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"Business Cycles in Emerging Economies: The Role of Country Risk."

Pablo A. Neumeyer

(Universidad Torcuato Di Tella)

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Business Cycles in Emerging Economies: The Role of Country Risk

Pablo A. Neumeyer
Universidad T. di Tella

Fabrizio Perri
New York University

PRELIMINARY AND INCOMPLETE

ABSTRACT

This paper quantitatively assesses the relation between fluctuations in the interest rate (country risk) faced by an emerging economy and the business cycle. We develop a model in which the borrowing rate affects households' decisions on consumption and asset accumulation and firms' demand for labor and capital. A key assumption is that firms have to pay for factors of production before receiving the proceeds of their sales. We calibrate the model to Argentina for the period 1983-1998 and find that country risk alone explains a significant fraction (55%) of output fluctuations.

The quantitative literature on business cycles in small open economies has stressed the role of technology, terms of trade, and interest rate shocks in generating fluctuations in economic activity (see Mendoza 1991, and 1995, Correia et. al 1995). One important finding (Mendoza 1991) is that in a standard neoclassical model, calibrated to the Canadian economy, interest rate disturbances do not appear to play a significant role in driving business cycles.

In recent years, however, emerging economies have experienced large disturbances in the interest rate they face in global financial markets.The aim of this paper is to explore how much of the ouput fluctuations in these economies can be explained by country risk. Figures 1, 2 and three below show that in Argentina, Brazil and Mexico there is a strong negative correlation between interest rate (on dollar denominated bonds) and output.

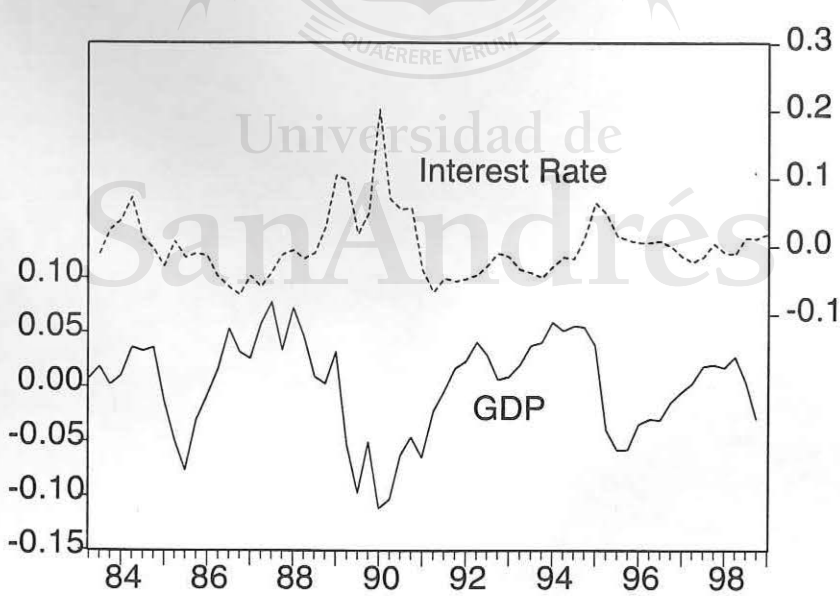

Figure 1: Interest Rates and Business Cycles in Argentina (Quarterly).

There is a debate [Calvo 1999, Corsetti Pesenti and Roubini 1998 among others] on

