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International transmission of interest rates: the role of international reserves and sovereign debt*

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Abstract

We analyse the international transmission of interest rates by focusing on the role of the accumulation of international reserves and on the financing of sovereign debt. An increase in foreign exchange reserves is expected to moderate the influence of U.S. interest rates. However, a high level of government debt raises the sovereign risk premium. Moreover, an increase in the stock of government debt denominated in foreign currency may increase the expected rate of depreciation of the domestic currency. We explain the theoretical mechanisms in a model, which describes the money market equilibrium in an economy with capital account openness. Then, we test the predictions of the model for a panel of advanced and developing economies over the period 1970-2018. Our main findings are: i) significant spillovers from the U.S. interest rates to other countries, mostly for Advanced Economies; ii) a dampening effect of the share of external liabilities in the domestic currency, clearly a determinant of risk premium; iii) a negative effect of international reserves on interest rates, as expected; iv) higher reserves decrease risk premia, for long-term interest rates; v) the significance of spillovers fades once the sovereign debt reaches 100% of GDP in developed countries.

Keywords: interest rates, international reserves, government debt, spillover effects, monetary policy, fiscal policy, panel analysis
JEL Codes: C23, E43, E63, F31, F34, G15, H60

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1. Introduction

The prospect of a change in monetary policy in the United States (U.S.) matters for other countries, and this may be true whatever their exchange rate regime, if global financial flows have transformed the trilemma in international finance (fixed exchange rates, free capital flows, and independent monetary policy) into a dilemma (Rey, 2016). Moreover, other factors, which influence interest rates, may attenuate the international transmission of U.S. interest rates. In our paper, we focus on the role of government debt and on the role of international reserves.

The level of government indebtedness has two opposite effects on domestic long-term interest rates. It has a positive effect since it influences risk premiums and sovereign bond yields typically upwards, and the latter can influence other interest rates in the economy. However, it can also have a negative impact if there is some indirect monetary financing of budget deficits, notably via quantitative easing measures, which expands the liquidity in the economy and lowers short-term interest rates. In addition, the accumulation of international reserves may reinforce this liquidity effect by increasing money supply.

Therefore, our contribution is to verify whether the accumulation of reserve assets by central banks enable countries with a high level of government debt to keep interest rates low and to be less exposed to the global transmission of interest rate shocks. Hence, we first explain the theoretical mechanisms in a model, which describes the money market equilibrium in an economy with capital account openness. Then, we test empirically the predictions of the model for a panel of advanced and developing economies over the period 1970-2018.

The remainder of the paper is organized as follows. Section 2 provides a literature review. Section 3 outlines the theoretical framework. Section 4 details the empirical strategy and discusses our results. Section 5 concludes.

2. Related literature

The strength and determinants of international interest rate spillovers is a central issue in international economics. Notably, the standard textbook approach suggests that in a financially globalized world only floating exchange rates can ensure (some degree of) monetary independence (Mundell, 1963). This view, as noted in the introduction, has been recently challenged by Rey (2016). It seems, however, that the debate is far from being settled.

Other theoretical frameworks shedding some light on the issue include the New-Keynesian approach. In such a setup, Farhi & Werning (2014) show that capital controls do not change significantly the reaction of interest rates, whereas under fixed exchange rate their behaviour is

strongly affected. However, they find that both capital controls and flexible exchange rates are useful to respond to sudden stops. Noteworthy, the Dominant Currency Paradigm (Gopinath et al., 2020) implies a high degree of interest rates' synchronization. They also assume that the dollar interest rate in the country is an increasing function of its external debt (p. 690, note 9) – an issue that we will empirically explore in our study.

Frankel et al. (2004) empirically tested international transmission of interest rates on a sample of 46 countries observed over 1970-1999. Utilizing a static panel data analysis they find that in most cases full transmission cannot be rejected (coefficient not significantly different from 1). Their point estimates are located between 0.53-0.64 except for managed floating with a lower and insignificant value of 0.17. However, the differences in slope coefficients are not significant, but differences in constants are (indicating higher risk premia in the floating countries). Furthermore, utilizing Autoregressive Distributed Lag (ARDL) models for individual countries, they find that interest rates of countries with floating exchange rate regimes adjust more slowly.

In an alternative (but comparable) approach, Shambaugh (2004) focuses on interest rates' changes in an even larger panel of 155 countries over roughly the same post-Bretton Woods period (1973-2000). He finds that the elasticity of spillover is of roughly 0.5 for fixed exchange rate regime and of roughly 0.3 for non-pegged economies (p. 303). Additionally, both fixed exchange rates and open capital markets increase the responsiveness to the base interest rate." (p. 304). The relationship is also the strongest for the pegs without capital controls (0.67, even higher for 1990s), then non-pegs without capital controls (0.56), pegged with capital controls (0.41) and non-pegged with capital controls (0.15, insignificant). Moreover, under the dynamic ARDL specifications Shambaugh (2004) confirms that the pegs adjust more quickly.
Di Giovanni & Shambaugh (2008), while explaining channels of influence of foreign rates on the domestic economy find that 36% of the base interest rate is transmitted to pegged countries.

However, they differentiate between 10 different base countries to which implicitly or explicitly the other currencies are linked. All these empirical studies find a relatively sound support of the Mundellian trilemma and a high(er) degree of pass-through in the pegged countries. At the same time, none of them considers explicitly the role of government debt nor international reserves as possible determinants of such a pass-through.

More recently, Han & Wei (2018) estimate a variant of a differenced Taylor rule, augmented by monetary spillovers from the US (further divided into four cases depending on the exchange

rate regime[1] and existence of capital controls), inertia (or "momentum") parameter and the VIX (also in first difference). Monetary policy spillovers turn out to be asymmetrical: peripheral countries enjoy monetary autonomy under floating exchange rates and without capital controls but only when the US tightens their monetary policy stance. A monetary easing in the US, however, forces them to cut interest rates, too (in a "fear of appreciation"). Thus, they argue in favour of a 2.5-lemma (or an intermediate state between a trilemma and a dilemma). Additionally, capital controls allow for monetary autonomy under either of exchange rate regimes.

Focusing on 43 emerging economies between 1983 and 2013, Obstfeld et al. (2019) find that the trilemma holds in the following sense: fixed and intermediate regimes provide less insulation from the global financial shocks. However, the American interest rates do not show any significant impact on the GDP or credit growth, net capital flows nor stock returns. Nevertheless, the question of interest rate transmission was not studied directly.

In an attempt to gauge the impact of the third element of the trilemma – free flows of capital, Bekaert & Mehl (2019), utilizing a two-factor (global – local) model, assess long-term evolutions of international financial integration and find a "swoosh" shape. Then, in the spirit of Obstfeld et al. (2005), they estimate the incidence of American interest rates on the other countries but augment this equation with their financial globalization measure and the exchange rate system. Overall, the pass-through coefficient is estimated at 0.3, but it assumes the highest value of 0.56 for the post-Bretton Woods era. The remainder of their results suggest that the trilemma holds, as the peg decreases interest rates spillovers, and more financial openness increases – especially for the non-floaters. Bekaert & Mehl (2019) also explicitly consider the quantitative easing period and again find some evidence of asymmetric transmission (or 2.5-lemma).

An explicit consideration to international transmission of unconventional monetary policy (here in case of the ECB to Poland) is given by Janus (2020). He studies spillovers in mean and in variance to interest rates and exchange rates via a VAR-GARCH-DCC model as well as event studies, and finds at best modest spillovers, possibly due to the free-floating regime in Poland.

Among the newest noteworthy approaches to the problem of international monetary transmission, one is based on spillovers from implied Fed-induced surprises to bond markets (Albagli et al., 2019; Gilchrist et al., 2019) and the other based on meta-analysis evaluating

[1] They utilize de facto classification of exchange rates by Ilzetzki et al., (2019).

international spillovers from both conventional and unconventional monetary policy to banking-sector lending rates (Buch et al., 2019). While the latter is based on a large international collaboration of central bank teams and utilizes micro-level (partially confidential) data and the former relies on the monetary shocks estimated from a very short-term horizon changes in the yields around policy meetings – both find significant spillovers from the US and other monetary policy rates. Overall, it seems that the debate over the mechanisms of the transmission of U.S. interest rates to other economies has not been definitively settled and that the evidence of the role of public debt and international reserves is scarce. We aim to fill-in this gap.

2. Theoretical framework

We extend the model in Edwards and Khan (1985) in such a way that we are able to distinguish the effects of international reserves and those of government debt on interest rates. They proposed a model of interest rate determination in an economy with capital account openness. Domestic interest rates are influenced by foreign factors (via the interest rate parity) depending on the degree of the capital account openness. They are also dependent on domestic monetary conditions (via the Fisher equation). The model describes the money market equilibrium whereby the real interest rate is influenced by a liquidity effect (it deviates from its long run equilibrium level if there is an excess supply of money). We amend this model by adding the role of international reserves and the presence of government debt. Thus, we modify the specification of the interest rate parity and of the money supply:

- we define the expected rate of change of the exchange rate as a function of international reserves;
- we add a risk premium (sovereign default) in the interest rate parity;
- we define the risk premium as a function of the level of government debt;
- we introduce monetary financing of budget deficits in the model by specifying the counterparts of money supply.

