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Business cycles in emerging economies: The role of interest rates

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ABSTRACT

We find that in a sample of emerging economies business cycles are more volatile than in developed ones, real interest rates are countercyclical and lead the cycle, consumption is more volatile than output and net exports are strongly countercyclical. We present a model of a small open economy, where the real interest rate is decomposed in an international rate and a country risk component. Country risk is affected by fundamental shocks but, through the presence of working capital, also amplifies the effects of those shocks. The model generates business cycles consistent with Argentine data. Eliminating country risk lowers Argentine output volatility by 27% while stabilizing international rates lowers it by less than 3%.

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1. Introduction

In recent years a large number of emerging economies have faced frequent and large changes in the real interest rates they face in international financial markets; these changes have usually been associated with large business cycle swings. The virulence of these crises has prompted proposals to enact policies that would stabilize international credit conditions for emerging markets. This paper is motivated by this observation and has two objectives. The first is to systematically document the relation between real interest rates and business cycles in emerging economies and to contrast it with the relation we observe for developed countries. The second is to lay out a model that is helpful in understanding and quantifying the nature of this relation. In particular we seek to measure the contribution of real interest rate fluctuations to the high volatility of output in emerging economies. This is useful to asses the effectiveness of policies that seek to moderate business cycles in emerging markets by stabilizing real interest rates.

We start with a statistical analysis of business cycles in a set of small open emerging economies (Argentina, Brazil, Mexico, Korea, and Philippines) on one hand and a set of small open developed economies (Australia, Canada, Netherlands, New Zealand, and Sweden) on the other. The data show that many features of business cycles are similar in the two sets of economies, but that there are also some notable differences. In emerging economies real interest rates are countercyclical and lead the business cycle. In contrast, real rates in developed economies are acyclical and lag the cycle. Also, emerging economies display high, relative to developed economies, output volatility, and the volatility of consumption relative to income is on average greater than one and higher than in the developed economies. Finally, net exports appear much more strongly countercyclical in emerging economies than in developed economies.

The strong relation between interest rates and business cycles in emerging economies is at odds with the minor role played by interest rate shocks in previous models of business cycles in small open economies. Quantitative exercises performed in this class of models show that interest rate disturbances do not play a significant role in driving business cycles (see Mendoza, 1991, and Correia et al., 1995). Moreover, in these models interest rates are either acyclical or procyclical, consumption is less volatile than output, and countercyclicality of net exports is mild.

We introduce two simple modifications to an otherwise standard neoclassical framework in order to have a model of business cycles that is consistent with the main empirical regularities of emerging economies and, in particular, with the cyclical properties of interest rates. The first modification is that firms have to pay for part of the factors of production before production takes place, creating a need for working capital. The second modification (common in the small open economy business cycle literature) is that we consider preferences which generate a labor supply that is independent of consumption. These two modifications generate the transmission mechanism by which real interest rates affect the level of economic activity. The need for working capital to finance the wage bill makes the demand for labor sensitive to the interest rate. Since firms have to borrow to pay for inputs, increases in the interest rate make their effective labor cost higher and reduce their labor demand for any given real wage. The impact of this fall in labor demand on equilibrium employment will depend on the nature of the labor supply. Our preference specification guarantees that the labor supply is independent of shocks to interest rates. Hence, declines in labor demand induce a fall in equilibrium employment that depends on the elasticity of the labor supply with respect to the real wage. Because at business cycle frequencies the capital stock is relatively stable, declines in equilibrium employment translate into output declines.

We then use the dynamic general equilibrium model of a small open economy with working capital to assess quantitatively the role of interest rates in driving business cycles. In order to do so, we calibrate our model to Argentina's economy for the period 1983-2001; we chose Argentina because it is the country for which the longest relevant interest rate series is available.

One important issue we have to model is the nature of interest rate fluctuations. the interest rate faced by an emerging economy is the sum of two independent components: an international rate plus a country risk spread. We identify the international rate relevant for emerging economies as the rate on non-investment-grade bonds in the United States. We then construct the country risk spread as the difference between the rate faced by emerging economies and this international rate. Because fluctuations in country risk spreads are large, we consider two simple polar (non-mutually exclusive) approaches to their determination. The first is that factors that are largely independent of domestic conditions (like foreign rates, contagion, or political factors) drive country risk. In the second approach changes in country risk are induced by the fundamental shocks to a country's economy (productivity shocks in our model). In this case, these shocks drive, at the same time, business cycles and fluctuations in country risk.

Our first finding is that the quantitative results from the model with productivity shocks and country risk induced by productivity shocks can account for most empirical regularities (second moments of national account components and interest rates) of Argentina's economy during the period. This suggests that country risk is induced by domestic fundamentals but that at the same time, through the presence of working capital, amplifies the effects of fundamental shocks on business cycles. Given our first result we can use the model to assess how much business cycle volatility would be reduced by eliminating interest rate fluctuations. We find that eliminating fluctuation in country risk would lower gross domestic product (GDP) volatility by around 27%, while eliminating international real rate fluctuations would lower volatility by less than 3%. Our results lead us to think that in order to understand business cycle volatility in emerging economies, it is crucial to understand the exact mechanism through which shocks to fundamentals induce fluctuations in country risk.

Our work builds on related empirical and quantitative work on business cycles in emerging and developed countries. Our findings on the empirical regularities of business cycles are consistent with those of Backus and Kehoe (1992), Mendoza (1995), and Agenor et al. (2000), among others, who find that, although the magnitude of output fluctuations has varied across countries (with less developed countries displaying larger fluctuations) and periods, the co-movements of consumption, investment, and net exports with output during the cycle are quite uniform. Recently, Uribe and Yue (2003) have investigated the relation between international interest rates, country spreads, and output fluctuations in a sample of seven emerging economies, and they find a strong negative correlation between real interest rates and economic activity.

There are three strands of quantitative business cycle literature that are related to this paper: the first is the one that studies the effects of "sudden stops"[1] in capital flows on economic activity in emerging economies, the second is the one that focuses on the business cycle associated with exchange rate based stabilizations, and the third one studies the effect on business cycles of shocks to the wedge between the marginal product of labor and the consumption-leisure marginal rate of substitution.

As we do in this paper, the quantitative literature on the economics of "sudden stops" (see Mendoza and Smith, 2002, and Christiano, et al., 2003, among others) highlights the importance of external financial factors for macroeconomic developments in emerging economies. These models study the effect of the sudden imposition of an external credit constraint on business cycles. In these models, when the credit constraint suddenly binds, domestic interest rates rise, output drops, and there is a dramatic increase in the current account surplus (the "sudden stop" in capital flows). This paper looks at the effect of external financial conditions on economic activity through prices instead of quantities.

The literature that focuses on the business cycles associated to exchange rate based stabi-

[1]The term "sudden stops" refers to sudden stops in capital flows to emerging economies (see Calvo, 1998).

lization plans (see Rebelo and Vegh, 1995, and Calvo and Vegh, 1999) argues that current theories cannot account for the magnitude of the fluctuations in economic activity observed at the onset and at the end of a stabilization plan. The quantitative exercise carried out in this paper suggests that fluctuations in country risk might provide the amplification mechanism needed to reconcile data and theory. In the case of Argentina, for example, the stabilization plans that fall within our sample are the Austral Plan that started in June 1985 and the Currency Board that started in April 1991. In both events the business cycle expansion that characterized the start of the plan was also associated with declines in the real interest rate. Conversely, the recessions that hit the country at the end of the plans were associated with interest rate spikes.

In the closed economy literature, Cooley and Hansen (1989) and Christiano and Eichenbaum (1992) study the effect of shocks to the wedge between the consumption-leisure marginal rate of substitution and the marginal product of labor. In Cooley and Hansen, this wedge stems from a cash-in-advance constraint, and it is equal to the nominal interest rate (the inflation tax). Christiano and Eichenbaum create this wedge, as we do, by assuming that firms must borrow working capital to finance labor costs. In our experiment real interest rates affect the same margin as in the articles cited above, but have different causes (country risk instead of monetary policy) and different effects due to the different specification of preferences. It is worth emphasizing that our model is non-monetary and that the distortion introduced by the firm's need for working capital depends on real interest rates and not on nominal ones. If we had used nominal interest rates as the source of distortion, the model would have predicted large output fluctuations in the 1980s (when Argentine inflation was extremely volatile) (see Neumeyer, 1998) but almost no movement in the 1990s when inflation was virtually zero.[2]

[2] Uribe (1997) uses the same margin as Cooley and Hansen, with a nominal distortion, to generate the output expansion that follows an exchange rate based stabilization plan.

2. Real interest rates and business cycles in emerging economies

This section documents empirical regularities about business cycles and real interest rates in the five small open emerging economies for which we could obtain comparable real interest rate time series: Argentina, Brazil, Korea, Mexico, and Philippines. To highlight the features of business cycles that are special to emerging economies, we also document the same facts for five small open developed economies: Australia, Canada, Netherlands, New Zealand, and Sweden. The sample has a quarterly frequency, starts in the third quarter of 1983, and ends in the last quarter of 2001 for Argentina and the developed economies. For the other emerging economies, it starts in the first quarter of 1994.[3]

2.1. Data description

The data we use to compute business cycle statistics are standard and were obtained from the Organisation for Economic Co-operation and Development (OECD) and local national accounts sources (see the Data Appendix for more details). The interest rate we want to measure is the expected 3-month real interest rate at which firms in a country can borrow. This rate is easily constructed for developed economies (see the Data Appendix) but is more difficult to obtain for emerging economies. Some local sources report local currency nominal interest rates, but the high variability of local inflation in same cases makes it hard to derive a measure of domestic expected inflation needed to construct the real interest rate.[4] Other sources report interest rate data on new loans denominated in U.S. dollars, so the real interest rate can be computed without computing

[3] Our sample for emerging economies is limited both in terms of countries and in terms of time span. The limitation stems from the fact that we construct interest rate series using dollar denominated bond prices or indexes. To our knowledge, Argentina is the only country for which there are data on bond prices going back to the 1980s since it issued four 10-year dollar denominated sovereign coupon bonds between 1980 and 1984. We start our sample in the third quarter of 1983 because it is the first quarter for which we have at least three bond prices. Brazil, Korea, Mexico, and Philippines are the non-oil exporting countries with the longest data series in the data set of dollar denominated bonds index (EMBI) constructed by J.P. Morgan.

[4] In Argentina, for example, inflation swings from one month to the next reached over 1000% per year. As a consequence measures of expected inflation constructed using actual inflation are also very volatile and imply volatile and, sometimes, implausibly negative real interest rates.

domestic expected inflation; the problem with those series is that during financial crises most of the new borrowing of emerging countries is through official institutions, and thus recorded interest rates do not reflect the true intertemporal terms of trade faced by local private agents.[5] For these reasons we use secondary market prices of emerging market bonds to recover nominal U.S. dollar interest rates and obtain real rates by subtracting expected U.S. inflation. Since these bonds are traded on international financial markets, they reflect the intertemporal terms of trade locals face on these markets, and, since they are dollar denominated, real interest rates can be computed without constructing domestic expected inflation.[6] More precisely for Argentina we construct interest rates using a combination of government bonds issued from 1980 onward and the EMBI, while for the other emerging economies we use only the EMBI. (See the Data Appendix for more details on the construction of interest rates.) One last issue is that the interest rates we construct are primarily based on government bonds, and private firms might, in principle, face a very different rate. In order to check that this is not the case, we obtained for Argentina a dollar denominated prime corporate rate that is relevant for the private sector and that we can directly compare with the rate we construct.[7] Although the two rates are not identical, they have very similar magnitudes and they track each other very closely with a correlation of 0.89.

2.2. Business cycle statistics

The main result of this section is that business cycles in these two sets of economies differ along some important dimensions. In contrast to developed economies, in the emerging economies we study, real interest rates are countercyclical and they lead the cycle. The emerging economies are also more volatile than the developed ones because the volatilities of output, real interest rates, and

[5] For example, the World Bank Global Development Finance reports an average interest rate on new loans to Argentina of only 6% during the hyperinflation of the 1990s and of 7% during the Tequila Crisis of 1994-95.

[6] The interest rates on dollar (foreign currency) denominated assets are also relevant for domestic agents as long as there are no large and predictable changes in purchasing power parity.

[7] The 90-day, dollar denominated, prime corporate rate in Argentina is from Boletín Estadístico, Banco Central de la República Argentina. The reason we do not use this rate directly is that it is available only starting in 1994.

net exports are higher for these economies. Another interesting finding is that consumption tends to be more volatile than output in emerging economies while it is roughly as volatile as output in developed economies. Finally, although net exports tend to be countercyclical in both groups, they are much more so in developing economies. Other features of business cycles are roughly comparable in the two economies.[8]

These empirical regularities are documented in Figures 1 through 3 and in Tables 1A through 1C. Figures 1 and 2 show the time series of output and real interest rates for the five emerging economies and for the five developed economies. The figures immediately reveal that in emerging economies there is a negative comovement between output and real interest rates while in developed economies there is no such pattern. Figure 3, which shows the cross-correlation between output and real interest rates at different lags, makes this point more precisely. In emerging economies real interest rates are countercyclical, with correlation coefficients ranging from -0.38 in Brazil to -0.7 in Korea and an average correlation of -0.55. In developed economies real interest rates are mildly procyclical, with correlations ranging from 0.37 for Australia to -0.05 for Sweden and an average of 0.19. Figure 3 also shows that in the five emerging economies real interest rates lead the cycle by a quarter, while in the developed economies real interest rates, on average, lag the cycle by three quarters. Finally, observe that the pattern of cross-correlations in Figure 3 exhibits a U-shape in the emerging economies and a completely different shape in the developed ones.

