

Finance-driven business cycles in emerging markets? An empirical assessment of Minskyan endogenous cycle approaches

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Abstract

Post-Keynesian and structuralist approaches argue that business cycles in emerging market economies (EMEs) are generated by endogenous cycle mechanisms rather than exogenous shocks. We provide a simple Minskyan open economy model which identifies three distinct financial variables that may interact with output in a cyclical manner: interest rates, external debt, and the nominal exchange rate. We estimate country-wise VARs to test these three cycle mechanisms using data for 13 emerging market economies over the period 1960-2017. We find evidence for a cyclical interaction mechanism between output and the exchange rate in Chile the Philippines, and South Africa, consistent with business cycle models that highlight the role of balance sheet effects. There is some evidence for a cycle mechanism in Israel, in line with models in which currency depreciations are expansionary. With respect to external debt, we find some evidence for a Minskyan interaction mechanism with contractionary effects of external debt in Mexico and South Africa. Lastly, there is some but weaker evidence for an interaction mechanism with the real interest rate in Argentina, Mexico and South Africa. Overall, the results indicate that different variables are likely to be relevant for business cycles in different countries but that multiple cycle mechanisms can coexist and produce different business cycle frequencies.

JEL codes: E12, E32, F31, C32

Key words: Minsky, structuralism, emerging market economies, business cycle, financial-real cycles, vector-autoregression.

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1 Introduction

Business cycles in emerging market economies (EMEs) are considerably more volatile compared to industrial economies and are often referred to as boom-bust cycles. Recessions are typically deeper and costlier compared to rich economies, and tend to be more severe when they coincide with banking and currency crises (Calderón and Fuentes, 2014). As a result, boom-bust cycles have received much attention from both the policy-making and academic world. Economic theory faces the challenge to develop business cycle models that adequately account for structural features of EMEs, especially their dependence on external and financial factors.

Mainstream economists have modified standard real business cycle (RBC) models to explain some of the specificities of EM business cycles (Neumeyer and Perri 2005, Aguiar and Gopinath 2007, Chang and Fernández 2013; see also the recent textbook by Uribe and Schmitt-Grohé 2017). RBC models study different propagation mechanisms that can account for excess volatility in EME cycles, but the ultimate source of fluctuations are exogenous shocks. By contrast, Post-Keynesians and structuralists (PK-S) highlight the endogenous nature of (EME) cycles (Palma, 1998; Harvey, 2010). PK-S approaches offer various endogenous interaction mechanisms between certain macroeconomic variables that generate aggregate fluctuations. The Minskyan branch of the PK-S approach argues that business cycles are finance-driven (for a survey see Nikolaidi and Stockhammer, 2017). Variables that have been considered key for finance-driven business cycles in EMEs are interest rates (Foley, 2003; Frenkel, 2008; Frenkel and Rapetti, 2009), external debt (Palma, 1998; Taylor, 1998; Taylor, 2004, chap. 10; Botta, 2017), and exchange rates (Stiglitz et al., 2006, chap. 6; Ocampo, 2016; Kohler, 2019). However, there are only a few fully specified business cycles models that consider how these variables interact with output, as many approaches remain partial (e.g. Taylor, 2004, chap. 10; Botta, 2017) or descriptive (e.g. Palma, 1998; Taylor, 1998; Frenkel and Rapetti, 2009; Harvey, 2010).

The empirical literature on business cycles in EMEs broadly falls into three categories. First, there is a large number of event studies that either identifies factors that make the occurrence of crisis episodes more likely or that examines the behaviour of key macroeconomic indicators around those events (Kaminsky and Reinhart, 1999; Reinhart and Reinhart, 2009; Agosin and Huaita, 2011; Reinhart and Rogoff, 2011; Claessens et al., 2012; Gourinchas and Obstfeld, 2012; Catão and Milesi-Ferretti, 2014; Calderón and Fuentes, 2014; Ghosh et al., 2016). Crisis episodes in this literature are discrete events such as currency, financial or external debt crises, and the predominant econometric methods relies on models with limited dependent variable models (e.g. logit or probit) or descriptive statistics. Second, there is a growing literature on the effects of global financial shocks on domestic variables in EMEs (Adler and Tovar, 2013; Carrière-Swallow and Céspedes, 2013;

Cesa-Bianchi et al., 2015; Cesa-Bianchi et al., 2018; Choi, 2018). These studies typically rely on impulse response functions from vector-autoregressions (VARs), which track the dynamic behaviour of a set of endogenous variables in response to external shocks. Lastly, the heterodox empirical literature offers rich descriptive accounts that try to capture the complex mechanisms behind cycles and often pay close attention to the institutional and historical context of specific episodes (Palma, 1998; Taylor, 1998; Frenkel, 2008; Frenkel and Rapetti, 2009; Harvey, 2010; Herr, 2013; Ocampo, 2016).

Overall, the existing empirical literature has not aimed at identifying interaction mechanisms that may endogenously generate boom-bust cycles. Event studies, by construction, treat EME crises as discrete events without investigating macroeconomic mechanisms that would bring about those events with a certain periodicity. Similarly, the research on external shocks does not offer an explanation for the occurrence and frequency of shocks. While it discusses domestic amplification mechanisms of global financial shocks, these mechanisms by themselves do not (necessarily) generate periodic cycles, they merely make the response to shocks more volatile. These two strands of the empirical literature are thus close in spirit to the RBC approach, where business cycles are ultimately driven by exogenous shocks. The heterodox literature, in contrast, highlights the endogenous generation of cycles, as well as their periodicity.¹ However, it has hitherto mostly remained at a descriptive level and has not attempted to test the key cycle mechanisms proposed in theoretical models econometrically.

The contribution of the present paper is to formalise a set of endogenous business cycle mechanisms discussed in the Minskyan open economy literature and to test them empirically. We first develop a simple benchmark model and discuss three different closures that emphasise distinct variables that may interact with output in a cyclical manner: the interest rate, external debt, and the exchange rate. Second, we employ the econometric approach developed in (Stockhammer et al., 2019) and estimate a set of bivariate VARs that allows for an assessment whether the key interaction mechanism postulated in those models is satisfied.

The dataset covers 13 EMEs (Argentina, Brazil, Chile, Colombia, India, Indonesia, Israel, Korea, Mexico, Philippines, South Africa, Thailand, and Turkey) and the maximum sample size ranges from 1960 to 2017. As the key variable to capture the business cycle, we use real gross domestic product (GDP). We consider three different variables that may interact

¹ Palma (1998, p. 790, emphasis in original) claims that "'over-lending' and 'over-borrowing' are essentially endogenous market failures: under-regulated and over-liquid financial markets setting in motion Kindleberger's cycles of 'mania, panic and crash'". Frenkel and Rapetti (2009) suggesting that "the nature of these cycles is fairly general" (ibid., p. 690).

with GDP in a cyclical manner: short-term real interest rates, external debt, and the nominal exchange rate with respect to the US dollar.

We find strong evidence for Chile and South Africa, and some evidence for the Philippines for an interaction mechanism between output and the exchange rate, where exchange rate depreciations drag down output dynamics due to balance sheet effects, whereas economic expansions reduce the value of the currency. There is some evidence for an exchange rate mechanism with opposite signs in Israel, in line with models in which currency depreciations are expansionary. With respect to external debt, we find some evidence for an interaction mechanism between output and external debt in Mexico and South Africa, consistent with the hypothesis of rising indebtedness during economic booms, which then feed negatively into output. Lastly, there is weak evidence for an interaction mechanism between the short-term interest rate and output, where rising interest rates depress output, whereas economic expansions lead to an increase in interest rates in Argentina, Mexico, and South Africa.

The remainder of the paper is structured as follows. The second section provides a brief overview of PK-S theories of business cycles in EMEs. Section 3 then develops a benchmark PK-S business cycle model for EMEs and discusses three different closures each of which identifies a core cyclical interaction mechanism that can be tested empirically. The fourth section introduces the data set and estimation framework. Section 5 presents the estimation results. Finally, section 6 concludes.

2 Post-Keynesian and structuralist theories of business cycles in emerging market economies

While PK-S have traditionally placed a somewhat stronger focus on the determinants of long-run growth, they have also made major contributions to a better understanding of short- to medium-run macroeconomic fluctuations in EMEs. Business cycles in PK-S theories are conceived of as an endogenous outcome of specific macroeconomic interaction mechanisms rather than the result of stochastic shocks. Such cycle-generating mechanisms typically consist of the dynamic interaction of two or more state variables whereby one variable pushes up the other, which in turn drags down the first variable (see for instance Taylor, 2004, chap. 9). While traditional heterodox business cycle models in the spirit of Kalecki, Kaldor, Goodwin, and Minsky are predominantly closed economy models,² there is a handful of open economy business cycle models that are applicable to EMEs.

² For a survey of vintage Kaleckian, Kaldorian, and Goodwinian cycle models see Semmler (1986). For a recent survey of Minskyan approaches see Nikolaidi and Stockhammer (2017). Notably, none of the reviewed business cycles models therein is an open economy model.

Differences between PK-S approaches to cycles in EMEs arise with respect to the assumed exchange rate regime – largely for historical reasons. Descriptive accounts that were written under the impression of the Latin American crises in the 1990s and early 2000s, as well as the East Asian crisis in 1997-98, highlight the role of a fixed exchange rate regime, reflecting the dominant exchange rate policy at the time (e.g. Taylor 1998, Frenkel and Rapetti 2009). This is embodied in the assumption of a fixed nominal exchange rate in several formal models (Sethi 1992, Foley 2003, Taylor 2004, chap. 10). More recent descriptive approaches highlight the role of exchange rate volatility (Herr 2013, Kaltenbrunner and Paineira 2015, Ocampo 2016), which came with the adoption of (semi-)flexible exchange rate regimes in the last two decades. The switch to flexible or at least semi-flexible exchange rates has been captured in more recent cycle models (Lima and Porcile 2013, Sasaki et al. 2013, Botta 2017, Kohler 2019).

A second dimension along which PK-S approaches to EM cycles differ concerns the role of (external) financial factors. Heterodox open economy business cycle models in the Kaldorian, Goodwinian, and Kaleckian traditions are more tilted to the real side and typically focus on multiplier-accelerator effects, distributional conflict, and the real exchange rate (Sethi, 1992; Asada, 1995; La Marca, 2010; Lima and Porcile, 2013; Sasaki et al., 2013). Second, approaches in the Minskyan tradition of finance-driven business cycles assign a key role to finance; in particular to the role of interest rates, external debt, and nominal exchange rates (Foley, 2003; Taylor, 2004, chap. 10; Botta, 2017; Kohler, 2019). The focus of this paper is on Minskyan theories of finance-driven business cycles. This approach has consistently accounted for the implications of financial openness for macroeconomic dynamics, which is widely considered to be the defining feature of emerging market economies.

Foley (2003) and Taylor (2004, chap. 10) develop models in which interest rate dynamics are at the centre. In Foley (2003), boom-bust cycles are generated by the interplay of a confidence factor that drives up investment expenditures when interest rates fall and a central bank that raises the interest rate whenever the growth rate of the economy is above its target level. In Taylor (2004), interest rate dynamics are governed by risk premia which are decreasing in the stock of foreign reserves – a mechanism that is also highlighted in Frenkel (2008) and Frenkel and Rapetti (2009). Capital inflow shocks increase the stock of reserves and diminish risk premia, but the resulting boom leads to a build-up of a current account deficits. As a result, foreign reserves begin to shrink, the risk premium increases, and the boom comes to an end.

There is also a rich, but largely informal literature, that introduces open economy aspects into the Minskyan framework and highlights the importance of external debt in EME

business cycles (Palma, 1998; Taylor, 1998; Kregel, 1998; Arestis and Glickman, 2002; Cruz et al., 2006; Frenkel and Rapetti, 2009; Harvey, 2010; Kaltenbrunner and Paineira, 2015). External debt is considered a key source of financial instability in EMEs, which often borrow from abroad given high domestic funding cost and weak financial institutions. While capital inflows may finance real investment expenditures, rising external debt burdens are associated with increasing interest payments and decreasing net worth of economic units, which often involve higher risk premia, credit rationing or sudden capital outflows when foreign investors become nervous. External debt thereby becomes a key variable for business cycle dynamics.

Lastly, recent approaches have addressed the role of flexible exchange rates for Minskyan business cycle dynamics in open economies (Botta, 2017; Kohler, 2019). In the nominal exchange rate interacts with external debt in a cyclical manner. Capital inflows lead to nominal exchange rate appreciation; however, as the stock of external debt successively increases during the boom, foreign investors get anxious and curb the supply of foreign finance. At the same time, the resulting real appreciation worsens the current account position, which puts further downward pressure on the nominal exchange rate. This mechanism leads to external deleveraging. Kohler (2019) presents a model in which procyclical exchange rates and currency mismatches drive EM business cycles. Exchange rate appreciation improves the balance sheets of firms with foreign-currency debt. The resulting boom drives up the current account deficit, which puts pressure in exchange rates. The currency depreciation induces contractionary balance sheet effects then turn the boom into a bust.

Overall, the PK-S literature identifies several interaction mechanisms that may generate business cycles endogenously. The more recent Minskyan literature highlights the role of financial factors. Key variables that feature prominently in finance-driven business cycle mechanisms are interest rates, external debt, and the exchange rate.

3 Formalising endogenous cycle mechanisms

3.1 A basic formal framework for endogenous cycle mechanisms

The endogenous cycle-generating mechanism that is at the heart of PK-S theories of business cycles can be formalised in a straightforward manner. Consider a simple bivariate first-order system of differential equations in which two variables (y, z) interact with each other over time:³

³ To facilitate comparison with the PK-S literature where models are predominantly written in continuous time, the framework presented in this section is in continuous rather than discrete time. However, the key

$$\begin{bmatrix} \dot{y} \\ \dot{z} \end{bmatrix} = \begin{bmatrix} \alpha_0 \\ \beta_0 \end{bmatrix} + \begin{bmatrix} \alpha_1 & \alpha_2 \\ \beta_1 & \beta_2 \end{bmatrix} \begin{bmatrix} y \\ z \end{bmatrix}. \quad (1)$$

The system in (1) can be regarded as a generic linearized reduced-form representation of the basic structure of many of the PK-S models discussed in the previous section.