The nominal interest rate at time *t*, i_t, is specified as follows:

$$i_t = \psi(i_t^* + \dot{e}_t + z_t) + (1 - \psi)(r_t + \pi_t^e) \quad (1)$$

where i_t^* is the foreign (U.S.) interest rate, $\dot{e}_t$ the expected rate of depreciation of the domestic currency, (the exchange rate is defined as a direct quotation for foreign currency: one unit of foreign currency in terms of units of domestic currency), z_t the country risk premium, r_t the

real interest rate, π_t^e the expected inflation rate, and ψ a parameter, which measures the degree of the country financial openness (capital account). The first component of Eq. (1) represents the uncovered interest rate parity (UIP) and the second component the Fisher equation.

The domestic interest rate responds with a delay to any changes in the expected return of foreign financial assets. This may be due to transaction costs, information lags or any other kind of frictions. Hence, we have: $\Delta i_t = \theta[(i_t^* + \dot{e}_t + z_t) - i_{t-1}]$, where Δ is the first difference operator, and θ the adjustment parameter ($0 \leq \theta \leq 1$). It follows:

$$i_t = \theta(i_t^* + \dot{e}_t + z_t) + (1 - \theta)i_{t-1}. \quad (2)$$

The real interest rate is influenced by a liquidity effect. It deviates from its (constant) long-term equilibrium level, ρ, if there is any excess money supply ($EMS > 0$) in the money market:

$$r_t = \rho - \lambda EMS_t + \omega_t \quad (3)$$

where λ is a parameter ($\lambda > 0$) and ω_t an error term.

The excess money supply is defined as:

$$EMS_t = m_t - m_t^d \quad (4)$$

where m_t is the actual stock of real money and m_t^d the desired equilibrium stock of real money balances. The equilibrium demand for money is specified in a standard manner (narrow aggregate). The long-run demand for money is assumed to be a function of real income y_t, the long-term equilibrium nominal interest rate $(\rho + \pi_t^e)$ rather than the current nominal interest rate, and inflation expectations π_t^e:[2]

$$m_t^d = \alpha_0 + \alpha_1 y_t - \alpha_2(\rho + \pi_t^e) - \alpha_3 \pi_t^e. \quad (5)$$

As for money supply, the stock adjusts according to the following mechanism: $\Delta m_t = \beta(m_t^d - m_{t-1})$, where β is the adjustment coefficient ($0 < \beta < 1$). This process allows the nominal interest rate to return eventually to its long-term equilibrium level. It can also be written as:

[2] This is a rather orthodox view of money demand and inflation, as mentioned, for instance, by McCallum (1999).

$$m_t = \beta m_t^d + (1-\beta) m_{t-1}. \quad (6)$$

International reserves and government debt are incorporated into the model through monetary conditions and the interest rate parity.

- The effect of money supply m_t on the interest rate can be specified through the counterparts of money supply: domestic assets (a_t) and international reserves (res_t). Domestic assets, in turn, are decomposed into loans to the private sector (l_t) and loans to the general government (b_t). Indeed, a share of domestic loans is used to finance budget deficits. Government debt can be either in local currency (b_t^{LC}) or in foreign currency (b_t^{FC}).[3]
- The expected rate of depreciation of the domestic currency is a negative function of international reserves and a positive function of government debt denominated in foreign currency. The country risk premium, z_t, is a positive function of overall government debt as long as a higher level of government debt increases the probability of sovereign default (Afonso et al., 2018; Bi, 2012).[4] Therefore, we can write:
-

$$\dot{e}_t = \delta_0 - \delta_1 res_{t-1} + \delta_2 b_{t-1}^{FC}, \quad (7)$$

$$z_t = \mu_0 + \mu_1 b_{t-1}. \quad (8)$$

We can finally derive the reduced-form equation for the nominal interest rate by combining Equations (2)-(8):

$$i_t = \gamma_0 + \gamma_1 i_{t-1} + \gamma_2 i_t^* + \gamma_3 y_t + \gamma_4 \pi_t^e + \gamma_5 l_{t-1} + \gamma_6 b_{t-1}^{LC} + \gamma_7 b_{t-1}^{FC} + \gamma_8 res_{t-1} + \varepsilon_t \quad (9)$$

with

$\gamma_0 = \psi\theta(\delta_0 + \mu_0) + (1-\psi)[\rho + \lambda(1-\beta)(\alpha_0 - \alpha_2\rho)]$

$\gamma_1 = \psi(1-\theta)$

[3] Similarly, loans to the private sector can be denominated in local currency (l_t^{LC}) and in foreign currency (l_t^{FC}).

[4] One can further consider that countries with independent monetary policies, and with a de facto national central bank as lender of last resort, can provide additional guarantee that the sovereign bonds of these countries face limited default risk compared to countries without monetary policy (see Afonso et al., 2018).

$$\gamma_2 = \psi\theta$$
$$\gamma_3 = (1-\psi)\lambda(1-\beta)\alpha_1$$
$$\gamma_4 = (1-\psi)[1-\lambda(1-\beta)(\alpha_2+\alpha_3)]$$
$$\gamma_5 = -(1-\psi)\lambda(1-\beta)$$
$$\gamma_6 = \psi\theta\mu_1 - (1-\psi)\lambda(1-\beta)$$
$$\gamma_7 = \psi\theta(\delta_2+\mu_1) - (1-\psi)\lambda(1-\beta)$$
$$\gamma_8 = -\psi\theta\delta_1 - (1-\psi)\lambda(1-\beta)$$

and $\varepsilon_t = (1-\psi)\omega_t$.

With immediate adjustment to UIP, the lagged value of the nominal interest rate would disappear from Equation (9): $\theta = 1$ and $\gamma_1 = 0$. The international transmission of interest rates is captured by the composite parameter $\gamma_2 > 0$. An increase in real income is expected to cause a rise in domestic interest rates ($\gamma_3 > 0$) whereas credit growth to the private sector expands liquidity in the economy and has a negative effect on interest rates ($\gamma_5 < 0$). The effect of inflation expectations (γ_4) is positive if $\lambda(1-\beta)(\alpha_2+\alpha_3) < 1$. It depends in particular on how money demand is affected by inflation expectations (α_2 and α_3).

The effect of government debt on domestic interest rates is ambiguous (sign of parameters γ_6 and γ_7) because there are two opposite effects. Indeed, there is a positive effect (first part of the parameters) through the risk premium and the expected rate of depreciation of the domestic currency, and there is a negative effect (second part of the parameters) because domestic banking loans to the public sector increase liquidity in the economy. In short, an increase in sovereign indebtedness can lead to a rise of interest rates in the economy *via* a "premium effect" or a decline of interest rates *via* a "liquidity effect". The premium effect is stronger when government debt is denominated in foreign currency ($\gamma_7 > \gamma_6$). In contrast, an increase in international reserves has an unambiguously negative effect on domestic interest rates (γ_8). This influence is reduced though in situations with sterilized central bank interventions in foreign exchange market.[5]

[5] Depending on the extent of sterilized interventions, $\lambda(1-\beta)$ is close to zero and as a result, the size of the parameter γ_8 is reduced to a value close to $-\psi\theta\delta_1$.

4. Empirical strategy and analysis

4.1. Empirical strategy and data

We estimate the model described by Equation (9). The dependent variable i_t is the short-term interest rate (3-month market rate) or in an alternative specification the long-term interest rate (10-year sovereign bond yield). The foreign interest rate i_t^* is the U.S. interest rate (the federal funds rate, and in alternative specifications, the 3-month Treasury bill rate and the 10-year sovereign yield). Real income y_t is measured by the real GDP growth rate. Loans to the private sector l_t are represented by the ratio of credit to the private sector to GDP.

Government debt (b_t) is measured by general government debt as a percentage of GDP (or central government debt for some countries). We use the IMF Global Debt Database (Mbaye, Moreno-Badia and Chae, 2018). The theoretical model makes a distinction between government debt denominated in local currency and government debt denominated in foreign currency. Unfortunately, due to issues of data availability, we cannot make this distinction in the empirical analysis. Still, in robustness checks, we propose to test the influence of external debt liabilities in domestic currency and in foreign currency by using the dataset built by Bénétrix, Lane and Shambaugh (2015), which has been recently updated and extended to a larger sample of countries and a longer time span by Bénétrix et al. (2019). As for international reserves (res_t), we use IFS data from the IMF about reserve assets. They are expressed in U.S. dollars. We compute them in domestic currency as a percentage of GDP.

The constant term γ_0 in Eq. (9) includes the constant term of the risk premium μ_0. From an empirical viewpoint, we can add a random term in the formulation of the risk premium, and this term can be a part of the error term ε_t. To account for various time-varying factors of the risk premium, which can be domestic or global risk factors, we alternatively use for robustness checks the role of global uncertainty (VIX). The degree of financial openness is measured by the Chinn-Ito index, KAOPEN (Chinn & Ito, 2006).

