Contractionary devaluation and credit crunch: analysing Argentina *

Marcus Miller †, *Javier García Fronti* ‡and *Lei Zhang* §

October 2005

Key words: Contractionary devaluation, Keynesian recession, Argentine economic crisis, asymmetric pesification

JEL Classification: E12, E51, F34, G18

Contact author: marcus.miller@warwick.ac.uk

*For comments and suggestions, we thank Santiago Acosta-Ormaechea, Philippe Aghion, Lisandro Barry, Mario Blejer, Luis Céspedes, Guillermo Escude, Matthew Fisher, Daniel Heymann, Daniel Laskar, Andrew Powell and Klaus Scdhmidt-Hebbel; but responsibility for views expressed is our own. The first two authors are grateful to the ESRC for financial support supplied to the research project RES-051-27-0125 "Debt and Development" and Lei Zhang for support from RES-156-25-0032. For research assistance, we thank Elba Roo, funded in part by the CSGR.

†University of Warwick and CEPR

‡University of Warwick

§University of Warwick

Abstract

Sharp economic contraction often follows currency devaluation in emerging markets – due mainly to liability dollarisation. Such adverse balance sheet effects play a key role in the well-known model of Aghion et al (2000), by reducing investment and future supply. We show how the prompt contraction of output can accounted for by incorporating demand failure – due to a slow export response and a credit crunch. The resulting eclectic framework is used to study the collapse of the Argentine economy when Convertibility ended in 2002; and to see why efforts to imitate President Roosevelt by 'pesifying' the economy proved counter-productive.

Professor Marcus Miller, Department of Economics, University of Warwick and CEPR.

Javier García-Fronti, Department of Economics, University of Warwick.

Dr Lei Zhang, Department of Economics, University of Warwick.

Why did Argentina collapse with the worst economic crisis in its history? What brought to such a catastrophic end a monetary system that had attracted great praise and popular support until the very last moment? Gerchunoff & Llach (2003)

I Introduction

The currency board system implemented in Argentina in 1990 initially proved very successful in ending hyperinflation and initiating rapid economic growth with stable prices. It also led to across-the-board debt dollarisation in both traded and non-traded sectors of the economy. But it proved to be unsustainable: as Krueger & Fisher (2003) ruefully observe: "the combination of a highly dollarised banking system and a rigid exchange rate regime can result in vulnerabilities that are difficult to manage".

It is not uncommon for sharp economic contraction to follow on the heels of devaluation in emerging market countries, a result which Frankel (2004) attributes principally to the adverse balance-sheet effects of dollarised liabilities. But for Argentina the end of the dollar peg took the form of a full-blown financial crisis, where the collapse of the peso and the paralysis of the banking system threw the economy into deep depression, Blejer (2005), Sturzenegger (2003). Other informative accounts of the crisis and events leading up to it are provided in Gerchunoff & Llach (2003) and Blustein (2005): Powell (2003, p.42) provides an econometric assessment, with evidence of a shift between multiple equilibria as "political risk, playing together with the mild level of required adjustment in fiscal accounts, put Argentina into a bad equilibrium". How to model post-devaluation crises characteristic of emerging markets is the issue addressed in this paper — with Argentine economic collapse as the case in point.

Céspedes, Chang & Velasco (2004) discuss the balance between trade competitiveness and asset valuation effects in a Keynesian model of an open economy with sticky prices. They show that for a highly dollarised economy, the asset price effects of devaluation can overwhelm trade effects, leading to economic contraction. A dynamic analysis of balance sheet effects in Argentina in particular is included in the comprehensive, New Keynesian framework developed by Escude (2004), where exports are sold in euros while debts are contracted in dollars: with sticky wages and service prices, dollar appreciation

causes unemployment and leads to a sudden stop in capital flows, followed by devaluation and default. This inter-temporally optimizing, two-sector approach has its attractions: but the continuous-time dynamic system is already complex, without taking account of investment demand and its supply-side effects.

Aghion, Bacchetta & Banerjee (2000), hereafter ABB, provide a two-period dynamic framework which offers a neat characterization of output and exchange rate determination in a small open economy producing a traded good. One-period of price stickiness for the traded good [1] is enough to yield adverse balance sheet effects where a fall in the exchange rate induces a supply-side contraction as investment is cut back, reducing productive potential in the next period. There is goods-market clearing and international asset arbitrage; but the multiplicity of equilibria opens up the possibility of sudden shifts in the exchange rate — reflecting, maybe, the Sudden Stops in capital flows emphasized by Calvo, Izquierdo & Talvi (2003). This is the framework we adopt in this paper — subject to two key modifications.

Table 1: GDP in Argentina from 1997 to 2003.

GDP in constant prices (bn peso)[a, b]							
Year	GDP	Consumption (private)	Consumption (public)	Investment	Exports	Imports	Statistical error
1997	277.4	190.9	34.1	57.0	27.9	35.9	3.4
1998	288.1	197.6	35.2	60.8	30.8	38.9	2.6
1999	278.4	193.6	36.2	53.1	30.4	34.5	-0.5
2000	276.2	192.3	36.4	49.5	31.3	34.5	1.2
2001	264.0	181.3	35.6	41.7	32.1	29.7	2.9
2002	**235.2**	**155.3**	**33.8**	**26.5**	**33.1**	**14.8**	**1.3**
2003	256.0	168.0	34.3	36.7	35.1	20.4	2.4

[a] Source: Ministerio de Economía Argentina.

[b] All quantities reported are in 1993 prices.

