A Country-Risk Approach to the Business Cycle
With an application to Argentina
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Resumen

El ensayo desarrolla un modelo simple en donde el riesgo-país juega un papel clave, mide las relaciones empíricas entre el riesgo-país y el PBI, el consumo, la inversión y la cuenta corriente, y compara el enfoque de riesgo-país con los enfoques de diversas escuelas de pensamiento macroeconómico. Principales conclusiones: 1) La Ley de Say no se cumple en una recesión. 2) Las series de tiempo argentinas muestran una fuerte correlación negativa entre el riesgo-país y las primeras tres variables agregadas, y una fuerte correlación positiva entre el riesgo-país y la cuarta variable.

Abstract

The essay develops a simple model where country risk plays a central role, measures empirical relationships between country risk and GDP, consumption, investment and the current account balance, and compares the country risk approach with the approaches of various schools of macroeconomic thought. Main conclusions: 1) The Say's Law doesn't hold in a recession. 2) Argentine time series show a strong negative correlation between country risk and the first three aggregate variables and a strong positive correlation between country risk and the last variable, while causality goes from country risk to aggregate variables.

JEL: E32, F41

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This paper is a simplified, re-ordered and re-worked English version of an earlier paper that I presented at the 1998 meeting of the AAEP.

Introduction

I see international finances as a control panel with as many boxes as countries there are in the World. Within each box there are two variables: the rate of return to investment projects in the country and the country risk premium. Each Monday morning, the boards of investment funds and banks meet in New York to balance returns and risks of their portfolios with the assistance of economic and political analysts. The first variable demands little discussion since the rate of return is a long-run phenomenon; in other words, the yield to fixed capital in a country varies slowly according to capital accumulation, progress in education, improvement of institutions and the discovery of natural resources. Board discussions concentrate on the evolution of the second variable. Risk premiums fluctuate largely. Not much in developed and stable countries but certainly a lot in underdeveloped and unstable ones. After scanning the uncertainty horizon of every country the boards take decisions to maximize the value of their world portfolios. In so doing, the macroeconomic fate of most countries is sealed until a new revision takes place. A highly volatile country like Argentina fits properly in this frame.

The country risk premium refers to the cost of macroeconomic or systemic uncertainty. It is the market value of risk associated with a bond that finances capital to be sunk in a country. With perfect foresight or for a perfectly stable country, the premium is null. On the contrary, for a country in the middle of a catastrophe (hyperinflation, banking panic) the premium tends to infinity. The market process determining the premium is complex and changing. We don't know the weight that is attached to every possible source of uncertainty in its formation. To understand what we are saying, compare the Argentine risk premium in the first half of 1982 with that in 1996. In 1982, Argentina was at war with the UK, public spending hovered 50% of GDP, annual inflation amounted to 260%, government was authoritarian, and the economy was largely closed to foreign trade; while in 1996 foreign policy was clearly pro-US, public spending was cut down to 25% of GDP, inflation was negligible, government was democratic, and the economy was relatively open to foreign trade and capital movements. In spite of the great change of scenario, the premium ranged between 1 and 2 points in 1982 and couldn't fall below 7 points in 1996.

The essay holds that fluctuations of the country risk premium trigger the business cycle in a small economy under perfect capital mobility. A premium rise determines a capital outflow, an aggregate demand contraction and a recession, while a premium fall determines a capital inflow, an aggregate demand expansion and a boom. A deeper financial integration in the past two decades may have shortened the lag between the change in the premium and the change in economic activity to a few weeks, intensifying the cycle.

In the first section, we develop a simple model where country risk plays a central role in macroeconomic equilibrium. In the second section, we study the empirical correlation between the Argentine risk premium and GDP, consumption, investment and current account balance. In the third section, we contrast our approach with those of seven schools of macroeconomic thought with an active research agenda. Conclusions follow in the last section.

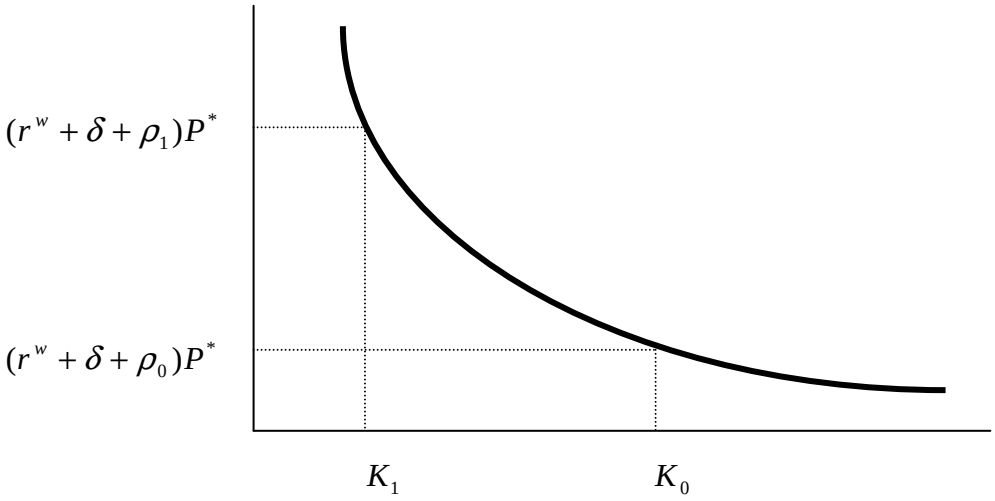
The first conclusion is theoretical. The Say's Law doesn't hold during a recession, when the economy adjusts to a jump in the country risk premium. A wage deflation or a minimum wage cut would lead to a fall in the price of capital while keeping unemployed labor invariant. Foreign and local investors determine the fraction of world income they want to spend in the country and the country's GDP adjusts passively to that fraction. The second conclusion is empirical. For the period 1985-1997 Argentine time series show strong negative correlation between country risk and GDP, consumption, investment and current account balance. The quality of regressions is very good (regression outputs for the period 1993-2006 are reported in Appendix III). Country risk seems to be the unchallenged cause of the Argentine business cycle.

I. A Simple Model

In Appendix I we have developed a dynamic model for a small open economy subject to perfect capital mobility and country risk. An infinite-lived individual produces, consumes, exports and imports one good. Besides, he imports a capital good which once invested can't

be re-exported or consumed at home. So we have two nominal prices in the economy: that of consumption goods (the system numeraire) and that of capital goods, P. According to domestic demand conditions, P could be higher than, equal to or lower than P*, the world price of imported new capital goods. When the economy grows and investment is positive and important, P > P*; when the economy reaches its long-run position and investment equals capital depreciation, P tends to P*; and when the economy falls into recession and investment vanishes, P < P*. Figure 1 shows the optimal capital stock for every country risk premium. The schedule measures the marginal product value of capital. In equilibrium, this variable must equal the rental price of capital. An increase in the premium determines a gradual fall of the optimal capital stock, until reaching its lower long-run level via technical depreciation.