The Jacobian matrix J of (4.1) has the following structure,

$$J = \begin{bmatrix} J_{11} & J_{12} \\ J_{21} & J_{22} \end{bmatrix} = \begin{bmatrix} \alpha_1 & \alpha_2 \\ \beta_1 & \beta_2 \end{bmatrix}. \quad (2)$$

Oscillations in (1) exist when the eigenvalues of the Jacobian in (2) are complex conjugates. The eigenvalues λ are the roots of the characteristic equation,

$$\lambda^2 - \lambda Tr(J) + Det(J) = 0.$$

with roots

$$\lambda_{1,2} = \frac{Tr(J) \pm \sqrt{Tr(J)^2 - 4Det(J)}}{2},$$

where $Tr(J) = f'(y^*) + g'(z^*)$ and $Det(J) = f'(y^*)g'(z^*) - f'(z^*)g'(y^*)$ (see Gandolfo, 2009, chap. 18). The condition for oscillations can be expressed in terms of the discriminant Δ which must be negative for complex eigenvalues. This condition can also be written as follows (see Stockhammer et al., 2019):

$$\begin{aligned} \Delta &= Tr(J)^2 - 4 Det(J) < 0 \\ &= (J_{11} + J_{22})^2 - 4(J_{11}J_{22} - J_{21}J_{12}) < 0 \\ &= (J_{11} - J_{22})^2 + 4J_{21}J_{12} < 0. \end{aligned}$$

The first term of the condition is always positive. Then it is immediate that a necessary condition for the existence of oscillations must be $J_{21}J_{12} < 0$, or $\alpha_2\beta_1 < 0$ in (1) and (2). This condition has a clear economic intuition: oscillatory dynamics in the system in (1) can only emerge if there is an interaction mechanism between the two state variables of the system by which an increase in one variable induces an acceleration of the second variable, which in turn drags down the first.

condition for a cycle mechanism derived in continuous time equally holds in the discrete time framework employed in the econometric analysis of this paper.

While a two-dimensional (2D) model is somewhat restrictive given that real world time series are likely to be determined by higher-dimensional processes, the two dimensional framework has the advantage that a tractable condition with a clear economic interpretation for the presence of cycles can be derived.⁴ Moreover, many theoretical benchmark models in the PK-S tradition are 2D (see e.g. Taylor 2004, chap. 9; Asada 2001; Foley 2003). We therefore consider the 2D framework as the most appropriate to identify relevant cycle-generating mechanisms. A practical implication of this approach is that in principle the same variable may interact with multiple variables in a cyclical manner. Therefore, the reduced-form in (1) should not be regarded as unique, as there are possibly several of such interaction mechanisms which are not mutually exclusive.

3.2 Endogenous business cycles in an emerging economy - An encompassing post-Keynesian/structuralist model

In this sub-section, we develop a common framework for a simple PK-S business cycle model for EMEs that encompasses several 2D cycle mechanisms as special cases. We focus on finance-driven business cycles in the Minskyan tradition and discuss three possible financial-real interaction mechanisms: output-interest rate interactions, output-external debt interactions, and output-exchange rate interactions. Each of these cycle mechanisms will then be tested empirically in the remainder of the paper.

The economy consists of one sector that produces a homogenous good using capital and labour, which can be used for consumption and investment. For simplicity, there is no depreciation of the capital stock and no overhead labour. The technical coefficients of labour and capital are assumed to be constant, so there is no substitution between capital and labour, and no technical progress. There is Keynesian quantity adjustment to changes in demand. For the sake of simplicity, there is no fiscal authority, and no inflation. We normalise the domestic and foreign price level to unity. Furthermore, there is no substitution between the imported good and the domestic good. The economy is small and open, so that all foreign variables are exogenously given.

⁴ To illustrate the complications implied by the addition of only one further dimension, observe that the characteristic equation from a three-dimensional model would be a third-order polynomial $\lambda^3 + a_1\lambda^2 + a_2\lambda + a_3 = 0$, with $a_1 = -(J_{11} + J_{22} + J_{33})$; $a_2 = J_{22}J_{33} - J_{32}J_{23} + J_{11}J_{33} - J_{31}J_{13} + J_{11}J_{22} - J_{21}J_{12}$ and $a_3 = -[J_{11}(J_{22}J_{33} - J_{32}J_{23}) + J_{22}(J_{11}J_{33} - J_{31}J_{13}) + J_{33}(J_{11}J_{22} - J_{21}J_{12})]$. This polynomial has the discriminant $\Delta = 18a_1a_2a_3 + a_1^3a_2^2 - 4a_1^3a_3 - 4a_2^3 - 27a_3^2$. It is practically impossible to derive economically meaningful conditions under which this discriminant becomes negative.

Equilibrium conditions⁵

Aggregate demand (Y^D) is composed of consumption (C), investment (I), and net exports ($X - sM$), where s is the spot exchange rate defined as units of domestic currency per unit of foreign currency so that an increase in s corresponds to a currency depreciation. Equilibrium in the goods market requires that national income (Y) equals aggregate demand:

$$Y = Y^D \equiv C + I + X - sM. \quad (3)$$

The balance-of-payments (BoP) is given by

$$(X - sM - si^f D^f) + (s\dot{D}^f) = s\dot{F}, \quad (4)$$

where the first term in brackets represents the current account, i.e. the trade surplus minus interest payments abroad, and the second term is the financial account, i.e. net capital inflows. The superscript f denotes foreign variables. i^f is the interest rate on foreign-currency denominated debt (D^f). A surplus in the current (financial) account that is not fully matched by a deficit in the financial (current) account leads to an accumulation of foreign reserves ($s\dot{F}$). Equilibrium in the balance of payments is given when reserve changes are zero:

$$(X - sM - si^f D^f) + (s\dot{D}^f) = s\dot{F} = 0. \quad (5)$$

Under the assumption that workers do not save and firms do not consume we have $X - sM = R - I$, and the BoP thus coincides with the budget constraint of the firm sector:

$$R - I - si^f D^f + s\dot{D}^f = s\dot{F}, \quad (6)$$

where R is gross profits.

Output determination

I now scale all variables by the capital stock (K) and use lower case letters henceforth. We assume that workers consume all their income and that firms save all their net profits. This yields the following consumption function:

⁵ A list of a symbol definitions can be found in Appendix A1. A dot over a variable denotes its derivative with respect to time, i.e. $\dot{x} = \frac{dx}{dt}$.

$$c \equiv \frac{C}{K} = u - u\pi \qquad u \equiv \frac{Y}{K}; \pi \equiv \frac{R}{Y}, \qquad (7)$$

For investment, We will use a more generic function that encompasses several special cases to derive a set of testable 2D business cycle mechanisms.

$$g = \phi(u, i^f, \lambda, s) \qquad \lambda \equiv \frac{D^f}{K}; \phi_u > 0; \phi_i, \phi_s, \phi_\lambda \leq 0, \qquad (8)$$

As is common in post-Keynesian models, investment is assumed to depend positively on the rate of capacity utilisation (u), which is interpreted as a measure of expected future demand. Each of the subsequent three arguments in the function captures a key mechanism from existing PK-S theories. The assumption that interest payments exert a negative effect on investment demand is standard in post-Keynesian models, as they reduce internal means of finance (see Hein, 2014, chap. 9). In Foley (2003), who in turn draws on Taylor and O'Connell (1985), the negative effect of interest rates on investment constitutes one of the key mechanisms for financial fragility in an open economy context. Similarly, the adverse effect of the debt-to-capital ratio (λ) on investment stems from the hypothesis that firm net worth matters for external financing conditions (Kalecki 1937). Asada (2001) presents a closed economy Minsky model, where the interaction between business debt and output is the key mechanism driving the business cycle. Lastly, the spot exchange rate (s) enters the investment function, which captures contractionary balance sheet effects stemming from the presence of foreign currency-denominated debt on firms' balance sheets.⁶

Lastly, we use a net exports functions that relates the net exports ratio (b) to the foreign rate of capacity utilisation (u^f), the domestic rate of capacity utilisation, and the exchange rate, following standard Kaleckian open economy models (Blecker, 2011):

$$b \equiv \frac{X - sM}{K} = \beta(u^f, u, s) \qquad \beta_{u^f} > 0; \beta_u < 0. \qquad (9)$$

The foreign rate of capacity utilisation improves the trade balance as it translates into export demand for the home country, so the partial derivative β_{u^f} is assumed to be positive.⁷ Second, the domestic rate of capacity utilisation has a negative effect on the trade balance through domestic import demand. Third, whether the effect of an increase in the real exchange rate on the trade balance is positive depends on whether the Marshall-

⁶ In the Keynesian currency crisis model in Charpe et al. (2011, chap. 2), investment is a nonlinear function only of the spot exchange rate due to balance sheet effects.

⁷ Inclusion of the foreign rate of capacity utilisation requires that the domestic and foreign capital stock grow at the same rate.

Lerner condition (MLC) holds, which is captured by the sign of the partial b_s . The empirical evidence on the MLC is mixed (Bahmani et al., 2013), so that b_s can assume positive or negative values.

As in Asada (2001), but extended to the open economy, we adopt the following quantity adjustment equation to specify the dynamics of the rate of capacity utilisation:

$$\dot{u} = \omega(c + g + b - u) \quad \omega > 0. \quad (10)$$

Hence, whenever the goods market equilibrium condition (3) is violated, the rate of capacity utilisation sluggishly adjusts: in a situation of excess demand, where $c + g + b - is\lambda > u$, the rate of capacity utilisation accelerates, while it decelerates under excess supply. Substituting (7) - (9) into (10) finally yields the following differential equation for the dynamics of output:

$$\begin{aligned} \dot{u} &= \omega[(u - u\pi + \phi(u, i^f, \lambda, s) + \beta(u^f, u, s) - u)] \\ &= \omega[\phi(u, i^f, \lambda, s) + \beta(u^f, u, s) - u\pi] \end{aligned} \quad (11)$$

Output dynamics are thus governed by the current level of the rate of capacity utilisation, the foreign interest rate, the external debt to capital ratio, the spot exchange rate, the foreign rate of capacity utilisation, and the profit share.

Closing the model

We will treat the profit share as well as the foreign rate of capacity utilisation as exogenous, leaving three potentially endogenous variables: the foreign interest rate, the external debt to capital ratio, and the exchange rate. As discussed in section 3.1, We aim for 2D systems for analytical clarity. In order to keep the dynamics of the system at two dimensions, we will have to introduce some further assumptions pinning down the dynamic behaviour of one of these variables, while keeping the other two fixed. In the following, we will therefore consider three different closures of the model, each of which highlights a specific cycle mechanism. Moreover, we will also address the question of how balance-of-payments equilibrium (as defined in equation 5) is established in each of those closures. We stress again that different 2D interaction mechanisms are not mutually exclusive and may coexist empirically.

3.2.1 Output-interest rate interaction

Foley (2003) provides the only fully-specified Minskyan open economy model in which the goods market and its interaction with the financial side of the economy is explicitly modelled. The key interacting variable in his model is the interest rate. We therefore first

consider a closure that constitutes an adaptation of Foley's (2003) model to the general framework developed in the previous section.⁸ In Foley (2003), the exchange rate is fixed, so that one can set $s = 1$ and, in the investment and net exports functions, $\phi_s = \beta_s = 0$. Moreover, Foley (2003) does not distinguish foreign and domestic interest rates and implicitly assumes that firms pay the domestic interest rate on their external debt ($i^f = i$). The implicit assumption behind this seems to be that there are no risk premia and no exchange rate expectations that would drive a wedge between the domestic and foreign rate (see e.g. Taylor, 2004, chap. 10; Frenkel, 2008). This is a contestable assumption that can be regarded as a weakness of the model. Bearing in mind the possible limitations of this assumption, we here follow Foley (2003) and assumes that $i^f = i$. Foley (2003) further assumes that external debt is the residual source of finance of the firm sector, so that external debt is created endogenously. In that way, the BoP is always in equilibrium as capital flows adjust. Correspondingly, reserve changes are zero ($\dot{F} = 0$). Scaling equation (4.5) by the capital stock and setting $s = 1$ yields:

$$\frac{\dot{D}^f}{K} = g + i\lambda - u\pi. \quad (12)$$

In order to transform this into a differential equation in λ , We totally differentiate λ with respect to time, $\frac{d\lambda}{dt} \equiv \dot{\lambda} \equiv \frac{\dot{D}^f}{K} - \lambda g$, and substitute the resulting expression into (12):

$$\dot{\lambda} = \lambda(i - g) + g - u\pi. \quad (13)$$

Foley (2003) assumes that investment demand is independent of the level of external debt, so that $\phi_\lambda = 0$. Correspondingly, λ is a state variable whose dynamics depend on the other variables in the system but do not feed back into the system. The stability of the external debt ratio depends on the negativity of

$$\frac{\partial \dot{\lambda}}{\partial \lambda} = i - g, \quad (14)$$

⁸ The main differences between the model in Foley (2003) and the adaptation presented in this section are as follows. First, we use the rate of capacity utilisation instead of the rate of investment as the state variable that captures the business cycle. In Foley (2003), investment dynamics are governed by a confidence factor, which in turn is negatively affected by the interest rate. While We disregard the confidence factor for the sake of simplicity, our reduced-form is very similar to Foley's in that the dynamics of the real side of the economy are negatively affected by the interest rate. Second, Foley (2003) provides an interesting formalisation of Minsky's stages of financial fragility (speculative, hedge, and Ponzi finance) and shows how firms endogenously switch between them over the business cycle. We abstract from this aspect of his model. Third, in our model net exports are determined behaviourally, whereas Foley specifies a behavioural equation for the capital account. Lastly, we pay more attention to the question how balance-of-payments equilibrium is established, also taking into account interest payments on external debt, which Foley 2003 neglects.

which is a relationship that changes over the cycle as both the interest rate and capital accumulation are endogenous. Foley (2003) discusses the conditions under which the business cycle might endogenously create financial fragility (when $i > g$). Our main interest, however, lies in the business cycle mechanism of the model, which is given by the interaction between the interest rate and output. To specify interest rate dynamics, Foley (2003) introduces a law of motion of the interest rate, where the monetary authorities raise the interest rate whenever the growth rate exceeds its equilibrium value. Adapting this assumption to the present framework, where output is the key state variable, we specify:

$$\frac{di}{dt} = \eta(u - u^*) \quad \eta > 0, \quad (15)$$

so that the interest rate increases when the rate of capacity utilisation is above its steady state level.⁹

Having pinned down the behaviour of the exchange rate, external debt, and the interest rate, one can examine the dynamics of the system, which are given by:

$$\begin{aligned} \dot{u} &= \omega[\phi(u, i) + \beta(u^f, u) - u\pi] \\ \frac{di}{dt} &= \eta(u - u^*). \end{aligned}$$

Thus, the Jacobian matrix of the system, evaluated at the unique fixed point where $u = u^*$, is:

$$J(u, i) = \begin{bmatrix} \omega(\phi_u + \beta_u - \pi) & \omega\phi_i \\ \eta & 0 \end{bmatrix}. \quad (16)$$

Stability of the system requires the following two conditions to be satisfied:

$$\begin{aligned} Tr(J) &= \omega(\phi_u + \beta_u - \pi) < 0 \\ Det(J) &= -\eta\omega\phi_i > 0. \end{aligned}$$

The first condition constitutes an open economy Keynesian stability condition, i.e. savings and imports must respond more strongly to a change in the rate of capacity utilisation

⁹ An alternative interpretation of (15) could loosely follow Taylor (2004, chap. 10), where it is assumed that domestic interest rates in EMEs are determined by the foreign rate plus a country risk premium. Insofar as the country risk premium is a function of external conditions (the current account deficit and the stock of external debt), economic booms will lead to rising domestic interest rates.

than investment ($\phi_u + \beta_u - \pi < 0$). We will assume that this condition holds. The second condition is always satisfied by the assumption that investment responds negatively to a change in the interest rate ($\phi_i < 0$).