While testing the overall predictions of the model presented in section 3, we specifically focus on the transmission of the American interest rates as determined or moderated by three main factors of our interest: (fixed) exchange rate regime, level of public debt (as share of GDP) and the abundance of reserves (in log). More specifically, we utilize the exchange rate arrangement classification by Ilzetzki et al. (2019), and, as a robustness check, the one proposed more recently by Dąbrowski et al. (2020) In the former case as the dummy for fixed exchange

rate arrangement we utilize the category 1 of the "coarse" classification[6] and in the latter – their "fixed" category.

To uncover the mechanisms of transmission of the American interest rate depending on the exchange rate regime and the level of public debt to GDP, we estimate the coefficient on each of these three variables as well as their interactions. If the interaction term between the debt-to-GDP and the US interest rate turns significant, we additionally report the average marginal effects by thresholds of 20% of debt-to-GDP ratio and generally find that the significance fades once the indebtedness indicator reaches 100% of GDP.

We also compare the results for the subsamples of advanced and developing economies.

4.2. Empirical Results

As discussed above, and similarly to Frankel et al. (2004) we concentrate on the level of short-term and long-term interest rates (denoted, respectively i_t^S and i_t^L) to assess empirically the model via the estimation of several alternative versions of equation (9). Thus, the set of independent variables we consider in the following estimates includes:

$i_{i,t-1}^S$ or $i_{i,t-1}^L$ – respectively short-term or long-term rates lagged one period

$i_{i,t}^{S\_US}$ or $i_{i,t}^{L\_US}$ – respectively short-term or long-term US interest rates at time $\underline{t}$

$IRR\_1_{i,t}$ – dummy variable denoting a fixed exchange rate regime in Ilzetzki et al. (2019) "coarse" classification

ln $RES_{i,t}$ – natural logarithm of foreign exchange reserves in USD at time *t*

$d_{i,t}$ – ratio of public debt to GDP at time *t*

$pc_{i,t}$ – credit to private sector at time *t*

$\pi_{i,t}^e$ – inflation expectations in the current period

$\pi_{i,t-1}^e$ – inflation expectations in the previous period

$VIX_{i,t}$– value of CBOE volatilility index at time *t*

$g_{i,t}$ – real GDP growth rate

$kaopen_{i,t}$ – value of Chinn-Ito index at time *t*

$ka_{i,t}$ – capital controls - overall restrictions index, all asset categories

$kai_{i,t}$– capital controls - overall inflow restrictions index

$kao_{i,t}$ – capital controls - overall outflow restrictions index

[6] We have also tested a dummy covering both categories 1 and 2 of the classification, with qualitatively similar, but generally weaker, results. These robustness checks are available upon request.

$FD_{i,t}$ – financial development (findev) index from Svirydzenka (2016)

$el\_FC_{i,t}$ – share of external liabilities denominated in foreign currencies

$el\_gdp\_FC_{i,t}$ – relation of external liabilities denominated in foreign currency to GDP

$el\_gdp\_DC_{i,t}$ – relation of external liabilities denominated in domestic currency to GDP (the three last variables related to external liabilities come from Bénétrix et al., 2019).

Therefore, we have estimated six main specifications both for short- (*S*) and long-term (*L*) interest rates with variations in the definitions of the explanatory and control variables:

1. $i_{i,t}^{T} = c + \beta_0 i_{i,t-1}^{T} + \beta_1 \ln RES_{i,t} + \beta_2 pc_{i,t} + \beta_3 g_{i,t} + \beta_4 \pi_{i,t}^{e} + \beta_5 VIX_{i,t} + \beta_6 FD_{i,t} + \beta_7 kaopen_{i,t} + \beta_8 IRR\_1_{i,t} + \beta_9 i_{i,t}^{T\_US} + \beta_{10} IRR\_1_{i,t} * i_{i,t}^{T_{US}} + \beta_{11} d_{i,t} + \beta_{12} IRR_{1_{i,t}} * d_{i,t} + \beta_{13} i_{i,t}^{T_{US}} * d_{i,t} + \beta_{14} IRR_{1_{i,t}} * i_{i,t}^{T_{US}} * d_{i,t}$ with $T = S, L$
2. $i_{i,t}^{T} = c + \beta_0 i_{i,t-1}^{T} + \beta_1 \ln RES_{i,t} + \beta_2 pc_{i,t} + \beta_3 g_{i,t} + \beta_4 \pi_{i,t-1}^{e} + \beta_5 VIX_{i,t} + \beta_6 FD_{i,t} + \beta_7 kaopen_{i,t} + \beta_8 IRR\_1_{i,t} + \beta_9 i_{i,t}^{T\_US} + \beta_{10} IRR\_1_{i,t} * i_{i,t}^{T_{US}} + \beta_{11} d_{i,t} + \beta_{12} IRR_{1_{i,t}} * d_{i,t} + \beta_{13} i_{i,t}^{T_{US}} * d_{i,t} + \beta_{14} IRR_{1_{i,t}} * i_{i,t}^{T_{US}} * d_{i,t}$ with $T = S, L$
3. $i_{i,t}^{T} = c + \beta_0 i_{i,t-1}^{T} + \beta_1 el\_FC_{i,t} + \beta_2 pc_{i,t} + \beta_3 g_{i,t} + \beta_4 \pi_{i,t-1}^{e} + \beta_5 VIX_{i,t} + \beta_6 FD_{i,t} + \beta_7 kaopen_{i,t} + \beta_8 IRR\_1_{i,t} + \beta_9 i_{i,t}^{T\_US} + \beta_{10} IRR\_1_{i,t} * i_{i,t}^{T_{US}} + \beta_{11} d_{i,t} + \beta_{12} IRR_{1_{i,t}} * d_{i,t} + \beta_{13} i_{i,t}^{T_{US}} * d_{i,t} + \beta_{14} IRR_{1_{i,t}} * i_{i,t}^{T_{US}} * d_{i,t}$ with $T = S, L$
4. $i_{i,t}^{T} = c + \beta_0 i_{i,t-1}^{T} + \beta_1 el\_gdp\_FC_{i,t} + \beta_2 el\_gdp\_DC_{i,t} + \beta_3 pc_{i,t} + \beta_4 g_{i,t} + \beta_5 \pi_{i,t-1}^{e} + \beta_6 VIX_{i,t} + \beta_7 FD_{i,t} + \beta_8 kaopen_{i,t} + \beta_9 IRR\_1_{i,t} + \beta_{10} i_{i,t}^{T\_US} + \beta_{11} IRR\_1_{i,t} * i_{i,t}^{T_{US}} + \beta_{12} d_{i,t} + \beta_{13} IRR_{1_{i,t}} * d_{i,t} + \beta_{14} i_{i,t}^{T_{US}} * d_{i,t} + \beta_{15} IRR_{1_{i,t}} * i_{i,t}^{T_{US}} * d_{i,t}$ with $T = S, L$
5. $i_{i,t}^{T} = c + \beta_0 i_{i,t-1}^{T} + \beta_1 \ln RES_{i,t} + \beta_2 pc_{i,t} + \beta_3 g_{i,t} + \beta_4 \pi_{i,t}^{e} + \beta_5 VIX_{i,t} + \beta_6 FD_{i,t} + \beta_7 ka_{i,t} + \beta_8 IRR\_1_{i,t} + \beta_9 i_{i,t}^{T\_US} + \beta_{10} IRR\_1_{i,t} * i_{i,t}^{T_{US}} + \beta_{11} d_{i,t} + \beta_{12} IRR_{1_{i,t}} * d_{i,t} + \beta_{13} i_{i,t}^{T_{US}} * d_{i,t} + \beta_{14} IRR_{1_{i,t}} * i_{i,t}^{T_{US}} * d_{i,t}$ with $T = S, L$
6. $i_{i,t}^{T} = c + \beta_0 i_{i,t-1}^{T} + \beta_1 \ln RES_{i,t} + \beta_2 pc_{i,t} + \beta_3 g_{i,t} + \beta_4 \pi_{i,t}^{e} + \beta_5 VIX_{i,t} + \beta_6 FD_{i,t} + \beta_7 kai_{i,t} + \beta_8 kao_{i,t} + \beta_9 IRR\_1_{i,t} + \beta_{10} i_{i,t}^{T\_US} + \beta_{11} IRR\_1_{i,t} * i_{i,t}^{T_{US}} + \beta_{12} d_{i,t} + \beta_{13} IRR_{1_{i,t}} * d_{i,t} + \beta_{14} i_{i,t}^{T_{US}} * d_{i,t} + \beta_{15} IRR_{1_{i,t}} * i_{i,t}^{T_{US}} * d_{i,t}$ with $T = S, L$

In addition, we used different estimation methods: OLS pooled with robust SE (Table 1); PCSE pooled (Table 2); Driscoll-Kraay SE pooled (Table 3). In standard OLS estimations, there

are three panel error assumptions: groupwise heteroskedasticity, contemporaneous correlation, and serial correlation. The PCSE method only corrects for the first two. In the Driscoll and Kraay (1998) robust estimation, the error structure is assumed to be heteroskedastic, autocorrelated up to some lag (in this case 2 years), and possibly correlated between the groups (panels). Driscoll-Kraay standard errors are robust to very general forms of cross-sectional ("spatial") and temporal dependence when the time dimension becomes large. This nonparametric technique of estimating standard errors does not place any restrictions on the limiting behaviour of the number of panels.