Figure 1: Country Risk and Long-Run Capital Stock



The domestic interest rate is taken from the world market and equals the interest yield on, say, the US Treasury bond (r^w) plus a risk premium Wall Street assigns to the country (ρ). For the sake of simplicity, we assume that the individual invests his savings in US bonds while foreign investors take care of physical investment. Hence, the individual earns r^w and foreign investors earn the country's rental price of capital, $w_K = r^w + \rho + \delta$ (where δ is the rate of capital depreciation). We close the model with a further assumption: in the face of a contracting domestic demand the economy is unable to place in foreign markets the whole surplus of production over spending.

These equations sum up the main conclusions of the model developed in Appendix I.

15) $W = b(t) + \int_t^{\infty} e^{-r^w(s-t)}\left[f(k) - (r^w + \rho + \delta)P^* k - \gamma(i)\right]ds$

12) $\lambda(t) = \lambda(0)$

13) $c(t) = g[\lambda(0)],\ g' < 0$

18) $\theta(t) = \int_t^{\infty} e^{-(r^w+\delta)(s-t)}\left[f'(k) - (r^w + \rho + \delta)P^*\right]ds$

They explain the way through which changes in the country risk premium affect wealth, consumption, investment and the price of sunken capital. Equation 15 says that wealth is a

negative function of the premium. Equation 12 shows the shadow price of savings, which is a negative function of wealth. Equation 13 says that consumption is a negative function of the shadow price of savings. Equation 16 says that the price of invested capital is a negative function of the premium. In brief, an increase in the country risk premium determines a fall in both spending and the price of sunken capital goods.

Macroeconomic Equations

The discussion gets a distinct macroeconomic flavor when we define as absorption (A) the sum of consumption and investment:

i) $A = C(\rho) + I(\rho) = A(\rho)$, $\frac{\partial A}{\partial \rho} < 0$

Based upon the above referred to behavioral relationships, equation *i* says that absorption is a negative function of country risk. Equation *ii* explains that income depends on absorption and the capital stock:

ii) $Y = H[A(\rho), K] \equiv Y(\rho, K)$, $\frac{\partial Y}{\partial \rho} < 0$, $\frac{\partial Y}{\partial K} > 0$

The transformation function H[$\bullet$] indicates the level of output that corresponds to a certain level of absorption, which, in turn, is only determined by the country risk premium. Empirical observation shows that income (or output) moves along the business cycle hand in hand with absorption but at a lower pace. With perfect capital arbitrage between local and international markets, absorption depends on perceptions while income is limited, in the short run, by factor endowments and technology. Therefore, absorption as well as income fall in response to a rise in the country risk premium but absorption falls deeper: $\left|\frac{\partial A}{\partial \rho}\right| > \left|\frac{\partial Y}{\partial \rho}\right|$ It follows that the current account is a positive function of the country risk premium:

iii) $CA = Y(\rho, K) - A(\rho)$

The higher the premium, the larger the current account surplus, and vice versa. Time series for Argentina provide evidence in this respect (Section II).

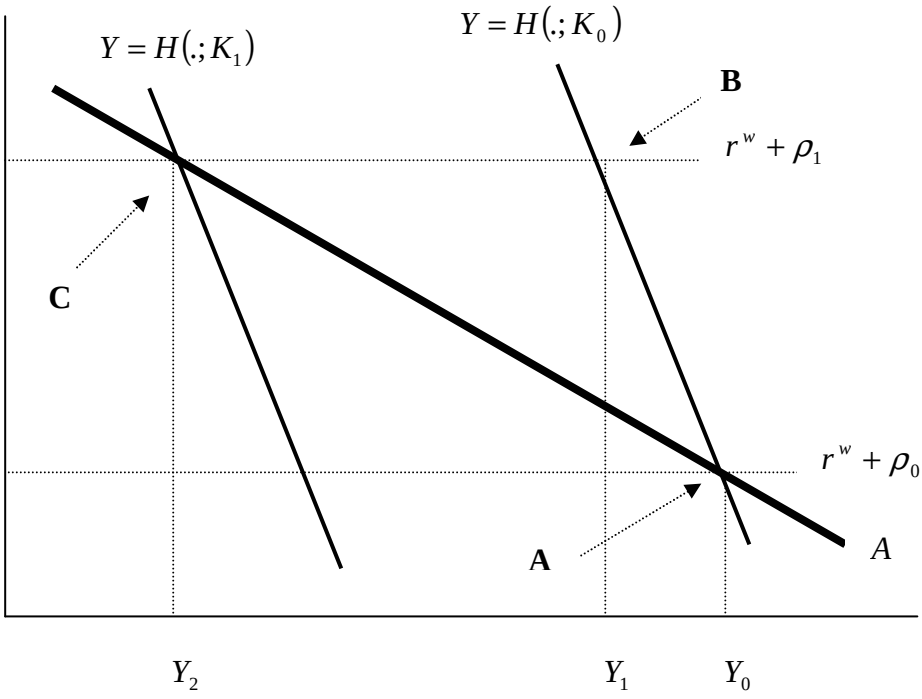
Figure 2 introduces a country-risk vision of macroeconomic equilibrium. Our model does not include a money market. Monetary forces were not an important factor in explaining the Argentine business cycle in the time we study.[1] Before hyperinflation, monetary policy was so active as to lose any lasting impact on macroeconomic equilibrium. Under the dollar standard (convertibility) in the 1990's, it became strictly passive.