Having established the asymptotic stability of the system, we investigate the conditions under which cycles emerge. The necessary condition for complex eigenvalues derived in section 3.1 requires that $\eta\omega\phi_i < 0$, which is satisfied as interest rates exert a negative effect on output dynamics, while output feeds positively back into interest rate dynamics. If this effect is large enough (in absolute magnitude) to render the discriminant of the characteristic polynomial negative, the system will generate damped oscillations.

Summing up, the adaption of the model in Foley (2003) postulates an interaction mechanism between output and interest rates that can give rise to (open economy) business cycles dynamics. The key mechanism that is at the heart of this model is a negative effect of interest rates on investment, e.g. through rising cost of capital which discourage investment demand, and a countercyclical monetary policy rule, which induces the central bank to raise interest rates during economic booms.

3.2.2 Output-external debt interaction

A different closure highlights the role of external debt for endogenous business cycle dynamics, treating the foreign interest rate (and exchange rate) as exogenous. While this mechanism has not been modelled formally before, external debt features prominently in the descriptive approaches discussed in section 2 (Palma, 1998; Taylor, 1998; Frenkel and Rapetti, 2009; Harvey, 2010; Kaltenbrunner and Paineira, 2015). Moreover, it can be regarded as a relatively natural extension of closed economy Minsky models with domestic debt (e.g. Asada, 2001) to open EMEs in which private sector debt often comes from abroad. Following this tradition, we will focus on business debt. As in the previous closure, exchange rates are fixed, so that one can set $s = 1$ and $\phi_s = \beta_s = 0$. Different from the previous closure, the foreign interest rate is exogenous. While in principle it could act as a shift variable pushing down investment demand, we simply assume $\phi_i = 0$ to focus on the endogenous cycle mechanism. External debt is again assumed to be the adjustment variable which ensures that the firm budget constraint is met and the BoP is always in equilibrium. The dynamics of the external debt to capital ratio are then given by (13). In contrast to the previous closure, it is assumed that external debt exerts a negative effect on investment demand: $\phi_\lambda < 0$. The dynamics of the system are then described by:

$$\begin{aligned}\dot{u} &= \omega[\phi(u, \lambda) + \beta(u^f, u) - u\pi] \\ \dot{\lambda} &= \lambda[i^f - \phi(u, \lambda)] + \phi(u, \lambda) - u\pi,\end{aligned}$$

with Jacobian:

$$J(u, \lambda) = \begin{bmatrix} \omega(\phi_u + \beta_u - \pi) & \omega\phi_\lambda \\ \phi_u(1 - \lambda^*) - \pi & \phi_\lambda(1 - \lambda^*) + i^f - \phi(u^*, \lambda^*) \end{bmatrix}. \quad (17)$$

The differential equation for λ now contains an intrinsic nonlinearity, allowing for multiple fixed points. We will consider a fixed point where $\lambda^*, u^* \in (0,1)$. The stability conditions are given by:

$$\begin{aligned} Tr(J) &= \underbrace{\omega(\phi_u + \beta_u - \pi)}_{<0} + \underbrace{\phi_\lambda(1 - \lambda^*)}_{<0} + \underbrace{i^f - g^*}_{>0} < 0 \\ Det(J) &= [\omega(\phi_u + \beta_u - \pi)][\phi_\lambda(1 - \lambda^*) + i^f - g^*] - \omega\phi_\lambda[\phi_u(1 - \lambda^*) - \pi] > 0. \\ &= \underbrace{(\phi_u + \beta_u - \pi)}_{<0} \underbrace{(i^f - g^*)}_{>0} + \underbrace{\phi_\lambda[\beta_u(1 - \lambda^*) - \pi \lambda^*]}_{>0} > 0. \end{aligned}$$

We will again assume that the open economy goods market condition holds, so that $\phi_u + \beta_u - \pi < 0$. The first two terms in the trace of (17) are then negative. The third term captures the relation between the foreign rate of interest and the steady state rate investment rate. Consider the empirically plausible case where the foreign interest rate exceeds the growth rate of the capital stock, so that $i^f - g^* > 0$. While this introduces the possibility of instability to the model, we will assume that the stabilising forces outweigh the destabilising ones, so that overall the trace is negative. Next consider the determinant. Based on the foregoing, the first term will be negative, creating the possibility for saddle point instability. The second term, however, must be positive given that $\phi_\lambda, \beta_u < 0$. We assume that the second term dominates, rendering the stability condition on the determinant satisfied. Economically, this is more likely when the effect of external debt on investment is strong.

The key condition for oscillations, which requires opposite signs on the off-diagonal of (17), will be satisfied if $\phi_u(1 - \lambda^*) - \pi > 0$. This is likely to be the case when the demand effect in the investment function is strong and when the steady state debt to capital ratio is large. In this case, an increase in output is associated with an increase in external debt dynamics – an assumption that is often made in the Minskyan literature where it is argued that agents adopt riskier financial positions when the economy booms, e.g. to finance investment spending (see Nikolaidi and Stockhammer 2017).

In sum, the closure discussed in this sub-section puts external debt dynamics at the centre of an endogenous interaction mechanism that may generate business cycles. The key mechanism in this closure is a strong negative effect of external debt on investment demand

through a worsening of firm net worth, while economic booms lead to rising external indebtedness.

3.2.3 Output-exchange rate interaction

Lastly, consider a closure where the exchange rate is flexible and interacts with output, while the interest rate is fixed. This closure represents a simplification of the model in Kohler (2019), which in turn constitutes a formalisation of business cycle mechanisms discussed in Ocampo (2016) and Stiglitz et al. (2006, chap. 6), where the exchange rate assumes a procyclical role. The key mechanism through which the exchange rate interacts with output in this model is a balance sheet effect: as firms' external debt is denominated in foreign currency, a depreciation of the domestic currency will raise the external debt burden and depress investment demand. At the same time, exchange rate dynamics are related to output via the trade balance. Again, as the exogenous foreign interest rate does not play a major role in this closure, we set $\phi_i = 0$. In contrast to the previous closures, we will not treat external debt as an adjustment variable of the firm budget constraint. This raises the question which variable ensures that the constraint is always satisfied. Considering (6), we assume that foreign reserves fulfil this function and that there is no feedback of reserves on the remaining variables of the system.

Next, we address the question of exchange rate determination. We assume that BoP-disequilibria lead to gradual changes in the exchange rate, which only sluggishly responds to pressures in the FX market. Using (5) normalised by the capital stock, we postulate the following law of motion for the exchange rate:

$$\dot{s} = \mu \left(si^f \lambda - b - \frac{s \dot{D}^f}{K} \right) \quad (18)$$

In order to keep the dynamic model at two dimensions, consider the case where firms (or lenders) pursue a constant external debt to capital ratio $\left(\dot{\lambda} \equiv \frac{\dot{D}^f}{K} - \lambda g = 0 \right)$.¹⁰ This requires new debt to be issued according to:

$$\frac{\dot{D}^f}{K} = \lambda g. \quad (19)$$

As a result, λ becomes a constant and (18) can be rewritten as:

¹⁰ The more general case of a flexible external debt ratio is considered in Kohler (2019).

$$\dot{s} = \mu[s\lambda(i^f - g) - b]. \quad (20)$$

The dynamic system thus consists of the two equations:

$$\begin{aligned} \dot{u} &= \omega[\phi(u, s) + \beta(u^f, u, s) - u\pi] \\ \dot{s} &= \mu\{s\lambda[i^f - \phi(u, s)] - \beta(u^f, u, s)\}, \end{aligned}$$

with Jacobian

$$J(u, s) = \begin{bmatrix} \omega(\phi_u + \beta_u - \pi) & \omega(\phi_s + \beta_s) \\ -\mu(s^*\lambda\phi_u + \beta_u) & \mu\{\lambda[i^f - \phi(u^*, s^*) - s^*\phi_s] - \beta_s\} \end{bmatrix}. \quad (21)$$

As the differential equation for s contains an intrinsic nonlinearity, there may arise multiple fixed points. Consider a fixed point where $s^*, u^* \in (0,1)$. Moreover, assume that the given external debt ratio is $\lambda \in (0,1)$. The stability conditions are given by:

$$\begin{aligned} Tr(J) &= \omega \underbrace{(\phi_u + \beta_u - \pi)}_{<0} + \mu \left\{ \lambda \underbrace{[i^f - g^* - s^*\phi_s]}_{>0} - \beta_s \right\} < 0 \\ Det(J) &= \omega(\phi_u + \beta_u - \pi)\mu\{\lambda[i^f - g^* - s^*\phi_s] - \beta_s\} + \mu(s^*\lambda\phi_u + \beta_u)\omega(\phi_s + \beta_s) > 0 \\ &= \underbrace{(\phi_u + \beta_u - \pi)}_{<0} \underbrace{\lambda(i^f - g^*)}_{>0} - \beta_s(\phi_u - \pi) + s^*\lambda \left[\phi_u\beta_s - \underbrace{\phi_s(\beta_u - \pi)}_{>0} \right] + \underbrace{\beta_u\phi_s}_{>0} > 0. \end{aligned}$$

We assume again that the open economy goods market condition holds, so that $\phi_u + \beta_u - \pi < 0$. As in the previous closure, consider the case where the foreign interest rate exceeds the growth rate of the economy ($i^f - g^* > 0$). In this case, the first condition can still be satisfied, especially when balance sheet effects are strong ($\phi_s \gg 0$) and the MLC holds ($\beta_s > 0$). The determinantal condition is more complicated but suggests that stability is more likely when the MLC holds and when the import propensity (β_u) is large in absolute value.

With respect to the necessary condition for a cycle mechanism, two regimes can be distinguished: First, consider the case where $(\phi_s + \beta_s) > 0$ and $-(s^*\lambda\phi_u + \beta_u) < 0$. This configuration may arise when the price elasticities of export and import demand are high, balance sheet effect are weak, and the import propensity is low, while the effect of demand on investment is relatively strong. Such a regime can give rise to a cycle mechanism whereby a depreciation of the currency induces expansionary output dynamics, which in

turn lead to an appreciation of the currency. As this regime is based on strong price elasticities of tradables, we will call it the “Marshall-Lerner regime”.

Second, consider the case where an increase in the exchange rate (i.e. a depreciation) drags down output dynamics because the contractionary balance sheet effect outweighs the price competitiveness effect: $(\lambda\phi_s + \beta_s) < 0$. This is likely to be the case when the external debt ratio is high and the Marshall-Lerner condition is not satisfied, e.g. because price elasticities are low. A cyclical mechanism may then occur if $-\mu(s^*\lambda\phi_u + \beta_u) > 0$, which requires a strong import propensity and a comparatively low demand effect on investment. We will call this regime the “balance sheet effect regime” as it requires the balance sheet effect to dominate the competitiveness effect.

Summing up, this closure highlights the role of flexible exchange rates in generating business cycle dynamics, considering both competitiveness and balance sheet effect of a currency depreciation. The closure allows for two regimes that may produce interaction cycles, one in which the competitiveness effect dominates (the “Marshall-Lerner regime”) and one in which the balance sheet effect dominates (the “balance-sheet effect regime”).

3.2.4 Summary of model closures

Consider again the reduced-form dynamic system given by (1) and reproduced here for convenience:

$$\begin{bmatrix} \dot{y} \\ \dot{z} \end{bmatrix} = \begin{bmatrix} \alpha_0 \\ \beta_0 \end{bmatrix} + \begin{bmatrix} \alpha_1 & \alpha_2 \\ \beta_1 & \beta_2 \end{bmatrix} \begin{bmatrix} y \\ z \end{bmatrix}. \quad (1)$$

Based on the models developed in this section, one can now interpret y as a measure for real activity, e.g. output. The variable z then represents any of the three variables that may interact with output in a cyclical manner: the interest rate, the external debt ratio, or the exchange rate. The three closures pin down expected signs of the coefficients on the off-diagonal of (1). The interest rate and external debt closure both predict a negative effect of the interest rate and external debt on output ($\alpha_2 < 0$), while output in turn is expected to push up the interacting variable ($\beta_1 > 0$). The exchange rate closure allows for two regimes: in the Marshall-Lerner regime, exchange rate depreciations boost output dynamics, which in turn lead to currency appreciation ($\alpha_2 > 0, \beta_1 < 0$). In the balance sheet effect regime, depreciations are contractionary and economic booms reduce the value of the currency ($\alpha_2 < 0, \beta_1 > 0$). The three closures and its main properties are summarised in Table 1:

Table 1: Summary of model closures

Interaction mechanism	Motivated by	Interest rate	External debt	Exchange rate	Investment	Predicted signs in (4.1)
Output - interest rate	Foley (2003)	Determined by central bank	Residual source of firm finance; no feedback on investment	Fixed	Sensitive to interest rate	$\alpha_2 < 0$ $\beta_1 > 0$
Output - external debt	Minskyan open economy literature (e.g. Arestis and Glickman, 2002; Cruz et al., 2006; Frenkel and Rapetti, 2009)	Exogenous	Residual source of firm finance; feeds back onto investment	Fixed	Sensitive to external debt	$\alpha_2 < 0$ $\beta_1 > 0$
Output - exchange rate	Kohler (2019); Stiglitz et al. (2006); Harvey (2010); Ocampo (2016);	Exogenous	Issued so as to keep external ratio constant; feeds back onto investment	Flexible; driven by balance-of-payments disequilibrium	Sensitive to exchange rate	Marshall-Lerner regime: $\alpha_2 < 0$ $\beta_1 > 0$. Balance sheet effect regime: $\alpha_2 > 0$ $\beta_1 < 0$.