Tables 1, 2 and 3 present the estimated coefficients for the short-term rates in whole panel of up to 53 countries (regressions 1 – 6). Table 4 shows a comparison of estimates of regression 1 for advanced and developing economies with the three alternative methods we utilize. Tables 5, 6 and 7 report the corresponding results for the case of long-term interest rates (10-year government bond yields) in advanced economies, whereas tables 8, 9 and 10 include the results of estimates for developing countries, for which long-term rates are taken from JP Morgan emerging market bond index (EMBI).

[Table 1]

[Table 2]

[Table 3]

[Table 4]

The results can be summarized as follows:

- the interest rates are very persistent, as observed in the first lag of the dependent variable with the order of value of 0.55 to 0.7;
- there are important direct spillovers from the U.S. interest rates to advanced economies, but not to developing countries (as evidenced in Table 4), which also makes the transmission not robustly significant for the whole panel of countries (Tables 1 – 3);
- Private credit to GDP tends to reduce interest rates, thus confirming a prediction of the model ($\gamma_5 < 0$);
- Inflation expectations (especially the formed at the current period) robustly increase the nominal interest rates – which is in line general economic intuition and possible within our model (γ_4 turns out to be positive);
- The estimated coefficient for economic growth has the expected positive sign only for advanced economies (Table 4); does not seem to impact the level of short-term interest

rates in the whole panel (Tables 1-3) and exhibits even paradoxical sign once long-term rates are considered both in advanced and developing economies;

- Global volatility index (VIX) is a significantly robust determinant long-term rates in developing countries (Tables 8-10), confirming the intuition that in more turbulent times the capital flights to safer bays;
- Financial openness measures (kaopen, ka, kai, kao) exert a dampening effect on interest rates, although with a varying strength and significance in different specifications;
- Financial development allows for lowering short term rates (Tables 1-3);
- Composition of external liabilities plays a significant role for both short-term and long-term rates - countries with higher shares of liabilities denominated in foreign currencies (a risk factor) exhibit higher interest rates, which is also in line with predictions of the model ($\gamma_7 > \gamma_6$).

[Table 5]

[Table 6]

[Table 7]

Turning to our main variables of interest, reserves and public debt as well as its interactions with the exchange rate arrangement and the American interest rates, we can note that:

- The coefficient on foreign reserves is indeed negative and significant (the model predicted $\gamma_8 < 0$), but only in case of long-term rates in developed countries (Tables 5-7);
- Up to 0.35 of the U.S. impulses are passed through to or short term rates in the whole sample (Tables 1-3), in the specifications with composition of external liabilities, the effect can be seen by the interaction term with the fixed exchange rate dummy meaning that the transmission occurs in the countries having their currencies anchored. On the other hand, Table 4 demonstrates that the pass-through of short-term rates happens only in developed countries;
- Transmission of long-term rates is much stronger for the developed economies and in the long-run: as illustrated in Tables 5-7 the pass-through coefficient is always significant and varies between 0.47 and 0.73. The effect is further strengthened in countries with fixed exchange rates. Contrarily to advanced economies, in developing ones such pass-through is never significant according our estimates presented in Tables 8-10;

- The fixed exchange rate dummy (exchange rate arrangement denoted by "1" in the "coarse" classification by Ilzetzki et al. 2019) may help to lower short-term rates (Tables 1-3, regressions 3-4), however, for developing countries the effect seems to be paradoxical both for short-term (Table 4) and long-term rates (Tables 8 and 10).
- Public debt has directly only a limited and not robust positive effect on interest rates (long, short and in all sub-samples), which might be implied by the two opposing effects (risk and liquidity) cancelling out each other. However, interacted with the US interest rate public debt reveals some interesting moderating role. For the instances, in which this coefficient turned out significant (notably regressions 3 and 4 for long-term rates in the developed economies – Tables 5 and 6) we estimate the marginal effects (Table 11). It turns out that at a low level of public debt ratios the US long-term rates are significantly passed-through. However, for a debt-to-GDP ratio of 80%, the effect vanishes and for the most indebted countries, the relation might be even inversed. We interpret this as a sign that excessive public debt effectively excludes a country from international financial markets or at least forces it to borrow at a different level of interest rates.

[Table 8]

[Table 9]

[Table 10]

[Table 11]

5. Conclusion

In this paper, we study the determinants of international transmission of interest rates with a special emphasis on the role of international reserves and government debt. We confirm that the trilemma still holds, although a true monetary independence is only achieved through capital controls.

While testing predictions of our theoretical model we notably find that the government debt can have a liquidity effect on short-term rates (leading to their reduction), but for the long-term rates the net effect is nil or the opposite effects of liquidity and risk cancel out each other. A higher level of international reserves can help to reduce long-term interest rates.

Summarising we find: i) significant spillovers from the U.S. interest rates to other countries; ii) a dampening effect of the share of external liabilities in the domestic currency, clearly a determinant of risk premium; iii) a negative effect of international reserves on interest rates, as expected; iv) higher reserves decrease risk premia, for long-term interest rates; v) the spillover

effect of the US interest rate is mostly significant for the Advanced Economies sub-group; and vi) the significance of this effect fades once the sovereign debt reaches 100% of GDP.

As main directions for further research we may point out a more in-depth exploration of the risk and liquidity channels of public debt with a possible estimation of the threshold of public debt-to-GDP ratio above which the sign of the effect of the public debt variable on interest rates changes. Finally, future work could also use error-correction models to uncover the underlying dynamics of interest rates adjustment.

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Table 1: Transmission of short-term rates – all countries, pooled OLS with robust SE

VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)
L.st_intrate	0.613***	0.707***	0.665***	0.674***	0.631***	0.630***
	(0.066)	(0.077)	(0.091)	(0.089)	(0.067)	(0.067)
lnreserves	-0.014	-0.014			0.105	0.112
	(0.083)	(0.080)			(0.078)	(0.077)
privcredit_gdp	-0.004	-0.004	-0.009*	-0.008*	-0.004	-0.003
	(0.003)	(0.003)	(0.005)	(0.005)	(0.003)	(0.003)
gdpgrowth	-0.065	-0.059	-0.115	-0.115	-0.085	-0.083
	(0.080)	(0.091)	(0.121)	(0.122)	(0.082)	(0.082)
infexp_current	0.154		0.108	0.108	0.133	0.133
	(0.102)		(0.101)	(0.101)	(0.096)	(0.096)
vix	-0.022	-0.016	-0.024	-0.022	-0.028	-0.027
	(0.020)	(0.020)	(0.017)	(0.017)	(0.019)	(0.019)
kaopen	-0.054	-0.156	-0.206	-0.178		
	(0.108)	(0.139)	(0.162)	(0.156)		
findev	-0.806	-1.444**	1.122*	0.625	-1.705**	-1.855**
	(0.747)	(0.702)	(0.689)	(0.679)	(0.749)	(0.736)
irr_dummy_1	0.042	-0.286	-0.765*	-0.805**	0.015	0.093
	(0.552)	(0.594)	(0.402)	(0.405)	(0.528)	(0.537)
publicdebt_gdp	-0.001	-0.003	0.002	0.002	0.001	0.002
	(0.006)	(0.006)	(0.002)	(0.002)	(0.005)	(0.005)
irr_dummy_1#publicdebt_gdp	-0.010	-0.006	0.002	0.000	-0.011	-0.012
	(0.008)	(0.009)	(0.006)	(0.006)	(0.008)	(0.008)
st_intrate_US	0.207	0.186	0.108	0.111	0.338**	0.347**
	(0.144)	(0.143)	(0.093)	(0.095)	(0.135)	(0.135)
irr_dummy_1#st_intrate_US	-0.112	-0.032	0.373**	0.351**	-0.001	-0.003
	(0.193)	(0.195)	(0.145)	(0.142)	(0.174)	(0.174)
publicdebt_gdp#st_intrate_US	-0.001	0.000	-0.000	-0.000	-0.003	-0.004
	(0.003)	(0.003)	(0.001)	(0.001)	(0.002)	(0.002)
irr_dummy_1#publicdebt_gdp#st_intrate_US	0.003	0.002	-0.003	-0.002	0.003	0.003
	(0.003)	(0.004)	(0.002)	(0.002)	(0.003)	(0.003)
infexp_previous		-0.052				
		(0.119)				
share_extL_FC			1.220*			
			(0.709)			
extL_DC_gdp				-0.000		
				(0.001)		
extL_FC_gdp				0.002		
				(0.002)		
ka					-0.656*	
					(0.367)	
kai						-1.070
						(0.727)
kao						0.223
						(0.605)
Constant	2.458*	3.243**	1.296	1.919*	2.006*	1.954
	(1.264)	(1.265)	(0.944)	(1.118)	(1.239)	(1.234)
Observations	586	585	493	493	537	537
R-squared	0.827	0.811	0.852	0.851	0.837	0.837
r2_a	0.823	0.806	0.847	0.846	0.832	0.832
F	76.034	74.807	69.256	65.447	72.560	68.058