The figure shows absorption and income as functions of the country risk premium. Regarding the absorption curve, our view resembles that of the permanent income hypothesis. The agent forms his expectation of the potential wealth of the country based upon a few facts: size of the country, geographical location, natural resource endowment (climate, coastal extension, water ways) and some key forecasts on technical progress and development of

[1] Necessity forced Keynes to include a money market in The General Theory: 1) In his closed-economy model, the liquidity trap played the same role as the capital account in our open-economy model: a hole that swallows aggregate demand when "fundamental uncertainty" increases. 2) Also, the money market provided Keynes with an interest rate. In our model, the interest rate is imported from world capital markets. 3) While in the classical model (Marshall-Pigou) the interaction between the savings and investment curves threw the interest rate, for Keynes the mechanism that determines the interest rate became complex because he thought savings are endogenous.

institutions favoring economic efficiency (property rights, free international trade, domestic markets competition). For a premium equal to zero, the agent is thus able to estimate whether the country's potential per capita income corresponds to a rich country, a mid-income country or a poor country. We may question the accuracy of this kind of evaluation but it wouldn't be wise to question the existence of a process of continual revision of the national potential. It seems obvious that the individual as consumer and investor finds himself in need of an opinion in this respect. Hence, as the premium rises, absorption falls. The rise in the premium causes a reduction in wealth and a fall in consumption; also causes a rise in the gross return demanded from investment and a fall in investment. Assuming constant the basic data of the country, we can define absorption as an inverse function of the country risk premium.

Figure 2: Equilibrium in the Markets for Goods



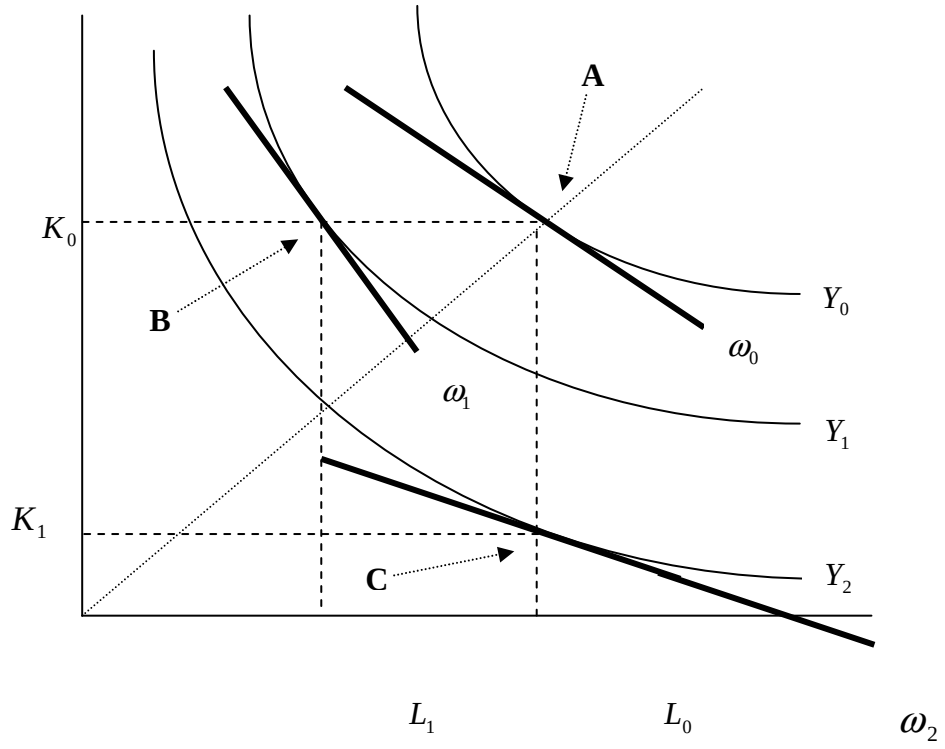
Fluctuations of the country risk premium determine movements along the absorption and income curves. For a given capital stock, a high premium induces a low absorption, a less low income, and a current account surplus; a low premium induces a high absorption, a less high income, and a current account deficit. The bridge between the fluctuations in country risk and the movements of aggregate variables is the flow of international capital. Figure 2 shows the impact of a premium rise. Macroeconomic equilibrium goes immediately from point A, where absorption equals income and current account is balanced, to point B, where absorption falls to the Y_2 level, income falls to the Y_1 level, and the current account shows a surplus. Equilibrium goes then gradually from point B to point C as the capital stock wears away ($K_1 < K_0$); in this process, the income curve moves itself towards the left. At point C, which represents the new long run position, the absorption and income curves cross again though at a higher domestic interest rate, income stops falling, and the current account gets balanced again.

Factor Market Behavior

Figure 3 focus upon the dynamics of factor markets in response to a jump in the country risk premium. Point A stands for the initial long run equilibrium, where absorption and income equals output Y_0 and the current account is balanced. Let's follow now the same analytical

sequence as in Figure 2: the premium rises, absorption falls to a level equivalent to isoquant Y_2, income falls to the level of isoquant Y_1 (by assumption income falls by less than absorption), and the current account goes into surplus. Equilibrium in production passes at once from point A to point B. Capital and labor compete for producing the lower output. Since the supply of capital is perfectly inelastic and the supply of labor is elastic in relative terms (workers have a positive reservation wage), capital has the ability to drive labor out of production in the extent needed to ensure full capital employment. (The rental price of capital may fall to zero if necessary while the labor wage can't fall below the reservation wage.) There is no way for a worker to land a job. If he offered the same effort in exchange for a lower wage or if the government cut the minimum wage, the rental price of capital would fall again in order to keep unchanged the higher capital-labor ratio achieved at point B. Unemployed labor increases from nothing to the difference between L_0 and L_1. It looks very much like involuntary unemployment. But at any moment the opportunity cost of time for the unemployed worker equals the reservation wage earned by the employed worker.

Figure 3: Factors Employment and Output Levels



In the meantime the market price of sunken capital is lower than the price of imported new capital and no investment takes place. So, technical depreciation steadily reduces the stock of capital. As we said before, the transition from point B to point C is a gradual process. Through this process, the relative scarcity of capital increases, the relative factor price of labor decreases, the capital-labor ratio decreases and output steadily falls to a lower long run level. At point C, the market price of sunken capital comes back to the price of imported new capital goods, the relative factor price of labor stops falling, full employment of labor obtains again, output stabilizes at the level of isoquant Y_2, and the current account surplus vanishes.[2]

