Real Interest Rates and Productivity in Small Open Economies*

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February 2023

Abstract

We construct factor utilization-adjusted measures of aggregate TFP for a sample of advanced (AEs) and emerging market small open economies (EMEs). We estimate the effects of real interest rate shocks on TFP and GDP using structural VARs. The results are starkly different in the two groups of countries. While TFP is pro-cyclical in both sets of countries, lower real interest rates - a proxy for capital inflows - lead to productivity booms in EMEs, whereas they lead to a contraction in productivity in AEs.

Keywords: aggregate productivity, real interest rates, capital inflows, structural VARs.

JEL Classification Numbers: F32, F41.

*We thank George Alessandria, Manuel Amador, Philippe Bacchetta, Gadi Barlevy, Jeffrey Campbell, Ambrogio Cesa-Bianchi, Stefano Gnocchi, Luca Guerrieri, Stéphane Guibaud, Oleg Itskhoki, Masashige Hamano, Jonathan Heathcote, Robert Kollmann, Luisa Lambertini, Miguel Leon-Ledesma, Pierlauro Lopez, Matthias Meier, Alberto Martín, Makoto Nakajima, Nitya Pandalai-Nayar, José-Luis Peydró, Fabrizio Perri, Albert Queralto, Robert M. Townsend, Jing Zhang, two anonymous referees and participants at GSE summer forum 2018, ESSIM 2018, Midwest Macro 2018, CEF 2018, T2M 2018, AMSE-BdF Workshop on Open Macro 2017, BdF-BoE workshop 2016, ESEM 2016, SAET 2015 and various seminars at Minneapolis FED, Chicago FED, FED Board, Bank of Canada, Reserve Bank of Australia, Michigan State University, UCL, Banca d'Italia, Banque de France, Bocconi University, ESM, and CREST for helpful suggestions. We thank Francesco Nuzzi, Roberto Colarieti, Niccoló Cattadori, Francesco Giovanardi, Eugenia Menaguale and Muriel Metais for excellent research assistance. All remaining errors are ours. The views expressed in this paper are those of the authors and do not reflect those of the Bank of France.

1 Introduction

Real interest rates are considered important determinants of business cycle fluctuations, especially in emerging market economies. Periods of high (low) real interest rates are associated to economic contractions (expansions) (Neumeyer and Perri (2005), Uribe and Yue (2006) and Akinci (2013)). In the presence of financial frictions, variations in real interest rates, and the ensuing capital flows, are also believed to affect the allocation of capital and labor across firms and sectors, and therefore aggregate productivity (Reis, 2013; Gopinath et al., 2017; Castillo-Martinez, 2020). In this paper, we study the effects of variations in real interest rates on aggregate total factor productivity (TFP) and the real exchange rate in *both* emerging market (EMEs) and advanced small open economies (AEs).

Our analysis relates to three sets of issues. First, the recent heated debate on the effects of especially low interest rates in the AEs on capital flow in emerging markets (Rey, 2013; Passari and Rey, 2015; Miranda-Agrippino and Rey, 2015). Second, the effect, since the onset of the euro area, of lower real interest rates on capital inflows in the euro area periphery (Reis, 2013; Gopinath et al., 2017; Castillo-Martinez, 2020; Siena, 2021). Those inflows have been associated with current account imbalances, loss of competitiveness, and a slowdown in aggregate productivity. The dismal performance of productivity in the euro area periphery in the first decade of the 2000s, in particular, has ignited a wider debate on the alleged "misallocation effects" of capital (in)flows. Third, the role of real interest rate fluctuations for EMEs business cycles (Neumeyer and Perri, 2005; Uribe and Yue, 2006; Aguiar and Gopinath, 2007). Noticeably, the latter empirical literature has generally not focused on the *causal* effect on total factor productivity of variations in real interest rates, usually treating real interest rates and productivity as co-moving exogenous processes.

Using a structural vector auto regression (VAR) analysis we document a striking difference between EMEs and AEs. Conditional on identified real interest rate shocks, aggregate productivity moves in opposite directions in EMEs and in AEs. An unexpected rise in the real interest rate causes (on average) a *fall* in productivity in EMEs, while the opposite holds for AEs countries (i.e., a positive real interest rate shock causes a *rise* in productivity). This result holds independently of the measure of the real interest rate and of using a factor-utilization adjusted or a simple measure of aggregate TFP.

In all cases aggregate TFP responds pro-cyclically to real interest rate shocks (i.e., productivity is conditionally positively correlated to GDP), yet GDP responds positively to a positive real interest rate shock in AEs whereas it responds negatively in EMEs. In EMEs, a rise in the real interest rate causes a depreciation of the real exchange rate while in all countries it improves the trade balance, consistent with the view that a positive real interest rate shock proxies a capital outflow.

A noticeable implication of our results is that the alleged "misallocation narrative" of capital flows - whereby capital inflows associated with lower real interest rates lead to a slowdown in aggregate TFP - seems to describe well only the experience of the AEs, and especially of the euro area periphery countries since the onset of the euro, as, e.g., in Gopinath et al. (2017)). But the same narrative is clearly at odds with our observed evidence for EMEs: in EMEs lower real interest rates and capital inflows lead to a pro-cyclical rise in aggregate TFP.

Related literature. Our paper relates to different strands of the literature, connecting business cycles, productivity and capital flows. Within a standard RBC small open economy model, Mendoza (1991) and Correia et al. (1995) show that interest rate fluctuations account only for a small fraction of business cycle fluctuations in EMEs. Neumeyer and Perri (2005) find that the importance of interest rate shocks can be restored by augmenting a real business cycle model with a working capital constraint, zero wealth elasticity of labor supply and correlated movements of productivity and country risk (the latter being a component of the interest rate). In line with this finding, Neumeyer and Perri (2005) show that an (exogenous) negative correlation between real interest rates and (temporary) productivity shocks allows to better match the business cycle moments of EMEs. Uribe and Yue (2006) find that this approach might overestimate the role of world interest rate shocks as it does not account for the endogenous movements of domestic interest rates in response to domestic macroeconomic conditions. Other papers investigating the role of real interest rates shocks for emerging market business cycles are Aguiar and Gopinath (2007), García-Cicco et al. (2010) and Akinci (2013). All these papers, however, share the common feature of treating aggregate productivity like an exogenous stochastic process.

A recent iterature on endogenous firm level productivity (Guerron-Quintana and Jinnai (2019) and Queralto (2020)) higlights that interest rate shocks can trigger a reduction in firm-level productivity, leading to a slowdown in aggregate productivity growth.