Robust standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.11

Table 2: Transmission of short term rates – all countries, PCSE pooled

VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)
L.st_intrate	0.542***	0.665***	0.606***	0.620***	0.573***	0.573***
	(0.060)	(0.063)	(0.078)	(0.076)	(0.064)	(0.064)
lnreserves	-0.048	-0.041			0.081	0.087
	(0.096)	(0.098)			(0.090)	(0.090)
privcredit_gdp	-0.007**	-0.007**	-0.011***	-0.011***	-0.006*	-0.006*
	(0.003)	(0.003)	(0.004)	(0.004)	(0.003)	(0.003)
gdpgrowth	-0.066	-0.054	-0.125*	-0.126*	-0.082	-0.081
	(0.052)	(0.055)	(0.075)	(0.076)	(0.055)	(0.055)
infexp_current	0.163***		0.122***	0.121***	0.142***	0.143***
	(0.043)		(0.040)	(0.040)	(0.041)	(0.041)
vix	-0.012	-0.004	-0.018	-0.017	-0.020	-0.019
	(0.021)	(0.022)	(0.018)	(0.018)	(0.020)	(0.020)
kaopen	-0.079	-0.220	-0.265*	-0.226*		
	(0.124)	(0.138)	(0.138)	(0.137)		
findev	-0.797	-1.599*	1.378*	0.711	-1.736**	-1.873**
	(0.822)	(0.912)	(0.775)	(0.794)	(0.778)	(0.772)
irr_dummy_1	-0.057	-0.406	-0.687	-0.731	0.047	0.118
	(0.634)	(0.677)	(0.458)	(0.462)	(0.594)	(0.599)
publicdebt_gdp	-0.001	-0.005	0.003	0.003	0.001	0.001
	(0.006)	(0.006)	(0.003)	(0.003)	(0.006)	(0.006)
irr_dummy_1#publicdebt_gdp	-0.011	-0.006	0.002	-0.001	-0.012	-0.014*
	(0.009)	(0.009)	(0.006)	(0.005)	(0.008)	(0.008)
st_intrate_US	0.185	0.160	0.131	0.132	0.321**	0.328**
	(0.146)	(0.142)	(0.134)	(0.134)	(0.137)	(0.137)
irr_dummy_1#st_intrate_US	-0.066	0.004	0.370**	0.345**	0.024	0.022
	(0.190)	(0.191)	(0.161)	(0.159)	(0.176)	(0.176)
publicdebt_gdp#st_intrate_US	0.000	0.001	-0.000	-0.000	-0.003	-0.003
	(0.002)	(0.002)	(0.001)	(0.001)	(0.002)	(0.002)
irr_dummy_1#publicdebt_gdp #st_intrate_US	0.002	0.001	-0.003	-0.002	0.002	0.002
	(0.003)	(0.003)	(0.002)	(0.002)	(0.002)	(0.002)
infexp_previous		-0.121				
		(0.120)				
share_extL_FC			1.703**			
			(0.680)			
extL_DC_gdp				-0.001		
				(0.001)		
extL_FC_gdp				0.003		
				(0.002)		
Ka					-0.704*	
					(0.429)	
Kai						-1.041
						(0.852)
Kao						0.162
						(0.691)
Constant	3.218**	4.214***	1.304	2.164**	2.575**	2.543**
	(1.372)	(1.526)	(0.935)	(1.003)	(1.268)	(1.266)
Observations	586	585	493	493	537	537
Countries	53	53	35	35	48	48
R-squared	0.767	0.747	0.810	0.811	0.787	0.787

Notes: Standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.11. In standard OLS estimations, there are three panel error assumptions: groupwise heteroskedasticity, contemporaneous correlation, and serial correlation. The PCSE method only corrects for the first two. In the PCSE estimation method, when computing the standard errors and the variance-covariance estimates, it is assumed that the disturbances are, by default, heteroskedastic and contemporaneously correlated across panels.

Table 3: Transmission of short-term rates – all countries, Driscoll-Kraay SE pooled

VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)
L.st_intrate	0.613***	0.707***	0.665***	0.674***	0.631***	0.630***
	(0.058)	(0.086)	(0.058)	(0.056)	(0.056)	(0.055)
lnreserves	-0.014	-0.014			0.105	0.112
	(0.095)	(0.100)			(0.072)	(0.071)
privcredit_gdp	-0.004	-0.004	-0.009	-0.008	-0.004	-0.003
	(0.003)	(0.003)	(0.005)	(0.005)	(0.003)	(0.003)
gdpgrowth	-0.065	-0.059	-0.115	-0.115	-0.085	-0.083
	(0.092)	(0.094)	(0.147)	(0.149)	(0.111)	(0.113)
infexp_current	0.154		0.108	0.108	0.133*	0.133*
	(0.090)		(0.084)	(0.084)	(0.076)	(0.076)
vix	-0.022	-0.016	-0.024	-0.022	-0.028	-0.027
	(0.021)	(0.028)	(0.021)	(0.020)	(0.022)	(0.022)
kaopen	-0.054	-0.156	-0.206	-0.178		
	(0.071)	(0.119)	(0.145)	(0.131)		
findev	-0.806	-1.444***	1.122*	0.625	-1.705**	-1.855**
	(0.697)	(0.438)	(0.654)	(0.441)	(0.754)	(0.688)
irr_dummy_1	0.042	-0.286	-0.765*	-0.805**	0.015	0.093
	(0.386)	(0.529)	(0.363)	(0.373)	(0.277)	(0.316)
publicdebt_gdp	-0.001	-0.003	0.002	0.002	0.001	0.002
	(0.002)	(0.005)	(0.002)	(0.002)	(0.002)	(0.002)
irr_dummy_1#publicdebt_gdp	-0.010	-0.006	0.002	0.000	-0.011	-0.012
	(0.006)	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)
st_intrate_US	0.207**	0.186	0.108	0.111	0.338***	0.347***
	(0.091)	(0.118)	(0.112)	(0.106)	(0.051)	(0.048)
irr_dummy_1#st_intrate_US	-0.112	-0.032	0.373***	0.351***	-0.001	-0.003
	(0.097)	(0.139)	(0.112)	(0.096)	(0.086)	(0.087)
publicdebt_gdp#st_intrate_US	-0.001	0.000	-0.000	-0.000	-0.003***	-0.004***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
irr_dummy_1#publicdebt_gdp #st_intrate_US	0.003**	0.002	-0.003**	-0.002**	0.003	0.003
	(0.001)	(0.002)	(0.001)	(0.001)	(0.002)	(0.002)
infexp_previous		-0.052				
		(0.094)				
share_extL_FC			1.220			
			(0.735)			
extL_DC_gdp				-0.000		
				(0.000)		
extL_FC_gdp				0.002*		
				(0.001)		
ka					-0.656***	
					(0.210)	
kai						-1.070
						(0.616)
kao						0.223
						(0.582)
Constant	2.458	3.243	1.296	1.919	2.006	1.954
	(2.016)	(1.999)	(1.095)	(1.355)	(1.754)	(1.740)
Observations	586	585	493	493	537	537
Countries	53	53	35	35	48	48
R-squared	0.827	0.811	0.852	0.851	0.837	0.837

Notes: Standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.11. In the Driscoll and Kraay (1998) robust estimation the error structure is assumed to be heteroskedastic, autocorrelated up to some lag (in this case 2 years), and possibly correlated between the groups (panels). Driscoll-Kraay standard errors are robust to very general forms of cross-sectional ("spatial") and temporal dependence when the time dimension becomes large. This nonparametric technique of estimating standard errors does not place any restrictions on the limiting behavior of the number of panels.