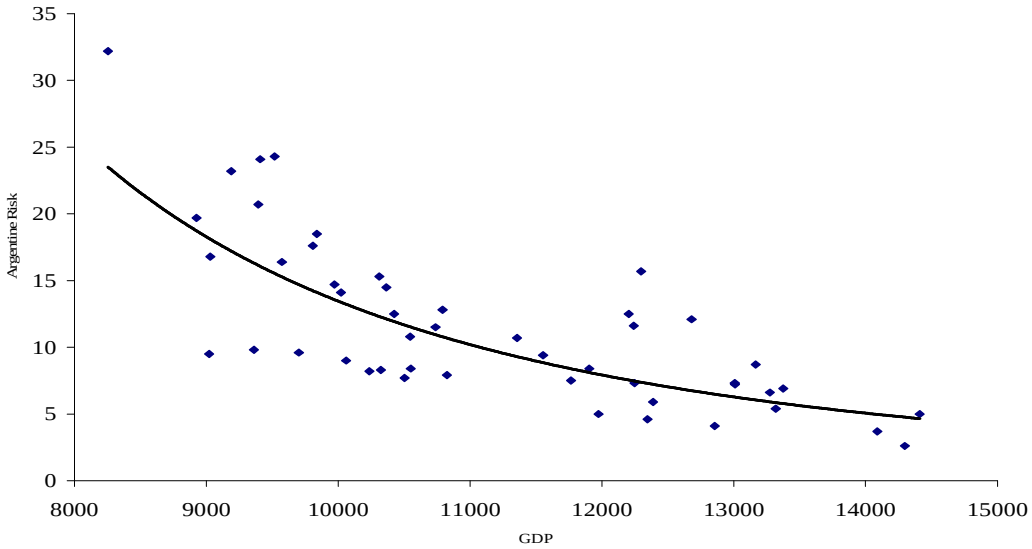
[2] Look now at the labor-market adjustment process from a partial equilibrium standpoint. Assume an upward sloping supply curve of labor. The lower wage corresponding to the final long-run equilibrium will determine in this setting a level of employment lower than L_0 and a final output lower than Y_2. Point C will thus move to

In a nutshell, under country risk the ability of the economy to recover full employment would be an independent phenomenon of the will to work of the unemployed worker or the legal wage flexibility. In the transition from a long-run point characterized by a high capital stock to a long-run point characterized by a low capital stock, the Say's Law wouldn't hold. Since absorption is determined by country risk, the fall in output is a fact. Why should the individual consume more when the high premium erases part of his wealth? Why should the individual invest more when the high premium points to a lower-optimal capital stock? In other words, being the country just a box in the control panel of world finances, foreign and local investors make a decision on the fraction of world income they like to spend in the country and the country's GDP adjusts passively to that fraction.

Besides a large scale economic depression, the very high Argentine risk premium of the 1980's knocked factor markets in a way that resembles the above description. The economy shrank. Wages fell sharply and the market price of sunken capital underwent a great loss. Unemployed workers became public employees, taxi drivers or small shop keepers. And as time went on, factories became rusty and buildings were made their homes by intruders. To the best of my knowledge, there are not available statistics to estimate the time path of the relative factor price and the capital-labor ratio.

II. The Empirical Evidence

Figure 4: Relationship between Argentine Risk and GDP
Argentine risk measured in percentage points per year
GDP measured in constant 1986 pesos
1985 IV – 1997 IV



The high-risk Argentina of the 1980s gave birth to a new macroeconomic relationship. Instead of the Phillips curve which points to a negative correlation between the inflation rate and the rate of unemployment, the new curve emphasizes a negative correlation between the country risk premium and the economic activity level. The new curve should be named after Keynes since it fits nicely in the relationship between the "state of confidence" and the activity level that Keynes often mentioned in The General Theory (Ávila 1997). The next figure shows the new

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the left. Yet I prefer not to alter Figure 3. The reservation wage (or the position of the labor supply curve) should depend on the economic possibilities open to the worker. If it makes sense to assume that the Chinese reservation wage is lower than the American counterpart, the same should apply to the reservation wage at point C as compared with that at point A. In such a case, point C should stay undisturbed.

relationship for the period 1985 IV – 1997 IV. On the horizontal axis, we measure GDP; on the vertical axis, the country risk premium.

Now we present the econometric output for the estimated equations:

1) $LGDP = 9.49 - 0.09LARP - 0.10LARP(-4) + 0.0056TREND$
(180) (-6.5) (-6.8) (11.8)

R2: 93% Prob. F-stat: 0.0000 D-W: 1.97

2) $LCON = 9.27 - 0.11LARP - 0.09LARP(-4) + 0.0062TREND + 0.32AR(1)$
(130) (-6.2) (-4.8) (9.2) (2.3)

R2: 94% Prob. F-stat: 0.0000 D-W: 2.01

3) $LINV = 8.37 - 0.22LARP - 0.29LARP(-4) + 0.0100TREND + 0.32AR(1)$
(49.8) (-5.4) (-6.6) (6.3) (2.2)

R2: 93% Prob. F-stat: 0.0000 D-W: 2.10

4) $SCA = -0.074 + 0.005ARP(-1) + 0.386SCA(-4)$
(-9.9) (9.4) (5.0)

R2: 86% Prob. F-stat: 0.0000 D-W: 1.29

LGDP is log of GDP. LARP is log of Argentine risk premium for the current quarter. LARP(-4) is log of Argentine risk premium for the same quarter of the previous year. LCON is log of consumption. LINV is log of investment. TREND represents a trend variable to account for demographic growth and technical progress. SCA represents the current account as a share of GDP while ARP is the Argentine risk premium measured in percentage points.

Argentine risk premium data come from own calculations (1985 IV – 1992 IV) and from J. P. Morgan data bank (1993 I – 1997 IV). National accounts data come from official sources. We have used series at 1986 prices (Appendix II).

Main observations of the econometric analysis

1. As an explanatory variable of GDP, consumption or investment, the sign of the coefficient of the country risk premium is negative and statistically significant in all cases, whether the premium is a contemporaneous or a lagged variable.

2. The country-risk elasticity is important. A 20% premium rise (e.g. from 5 to 6 percentage points per year) determines a 1.8% contraction of current quarterly GDP (20% times 0.09), while consumption and investment fall 2.2% and 4.4% each.

3. When the rise in the premium spans for 4 consecutive quarters, quarterly GDP contraction increases to 3.8%, while the fall in consumption and investment increase to 4.0% and 10.2% each.

4. As an explanatory variable of SCA, the sign of the coefficient of the country risk premium is positive and statistically significant. On average, when Argentine risk premium increases by one percentage point SCA rises by half a percentage point of GDP. No serial correlation problems.

5. The quality of regressions is quite good. Basically one variable, the country risk premium, is enough to explain around 90% of the volatility of GDP, consumption, investment and current

account balance. We haven't found problems of serial correlation in the estimation of the GDP equation. Regarding the estimations of the consumption and investment equations, we have added an AR(1) variable; the substitution of the dependent variable lagged one quarter for the AR(1) variable yields similar results.