Pratap and Urrutia (2012) and Meza et al. (2019) study the productivity effects during EMEs financial crises, focusing on a systematic relationship between capital flows, misallocation, and productivity movements. Moreover, using detailed firm-level data, Alfaro et al. (2019) show that productivity responds negatively to a real exchange rate depreciation in most EMEs (with the exception of export-oriented emerging Asia), while it does not have significant effects on firms in industrialized economies. This is consistent with our (aggregate) empirical results. Also consistent with our findings, Gopinath et al. (2017) provide empirical evidence, at the micro level, that the reduction in real interest rates at the onset of the euro contributed, via a misallocation channel in the manufacturing sector, to a slowdown in productivity in Spain (as well as in other Euro area periphery countries). A similar argument is put forward by Reis (2013) and Bilan et al. (2019) concerning the productivity growth slowdown in Portugal after the adoption of the euro, and by Cette et al. (2016) for Italy and Spain. Furthermore, Castillo-Martinez (2020) shows that the capital outflow of Spain in 2009-2013 caused an increase in aggregate TFP and this was imputable to the operation of an extensive margin of firms (i.e. less productive firms exiting the market). All this evidence is in line with our empirical findings for AEs.

Focusing on EMEs, Ates and Saffie (2021) show that the sudden stop in capital inflows that hit Chile in 1998 led to a selection effect among entrants in the manufacturing sector: it slowed down firms' entry, especially of the least productive ones. Hence a capital outflow, in that episode, was associated to a reduction in TFP. Queralto (2020) shows that the tightening of financial conditions during the 1997 sudden stop in South Korea resulted in a fall in the number of entrants, a sharp decline in R&D, and a decline in productivity.

Midrigan and Xu (2014), using a theoretical framework and Korean manufacturing data, find that in the presence of two sectors (a traditional less productive sector and a manufacturing more productive sector), as well as financial frictions, (i) entrants are less productive than the average in periods of higher borrowing limits (like a sudden stop); (ii) there are more entrants in the traditional sector and less in the manufacturing sector during a financial crisis; (iii) there is a significant decrease in aggregate productivity due to the presence of financial frictions (estimated up to 40 percent).

2 Empirical analysis

In this section we assess the causal effect of real interest rate innovations on TFP and a number of selected variables. Our approach extends the analysis of Uribe and Yue (2006) in two directions. First, it investigates the effect of real interest rate shocks on TFP. Second, it comprises both emerging market and advanced economies. We estimate impulse response functions from country-specific SVARs with a recursive identification method and employ the stochastic pooling Bayesian approach introduced in Canova and Pappa (2007). This approach allows us to report a single measure of location and a 68 percent credibility set differentiated for EMEs and AEs, using all the relevant cross-sectional information.

Data. We use quarterly data over the period 1994Q1 to 2019Q4 for EMEs and AEs. We include fifteen EMEs (Argentina (Ar), Brazil (Br), Chile (Ch), Colombia (Co), Hungary (Hu), Indonesia (Id), Malaysia (My), Mexico (Mx), Perú (Pe), Poland (Pl), South Africa (SA), South Korea (Ko) – sample ending in 2004Q1 –, Taiwan (Tw), Turkey (Tk), and Uruguay (Uy), mnemonics used next in the Figures) and sixteen AEs (Australia (Au), Austria (At), Canada (Ca), Greece (Gr), Denmark (Dk), Finland (Fi), France (Fr), Iceland (Ic), Ireland (Ir), Italy (It), Netherlands (Nl), New Zealand (NZ), Norway (Nw), Portugal (Pt), Spain (Es), and Sweden (Sw)) in the analysis. For EMEs, the selection is driven by data availability, mostly constrained by the lack of reliable data on employment, hours worked, and wages. The latter are in fact necessary for the construction of a measure of quarterly adjusted TFP. For AEs, the choice has fallen on standard advanced small open economies and euro area periphery countries. We start by describing the methodology used for the construction of the quarterly TFP measure. Next, we define our measure of the real interest rate and describe the unconditional cyclical properties of our series. Finally set up the empirical model used for the structural analysis.

Measuring TFP. We construct a quarterly measure (both utilization-adjusted and not) of TFP for both the sample of EMEs and the sample of Advanced Economies. In the baseline specification, we focus on a measure of TFP adjusted for capital utilization and labor effort while in Section 3 we show that all results are robust when using a non-adjusted measure of TFP.

To compute the quarterly measure of adjusted TFP, we follow Imbs (1999). In fact quarterly data to implement Fernald (2014) methodology to adjust TFP are not available for most of our AEs and for all EMEs for the time frame considered. The idea is to use movements in inputs and outputs (as in Kimball et al. (2006a)) to proxy for fluctuations in the unobserved aggregate factors' utilization. Through firm's and household's maximization, it is possible to compute capital utilization and labor effort using observed output, capital, and hours worked. In what follows, we briefly describe the logic behind the adjustment and we refer to Imbs (1999) for a detailed description of the methodology and to Levchenko and Pandalai-Nayar (2020) for the algorithm to implement it.

The model assumes that output (Y_t) is produced using a constant returns to scale function of effective capital (utilization adjusted capital) ($u_t K_t$) and labor services (effort adjusted hours worked) ($e_t L_t$) of the type:

$$Y_t = TFP_t^{Adj}(u_t K_t)^{\alpha}(e_t L_t)^{1-\alpha}$$

where u_t is the capital utilization rate and e_t denotes labor effort. To obtain a measure of capital, we apply the perpetual inventory method (henceforth PIM, Fernald (2014); Bergeaud et al. (2016)) and construct an end-of-the-period measure starting from data on physical investment. We assume that investment is undertaken in one flow at the end of the quarter, implying no partial depreciation during the same quarter. The PIM capital accumulation equation reads:

$$K_{t+1} = (1 - \delta_t)K_t + I_t \tag{1}$$

where I_t denotes investment at time t and δ_t denotes the time varying quarterly depreciation rate of capital. The total amount of labor used in production is computed as the product of hours worked and employment. Quarterly data on employment are not always directly available for EMEs and are, when necessary, reconstructed using Census data. The online Appendix provides a detailed description of the data and the methodology used country by country.