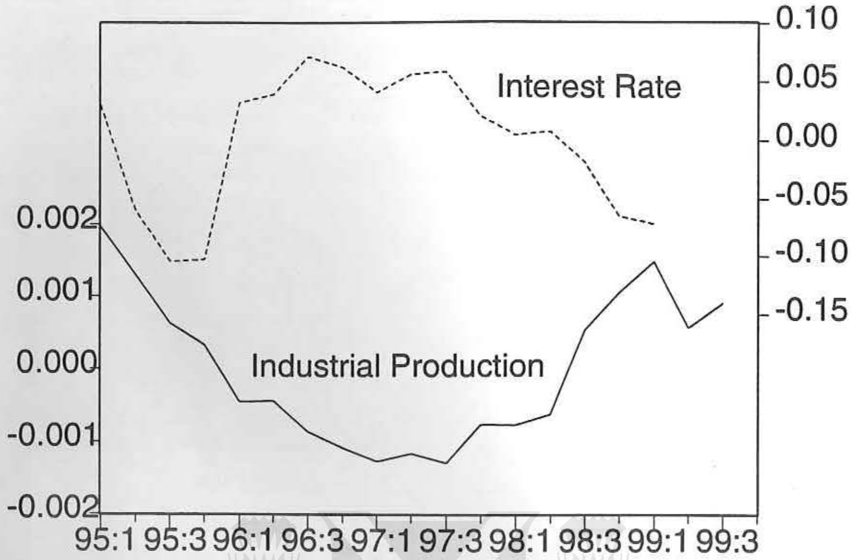

Figure 2: Interest Rates and Business Cycles in Brazil (Quarterly).

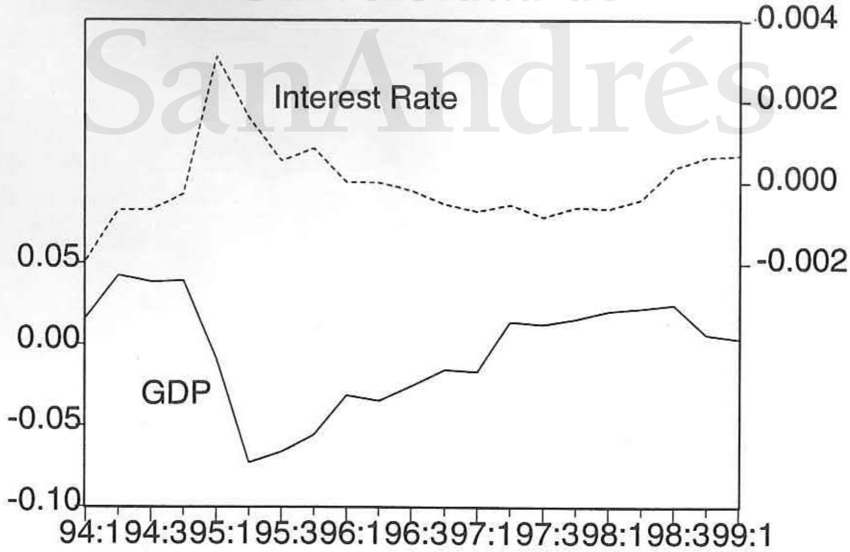

Figure 3: Interest Rates and Business Cycles in Mexico (Quarterly).

the extent to which fluctuations in emerging market bond prices are exogenous to individual countries (pure contagion), or determined by local fundamentals. This paper assumes that all fluctuations in interest rates faced by emerging countries are exogenously given, and focuses on the effects of such fluctuations. Notice that even if interest rates are endogenous and depend on local factors (like government policy or technology shocks) the equilibrium relation between interest rates and output flutuations analyzed in this paper will still hold.

If government policies do indeed influence country risk, the economic relations emphasized in this investigation have important implications for the literature on the real effects of stabilization plans in Latin America. Rebelo and Vegh (1995) have shown that current theories cannot account for the magnitude of the fluctuations in economic activity observed during exchange rate based stabilization plans. The quantitative exercise carried out in this paper implies that fluctuations in country risk might provide the amplification mechanism needed to reconcile data and theory.

In the standard neoclassical model of a small open economy fluctuations in interest rates affect economic activity through two channels: changes in the level of investment and changes in the labor supply. An increase in international interest rates induces agents to substitute away from local capital, lowering investment and, hence, future output. At the same time, interest rates affect the supply of labor through income and substitution effects. For debtor countries, both effects tend to raise the labor supply when interest rates rise. Both of these effects are quantitatively small even when movements in the interest rate are as large as those faced by emerging economies. In a calibrated model they account for less than 8% of fluctuations in Argentine output. Furthermore, this model yields a correlation between interest rates and output of .97, while in the Argentine data the correlation is -0.7.