4 Econometric approach

4.1 Estimation framework

The estimation strategy employed in this paper follows Stockhammer et al. (2019). As argued therein, the basic reduced-form interaction cycle model given by equation (1) can be written as a system of difference equations to which the condition for a cycle mechanism identified in section 3.1 applies in the same way. In principle a discretised version of the system in (1) could be estimated as VAR(1). However, the system in (1) is likely to be an over-simplification of the data generating process, which may be a higher-dimensional, higher-order dynamic system. Almost any linear dynamic system can be approximated by a VAR(p) with sufficient lags (Lütkepohl, 2005, chap. 15) but if these higher-order lags are omitted from the estimated model, they will render the error terms serially correlated. A more realistic representation of the data-generating process is thus given by

$$\begin{bmatrix} y_t \\ z_t \end{bmatrix} = \begin{bmatrix} \alpha_0 \\ \beta_0 \end{bmatrix} + \begin{bmatrix} \alpha_1 & \alpha_2 \\ \beta_1 & \beta_2 \end{bmatrix} \begin{bmatrix} y_{t-1} \\ z_{t-1} \end{bmatrix} + \begin{bmatrix} u_{yt} \\ u_{zt} \end{bmatrix}, \quad (22)$$

$$\begin{bmatrix} u_{yt} \\ u_{zt} \end{bmatrix} = \sum_{i=1}^p A_i \begin{bmatrix} u_{yt-i} \\ u_{zt-i} \end{bmatrix} + \begin{bmatrix} \epsilon_{yt} \\ \epsilon_{zt} \end{bmatrix}, \quad (23)$$

where ϵ_{yt} and ϵ_{zt} are white noise error terms, and A_i are diagonal parameter matrices. Substituting (4.22) into (4.23) and re-arranging, one can rewrite this as a VAR(p) with p lags in which α_2 and β_1 are the only parameters which are uniquely identified:

$$\begin{bmatrix} y_t \\ z_t \end{bmatrix} = \begin{bmatrix} \alpha_0 \\ \beta_0 \end{bmatrix} + \begin{bmatrix} \alpha_1 & \alpha_2 \\ \beta_1 & \beta_2 \end{bmatrix} \begin{bmatrix} y_{t-1} \\ z_{t-1} \end{bmatrix} + \sum_{i=1}^p A_i \left(\begin{bmatrix} y_{t-1} \\ z_{t-1} \end{bmatrix} - \begin{bmatrix} \alpha_0 \\ \beta_0 \end{bmatrix} + \begin{bmatrix} \alpha_1 & \alpha_2 \\ \beta_1 & \beta_2 \end{bmatrix} \begin{bmatrix} y_{t-i-1} \\ z_{t-i-1} \end{bmatrix} \right) + \begin{bmatrix} \epsilon_{yt} \\ \epsilon_{zt} \end{bmatrix}. \quad (24)$$

By estimating the higher-order VAR(p) in (24), one can therefore evaluate the necessary condition for the existence of a cycle mechanism in (1), i.e. $\alpha_2\beta_1 < 0$, and assess whether the predicted signs summarised in Table 1 are empirically valid. To determine the appropriate lag length p in practice, we start with a minimum lag length of 2. We then check for serial correlation in the residuals and successively increase the number of lags up to 6 until all serial correlation is removed. If this approach fails to remove serial correlation, we disregard the respective country from the results as irreducible serial correlation might point to model mis-specification.

Lastly, the VAR approach can also be used to obtain the eigenvalues of the Jacobian matrix. From the complex conjugate eigenvalues, the implied cycle length can be calculated. To see this, consider the complex conjugate pair of eigenvalues $\lambda = h \pm \Omega i$. Its polar form is $\lambda = R(\cos\theta \pm i.\sin\theta)$, where $R = \sqrt{h^2 + \Omega^2}$ is the modulus and θ is an angle measured in radians. In the solution to the VAR model in (4.24), the eigenvalues will appear in the form λ^t . By De Moivre's theorem, this expression can be transformed into polar form as follows: $\lambda^t = [R(\cos\theta \pm i.\sin\theta)]^t = R^t(\cos\theta t \pm i.\sin\theta t)$. In the latter trigonometric expression, the implied length of the cycles is given by $L = \frac{2\pi}{\theta} = \frac{2\pi}{\arccos(\frac{h}{R})}$. Thus, each pair of complex eigenvalues of the estimated system in (24) corresponds to a distinct cycle frequency in the endogenous variables of the system (Shibayama, 2008).

4.2 Dataset

The dataset consists of 13 medium- to large EMEs: Argentina, Brazil, Chile, Colombia, India, Indonesia, Israel, Korea, Mexico, Philippines, South Africa, Thailand, and Turkey. The data is at annual frequency and, depending on the country and variables for which the

VAR is estimated, the sample size ranges from 1960 to 2017. In the estimations, we impose a minimum of 30 degrees of freedom and exclude those countries whose number of observations do not permit to meet this requirement. As the standard measure of the business cycle is gross domestic product (GDP), We use the natural logarithm of real GDP (*GDP*) in each of the bivariate VARs. To test the output-interest rate interaction mechanism, we use the short-term real interest rate (*INTR*). For the cycle mechanism with external debt, we construct a proxy for private external debt by deducting long-term public external debt from total external debt and divide by gross domestic product (*EXDEBT*).¹¹ Unfortunately, data availability does not permit to subtract short-term public debt. It should thus be borne in mind that *EXDEBT* is only a proxy for private external debt. Moreover, note that we use debt to income ratios rather than the level of debt because the negative effects of rising debt assumed in the theoretical literature typically hinge on deteriorating financial robustness, which can be proxied by debt to income ratios. Lastly, to test the models where exchange rates are at the heart of the interaction mechanism, we use the natural logarithm of the bilateral nominal exchange rate with the US dollar (*XRATE*). Compared to effective exchange rate series, the exchange rate with the US dollar has considerably more observations and is thus preferred.¹²

The VAR is estimated in (log-) levels, which is common in the VAR literature when it is unclear whether the relevant variables contain a unit root and/or are cointegrated. As Kilian and Lütkepohl (2017, chap. 3) point out, there is an asymmetry between incorrectly imposing a unit root (and then overdifferencing the data) and failing to impose a unit root when there is one. While the former renders the VAR estimator inconsistent under standard assumptions, the latter approach preserves consistency and may only come with a loss in efficiency (i.e. a reduction in the precision of the estimator). The VAR can be consistently estimated in levels with asymptotically normal standard errors even if some variables are $I(1)$ because the presence of lags would allow the $I(1)$ variables to be re-written as coefficients on differenced and thus $I(0)$ variables (Sims et al., 1990). If the $I(1)$ variables drift, this will be captured by the intercept term of the VAR model. This approach may require a lag augmentation of the VAR (which We practically achieve by adding lags to the model until all serial correlation in the errors is removed), hence the loss in efficiency. However, compared with the potential inconsistency of a VAR in differences, the VAR in levels clearly is the preferable alternative. Furthermore, no further insights for our purposes would be gained from imposing a specific cointegration structure and estimating a vector

¹¹ For Chile, Israel and Korea long-term public external debt series are not available. Hence, *EXDEBT* for these countries is total external debt.

¹² Moreover, external liabilities are predominantly denominated in US-dollars. Bilateral US dollar exchange rates are therefore more suitable to capture balance sheet effects than trade-weighted effective exchange rates.

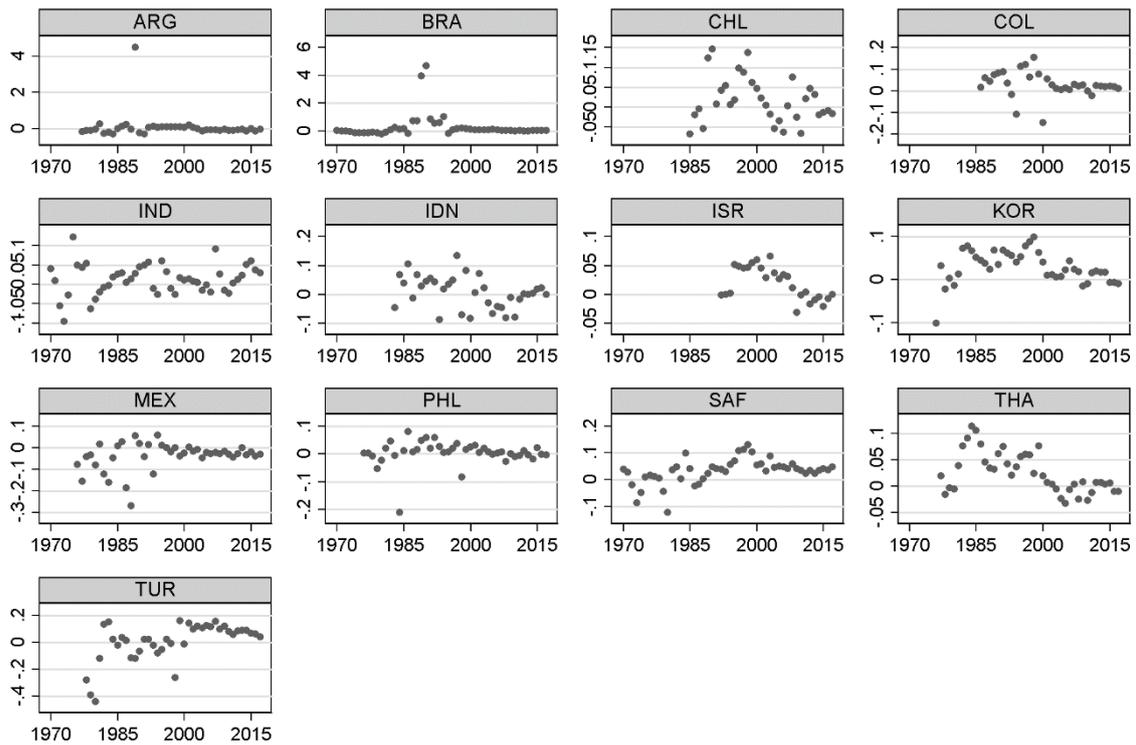
error correction model (VECM). In sum, the VAR model in (log) levels is the most appropriate specification for the purposes of this paper.

As illustrated by the models presented in section 3.2, the coefficients of the matrix (1) are functions of structural parameters of the economy, e.g. the import propensity and the sensitivity of investment with respect to output, which are likely to differ across countries. Point estimates are thus expected to be heterogeneous across countries, which would render a dynamic panel estimator inconsistent (Pesaran and Smith, 1995). We consider econometric remedies to this heterogeneity-problem such as mean group estimators which aggregate point estimates after estimation not useful for our purposes, as the aggregation procedure would potentially even out different country-specific regimes. We therefore opt to estimate country-wise VARs rather than pooling all series in a panel.

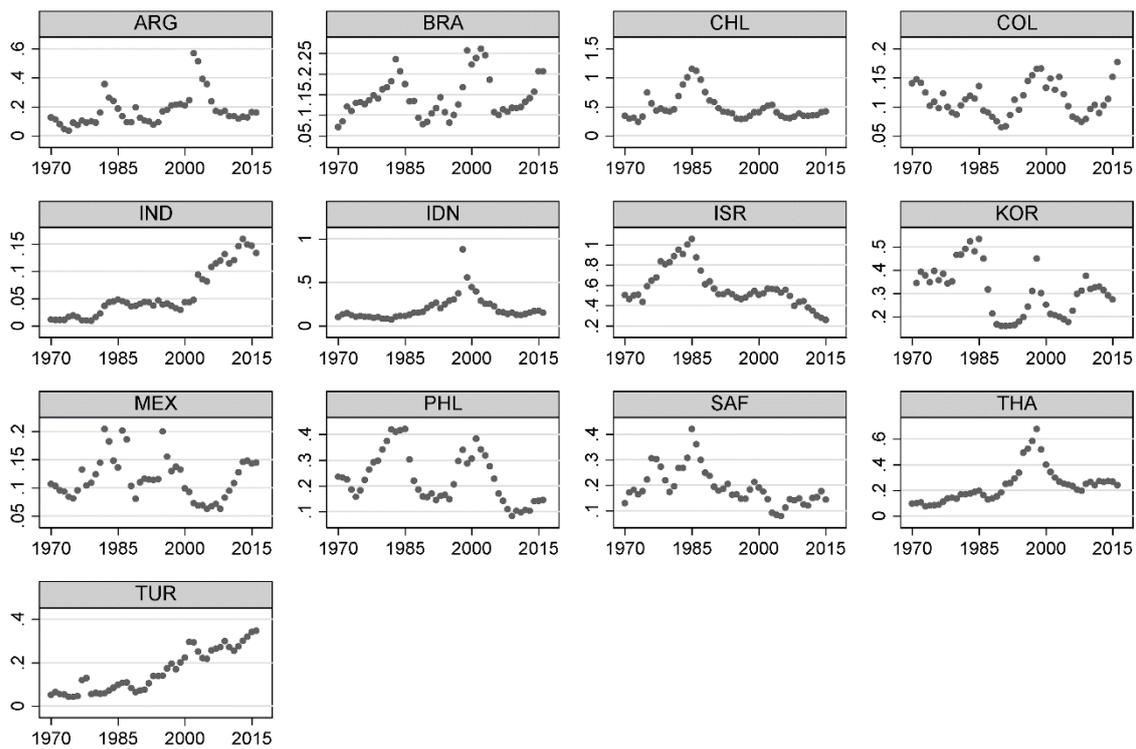
EMEs are well known for undergoing turbulent episodes in their monetary history, for instance due to speculative attacks on the exchange rate, hyperinflation, or large-scale debt default. Oftentimes, these episodes are not systematically related to the business cycle and stem from extraneous international events or unique policy interventions. These episodes can manifest themselves in time series mainly in two forms, either as outliers or as mean shifts. Insofar as they remain unexplained by the interaction mechanism captured by the VAR model, they can bias the estimated coefficients due to model misspecification. In order to detect possible outliers or mean shifts we plot the time series of the financial variables in Figure 1:

Figure 1: Scatterplots of financial variables

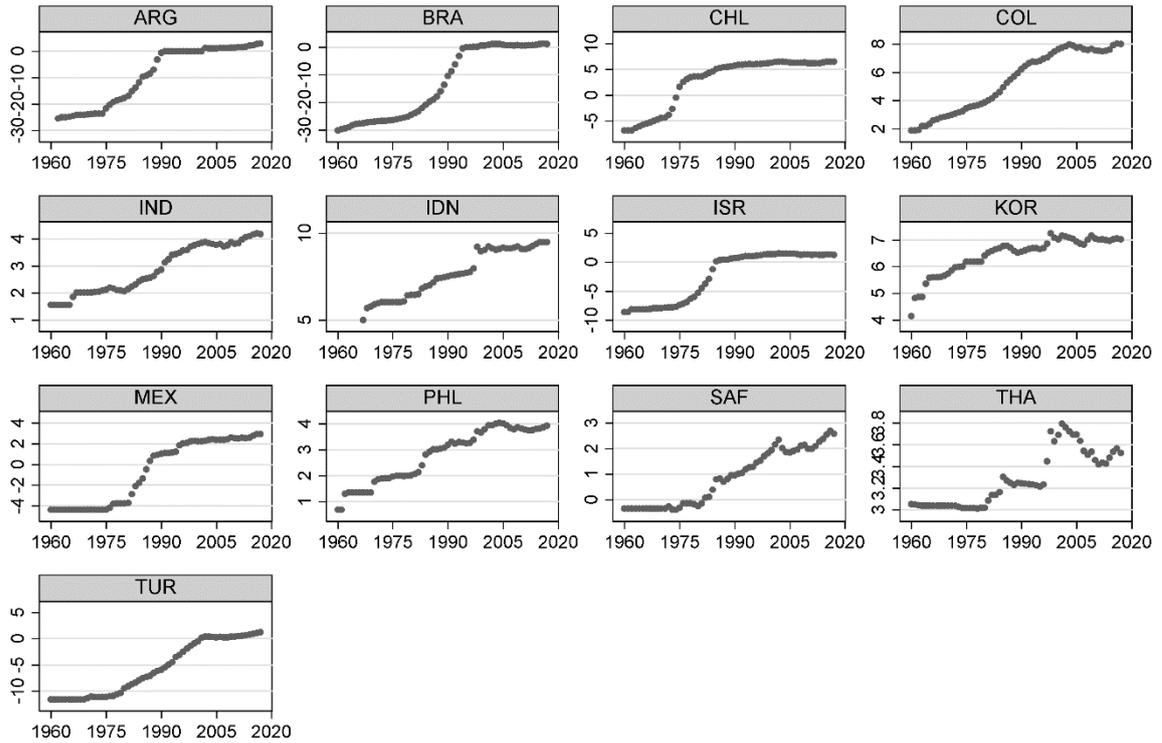
INTR



EXDEBT



XRATE



Notes: ARG: Argentina; BRA: Brazil; CHL: Chile; COL: Colombia; IND: India; IDN: Indonesia; ISR: Israel; KOR: South Korea; MEX: Mexico; PHL: Philippines; SAF: South Africa; THA: Thailand; TUR: Turkey. Data definitions in Table A1 in Appendix A2.