To compute labor effort and capital utilization we rely on the intuition that both variables are choices of firms in their maximization problem (equation (2)) and depend on the wage schedule $w(e_t)$ determined by the households' utility maximization. In fact, we assume that utilization and effort can be both adjusted instantaneously against a different depreciation rate of capital ($\delta_t = \delta u_t^{\phi}, \phi > 1$) or a change in wages, while employment is predetermined and cannot vary within the period. Thus, the firm's optimization problem becomes:

$$\max_{e_t, u_t, K_t} TFP_t^{Adj}(K_t u_t)^{\alpha}(L_t e_t)^{1-\alpha} - w(e_t)L_t - (r_t + \delta_t)K_t. \tag{2}$$

where the first order conditions, jointly with the wage schedule (derived from households' maximization of a preference explicitly distinguishing between the dis-utility of working harder and working more hours) and the value of α, give a unique relationship between unobservable and observable variables. This allows to determine e_t and u_t and to compute a factor utilization quarterly measure of TFP. This measure should be interpreted as an aggregate measure of productivity and not as a measure of technology (see Kimball et al. (2006b); Basu et al. (2012)).

In Section 3 we show that our results are robust when including partial depreciation (i.e. investment is undertaken in the middle of the quarter) and when considering two categories of investments $j =$ (Equipment, Buildings), capturing the different longevity of capital.

Real interest rates. In measuring real interest rates we face two main challenges. First, we need to make the measures comparable across AEs and EMEs. Second, we need to measure domestic expected inflation. While for AEs past inflation can be used to form quarterly reliable expectations, in EMEs the high volatility of inflation often generates implausible movements in (ex-post) real interest rates.

We proceed as follows. For EMEs, we follow Neumeyer and Perri (2005) and Uribe and Yue (2006) and compute the real interest rate as the sum of the U.S. risk free rate (measured as the 90-day U.S. Treasury Bill rate) and a measure of the country's interest rate premium reported by the JP Morgan Emerging Market Bond Global Strip Spread Index (henceforth EMBI global spread) minus US expected inflation, computed as the four-period moving average of US GDP deflator inflation. The EMBI global spread is a quarterly bond spread index of foreign denominated (US dollar) debt instruments issued by sovereign and quasi-sovereign entities with a minimum current face outstanding of US$500 million and at least two and half years to maturity (with an issue age less than 5 years). Hence the real interest rate RR_t^i for the typical emerging economy i is constructed as:

$$RR_t^i = \left(R_t^{US} - \mathbb{E}\pi_t^{US}\right) + \Delta_t^{EMBI}, \ i \in EME$$

where R_t^{US} is the 90-day U.S. treasury bill rate, $\mathbb{E}\pi_t^{US}$ is expected inflation in the US, and Δ_t^{EMBI} is the EMBI global spread.

For AEs, we compute the baseline real interest rate for country j as the 1-year nominal Government bond rate deflated by its four-period moving average GDP deflator inflation:

$$RR_t^j = R_t^j - \mathbb{E}\pi_t^j, \ j \in AEs$$

In Section 3 we however present results using alternative measures of the real interest rate for AEs. In particular, we show that results are robust when using (1) the corporate lending rate to non financial firms (the same one used by Gopinath et al. (2017), available from 2000q1); (2) the 3-month interbank rate; (3) CPI measures of domestic inflation to deflate nominal rates instead of the GDP deflator; (4) computing, for Euro area countries, the real interest rate following the same logic of EMEs:

$$RR_t^j = \left(R_t^{GER} - \mathbb{E}\pi_t^{EZ}\right) + \Delta_t^j,\ i \in AE$$

where R_t^{GER} is the 1-year nominal Bund rate , $\mathbb{E}\pi_t^{EZ}$ is expected *eurozone* inflation (measured as four-period moving average of current GDP deflator inflation), and Δ_t^j is the 1-year sovereign spread in country j. Notice that by using euro area-wide expected inflation we aim at better comparing euro area countries with EMEs, in that countries in a monetary union borrow, in real terms, in a weighted-average composite of foreign goods across member states, while at the same time repaying in units of domestic goods.

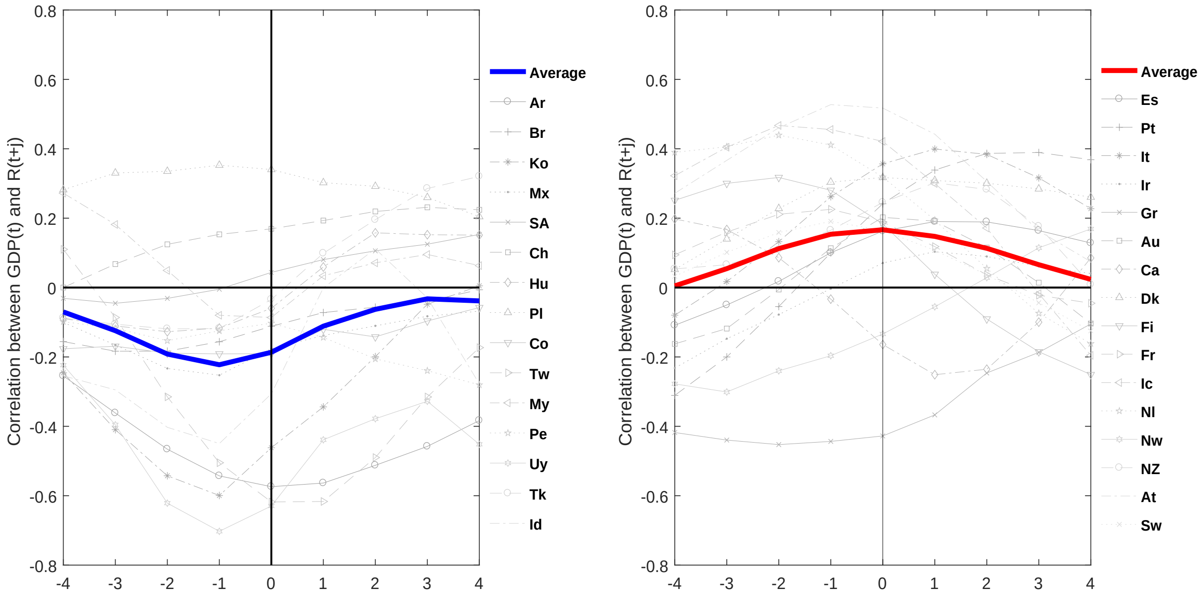
Cyclical properties. The cyclical properties of real interest rates and TFP differ sharply across EMEs and AEs. Figure 1 plots the cross-correlation function of detrended log GDP and the measure of the real interest rate for each country computed above. For the cross-correlation of the real interest rate and GDP in EMEs, Figure 1 updates Neumeyer and Perri (2005) to the 1994Q1-2019Q1 period. Interestingly, cross correlations computed in the more recent time frame are higher, both for EMEs and AEs, than the one computed in Neumeyer and Perri (2005), where the sample ends in 2002Q2. Figure 2, on the other hand, plots the cross-correlation function between detrended log TFP and the real interest rate for both sets of countries. Clearly, in EMEs, the real interest rate and TFP are on average *counter-cyclical.* Conversely, in AEs, the real interest rate and TFP are on average *pro-cyclical.*

2.1 SVARs

The evidence reported in Figure 1 and Figure 2 is unconditional and does not establish any causal link. Next we explore the causal effect of identified real interest rate shocks on TFP and a number of selected variables.