Table 4: Estimation of regression 1 with alternative estimators, by income group

VARIABLES	OLS-AE	OLS-DEV	PCSE-AE	PCSE-DEV	DCSE-AE	DCSE-DEV
L.fidr_2017_apr	0.651***	0.591***	0.593***	0.504***	0.651***	0.591***
	(0.058)	(0.073)	(0.044)	(0.068)	(0.059)	(0.059)
lnreserves	0.005	0.067	0.018	0.015	0.005	0.067
	(0.048)	(0.137)	(0.056)	(0.170)	(0.039)	(0.161)
privcredit_gdp	0.003	-0.013	0.003	-0.023**	0.003*	-0.013
	(0.002)	(0.008)	(0.002)	(0.010)	(0.001)	(0.008)
gdpgrowth	0.118***	-0.171	0.132***	-0.173**	0.118***	-0.171
	(0.027)	(0.114)	(0.026)	(0.073)	(0.030)	(0.134)
infexp_current	0.153***	0.145	0.179***	0.152***	0.153**	0.145
	(0.049)	(0.107)	(0.049)	(0.044)	(0.066)	(0.100)
vix	0.015	-0.042	0.025**	-0.027	0.015	-0.042
	(0.012)	(0.034)	(0.011)	(0.038)	(0.016)	(0.042)
kaopen	0.086	-0.150	0.082	-0.181	0.086	-0.150
	(0.090)	(0.168)	(0.098)	(0.185)	(0.084)	(0.152)
findev	0.484	-1.529	0.394	-0.355	0.484	-1.529
	(0.516)	(2.256)	(0.592)	(2.603)	(0.460)	(3.231)
irr_dummy_1	-0.248	2.371*	-0.206	2.032	-0.248	2.371**
	(0.443)	(1.383)	(0.457)	(1.427)	(0.317)	(1.010)
publicdebt_gdp	-0.002	0.010	-0.003	0.008	-0.002	0.010
	(0.003)	(0.017)	(0.003)	(0.016)	(0.002)	(0.008)
irr_dummy_1#publicdebt_gdp	0.007	-0.068**	0.007	-0.059*	0.007	-0.068**
	(0.006)	(0.034)	(0.006)	(0.030)	(0.004)	(0.027)
st_intrate_US	0.340***	0.213	0.364***	0.141	0.340***	0.213
	(0.092)	(0.325)	(0.088)	(0.286)	(0.065)	(0.174)
irr_dummy_1#st_intrate_US	0.039	-0.890*	0.009	-0.763*	0.039	-0.890***
	(0.127)	(0.461)	(0.133)	(0.400)	(0.098)	(0.223)
publicdebt_gdp#st_intrate_US	-0.001	-0.002	-0.001	-0.000	-0.001*	-0.002
	(0.001)	(0.007)	(0.001)	(0.005)	(0.000)	(0.003)
irr_dummy_1#publicdebt_gdp#st_intrate_US	-0.001	0.022**	-0.001	0.019**	-0.001	0.022***
	(0.002)	(0.011)	(0.002)	(0.008)	(0.001)	(0.005)
Constant	-1.581**	3.450*	-1.796**	4.441**	-1.581***	3.450
	(0.614)	(1.777)	(0.709)	(2.152)	(0.421)	(2.166)
Observations	303	283	303	283	303	283
R-squared	0.777	0.798	0.742	0.724	0.777	0.798
Countries	26	27	26	27	26	27

Notes: Robust standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.11

Table 5: Transmission of long-term rates – Advanced Economies, OLS pooled with robust SE

VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)
L.bond_yields	0.638***	0.660***	0.538***	0.548***	0.778***	0.789***
	(0.094)	(0.096)	(0.196)	(0.191)	(0.045)	(0.044)
Lnreserves	-0.198***	-0.158**			-0.170***	-0.204***
	(0.061)	(0.064)			(0.055)	(0.066)
privcredit_gdp	0.003*	0.004**	0.005*	0.004	0.004**	0.005***
	(0.002)	(0.002)	(0.003)	(0.003)	(0.002)	(0.001)
gdpgrowth	-0.132*	-0.109*	-0.064	-0.066	-0.064	-0.068
	(0.071)	(0.058)	(0.052)	(0.049)	(0.062)	(0.062)
infexp_current	0.077		0.109	0.102	0.012	0.016
	(0.054)		(0.089)	(0.091)	(0.034)	(0.031)
vix	0.001	0.003	0.015	0.015	0.003	0.003
	(0.013)	(0.012)	(0.012)	(0.011)	(0.011)	(0.011)
kaopen	-0.034	0.014	-0.463**	-0.555**		
	(0.165)	(0.181)	(0.207)	(0.242)		
findev	-0.926	-0.680	-1.638***	-1.804***	-0.624	-0.684
	(0.625)	(0.545)	(0.616)	(0.678)	(0.573)	(0.578)
irr_dummy_1	-2.206	-1.842	-4.573***	-4.338***	-3.472**	-3.299**
	(2.069)	(2.005)	(1.606)	(1.514)	(1.613)	(1.599)
lt_intrate_US	0.692***	0.647***	0.637***	0.651***	0.470***	0.485***
	(0.207)	(0.201)	(0.137)	(0.144)	(0.143)	(0.141)
irr_dummy_1#lt_intrate_US	0.342	0.287	0.891**	0.832**	0.612*	0.590*
	(0.428)	(0.415)	(0.366)	(0.347)	(0.335)	(0.333)
publicdebt_gdp	0.007	0.008	0.006*	0.006**	0.003	0.005
	(0.010)	(0.009)	(0.003)	(0.003)	(0.008)	(0.007)
irr_dummy_1#publicdebt_gdp	0.025	0.023	0.070***	0.067***	0.043**	0.038*
	(0.025)	(0.025)	(0.024)	(0.023)	(0.020)	(0.020)
lt_intrate_US#publicdebt_gdp	-0.003	-0.003	-0.003**	-0.003**	-0.002	-0.002
	(0.002)	(0.002)	(0.001)	(0.001)	(0.002)	(0.002)
irr_dummy_1#lt_intrate_US#publicdebt_gdp	-0.004	-0.004	-0.013**	-0.012**	-0.008*	-0.007*
	(0.005)	(0.005)	(0.005)	(0.005)	(0.004)	(0.004)
infexp_previous		0.228**				
		(0.111)				
share_extL_FC			0.884			
			(0.585)			
extL_DC_gdp				-0.001		
				(0.001)		
extL_FC_gdp				0.002*		
				(0.001)		
ka					-0.389	
					(0.590)	
kai						-1.522*
						(0.862)
kao						0.397
						(0.288)
Constant	1.460	0.267	0.494	1.037	1.055	1.296
	(1.300)	(1.189)	(0.886)	(1.080)	(1.555)	(1.576)
Observations	293	293	310	310	275	275
Countries	26	26	22	22	24	24
R-squared	0.725	0.736	0.733	0.733	0.816	0.819

Notes: Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.11

Table 6: Transmission of long term rates – Advanced Economies, PCSE pooled

VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)
L.bond_yields	0.620***	0.658***	0.378***	0.400***	0.761***	0.780***
	(0.079)	(0.074)	(0.110)	(0.107)	(0.065)	(0.064)
Lnreserves	-0.205***	-0.159***			-0.181***	-0.210***
	(0.061)	(0.059)			(0.055)	(0.058)
privcredit_gdp	0.004	0.004**	0.005*	0.004*	0.004**	0.005**
	(0.002)	(0.002)	(0.003)	(0.003)	(0.002)	(0.002)
gdpgrowth	-0.134***	-0.109***	-0.045	-0.046	-0.061*	-0.066**
	(0.036)	(0.034)	(0.040)	(0.040)	(0.032)	(0.032)
infexp_current	0.074		0.100	0.091	0.007	0.012
	(0.057)		(0.070)	(0.071)	(0.060)	(0.058)
vix	0.001	0.003	0.023*	0.022*	0.004	0.003
	(0.010)	(0.010)	(0.012)	(0.012)	(0.008)	(0.008)
kaopen	-0.052	0.012	-0.574*	-0.693**		
	(0.152)	(0.150)	(0.304)	(0.345)		
findev	-0.942	-0.682	-2.000***	-2.182***	-0.629	-0.684
	(0.606)	(0.557)	(0.765)	(0.799)	(0.629)	(0.606)
irr_dummy_1	-2.291	-1.850	-5.567***	-5.201***	-3.643***	-3.407***
	(1.445)	(1.391)	(1.367)	(1.339)	(1.073)	(1.060)
lt_intrate_US	0.703***	0.648***	0.725***	0.737***	0.472***	0.485***
	(0.173)	(0.164)	(0.122)	(0.123)	(0.154)	(0.151)
irr_dummy_1#lt_intrate_US	0.354	0.288	1.102***	1.016***	0.639***	0.607**
	(0.316)	(0.303)	(0.315)	(0.305)	(0.239)	(0.236)
publicdebt_gdp	0.007	0.008	0.006	0.006	0.003	0.005
	(0.009)	(0.008)	(0.005)	(0.005)	(0.008)	(0.007)
irr_dummy_1#publicdebt_gdp	0.026	0.023	0.087***	0.083***	0.044***	0.039***
	(0.017)	(0.017)	(0.020)	(0.019)	(0.013)	(0.013)
lt_intrate_US#publicdebt_gdp	-0.003	-0.003	-0.004**	-0.004***	-0.002	-0.002
	(0.002)	(0.002)	(0.001)	(0.001)	(0.002)	(0.002)
irr_dummy_1#lt_intrate_US#publicdebt_gdp	-0.004	-0.004	-0.016***	-0.015***	-0.008***	-0.007**
	(0.004)	(0.004)	(0.005)	(0.005)	(0.003)	(0.003)
infexp_previous		0.229***				
		(0.072)				
share_extL_FC			1.368*			
			(0.834)			
extL_DC_gdp				-0.001*		
				(0.001)		
extL_FC_gdp				0.003*		
				(0.002)		
Ka					-0.426	
					(0.515)	
kai						-1.491*
						(0.771)
Kao						0.367
						(0.314)
Constant	1.641	0.285	0.991	1.753*	1.228	1.392
	(1.145)	(1.140)	(0.890)	(1.092)	(1.131)	(1.116)
Observations	293	293	310	310	275	275
R-squared	0.712	0.734	0.636	0.641	0.801	0.811
Countries	26	26	22	22	24	24

Notes: Standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.11, see also notes to Table 2 above.