The first is to allow for Keynesian demand-side recession. In the ABB framework

[1] This device is one way of capturing the price stickiness modeled explicitly by Escude(2004).

output is essentially supply-determined: demand matches supply by the adjustment of net exports. This feature means that the model will not capture contractions that follow quickly upon devaluation, Frankel (2004). The prompt reaction of output triggered by devaluation and default in Argentina, for example, is shown in Table 1 where GDP and its components are measured in billion of pesos at 1993 prices. The recession evidently began before the crisis of 2001/02: from a peak in 1998 output fell by some 2% or 3% per annum over the next three years (column two). But with default and devaluation in December 2001/Janaury 2002, output collapsed by more than 12% in 2002 — with private consumption falling by 14% and investment by more than a third — while exports remained more or less constant in real terms. (A delayed response to devaluation by exports is not unusual; indeed, in emerging market currency crises, exports typically fall before recovering to their pre-crisis levels, Calvo & Reinhart (2000)).

The report by the IADB on "Unlocking Credit" emphasizes how important — and how volatile — is bank lending in Latin American economies. Accordingly, the second modification to the ABB model is to allow for changes in the credit multiplier — something the authors themselves have suggested in a subsequent paper. [2] Here, we explicitly consider insolvency of the banking system[3] for reasons discussed in detail later (Section IV).

In Section II, therefore, the ABB model is modified to include the demand-determination of output in the period of collapse and also to allow for contraction of domestic credit. This provides an eclectic blend of the demand-side approach of Krugman (1999) or Céspedes *et al* (2003, 2004) and the dynamic, supply-side account of ABB, which may be useful for considering contractionary devaluations[4].

In section III the framework is used to analyse Argentine crisis, where the government complemented devaluation with pesification of all domestic liabilities (that is, the compulsory conversion of dollar liabilities at the one-to-one exchange rate). While this

[2]They specifically suggest incorporating bank currency exposure, where currency depreciation can result in a disruption of lending, so that "... the credit multiplier μ may be reduced...".

[3]Unlike the authors cited who assume that "banks have enough assets not to fall into insolvency in case a currency crisis occurs"(Aghion, Bacchetta & Banerjee (2004, p15)).

[4]For some countries, however, prompt pass-through can neutralize the effects of liability dollarisation, Galindo, Panizza & Schiantarelli (2003): this issue is discussed in Appendix A.

policy essentially eliminated the potential balance sheet effect for non-financial firms, for banks — which had to convert their dollar liabilities at a higher rate — it proved a paralyzing blow. We discuss how pesification can, in principle, mitigate adverse balance sheet effects; but how it can plunge the economy into chaos if it precipitates a credit crunch. In Section IV the Argentine pesification is compared and contrasted with the historical precedent of President Roosevelt's cancelation of the gold clause before the US left the gold standard. After a brief discussion of capital flight and missed opportunities for alternative policies in the Argentine case in section V, the paper concludes.

II An eclectic model of financial crisis

II.1 ABB's supply-side model: a brief outline

The macroeconomic model of ABB is designed to capture the balance sheet effect on private sector investment of an exchange rate collapse in a small open economy. Before indicating our modifications, we briefly outline the central elements of this widely-cited two-period model.

There is full capital mobility and uncovered interest parity holds. Purchasing Power Parity (PPP) for traded goods also holds except in period 1 when an unanticipated shock leads to a deviation as prices are preset, but other variables — the nominal exchange rate in particular — are free to adjust. The actual timing of the events in period 1 is: first the price of traded output is pre-set according to the *ex ante* PPP condition and firms invest; then there is an unanticipated shock, followed by the adjustment of interest rate and the exchange rate; finally, output and profits are generated, with a fraction of earnings retained after debt repayment saved for investment in period 2. This determines the level of production in the second period, when there are no shocks and prices are flexible, so PPP is restored.

Equilibrium can be summarized by the intersection of two schedules, called the IPLM curve and the W curve. The former, as the name suggests, is a combination of the Uncovered Interest Parity, money market equilibrium and the PPP condition for the

second period. Formally, it is written as:

$$E_1 \quad = \quad \frac{1+i^*}{1+i_1}\frac{M_2^S}{L(Y_2, \bar{i_2})} \tag{1}$$

where E_1 is the exchange rate for the first period, i^* is the foreign interest rate, i_1 and $\bar{i_2}$ are domestic interest rates for periods 1 and 2, M_2^S and Y_2 are money supply and output in period 2, and $L(Y_2, \bar{i_2})$ is the money demand function. This IPLM curve is downward sloping in the E_1 and Y_2 space because higher output in the second period increases money demand (i.e., higher L given interest rate in period 2) and so strengthens the exchange rate (note M_2^S is given).

The W-curve characterizes the supply of output on the assumption that entrepreneurs are credit-constrained. (The production function is assumed to be linear in capital stock, which depreciates completely at the end of the period.) Total investment consists of last-period retained earnings together with borrowing (in both domestic and foreign currencies, with proportions given exogenously) which is limited to a given fraction $\mu_t(i_{t-1})$ of retained earnings. The credit multiplier $\mu_t(i_{t-1})$, with $\mu_t^{'} < 0$, is designed to capture the imperfection of the credit market. The W-curve is specifically given by

$$Y_2 = \sigma[1+\mu_2(i_1)](1-\alpha)\left[Y_1 - (1+r_0)D^C - (1+i^*)\frac{E_1}{P_1}(D_1 - D^C)\right] \tag{2}$$

where σ is a productivity parameter, α is the fraction of output consumed in each period, D_1 is total borrowing in period 1, and D^C is its domestic currency component. Because currency depreciation increases the burden of corporate debt and reduces next-period output, the W-curve is downward sloping in E_1 and Y_2 space.[5] Clearly this formulation captures the contractionary effect of devaluation on the supply-side. Next we discuss two major modifications proposed — a fall of demand below supply immediately after devaluation and a contraction in the credit multiplier.