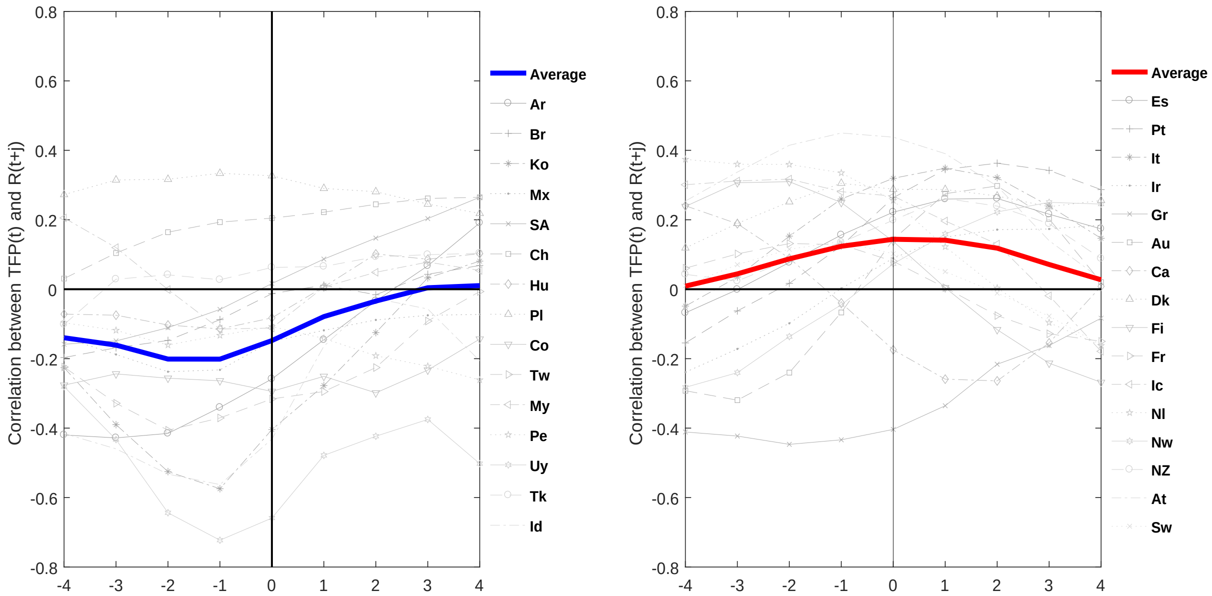
Our empirical model is a vector autoregression (VAR) of the following form:

$$A_0\mathbf{Y}_t = A_1\mathbf{Y}_{t-1} + ...A_p\mathbf{Y}_{t-p} + \varepsilon_t \tag{3}$$



(a) Emerging Markets (b) Advanced Economies

Figure 1: Cross-correlation functions of GDP and the real interest rate in EMEs and AEs



(a) Emerging Markets (b) Advanced Economies

Figure 2: Cross-correlation functions of TFP and the real interest rate in EMEs and AEs

where $\mathbf{Y}_t$ is a $n \times 1$ vector of variables, $A_0, A_1, ..., A_p$ are $n \times n$ matrices of structural coefficients, and ε_t is a $n \times 1$ vector of structural shocks with mean zero and identity variance-covariance matrix Σ_ε. The vector $\mathbf{Y}_t$ comprises $n = 5$ variables: total factor productivity (TFP_t), real gross domestic product (GDP_t), net exports as a percentage of GDP (NX_t), real interest rate (RR_t) and the real effective exchange rate ($REER_t$):

$$\mathbf{Y}_t = \begin{bmatrix} TFP_t \\ GDP_t \\ NX_t \\ RR_t \\ REER_t \end{bmatrix} \tag{4}$$

In (4), TFP_t and GDP_t are expressed in logs, NX_t in levels and then HP-filtered. $REER_t$ is expressed in logs, whereas RR_t is expressed in percentage units. The number of lags is set to 2, to preserve enough degrees of freedom.[1]

We assume that A_0 is a lower triangular matrix with TFP_t ordered first and RR_t second to last in $\mathbf{Y}_t$. These assumptions, in line with Uribe and Yue (2006) and Schmitt-Grohé and Uribe (2017), imply that domestic TFP, domestic GDP and net exports do not react on impact to innovations in the real interest rate, while only the real exchange rate is allowed to respond. The underlying idea is that macroeconomic variables take at least one lag to respond to innovations in financial markets, whereas the real exchange rate is allowed to respond contemporaneously to financial market shocks.

In Section 3 we show that our results are robust to different orderings: (i) ordering RR_t last; (ii) ordering RR_t as the second variable, leaving all variables but TFP unrestricted.

Premultiplying both sides of (3) by A_0^{-1} we obtain the reduced form:

$$\mathbf{Y}_t = C_1 \mathbf{Y}_{t-1} + ... + C_p \mathbf{Y}_{t-p} + \mathbf{u}_t \tag{5}$$

where $C_i \equiv A_0^{-1} A_i$, $\mathbf{u}_t \equiv A_0^{-1} \varepsilon_t$ and $Var(\mathbf{u}_t) = \Sigma_u = A_0^{-1} \mathbf{I} (A_0^{-1})'$. It is then straightforward to compute A_0^{-1} as the Choleski factor of the matrix Σ_u. In the figures below, however, we normalize the size of the shock to the real interest rate ε_t^{RR} to 1.

[1] Uribe and Yue (2006) and Schmitt-Grohé and Uribe (2017) propose a specification introducing the US real interest rate and the domestic real rate separately. The specific goal is to separately identify the contribution of US real rate shocks from the country spread shocks. Our main results are robust to that specification.

Stochastic pooling. Following Canova and Pappa (2007), we pool the impulse responses of the different countries. We assume that each country-specific impulse response of variable r to ε_t^{RR} has the prior distribution:

$$\alpha_{\iota,h}^r = \mu_h^r + v_{\iota,h}^r \quad \text{where} \quad v_{\iota,h}^r \sim N(0, \tau_h^r)$$

where h is the impulse response horizon, $h = 0, 1, ..., H$ and $\iota \in N$ is the country identifier ($\alpha_{\iota,10}^r$ is therefore the impulse response of variable r, for country ι, 10 periods after the shock).

