.0146) | (0.0229) | (0.0233) | (0.0243) | (0.0243) | (0.0263) |
| **$ER_{t-2}$** | **-0.0054** | **-0.0049** | **-0.0015** | **0.0019** | **0.0023** | **-0.0094** |
| | (0.0136) | (0.0137) | (0.0222) | (0.0225) | (0.0225) | (0.0240) |
| **$ER_{t-3}$** | **-0.0144** | **-0.0137** | **-0.0137** | **0.0075** | **0.0085** | **0.0034** |
| | (0.0132) | (0.0133) | (0.0134) | (0.0219) | (0.0219) | (0.0232) |
| **$Dol_t*ER_t$** | **0.1072**** | **0.0971**** | **0.0927**** | **0.0599*** | **0.0587*** | **0.0536** |
| | ( 0.0432) | (0.0437) | (0.0482) | (0.0494) | (0.0548) | (0.0607) |
| **$Dol_{t-1}*ER_{t-1}$** | | **-0.0706** | **-0.0744** | **-0.0956** | **-0.0977 **** | **-0.1111** |
| | | (0.0458) | (0.0462) | (0.0463) | (0.0493) | (0.0532) |
| **$Dol_{t-2}*ER_{t-2}$** | | | **-0.0055** | **-0.0096** | **-0.0077** | **0.0030** |
| | | | (0.0460) | (0.0445) | ( 0.0463) | (0.0492) |
| **$Dol_{t-3}*ER_{t-3}$** | | | | **-0.0581** | **-0.0604** | **-0.0790** |
| | | | | (0.0445) | (0.0444) | (0.0469) |
| **$Food\ Inflation_t$** | **0.2316***** | **0.2311**** | **0.2339***** | **0.2341***** | **0.2099 ***** | |
| | (0.0281) | (0.0281) | (0.0284) | (0.0285) | (0.0178) | |
| **$Real\ GDP\ Growth_{t-4}$** | **0.1400***** | **0.1445**** | **0.1416**** | **0.1481***** | **0.1482***** | **0.1428***** |
| | (0.0487) | (0.0488) | (0.0491) | ( 0.0491) | (0.0491) | ( 0.0514) |
| **$Oil\ Inflation_t$** | **-0.0151** | **-0.0138 **** | **-0.0140** | **-0.0142** | | **0.0673***** |
| | (0.0129) | (0.0129) | (0.0130) | (0.0130) | | ( 0.0086) |
| **Constant** | **0.0345***** | **0.0342***** | **0.0338***** | **0.0335***** | **0.0331***** | **0.0348***** |
| **Number of countries** | **11** | **11** | **11** | **11** | **11** | **11** |
| **R Squared** | **0.4840** | **0.4868** | **0.4880** | **0.4904** | **0.4891** | **0.4180** |

***** P<0.01 ** P<0.05 * P<0.1**

*NEER increase means appreciation; ER increase means depreciation.*

**Source: authors' estimates**

# Appendix B – model equations

Hybrid Phillips Curve:

$$\pi_t^H = \frac{\beta}{1+\beta} E_t \pi_{t+1}^H + \frac{1}{1+\beta} \pi_{t-1}^H + \frac{\beta}{1+\beta} \frac{(1-\beta\theta)(1-\theta)}{\theta} (mc_t - mc_{ss})$$

Marginal costs:

*Without dollarization:*

$$mc_t = i_t + (w_t - p_t - a_t)$$

*With dollarization:*

$$mc_t = \left(i_t^{usd} + E_t s_{t+1} - s_t\right) + (w_t - p_t - a_t)$$

Real wages:

$$w_t - p_t = \sigma c_t + \vartheta n_t$$

Headline inflation:

$$\pi_t = \pi_t^H + \frac{\alpha}{1-\alpha}(reer_t - reer_{t-1})$$

UIP condition:

$$(i_t - \pi_t) - (i_t^{us} - \pi_t^{us}) = E_t e_{t+1} - \mu e_t + b\varphi e_{t-1}$$

*where,* $\mu = 1 + b\,\varphi + \gamma\, b\, \delta^2$

Real exchange rate:

$$e_t = s_t + p_t^{us} - p_t^H$$

Domestic price level:

$$p_t^H = p_{t-1}^H + \pi_t^H$$

Foreign price level:

$$p_t^{us} = p_{t-1}^{us} + \pi_t^*$$

Foreign inflation:

$$\pi_t^{us} = \rho_\pi \pi_{t-1}^{us} + (1 - \rho_\pi)\pi_{ss}^{us} + \epsilon_\pi$$

Foreign interest rate:

$$i_t^{us} = \rho_i i_{t-1}^{us} + (1 - \rho_i) i_{ss}^{us} + \epsilon_i$$

Monetary policy reaction function:

$$i_t = r + \pi + \tau[E_t\pi_{t+1} - \pi]$$

Households' consumption:

$$c_t = \frac{h}{1+h}c_{t-1} + \frac{1}{1+h}E_t c_{t+1} - \frac{1}{\sigma}\ (i_t - E_t\pi_{t+1} - \rho\ )$$

$where, \rho = \beta^{-1} - 1$

Firms' output:

$$y_t = a_t + n_t$$

Technology process:

$$a_t = \rho_a a_{t-1} + \varepsilon_t$$

Market clearing condition (aggregate demand):

$$y_t = c_t + \frac{\alpha\omega}{\sigma}\frac{reer_t}{(1-\alpha)}$$

In those equations:

| | |
|---|---|
| $\pi_t^H$ | – Home country's domestic inflation |
| $\pi_t$ | – Headline inflation |
| $\pi$ | – Inflation target |
| $p_t$ | – Consumer price index (CPI) |
| $p_t^H$ | – Domestic price level |
| $mc_t$ | – Marginal cost |

$mc_{ss}$ – Steady state of marginal cost

$i_t$ – Monetary policy interest rate

$i_t^{us}$ – US monetary policy rate

$i_{ss}^{us}$ – Steady state of US monetary policy rate

$\pi_t^{us}$ – US inflation

$\pi^{ss}$ – US inflation target

$p_t^{us}$ – US CPI

$e_t$ – Real US dollar exchange rate

$s_t$ – Nominal US dollar exchange rate

$reer_t$ – Real effective exchange rate

$w_t$ – Wage

$a_t$ – Productivity

$c_t$ – Consumption

$y_t$ – Output

$n_t$ – Labor

**Table B1: Model parameters**

| **Parameters** | $\beta$ | $\theta$ | $\sigma$ | $\vartheta$ | $\alpha$ | $b$ | $\varphi$ | $\gamma$ | $\delta$ | $\rho_\pi$ | $\rho_i$ | $\tau$ | $h$ | $\rho_a$ | $\omega$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 0.99 | 0.5 | 1 | 3 | 0.4 | 0.085 | 10 | 50 | 0.0271 | 0.8 | 0.8 | 1.5 | 1 | 0.66 | 1 |

*Calibration is based on Gali and Monacelli (2005) and Baccheta and Wincoop (2019).

**Table B2: Steady state values**

| **Steady state values** | $mc_{ss}$ | $\pi$ | $i_{ss}^{*}$ | $\pi^{*}$ |
|---|---|---|---|---|
| | 4 | 3 | 3 | 2 |

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