II.2 Demand-determined output and a credit crunch

An unexpected currency collapse in period 1 lowers output in period 2 in the ABB model: but it leaves output in period 1 unchanged. As noted earlier, Argentine GDP collapsed

[5]Note that Y_2 is set to zero if the right hand side of (2) turns out to be negative, where $Y_2 = 0$ signifies the depression level of output.

at the same time as the currency, with investment showing the largest percentage fall. The simplest way to capture this while retaining other features of the model is to assume what is shown in Table 1, namely that export volumes remain unchanged — a modest assumption given the finding of Calvo & Reinhart (2000) that, in case of an emerging market currency crisis, exports typically fall before recovering to their pre-crisis levels after 8 months: and, with a banking crisis, exports may need 20 months to recover. A consideration relevant in the Argentine case is discussed in Kohlscheen & O'Connell (2004), namely the restriction of trade credit by external creditors faced with default on sovereign debt: it is in their strategic interest to limit the expansion of exports as a sanction in restructuring negotiations.[6]

As a consequence of taking export volumes as given, output in period 1 may be is demand-determined, i.e., the fall of investment can cut current output and consumption. Specifically, let output in period 1 be determined as follows:

$$Y_t^D = \gamma\alpha(Y_t - D_t^*) + (1+\mu_{t+1})(1-\alpha)(Y_t - D_t^*) + \bar{X} - mY_t, \tag{3}$$

where $D_1^* = (1+r_0)D^C + (1+i^*)(E_1/P_1)(D_1 - D^C)$ is the total cost of debt services and Y_t is aggregate demand measured in constant prices. In support of this specification, note that, in the midst of a credit crunch and bank closures, both consumers and producers were effectively denied access to new credit. The first term on the right hand side of (3) indicates consumption demand where $\alpha < 1$ is the labor share of income and $\gamma < 1$ is the fraction spent on consumption. The second term is demand for investment with $Y_t - D_t^*$ representing corporate profits net of borrowing costs, and μ is the credit multiplier. The last two terms represent net exports, where we assume export volumes are fixed in the current period while imports vary proportionally with current income – as the data above suggest is broadly appropriate. The failure of export volumes to rise means that a collapse of investment (due to balance sheet effects, for example) can reduce realized output in the current period, as well as supply potential in the next period.

[6]Other factors include contract lags and physical capacity constraints: the export response to the spectacular fall of the Indonesian currency in 1997/98 was considerably hampered by lack of container shipping capacity, for example.

Solving (3) for period 1 yields

$$Y_1^D = \frac{-D_1^*[\gamma\alpha + (1+\mu_{t+1})(1-\alpha)] + \bar{X}}{1+m-[\gamma\alpha+(1+\mu_{t+1})(1-\alpha)]},$$
$$= \frac{-\xi D_1^* + \bar{X}}{1-\xi+m} < Y_1^S, \tag{4}$$

where $\xi = \gamma\alpha + (1+\mu_{t+1})(1-\alpha)$ and $1 > 1-\xi+m > 0$, and Y_1^S is the aggregate supply in the same period. The Keynesian-style multiplier on exports is simply $1/(1-\xi+m)$, where ξ is the marginal propensity to spend and $1-\xi$ the marginal propensity to save.

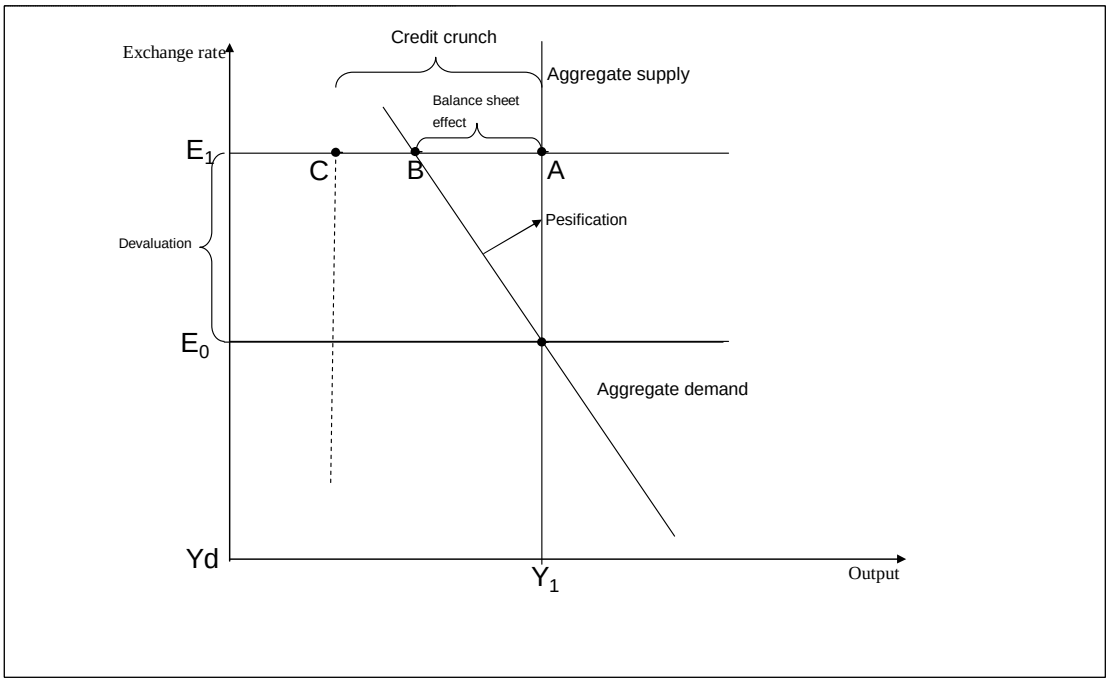

Figure 1: Aggregate demand and supply in period 1.