We choose a diffuse prior for μ_h^r, so that the average impulse responses are essentially driven by the data. We assume $\tau_h^r = (\delta_r / h^{\gamma_h})$, where δ_r takes into account the observed dispersion of the impulse responses for variable r across countries and $\gamma_h < 1$ allows for a slower decay in the cross-country differentiation with respect to the horizon.[2]

Under a Normal-Wishart prior for each country-specific VAR, the posterior for μ_h^r is

$$\mu_h^r | \tau_h^r, \hat{\Sigma}_{u_i} \sim N(\tilde{\mu}_h^r, \tilde{V}_{\mu,h}^r)$$

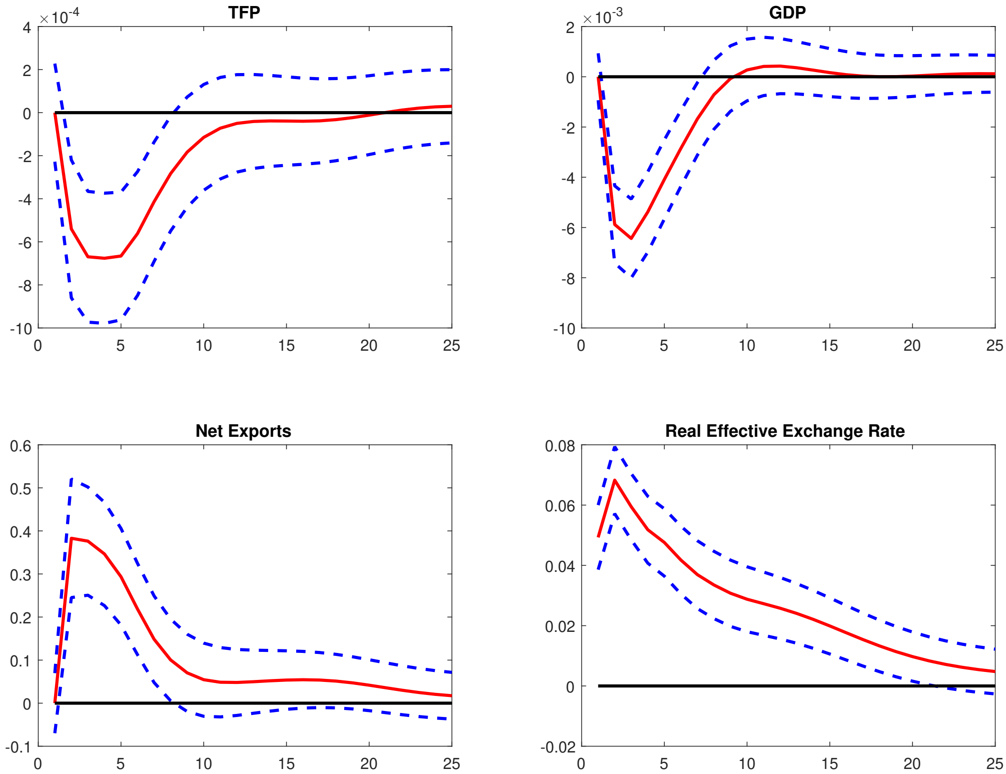
where $\tilde{\mu}_h^r = \tilde{V}_{\mu,h}^r \sum_{\iota=0}^N (\hat{V}_{\alpha_{\iota},h}^r + \tau_h^r)^{-1} \hat{\alpha}_{\iota,h}^r$, $\tilde{V}_{\mu,h}^r = (\sum_{\iota=0}^N (\hat{V}_{\alpha_{\iota},h}^r + \tau_h^r)^{-1})^{-1}$ and $\hat{\Sigma}_{u_\iota}$ is the estimated variance-covariance matrix of the reduced form residuals $\mathbf{u}_t$ in the VAR for country ι, $\hat{\alpha}_{\iota,h}^r$ is the country ι-specific OLS estimator of $\alpha_{\iota,h}^r$ and $\hat{V}_{\alpha_{\iota},h}^r$ its variance. The intuition behind this approach is that impulse responses are weighted by their precision. More precise impulse responses are weighted more than those estimated with less precision.

Results. Figure 3 depicts (weighted) impulse-responses of selected variables to a positive shock to the real interest rate RR_t for EMEs, whereas Figure 4 reports the same responses for AEs. An exogenous increase in the real interest rate should be interpreted here as a capital outflow shock. Three main results are worth emphasizing.

First, in the EMEs, a rise in the real interest rate induces a contraction in both GDP and TFP, a rise in net exports and a real exchange rate depreciation. This picture is consistent with the typical narrative of capital outflow episodes. Second, in Advanced Economies, an increase in the real interest rate causes a smoother and not significant response of the REER while it moves TFP and GDP in the opposite direction relative to EMEs: TFP and

[2] δ_r is computed by averaging the cross-sectional variance of the impulse responses across horizons and $\gamma_h = 0.25$, following Calza et al. (2013).