Table 1A (and Figures 1 and 2) shows that, on average, the emerging economies are more volatile than the developed ones. On average, output is more than twice as volatile in the emerging economies, the volatility of real interest rates is 40% higher, and that of net exports is 54% higher. The table presents two measures of the volatility of consumption: private consumption (PC) and total consumption (TC). The latter includes the former as well as government consumption, changes

[8]All the results reported in the paper are based on series detrended using the Hodrick-Prescott filter. We also computed all the statistics in the tables using linearly detrended data and found no large differences in the results.

in inventories, and the statistical discrepancy.[9] For both measures volatility of consumption in emerging economies is larger than the volatility of output, while this is not true for developed economies. Prasad et al. (2003) also report that the relative volatility of consumption in a sample of 55 developing economies is larger than in industrial countries.

Table 1A also shows that the relative volatility of investment is similar for both sets of economies. The relative volatility of labor input reported in the table is lower for the emerging economies, both when labor input is measured as number of bodies (column labeled EMP) and when it is measured as total hours worked (column labeled HRS). This finding may reflect the poor quality of employment statistics in emerging economies.[10]

Table 1B shows that net exports are more countercyclical in emerging countries than in developed countries (the correlation between net exports and GDP is -0.61 in the first group and -0.23 in the second), while the cyclical properties of consumption, investment, and employment are similar across the two groups. The difference in the correlation between output and real interest rates between emerging and developed economies implies that the correlations of real interest rates and the macroeconomic aggregates we consider have opposite signs in emerging and developed economies as shown in Table 1C.

3. The model economy

This section describes an economic environment in which the empirical regularities established in the preceding section can be interpreted as the equilibrium of an economy subject to shocks to

[9] The reason for looking at this variable is that prior to 1993 this is the only consumption series available for Argentina. Recall that we have 10 more years of interest rate data for this country than for the other emerging economies.

[10] An indication that the aggregate employment statistics may mismeasure labor input is that employment in the manufacturing sector in Argentina between 1980 and 1990, reported in Kydland and Zarazaga (1997), exhibits a volatility relative to output that is slightly higher than the one observed for the United States. Also, Kydland and Zarazaga (2002) argue that public employment in Argentina has been used as a covert form of unemployment insurance. This type of payroll credited unemployment insurance would lower the relative volatility of employment. An episode that makes us suspicious about the quality of employment data in Argentina is the 1988-90 recession. During that time GDP fell more than 15% while employment (measured both as number of bodies and as total hours) barely moved.

total factor productivity (TFP) and to interest rates. The model we use is that of a standard one-good neoclassical small open economy where the only asset traded in international financial markets is a noncontingent real bond. Both domestic firms and households trade in this asset. Firms trade in the asset because of the presence of working capital, that is, the need for them to pay (a fraction of) the wage bill before final output is available. The presence of working capital is the only difference from the standard setup, and it requires a careful specification of the timeline of events.

3.1. Timing of shocks

The timeline of events is displayed in Figure 4. Time is discrete and within each period (say, period t) there are two times: one at the beginning of the period, which we denote by t^-, and one at the end of the period, which we denote by t^+. times t^+ and $(t+1)^-$ are arbitrarily close. The economy is subject to shocks, s_t, which are revealed at time t^-, and the entire history of shocks to the economy up to period t is denoted by $s^t = (s_0, ..., s_t)$. These shocks affect TFP in period t, $A(s^t)$, and interest rates, $R\left(s^t\right)$, on bonds that mature at time $(t+1)^+$ and which are issued either at time $(t+1)^-$ or at time t^+. Below we specify in more detail the behavior of firms and households along the timeline, and we define the equilibrium.

3.2. Firms and technology

At time t^- firms hire labor, $l\left(s^t\right)$, and capital, $k(s^{t-1})$, to produce a final good, $y\left(s^t\right)$, that will become available at t^+.

Firms need to borrow working capital due to a friction in the technology for transferring resources to the households that provide labor services. In order to transfer $w(s^t)l(s^t)$ to workers that earn $w(s^t)$ goods per unit of time, firms need to set aside a fraction θ of the wage bill at t^- and a fraction $(1-\theta)$ at t^+. The worker receives $w(s^t)l(s^t)$ at t^+.[11] Because production becomes available

[11] We chose to model the need for working capital as a technological constraint on the firm for notational simplicity. An alternative model of the need for working capital would have been to assume some form of limited participation, that is, that a fraction of the workers are excluded from asset markets between t^- and t^+ but need resources to consume.

only at the end of the period, firms have to borrow $\theta w\left(s^t\right) l\left(s^t\right)$ units of goods (the working capital) between t^- and t^+, at rate $R(s^{t-1})$.

The market for the services of capital, however, is frictionless so firms can make payments to the owners of capital at the end of the period when production is realized. At the end of the period, when output becomes available, firms obtain resources $y(s^t)$ and use them to make the end-of-period labor payments $(1-\theta) w\left(s^t\right) l\left(s^t\right)$, to pay rental services to the owners of capital $r(s^t)k(s^{t-1})$, and to repay the working capital loan plus interest $\theta w\left(s^t\right) l\left(s^t\right) R\left(s^{t-1}\right)$.

The production technology is described by the constant returns to scale technology

$$y\left(s^t\right) = A\left(s^t\right)\left[k\left(s^{t-1}\right)\right]^\alpha \left[(1+\gamma)^t l\left(s^t\right)\right]^{1-\alpha} \tag{1}$$

where γ is the deterministic growth rate of labor-augmenting technological change.

Given the prices $w(s^t)$, $r\left(s^t\right)$, and $R\left(s^{t-1}\right)$, the *firm's problem* is to choose labor, $l\left(s^t\right)$, and capital, $k\left(s^{t-1}\right)$, in order to maximize profits (measured at time t^+)

$$y\left(s^t\right) - \left[w\left(s^t\right) l\left(s^t\right) + r\left(s^t\right) k\left(s^{t-1}\right)\right] - \left[R\left(s^{t-1}\right) - 1\right] \theta w\left(s^t\right) l\left(s^t\right) \tag{2}$$

subject to the technological constraint (1).

The term $[R(s^{t-1})-1]\theta w(s^t)l(s^t)$ in (2) represents the net interest on the fraction of the wage bill that was paid with borrowed funds.

3.3. Households

At time t^- households supply labor and rent out capital in competitive labor and capital markets. At time t^+ they receive labor payments and capital payments and make consumption and investment decisions. Their preferences are described by the expected utility

$$\sum_{t=0}^{\infty}\sum_{s^t}\beta^t\pi\left(s^t\right)u\left(c\left(s^t\right),l\left(s^t\right)\right) \tag{3}$$

where $\pi\left(s^t\right)$ is the probability of history s^t occurring conditional on the information set at time $t=0$, $0<\beta<1$ is the constant discount factor, and $c\left(s^t\right)$ is consumption. The household's budget constraints are then given by

$$c(s^t)+x(s^t)+b(s^t)+\kappa\left(b\left(s^t\right)\right)\leq w(s^t)l(s^t)+r(s^t)k(s^{t-1})+b(s^{t-1})R\left(s^{t-1}\right) \tag{4}$$

for all s^t.

At time t^+ households spend the proceeds from bond holdings $b\left(s^{t-1}\right)R\left(s^{t-1}\right)$ and their labor and capital income on consumption, investment $x(s^t)$, bond purchases $b(s^t)$, and the cost of holding bonds, $\kappa\left(b\left(s^{t-1}\right)\right)$, where $\kappa\left(\cdot\right)$ is a convex function.[12]

The resources used for investment $x(s^t)$ add to the current stock of capital and are used to cover a capital adjustment cost

$$x(s^t)=k(s^t)-(1-\delta)k(s^{t-1})+\Phi(k(s^{t-1}),k(s^t)) \tag{5}$$

for all s^t, where the function Φ represents the cost of adjusting the capital stock. Adjustment costs such as these are commonly used in the business cycle literature of small open economies in order to avoid excessive volatility of investment.

The *household's problem* then is to choose the state-contingent sequences of consumption,

[12]The quantitative experiments performed in the next section are computed linearizing the model around its steady state value. Bond holding costs are needed to guarantee that bond holdings do not display a unit root. See Schmitt-Grohé and Uribe (2003) for alternative ways of obtaining this. The parameters of the function κ are chosen so that these costs are minimal and do not affect the short-run properties of the model.

$c\left(s^t\right)$, labor, $l\left(s^t\right)$, bond holdings, $b\left(s^t\right)$, and investment, $x\left(s^t\right)$, that maximize the expected utility (3) subject to the sequence of budget constraints (4), the capital accumulation constraints (5), and a no-Ponzi-game condition, for given values of the initial levels of capital and debt, $k(0)$ and $b(0)$, and for the given sequences of prices, $w(s^t)$, $r\left(s^t\right)$, and $R\left(s^t\right)$.

3.4. Equilibrium allocations and prices

Given initial conditions $k(0)$ and $b(0)$, a state-contingent sequence of interest rates $R\left(s^t\right)$, and TFP $A(s^t)$, an *equilibrium* is a state-contingent sequence of allocations $\{c\left(s^t\right),\ l\left(s^t\right),\ b\left(s^t\right),\ x\left(s^t\right),\ k\left(s^t\right)\}$ and of prices $\{w(s^t),\ r\left(s^t\right)\}$ such that (i) the allocations solve the firm's and the household's problem at the equilibrium prices and (ii) markets for factor inputs clear. A balanced growth path for the economy is an equilibrium in which $R\left(s^t\right)$, $A(s^t)$ are constant. Along a balanced growth path $r(s^t)$ and $l(s^t)$ are constant and all other variables grow at rate γ.

Because this is a small open economy, the household's asset position, $b\left(s^{t-1}\right)$ net of the firm's working capital debt, $\theta w\left(s^t\right) l\left(s^t\right)$, is the country's net foreign asset position in period t. Similarly, the goods produced in the country that are not spent in consumption, investment, or bond holding costs are the country's net exports.

The parameter θ captures the importance of working capital. If it is set to zero, firms do not need working capital, the term capturing the cost of the working capital in the firm's profit function, (2), disappears, and the model reduces exactly to the standard neoclassical one.

4. Interest rates and country risk

The model economy described in the preceding section is subject to interest rate and productivity shocks. As we discussed in Section 2, the interest rates faced by emerging economies are quite volatile. In this section we provide a simple theory of this interest rate volatility in emerging economies.

We assume that a large mass of international investors is willing to lend to the emerging economy any amount at a rate $R(s^t)$. Loans to the domestic economy are risky assets because we assume that there can be default on payments to foreigners. This assumption creates two sources of volatility in R: first, real interest rates change as the perceived default risk changes; second, even if the default risk stays constant, interest rates can change because the preference of international investors for risky assets might change over time. We capture these two sources of interest rate volatility by decomposing the interest rate faced by the emerging economy as

$$R(s^t) = R^* \left(s^t\right) D(s^t) \tag{6}$$

where R^* is an international rate for risky assets (which is not specific to any emerging economy) and D measures the country spread over R^* paid by borrowers in a particular economy. One important issue is how to model default decisions. To keep matters very simple, we assume that private domestic lenders always pay their obligation in full but that in each period there is a probability that the local government will confiscate all the interest payments going from local borrowers to the foreign lenders.[13] Time variation in this confiscation probability will cause time variation in the country spreads D.

In our computational experiments domestic firms borrow funds from domestic households and from foreign investors. The existence of only one asset implies that all agents (domestic or foreign, borrower or lender) face the same rate of interest R. The small open economy assumption implies that the interest rate on this internationally traded bond is determined by the foreign bond holders that are subject to default risk. Domestic lenders always receive back the full value of their loan plus interest. Thus, our assumptions on interest rates are fully consistent with the model described in the preceding section as long as foreigners lend positive amounts to the domestic economy all

[13] Kehoe and Perri (2004) model international default in a similar fashion.

along the equilibrium path. [14]

Throughout the paper we will identify R^* as a U.S. rate for risky assets and model it as a stochastic process completely independent from conditions in the emerging economy (see Section 5).

The more important issue to resolve though is what drives fluctuations in the confiscation probability in a particular economy and hence in its country spread D. A complete model of the determination of fluctuations in country risk is beyond the scope of this paper, because our main goal is to analyze the relation between interest rates and business cycles. However, a minimal model of country risk is necessary to conduct our quantitative analysis. In the rest of the paper, we consider two polar (non-mutually exclusive) approaches.

The first approach is that exogenous factors (like foreign events, contagion, or political factors that are largely independent of local productivity shocks) also drive country risk. Under this view, the interest rate R is determined by two separate stochastic processes (chosen to replicate observed data) that are both independent from the fundamentals of the economy in question. We refer to this approach as the *independent country risk* case.