This suggest that the standard model might be missing potentially important channels through which interest rates affect economic activity. As James Tobin suggests, "Experience and common sense tell us that ... ordering materials and hiring workers ... will look like a better deal if the prime rate is 6% instead of 8%."[1] In order to capture this relation between interest rates and the demand for labor we introduce a friction caused by the fact that the payments and recipts of firms are not perfectly syncronized. More specifically, we assume that firms must pay for the factors of production a period before receiving the proceeds of their sales. In a related paper Agenor (1997) argues that a model with a similar friction is consistent with the qualitative properties of the Argentine business cycle in the aftermath of the Tequila crisis. Here we want to assses the quantitative importance of this friction and we find that for the period 1983-1998 the percentage of the volatility of output explained solely by country risk is 55% and also that the correlation between interest rates and output predicted by the model is now in line with data.

1. Interest Rates and Business Cycles in Argentina

In this section we present empirical evidence about the nature of the business cycles in Argentina and about the relation between economic activity and the real interest rate on dollar denominated bonds issued by the argentinian government (hereafter R) that is our measure of the intertemporal price Argentina faces in global capital markets.

Figure 4 shows the argentine rate (R), LIBOR and country risk (R-LIBOR). The graph shows that LIBOR moves less than the argentine rate and that a large part of movements in R is attributable to country risk. More precisely, the standard deviation for the argentine rate is 7.5, the one for the spread is 6.0 and the one for LIBOR is 2.1. Also, the correlation of

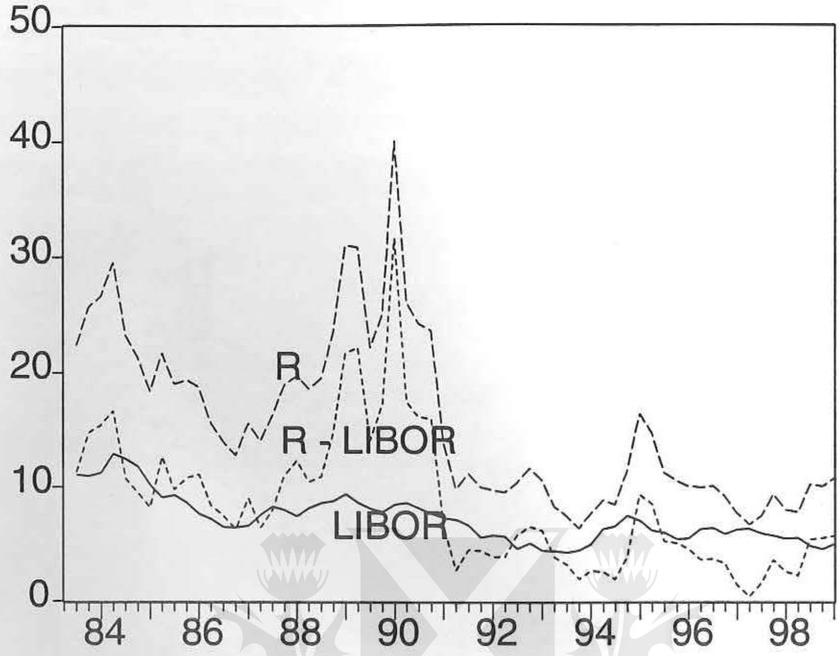

Figure 4: Argentine Rate, LIBOR and Country Risk.

R with the spread is 0.97 and the one with LIBOR is 0.78 .We thus conclude that country risk is an important, although not the only, determinant of the interst rate faced by Argentina on the world markets.

In table 3 we report the percentage standard deviations of the deviations from trend[2] of the quarterly tseries for the main macroeconomic variables in Argentina for the period 1982.3-1999.1. To enable comparison we report also the same statistics for the US economy in the same sample period and over a longer sample. The interest rate we use for the United States is the real rate on 5 years US government T-Bills. In table 5 we report the correlation of the same variables with GDP and R.