Figure 1, with output on the horizontal axis and the exchange rate on the vertical, illustrates how demand failure can lead to prompt contractionary devaluation in the ABB model. Since it depends on output and interest rate in the previous period, aggregate supply appears as a vertical line Y_1^S. Aggregate demand, however, moves inversely with the exchange rate due to the adverse balance sheet effects of a devaluation which raises the price of a dollar from E_0 to E_1. At E_1 for example, demand has fall by AB as a result. (The reduction of investment — not shown here — will of course reduce future

potential output.) If, however, devaluation is accompanied by pesification, the aggregate demand effect will be eliminated, as indicated by the arrow in the figure: in the case of Argentina, for example, "the pesification ... of all domestic liabilities that followed the January 2002 devaluation all but eliminated any potential balance sheet effect" Galiani, Levy-Yeyati & Schargrodsky (2003, p.344). [7] But if devaluation and pesification lead to a credit crunch, the reduction in the credit multiplier in equation 3 will shift the aggregate demand schedule to the left, as shown by the dotted line: so output falls to C at E_1. (An increase in the period 1 interest rate will also shift Y_1^D leftwards and flatten it as high interest rates reduce the credit multiplier and investment demand.)

Table 2: Comparison with the ABB model.

	ABB model	MFZ modification
Y_1	$Y_1^s = \sigma[1+\mu_1(i_0)](1-\alpha)[Y_0 - D_0^*]$	$Y_1^D = [\gamma\alpha+(1+\mu_2)(1-\alpha)]\times[Y_1 - D_1^*] + \bar{X} - mY_1$
	$Y_1 = Y_1^s = Y_1^D$	$Y_1 = Y_1^D < Y_1^s = Y_1^s(ABB)$
Y_2	$Y_2^s = \sigma[1+\mu_2(i_1)](1-\alpha)[Y_1 - D_1^*]$	$Y_2^D = Y_2^s < Y_2^s(ABB)$

Table 2 compares and contrasts the determination of output when the quantity of exports cannot adjust within period to maintain the balance of demand with supply with that of the standard ABB model where output is supply-determined (as indicated in the first column). For the latter, an adverse devaluation-induced shock to the balance sheet in period 1 has no effect on period 1 output (which is determined by previous period investment), but reduces period 2 output through reduced capital accumulation.

The table can also be used to show how a credit crunch may have an impact on current-period output. Consider, for example, a contraction in the credit multiplier μ_2 due to asymmetric pesification leading to bank closures in period 1. In the ABB model, the impact on output is delayed until period 2 as can be seen from column 1 (which is presumably why the credit multiplier carries the label 2). With Keynesian demand determination, however, the effects are more immediate and more damaging. The tightening of corporate credit constraints reduces investment in period 1 directly:

[7] With partial pesification which reduces corporate dollar debt to $\hat{E}_1 > E_0$, the demand curve will become vertical at a lower level of aggregate demand

but this exogenous fall in demand triggers a contraction of income in period 1, which in turn leads to even less investment as profits fall. The knock-on effect on period 2 supply is consequently greater than in the ABB model.[8]

How adding Keynesian demand in period 1 alters a key policy implication of the ABB model, may be summarized as follow:

Proposition 1 *If output in period 1 is demand-determined, as specified in (4), an increase in the period 1 interest rate will weaken the domestic currency relative to when output is supply determined.*

Proof: As noted above, the equilibrium of (Y_2, E_1) is given by the intersection of (1) and (2) with Y_1 in (2) being replaced by Keynesian demand given in (4). The proposition is true if an increase in i_1 induces more leftward shift to Y_2 in our specification than that in the ABB's, i.e.,

$$\left.\frac{\partial Y_2}{\partial i_1}\right|_{MFZ} < \left.\frac{\partial Y_2}{\partial i_1}\right|_{ABB}. \tag{5}$$

Differentiating Y_2 in (2) with respect to i_1 (with Y_1 replaced by Y_1^D from (4)) yields

$$\left.\frac{\partial Y_2}{\partial i_1}\right|_{MFZ} = \frac{\mu_2^{'}(i_1)}{1+\mu_2(i_1)} Y_2 + \sigma(1+\mu_2)(1-\alpha)\frac{\partial Y_1^D}{\partial i_1}.$$

where the first term on the left hand side is what we would have obtained if we use ABB specification, and the second term gives the additional effect because the output in period 1 is demand determined. As is clear from (4) that $\partial Y_1^D/\partial i_1 < 0$, so (5) must hold.

In table 2 and the analysis below, we follow ABB in assuming that output in period 2 is supply-determined. This does not mean that output in period 2 matches that of the ABB model, however: the contraction is greater because of the reduced investment associated with the fall in aggregate demand in period 1. (The simplifying assumption made by ABB that capital depreciates completely within one period dramatically highlights this effect, but is surely an exaggeration.) Of course, if exports fail to respond sufficiently promptly, output may also fall below supply in period 2 as well.

In Appendix A we discuss the pass-through of the exchange rate on to the price level

[8]Cutting μ_1, credit multiplier corresponding to period 0, would, however, have same effects on period 1 supply in both models.

and how this could, in principle, offset adverse balance sheet effects. For Argentina, we conclude that this is not the case.