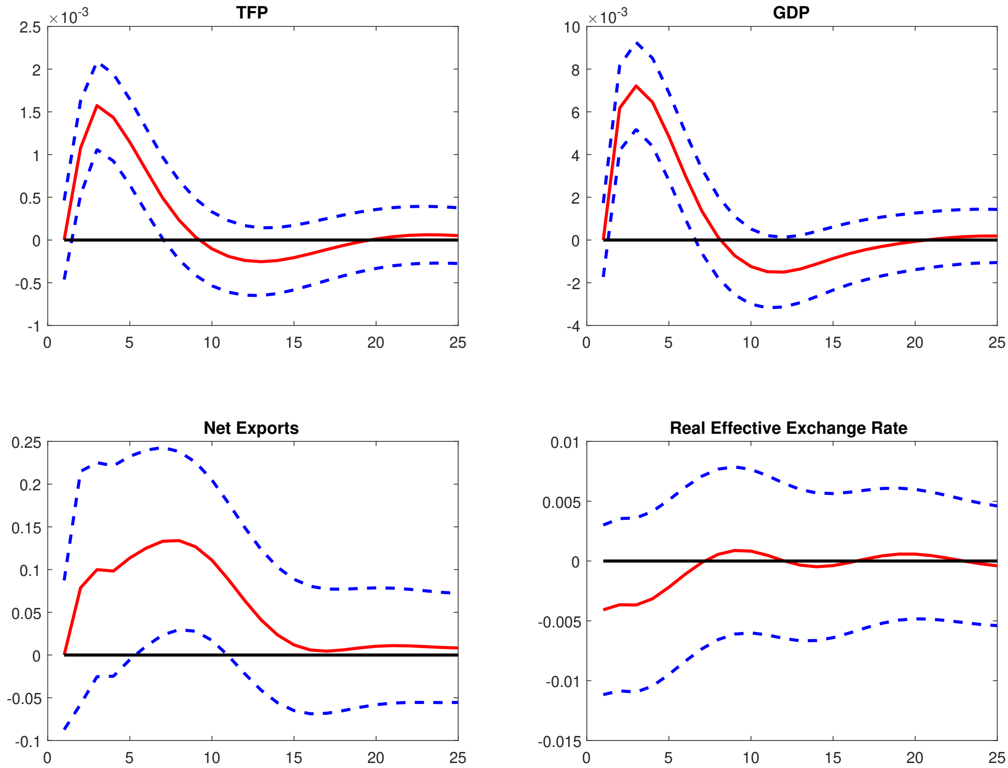
Figure 3: Emerging Market Economies



Notes. Impulse responses to a positive normalized shock of the real interest rate (RR_t) of one percentage point. Sample of pooled countries: Argentina, Brazil, Chile, Colombia, Hungary, Indonesia, Malaysia, Mexico, Perú, Poland, South Africa, South Korea (until q1:2004), Taiwan, Turkey and Uruguay. Sample period 1994Q1 - 2019Q4. REER = Foreign/Domestic, therefore a rise is a real depreciation. Solid line: point estimates. Dashed line: 68 percent credible bands.

GDP both *rise* in response to a positive real interest rate shock. Hence, conditional on real interest rate shocks, TFP decreases in EMEs and increases in AEs. Third, conditional on a real interest rate shock, net exports increase both in EMEs and AEs. The above results are robust to alternative measures of the real interest rate (i.e., alternative nominal and inflation rates), to the sample period considered (i.e., excluding the Great Recession) and accounting or not for utilization in the computation of TFP (see Section 3).

Figure 4: Advanced Economies

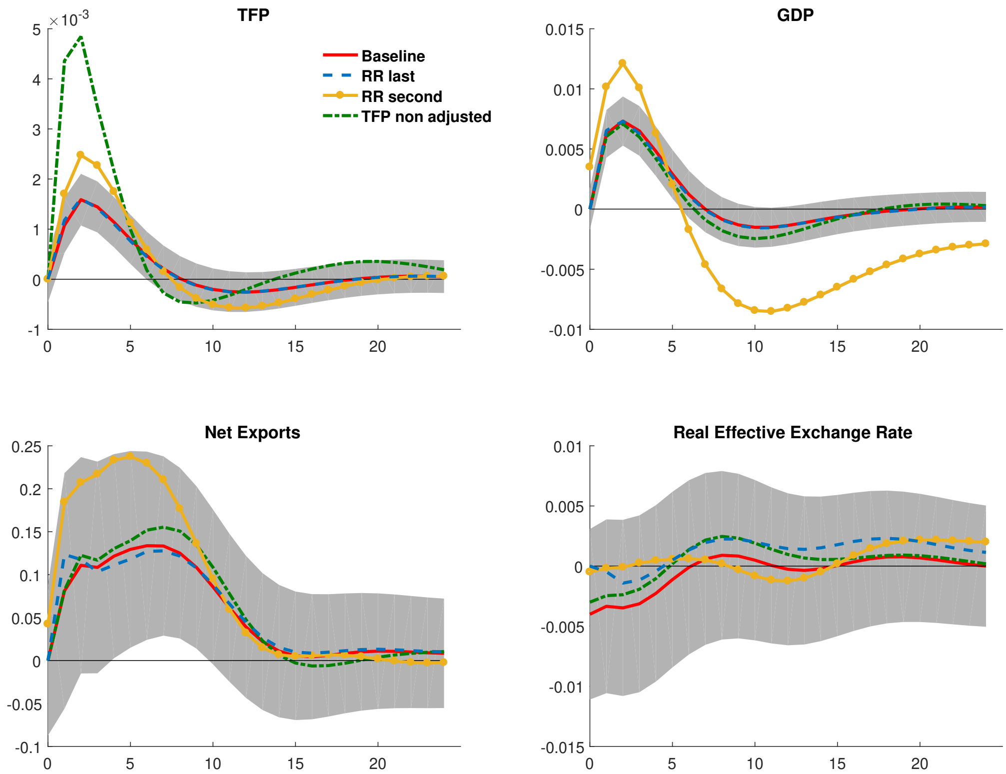


Notes. Impulse responses to a positive normalized shock of the real interest rate (RR_t) of one percentage point. Sample of pooled countries: Australia, Austria, Canada, Greece, Denmark, Finland, France, Iceland, Ireland, Italy, Netherlands, New Zealand, Norway, Portugal, Spain and Sweden. Sample period: 1995Q1 - 2019Q1. REER = Foreign/Domestic, therefore a rise is a real depreciation. Solid line: point estimates. Dashed line: 68 percent credible bands.

3 Robustness of the SVAR results

In this Section we consider eight alternative specifications of our baseline SVAR to check the robustness of the estimated conditional relationship between real interest rates and TFP. Figures 5 and 6 show the impulse-responses from the SVAR model changing the ordering of variables and using a non-adjusted measure of TFP. Figure 7 then shows SVARs impulse-responses where we consider different measures of the real interest rate in AEs. All results are displayed as a comparison with our baseline result (red line) with its 68 percent credible set (gray area). All IRFs with their credible bands are in the replication package attached to this paper.