Table 1: Percentage Standard Deviations

	% Standard Dev.			$\frac{\%\text{Standard Dev}}{\%\text{Standard Dev.of GDP}}$			
	GDP	Nx	R	Con	Inv	Emp	Emp (hrs)
Argentina:83.2-99.1	4.26	2.20	4.65	1.19	2.99	0.63	(.8-.9)
US:83.2-99.1	1.00	0.36	0.93	0.83	5.36	0.96	1.17
US:60.1-99.1	1.61	0.34	1.19	0.79	4.62	0.85	1.10

From the above table we first notice the high volatility of output that characterize the Argentine cycle (over twice the US level). The relative volatility of employment[3] and investment are somewhat lower than those observed in th US while consumption is more volatile[4]. Unfortunately we were not able to find data on total hours worked in Argentina. The range reported is derived assuming that ratio of volatilty of hours to volatility of employment is the same in US and Argentina. Since in US the ratio ranges from 1.3 (Establishment Survey) to 1.4 (Household Survey) we obtain a range between .8 and .9 for voltaility of hours in Argentina. Finally, the volatility of net exports in Argentina is much higher than the one in US.

Table 2: Correlations

	Correlation with GDP						
	GDP	NX	R	Con	Inv	Emp	Emp (hrs)
Argentina	1.00	-.88	-.49	.97	.94	.31	
US:83.2-99.1	1.00	-.33	.19	.84	.85	.88	.91
US:60.1-99.1	1.00	-.43	-.09	.88	.90	.83	.89
	Correlation with R						
	GDP	NX	R	Con	Inv	Emp	Emp (hrs)
Argentina	-.49	.61	1.00	-.57	-.48	-.34	
US:83.2-99.1	.19	.01	1.00	-.06	.35	-.22	-.04
US:60.1-99.1	-.09	.13	1.00	-.09	-.03	-.32	-.28

2. The Model

We consider a model of a small open economy in which interest rate $R(s^t)$ is stochastic and exogenously given. The only difference with a standard model is the presence of working capital, that is the assumption that firms have to pay inputs before they receive the proceeds form their sales.

Preferences are given by

$$\Sigma_{t=o}^{\infty}\beta^t\pi(s^t)u(\tilde{c}(s^t),1-l(s^t))$$

where s^t is the history of events up to period t and $\pi(s^t)$ is the time 0 probability of a given history, $\tilde{c}(s^t)$ is consumption and $\tilde{l}(s^t)$ is labor and u is a well behaved utility function.

The budget constraint of the consumers can therefore be written as

$$\begin{aligned} & \tilde{c}(s^t)+\tilde{x}(s^t)+q(s^t)\tilde{b}(s^t) \\ = \ & r(s^t)\tilde{k}(s^{t-1})+\tilde{w}(s^t)l\left(s^t\right)+\tilde{b}(s^{t-1}) \quad \text{for } t=0,1,\ldots \end{aligned}$$

with NPG condition

$$\lim_{t\to\infty}\prod_{s=0}^{t}q\left(s^s\right)\left(\tilde{b}\left(s^t\right)+\tilde{k}\left(s^t\right)\right)\geq 0$$

There are firms that produce a single good using capital and labor using a constant returns to scale (F) technology. Profits of the firm are given by

$$A(s^t)F(\tilde{k}(s^{t-1}),e^{\gamma t}l(s^t))-R(s^t)\left[\tilde{w}(s^t)l(s^t)-r(s^t)\tilde{k}(s^{t-1})\right]$$

where $r(s^t)$ is rental rate on capital and $\tilde{w}(s^t)$ is the wage rate and $\tilde{k}(s^t)$ is the capital stock (owned by consumers), $A(s^t)$ is an exogenous process for productivity that evolves according to

$$\log A(s^t) = \rho_0 + \rho_1 \log A(s^{t-1}) + \varepsilon^A(s^t)$$
$$\varepsilon^A(s^t) \rightsquigarrow N(0, \sigma_A^2)$$

and $e^{\gamma t}$ is the process for labour augmenting technological change. Notice that input costs are multiplied by the gross interest rate and this reflects our assumption that firms have to pay factors one period before they receive proceeds from the sale of their output.