III Analysing the Argentine crisis

In this section the modified ABB model is used to help explain how "Argentina passed from being one of the world's fastest growing economies in the 1990s to suffering one of the sharpest recessions of any peace-time capitalist economy since the Second World War" (Gerchunoff & Llach 2003, p.456). For this purpose it is convenient to identify the three separate periods as follows: Pre-collapse (approximately 2001); Currency Collapse and Depression (approximately 2002); Continued Depression (2003), which are referred to as Period 0, 1 and 2 respectively. For reference, inter-bank interest rates from the beginning of 2000 to September 2004 are shown in Figure 2 (monthly average of the BAIBOR 30 days in pesos: data for Dec 2001, Jan 2002 are not available).

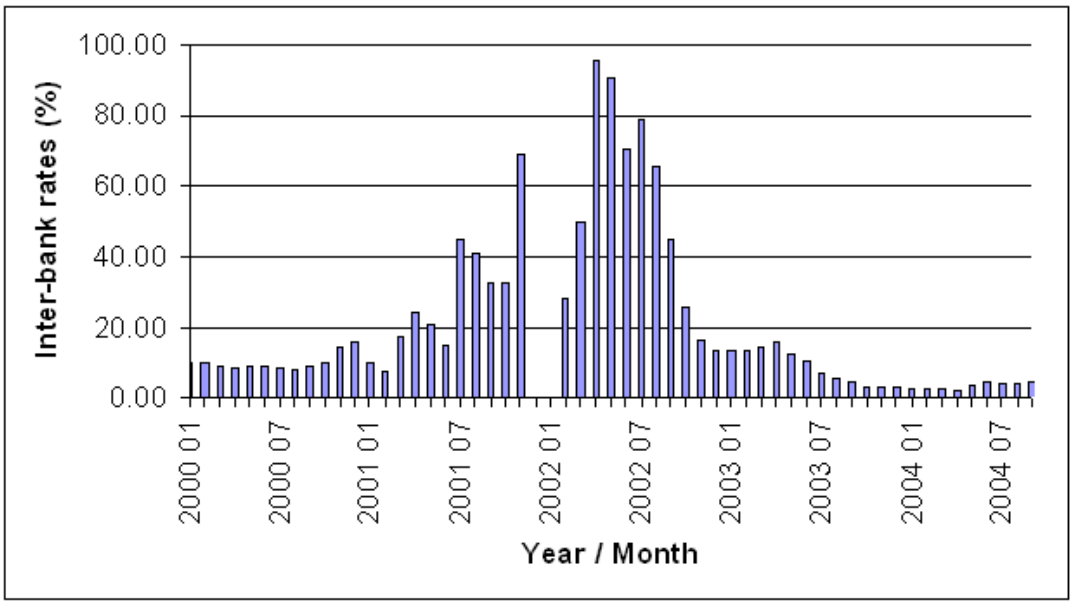

Figure 2: Inter-bank rates in Argentina from Jan 2001 to Sep 2004

(Source: Banco Central de la República Argentina.)

III.1 The end of Convertibility and the prospect of economic collapse

The proximate trigger for the end of convertibility was the IMF announcement in December 2001 that the country would not receive the $1.3 bn of financial support that the government had requested to cover debt payments (Blustein 2005, Prologue and pp.181ff.). When the denial of financial support led to restrictions on the withdrawal of bank deposits, there was a rapid spread of street demonstrations, looting of supermarkets and a general strike, and domestic turmoil forced De la Rua to resign the presidency on the 20th of December, leaving the country in constitutional chaos with three successive presidents elected by the Congress in quick succession. Political stability was partially regained at the beginning of January 2002 when Eduardo Duhalde was appointed as the new president. One of his first economic measures was the devaluation of the peso. It fell far more than anticipated: instead of rising to 1.4 as planned, the price of a dollar climbed to over 3 pesos. The economy as a whole promptly fell into recession, and output remaind below its level in 2001 for two years (as can be seen in Table 1 above).

To understand the sequence of events that led to currency and output collapse we manipulate the IPLM and W schedules. (Note that, as in ABB, the axes here are the exchange rate in period 1 and output the following period: the behavior of output in period 1 when the currency collapses will be discussed in the text). We start in period 0, where Cavallo's last-ditch attempts to maintain the dollar peg were associated with punishingly high interest rates and low investment. With the peg still in place, the IPLM curve is not relevant, its place being taken by the parity peg. The high interest rates shift the W-curve leftwards, however, decreasing potential output in period 2 from A to B, see Figure 3 and Appendix B which analyses forces of contraction under the dollar peg.

Next consider period 1 when the peso was floated and interest rate increased sharply (see Figure 2). The higher cost of credit would shift the W further left, decreasing potential output from B to B' were the peso still at parity with the dollar. Assuming, however, that monetary policy was expected to accommodate a modest devaluation, the IPLM curve is drawn intersecting the W curve at C, with the dollar rising from E_0 to $\hat{E}_1$ and the IPLM intersecting the W curve at C. (Note that the "indexation" of 40% of