Table 7: Transmission of long term rates – Advanced Economies, **Driscoll-Kraay SE pooled**

VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)
L.bond_yields	0.638***	0.660***	0.538***	0.548***	0.778***	0.789***
	(0.073)	(0.054)	(0.150)	(0.152)	(0.026)	(0.021)
lnreserves	-0.198**	-0.158*			-0.170**	-0.204**
	(0.071)	(0.076)			(0.068)	(0.084)
privcredit_gdp	0.003*	0.004**	0.005	0.004	0.004**	0.005**
	(0.002)	(0.002)	(0.005)	(0.005)	(0.002)	(0.002)
gdpgrowth	-0.132**	-0.109**	-0.064	-0.066	-0.064*	-0.068*
	(0.058)	(0.038)	(0.050)	(0.046)	(0.035)	(0.037)
infexp_current	0.077*		0.109**	0.102*	0.012	0.016
	(0.039)		(0.047)	(0.049)	(0.033)	(0.033)
vix	0.001	0.003	0.015	0.015	0.003	0.003
	(0.014)	(0.014)	(0.010)	(0.010)	(0.011)	(0.012)
kaopen	-0.034	0.014	-0.463*	-0.555*		
	(0.140)	(0.139)	(0.248)	(0.290)		
findev	-0.926	-0.680	-1.638	-1.804	-0.624	-0.684
	(0.761)	(0.600)	(1.374)	(1.398)	(0.648)	(0.654)
irr_dummy_1	-2.206*	-1.842	-4.573**	-4.338**	-3.472**	-3.299**
	(1.238)	(1.341)	(1.571)	(1.496)	(1.332)	(1.275)
publicdebt_gdp	0.007	0.008	0.006**	0.006**	0.003	0.005
	(0.005)	(0.006)	(0.003)	(0.003)	(0.006)	(0.006)
irr_dummy_1#publicdebt_gdp	0.025	0.023	0.070***	0.067**	0.043*	0.038*
	(0.019)	(0.020)	(0.023)	(0.023)	(0.019)	(0.019)
lt_intrate_US	0.692***	0.647***	0.637***	0.651***	0.470***	0.485***
	(0.100)	(0.084)	(0.160)	(0.157)	(0.093)	(0.089)
irr_dummy_1#lt_intrate_US	0.342	0.287	0.891**	0.832**	0.612**	0.590**
	(0.226)	(0.248)	(0.303)	(0.293)	(0.268)	(0.263)
publicdebt_gdp#lt_intrate_US	-0.003**	-0.003*	-0.003**	-0.003**	-0.002	-0.002
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
irr_dummy_1#publicdebt_gdp#lt_intrate_US	-0.004	-0.004	-0.013***	-0.012**	-0.008*	-0.007*
	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)
infexp_previous		0.228*				
		(0.130)				
share_extL_FC			0.884*			
			(0.513)			
extL_DC_gdp				-0.001		
				(0.001)		
extL_FC_gdp				0.002		
				(0.001)		
ka					-0.389	
					(0.850)	
kai						-1.522
						(1.047)
Kao						0.397
						(0.358)
Constant	1.460	0.267	0.494	1.037	1.055	1.296
	(1.152)	(1.119)	(0.850)	(1.114)	(1.723)	(1.774)
Observations	293	293	310	310	275	275
R-squared	0.725	0.736	0.733	0.733	0.816	0.819
Countries	26	26	22	22	24	24

Notes: Standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.11. See also notes to Table 3.

Table 8: Transmission of long-term rates – Emerging Markets - **OLS pooled with robust SE**

VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)
L.lnembi	0.669***	0.685***	0.708***	0.704***	0.659***	0.658***
	(0.044)	(0.047)	(0.045)	(0.046)	(0.044)	(0.044)
lnreserves	-0.007	-0.001			-0.013	-0.012
	(0.026)	(0.027)			(0.025)	(0.026)
privcredit_gdp	-0.000	-0.001	0.000	0.000	-0.001	-0.001
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
gdpgrowth	-0.016***	-0.018***	-0.016**	-0.015**	-0.015***	-0.015***
	(0.005)	(0.006)	(0.008)	(0.008)	(0.005)	(0.005)
infexp_current	0.012***		0.010***	0.010***	0.011***	0.011***
	(0.003)		(0.003)	(0.003)	(0.002)	(0.003)
vix	0.034***	0.035***	0.025***	0.025***	0.037***	0.037***
	(0.004)	(0.005)	(0.004)	(0.005)	(0.004)	(0.004)
kaopen	-0.006	-0.019	-0.015	-0.021		
	(0.020)	(0.020)	(0.022)	(0.027)		
findev	-0.437	-0.480*	-0.078	-0.182	-0.350	-0.362
	(0.275)	(0.290)	(0.282)	(0.265)	(0.277)	(0.282)
irr_dummy_1	1.014	1.077	-0.981	-1.127	1.549*	1.550*
	(0.937)	(1.049)	(1.350)	(1.384)	(0.822)	(0.823)
lt_intrate_US	0.078	-0.004	-0.003	-0.005	0.080	0.082
	(0.069)	(0.086)	(0.039)	(0.042)	(0.069)	(0.072)
irr_dummy_1#lt_intrate_US	-0.247	-0.244	0.160	0.183	-0.343**	-0.345**
	(0.190)	(0.215)	(0.264)	(0.273)	(0.168)	(0.170)
publicdebt_gdp	0.001	-0.008	0.003	0.003	0.001	0.001
	(0.008)	(0.009)	(0.004)	(0.004)	(0.008)	(0.008)
irr_dummy_1#publicdebt_gdp	-0.021	-0.019	0.016	0.019	-0.033*	-0.033*
	(0.022)	(0.025)	(0.035)	(0.037)	(0.017)	(0.018)
lt_intrate_US#publicdebt_gdp	-0.000	0.002	-0.001	-0.001	-0.000	-0.000
	(0.002)	(0.002)	(0.001)	(0.001)	(0.002)	(0.002)
irr_dummy_1#lt_intrate_US#publicdebt_gdp	0.005	0.004	-0.003	-0.003	0.008**	0.008**
	(0.005)	(0.005)	(0.007)	(0.008)	(0.004)	(0.004)
infexp_previous		0.005				
		(0.003)				
share_extL_FC			0.456*			
			(0.271)			
extL_DC_gdp				-0.002		
				(0.001)		
extL_FC_gdp				0.004*		
				(0.002)		
ka					0.032	
					(0.086)	
kai						-0.013
						(0.149)
kao						0.042
						(0.125)
Constant	0.942*	1.169*	0.868**	1.108***	0.966*	0.955*
	(0.553)	(0.607)	(0.427)	(0.376)	(0.531)	(0.549)
Observations	207	207	182	182	194	194
R-squared	0.871	0.860	0.854	0.853	0.881	0.881

Notes: Robust standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.11

Table 9: Transmission of long-term rates – Emerging Markets - PCSE pooled method

VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)
L.lnembi	0.577***	0.611***	0.631***	0.627***	0.564***	0.563***
	(0.045)	(0.048)	(0.047)	(0.046)	(0.045)	(0.045)
Lnreserves	-0.018	-0.009			-0.024	-0.023
	(0.030)	(0.031)			(0.032)	(0.032)
privcredit_gdp	-0.001	-0.001	-0.000	-0.000	-0.002	-0.002
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
gdpgrowth	-0.014**	-0.016**	-0.015**	-0.014**	-0.013**	-0.013**
	(0.006)	(0.006)	(0.007)	(0.007)	(0.005)	(0.005)
infexp_current	0.013***		0.011***	0.011***	0.012***	0.012***
	(0.002)		(0.003)	(0.003)	(0.002)	(0.002)
vix	0.040***	0.040***	0.028***	0.028***	0.043***	0.043***
	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)
kaopen	-0.019	-0.034	-0.027	-0.034		
	(0.024)	(0.024)	(0.024)	(0.027)		
findev	-0.626*	-0.663*	-0.144	-0.244	-0.551	-0.562
	(0.366)	(0.357)	(0.311)	(0.332)	(0.378)	(0.382)
irr_dummy_1	0.457	0.596	-1.095	-1.208	1.210	1.214
	(0.861)	(0.945)	(2.439)	(2.452)	(0.833)	(0.838)
lt_intrate_US	0.066	-0.031	-0.025	-0.025	0.069	0.071
	(0.084)	(0.090)	(0.054)	(0.055)	(0.084)	(0.084)
irr_dummy_1#lt_intrate_US	-0.133	-0.143	0.172	0.188	-0.272	-0.274
	(0.188)	(0.207)	(0.508)	(0.511)	(0.183)	(0.185)
publicdebt_gdp	-0.001	-0.011	0.002	0.002	-0.001	-0.001
	(0.009)	(0.009)	(0.005)	(0.006)	(0.009)	(0.009)
irr_dummy_1#publicdebt_gdp	-0.010	-0.009	0.012	0.014	-0.027	-0.027
	(0.020)	(0.022)	(0.070)	(0.071)	(0.019)	(0.019)
lt_intrate_US#publicdebt_gdp	0.000	0.003	-0.001	-0.001	0.000	0.000
	(0.002)	(0.002)	(0.001)	(0.001)	(0.002)	(0.002)
irr_dummy_1#lt_intrate_US#publicdebt_gdp	0.003	0.002	-0.002	-0.002	0.006	0.007
	(0.004)	(0.005)	(0.015)	(0.015)	(0.004)	(0.004)
infexp_previous		0.004				
		(0.003)				
share_extL_FC			0.579**			
			(0.282)			
extL_DC_gdp				-0.002		
				(0.002)		
extL_FC_gdp				0.005*		
				(0.002)		
ka					0.073	
					(0.103)	
kai						0.008
						(0.154)
kao						0.062
						(0.143)
Constant	1.558**	1.731**	1.297***	1.577***	1.556**	1.555**
	(0.653)	(0.691)	(0.436)	(0.417)	(0.628)	(0.628)
Observations	207	207	182	182	194	194
R-squared	0.898	0.881	0.866	0.865	0.908	0.908
Countries	22	22	14	14	20	20

Notes: Standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.11, see also notes to Table 2 above.