International credit markets are incomplete (there is a single uncontingent bond) and the price of the bond is an exogenous stochastic variable that evolves according to the following law of motion

$$\text{(1)} \quad \log q(s^t) = \theta_0 + \theta_1 q(s^{t-1}) + \varepsilon^q(s^t)$$
$$\varepsilon^q(s^t) \rightsquigarrow N(0, \sigma_q^2).$$

The capital accumulation technology is:

$$\tilde{k}\left(s^t\right) = (1-\delta)\,\tilde{k}\left(s^{t-1}\right) + \tilde{x}(s^t)$$

Detrending all the variables with an overscript $\tilde{}$, according to

$$\xi = \tilde{\xi}\, e^{-\gamma t}$$

the model is tranformed as follows:

Households solve

$$\text{(2)} \quad \max \Sigma_{t=o}^{\infty} \beta^t \pi(s^t) u(e^{\gamma t} c(s^t), 1 - l(s^t))$$

subject to

$$(3) \qquad c(s^t) + e^{\gamma} k\left(s^t\right) + q(s^t) b(s^t)$$
$$= \left(1 + r(s^t) - \delta\right) k\left(s^{t-1}\right) + w(s^t) l\left(s^t\right) + b(s^{t-1}) \quad \text{for } t = 0, 1, \ldots$$

with NPG condition

$$\lim_{t \to \infty} \prod_{s=0}^{t} q\left(s^s\right)\left(b\left(s^t\right) + k\left(s^t\right)\right) \geq 0$$

The capital accumulation equation

$$e^{\gamma} k\left(s^t\right) - (1-\delta) k\left(s^{t-1}\right) = x(s^t)$$

The Firm's problem is

$$(4) \qquad \max\left[A(s^t) F(k(s^{t-1}), l(s^t)) - \left[w(s^t) l(s^t) - r(s^t) k(s^{t-1})\right] R(s^t)\right] e^{\gamma t}.$$

The resulting first order conditions of the firm will be

$$A(s^t) F_k(k(s^{t-1}), l(s^t)) = r(s^t) R(s^t)$$

$$A(s^t) F_l(k(s^{t-1}), l(s^t)) = w(s^t) R(s^t)$$

The household's chooses $\left\{b\left(s^t\right), k\left(s^t\right), c\left(s^t\right), l\left(s^t\right)\right\}$ to maximize (2) subject to the sequence of budget constraints (3)

The first order conditions are given by

$$b\left(s^t\right) : q(s^t) u_c(e^{\gamma t} c(s^t), l(s^t)) = \beta e^{\gamma} E(u_c(e^{\gamma(t+1)} c(s^{t+1}), l(s^{t+1}))$$

$$
\begin{aligned}
k\left(s^t\right) \quad &: \quad u_c\left(e^{\gamma t}c(s^t), l(s^t)\right) = \\
&\qquad \beta E\left[u_c(e^{\gamma(t+1)}c(s^{t+1}), l(s^{t+1}))\left[F_k(k(s^t), l(s^{t+1})) + 1 - \delta\right]\right] \\
l(s^t) \quad &: \quad u_c(e^{\gamma t}c(s^t), l(s^t))w(s^t) \\
&= \quad u_L(e^{\gamma t}c(s^t), 1 - l(s^t))
\end{aligned}
$$

Asssume now $u(c(s^t), l(s^t)) = \frac{\left(c^{\mu}(1-l)^{1-\mu}\right)^{1-\sigma}}{1-\sigma}$ and $F(k,l) = Ak^{\alpha}l^{1-\alpha}$.

Also define leisure to be $L_t = 1 - l_t$

The linearized first order condition are then

$$
\begin{aligned}
\hat{q}_t + \hat{u}_{c,t} &= E(\hat{u}_{c,t+1}) \\
\hat{u}_{c,t} &= E\left[\hat{u}_{c,t+1} + \hat{G}_{t+1}\right] \\
\hat{G}_t &= \alpha\tilde{\beta}\frac{\bar{y}}{\bar{k}}(\hat{y}_t - \hat{k}_{t-1}), \; \tilde{\beta} = \beta^{[1+\gamma\mu(1-\sigma)]} \\
\hat{L}_t &= -\frac{\bar{l}}{1-\bar{l}}\hat{l}_t
\end{aligned}
$$