Visual inspection of the series leads to the following observations:

- In the *INTR* series, the observations for Argentina (1989), Brazil (1898-1990) and the Philippines (1984) are potential outlier candidates, as they appear to be relatively isolated hikes. In contrast, there do not appear to be mean shifts. Upon closer inspection, the value for Argentina in 1989 is identified as a clear outlier, which constitutes a one-off interruption (probably due to hyperinflation in that year) of an otherwise fairly regular cycle in *INTR*. For the outlier candidates in Brazil and the Philippines, the situation is less clear-cut as the spikes could also be regarded as the (especially strong) peak (trough) of a cycle.
- In *EXDEBT* no outliers are immediate. Mean shifts do not appear to be an issue either.
- Lastly, the *XRATE* series appears to undergo multiple mean shifts in several countries. This is not surprising, as EMEs have often experienced currency crises after which the exchange rate stabilised at a higher (i.e. more depreciated) level. An example that is clearly visible in the sample is the attack on the Thai baht in 1997, which triggered the Asian financial crisis and hit other regional countries' currencies too, such as Indonesia. Another cause for mean shifts are currency reforms which are often enacted in order to end periods of hyperinflation, for instance in Brazil in the early 1990s.

In order to deal with potential outliers in the *INTR* series, we include dummy variables that assume the value 1 in the respective year and zero otherwise. Accounting for the mean shifts in *XRATE* is more difficult, as visible inspection alone often does not allow for a clear-cut identification of the exact dates where mean shifts occur. For that reason, we resort to the step indicator saturation (SIS) approach developed in Castle et al. (2015). The simplest version of SIS is based on the split half approach: create step indicators (i.e. dummy variables that are equal to 1 from a specific break year onwards and zero before) for the entire sample period and split them in half. Then estimate the model on the full sample, first with only the first half of step indicators, and then with the second half. Retain those step indicators from both estimations whose p-value is equal or below $1/T$ and re-estimate the model with only those step indicators. Lastly, further exclude step indicators whose p-value exceeds $1/T$. As we are mainly interested in controlling for mean shifts in the *XRATE* series, we only select those step indicators that are statistically significant in the *XRATE*-equation. We then use those step indicators in both equations in order to maintain the symmetry of the VAR and to ensure that the slope coefficients on *XRATE* in the *GDP* equation capture only those effects that stem from the regular business cycle mechanism rather than exogenous shocks to the exchange rate regime.

5 Estimation results

5.1 Output-interest rate interaction

The estimation results with *INTR* for the eight countries with at least 30 degrees of freedom are displayed in Table 2. For Argentina and Brazil, two separate models were estimated one without outlier dummies and one including impulse dummy (ID) variables to control for potential outliers visible in Figure 1. As these are statistically significant, we regard specifications (ID) for Argentina and Brazil preferable. For the Philippines, a model with an outlier dummy for 1984 was discarded as this introduced serial correlation, which also did not vanish after the inclusion of up to six lags.

Table 2: Estimation result for the VAR(q) with *GDP* and *INTR*

	ARG	ARG (ID)	BRA	BRA (ID)	IND	KOR	MEX	PHL	SAF	TUR
<i>GDP</i>										
<i>L.GDP</i>	1.172*** (0.000)	1.128*** (0.000)	1.277*** (0.000)	1.323*** (0.000)	0.914*** (0.000)	0.967*** (0.000)	1.166*** (0.000)	1.522*** (0.000)	1.282*** (0.000)	1.034*** (0.000)
<i>L.INTR</i>	-0.010 (0.457)	-0.012 (0.342)	-0.007 (0.291)	0.007 (0.467)	-0.228** (0.031)	0.017 (0.944)	-0.073 (0.400)	0.127 (0.187)	-0.262*** (0.000)	0.163*** (0.006)
<i>INTR</i>										
<i>L.GDP</i>	-1.701 (0.395)	0.180 (0.600)	-0.715 (0.794)	-0.600 (0.506)	0.113 (0.590)	0.100 (0.270)	0.299 (0.257)	-0.233 (0.377)	0.346 (0.211)	-0.059 (0.864)
<i>L. INTR</i>	-0.136 (0.414)	-0.041 (0.150)	0.747*** (0.000)	0.125* (0.053)	0.345** (0.023)	0.828*** (0.000)	-0.005 (0.972)	0.171 (0.309)	0.589*** (0.000)	0.244* (0.072)
Obs	39	39	52	52	53	39	40	40	54	37
Lags (q)	2	2	2	2	4	3	2	2	3	3
Df	34	33	47	45	44	32	35	35	47	30
Period	1979-2017	1979-2017	1966-2017	1966-2017	1965-2017	1979-2017	1978-2017	1978-2017	1964-2017	1981-2017
Necessary condition satisfied	no	yes	no	yes	yes	no	yes	yes	yes	yes
Expected signs	no	yes	no	no	yes	no	yes	no	yes	no
Impulse dummy (ID)	no	1989	no	1989, 1990	no	no	no	no	no	no

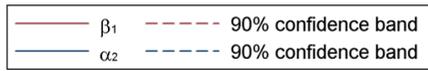
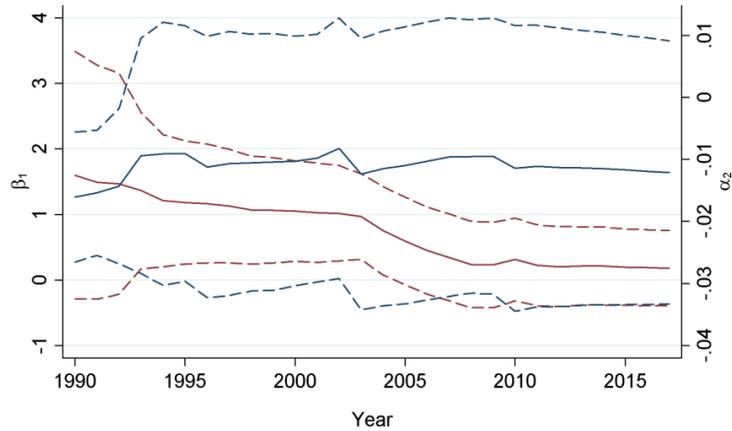
Notes: ARG: Argentina; BRA: Brazil; IND: India; KOR: South Korea; MEX: Mexico; PHL: Philippines; SAF: South Africa; TUR: Turkey; p-values in parentheses; * p<0.10, ** p<0.05, *** p<0.01; Obs: number of observations; Df: degrees of freedom in each equation. Each equation was estimated with an intercept, which is not reported. Only the coefficients on the first lags are reported.

Overall, we note that the necessary condition for a cycle mechanism is satisfied in seven out of eight countries (for Argentina and Brazil, this is only the case in the models with outlier dummies). Out of these seven countries, four countries (Argentina, India, Mexico, South Africa) exhibit the signs predicted by the business cycle model discussed in section 3.2.1 of this paper ($\alpha_2 < 0$, $\beta_1 > 0$). Brazil, the Philippines, and Turkey, in contrast, display theoretically unexpected signs. Note that p-values are mostly below conventional levels of statistical significance with the exception of India and South Africa, where interest rates exert a statistically significant negative effect on GDP (at the 5% and 1% level, respectively). This is not untypical for VAR models with several lags where multicollinearity is often strong due to autocorrelated regressors. This means that the results have to be taken with some caution.

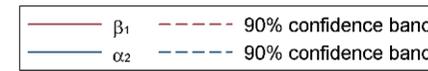
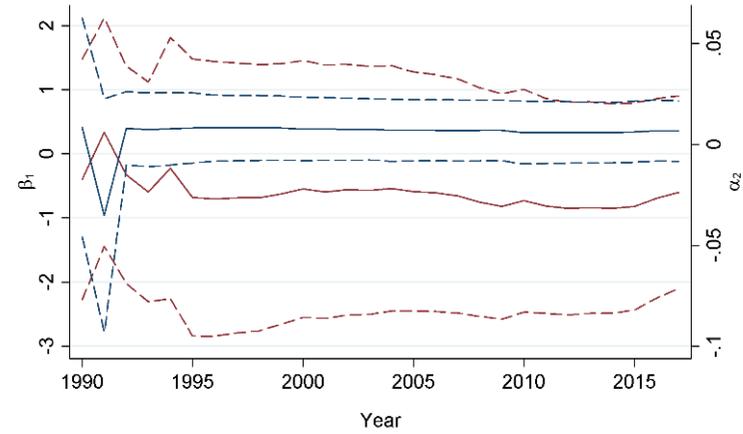
In order to gain further insights into the robustness of those estimates where the necessary condition for a cycle mechanism is satisfied, we conduct forward recursive estimations in which the parameters of the VAR are estimated for a restricted sample from the sample start to 1990, and then successively extend the sample by one period each. This exercise allows to assess whether the estimated coefficients are structurally stable over time: if the point estimates retain their sign over time, the parameter can be regarded as structurally stable. In contrast, if it passes through zero, the coefficients suffer from structural instability.

Figure 2: Forward recursive parameter estimation, VAR with *GDP* and *INTR*

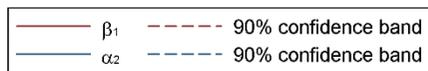
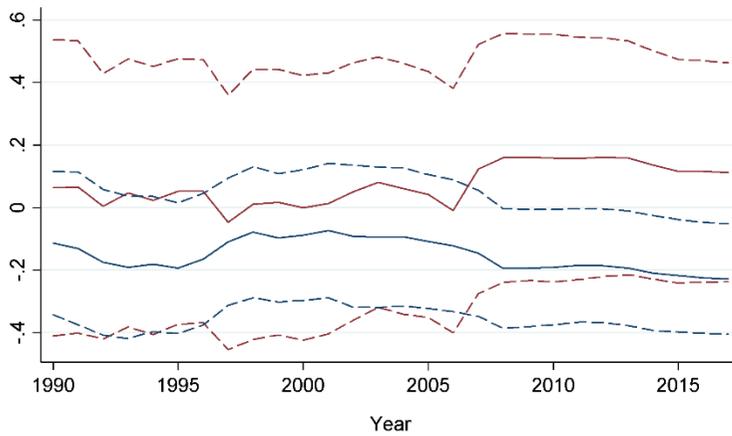
Argentina (ID)



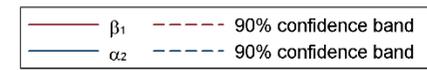
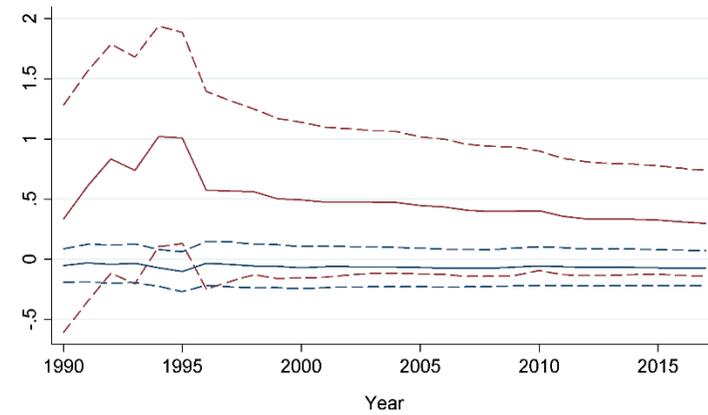
Brazil (ID)



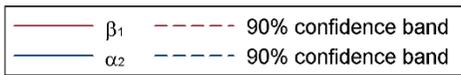
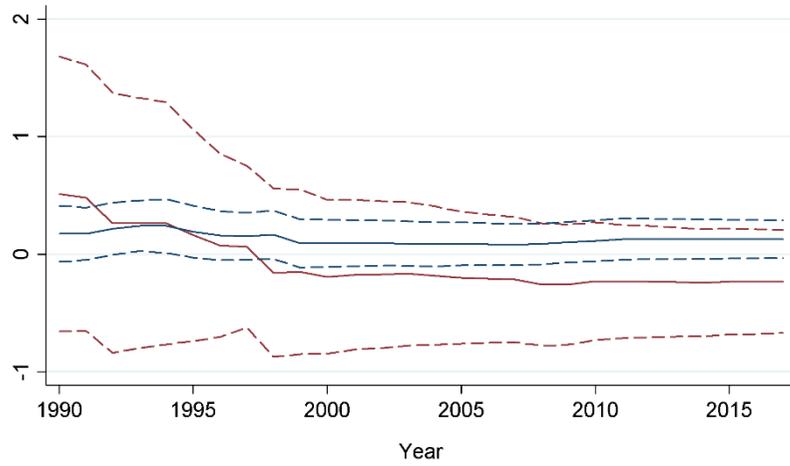
India



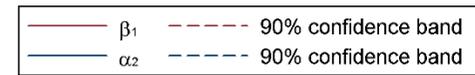
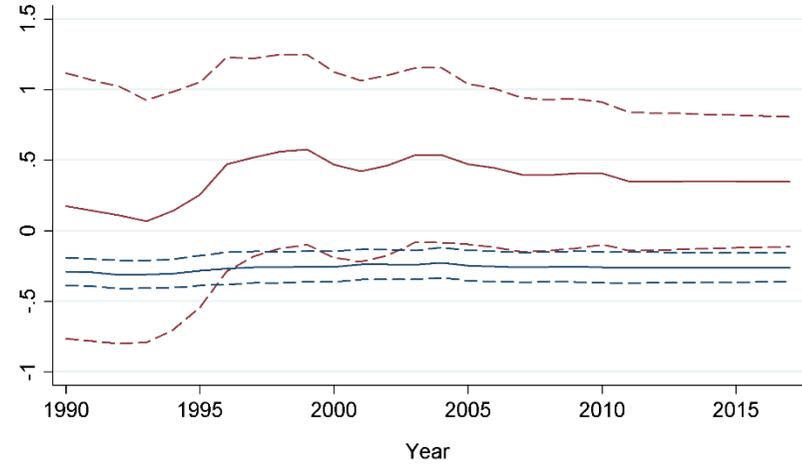
Mexico



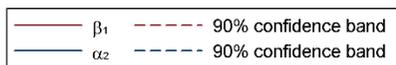
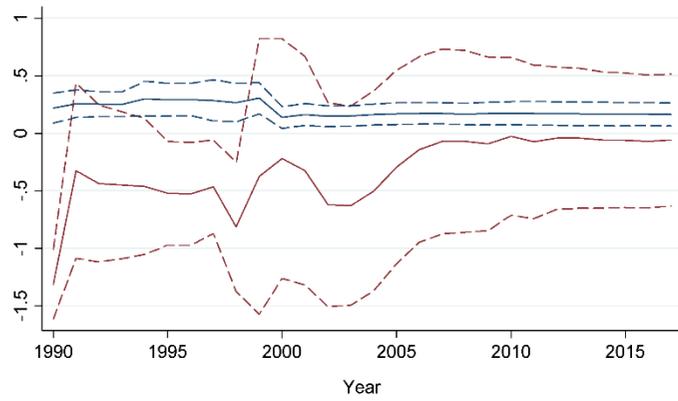
Philippines



South Africa



Turkey



Overall, parameters tend to be stable in the VARs for Argentina, Brazil, Mexico, South Africa, and Turkey. India and the Philippines, in contrast, exhibit parameter instability with the coefficient β_1 changing signs throughout the sample period. We therefore regard the estimates for these two countries as not robust.