The second approach is that fundamental shocks to a country's economy (productivity shocks in our model) drive the business cycle and country risk at the same time. The simplest way to model this is to assume that default probabilities and, hence, country risk are a function of productivity shocks. This idea is based on models of default and incomplete markets (see, for example, Eaton and Gersovitz, 1981, or more recently Arellano, 2003) in which default probabilities are high when expectations of productivity shocks are low. Thus, the country risk component of $R(s^t)$ (which is known in period t but is the rate at which firms borrow in period $t+1$) is a decreasing function of

[14] In our computational experiments we check that this condition is always satisfied.

expected productivity in $t+1$

$$D\left(s^t\right) = \eta\left(E_t A\left(s^{t+1}\right)\right). \tag{7}$$

This reduced form approach to endogenous default is subject to the usual critiques since the function $\eta(\cdot)$ may itself depend on other economic fundamentals. The purpose of introducing this relation is not to provide a satisfactory model of country risk, but only to show that country risk, even when it is fully determined by local fundamental economic conditions, can act as a powerful amplification mechanism. Under this approach, the driving forces of fluctuations are the realization of shocks to productivity and to international real interest rates. We refer to this approach as the *induced country risk* case.

5. Calibration of shock processes and parameters

The objective of the computational experiments performed in Section 6 is to evaluate the role played by interest rates in the business cycles of emerging economies and contrast it with the role played by productivity shocks. To that end we need to calibrate the parameters of the model and the stochastic processes for country risk, international real interest rates, and productivity shocks. A period in the model is assumed to be a quarter. We will use data from Argentina for the period 1983-2001. We will first describe how we model total factor productivity, then how we obtain processes for interest rates, and finally, how we calibrated other parameters. From now on we let $\hat{x}$ denote the percentage deviation of variable x from its balanced growth path.

5.1. Total factor productivity

Estimating a reliable process for the shocks to total factor productivity for our experiments entails the estimation of a reliable series for Argentina's Solow residuals with a quarterly frequency. Unfortunately, this is impossible at the quarterly level since labor statistics in Argentina are collected at semi-annual frequencies. Furthermore, the available labor statistics may not measure accurately labor inputs as discussed in Section 3. Because of these issues we simply assume that the process for percentage deviations from trend of total factor productivity, $\hat{A}(s^t)$, follow the AR(1) process

$$\hat{A}\left(s^t\right) = \rho_A \; \hat{A}\left(s^{t-1}\right) + \varepsilon_A\left(s^t\right) \tag{8}$$

and assume that it has the same persistence as the process estimated for the United States with $\rho_A = 0.95$. We assume that innovations to productivity $\varepsilon_A\left(s^t\right)$ are normally distributed and serially uncorrelated and, in the experiments in which productivity shocks are turned on, set their volatility so that the simulated volatility of output in the experiments we conduct matches the Argentine data.

5.2. Interest rates

Country risk, $D\left(s^t\right)$, is defined as the ratio between Argentine rates, $R(s^t)$, and international interest rates, $R^*\left(s^t\right)$, as in (6). We measure $R(s^t)$ as the 3-month real yield on Argentine dollar denominated sovereign bonds (as discussed in the data section, this rate is a good approximation for the rate faced by Argentine firms) and $R^*\left(s^t\right)$ as the redemption real yield on an index on non-investment-grade U.S. domestic bonds. Since Argentine sovereign bonds are also non-investment-grade a change in the difference between $R(s^t)$ and $R^*\left(s^t\right)$ should capture a change in Argentina's idiosyncratic default risk and not a change in the overall risk preference of international (U.S.) investors. Figure 5 shows the evolution of R and R^* over the sample period. Note how in "tranquil times" (for example, the early '90s) the rate faced by Argentina is very close to the U.S. risky rate, while during crisis times (for example, the hyperinflation of 1989) country risk goes up significantly.

Because we find that $\hat{R}^*(s^t)$ and $\hat{D}(s^t)$ are uncorrelated[15] in the independent country risk

[15] In our sample the correlation between the two time series is 0.05.

case, we simply estimate two independent first-order autoregressive processes of the form

$$\hat{R}^*\left(s^t\right) = \rho_1 \hat{R}^*\left(s^{t-1}\right) + \varepsilon_R\left(s^t\right) \tag{9}$$

$$\hat{D}\left(s^t\right) = \rho_2 \hat{D}\left(s^{t-1}\right) + \varepsilon_D\left(s^t\right) \tag{10}$$

where $\varepsilon_R\left(s^t\right)$ and $\varepsilon_D\left(s^t\right)$ are normally distributed independent innovations. The OLS estimates of the persistence parameters for the processes are $\rho_1 = 0.81$ and $\rho_2 = 0.78$. Although the two processes have similar persistence, $\hat{D}\left(s^t\right)$ is much more volatile than $\hat{R}^*\left(s^t\right)$: the standard deviation of $\hat{D}\left(s^t\right)$ is 3.66% while the one of $\hat{R}^*\left(s^t\right)$ is only 1.08%.

In the induced country risk case, we use the same process for $\hat{R}^*$, but we replace (10) with the following log-linearized version of (7):

$$\hat{D}\left(s^t\right) = -\bar{\eta} E_t(\hat{A}\left(s^{t+1}\right)) + \varepsilon_I\left(s^t\right) \tag{11}$$

where $\bar{\eta} > 0$ is a constant capturing how much country risk responds to expected productivity shocks and $\varepsilon_I\left(s^t\right)$ is a normally distributed independent shock. By (6) and (7), then, percentage trend deviations for Argentine rates in the model become $\hat{R}\left(s^t\right) = \hat{R}^*\left(s^t\right) - \bar{\eta} E \hat{A}\left(s^{t+1}\right) + \varepsilon_I\left(s^t\right)$. We then choose $\bar{\eta}$ and $Var(\varepsilon_I)$ so that, given processes for $\hat{A}\left(s^t\right)$ and $\hat{R}^*\left(s^t\right)$, the Argentine interest rate series $(\hat{R}\left(s^t\right))$ generated by the model has the same standard deviation and same persistence as the one in the data.[16]

5.3. Functional forms and parameters

Here we first state the functional forms chosen to represent the household's preferences, the investment adjustment costs, and the bond holding costs in the model economy. Then we describe

[16] In particular we set $\bar{\eta}^2 = \left(Var(\hat{R})\rho(\hat{R}) - Var(\hat{R}^*)\rho_1\right)/\rho_A^3 Var\hat{A}$ and $Var(\varepsilon_I) = Var(\hat{R}) - Var(\hat{R}^*) - \bar{\eta}^2\rho_A^2 Var\hat{A}$, where $\rho(\hat{R})$ is the serial correlation of $\hat{R}$ in the data.

how all the relevant parameters were determined. We assume that the period utility function takes the form[17]

$$u(c,l) = \frac{1}{1-\sigma}\left[c - \psi(1+\gamma)^t l^v\right]^{1-\sigma}, \; v > 1, \; \psi > 0. \tag{12}$$

These preferences (that we label GHH) have been introduced in the macro literature by Greenwood et al. (1988) and have been used in open economy models by Mendoza (1991) and Correia et al. (1995), among others. Many authors have noted that these preferences improve the ability of these models to reproduce some business cycle facts. We also analyze how the results change if we consider the Cobb-Douglas utility function

$$u(c,l) = \frac{1}{1-\sigma}\left[c^{\mu}(1-l)^{1-\mu}\right]^{1-\sigma}, \; 0 < \mu < 1. \tag{13}$$

We assume that the adjustment cost function is $\Phi\left(k\left(s^{t-1}\right), k\left(s^t\right)\right) = \frac{\phi}{2}k\left(s^{t-1}\right)\left(\frac{k(s^t)-k(s^{t-1})(1+\gamma)}{k(s^{t-1})}\right)^2$ and that the bond holding costs are $\kappa\left(b(s^t)\right) = \frac{\kappa}{2}y(s^t)\left(\frac{b(s^t)}{y(s^t)} - \bar{b}\right)^2$,where κ is a constant determining the size of the bond holding costs and $\bar{b}$ is the steady state level of bonds-to-GDP ratio. These functional forms guarantee that as the economy grows the average resources used for the costs relative to the size of the economy remain constant and that along a balanced growth path (without shocks) costs are zero.

The parameters we set beforehand are the curvature of the period utility σ that we set to five following Reinhart and Vegh (1995) and the curvature of labor in the GHH preference specification v that we set to 1.6, which is an intermediate value between the value of 1.5 used by Mendoza (1991) and the value of 1.7 used by Correia et al. (1995). This parameter determines

[17] Note that for these preferences to be consistent with long-run growth, one needs to assume that technological progress increases the utility of leisure. Benhabib et al. (1991) show that these preferences can be interpreted as reduced form preferences for an economy with home production and technological progress in the home production sector.

the labor supply elasticity that is given by $\frac{1}{\nu-1}$ and is important for the quantitative results.[18] We assume that all the wage bill is paid in advance and set $\theta = 1$. The sensitivity of our quantitative exercises to this choice of parameter and to the choice for the parameter v is analyzed after we present the results.

The parameters γ, β, ψ, μ, α, and δ are set so that the balanced growth paths in the model are consistent with the long-run growth averages in the data. In particular we set γ to match an average growth rate of Argentine real output over our sample of 2.5% per year, β to match an average real interest rate in Argentina over our sample of 14.8% per year,[19] ψ (in the GHH case) and μ (in the Cobb-Douglas case) to match an average time spent working of 20% of total time, α to match labor's share of income[20] of 0.6, and δ to match an average investment/output ratio in Argentina over the period 1983-2001 of 0.21.

The steady state asset holdings of the households (b) in the model are not uniquely pinned down by the parameter values, so we set them to match the historical average of the ratio between net foreign asset position and output in Argentina, which in the data is equal to -42% and in the model corresponds to $\theta wl/y - b/y$.[21]

The capital stock adjustment cost parameter, ϕ, mostly affects the volatility of investment relative to output, so in most experiments we set it to match this statistic in the Argentine data. Finally, the bond holding cost parameter κ is set to the minimum value that guarantees that the

[18] We could not find an independent estimate of the elasticity of the labor supply with respect to wages in Argentina, but the value of v we use is consistent with micro studies for the United States and Canada.

[19] The presence of growth implies that β is calibrated to two different values in the two different preference specifications.

[20] Since here part of the income is used to pay interest, the parameter α is not exactly equal to one minus the labor share. To calibrate α we use data on the labor share plus the following steady state relation

$$\text{Labor Share} = \frac{1-\alpha}{1+(\bar{R}-1)\theta}$$

where $\bar{R}$ is the steady state interest rate.

[21] We compute the average net foreign assets of Argentina by averaging foreign asset positions data, constructed using cumulated capital flows, from 1983 to 1998, as reported in Lane and Milesi-Ferretti (2001).

equilibrium solution is stationary. The parameter values are summarized in Table 2. Once shock processes and parameters are set, it is straightforward to compute impulse responses to shocks and simulation results based on equilibrium paths of the economy, computed by log-linearizing the model around its balanced growth path.

6. Characterization of equilibrium and results

In this section we present the main results of the paper. We first discuss how in our basic framework macroeconomic variables respond to interest rate and productivity shocks, and then we analyze the statistical properties of the model economy with the goal of assessing the importance of interest rate shocks for business cycles.

6.1. The impact of interest rate and productivity shocks

We start by analyzing how interest rate and productivity shocks affect the economy in the different cases we consider.

6.1.1. Interest rate shocks

In order to understand the effect of an interest rate shock on the economy's equilibrium, it is useful to focus on its impact on the labor market first. Combining the firm's and the household's optimization conditions for labor, we obtain

$$\frac{1}{1+\theta\left(R(s^t)-1\right)}A\left(s^{t+1}\right)F_l\left(k\left(s^t\right),l\left(s^{t+1}\right)\right)=w(s^{t+1})=-\frac{u_l\left(c\left(s^{t+1}\right),l\left(s^{t+1}\right)\right)}{u_c\left(c\left(s^{t+1}\right),l\left(s^{t+1}\right)\right)}. \tag{14}$$

This equation states that, in equilibrium, the value of the marginal product of labor must equal wages and the consumption-leisure marginal rate of substitution. Under our assumptions, the former depends on the fraction of the wage bill that is paid in advance, θ. When firms pay for labor services in advance, $\theta>0$, an interest rate shock in period t affects production decisions in $t+1$ in the same way that productivity shocks do; in particular, an increase in the interest rate reduces the firms's demand for labor for any level of wages.

The solution of this equation is represented by the crossing of the two lines in the panels in Figure 6. The left-hand side of (14) can be interpreted as the labor demand (L^d) and the right-hand side as the labor supply (L^s). Starting from an initial equilibrium employment l_0, an interest rate shock shifts the labor demand to the left, and its effect on equilibrium employment will depend on the slope of the labor supply curve and on its reaction to an interest rate shock.

For our benchmark economy with GHH preferences and $\theta = 1$, represented in the left panel of Figure 6, the labor supply curve is independent of consumption and, hence, is independent of the interest rate. A shift in the labor demand, in this case, induces a movement along the labor supply curve and a reduction in equilibrium employment (and output). The linearization of equation (14) around the steady state yields

$$\hat{l}_{t+1} = -\frac{1}{1/\varepsilon_s - 1/\varepsilon_d}\hat{R}_t + \frac{\alpha}{1/\varepsilon_s - 1/\varepsilon_d}\hat{k}_t. \tag{15}$$

Because the change in the capital stock induced by the interest rate shock is quantitatively small, equation (15) shows that an increase in the interest rate paid by firms on working capital induces a fall in employment that depends mainly on the wage elasticity of the labor demand, $\varepsilon_d = -1/\alpha$, and on the wage elasticity of the labor supply, $\varepsilon_s = 1/(\nu - 1)$.