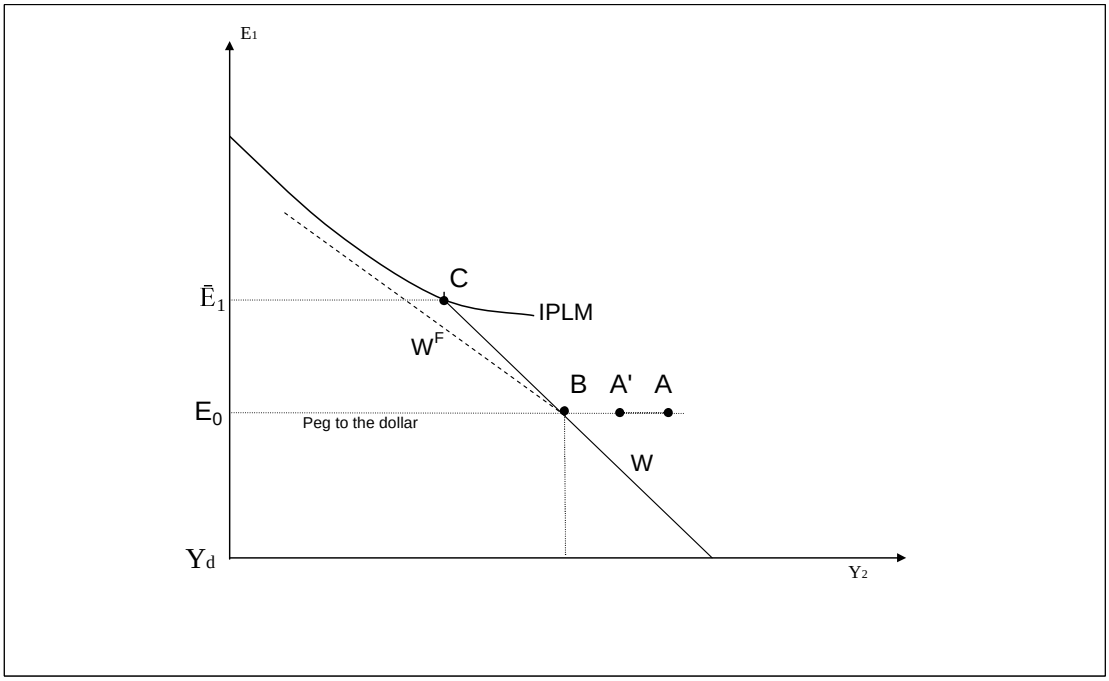

Figure 3: Demand failure and the risk of economic collapse.

deposits to the dollar ensured some nominal accommodation.)

Equilibrium at C requires that export volumes rise sufficiently to keep aggregate demand equal to supply in period 1. With exports slow to react, however, devaluation will be contractionary for output: and the knock-on effect of demand failure on potential output in period 2 is captured by schedule W_F in the figure. (Note that we assume no demand failure in period 2.)

There may be no intersection with the IPLM curve until output falls to depression level Y_d and the price of the dollar rises sharply, as the figure suggests. This was the risk of economic collapse facing the incoming administration.

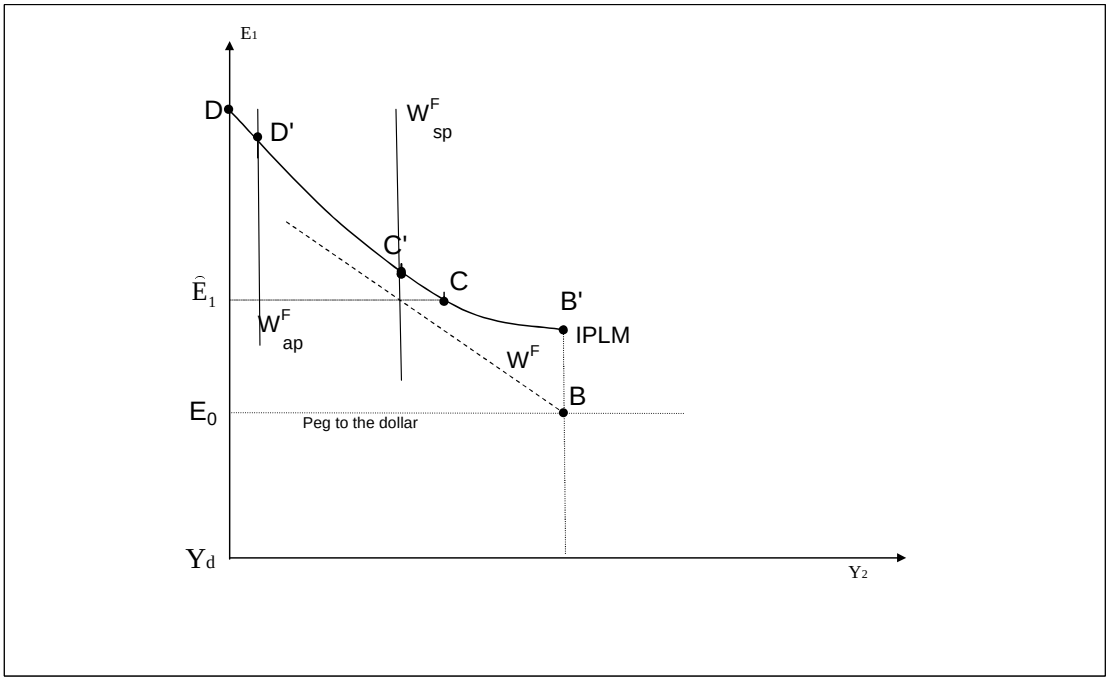

Figure 4: Pesification and credit contraction: "Nuestra gran depresión"?