6. Granger's causality tests yield very definite results. The likelihood of country risk premium being the cause of GDP is definitely higher than the likelihood of GDP being the cause of country risk premium, for lags of 1, 2, 3, 4, 5, and 6 quarters. The results of the test are the same for consumption and overwhelmingly so for investment and the current account balance.

7. The responsiveness of aggregate variables to country risk premium fluctuations diminishes when we take into account pre-1985 data. Responsiveness seems to be the highest since the hyperinflation event (1989-1990), moderate during the Plan Austral (1985-1987) and non-existent before the Plan Austral (June 1985). Three reasons may explain this observation: a) before 1985 public spending as percentage of GDP was larger; this fact may have contributed to a more stable aggregate demand; b) international financial arbitrage had not reached the rapidity it would reach later on; this fact may have contributed to a more effective monetary policy; c) the Argentine macroeconomic record was still not as traumatic as it would become after the hyperinflation episode; this fact may have contributed to a less attentive follow up of Argentine financial affairs.

8. Regression results should improve if we correct aggregate variables for seasonality and use the Argentine dollar long-term interest rate instead of the Argentine risk premium. We decided no to do so since correcting for seasonality may yield an unreliable outcome when applied to the highly volatile Argentine macroeconomic time series, and because we wanted to show the raw explanatory power of the country risk premium alone.

9. Regression outputs are based on national accounts computed at 1986 prices. Around 1999 the Government released a set of national accounts computed at 1993 prices. The change in the price structure between 1986 and 1993 was sizable. The drop in the real exchange rate reached 62%! Hence, the weight of the manufacturing and investment sectors in GDP was larger in 1986 than in 1993. Since these sectors are much more responsive to credit conditions than the service sector, it shouldn't be a surprise that regression outputs coming from the old national accounts are more responsive to country risk fluctuations than those coming from the new national accounts (see regression outputs for the period 1993 I - 2006 IV in Appendix III).

III. The Country Risk Approach and the Main Schools of Macroeconomic Thought

According to Phelps (1992), there are seven schools of macroeconomic thought with an active research agenda: Keynes and the Keynesians, Friedman and the Monetarists, Real Business Cycle, Rational Expectations, Supply Side Economics, Neo Keynesians, and Structuralists. He groups them in view of their adherence to a couple of hypotheses: rational expectations and price and wage flexibility. Based on this criterion, Phelps argues that the first two schools are neighbors since the Keynesians and the Monetarists build on the hypotheses of non rational expectations and full price flexibility. The schools of Rational Expectations, Real Cycle and Supply Side share those two fundamental assumptions but stand apart because of differences regarding secondary issues or the types of problems they try to explain. The Neo-Keynesian school accepts the rational expectation hypothesis and rejects the price flexibility assumption; for their members the existence of overlapping contracts, which prevent the price level from adjusting to monetary shocks in the short run, is an important feature of reality consistent with the rationality hypothesis. In turn, the Structural school denies both hypotheses.

As regards style, our model resembles that of the Real Business Cycle. It is not monetary, assumes rational expectations and full wage flexibility. The difference lies in the nature of the shock that triggers the cycle. While for the Rational Expectations school the triggering factor is a monetary shock and the propagation mechanism, an asymmetry of information, and while for

the Real-Cycle school the triggering factor is a technological or labor supply shock and the propagation mechanism lies in the cost of adjustment, in our approach the triggering factor is a change in the country risk premium. In this respect, our approach comes closer to the thought of Keynes and the Keynesians who believe that "fundamental uncertainty" is the key factor in the business cycle. Another similarity between our approach and the latter is the lack of a specific propagation mechanism. In turn, the Neo-Keynesians are eclectic on the origin of the cycle; in their view the triggering factor could be monetary, non-monetary or fundamental; after all, the Tobin's Q, a variable that captures the state of expectations on the future returns on capital, is one of their main contributions to the study of the cycle.

A rather important difference between our approach and the Keynesian school lies in the way uncertainty hits capital markets. For the Keynesians, and for Keynes himself, uncertainty shifts the investment demand curve towards the origin. While for us the country risk premium works as a tax. On a fixed investment demand curve, the premium opens a wedge between the gross yield on marginal capital and the international interest rate which leads to lower capital accumulation. In brief, while for the Keynesians the economy goes into recession or recovery depending on whether the investment demand curve shifts to the left or to the right, for us recessions and recoveries depend on the country risk premium going up or down.

IV. Concluding Remarks

The essay arrives at two results. First, the Say's Law doesn't hold when the economy adjusts itself to a jump in country risk. Labor employment shrinks. No matter how flexible wages are, the full price flexibility of sunken capital would move labor out of production. Once the capital stock has been reduced by technical depreciation to its lower long-run level, the market price of sunken capital returns to the price of new capital goods and labor recovers full employment. Since the country is a box in the control panel of world finances, foreign and national investors determine the fraction of world income they want to spend in the country and the country's GDP adjusts passively to that fraction.

Second, the fundamental determinant of the Argentine business cycle in the period 1985-1997 is the country risk premium. The volatility of the premium is able to explain around 90% of the volatility of aggregate variables such as GDP, consumption, investment and the current account balance, without first-order serial correlation problems. The statistical evidence shows that causality goes from the premium to the aggregate variables. Furthermore, the premium-elasticity of the aggregate variables is important and statistically significant. A premium rise from 5 percentage points to 6 p.p. lasting four quarters leads on average to a GDP fall of 3.8%, a consumption fall of 4%, an investment fall of 10.2%, and a current account improvement of 0.5 percentage points of GDP.

Our model shares many features with the Real Business Cycle model. There is full price and wage flexibility, no money, and expectations are rational. But our model has in common a key feature with the model of Keynes and the Keynesians: the triggering factor of the cycle is the country risk premium, a very Latin American expression for the Keynesian "fundamental uncertainty".

Appendix I: Dynamic Model with Country Risk

Each member of the family contributes with capital and labor to the firm (the economy). He is paid the country's rental price of capital for capital services, and the wage rate for labor services. The next equation represents the firm's benefits:

1) $\Pi = \pi.L = L.\left[f(k) - \left(r^w + \rho + \delta\right)P^* k - w \right]$

Where *L* stands for the size of the family, π for per capita benefits and $f(k)$ for per capita output. First order conditions for maximizing benefits are:

2) $\frac{\partial \Pi}{\partial k} = 0 \Rightarrow f'(k) = (r^w + \rho + \delta)P^*$

3) $\frac{\partial \Pi}{\partial L} = 0 \Rightarrow w = f(k) - k.f'(k)$

According to equations 2 and 3, benefits are maximized when the marginal product of capital equals the country's rental price of capital and the excess of output over the rental price of capital equals the wage. To investigate the dynamic optimization process we need an equation for the current account or the rate of accumulation of US bonds (Barro and Sala-i-Martin 1995, III).