$$
\begin{aligned}
\hat{y}_t &= \hat{a}_t + \alpha\hat{k}_{t-1} + (1-\alpha)\hat{l}_t \\
\hat{R}_t\hat{w}_t &= \hat{y}_t - \hat{l}_t \\
\hat{R}_t\hat{r}_t &= \hat{y}_t - \hat{k}_{t-1} \\
\hat{k}_t &= (1-\delta)\hat{k}_{t-1} + \delta\hat{x}_t
\end{aligned}
$$

$$
\hat{u}_{c,t} = \left[\mu\left(1-\sigma\right) - 1\right]\hat{c}_t + \left[\left(1-\mu\right)\left(1-\sigma\right)\right]\hat{L}_t
$$

$$\hat{u}_{L,t} = [\mu(1-\sigma)]\hat{c}_t + [(1-\mu)(1-\sigma)-1]\hat{L}_t$$

$$\hat{u}_{c,t} + \hat{w}_t = \hat{u}_L$$

$$\begin{aligned} & \frac{\bar{C}}{\bar{Y}}\hat{c}_t + \frac{\bar{X}}{\bar{Y}}\hat{x}_t + \frac{\bar{q}\bar{b}}{\bar{Y}}\left(\hat{q}_t + \hat{b}_t\right) \\ = & \ \hat{y}_t + \frac{\bar{b}}{\bar{Y}}\hat{b}_{t-1} \end{aligned}$$

$$\frac{\overline{nx}}{\bar{y}}\widehat{nx} = \hat{y} - \frac{\bar{x}}{\bar{y}}\hat{x} - \frac{\bar{c}}{\bar{y}}\hat{c}$$

$$\frac{\widehat{nx}}{y} = \widehat{nx} - \hat{y}$$

$$\hat{R}_t = -\frac{1}{1-\bar{q}}\hat{q}_t$$

In the calibrated versions of the model we will introduce cost of adjusting the capital stock (in order to reduce the volatility of investment in response to shocks. The capital accumulation equation of the stationary model then takes the following form

$$e^{\gamma}k\left(s^t\right) + \phi\left(\frac{x\left(s^t\right)}{k\left(s^{t-1}\right)}\right)k\left(s^{t-1}\right) = (1-\delta)\,k\left(s^{t-1}\right) + x(s^t)$$

where ϕ is an increasing and convex function.

3. Calibration

We pick the following utility function

$$U(c,l) = \frac{\left[c^{\mu}l^{1-\mu}\right]^{1-\sigma}}{1-\sigma}$$

that is consistent with the long term growth of output and wages and stationary labor inputs. We assume that technical progress is labor augmenting and take the production function to be Cobb Douglas in capital and effective labor with the share of capital denoted by the parameter α. We pick parameters so to match long term averages. We set the growth rate parameter $\gamma = 2.6\%$ to match the average growth of real output in the period 1960-1998 (Data are from the World Development Report). We set $\alpha = .4$ to match a labor share of .6 that is derived from the numbers reported in Uribe (1997). Now notice that from the budget constraint we have

$$\begin{aligned} c + x + qb &= b_{-1} + y \\ \frac{c}{y} + \frac{x}{y} + q\frac{b}{y} &= \frac{b_{-1}}{y_{-1}}\frac{1}{1+\gamma} + 1 \\ \frac{c}{y} + \frac{x}{y} &= \frac{b}{y}\frac{r-\gamma}{(1+\gamma)(1+r)} + 1 \end{aligned}$$

that in steady state implies

$$\frac{\overline{b}}{y} = \frac{1 - \frac{c}{y} - \frac{x}{y}}{(q - \frac{1}{1+\gamma})} = 0$$

this imply that , given observations for the average real bond prices $\bar{q}$ and for the long run growth rate the model cannot contemporaneously reproduce the observed consumption, investment and debt to output ratio. In the bench mark case we impose the steady state value of x/y to be .21 to match the observed gross domestic investment to output ratio for the period 1960 -1998 and the steady state value of b/y to be .45 to match the average observed external debt to output ratio in the same period. This implies a consumption to output ratio of .77 that is slightly different from the average ratio between total consumption and output in the period 1960-1998 that is equal to .79. We also experiment with a version of the model that reproduces the investment and consumption to output ratio observed in the data but fails to reproduce the measured debt to output ratio.