Figure 7 depicts the impulse response function to a shock in international interest rates in the benchmark economy with the parameter values described in the previous section. On impact, the interest rate shock has no effect on equilibrium employment because firms finance the t^{th} period working capital at the rate $R(s^{t-1})$. A 1% increase in $R(s^t)$ induces a fall in employment in $t+1$ of just over 1% ($\frac{1}{v-1+\alpha}$%) of the steady state value, and thereafter employment slowly approaches the steady state as the interest rate shock vanishes. Output follows a pattern that mimics the path of employment through the production function, so output decline is about $(1-\alpha)\%$ the size of employment decline. To understand the behavior of consumption, it is useful to consider the linearized first-order condition for bonds:

$$\hat{c}_{t+1} - \hat{c}_t = \frac{1}{\sigma}\left(1 - \frac{\bar{w}}{v}\right)\hat{R}_t + \bar{w}\left(\hat{l}_{t+1} - \hat{l}_t\right) \tag{16}$$

where $\bar{w}$ is the balanced growth path ratio between the wage bill and consumption that in the model economy (and in Argentina) is about 80%. Equation (16) shows how interest rate shocks have two effects on consumption growth. One direct effect is proportional to the intertemporal elasticity of substitution $\frac{1}{\sigma}$, and one indirect effect derives from employment growth (because of nonseparabilities between consumption and leisure in the utility function) and is proportional to $\bar{w}$. In our baseline economy, even with a relatively low value of the intertemporal elasticity, the sum of the two effects is sufficient to cause a response of consumption to interest rate shocks that exceeds the response of output. This is the opposite to what happens in response to a productivity shock when, unless the shock is completely permanent, consumption responds less than output. Finally, net exports behave as in the standard neoclassical model. An increase in interest rates induces savings to increase and investment to fall, and, hence, net exports expand.

The analysis of the impulse response suggests thus that if interest rate shocks are large relative to productivity shocks, this model will induce equilibrium consumption to be more volatile than output, a positive correlation between net exports and interest rates, countercyclical and leading interest rates, and strongly countercyclical net exports.

The model with Cobb-Douglas preferences behaves quite differently. For the Cobb-Douglas preferences specification, the labor supply depends negatively on consumption, and, since a rise in the interest rate causes an immediate drop in consumption, it also induces an outward shift in the labor supply curve. Since on impact the labor demand does not move, an interest rate shock will cause employment and output, on impact, to go up. In subsequent periods the interest rate shock shifts the labor demand to the left; this can offset the outward shift in the labor supply curve, and the final effect on equilibrium employment can be positive or negative (see the right panel of Figure 6). Analytically, the linearized version of the labor market equilibrium condition, (14), under Cobb-Douglas preferences becomes

$$\hat{l}_{t+1} = -\frac{1}{\frac{\bar{l}}{1-\bar{l}} - 1/\varepsilon_d}\left(\hat{R}_t + \hat{c}_{t+1}\right) + \frac{\alpha}{\frac{\bar{l}}{1-\bar{l}} - 1/\varepsilon_d}\hat{k}_t \tag{17}$$

where $\bar{l}$ is the constant value of employment along the balanced growth path. Since $\hat{k}_t$ is small the effect of $\hat{R}_t$ on $\hat{l}_{t+1}$ depends on the consumption response relative to $\hat{R}_t$. If consumption responds strongly to interest rates, labor supply will increase a lot and employment will tend to increase even in subsequent periods. If consumption does not move much, labor supply will be more stable and employment will fall. In the sensitivity section we will discuss the key parameters that affect the magnitude of these effects.

6.1.2. Productivity shocks

The effect of productivity shocks on the economy will depend on the nature of country risk. In the case in which country risk is independent of these shocks, the reaction of the economy to a productivity shock is the same as in the standard business cycle model of a small open economy (see, for example, Mendoza, 1991). A shock to total factor productivity increases the labor demand for any level of wages and induces a change in equilibrium employment that depends on the wage elasticities of the labor supply and demand, ε_s and ε_d. The change in employment is $\hat{l}_{t+j} = 1/\left(1/\varepsilon_s - 1/\varepsilon_d\right)\ \hat{A}_{t+j}$, where the autoregressive process for A_t specified in (8) implies $\hat{A}_{t+j} = \rho_A^j\ \varepsilon_{At}$ for $j = 0, 1, \ldots$.

In the case in which country risk is "induced" by productivity shocks as in (7), changes in country risk act as an amplification mechanism of fluctuations in productivity through the working capital channel. The best way of illustrating this is by analyzing the effect of productivity shocks on equilibrium employment, shown in the following equation:

$$\hat{l}_t = \frac{1}{1/\varepsilon_s - 1/\varepsilon_d}\varepsilon_{At} \tag{18a}$$

$$\hat{l}_{t+j} = \frac{1}{1/\varepsilon_s - 1/\varepsilon_d}\left(1 + \frac{\bar{R}\theta}{1 + \left(\bar{R} - 1\right)\theta}\bar{\eta}\ \rho_A^{-1}\right)\rho_A^j \varepsilon_{At} \quad \text{for } j = 1, 2, \ldots. \tag{18b}$$

On impact a productivity shock has the same effect as in the standard neoclassical model as shown in (18a). In this model, in addition, a positive productivity shock reduces country risk, following (7), and this affects the labor demand in all future periods as shown in (18b). When country spreads are a function of productivity shocks, the rise in productivity induces a fall in interest rates which, in turn, further expands the labor demand for any level of wages. The size of this amplification effect of productivity shocks on the labor demand is equal to the term in brackets in equation (18b), and it depends on the sensitivity of interest rates to productivity shocks, $\bar{\eta}$, and on the proportion of the wage bill that has to be financed in advance, θ. Thus, the interaction between the effect of productivity shocks on country risk and the assumption of working capital amplifies the effect of a productivity shock. If there is no spillover effect from productivity shocks to country risk, $\bar{\eta} = 0$, or if there is no need for working capital, $\theta = 0$, the amplification effect disappears, and the model behaves as a standard business cycle model. Under our parameter specification with $\bar{\eta} = 1.04$, for $\theta = 1$, the impact of a productivity shock in t on employment in $t + j$, for $j \geq 1$, more than doubles its size relative to the standard model.

6.2. Computational experiments

In order to assess the role of interest rates in driving business cycles, we now analyze the statistical properties of the model economy using three experiments. First, we consider a model economy without country risk, then we analyze the model economy with independent country risk, and finally, we analyze the economy with induced country risk. In all three experiments we will include shocks to international interest rates R^* and consider the benchmark model with working capital, $\theta = 1$, and GHH preferences. Table 3 and Figures 8 and 9 contain the results. Finally, we discuss how some of the key effects analyzed here change when we deviate from the baseline parameterization.

6.2.1. No country risk

In the first experiment we analyze business cycle statistics in a model economy where the only shocks are to international interest rates R^* (U.S. real yield on non-investment-grade bonds) and then consider an economy with shocks to international rates and to TFP. To generate interest rates in the model, we use (9) and the innovations from the data to mimic the actual behavior of the percentage deviations from trend of R^*. Productivity shocks are randomly generated by (8), and the standard deviation of productivity innovations, $\sigma(\varepsilon_A\left(s^t\right))$, is set so that the volatility of GDP in the model with both shocks exactly matches the volatility of GDP in Argentina. The capital adjustment cost parameter, ϕ, is set so that the model with both shocks matches the relative volatility of investment in the data.

The model with only interest rate shocks (lines (a) in Table 3) generates a GDP volatility of 1.24% that is about 30% of the volatility of GDP in the data. Notice though that once we add TFP shocks, so that GDP volatility in the model is in line with GDP volatility in the data, the cross-correlation between interest rates and GDP in the model without country risk is quite far from the cross-correlation in the data (Figure 8): in particular, interest rates in the model are much less countercyclical than in the data. Also, the model is not able to generate countercyclical net exports or consumption that is more volatile than output (lines (b) in Table 3). We conclude that the absence of country risk prevents the model from explaining important features of the data.

6.2.2. Independent country risk

Lines (c) in Table 3 report statistics for the economy subject to shocks to international real interest rates and to independent country risk, while lines (d) report the statistics for the same economy also subject to TFP shocks. To generate international real interest rates and country risk in the model, we use (9) and (10) plus the innovations from the data so that the series for the percentage deviations from trend of interest rates in the model, $\hat{R}_t$ and $\hat{R}_t^*$, are identical to the series in the data. As in the preceding experiment, TFP shocks are randomly generated by (8). The standard deviation of productivity innovations, $\sigma(\varepsilon_A(s^t))$, and the capital adjustment cost parameter, ϕ, are set so that the volatility of GDP and the relative volatility of investment in the model with all three shocks exactly match the data.

Figure 9 shows the path for detrended output predicted by the model with only international interest rates and country risk shocks against detrended output in the data.

The series for output predicted by the model displays cyclical fluctuations very similar to the data, with a correlation between the actual and the simulated output series of 0.73. The figure suggests that country risk fluctuations can be a key factor in explaining business cycle volatility in emerging economies. In lines (c) in the first panel of Table 3, we can see that the volatility of output in the model is 2.33, or 55% of that in the data. Lines (c) though also show that the model with only interest rate shocks exaggerates the relative volatility of consumption, employment, and investment, as well as the correlation between interest rates and the main macroeconomic variables, thus suggesting the importance of other shocks. Indeed, the model with productivity shocks matches the data better along a number of dimensions. Figure 8 shows that the cross-correlation between GDP and interest rates generated by this model (the line with triangular markers) is quite close to the data. The model can also generate consumption that is more volatile than output (lines (d) in the first panel), countercyclical net exports (lines (d) in the second panel), and comovements between interest rates and macroeconomic aggregates that are close to the data.

Still some discrepancies between the model and the data remain. In particular, the negative comovement between interest rates and output in the model (-0.29) is about half of what it is in the data (-0.63), and net exports are much less countercyclical than in the data (-0.08 vs. -0.89). These discrepancies might be due to the fact that, in the current experiment, country risk affects business cycles but business cycles do not affect country risk. If, as we do in the next experiment, we also allow business cycles to influence country risk, the negative comovement between business cycles and interest rates will increase. Also, since, as we discussed previously, interest rate increases tend to generate a net exports boom, a negative impact of business cycles on interest rates will generate more countercyclical net exports.

6.2.3. Induced country risk

In this final experiment we study the effect of allowing productivity shocks to determine country risk. As in previous experiments, shocks to international interest rates R^* are determined by (9), but country risk is now induced by TFP shocks according to (11) so that the series for interest rates generated by the model has the same standard deviation and persistence as in the data. TFP shocks are randomly generated by (8). The standard deviation of productivity innovations, $\sigma(\varepsilon_A\left(s^t\right))$, and the capital adjustment cost parameter, ϕ, are set so that the volatility of GDP and the relative volatility of investment in the model exactly match the data. Observe that with this specification the model is able to reproduce well the entire U-shaped dynamic structure of cross-correlations between output and interest rates observed in the data (in Figure 8 compare the line with the square markers with the line without markers) and the comovements of the main macroeconomic aggregates with output and interest rates (lines (e) in the second and third panels of Table 3), including the countercyclicality of net exports. Two discrepancies between the model and the data remain: the model overpredicts the relative volatility of employment and the relative volatility of consumption and net exports. Regarding employment volatility, as we discussed in the data section, we have reasons to suspect that the volatility of employment in Argentine data underestimates the true volatility of labor input, so the part of the difference between model and data might reflect this issue. The excess volatility of net exports and consumption instead arises because, in the model, the household sector is directly facing the volatile rate $R(s^t)$. In response to large fluctuations in $R(s^t)$, households intertemporally substitute their consumption decision and this leads to high consumption volatility and high net exports volatility. Reducing the willingness of households to substitute is a possible way of bringing the model in line with the data.[22]

Since this last setup can account well for most of the Argentine data, we can use it to quantify the contribution of interest rate shocks to business cycle volatility. That is, we can ask how much GDP volatility would decline if one could eliminate fluctuations in international real rates or fluctuations in country risk. To estimate the contribution of international real rate fluctuations, we simply recompute the equilibrium without shocks to the international real rates. We find that the percentage standard deviation of GDP in the model without shocks to international rates is 4.10, only 3% smaller than the percentage standard deviation of GDP in the model with all shocks (4.22).[23]

To estimate the contribution of country risk fluctuations, we recompute the model setting $\bar{\eta} = 0$ and $\sigma(\varepsilon_I) = 0$ so that country risk is absent from the model. In particular, when $\bar{\eta} = 0$ the

[22] We experimented with increasing the parameter σ from 5 to 10, and the change brought both the volatility of consumption and the volatility of net exports in line with the data without significantly changing the other statistics generated by the model. Detailed results of this experiment are available upon request.

[23] The reason the volatility reduction from eliminating shocks to international rates is so small is that their variance is small compared to the variance of country risk. When international rates are eliminated, the standard deviation of the real interest rate falls but only from 3.87% to 3.67%. Since equation (15), together with the linearized production function, tells us that, approximately, the standard deviation of GDP is proportionally equal to $\frac{1-\alpha}{v-1-\alpha}$=0.63 times the volatility of R, a reduction of 20 points in the volatility of R only leads to a reduction in the volatility of GDP of around 12/13 points, that is, around 3% of the volatility in the data. If country risk were not present, then eliminating the shocks to international rates would have a larger impact on GDP volatility.

amplification of productivity shocks created by country risk (see equation (18)) disappears. In this case the percentage standard deviation of output drops to 3.06, more than 27% below the volatility of the model with all shocks.