4) $\dot{b} = w + r^w b - c$

Equation 4 says that the rate of change of the individual's bond stock is equal to his labor income plus his interest earnings on bonds, minus consumption. After plugging equations 2 and 3 in equation 4, we arrive to a new formulation of the country's current account:

5) $\dot{b} = f(k) - \left(r^w + \rho + \delta\right)P^* k + r^w b - c$

6) $\dot{b} = f(k) - \left(r^w + \rho + \delta\right)P^*(k - b) - (\rho + \delta)b - c$

Equation 5 says that the (per capita) current account equals the country's (per capita) output plus bond earnings minus payments to capital owners, minus consumption. Equation 6 is no more than a mathematically convenient way of writing equation 5. Given adjustment costs in investing ($\gamma(0) = 0, \gamma' \geq 1, \gamma'' > 0$), the country's capital stock changes gradually according to the difference between gross investment and capital depreciation.

7) $\dot{k} = i - \delta.k$, $k(0) = k_0$

Now we present the current value Hamiltonian for the country's optimization problem:

$$H(c, i; b, k, \lambda, \mu) = U(c) + \lambda.\left[f(k) - \left(r^w + \rho + \delta\right)P^*(k - b) - (\rho + \delta)b - c - \gamma(i) \right] + \mu(i - \delta.k)$$

Where λ stands for the shadow price of marginal savings, and μ stands for the shadow price of installed marginal capital. These are the first order conditions:

8) $\frac{\partial H}{\partial c} = 0 \Rightarrow U' = \lambda$

9) $\frac{\partial H}{\partial i} = 0 \Rightarrow \gamma' = \frac{\mu}{\lambda} \equiv \theta$

10) $\dot{\lambda} = \beta.\lambda - \frac{\partial H}{\partial b} = \lambda.\left(\beta - r^w\right)$

11) $\dot{\mu} = \beta.\mu - \frac{\partial H}{\partial k} = \beta.\mu - \left[\lambda\left[f'(k) - \left(r^w + \rho + \delta\right)P^*\right] - \mu.\delta\right]$

Equation 8 says that the marginal utility of consumption must equal the shadow price of bond savings. Equation 9 says that the marginal cost of setting up capital must equal the relative shadow price of investment. By integrating equation 10 we get this expression for the shadow price of savings:

12) $\lambda(t) = \lambda(0).e^{\left(\beta - r^w\right).t} \Rightarrow \lambda(t) = \lambda(0)$, for all time since $\beta = r^w$.

The intertemporal constant $\lambda(0)$ guarantees the continuous equality of the present values of consumption and wealth (net of adjustment costs). After replacing equation 12 in equation 8 and rewriting the latter, we get:

13) $c(t) = g[\lambda(0)],\ g' < 0$.

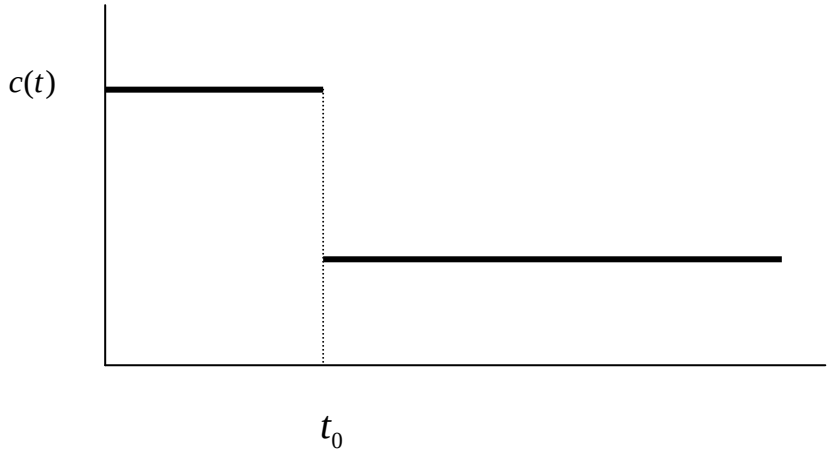
Now, by forward integration of the next equation for the current account:

14) $\dot{b} = f(k) - \left(r^w + \rho + \delta\right)P^*k + r^w b - c - \gamma(i)$

we end up with this equation for the country's wealth:

15) $W = \int_t^{\infty} e^{-r^w(s-t)} c(s)ds = b(t) + \int_t^{\infty} e^{-r^w(s-t)} \left[f(k) - (r^w + \rho + \delta)P^*k - \gamma(i)\right]ds$

Figure 1: Dynamics of Consumption



Equation 15 states that the present value of consumption must equal wealth (W), which, in turn, is equal to the present value of the country's product minus the rental price of installed capital, minus the cost of installing new capital. Notice the negative sign of the relationship between the country risk premium and wealth. If the country risk premium goes up the country's wealth goes down, $\lambda(t)$ rises and then consumption falls once-and-for-all (Figure 1).

The sign of the relationship between the country risk premium and investment is given by equation 2. If the premium goes up, the marginal yield on capital must also go up. This implies a lower optimal capital stock and, of course, a lower investment. By considering the relative shadow price of investment we reach the same conclusion.

16) $$\dot{\theta} = \frac{\dot{\mu}.\lambda - \mu.\dot{\lambda}}{\lambda^2}$$

After replacing equations 10 and 11 in equation 16 and considering that optimal investment requires that $\theta = \gamma'$ at any time, we arrive at the following expression:

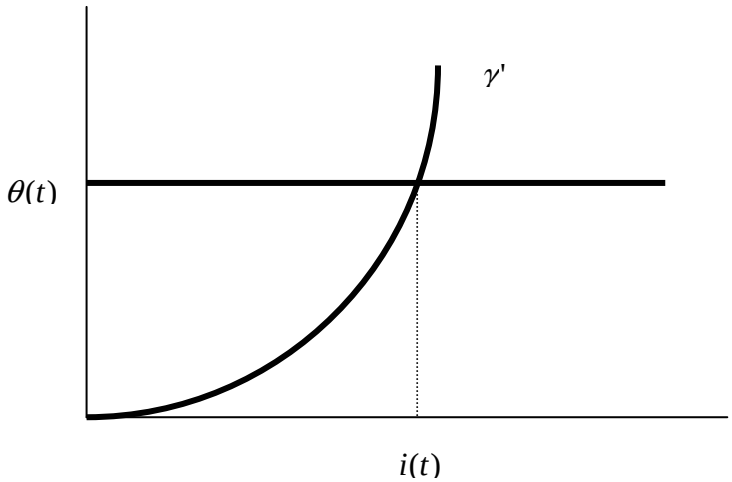
17) $$\frac{f'(k) - (r^w + \rho + \delta)P^*}{\gamma'} = r^w + \delta - \frac{\dot{\theta}}{\theta}$$

Equation 17 says that the quotient between the net return to capital and the cost of installing capital must equal the user's cost corrected for capital gains at every moment.