III.2 Imitating President Roosevelt

To mitigate or avoid depression, the government attempted to follow the example of President Roosevelt; and the potential effect of so doing is indicated in Figure 4. Consider first the pesification of corporate borrowing which has no negative effect on the solvency of the banking system (e.g., symmetric pesification when loans and deposits are *both* pesified at a rate of $\hat{E}_1$, for example). In this case, for values of the dollar greater than $\hat{E}_1$, the W^F-curve rotates clockwise to become vertical at $\hat{E}_1$, see Appendix C; and the new equilibrium is given by the intersection of W^F_{SP} with the IPLM curve, at point C'. This Rooseveltian policy of pesification prevents output from collapsing because it affords across-the-board relief to corporations with dollar debts, along the lines advocated by Joseph Stiglitz in his proposal for a Super-Chapter 11, Stiglitz (1999), Miller & Stiglitz (1999). But this equilibrium still involves some demand failure and the contraction of future supply. Giving borrowers even more relief – by pesifying all dollar loans below

$100,000 at the rate of 1:1 - was intended to maintain demand in period of the currency collapse (and so to shift equilibrium from C' towards the right in Figure 4).

[Figure 4 near here.]

To achieve this, while simultaneously providing compensation to depositors, was only possible if the banks could be credibly compensated for the losses involved in asymmetric pesification. This the government was in no position to do, for reasons discussed below. So the attempt to maintain output by imitating President Roosevelt proved counterproductive, transferring insolvency from the industrial sector to the banks and precipitating a credit crunch. The fall of the credit multiplier, cutting lending, investment and output in period 1, leads to a reduction of potential output in period 2. In Figure 4 the effects of asymmetric pesification is captured by the dramatic shift of W^F_{SP}-curve to the left, to W^F_{AP}. With a collapse in credit multiplier therefore equilibrium remains economic depression and currency collapse as indicated by point D'. To help understand why pesification failed in Argentina, we compare it with Roosevelt's earlier initiative.

IV Comparing Argentine "pesification" with Roosevelt's cancelation of the Gold Clause

When the US was on the gold standard, long-term loan contracts were typically indexed to the price of gold[9]. In 1933, however, Congress passed a Resolution nullifying the gold clauses in private and public debt. This abrogation was " a key part of Roosevelt's 'first hundred days', providing the foundation for much of the New Deal policies directed at reflating the economy including departure of the US from the gold standard", Kroszner (2003, p.1). The validity of the Resolution was challenged in court when the US left the gold standard a year later and the dollar price of gold rose by almost 70%. The Supreme Court upheld the Resolution, however, mainly on the grounds that the plaintiffs had not been harmed: in the case of Perry, for example, it was argued that he did not " show in relation to buying power he has sustained any loss whatever" . On the day the verdict was

[9]Gold clauses were included in all long-term government debt issues after WW1, and became so common in the private sector that " virtually all long-term corporate debt outstanding in the early 1930s contained gold clauses," Kroszner (2003, p.6).

announced, corporate bonds whose gold clause was abrogated rose in price – evidence, it appears, that cancelation promised a better return than enforcement, Kroszner (2003, p.22).

This historical precedent led some observers[10] to recommend devaluation-with-pesification as an appropriate policy option for Argentinain 2001; and Blustein (2005, p.142,3) indicates that economists in the IMF Research Department also backed devaluation-with-default as a better option than borrowing more to defend peso parity with the dollar[11]. When the Convertibility regime ended in January 2002, President Duhalde of Argentina did in fact 'pesify' debt contracts, and Roosevelt was explicitly cited as a precedent, Rodriguez-Diez (2003, p.89). In the analysis that follows, however, we argue that the process of pesification, rather than helping to ameliorate the crisis as in the US, may have played a key role in its propagation. This prompts the immediate question: what was so different between these two cases? Kroszner (2003, p.4 and p.28) indicates two factors: first unlike the US, the Argentine government engaged in 'asymmetric' pesification; and second that Argentina may have suffered more from the lack of respect for the rule of law involved in such across-the-board abrogation of contracts. These issues are considered in more detail, before proceeding with the formal model.

IV.1 Bank balance sheets and asymmetric pesification

Abrogation in the US affected only long-term bonds: it did not involve short-term loans and deposits; and it did not precipitate bank insolvency. In fact, US commercial banks, which would have made a substantial capital gain from the operation of the gold clause[12], had the prospective increase in their net worth anulled by the Act of Congress. So, for the balance sheets of US banks, dollar devaluation was a 'wash'.

Not so in Argentina. To begin with, the dollar-denomination of banking system assets was much more extensive than gold-indexation of bank assets had been in US, for it

[10] e.g. Hausmann (2001), Miller (2001).

[11] Specifically Ken Rogoff and Carmen Reinhart.

[12] With more than 20% of their portfolios invested in long term securities, a 70 percent increase in the value of these investments could have added almost about 15% to their net worth (normally about 12% of their assets).

included bank loans as well as investments, and amounted to almost half of all assets. As it was broadly matched by liability dollarisation — with half of all deposits denominated in the US currency — devaluation-with-pesification could have been a wash for bank balance sheets too; and it could have been economically beneficial, serving " to protect banks from devaluation, inasmuch as to have maintained deposits and loans in dollars would have made it very difficult to recover loans in sufficient volume to honor deposits" Sturzenegger (2003, p.49). But political imperatives led to the policy of asymmetric pesification, which exacerbated balance sheet problems for the banks.

The reasons for adopting this policy - and some of its immediate consequences - are graphically described in Blustein (2005, p.192,3):

> To head off mass bankruptcy, the government decreed that most people who had borrowed in dollars could repay their loans in depreciated pesos, at the rate of one peso per dollar. At the same time, to appease savers, the authorities announced deposits would be converted at a different rate - 1.4 pesos per dollar. As a result, the banking system, which was already on its knees, was rendered prostrate. The disparity between what banks could collect from their borrowers, and what they owed their depositors, added up to billions of dollars in new losses. So for people and businesses in need of credit, obtaining bank loans became all but unthinkable. As for depositors, they felt cheated, notwithstanding the concession the government had given them... Their angry reaction led to a deepening of the banking system's woes, as thousands of them obtained court orders requiring the return of their deposits in full, and money began draining anew from the banking system...
>
> [T]he economy headed into another downward spiral when the government, having encountered resistance in Congress against a proposal straighten out the banking mess, closed the banks and exchange houses on April 19 [2002]... When the banks reopened a week after the closure, they were still not lending; how could they, bankers asked, when they had no idea of how many depositors would win court orders, and could not even prepare meaningful statements of their financial condition.