The main lesson we learn from these three experiments is that in emerging economies the large fluctuations in country risk seem to be deeply connected with the large fluctuations in economic activity. The model that better reproduces the data is the one in which country risk is affected by fundamentals (through equation (11)) and at the same time, through the presence of working capital, amplifies the effects of fundamental shocks on the economy. Both directions of causation seem to be quantitatively important, and both deserve further investigation.

6.2.4. Sensitivity analysis

The elements of the model that are crucial for determining the effects of interest rate fluctuations on business cycles are the type of utility function, the elasticity of labor supply in the GHH preferences, and the presence of working capital. In Table 4 we analyze how the size of these effects quantitatively depends on these elements. In the table we report two key statistics from the model, the volatility of output (relative to the volatility of output in the data) and the correlation of output with interest rates for a variety of parameter configurations. We consider a high and a low value of the labor supply elasticity[24] in the GHH preferences and the case of Cobb-Douglas preferences with a high and low value of the parameter σ, which determines the intertemporal elasticity of substitution. We also consider a case in which only 50% of the labor cost has to be paid in advance ($\theta = 0.5$) and a case in which it is not necessary to pay labor in advance ($\theta = 0$). In all the cases we keep all parameters constant to their baseline value, and since we want to quantify the effect of interest rate shocks on business cycles, we focus on the model with only interest rate shocks (international real rates and independent country risk).

[24] A value of $\upsilon = 1.2$ implies an elasticity of five, while $\upsilon = 4$ implies an elasticity of one-third.

First, focus on the baseline GHH preferences. When $\theta = 1$ (100% of labor costs have to be paid in advance) the model generates a quite volatile output and a negative correlation between output and interest rates. Note that as we reduce the working capital parameter θ from one to zero, both the volatility of output and the absolute value of the (negative) correlation between output and interest rates are reduced. This is because by reducing θ we reduce the negative impact that interest rates have on labor demand. Notice though that even with $\theta = 0.5$ interest rate shocks induce significant output fluctuations (about one-third of the one observed in the data) that are negatively correlated with interest rates. When we set $\theta = 0$ (no working capital), the model reduces to the one in Mendoza (1991). In this case interest rates generate relatively small output fluctuations that are also positively correlated with interest rates, so it has no hope of explaining emerging economies data.[25]

Now consider changes in the labor supply elasticity in the GHH preferences. For a fixed θ (that determines how labor demand responds to interest rate shocks) increasing the labor supply elasticity (in terms of Figure 6, making the L^s curve flatter) generates larger output fluctuations and decreasing it induces smaller output fluctuations; for all values of v the correlation between output and interest rates is negative as long as interest rates affect labor demand ($\theta > 0$).

The importance of the specification of preferences is considered in the last four columns of Table 4 in which we analyze how the model behaves with Cobb-Douglas preferences. The intuition underlying the reaction of the economy to interest rate shocks in this case is discussed in Section 6. In the model with Cobb-Douglas preferences and with $\sigma = 5$, interest rate shocks can generate substantial output volatility, but interest rate shocks are highly positively correlated with output. As discussed previously the positive correlation between output and interest rates arises because

[25] The positive correlation between output and interest rates in this case can be understood in terms of the response to an interest rate innovation. On impact output does not move, but in the subsequent period, investment falls and output slowly declines because of the fall in capital stock. Interest rates also slowly decline, reverting to their steady state levels. This contemporaneous decline gives rise to (mildly) positive comovement between the two variables.

the change in consumption induced by the interest rate shock increases the labor supply, offsetting the effect of interest rates on the labor demand as shown in (17). As we reduce θ both the output-interest rate correlation and the volatility of output increase. To understand this consider the right panel of Figure 6: in response to interest rate shocks the consumption effect shifts labor supply to the right while the working capital effect shifts the labor demand to the left. If $\theta = 1$ the two effects tend to offset each other, dampening the fluctuations in equilibrium employment. As we reduce θ the consumption effect dominates and it causes equilibrium employment and output to increase more in response to an increase in interest rates.

Because the change in consumption mentioned above depends on the intertemporal elasticity of substitution, $1/\sigma$, a low value of $1/\sigma$ can, by dampening the labor supply response, induce a negative comovement between interest rates and output even in the Cobb-Douglas case. The last two columns confirm that is indeed the case. When $\sigma = 50$ consumption does not move much in response to interest rate shocks and consequently labor supply increases very little. If $\theta = 1$ labor demand declines significantly, and thus the increase in the interest rate leads to reductions in employment and output. This is to show that GHH utility is not essential to generate a negative impact of interest rate shocks on output.[26]

7. Conclusions

The fundamental issue addressed in this paper is why business cycles in emerging economies are much more pronounced than in developed economies. In particular, we explore the role of fluctuations in the real interest rates faced by these economies. We started by documenting some features of business cycles in a group of five emerging economies. Beyond the high volatility, these countries are also characterized by consumption volatility higher than output volatility and strongly

[26]The overall performance of a model with a Cobb-Douglas production function and $\sigma = 50$ is comparable to the model with GHH preferences. Complete results are not reported for brevity, but are available upon request.

countercyclical net exports. We also find that in these five economies real interest rates are quite volatile, strongly countercyclical and they lead the cycle.

We experiment with two ways of modeling the interest rate: one as a process completely independent from the fundamental shocks hitting the economy and the other as a process that is largely induced by these shocks. We find that adding the latter way of modeling interest rates to a simple dynamic general equilibrium model of a small open economy can explain the facts well. Real interest rates are induced by fundamental shocks but also, through the presence of working capital, amplify the effect of fundamental shocks on business cycles, contributing to the high volatility. We then use this model to evaluate the impact on business cycles of real interest rate fluctuations induced by fundamentals. We find that eliminating default risk in emerging economies can reduce about 27% of their output volatility. This finding suggests the importance of studying further both the mechanism through which fundamental shocks induce interest rate fluctuations and the mechanism through which interest rate fluctuations amplify the effects of fundamental shocks. Understanding these mechanisms could be key to designing policies or reforms that help stabilize emerging economies.

Data Appendix

1. Developed countries

1.1. National accounts

For all countries quarterly series for constant prices GDP, private consumption, total consumption (private and government consumption plus statistical discrepancy and change in inventories), gross fixed capital formation, and exports and imports of goods and services are obtained from OECD Quarterly National Accounts (QNA).

1.2. Employment and hours

For all countries except Netherlands, the quarterly employment series is the civilian employment index from OECD MEI. For Netherlands it is the number of jobs by employees from OECD Main Economic Indicators (MEI).

Total hours is obtained as the employment series multiplied by weekly hours of work. For Australia and Canada we use weekly hours of work in manufacturing from OECD MEI. For New Zealand we use weekly hours of work in nonagricultural establishments from ILO LABSTAT data set. For Sweden we use weekly hours worked in industry (OECD MEI) from 1987.1. From 1980.1 to 1986.4 we use weekly hours per person from ILO LABSTAT. The two series are joined by rescaling the ILO series so that the 1987.1 series has the same value as the OECD series. For Netherlands a consistent series of weekly hours worked is not available.

1.3. Real interest rates

For Australia and Canada the nominal interest rate series we use is the 90-day corporate commercial paper from OECD MEI. For Netherlands from 1983.3 to 1985.4, we use the call money rate, and from 1986.1 to 2001.4, we use the 90-day BAIBOR. When the two series overlap, their differences are negligible. Data are obtained from the Bank of Netherlands. For New Zealand the interest rate is the 90-day bank bill from OECD MEI. For Sweden it is the rate on 90-day treasuries from OECD MEI.

For all countries the real rate is obtained by subtracting the expected GDP deflator inflation from the nominal rate. Expected inflation in period t is computed as the average of inflation in the current period and in the three preceding periods.

2. Emerging countries

2.1. National accounts

For Argentina all series are in constant prices from Ministerio de Economía (MECON). The series for private consumption is only available from 1993.1. For Brazil all series are from Instituto Brasileiro de Geografia e Estatística (IBGE), Novo Sistema de Contas Nacionais. Real variables are obtained by dividing nominal components of GDP by the GDP deflator. For Mexico and Korea all series in constant prices are from OECD QNA. For Philippines all series are from IMF *International Financial Statistics*. Real variables are obtained by dividing nominal components of GDP by the GDP deflator.

2.2. Employment and hours

For Argentina the series for employment is the number of employed people working at least 35 hours per week and the series for total hours is employment multiplied by the average weekly hours worked in Buenos Aires (both series are from Encuesta Permanente de Hogares, Table A3.2, Informe Economico). Both series are semiannual, and the series for hours is only available from 1986.2.

For Brazil employment is the number of employed persons in urban areas from IBGE Pesquisa Mensal de Emprego. Total hours are computed as employment times hours per person. Hours per person are computed by dividing the index of total hours worked in manufacturing by the employment index in manufacturing. Both indexes are from Confederação Nacional da Indústria, Indicadores Industriais. For Korea employment is civilian employment from OECD MEI. Total hours are employment times weekly hours of work. Weekly hours are from ILO LABSTAT (until 1998), and from 1999 to 2001 they are weekly hours of work (annual series) from the Korean National Statistical Office.

For Mexico employment is derived as (1-unemployment rate) × (rate of activity of population over 12 years of age) × (fraction of population over 12 years of age) × total population. All series are from Instituto Nacional de Estatistica Geografia e Informatica except total population, which is from World Bank World Development Indicators. Total hours are computed as employment times hours per person. Hours per person are obtained by dividing the total hours of work in manufacturing (OECD MEI) by the employment in manufacturing (OECD MEI).

For Philippines employment is from ILO LABSTAT data set. A consistent series of weekly hours worked is not available.

2.3. Real interest rates

For all countries nominal interest rate in dollars for the period 1994.1-2001.4 are constructed as the 90-day U.S. T-bill rate plus the J.P. Morgan EMBI Global Spread.[27] Real rates are obtained by subtracting expected U.S. GDP deflator inflation from the nominal dollar rate. Expected inflation in period t is computed as the average of inflation in the current period and in the three preceding periods.

For Argentina we were able to extend the series of dollar denominated interest rates by constructing, using a procedure developed by Alvarez et al. (1999), an interest rate series starting in the second quarter of 1983. We use data on prices of Argentine government dollar denominated bonds (BONEX 80, BONEX 81, BONEX 82, BONEX 84, BONEX 89, GRA, Brady Discount, Global 01, Global 03, Global 06, Global 17, Global 27) and U.S. treasury strips. The Argentine rate on a j period zero coupon bond in period t, $r_{t,j}^{\text{arg}}$, can be written as the sum of the U.S. rate

[27] The data for Brazil start in 1994.3.

for a similar bond, $r_{t,j}^{US}$, plus a country spread, $\delta_{t,j}$. In order to estimate the term spreads, $\delta_{t,j}$, we assume they are given by the following functional form (a polynomial on j and t)

$$\delta_{t,j} = \hat{\delta}(t,j) + \varepsilon_{t,j} = \Delta_t + \alpha_1(t) \cdot j + \alpha_2(t) \cdot j^2 + \alpha_3(t) \cdot j^3 + \varepsilon_{t,j} \tag{19}$$

where

$$\alpha_i(t) = a_{i,0} + a_{i,1} \cdot t + a_{i,2} \cdot t^2 + a_{i,3} \cdot t^3, \qquad i = 1, 2, 3$$

$\varepsilon_{t,j}$ is the approximation error, and Δ_t is a fixed effect for each period (that can be interpreted as the spread of a zero maturity bond). The price, at period t, of a coupon bond, k, issued by the Argentine government, $P_{k,t}^{\arg}$, is given by

$$P_{k,t}^{\arg} = \sum_{j=1}^{J} C_{k,j} \cdot \exp(-(r_{t,j}^{us} + \delta_{t,j}) \cdot j)$$

where $C_{k,j}$ is the coupon paying at t of bond k. The estimated parameters, $a_{i,\cdot}$and Δ_t, of the spread function (19) are those that minimize the loss function L, that is,

$$\min_{a_{i,\cdot}\Delta_t} L = \sum_{t=1}^{T} \sum_{k=1}^{K} \left[\frac{1}{\mathrm{dur}_{t,k}} \ln \left(\frac{\sum_{j=1}^{J} c_j \cdot \exp\left(-\left(r_{t,j}^{us} + \hat{\delta}\left(t,j\right) \right) \cdot j \right)}{P_{k,t}^{\arg}} \right) \right]^2$$

where $\mathrm{dur}_{t,k}$ is the duration of bond k at time t, which is given by the formula

$$\mathrm{dur}_{t,k} = \frac{\sum_{j=1}^{J} c_{kj} \cdot \exp\left(-r_{t,j}^{us} \cdot j \right) j}{\sum_{j=1}^{J} c_{kj} \cdot \exp\left(-r_{t,j}^{us} \cdot j \right)}.$$

Thus, the series for 3-month Argentine nominal dollar interest rates from 1983.2 until 1993.4 is the sum of the U.S. 3-month treasury bill interest rate and the estimated spread with $j = 3$. For the period 1994.1-2000.1, we can compare the series for the Argentine rate constructed by us with the series constructed using the EMBI, and the two series have similar levels and comove very closely.