18) $$\theta(t) = \int_t^{\infty} e^{-(r^w+\delta).(s-t)} \left[f'(k) - (r^w + \rho + \delta)P^* \right] ds$$

Equation 18 says that the extra value of installed capital must equal the present value of the difference between the marginal return to capital and the rental price of the factor. Then, θ is the valuation of the service of installing capital. Every time the shadow price is positive, the country invests; every time it is negative, investment vanishes and the capital stock starts to decrease at the δ rate. In the long run, for any level of the country risk premium, the shadow price of capital tends to zero and investment is equal to capital depreciation. (In this model there are not technical progress and population growth.)

Figure 2: Capital Stock Adjustment



In Figure 2, γ' is the marginal cost of setting up capital and i is the investment rate. A fall in the country risk premium increases the shadow price of investment and makes its volume rise. The optimal rate of capital installation is finite. The capital stock and income rise gradually.

On the other hand, a premium rise determines a gradual reduction of the capital stock. This time, nevertheless, the explanation of the gradual process is not the adjustment costs but technical depreciation.

Appendix II: Time Series

Gross Domestic Product, Consumption, Gross Investment, Current Account and Argentine-Risk Premium, period: 1981 III – 1997 IV.

	GDP	Consumption	Investment	A-Risk Premium	Current Acc.
81 III	9749,4	7555,9	2317,6	0,9	-124,2
81 IV	9677,0	7742,9	2186,8	0,5	-252,7
82 I	8929,0	7067,6	1841,6	1,7	19,8
82 II	9191,2	7282,9	1673,2	0,8	235,1
82 III	9717,1	7576,4	1950,0	10,0	190,7
82 IV	9903,6	7837,3	1945,5	10,0	120,8
83 I	9170,9	7187,4	1730,5	6,2	253,0
83 II	9901,7	7740,1	1912,4	5,6	249,2
83 III	10167,7	8032,5	1967,4	12,7	167,8
83 IV	10052,6	8065,6	1829,5	12,2	157,6
84 I	9175,3	7334,3	1551,7	11,0	289,3
84 II	10199,7	8098,7	1845,6	18,9	255,4
84 III	10315,4	8386,2	1837,2	10,8	92,0
84 IV	10388,4	8497,1	1897,8	8,7	-6,5
85 I	8954,2	7350,2	1416,1	9,2	187,8
85 II	9381,9	7381,0	1481,2	12,2	519,7
85 III	9255,6	7222,5	1579,0	10,1	454,1
85 IV	9701,1	7761,6	1650,2	9,6	289,3
86 I	9021,8	7454,1	1428,1	9,5	142,7
86 II	10060,6	8104,9	1630,4	9,0	324,2
86 III	10550,2	8498,9	1885,6	8,4	167,6
86 IV	10324,8	8417,0	1858,8	8,3	48,7
87 I	9362,1	7641,2	1661,2	9,8	63,1
87 II	10503,1	8351,4	1960,7	7,7	190,5
87 III	10791,2	8706,7	2088,5	12,8	-1,3
87 IV	10311,4	8318,9	1972,6	15,3	19,2
88 I	9808,6	7793,1	1850,2	17,6	168,5
88 II	10365,4	8130,5	1907,9	14,5	326,1
88 III	10021,5	7791,3	1884,4	14,1	347,5
88 IV	9970,8	7911,8	1769,8	14,7	287,4
89 I	9394,0	7661,5	1558,6	20,7	177,1
89 II	9409,2	7292,3	1465,7	24,1	647,2
89 III	9030,4	7126,2	1274,7	16,8	630,1
89 IV	9518,5	7619,8	1512,3	24,3	386,8
90 I	8253,5	6650,0	1033,5	32,2	569,6
90 II	9188,3	7161,7	1219,2	23,2	830,9
90 III	9572,6	7547,6	1293,6	16,4	786,0
90 IV	9837,8	8027,2	1382,3	18,5	422,3
91 I	8924,9	7511,7	1208,9	19,7	218,2
91 II	10425,5	8357,1	1624,2	12,5	463,2
91 III	10545,8	8602,2	1735,9	10,8	248,4
91 IV	10825,1	9124,3	1914,3	7,9	-212,9
92 I	10237,1	8865,2	1758,7	8,2	-390,5
92 II	11766,6	9791,6	2244,5	7,5	-266,0
92 III	11554,4	9826,8	2302,0	9,4	-583,8
92 IV	11356,9	9591,5	2351,3	10,7	-630,6
93 I	10739,1	9234,8	2010,6	11,5	-512,8
93 II	12248,0	10151,0	2456,1	7,3	-366,2

93 III	12389,0	10503,5	2638,7	5,9	-766,3
93 IV	12346,6	10356,8	2936,7	4,6	-964,6
94 I	11974,8	10272,8	2771,9	5,0	-1088,1
94 II	13375,1	10987,7	3087,5	6,9	-715,7
94 III	13274,2	11001,4	3110,4	6,6	-854,1
94 IV	13166,9	10753,6	3257,9	8,7	-862,3
95 I	12297,7	10147,5	2803,0	15,7	-675,4
95 II	12679,7	10011,0	2543,5	12,1	124,5
95 III	12203,3	10075,5	2354,8	12,5	-228,7
95 IV	12240,9	10137,9	2538,3	11,6	-461,9
96 I	11904,2	10056,2	2362,9	8,4	-540,8
96 II	13009,4	10731,8	2823,3	7,2	-298,8
96 III	13008,7	10841,2	2790,4	7,3	-654,8
96 IV	13318,1	10898,2	3109,4	5,4	-741,3
97 I	12856,5	10780,2	2970,2	4,1	-1046,2
97 II	14089,2	11579,6	3546,0	3,7	-148,8
97 III	14296,6	11784,4	3633,2	2,6	-1336,3
97 IV	14410,2	11857,3	3871,2	5,0	-1468,7

Sources: 1) National accounts, official quarterly data at 1986 prices. 2) Argentine-risk premium, monthly data from own estimations and JPMorgan series. The premium is expressed in percentage points (one percentage point = 100 basic points). 3) In the 4th quarter of 1995, the current account series based on 1986 prices was spliced with the series based on 1993 prices.