Lastly, we use the estimated eigenvalue from the VARs to calculate the implied cycle frequency (see section 4.1). The results are summarised in Table 3. Notably, we do not find complex eigenvalues for the VARs with Brazil and Turkey, where the coefficients exhibit unexpected signs. This suggests that although the necessary condition for a cycle mechanism is met, there is no cycle mechanism between interest rates and output. For Argentina, Mexico, South Africa, we do find complex eigenvalues with relatively short cycle lengths of around 3 ½ to 4 ½ years for those. This corresponds to the findings in Stockhammer et al. (2019) for advanced economies.

Table 3: Estimated cycle length based on eigenvalues, VAR with *GDP* and *INTR*

	Real part (h)	Modulus (R)	Cycle length (L)
Argentina	-0.040	0.270	3.65
Brazil	-	-	-
Mexico	-0.008	0.614	3.97
South Africa	0.045	0.494	4.25
Turkey	-	-	-

Note: The cycle length is calculated as $L = 2\pi / \arccos\left(\frac{h}{R}\right)$. For Argentina, specification (b) from Table 2 was used.

In sum, there is some support for a stable interaction mechanism between interest rates and output in Argentina, Mexico, and South Africa as hypothesized by the business cycle model developed in section 3.2.1. The estimations suggest a cycle length between 3 ½ to 4 ½ years in those countries. Most coefficients lack statistical significance (except for the effect of interest rates on GDP for South Africa), so that the evidence is overall only weak.

5.2 Output-external debt interaction

Table 4 reports estimation results for the VAR with *GDP* and *EXDEBT*.¹³ Overall, the necessary condition for a cycle mechanism is satisfied in 7 of the 12 countries: Colombia, India, Indonesia, Korea, Mexico, the Philippines and South Africa. While the estimated coefficients for India exhibit unexpected signs, the coefficients for the remaining 6 countries display signs that correspond to the business cycle model in section 3.3, where increases in

¹³ The VAR for Chile exhibited serial correlation in the residuals, which did not vanish after the inclusion of up to 6 lags and was therefore excluded.

external debt drag down output dynamics whereas increases in output accelerate debt dynamics. Most coefficients are not statistically significant at conventional levels with the notable exception of the positive effect of *GDP* on *EXDEBT* in Indonesia and Mexico, and the negative effect of *EXDEBT* on *GDP* in South Africa, which are statistically significant at the 5% and 1% level.

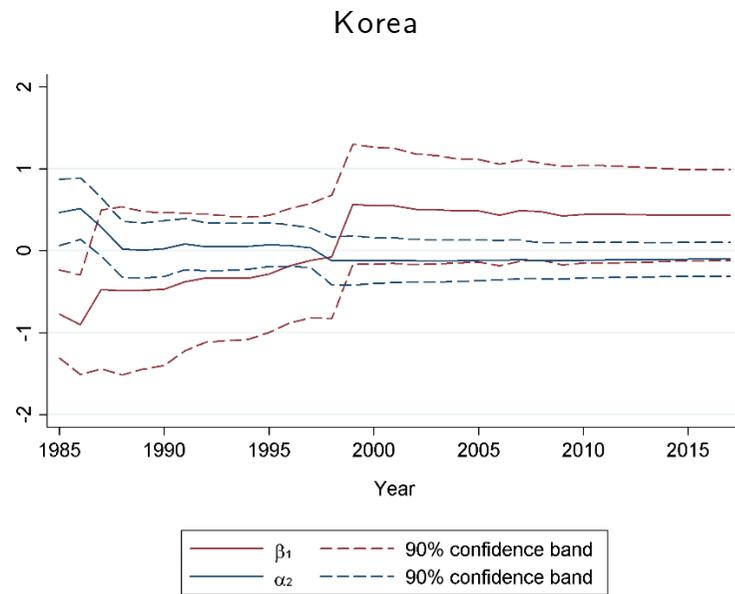
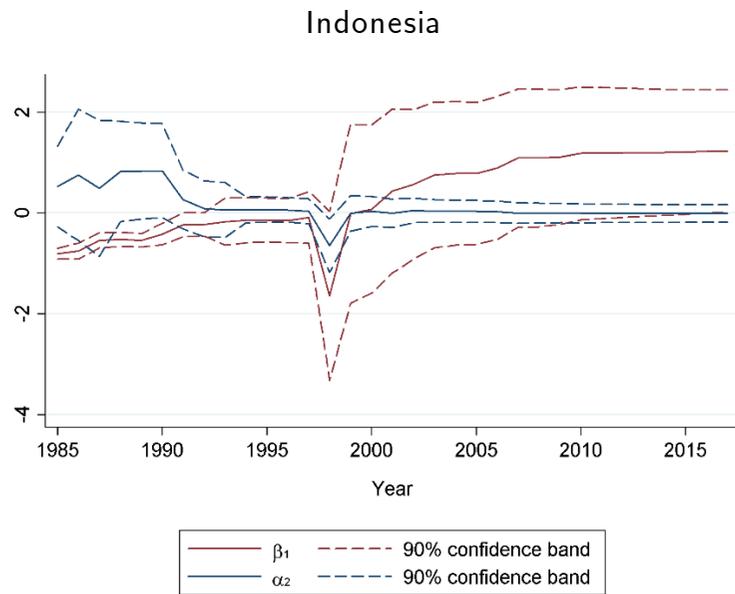
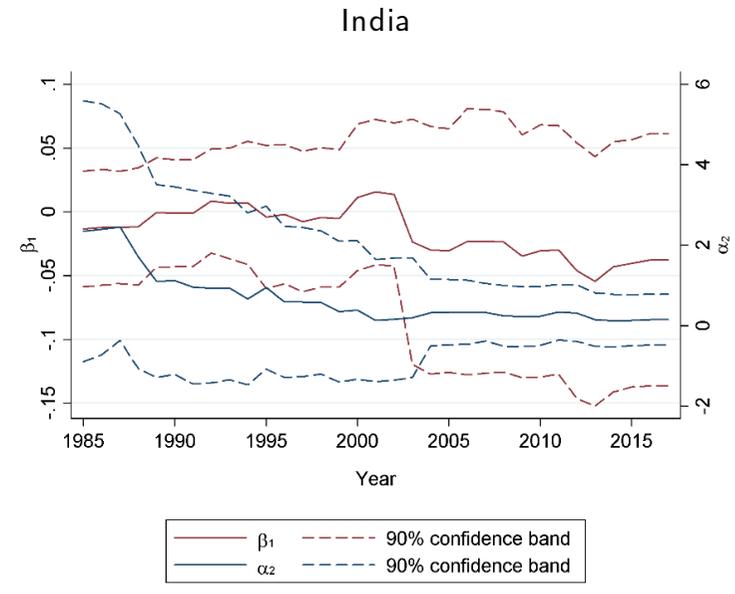
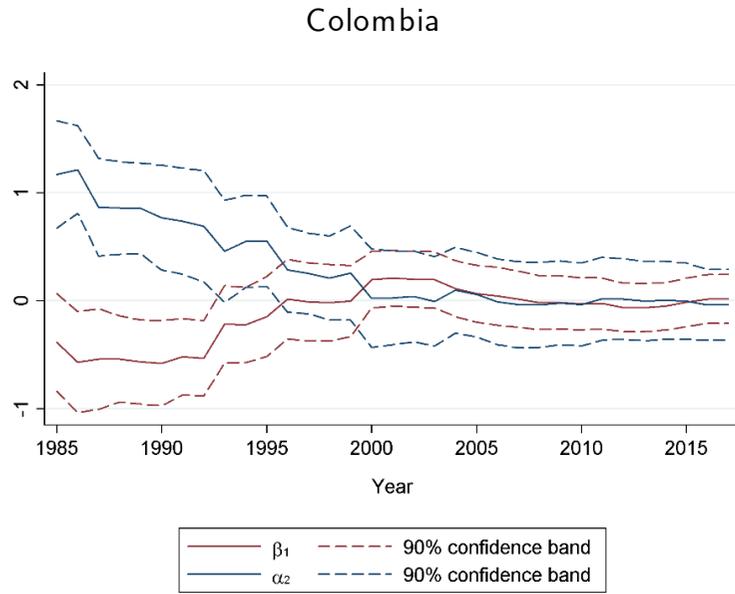
Table 4: Estimation result for the VAR(q) with *GDP* and *EXDEBT*

	ARG	BRA	COL	IND	IDN	ISR	KOR	MEX	PHL	SAF	THA	TUR
<i>GDP</i>												
<i>L. GDP</i>	1.066*** (0.000)	1.269*** (0.000)	1.274*** (0.000)	0.856*** (0.000)	1.186*** (0.000)	1.136*** (0.000)	0.881*** (0.000)	1.107*** (0.000)	1.404*** (0.000)	1.154*** (0.000)	1.380*** (0.000)	1.013*** (0.000)
<i>L. EXDEBT</i>	-0.003 (0.982)	-0.045 (0.801)	-0.039 (0.845)	0.148 (0.694)	-0.011 (0.915)	-0.023 (0.697)	-0.104 (0.399)	-0.032 (0.874)	-0.157 (0.116)	-0.246*** (0.004)	0.044 (0.702)	0.190 (0.463)
<i>EXDEBT</i>												
<i>L. GDP</i>	-0.291 (0.151)	-0.091 (0.470)	0.015 (0.910)	-0.038 (0.526)	1.224* (0.095)	-0.932** (0.018)	0.434 (0.194)	0.327*** (0.006)	0.255 (0.139)	0.345 (0.170)	0.135 (0.473)	0.127 (0.118)
<i>L. EXDEBT</i>	0.796*** (0.000)	1.081*** (0.000)	0.887*** (0.000)	0.857*** (0.000)	0.862*** (0.001)	0.934*** (0.000)	1.231*** (0.000)	1.025*** (0.000)	1.397*** (0.000)	1.207*** (0.000)	1.098*** (0.000)	1.012*** (0.000)
Obs	45	45	45	45	43	44	43	45	45	44	44	44
Lags (q)	2	2	2	2	4	2	2	2	2	2	3	3
Df	40	40	40	40	34	39	38	40	40	39	37	37
Period	1972- 2016	1972- 2016	1972- 2016	1972- 2016	1974- 2016	1972- 2015	1973- 2015	1972- 2016	1972-206	1972- 2015	1973- 2016	1973- 2016
Necessary condition satisfied	no	no	yes	yes	yes	no	yes	yes	yes	yes	no	no
Expected signs	no	no	yes	no	yes	no	yes	yes	yes	yes	no	no

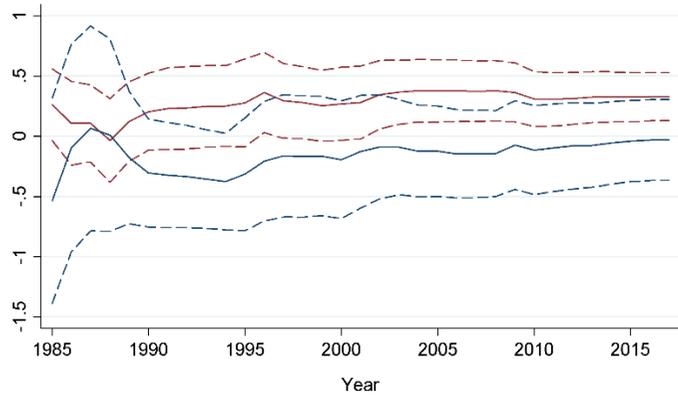
ARG: Argentina; BRA: Brazil; COL: Colombia; IND: India; IDN: Indonesia; ISR: Israel; KOR: South Korea; MEX: Mexico; PHL: Philippines; SAF: South Africa; THA: Thailand; TUR: Turkey. p-values in parentheses; * p<0.10, ** p<0.05, *** p<0.01; Obs: number of observations; Df: degrees of freedom in each equation. Each equation was estimated with an intercept, which is not reported. Only the coefficients on the first lags are reported.

Again, we investigate parameter stability by forward recursive estimation for those countries where the necessary condition for a cycle mechanism is satisfied, starting from a restricted sample (sample start to 1985) and then successively adding one more observation. The results are displayed in Figure 3:

Figure 3: Forward recursive parameter estimation, VAR with *GDP* and *EXDEBT*

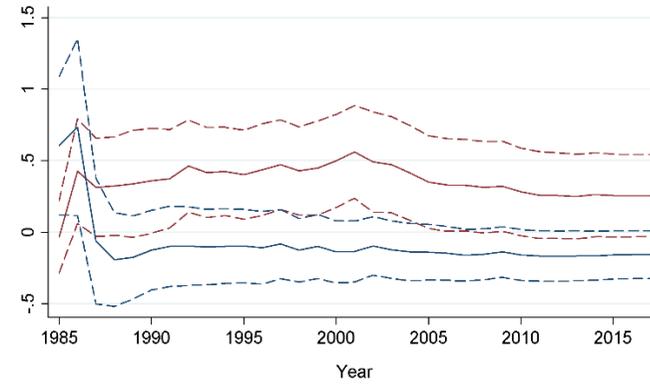


Mexico



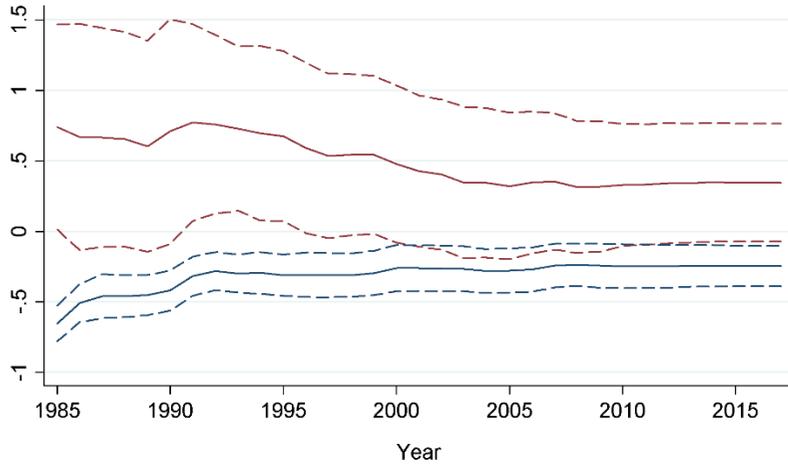
β_1 90% confidence band
 α_2 90% confidence band

The Philippines



β_1 90% confidence band
 α_2 90% confidence band

South Africa



β_1 90% confidence band
 α_2 90% confidence band

Recursive parameter estimation for Colombia, India, Indonesia and Korea reveals parameter instability as either or both coefficients pass through zero at relatively late stages of the sample period (i.e. past 1990), often multiple times.¹⁴ In contrast, Mexico, the Philippines and South Africa display structural stability over time. The implied cycle length for those countries meeting the condition for a cycle mechanism and exhibiting stable parameters is calculated in Table 5. Mexico exhibits a complex eigenvalue implying a cycle length of around 18½ years. Similarly, the complex eigenvalue from the VAR for Philippines implies a cycle length of 19 years. For South Africa, we find a comparatively shorter cycle length of 11 years. Overall, this suggests that external debt cycles are of a medium-run to long-run frequency, and thereby longer than cycles with interest rates.