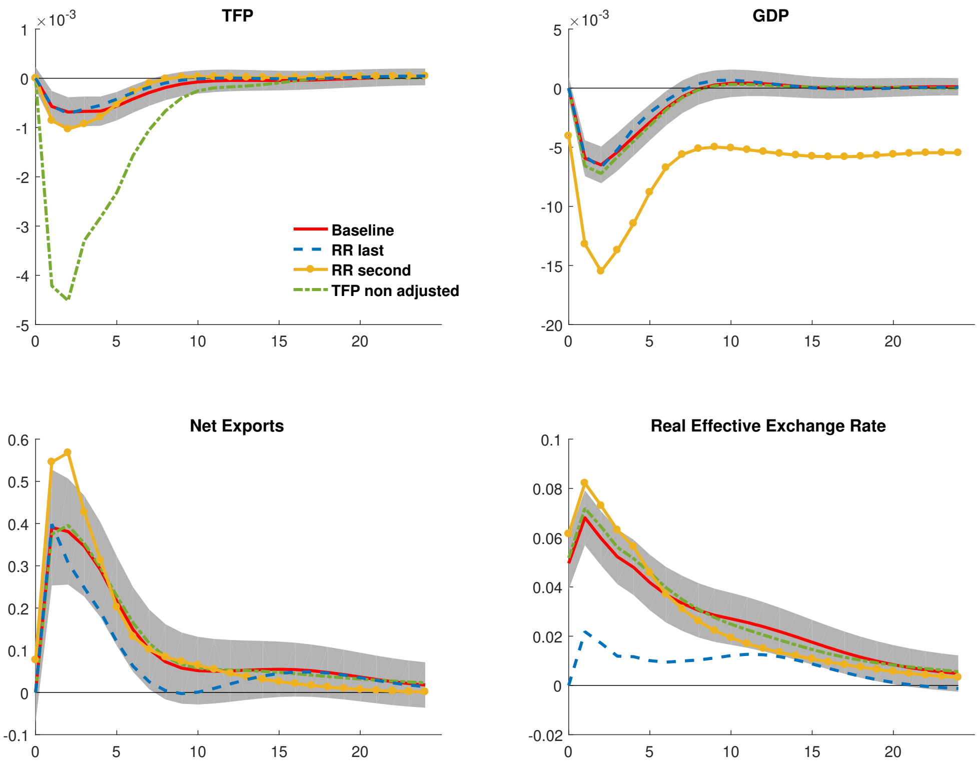
Figure 5: VAR ordering and non-adjusted TFP - AEs



Notes. Impulse responses to a positive normalized shock of the real interest rate (RR_t) of one percentage point. Sample of pooled countries: Australia, Austria, Canada, Greece, Denmark, Finland, France, Iceland, Ireland, Italy, Netherlands, New Zealand, Norway, Portugal, Spain and Sweden. Sample period: 1995Q1 - 2019Q1. REER = Foreign/Domestic, therefore a rise is a real depreciation. Solid line: point estimates. Gray area: 68 percent credible region.

Ordering. We start by checking the robustness of our results to different ordering of the real interest rate in the $\mathbf{Y}_t$ matrix of our SVAR model (equation 5). We analyze two different orderings. First, we set RR_t last in the ordering, so that no variable, including the real exchange rate, move on impact to a real interest rate shock (blue dashed line). Second, we set RR_t second in the ordering. In this case, GDP, net exports and real exchange rates are allowed to respond on impact to a real interest rate shock (yellow line with dot marker). Figure 5 shows responses for AEs while Figure 6 shows responses for EMEs. In AEs results are not statistically different from our baseline with only GDP responding more strongly on impact when the real interest rate is ordered second. For EMEs, the assumption that GDP and the real exchange rate are allowed or not to move on impact does matter for the size of the responses, but not for the sign, statistical significance, or dynamic behavior. Interestingly, in the model where RR_t is ordered last, the depreciation of the real effective exchange rate is still present and significant at 68 percent, but it is less evident. Similarly, the responses of GDP in the model with RR_t second are more negative and persistent, remaining significant up to 10 quarters.

Figure 6: VAR ordering and non-adjusted TFP - EMEs



Notes. Impulse responses to a positive normalized shock of the real interest rate (RR_t) of one percentage point. Sample of pooled countries: Argentina, Brazil, Chile, Colombia, Hungary, Indonesia, Malaysia, Mexico, Perú, Poland, South Africa, South Korea (until q1:2004), Taiwan, Turkey and Uruguay. Sample period 1994Q1 - 2019Q4. REER = Foreign/Domestic, therefore a rise is a real depreciation. Solid line: point estimates. Gray area: 68 percent credible region.

Factor utilization. Next we assess the importance of factor utilization in measuring TFP. Differently from before, we assume that total output is now produced employing the capital stock (K_t) and labor (L_t) through a standard Cobb-Douglas production function:

$$Y_t = TFP_t \cdot K_t^{\alpha} L_t^{1-\alpha} \;\; \alpha \in (0,1)$$

We measure labor as done previously but now we assume that investment is undertaken in one flow at the middle of the quarter, implying partial depreciation during the same quarter:

$$K_{t+1}^j = (1-\delta_q^j)K_t^j + I_{t+1}^j\sqrt{1-\delta^j} \;,\; j=(E,B) \tag{6}$$

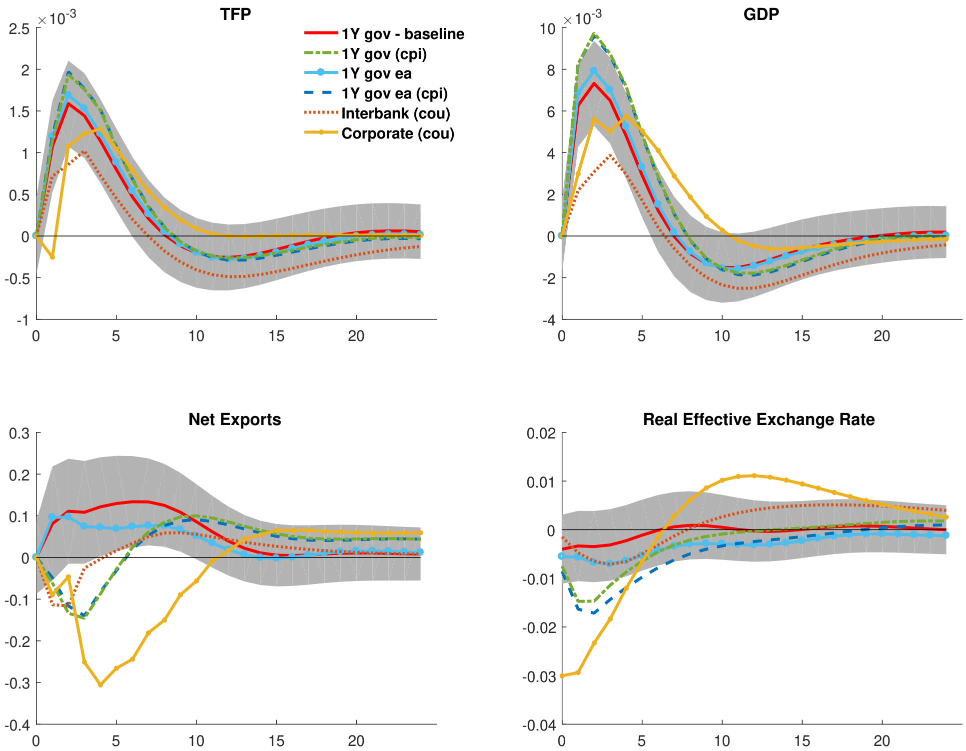
We also assume that investment is separated in two categories $j = (E, B)$, which capture the different longevity of capital, and where δ_q^j denotes the quarterly depreciation rate of capital of type j. The first category, $j = B$, captures the slowly depreciating capital with a rate of annual depreciation of $(\delta_j^B)^4 = 2.5$ percent, and is defined as buildings (Dwellings, Cultivated Biological Resources and Other Buildings and Structure); the second category, labeled equipment ($j = E$), captures the capital with quick turnover, with a yearly 10 percent depreciation rate (Intellectual Property Products, Machinery and Equipment and WPN Systems). One final assumption is needed to initialize the capital series. We assume that the growth rate of capital between the initial and the first period is equal to the average GDP growth rate. This implies that $1/n\sum_{t=0}^{n-1}(Y_{t+1} - Y_t)/Y_t = (K_1 - K_0)/K_0 = -\delta^j + \sqrt{(1-\delta^j)}(I_1^j/K_0^j)$, allowing us to compute the initial value K_0^j. Given δ^j, and applying (6), one can then recover the sequence for K_t^j, and compute the series for aggregate capital as $K_t =_{j=E,B} K_t^j$ for all t.