Appendix III: Time Series

Gross Domestic Product, Consumption, Gross Investment, Current Account and Argentine-Risk Premium, period: 1993 I – 2006 IV.

	GDP	Consumption	Investment	A-Risk Premium	Current Account
93 I	216.370.111	152.148.446	37.324.889	11,5	-4.693.138
93 II	241.871.858	166.025.867	43.955.971	7,3	-2.474.859
93 III	242.645.522	166.667.550	48.221.121	5,9	-6.688.974
93 IV	245.132.429	169.860.311	50.775.676	4,6	-8.889.589
94 I	232.945.326	164.965.420	45.580.104	5,0	-10.844.259
94 II	257.476.895	177.234.828	51.527.053	6,9	-5.857.803
94 III	253.467.778	174.510.154	53.181.918	6,6	-7.284.837
94 IV	257.341.544	177.721.808	54.636.626	8,7	-7.380.528
95 I	237.968.103	164.321.480	46.128.891	15,7	-5.501.338
95 II	248.093.639	166.567.449	43.399.785	12,1	4.295.594
95 III	242.214.699	164.276.737	44.019.700	12,5	-171.984
95 IV	244.467.965	168.866.520	44.564.733	11,6	-2.545.605
96 I	236.566.037	164.311.572	41.460.149	8,4	-3.592.701
96 II	260.751.925	175.591.878	47.590.750	7,2	-511.084
96 III	262.166.964	177.726.972	51.557.602	7,3	-4.589.021
96 IV	267.020.047	183.153.037	53.326.944	5,4	-5.043.481
97 I	256.387.857	177.490.019	48.510.922	4,1	-7.536.295
97 II	281.769.801	191.310.690	56.800.223	3,7	-4.792.024
97 III	284.092.267	195.505.523	60.488.603	2,6	-9.499.090
97 IV	287.515.346	199.383.506	62.390.250	5,0	-10.206.007
98 I	271.702.368	187.196.678	57.077.179	4,4	-10.352.579
98 II	301.207.598	202.675.183	62.699.419	4,5	-4.981.668
98 III	293.315.404	200.922.426	62.903.411	7,7	-8.756.073
98 IV	286.267.849	199.434.263	60.442.669	7,5	-8.174.710
99 I	265.024.636	185.463.056	48.383.924	7,7	-5.830.224
99 II	286.412.327	195.463.399	53.304.486	6,8	964.594
99 III	278.472.693	194.457.732	54.757.574	8,1	-5.596.333
99 IV	283.566.399	199.054.269	56.019.277	6,2	-5.824.819
00 I	264.555.918	186.315.129	45.938.124	5,5	-5.215.313
00 II	285.275.176	195.338.736	49.232.441	6,5	756.274
00 III	276.767.971	193.972.609	50.994.548	6,7	-4.323.711
00 IV	278.091.676	193.703.380	51.843.460	8,1	-3.995.065
01 I	259.199.874	182.900.187	41.580.294	7,5	-5.276.271
01 II	284.795.763	191.297.580	46.196.310	9,8	3.704.848
01 III	263.126.505	181.090.983	42.220.209	14,9	3.843.697
01 IV	248.864.555	169.871.185	37.001.538	29,9	7.605.960
02 I	216.849.495	148.507.392	22.718.815	44,7	16.145.462
02 II	246.314.633	158.475.554	26.310.998	55,2	21.007.805
02 III	237.416.867	156.093.858	26.713.598	42,8	19.477.350
02 IV	240.361.392	157.992.266	30.388.086	19,7	16.611.882
03 I	228.595.882	153.188.337	27.659.223	19,5	15.504.704
03 II	265.402.478	169.567.358	35.023.838	14,3	18.677.942
03 III	261.534.523	172.253.988	38.706.853	13,7	14.493.170
03 IV	268.560.967	176.794.330	45.247.923	14,0	10.253.237
04 I	254.330.423	171.056.272	41.571.380	9,4	8.578.241
04 II	284.375.611	183.635.133	47.908.306	10,2	10.500.566
04 III	284.392.060	187.557.703	51.702.472	9,5	9.557.271

04 IV	293.467.061	193.373.719	55.936.051	7,5	8.986.832
05 I	274.594.503	184.976.301	47.158.783	5,5	10.238.425
05 II	313.927.290	203.728.817	59.862.847	6,6	8.623.326
05 III	310.593.080	203.814.850	63.851.487	4,1	9.536.958
05 IV	319.939.241	208.747.142	70.960.654	4,2	6.728.117
06 I	298.695.562	200.565.514	57.963.266	4,0	7.444.596
06 II	338.243.728	219.462.442	71.049.562	3,5	7.994.620
06 III	337.741.885	218.509.900	77.256.326	3,4	5.198.360
06 IV	347.578.707	224.988.561	79.483.535	2,7	6.027.551

Sources: 1) National accounts, official quarterly data at 1993 prices. 2) Argentine-risk premium, monthly data from JPMorgan series. The premium is expressed in percentage points (one percentage point = 100 basic points).

Regression Outputs for this period:

1) $LGDP = 2.83 - 0.09LARP + 0.0022TREND + 0.52LGDP(-4)$
(8.6) (-12.5) (6.4) (8.8)

R2: 91% Prob. F-stat: 0.0000 D-W: 1.73

2) $LCON = 2.87 - 0.10LARP + 0.0015TREND + 0.48LCON(-4)$
(11.3) (-16.4) (5.6) (9.9)

R2: 92% Prob. F-stat: 0.0000 D-W: 1.76

3) $LINV = 1.62 - 0.09LARP - 0.18LARP(-1) + 0.73LINV(-4) + 0.87AR(1)$
(4.6) (-2.2) (-4.6) (9.0) (11.3)

R2: 93% Prob. F-stat: 0.0000 D-W: 1.73

4) $SCA = -0.0117 + 0.0014ARP + 0.36SCA(-1) + 0.40SCA(-4)$
(-4.6) (6.6) (3.6) (4.8)

R2: 91% Prob. F-stat: 0.0000 D-W: 1.78

The results of the Granger causality tests are not here as strong as those we have examined in Section I. In brief, we can say that the Argentine risk premium causes, with a delay of one quarter, GDP, consumption, investment and the current account balance. For 2, 3, 4, 5 and 6 lags, results are not statistically significant.

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