Table 10: Transmission of long-term rates – Emerging Markets - **Driscoll-Kraay SE pooled**

VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)
L.lnembi	0.669***	0.685***	0.708***	0.704***	0.659***	0.658***
	(0.112)	(0.113)	(0.094)	(0.100)	(0.108)	(0.108)
lnreserves	-0.007	-0.001			-0.013	-0.012
	(0.019)	(0.019)			(0.016)	(0.018)
privcredit_gdp	-0.000	-0.001	0.000	0.000	-0.001	-0.001
	(0.001)	(0.001)	(0.001)	(0.002)	(0.001)	(0.001)
gdpgrowth	-0.016*	-0.018*	-0.016	-0.015	-0.015*	-0.015*
	(0.009)	(0.009)	(0.010)	(0.012)	(0.008)	(0.008)
infexp_current	0.012***		0.010**	0.010**	0.011***	0.011***
	(0.003)		(0.004)	(0.004)	(0.003)	(0.003)
vix	0.034**	0.035**	0.025***	0.025**	0.037***	0.037***
	(0.011)	(0.012)	(0.008)	(0.008)	(0.012)	(0.012)
kaopen	-0.006	-0.019	-0.015	-0.021		
	(0.017)	(0.016)	(0.012)	(0.015)		
findev	-0.437	-0.480	-0.078	-0.182	-0.350	-0.362
	(0.283)	(0.315)	(0.323)	(0.305)	(0.272)	(0.288)
1.irr_dummy_1	1.014*	1.077	-0.981	-1.127	1.549**	1.550**
	(0.546)	(0.815)	(1.000)	(0.996)	(0.627)	(0.643)
lt_intrate_US	0.078	-0.004	-0.003	-0.005	0.080	0.082
	(0.096)	(0.121)	(0.037)	(0.031)	(0.095)	(0.093)
1.irr_dummy_1#c.lt_intrate_US	-0.247*	-0.244	0.160	0.183	-0.343**	-0.345**
	(0.120)	(0.175)	(0.203)	(0.201)	(0.132)	(0.136)
publicdebt_gdp	0.001	-0.008	0.003	0.003	0.001	0.001
	(0.005)	(0.008)	(0.003)	(0.003)	(0.005)	(0.005)
1.irr_dummy_1#c.publicdebt_gdp	-0.021	-0.019	0.016	0.019	-0.033**	-0.033**
	(0.016)	(0.021)	(0.028)	(0.028)	(0.014)	(0.014)
c.lt_intrate_US#c.publicdebt_gdp	-0.000	0.002	-0.001	-0.001	-0.000	-0.000
	(0.001)	(0.002)	(0.001)	(0.001)	(0.001)	(0.001)
1.irr_dummy_1#c.lt_intrate_US#c.publicdebt_gdp	0.005	0.004	-0.003	-0.003	0.008**	0.008**
	(0.003)	(0.004)	(0.006)	(0.006)	(0.003)	(0.003)
infexp_previous		0.005				
		(0.003)				
share_extL_FC			0.456*			
			(0.224)			
extL_DC_gdp				-0.002		
				(0.001)		
extL_FC_gdp				0.004		
				(0.002)		
Ka					0.032	
					(0.050)	
kai						-0.013
						(0.086)
kao						0.042
						(0.037)
Constant	0.942*	1.169*	0.868**	1.108**	0.966**	0.955**
	(0.517)	(0.561)	(0.399)	(0.450)	(0.423)	(0.409)
Observations	207	207	182	182	194	194
R-squared	0.871	0.860	0.854	0.853	0.881	0.881
Countries	22	22	14	14	20	20

Notes: Standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.11. See also notes to Table 3.

Table 11: Marginal effects of government debt-to-GDP ratio on the transmission of US long-term interest rates to advanced economies

	Tab. 5, reg. 3		Tab. 5, reg. 4		Tab. 6, reg. 3		Tab. 6, reg. 4	
	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.
debt-to-GDP ratio (%)	-0.003**	(0.001)	-0.003**	(0.001)	-0.004**	(0.001)	-0.004***	(0.001)
	dy/dx	Std. Err.	dy/dx	Std. Err.	dy/dx	Std. Err.	dy/dx	Std. Err.
0	1.160***	(0.278)	1.139***	(0.269)	1.372***	(0.226)	1.333***	0.223
20	0.950***	(0.216)	0.936***	(0.210)	1.114***	(0.173)	1.085***	0.171
40	0.741***	(0.159)	0.734***	(0.156)	0.856***	(0.125)	0.837***	0.123
60	0.531***	(0.110)	0.531***	(0.112)	0.598***	(0.087)	0.589***	0.088
80	0.322***	(0.088)	0.328***	(0.095)	0.340***	(0.077)	0.341***	0.080
100	0.112	(0.109)	0.125	(0.117)	0.082	(0.103)	0.093	0.108
120	-0.098	(0.157)	-0.077	(0.164)	-0.176	(0.148)	-0.155	0.152
140	-0.307	(0.214)	-0.280	(0.219)	-0.434**	(0.199)	-0.403**	0.203
160	-0.517*	(0.275)	-0.483*	(0.279)	-0.692***	(0.252)	-0.651**	0.256
180	-0.726**	(0.338)	-0.686**	(0.340)	-0.950***	(0.307)	-0.899***	0.310
200	-0.936**	(0.401)	-0.888**	(0.402)	-1.209***	(0.362)	-1.147***	0.365

Notes: Standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.11.

Appendix - variables and data sources

Variable	Definition and source
st_intrate	Short-term Interest Rate from World Economic Outlook database, Apr 2017 edition.
st_intrate_US	Short-term Interest Rate in the U.S. Source: World Economic Outlook database, Apr 2017 edition.
bond_yields	10-year bond yields from (FIGB_PA variable) from International Financial Statistics database
lt_intrate_US	10-year bond yields in the U.S. (FIGB_PA variable) from International Financial Statistics database
lnembi	Natural logarithm of JP Morgan emerging market bond index (EMBI).
Lnreserves	Natural logarithm of foreign exchange reserves minus gold, millions of current USD. Source: External Wealth of Nations Mark II database, as updated until 2015 in Lane and Milesi-Ferretti (2017).
privcredit_gdp	Domestic credit to private sector (% of GDP). Source: Global Financial Development Database, July 2018 edition.
Gdpgrowth	Real GDP Growth Rate in period t (%). Source: World Economic Outlook database, Apr 2017 edition.
infexp_current	Inflation (CPI) Forecast in Current (April) edition of the World Economic Outlook database, Apr 2017 edition.
infexp_previous	Inflation (CPI) Forecast in Previous year's (April) edition of the World Economic Outlook database, Apr 2017 edition.
vix	VIX index by Chicago Board of Exchange. Source: Bloomberg.
kaopen	Value of Chinn and Ito (2006) index from their updated database available at: http://web.pdx.edu/~ito/Chinn-Ito_website.htm.
findev	Financial development indicator from Svirydzenka (2016).
irr_dummy_1	Dummy for fixed exchange rate regime (value of 1 according to the "coarse" classification) from Ilzetzki, Reinhart and Rogoff (2018).
publicdebt_gdp	General government debt as % of GDP. Source: World Economic Outlook database, Apr 2017 edition.
share_extL_FC	Share of external liabilities in foreign currency. Source: Bénétrix et al. (2019).
extL_DC_gdp	Relation of external liabilities denominated in foreign currency to GDP. Source: Bénétrix et al. (2019).
extL_FC_gdp	Relation of external liabilities denominated in domestic currency to GDP. Source: Bénétrix et al. (2019).
Ka	Capital controls – overall restrictions index, all asset categories. Source: Fernández et al. (2016)
Kai	Capital controls – overall inflow restrictions index (Fernández et al. 2016).
Kao	Capital controls - overall outflow restrictions index (Fernández et al. 2016).

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