Table 5: Estimated cycle length based on eigenvalues, VAR with *GDP* and *EXDEBT*

	Real part (h)	Modulus (R)	Cycle length (L)
Mexico	0.547	0.580	18.48
The Phillipines	0.684	0.723	19.00
South Africa	0.419	0.502	10.84

Note: The cycle length is calculated as $L = 2\pi/\arccos\left(\frac{h}{R}\right)$.

In sum, three countries exhibit stable coefficients that are consistent with an endogenous cycle mechanism between output and external debt: Mexico, the Philippines, and South Africa.

5.3 Output-exchange rate interaction

The estimation results for the VARs with *GDP* and *XRATE* are presented in Table 6. We restrict the sample start to 1970 as exchange rates were mostly fixed under the Bretton-Woods Regime, which prevailed during the 1960s. For each country, the VAR is estimated once without step indicators and once with step indicators (SI), which were selected following the procedure discussed in section 4.1. Again, we exclude estimation results that suffered from serial correlation that did not vanish after the inclusion of up to six lags.¹⁵

¹⁴ Korea is an interesting case. A sign-switch of the two coefficients occurs at around 1998, i.e. after the East Asian crises. It is surprising that the conditions for a Minskyan cycle mechanism with external debt are only satisfied when adding the sample period *after* Asian crisis for Korea.

¹⁵ The VARs for the Philippines without step indicators and for Indonesia with step indicators were dropped due to serial correlation. The models with step indicators for Brazil and Turkey were dropped because of a lack of degrees of freedom.

Table 6: Estimation result for the VAR(q) with *GDP* and *XRATE*

	ARG	ARG (SI)	BRA	CHL	CHL (SI)	COL	COL (SI)	IND	IND (SI)	IDN	ISR	ISR (SI)
<i>GDP</i>												
<i>L. GDP</i>	1.014*** (0.000)	1.112*** (0.000)	1.158*** (0.000)	1.011*** (0.000)	0.491*** (0.000)	1.195*** (0.000)	0.981*** (0.000)	0.891*** (0.000)	0.769*** (0.000)	1.307*** (0.000)	1.113*** (0.000)	0.897*** (0.000)
<i>L. XRATE</i>	-0.006 (0.615)	0.030* (0.086)	-0.004 (0.421)	-0.077** (0.013)	-0.175*** (0.000)	-0.049* (0.083)	0.009 (0.770)	0.058 (0.295)	0.077 (0.270)	0.009 (0.844)	-0.010 (0.326)	0.006 (0.698)
<i>XRATE</i>												
<i>L. GDP</i>	-0.036 (0.986)	-0.966 (0.266)	-1.057 (0.629)	1.046 (0.132)	0.653*** (0.006)	-0.385 (0.554)	0.102 (0.797)	0.387 (0.273)	-0.014 (0.955)	-0.399 (0.811)	-1.336 (0.324)	-0.952*** (0.007)
<i>L. XRATE</i>	1.581*** (0.000)	0.609*** (0.000)	1.789*** (0.000)	2.246*** (0.000)	1.625*** (0.000)	1.584*** (0.000)	1.599*** (0.000)	1.404*** (0.000)	0.809*** (0.000)	0.691** (0.012)	1.692*** (0.000)	0.857*** (0.000)
Obs	48	48	48	48	48	48	48	48	48	47	48	48
Lags (q)	2	5	2	6	3	2	2	2	2	4	2	2
Df	43	30	43	35	30	43	35	43	37	38	43	35
Period	1970- 2017	1970-2017	1970- 2017	1970-2017	1970-2017	1970- 2017	1970-2017	1970- 2017	1970-2017	1971-2017	1970- 2017	1970-2017
Necessary condition satisfied	no	yes	no	yes	yes	no	no	no	yes	yes	no	yes
Expected signs	no	Marshall-Lerner regime	no	Balance sheet effect regime	Balance sheet effect regime	no	no	no	Marshall-Lerner regime	Marshall-Lerner regime	no	Marshall-Lerner regime
Step indicator	no	1974, 1978, 1981, 1985, 1988, 1990-91	no	no	1970-73, 1976, 1981, 1983-86, 1992	no	2003, 2005-07, 2009-10, 2014-15	no	1976, 1980, 1988, 1990, 2006-07	no	no	1974, 1977, 1979-80, 1982-83, 1985, 1990

Table 6 (continued): Estimation result for the VAR(q) with *GDP* and *XRATE*

	KOR	KOR (SI)	MEX	MEX (SI)	PHL (SI)	SAF	SAF (SI)	THA	THA (SI)	TUR
<i>GDP</i>										
<i>L. GDP</i>	0.936*** (0.000)	0.737*** (0.000)	0.953*** (0.000)	0.943*** (0.000)	1.189*** (0.000)	1.223*** (0.000)	1.176*** (0.000)	1.306*** (0.000)	1.106*** (0.000)	0.863*** (0.000)
<i>L. XRATE</i>	0.033 (0.599)	0.100** (0.019)	-0.031 (0.217)	0.029 (0.210)	-0.046 (0.267)	-0.077*** (0.000)	-0.068*** (0.003)	-0.045 (0.681)	-0.038 (0.673)	-0.030 (0.436)
<i>EXDEBT</i>										
<i>L. GDP</i>	0.999* (0.091)	1.123*** (0.005)	1.849* (0.094)	0.986** (0.027)	0.540 (0.244)	1.142 (0.148)	2.723*** (0.000)	-0.432 (0.213)	-0.215 (0.299)	1.286** (0.046)
<i>L. XRATE</i>	1.209*** (0.000)	1.066*** (0.000)	1.690*** (0.000)	0.988*** (0.000)	1.095*** (0.000)	1.244*** (0.000)	0.929*** (0.000)	0.917*** (0.000)	0.940*** (0.000)	1.390*** (0.000)
Obs	48	48	48	48	48	48	48	48	48	48
Lags (q)	2	4	2	2	2	2	2	5	5	5
Df	43	34	43	37	41	43	41	37	34	37
Period	1970- 2017	1970-2017	1970-2017	1970-2017	1970-2017	1970-2017	1970-2017	1970- 2017	1970-2017	1970-2017
Necessary condition satisfied	no	no	yes	no	yes	yes	yes	no	no	yes
Expected signs	no	no	Balance sheet effect regime	no	Balance sheet effect regime	Balance sheet effect regime	Balance sheet effect regime	no	no	Balance sheet effect regime
Step indicator (SI)	no	1974, 1979, 1997-99	no	1977, 1981, 1984-85, 1994- 95	1970, 1983	no	1983, 2002	no	1996, 1998-99	no

ARG: Argentina; BRA: Brazil; CHL: Chile; COL: Colombia; IND: India; IDN: Indonesia; ISR: Israel; KOR: South Korea; MEX: Mexico; PHL: Philippines; SAF: South Africa; THA: Thailand; TUR: Turkey. p-values in parentheses; * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$; Obs: number of observations; Df: degrees of freedom in each equation. Each equation was estimated with an intercept, which is not reported. Only the coefficients on the first lags are reported.

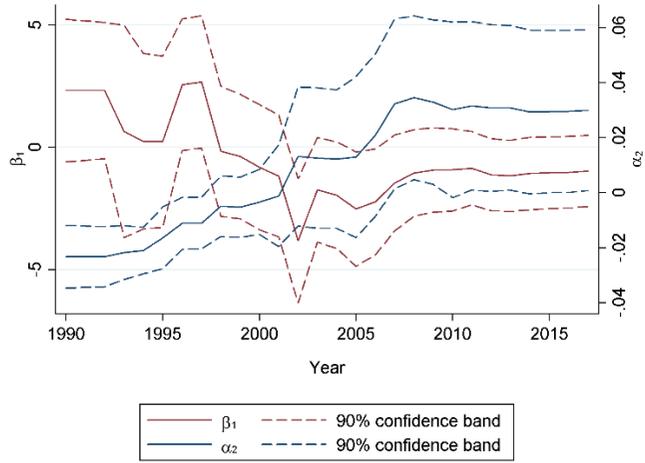
In the estimation without step indicators, 5 out of 12 countries meet the necessary condition for a cycle mechanism: Chile, Indonesia, Mexico, South Africa, and Turkey. The coefficients for Indonesia correspond to the Marshall-Lerner regime, discussed in section 3.2.3, where a depreciation of the currency pushes up output, which in turn leads to an appreciation of the currency. Chile, Mexico, South Africa, and Turkey, in contrast, display coefficients in line with the balance sheet effect regime in which balance sheet effects lead to contractionary depreciations while increases in output put pressure on the currency due to a worsening current account.

When step indicators are added to account for mean shifts in the exchange rate, the qualitative results change for a few countries, suggesting that some of the estimates are sensitive to mean shifts. Argentina, India, and Israel now meet the necessary condition for a cycle mechanism with coefficients corresponding to the Marshall-Lerner regime. Mexico ceases to meet the necessary condition for a cycle mechanism. The Philippines (whose VAR without step indicators suffered from serial correlation) now fall into the category of a balance sheet effect regime. The coefficients for Chile and South Africa still correspond to the balance sheet effect regime and now become statistically significant.

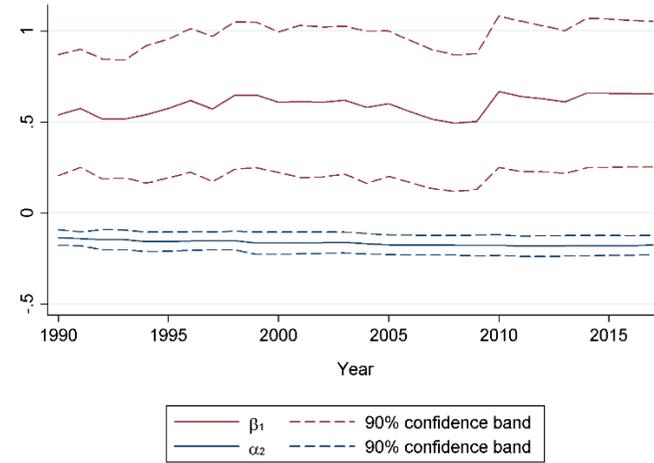
Figure 4 displays the results of forward recursive estimation of the VARs for those countries where the condition for a cycle mechanism is satisfied. Structurally stable parameters are found in the models with step indicators for Chile, Israel, the Philippines, and South Africa. The VARs for Argentina, India, and Turkey suffer from structural instability with coefficients switching signs at a relatively late point of the sample period. The VAR for Indonesia is an interesting borderline case with mostly stable coefficients that, however, are subject to a large negative shock in 1997-98, which is no doubt due to the East Asian crisis. Surprisingly, when estimating the model with step indicators, which were highly significant for those two years, the model suffers from serial correlation. Overall, we thus regard the results for Indonesia unreliable.

Figure 4: Forward recursive estimation, VARs with *GDP* and *XRATE*

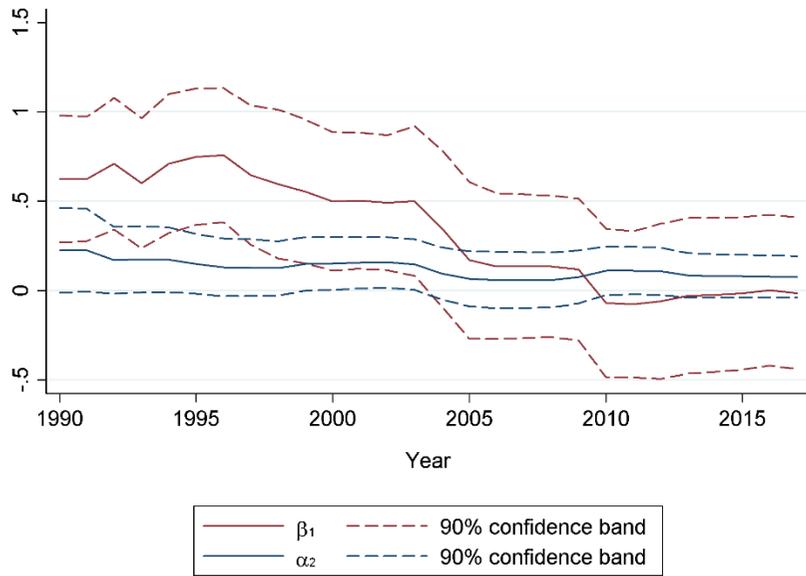
Argentina (SI)



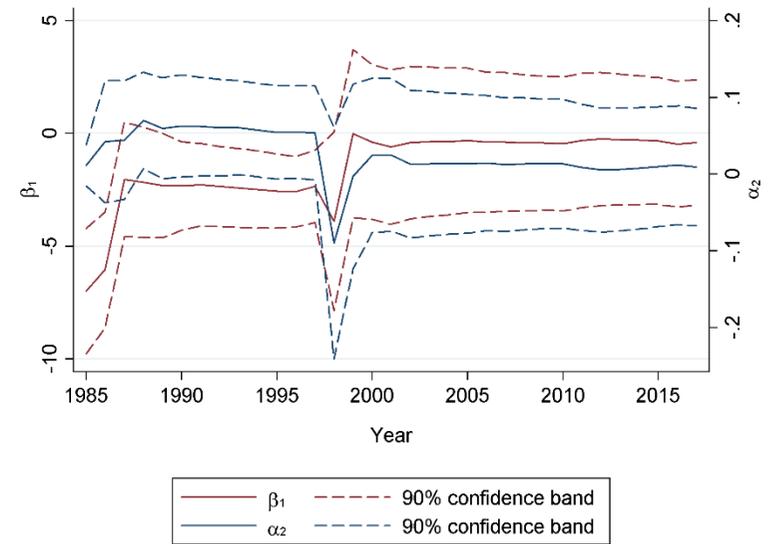
Chile (SI)



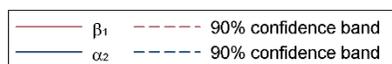
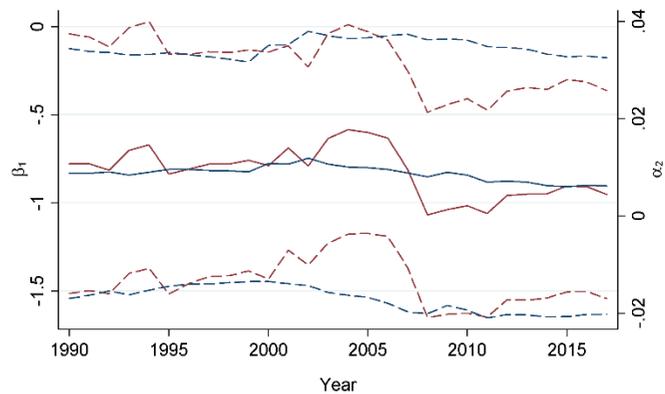
India (SI)