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Table 1A. Business Cycles in Emerging and Developed Economies (standard deviations)

	% Standard Deviation			% Standard Deviation / % Standard Deviation of GDP				
	GDP	R	NX	PC	TC	INV	EMP	HRS
				Emerging Economies				
Argentina	4.22	3.87	1.42	1.08	1.17	2.95	0.39	0.57
	(0.36)	(0.52)	(0.11)	(0.05)	(0.03)	(0.13)	(0.07)	(0.08)
Brazil	1.76	2.34	1.40	1.93	1.24	3.05	0.89	1.95
	(0.23)	(0.26)	(0.45)	(0.38)	(0.23)	(0.26)	(0.13)	(0.33)
Korea	3.54	1.42	3.58	1.34	2.05	2.20	0.59	0.71
	(0.50)	(0.23)	(0.55)	(0.07)	(0.18)	(0.16)	(0.07)	(0.05)
Mexico	2.98	2.64	2.27	1.21	1.29	3.83	0.43	0.33
	(0.36)	(0.38)	(0.28)	(0.08)	(0.06)	(0.17)	(0.09)	(0.08)
Philippines	1.44	1.33	3.31	0.93	2.78	4.44	1.34	NA
	(0.17)	(0.13)	(0.45)	(0.11)	(0.44)	(0.43)	(0.33)	
Average	2.79	2.32	2.40	1.30	1.71	3.29	0.73	0.89
				Developed Economies				
Australia	1.19	2.00	1.02	0.84	1.20	4.13	1.13	1.40
	(0.09)	(0.17)	(0.08)	(0.07)	(0.08)	(0.22)	(0.10)	(0.14)
Canada	1.39	1.54	0.76	0.74	0.84	2.91	0.75	0.82
	(0.08)	(0.12)	(0.06)	(0.05)	(0.05)	(0.18)	(0.04)	(0.04)
Netherlands	0.93	0.93	0.67	1.17	1.44	2.66	1.27	NA
	(0.06)	(0.12)	(0.07)	(0.08)	(0.12)	(0.22)	(0.14)	
New Zealand	1.99	1.92	1.31	0.82	0.86	3.32	1.15	1.28
	(0.18)	(0.19)	(0.13)	(0.08)	(0.09)	(0.34)	(0.10)	(0.12)
Sweden	1.35	1.92	0.86	1.01	1.67	4.18	1.24	2.94
	(0.14)	(0.26)	(0.09)	(0.10)	(0.22)	(0.34)	(0.13)	(0.17)
Average	1.37	1.66	0.92	0.92	1.08	3.44	1.11	1.61

Notes: Net exports (NX) are exports minus imports over GDP. Real interest rates (R) are in percentage points. Total consumption (TC) includes private (PC) and government consumption, changes in inventories, and statistical discrepancy. Investment (INV) is gross fixed capital formation. Employment (EMP) is number of workers, and total hours (HRS) is number of workers times weekly hours of work per worker. All series except net exports (NX) and real interest rates are in logs. All series have been Hodrick-Prescott filtered. All statistics are based on quarterly data with the exception of employment and hours statistics, which are computed on semiannual data to make them consistent with Argentine data. The numbers in parentheses are standard errors obtained posing the calculation of the statistic as a GMM estimation procedure.

Table 1B. Business Cycles in Emerging and Developed Economies
(correlations with GDP)

	Correlation of GDP with						
	R	NX	PC	TC	INV	EMP	HRS
			Emerging Economies				
Argentina	-0.63	-0.89	0.94	0.97	0.94	0.36	0.52
	(0.08)	(0.02)	(0.11)	(0.01)	(0.01)	(0.11)	(0.11)
Brazil	-0.38	-0.03	0.48	0.58	0.80	0.62	0.75
	(0.22)	(0.18)	(0.16)	(0.19)	(0.08)	(0.15)	(0.09)
Korea	-0.70	-0.86	0.96	0.92	0.94	0.91	0.96
	(0.11)	(0.04)	(0.02)	(0.03)	(0.02)	(0.04)	(0.02)
Mexico	-0.49	-0.87	0.93	0.96	0.96	0.56	0.37
	(0.13)	(0.05)	(0.02)	(0.02)	(0.02)	(0.13)	(0.13)
Philippines	-0.53	-0.40	0.69	0.51	0.76	0.26	NA
	(0.12)	(0.14)	(0.09)	(0.11)	(0.10)	(0.20)	
Average	-0.55	-0.61	0.80	0.79	0.88	0.54	0.65
			Developed Economies				
Australia	0.37	-0.59	0.63	0.79	0.87	0.77	0.76
	(0.11)	(0.08)	(0.07)	(0.05)	(0.03)	(0.06)	(0.06)
Canada	0.25	-0.01	0.83	0.86	0.73	0.93	0.93
	(0.09)	(0.11)	(0.04)	(0.02)	(0.05)	(0.02)	(0.02)
Netherlands	0.34	-0.28	0.64	0.77	0.58	0.81	NA
	(0.12)	(0.10)	(0.07)	(0.04)	(0.07)	(0.03)	
New Zealand	0.07	-0.06	0.72	0.59	0.66	0.73	0.73
	(0.14)	(0.11)	(0.06)	(0.09)	(0.08)	(0.08)	(0.08)
Sweden	-0.05	-0.23	0.55	0.38	0.81	0.81	0.93
	(0.10)	(0.12)	(0.08)	(0.12)	(0.04)	(0.05)	(0.02)
Average	0.20	-0.23	0.67	0.68	0.73	0.81	0.84

Notes: See the notes in table 1A.

Table 1C. Business Cycles in Emerging and Developed Economies
(correlations with the interest rate)

	Correlation of R with					
	NX	PC	TC	INV	EMP	HRS
	Emerging Economies					
Argentina	0.71	-0.70	-0.67	-0.59	-0.45	-0.58
	(0.06)	(0.21)	(0.07)	(0.09)	(0.11)	(0.12)
Brazil	-0.02	-0.39	-0.30	-0.12	-0.50	-0.46
	(0.10)	(0.14)	(0.16)	(0.20)	(0.18)	(0.23)
Korea	0.83	-0.78	-0.82	-0.67	-0.67	-0.78
	(0.03)	(0.06)	(0.05)	(0.09)	(0.14)	(0.13)
Mexico	0.68	-0.52	-0.58	-0.59	-0.42	-0.27
	(0.09)	(0.13)	(0.11)	(0.10)	(0.21)	(0.21)
Philippines	0.34	-0.35	-0.42	-0.43	-0.60	NA
	(0.12)	(0.13)	(0.11)	(0.12)	(0.14)	
Average	0.51	-0.55	-0.56	-0.48	-0.53	-0.52
	Developed Economies					
Australia	-0.42	0.58	0.44	0.36	0.49	0.44
	(0.10)	(0.07)	(0.10)	(0.09)	(0.15)	(0.17)
Canada	0.20	0.13	0.18	0.02	0.31	0.11
	(0.11)	(0.12)	(0.10)	(0.12)	(0.17)	(0.17)
Netherlands	-0.31	0.42	0.31	0.35	0.57	NA
	(0.10)	(0.08)	(0.12)	(0.08)	(0.08)	
New Zealand	-0.30	0.20	0.17	0.31	0.15	0.14
	(0.09)	(0.18)	(0.17)	(0.10)	(0.17)	(0.16)
Sweden	-0.25	-0.15	0.16	0.00	-0.02	-0.27
Average	-0.22	0.24	0.25	0.21	0.30	0.11

Notes: See the notes in table 1A.

Table 2. Baseline parameter values

Shocks

Name	Process	Parameter	Values
Productivity	$\hat{A}\left(s^t\right) = \rho_A\ \hat{A}\left(s^{t-1}\right) + \varepsilon_A\left(s^t\right)$	$\rho_A = 0.95$	$\sigma(\varepsilon_A) = \text{Varies}^*$
Intenational rate	$\hat{R}^*\left(s^t\right) = \rho_1 \hat{R}^*\left(s^{t-1}\right) + \varepsilon_R\left(s^t\right)$	$\rho_1 = 0.81$	$\sigma(\varepsilon_R) = 0.63\%$
Country risk (independent)	$\hat{D}\left(s^t\right) = \rho_2 \hat{D}\left(s^{t-1}\right) + \varepsilon_D\left(s^t\right)$	$\rho_2 = 0.78$	$\sigma(\varepsilon_D) = 2.59\%$
Country risk (induced)	$\hat{D}\left(s^t\right) = -\bar{\eta} E_t(\hat{A}\left(s^{t+1}\right)) + \varepsilon_I\left(s^t\right)$	$\bar{\eta} = 1.04$	$\sigma(\varepsilon_I) = 1.7\%$

Preference parameters

		Value	
Name	**Symbol**	**GHH**	**Cobb Douglas**
Discount factor	β	0.93	0.98
Utility curvature	σ	5	5
Labor curvature	υ	1.6	-
Labor weight	ψ	2.48	-
Consumption share	μ	-	0.24

technology parameters

Name	Symbol	Value
Technological progress growth	γ	0.62%
Capital exponent (production)	α	0.38
Depreciation rate	δ	4.4%
% labor income paid in advance	θ	1
Bond holding cost	κ	10^{-5}
Capital adjustment costs	ϕ	Varies*

* See the notes in table 3 for the value of the parameter in different experiments

Table 3. Simulated and Actual Argentine Business Cycles

	% Standard Dev.			$\frac{\text{\%Standard Dev. of } x}{\text{\%Standard Dev. of GDP}}$		
	GDP	R	NX	TC	INV	HRS
Argentine Data	4.22	3.87	1.42	1.17	2.95	0.57
	(0.36)	(0.52)	(0.11)	(0.03)	(0.13)	(0.08)
No country risk						
a) R* shocks	1.24	1.08	1.43	1.12	8.65	1.00
b) R* and A shocks	4.22	1.08	1.44	0.80	2.95	0.66
Independent country risk						
c) R* and D shocks	2.33	3.87	2.06	1.69	5.26	1.41
d) R*, D and A shocks	4.22	3.87	2.12	1.13	2.95	0.90
Induced country risk						
e) R* and A shocks	4.22	3.87	1.95	1.54	2.95	0.89

	Correlation of GDP with				
	R	NX	TC	INV	HRS
Argentine Data	-0.63	-0.89	0.97	0.94	0.52
	(0.08)	(0.02)	(0.01)	(0.01)	(0.11)
No country risk					
a) R* shocks	-0.36	-0.17	0.82	0.35	0.94
b) R* and A shocks	-0.10	0.03	0.97	0.56	0.98
Independent country risk					
c) R* and D shocks	-0.54	-0.48	0.88	0.57	0.97
d) R*, D and A shocks	-0.29	-0.08	0.87	0.44	0.90
Induced country risk					
e) R* and A shocks	-0.54	-0.80	0.97	0.90	0.98

	Correlation of R with			
	NX	TC	INV	HRS
Argentine data	0.71	-0.67	-0.59	-0.58
	(0.06)	(0.07)	(0.09)	(0.12)
No country risk				
a) R* shocks	0.96	-0.80	-0.98	-0.66
b) R* and A shocks	0.95	-0.31	-0.84	-0.27
Independent country risk				
c) R* and D shocks	0.99	-0.86	-0.99	-0.78
d) R*, D and A shocks	0.96	-0.70	-0.97	-0.62
Induced country risk				
e) R* and A shocks	0.65	-0.60	-0.66	-0.69

Notes: See the notes in table 1A for a definition of the data series and for a description of how data statistics are computed. Model series are treated exactly as the data series. Statistics computed on the model series are averages across 500 simulations, each simulation of same length as the data sample. The capital adjustment cost parameter is ϕ is set to 8 (models a and b), 25.5 (models c and d), and 40 (model e). The standard deviation of productivity shocks $\sigma(\varepsilon_A)$ is set to 1.98% (model b), 1.75% (model d), and 1.47% (model e).

Table 4. Sensitivity analysis

	Preferences									
	GHH ($\nu = 1.2$)		GHH ($Baseline$)		GHH ($v = 4$)		CD ($\sigma = 5$)		CD ($\sigma = 50$)	
	$\frac{\sigma(y)}{\sigma(y_{DATA})}$	Corr(Y,R)	$\frac{\sigma(y)}{\sigma(y_{DATA})}$	Corr(Y,R)	$\frac{\sigma(y)}{\sigma(y_{DATA})}$	Corr(Y,R)	$\frac{\sigma(y)}{\sigma(y_{DATA})}$	Corr(Y,R)	$\frac{\sigma(y)}{\sigma(y_{DATA})}$	Corr(Y,R)
$\theta = 1$	-0.57	89%	55%	-0.54	22%	-0.34	97%	0.86	36%	-0.18
$\theta = 1/2$	-0.44	52%	34%	-0.38	18%	-0.16	102%	0.94	26%	0.20
$\theta = 0$	0.16	27%	21%	0.14	15%	0.13	112%	0.97	24%	0.69

Notes: The capital adjustment cost parameter ϕ is set to 25.5 in all experiments. All remaining parameters are set to their baseline values.