The green dotted line of Figures 5 and 6 show the results. Responses of GDP, net export and REER are perfectly in line with our baseline results. However, an interesting difference arises in the size of the response of TFP, which is stronger when utilization is not properly taken into account. This is consistent with the idea that TFP measures not accounting for effort and capital utilization run the risk of overestimating the variance of TFP.

Alternative measures of the real interest rate. Finally, to test the robustness of our results for AEs, we check how responses of TFP, GDP and real exchange rate change when we use different measures of the real interest rate. Using the ordering of the variables of our baseline specification (equation 4), Figure 7 displays five different specifications. We start by deflating the nominal 1-year sovereign yield with CPI inflation (green dashed line) and then by deflating euro area periphery with the euro area GDP deflator (light blue dot marked line) and euro area CPI inflation (blue dotted line). Then, in the last two specifications we change the definition of the nominal interest rate. The orange dotted line displays the results using the inter-bank short-term interest rate, while the yellow star-marked line considers the corporate lending rate to non financial firms (the same one used by Gopinath et al. (2017), available from 2000q1).

Results are confirmed for TFP, GDP and the real exchange rate where no statistical differences are found. Net Exports, on the other hand, become not significant when using the corporate lending rate and when deflating for the CPI instead of the GDP deflator.

Figure 7: Real Interes Rates - AEs



Notes. Impulse responses to a positive normalized shock of the real interest rate (RR_t) of one percentage point measured in different ways. Sample of pooled countries: Australia, Austria, Canada, Greece, Denmark, Finland, France, Iceland, Ireland, Italy, Netherlands, New Zealand, Norway, Portugal, Spain and Sweden. Sample period: 1995Q1 - 2019Q1. REER = Foreign/Domestic, therefore a rise is a real depreciation. Solid line: point estimates. Gray area: 68 percent credible region.

4 Discussion

Rationalizing the observed striking difference between EMEs and AEs in the response of TFP to real interest rate shocks poses a theoretical challenge. The rise in TFP observed in AEs can in principle be explained in a model with a "cleansing channel", along the lines of (Gopinath et al., 2017). In such a framework, with firms' heterogeneous productivity, the marginal firm is indifferent between (i) entry and produce; and (ii) stay idle and lend its capital to the more productive firms. An exogenous rise in the real interest rate r_t^* makes the opportunity cost of production or, equivalently, the marginal return on saving, higher for the marginal firm. The latter, therefore, finds it optimal to exit the market and act as an unproductive lender. This *cleansing* effect of higher real interest rates raises the productivity threshold, because it now requires, in equilibrium, a higher productivity draw in order to make it profitable for the marginal firm to enter and become productive.

More challenging is to rationalize the contractionary effect on TFP of higher real interest rates observed in EMEs. In principle this can be done by appealing to a further *balance-sheet* exchange rate channel. To gain intution, notice that a higher (world) real interest rate leads to a depreciation of the real exchange rate - as typically witnessed during capital outflow episodes in EMEs. The real depreciation, followed by expected appreciation, lowers the (exchange-rate adjusted) opportunity cost of production (i.e., the marginal return on savings in foreign currency) thereby inducing, at the extensive margin, more and marginally less productive firms to enter production. Simultaneously, and in the presence of foreign-currency debt, the real depreciation tightens the collateral constraint of the incumbent firms (a balance-sheet effect), which reduces their borrowing, capital and labor demand at the intensive margin. In equilibrium, the resulting fall in the real wage induces marginally less productive firms to enter the market, thereby amplifying the fall in average productivity. The combined balance-sheet effect (on both the extensive and the intensive margin) described above can potentially overturn the positive cleansing effect thereby resulting in a negative net effect of higher real interest rates on aggregate TFP.[3]

The mechanism to rationalize the fall in TFP in EMEs just outlined, however, requires a potentially counter-factual effect, namely counter-cyclical entry: less productive firms entering more at the margin during periods of high real interest rates and tightening financial conditions. A potential fix to this problem comes from focusing on the ensuing effects of

[3] A detailed exposition of the mechanism can be found in Monacelli et al. (2018).

real interest rate changes on R&D investment by incumbent firms. On the one hand, Ates and Saffie (2021) show that the sudden stop in capital inflows that hit Chile in 1998 led to a selection effect among entrants in the manufacturing sector: it slowed down firms' entry, especially of the least productive ones. Simultaneously, the tightening of financial constraints for the more productive incumbent firms led to a contraction in R&D investment and therefore to a slowdown in TFP. Similarly, Queralto (2020) shows that the tightening of financial conditions during the 1997 sudden stop in South Korea resulted in a fall in the number of entrants, due to a sharp decline in R&D, and therefore to a composition effect leading to a contraction in TFP.

5 Conclusions

We have shown that, in emerging market economies (EMEs), capital inflows are associated to productivity booms, while the opposite is true for advanced small open economies (AEs). Empirical evidence, based on structural VARs, shows that the response of aggregate productivity to identified real interest rate innovations (a proxy for capital-flow shocks) is sharply different across the two groups of countries: in response to higher real interest rates, TFP rises in AEs, whereas it falls in EMEs. A framework with heterogeneous productivity, cleansing effects at the extensive margin, balance-sheet effects on financial constraints and on R&D investment can potentially rationalize the observed different behavior of TFP in the two groups of countries.

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