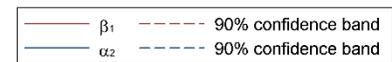
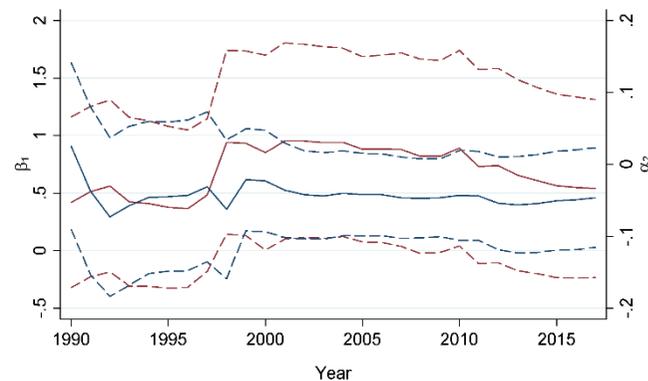
Indonesia



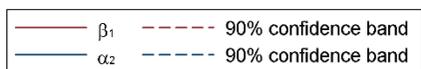
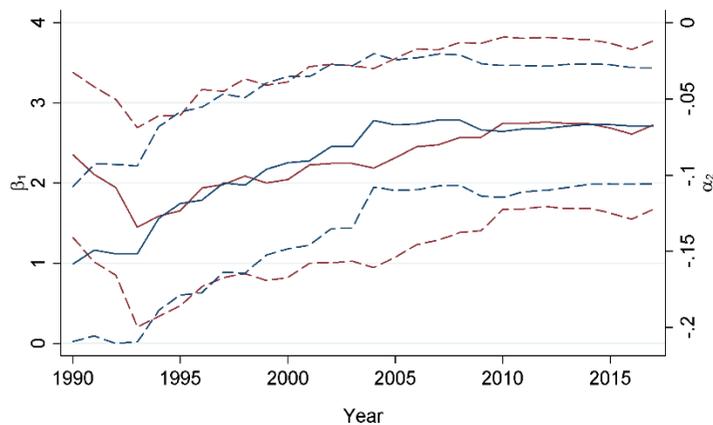
Israel (SI)



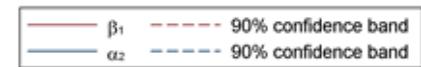
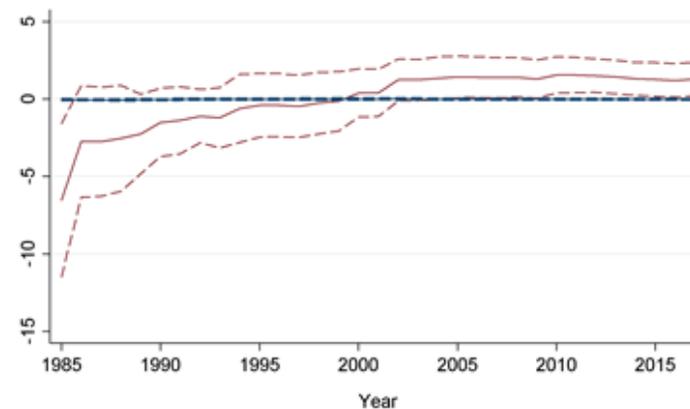
Philippines (SI)



South Africa (SI)



Turkey



Notes: ARG: Argentina; CHL: Chile; IND: India; IDN: Indonesia; ISR: Israel; MEX: Mexico; PHL: Philippines; SAF: South Africa; TUR: Turkey. Two-scaled axes were used where this improved visibility.

Table 7 presents estimated cycle length for the countries with stable parameters. For Chile, we find a short cycle length of around 3 years and a medium length of around 8 years. Israel exhibits a high cycle frequency of around 3 ½ years. The Philippines have a medium frequency of around 8 ½ years. Lastly, South Africa also exhibits a medium frequency of about 5 years. Overall, exchange rate cycles seem to be in the short-to-medium range of cycle lengths.

Table 7: Estimated cycle length based on eigenvalues, VAR with *GDP* and *XRATE*

	Real part (h)	Modulus (R)	Cycle length (L)
Chile	0.539	0.783	7.75
	-0.238	0.423	2.90
Israel	-0.019	0.099	3.57
Philippines	0.267	0.364	8.43
South Africa	0.184	0.5110	5.23

Note: The cycle length is calculated as $L = 2\pi / \arccos\left(\frac{h}{R}\right)$.

In sum, there is evidence for a stable interaction mechanism in line with the balance sheet effect regime in three countries (Chile, the Philippines, and South Africa), with statistically significant coefficients in Chile and South Africa. Stable parameters for the Marshall-Lerner regime could only be found for Israel, and this evidence is weaker as the relevant coefficients lack statistical significance at conventional levels.

5.4 Summary and discussion of estimation results

Overall, the results provide evidence for the existence of stable Minskyan financial-real interaction mechanisms in 6 countries. Specifically, there is evidence for interaction mechanisms between output and

- the real interest rate in Argentina, Mexico, and South Africa at high frequencies (3-4 years).
- the private external debt ratio in Mexico, the Philippines, and South Africa at medium to low frequencies (11 – 19 years).
- the exchange rate in Chile, the Philippines and South Africa (corresponding to the balance sheet effect regime), as well as Israel (corresponding to the Marshall Lerner regime). The estimated cycles are at short-to medium lengths (3 – 8 years).

Out of these results, the evidence for an interaction mechanism between output and exchange rates for Chile and South Africa is the strongest, with both relevant coefficients

statistically significant at conventional levels. The evidence for interaction mechanisms in external debt is weaker with only one of the two relevant coefficients statistically significant for Mexico, the Philippines, and South Africa. The evidence for an interest rate mechanism is weak only, as the estimated coefficients mostly lack statistical significance.

The fact that the estimation results for Mexico, the Philippines, and South Africa are consistent with several of the interaction mechanisms identified by the model in section 3.3 indicates that these are not mutually exclusive – a possibility that we stressed from the outset. Indeed, our examination of implied cycle frequencies suggests that different business cycle frequencies in output may stem from different interaction mechanisms with different variables. Interest rates seem to play a role for high frequency business cycles in Mexico and South Africa, whereas external debt appears to interact with output at low frequencies. For South Africa, there is furthermore a medium frequency in the interaction between output and exchange rates.

Lastly, the fact that We find evidence for cyclical interaction mechanisms in only 6 of the 13 countries in the sample raises the question why there is no such evidence for the remaining 7 countries. There are at least two possible explanations:

- (i) Limited data availability and structural change (e.g. due to political and institutional instability), as evident in the recursive parameter estimations, overall render it difficult to obtain robust estimates from macro-econometric models for EMEs. Consequently, it is not entirely surprising that for many countries no clear-cut results emerge.
- (ii) It is possible that there are no Minskyan financial-real interaction mechanisms in place in these 7 countries. Their business cycles may thus be driven by other endogenous mechanisms, such as Kaldorian goods market instability (Sethi, 1992), Goodwinian distributive cycles (La Marca, 2010), or distributional conflict around the real exchange rate (Sasaki et al., 2013; Lima and Porcile, 2013).

Both explanations cannot be ruled out and should be considered in future research. The possibility that business cycles are generated by other interaction mechanisms, such as output and the money supply (Sethi, 1992), output and the wage share (La Marca, 2010), or the nominal exchange rate and the price mark-up (Lima and Porcile, 2013) could be investigated by means of the estimation strategy employed in this paper. Limited data availability and structural change cannot be addressed as easily. This points to the limitations of macroeconometric analyses and suggest that case studies that focus on specific episodes using a variety of data sources remain an important component of research on boom-bust cycles in EMEs (Palma, 1998; Taylor, 1998; Kregel, 1998; Arestis and

Glickman, 2002; Cruz et al., 2006; Frenkel and Rapetti, 2009; Harvey, 2010; Kaltenbrunner and Paineira, 2015).

6 Conclusion

The aim of this paper was to derive a set of finance-driven business cycle mechanisms for emerging market economies and to test those mechanisms empirically. We took a post-Keynesian/structuralist theoretical approach that highlights the role of endogenous interaction mechanisms in the generation of business cycle dynamics. We developed a simple Minskyan model that encompasses three closures, each of which highlights a specific cyclical mechanism between output and a second interacting variable. For emerging market economies, we have identified the interest rate, external debt, and the exchange rate to be theoretically relevant interacting variables for finance-driven business cycles.

In the empirical part, we provided evidence for the existence of such interaction mechanisms from bivariate VAR-models. We find strong evidence for Chile and South Africa and some evidence for the Philippines for the existence of an interaction mechanism between exchange rate and output. This is consistent with business cycle theories that highlight the role of contractionary balance sheet effects due to foreign currency debt (Kohler, 2019; Stiglitz et al., 2006, chap. 6; Harvey, 2010; Ocampo, 2016). There is some evidence for a cycle mechanism in Israel that works in the opposite direction with depreciations being expansionary and economic booms leading to currency appreciation. We further find some evidence indicating the existence of a cycle mechanism with external debt in Mexico, the Philippines, and South Africa providing support for business cycle theories for open economies that emphasise cyclical dynamics of external overlending and overborrowing (Palma 1998; Taylor, 1998; Kregel, 1998; Arestis and Glickman, 2002; Cruz et al., 2006; Frenkel and Rapetti, 2009; Harvey, 2010; Agosin and Huaita, 2011; Kaltenbrunner and Paineira, 2015). Lastly, for Argentina, Mexico, and South Africa, there is weak evidence for an interaction mechanism between output and the interest rate along the lines of Foley (2003) and other authors that have highlighted the role of interest rates (Taylor 2004, chap. 10; Frenkel 2008).

Overall, the results provide support to the Minskyan branch of post-Keynesian and structuralist theories of endogenous business cycles that place financial and external variables at the centre of aggregate fluctuations in EMEs. In contrast to real business cycle theory where fluctuations are driven by unexplained shocks, post-Keynesian and structuralist theories identify specific economic mechanisms that may drive output volatility. The empirical analysis contributes to this research programme by suggesting, first, that different variables are likely to be relevant across countries (e.g., exchange rates seem to be relevant for the business cycle mechanism in Chile, but less important for

Argentina). Second, we show that the same country can exhibit several business cycle mechanisms, which potentially drive different cycle frequencies in output (e.g., interest rates are involved in high frequency cycles of around 4 years in Mexico, whereas external debt cycles display lower frequencies of around 18 years).

This approach helps identify areas for policy intervention. For example, in Chile where exchange rates appear to be an important driver of business cycles, countercyclical exchange rate policies such as managed floating may help curb the cycle. For Argentina there is instead (weak) evidence for a mechanism with interest rates in which raising interest rates during economic booms can generate cyclical dynamics (Foley, 2003), suggesting alternative monetary policy rules. For Mexico, the Philippines and South Africa, both external debt and exchange rates seem to be relevant, so that a policy mix of disincentivising procyclical capital flows through capital controls combined with exchange rate management may be attractive.

In providing a first attempt at testing endogenous cycle mechanism for emerging markets, this paper has focused Minskyan financial-real interaction mechanisms. It turned out that for a subset of countries no robust evidence for any of the cycle mechanisms could be found (Brazil, Colombia, India, Indonesia, Korea, Thailand, Turkey). Indeed, other interaction mechanisms may be relevant for these countries. Future research could test for other mechanisms involving wage shares, price mark-ups or the money supply. Second, our approach highlights endogenous mechanisms that can operate autonomously at the country-level. However, emerging markets are often hit simultaneously by exogenous global shocks, such as uncertainty shocks (Carrière-Swallow and Céspedes, 2013), waves in capital flows (Rey, 2015) or commodity price cycles (Erten and Ocampo, 2013). It would be interesting to investigate to what extent domestic fluctuations are driven by autonomous endogenous cycle mechanisms as opposed to joint external shocks.

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Appendix

A1 Symbol definition

Roman letters		
Symbol	Mathematical Definition	Conceptual Definition
b	$\frac{X - sM}{K}$	Net export rate
C		Consumption
c	$\frac{C}{K}$	Consumption rate
D^f		Foreign currency-denominated corporate debt
g	$\frac{I}{K}$	Investment rate
I		Investment
i^f		Foreign interest rate
L		Domestic loans
M		Imports (denominated in foreign currency)
R		Profits
r	$\frac{R}{K}$	Profit rate
r^f		Foreign rate of profit
s		Spot exchange rate (units of domestic currency per unit of foreign currency)
t		Time
u	$\frac{Y}{K}$	Rate of capacity utilisation
u^f		Foreign rate of capacity utilisation
W		Wage bill
X		Exports
Y		National income
Y^D		Aggregate demand
F		Foreign reserves
\dot{F}		Change in foreign reserves

Greek letters		
Symbol	Mathematical Definition	Conceptual Definition
β_u		Sensitivity of net exports w.r.t. domestic rate of capacity utilisation
β_{uf}		Sensitivity of net exports w.r.t. foreign rate of capacity utilisation
β_s		Sensitivity of net exports w.r.t. exchange rate
γ		Adjustment speed of investment rate
η		Adjustment speed of domestic interest rate
λ	$\frac{D^f}{K}$	External debt-to-capital ratio
π	$\frac{R}{Y}$	Profit share
μ		Adjustment speed of exchange rate
ϕ_u		Sensitivity of investment w.r.t. domestic rate of capacity utilisation
ϕ_i		Sensitivity of investment w.r.t. (foreign) interest rate
ϕ_s		Sensitivity of investment w.r.t. exchange rate
ϕ_λ		Sensitivity of investment w.r.t. external debt ratio
ω		Adjustment speed of output

A2 Data description

Variable	Definition	Data source(s)	Notes
<i>EXDEBT</i>	External debt to GDP	External Wealth of Nations dataset (updated and extended version of dataset constructed by Lane and Milesi-Ferretti, 2007); WDI (World Bank)	The ratio was constructed manually by transforming external debt stock measured in US dollars into domestic currency and dividing by nominal GDP.
<i>GDP</i>	Natural log of real gross domestic product	OECD; WDI (World Bank)	
<i>INTR</i>	Short-term real interest rate	IFS (IMF); OECD	<p>Real interest rate was calculated as $r = (i - \pi)/(1 + \pi)$, where i is the nominal interest rate and π is the growth rate of the GDP deflator.</p> <p>Depending on data availability, either the deposit, lending rate, or money market rate from IFS was used for i.</p> <p>For India, the money market rate was extrapolated forward with the growth rate of the lending rate.</p>

			For Thailand, a gap in in the deposit rate series in 2002-2003 was closed through linear interpolation.
<i>XRATE</i>	Natural log of nominal exchange rate with respect to US dollar	IFS (IMF)	The average of period series was used.