Figure 1. Output and Interest Rates in Emerging Economies

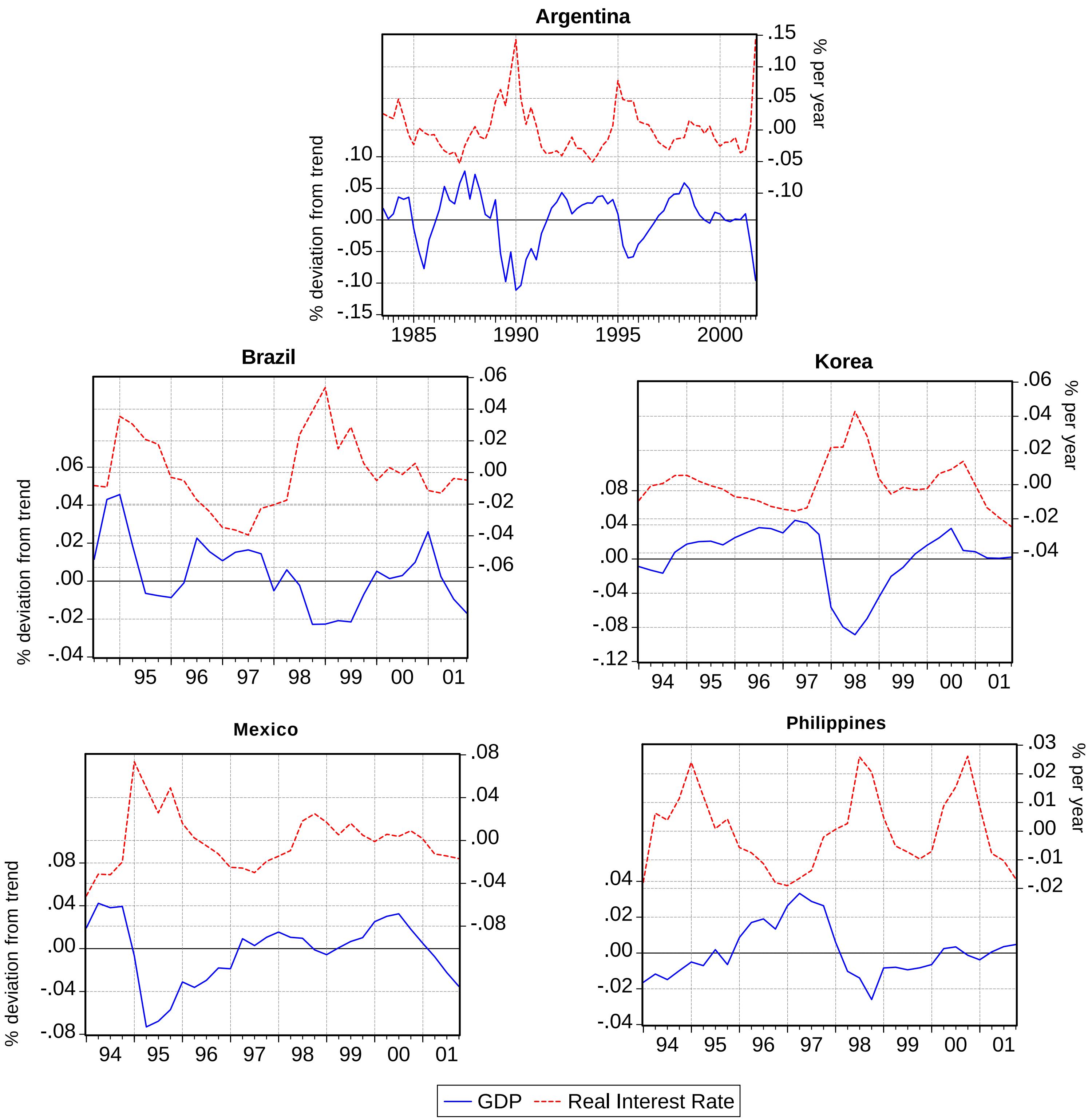


Figure 2. Output and Interest Rates in Developed Economies

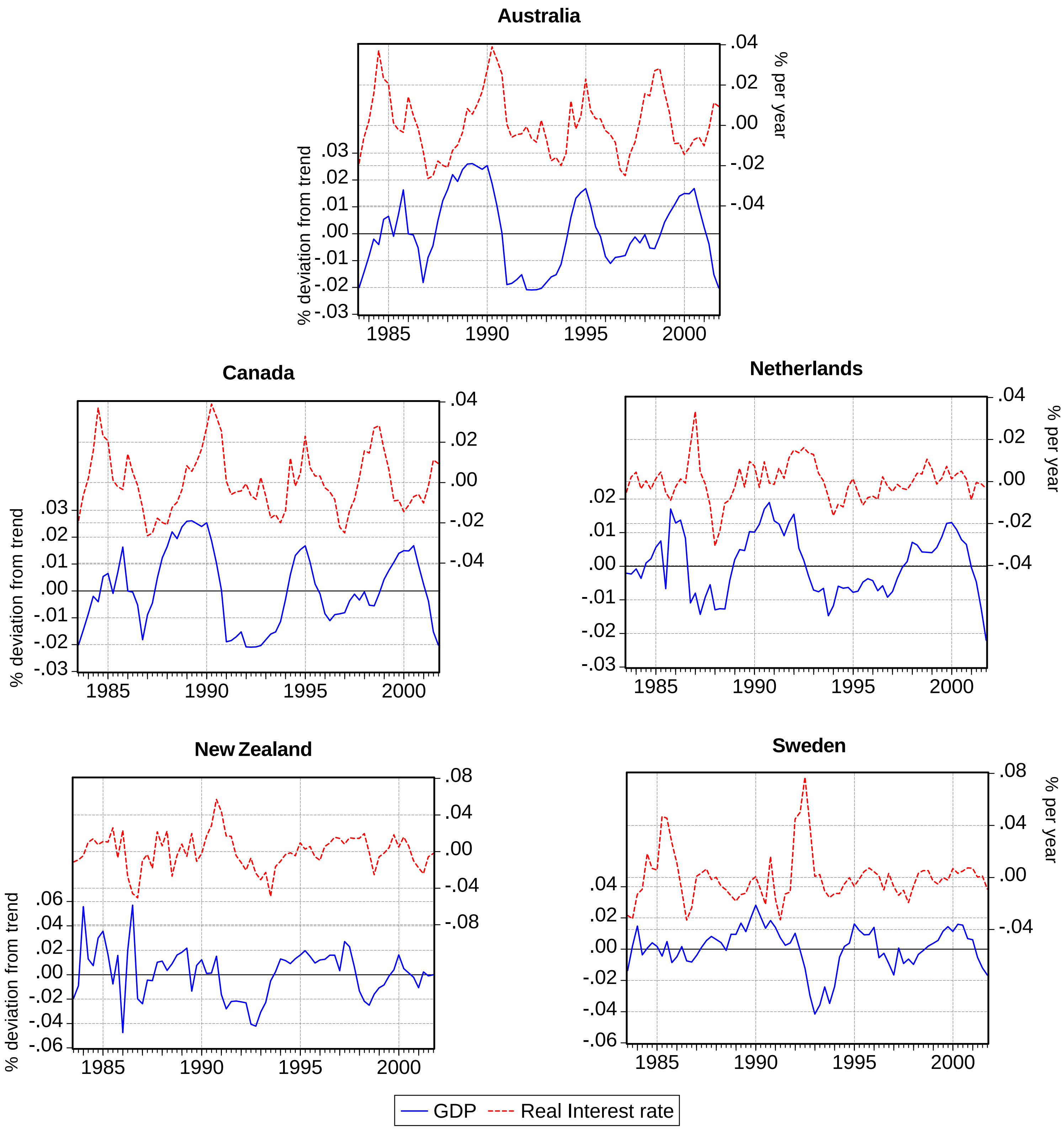


Figure 3. Cross-correlations between GDP and Interest Rates

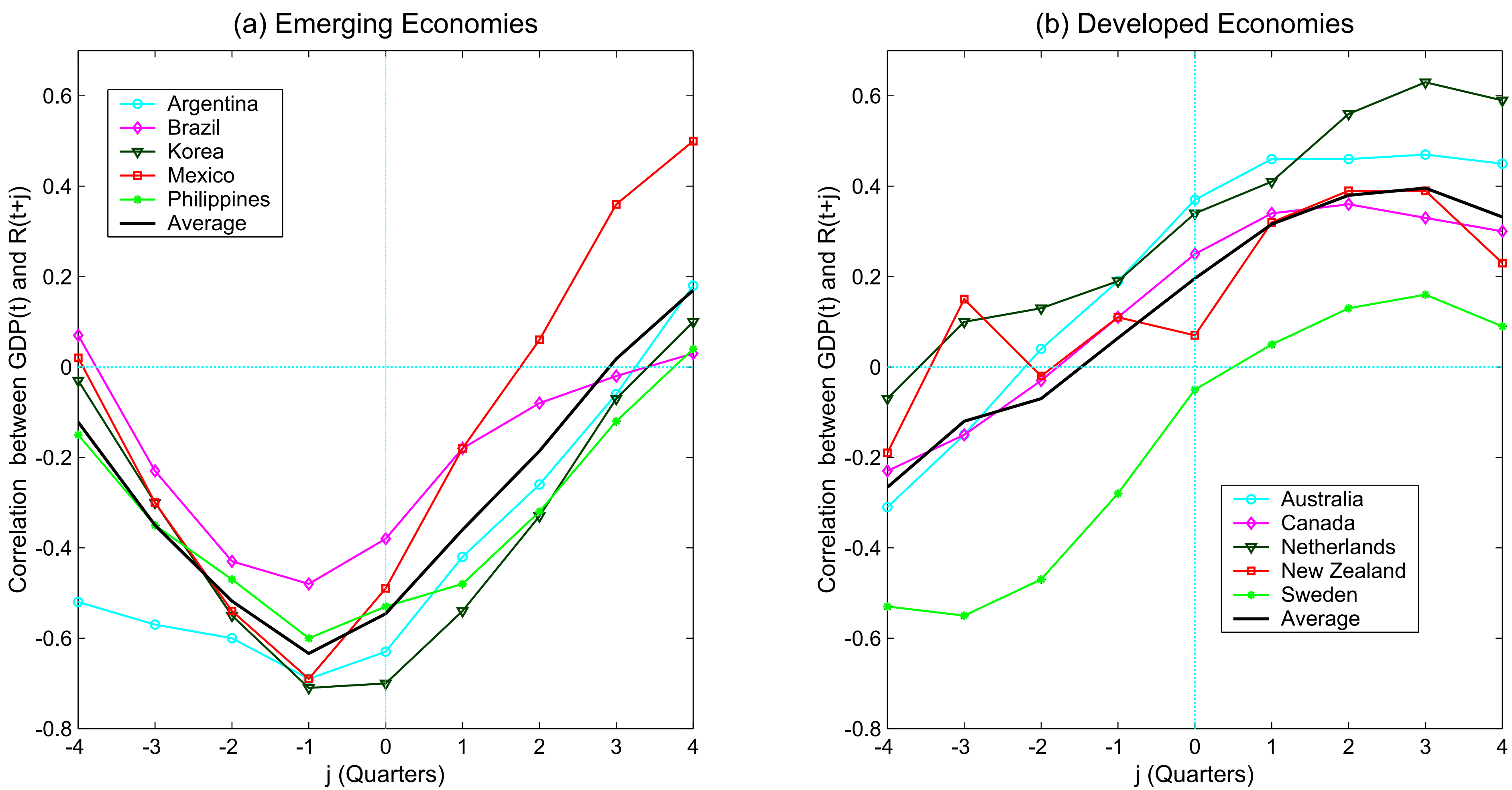


Figure 4. Timeline

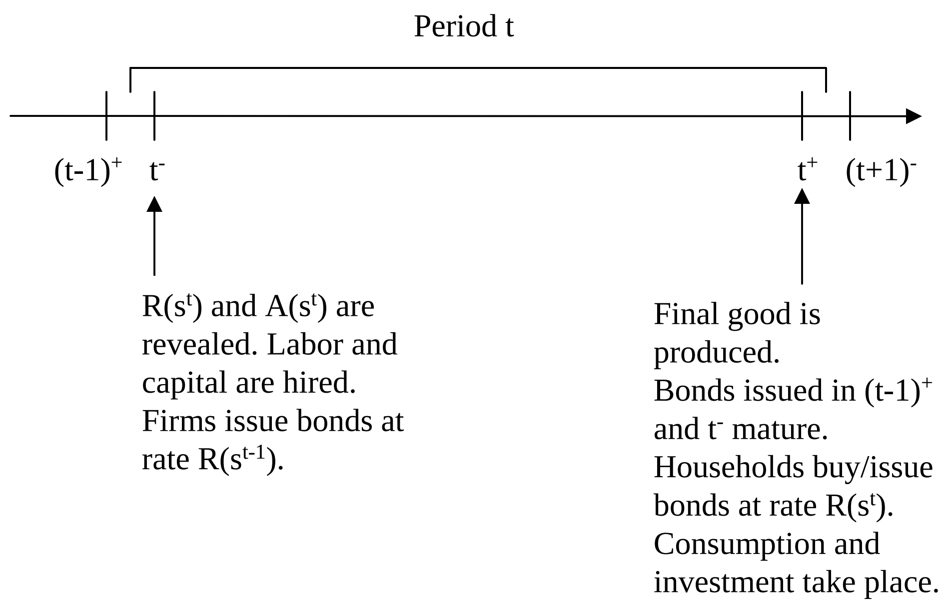
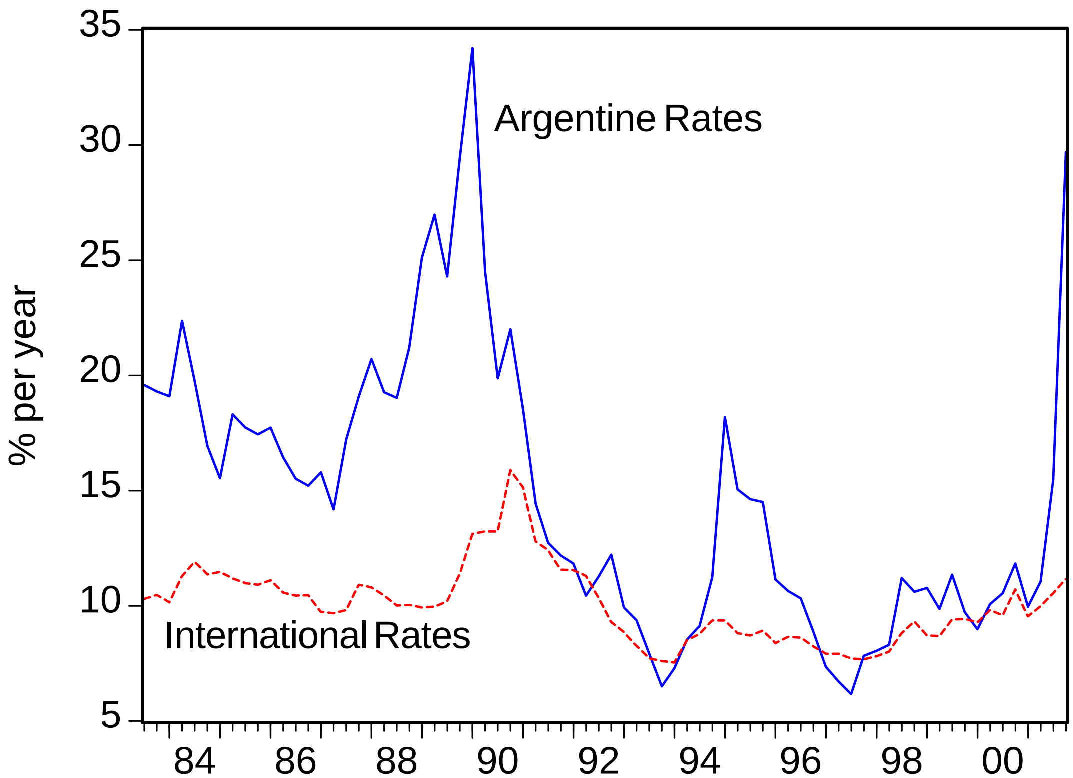
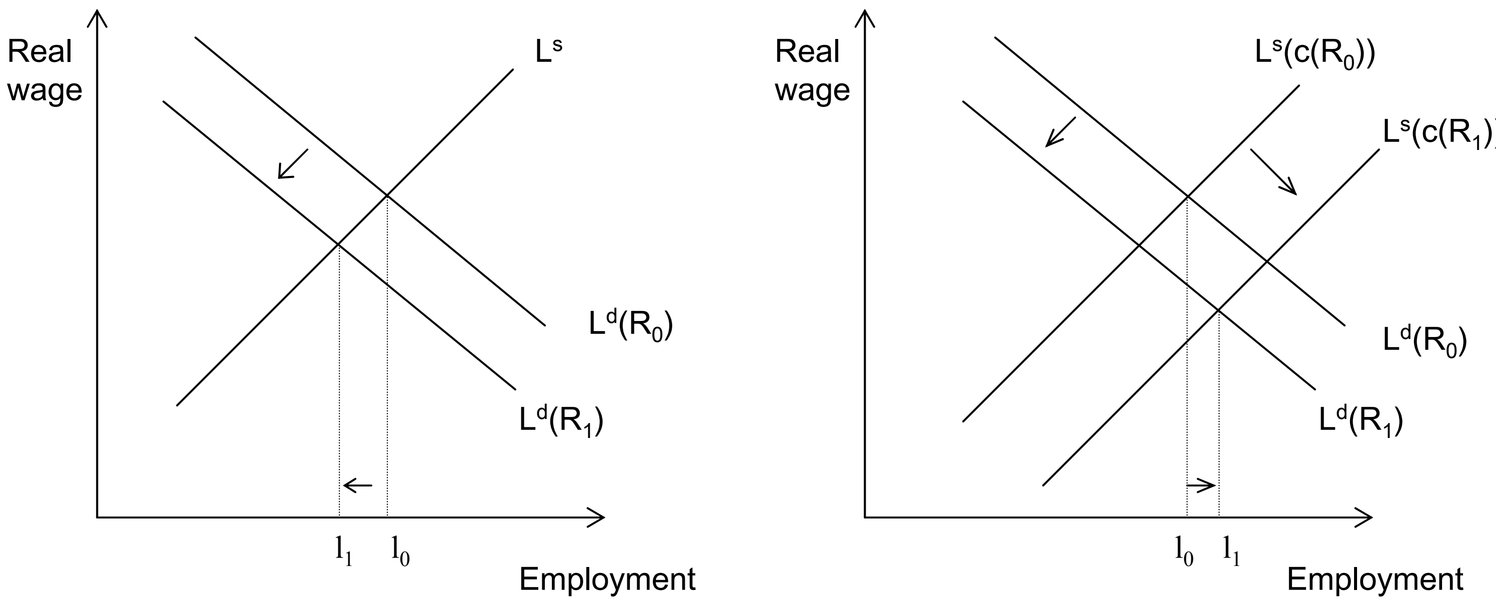


Figure 5. Argentine and International Real Interest Rates



Note: See the data appendix for how Argentine real rates are constructed.
International rates are yields from Merrill Lynch's HY175 U.S. bond index minus expected U.S. inflation.