We set the risk aversion parameter σ equal to 5 following Reinhart and Vegh (1995). The parameter μ is then derived from the first order conditions for leisure that imply

$$\frac{\mu}{1-\mu} = \frac{c}{y}\frac{l}{1-l}\frac{1}{1-\alpha}$$

The value of $\frac{c}{y}$, the fact that $\frac{l}{1-l} = \frac{1}{4}$ (20% of one period is spent working), together with a value of $\alpha = .4$, imply a value of $\mu = .25$.

The parameter β is calibrated from the first order condition for bonds

$$\log \beta = \log \bar{q} + \gamma(1 - \mu(1-\sigma))$$

where $\bar{q} = \frac{1}{1.14}$ is the average real bond price in the period $1982 - 1998$ that implies $\beta = .978$ (on a quarterly base).

In order to calibrate the depreciation rate of capital we use the first order condition for capital, that together with the law of motion for capital implies

$$1 = \beta(1 + \gamma\left[\mu(1-\sigma) - 1\right])(\frac{\alpha(\gamma+\delta)}{\frac{x}{y}} + 1 - \delta)$$

The values of β, γ and μ together with an average imply $\delta = .025$ on a quarterly basis.

Finally the adjustment cost function $\phi(\frac{x}{k})$ is set to $\phi(\frac{x}{k})^2$ and the parameter ϕ, is always set to that the model generates a volatility of investment relative to the volatility of GDP similar to the one observed for Argentina.

The process for bond prices (q_t) is estimated using data on real interest rates r_t (nominal rates minus the realized US inflation computed using GDP deflators) for dollar denominated Argentine government bond (See the data appendix for details) and the relation $q_t = \frac{1}{1+r_t}$. Since we treat q_t as an exogenous variable we estimate the following process on quarterly observations for q_t

$$q_t = c + \rho q_{t-1} + \varepsilon_t$$

and we find $\rho = .87$ and the variance of ε to be 3.7%. In our bench mark case we will use ony interest shocks and thus no process for productivity is used. in the case in which we have both shocks we use the autoregressive process for productivity that is commonly used for US business cycle studies. We set the persistentce parameter to .95 and we set the standard deviation of the innovation to 2.25 % so that the model reproduces the same volatility of output observed in the data.

4. Results

In picture 5 we show the predicted path for output from the model with working capital and only interest rate shocks. The innovations to the interest shocks are those computed from the the data. It is interesting to notice how the main booms and recession are captured by the model even though the predicted magnitude is smaller than in the data.

In the following tables we report the main business cycle statistics for a class of models. In addition to the model with interest shocks we consider a model with productivity and interest rate shocks. We also report statistics for a version of the model without working capital to enable comparison with previous literature. The statistics reported are the averages of 50 simulations of 100 periods each. The innovation of the interest rate shocks we consider are always those measured form the data while innovation to productivity shocks are randomly drawn (We do not use measured innovation to productivity because we do not have good measures offactors of production).

We want to stress that the model with working capital is able to explain a significant fraction of the volatility of the Argentinian Business Cycle and that many of the business cycles statistics are in line with data. Also by comparing the model with and without working

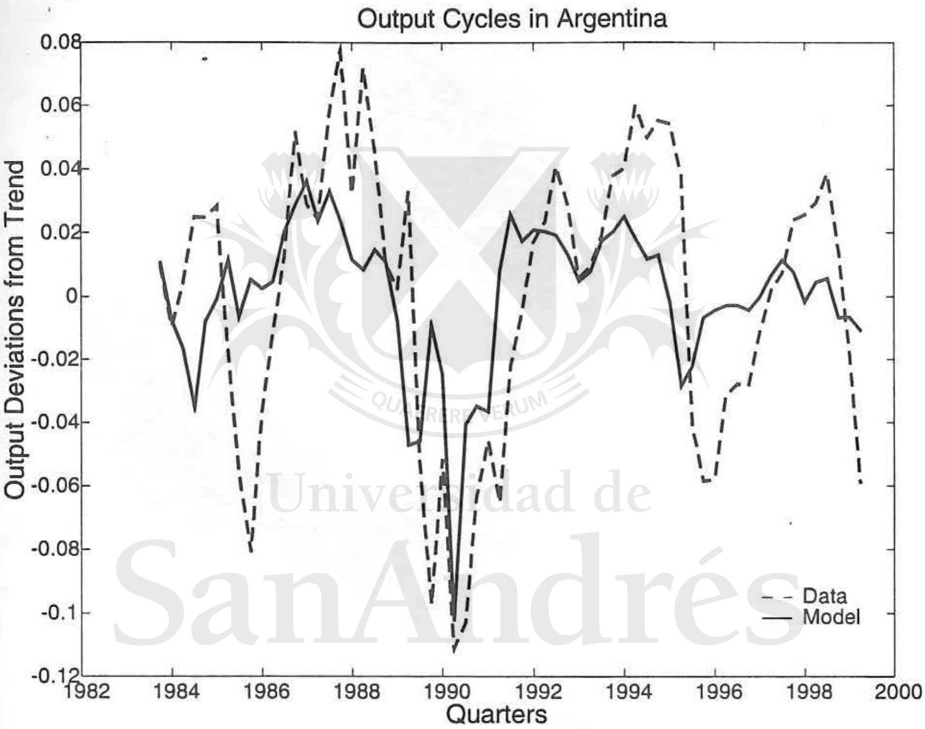
Output Cycles in Argentina
0.08
0.06
0.04
0.02
0
-0.02
-0.04
-0.06
-0.08
-0.1
-0.12
Output Deviations from Trend
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
Quarters
Data
Model

Figure 5:

capital it is apparent that the presence of working capital makes a large difference when the impact of interest rate shocks is evaluated.

Finally we can see that a model with working capital and productivity shocks is able to capture very well almost every feature of the Argentinian business cycle; this to us means that interest shocks are not the only shocks affecting the economy but they are an important factor when trying to understand business cycles in emerging economies.

Table 3: Perc. Standard Deviations

	% Standard Dev.			%Standard Dev / %Standard Dev.of GDP		
	GDP	Nx	R	Con	Inv	Emp
Argentina	4.26	2.20	4.65	1.19	2.99	(.8,.9)
Models						
With Working Capital						
Int. Rate Shocks	2.29	.89	4.65	.95	3.00	1.66
Int.Rate and Prod. Shocks	4.26	2.12	4.65	.65	3.00	.94
Without Working Capital						
Int. Rate Shocks	0.30	.74	4.65	1.02	3.00	1.61
Int.Rate and Prod. Shocks	3.69	1.85	4.65	.50	3.00	.42
Prod. Shocks	3.64	.57	0.0	.51	3.00	.39

Table 4: Correlations with GDP

	Correlation with GDP					
	GDP	NX	R	Con	Inv	Emp
Argentina	1.00	-.88	-.49	.97	.94	.31
Model						
With Working capital						
Int. Rate Shocks	1.00	-.91	-.99	.99	.98	.99
Int. Rate and Prod. Shocks	1.00	-.04	-.49	.94	.82	.75
Without Working Capital						
Int. Rate Shocks	1.00	0.99	0.97	-0.98	-0.94	0.99
Int. Rate and Prod. Shocks	1.00	.22	.11	.96	.78	.96
Prod. Shocks	1.00	-.07	-	.99	.96	.99

Table 5: Correlations with Interest Rate

	Correlation with R					
	GDP	NX	R	Con	Inv	Emp
Argentina	-.49	.61	1.00	-.57	-.48	-.34
Model						
With Working capital						
Int. Rate Shocks	-.99	.96	1.00	-.99	-1.0	-.99
Int. Rate and Prod. Shocks	-.49	.86	1.00	-.73	-.87	-.93
Without Working Capital						
Int. Rate Shocks	0.97	0.99	1.00	-0.99	-0.99	0.98
Int. Rate and Prod. Shocks	-.11	.94	1.00	-.11	-.47	.32
Prod. Shocks	-	-	-	-	-	-

5. Conclusions

TO BE COMPLETED

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