Expected inflation in period t is computed as average inflation at t and in the three preceding periods.

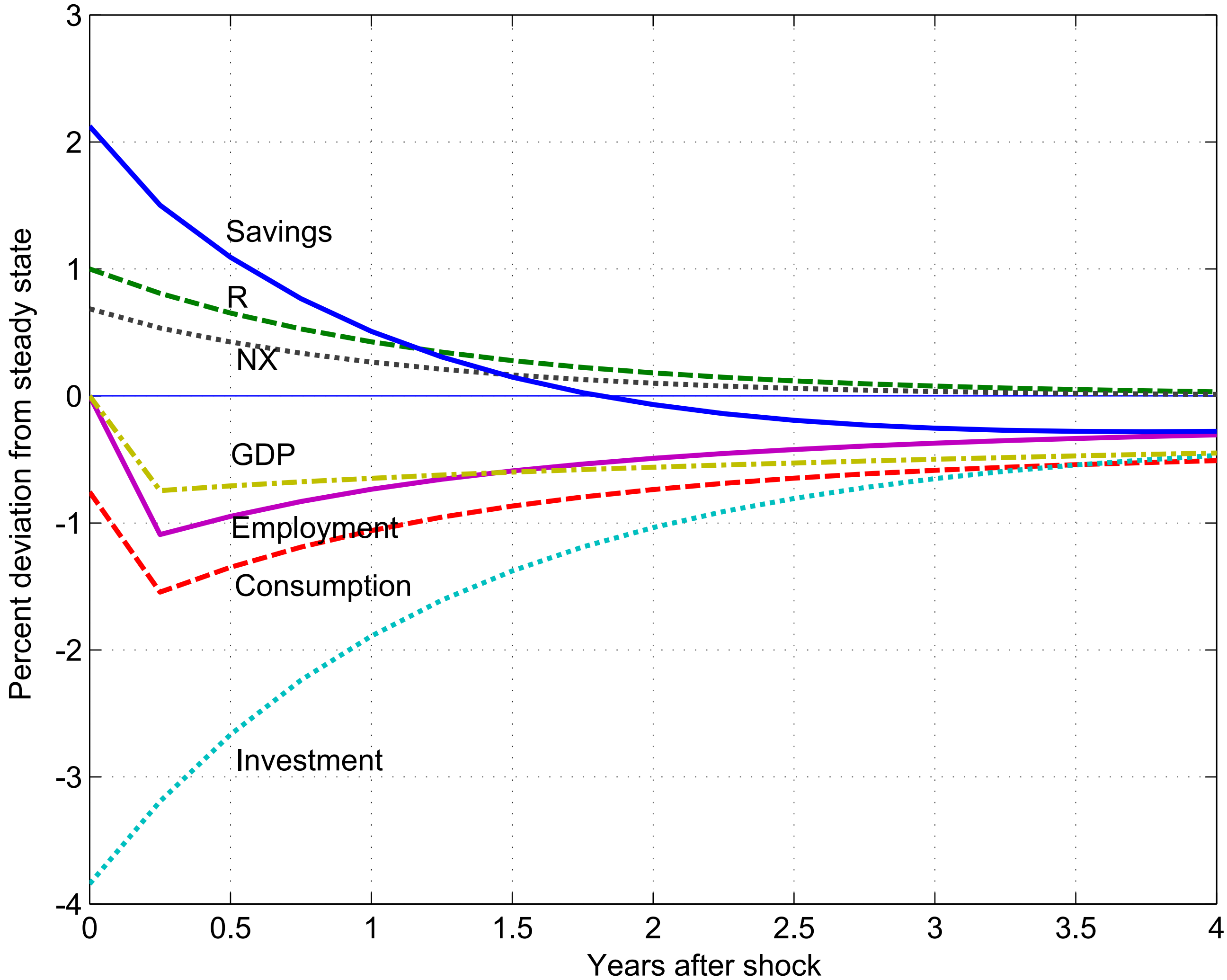
Figure 6. Equilibrium Employment and Interest Rate Shocks ($R_1 > R_0$)



GHH preferences

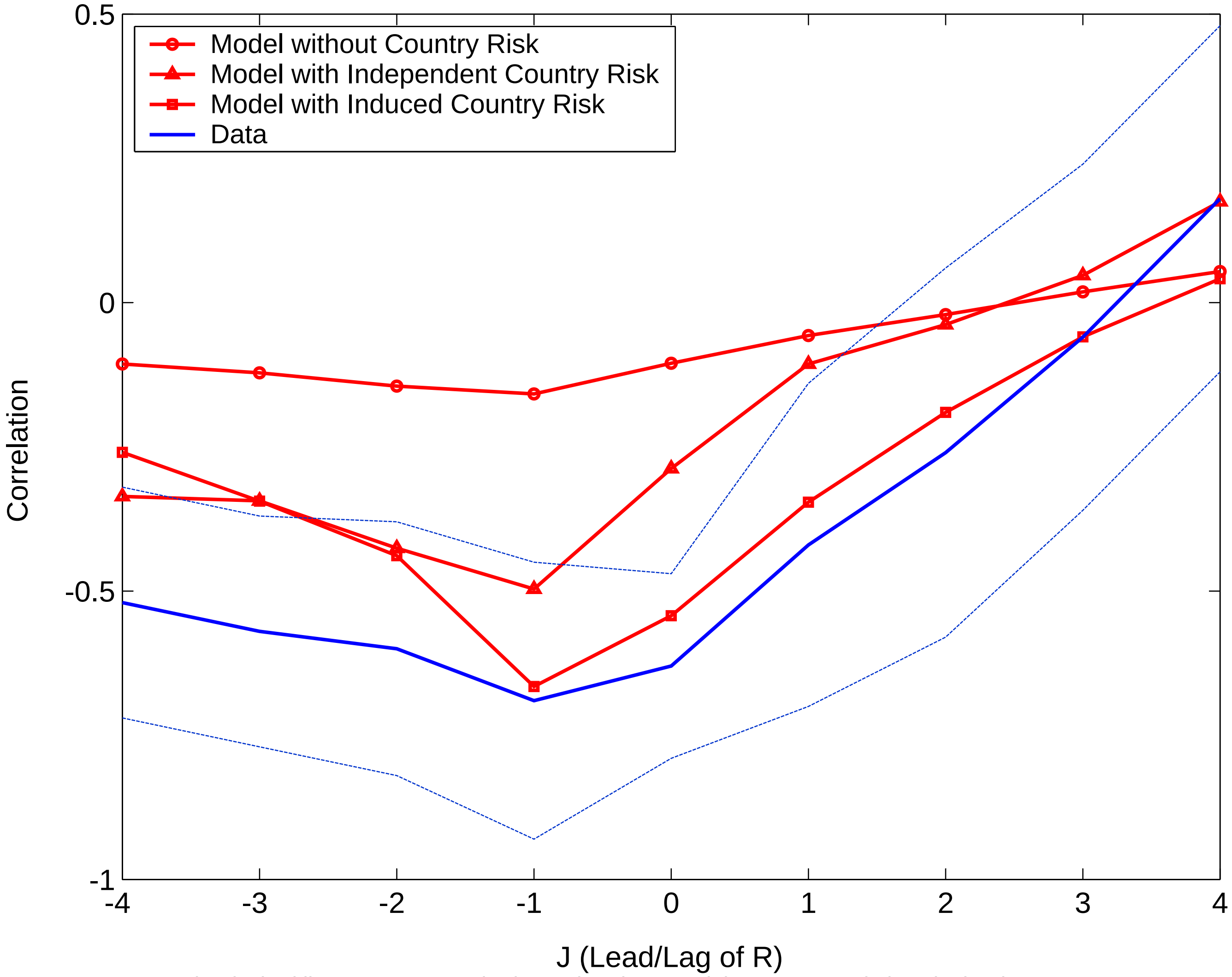
Cobb-Douglas preferences

Figure 7. Impulse Responses to a Shock in International Interest Rates



Note: Impulse responses are computed using baseline parameter values and a capital adjustment costs parameter (ϕ) equal to 25.1.

Figure 8. Correlation between GDP(t) and R(t+J)



Note: The dashed lines are two standard error bands around the cross-correlations in the data.
Shocks to international interest rates and to TFP are present in all three models.

Figure 9. Business Cycles in Argentina