Asymmetric pesification implied losses of 40% on about 30% of banks' portfolios (on the optimistic assumption that government debt would pesified at the same rate as

deposits) – enough to wipe out bank capital of about 12 percent, see Miller, García-Fronti & Zhang (2005).

IV.2 Credibility of the Government

In fact the Duhalde government promised from the outset that it would recapitalize bank losses in the form of government bonds, Rodriguez-Diez (2003, pp109-10). This brings us to the second crucial difference between the two cases: the standing of the government. The cancelation of the gold clause was a pre-emptive measure taken by an administration credible enough to borrow at interest rates of less than one percent to finance deficits of around 8 percent of GDP[13]; and it was soon to be followed by the creation of the FDIC to protect banks from panic. In Argentina, by contrast, pesification was pursued in the throes of political turmoil and self-fulfilling panic in capital markets. By August 2001, with the economy contracting and sovereign spreads reaching 1000 points, it appeared that debt dynamics were unsustainable, leading to high level discussions with the IMF about forcible sovereign debt restructuring[14]; and, by the time Duhalde took office in January 2002 to complete the term left unfinished by De la Rua, sovereign bonds were in outright default.

Not only were the assets offered to the banks by way capital restructuring of uncertain value, but the 'test of harm' used by the US Supreme Court was not applicable as many banks were foreign owned: for them, maintenance of peso values would not preserve their purchasing power[15].

Finally we note that commercial banks in Argentina were left free to export dollars unchecked until newly-borrowed foreign currency reserves were exhausted, but in the US pre-emptive cancelation of the gold clause was promptly followed an executive order of the President mandating the surrender of gold to the Treasury and the Federal reserve

[13]In 1934, for example, when GDP was approximately $50bn the deficit was $4bn.(Statistics abstract of the United States, Bureau of Census Library)

[14]Talks between Cavallo and the IMF in October 2001 aimed at securing an involuntary 30 to 40 percent write down of sovereign debt apparently foundered because they threatened bank insolvency, Blustein (2005, pp168,9).

[15]This theme is explored in Miller, García-Fronti & Zhang (2005), treating bank recapitalization in a strategic setting where domestically-owned banks will accept bonds but not foreign multinationals.

Banks, Kroszner (2003, p.7). Surprising as it may sound, private holding of gold in the US for any other purpose besides ornamentation or industrial use was effectively prohibited until this directive was revoked fifty years later.

V Policy alternatives

With time, the economy is on a recovery path; the government is paying compensation to the banks; sovereign debt has been restructured; and sovereign spreads have fallen below 5% in the summer 2005. But the fact that " the economic collapse that accompanied Argentina's eventual default and devaluation was much deeper than necessary to bring Argentina's external accounts into some semblance of balance ... suggests it is at least conceptually possible that an alternative policy path might have produced a smaller fall in output." Roubini & Setser (2004, p.355). What alternative policies might have helped?

The comprehensive review of financial conditions and crises in Latin America carried out by the IADB focuses on bank restructuring. Noting that "the initial measures taken by the authorities in Argentina aggravated rather than improved the solvency of banks", they criticize the authorities because they "did not put in place a serious and comprehensive program for bank restructuring... and did not discriminate int the treatment of bank according to quality" (in contrast to Uruguay were "credible funds" were secured to finance the implementation of a comprehensive restructuring program), IADB (2004, p.80). A government itself facing a solvency crisis will inevitably face great difficulty in restoring bank solvency: one must surely look for action that could been taken earlier to forestall or minimise crisis.

Note that Roosevelt took pre-emptive action nine months before devaluing, by canceling the gold clause and imposing capital controls to conserve US gold reserves. But in Argentina there were no capital controls until December 2001. The capital account was left open — with capital flight estimated at $23 bn in 2000-1, Bonelli (2004, p.216). So, despite IMF loans in early and mid-2001, official reserves ran down sharply, falling by $20 billion between October 2000 - when the political crisis began with the resignation of Vice President Alvarez - until the end of 2001, Bonelli (2004, p.215). The model of

Caballero & Krishnamurthy (2001) – where capital flight leads to output contraction via the loss of internationally acceptable collateral underpinning corporate borrowing – seems to provide a convincing rationale for outflow controls, at least on a temporary basis[16]. That such measures were not considered is no mystery: the late 1990s was the high water mark for the fashion of prompt and comprehensive liberalization, and Argentina was one of its leading exponents.

How would action to restrict outflows on capital account impact on the exchange rate and output in ABB model used here? In principle, it would move the IPLM curve down sufficiently to intersect the W''-curve, helping to avoid the precipitate collapse of output[17]. In addition, the protection so afforded to government solvency could have made a bank bailout more credible and prevented the collapse of the credit multiplier.

Absent capital controls, however, it seems clear that the Convertibility regime should have been ended earlier, certainly before the IMF agreed the second disbursement of funds in August/September 2001 in the view of Mussa (2002, pp.45-48): of this decision he remarks "Argentina was not helped. Indeed, external assistance that was potentially far more valuable in helping to contain the damage once a de facto sovereign default had occurred was instead squandered in a futile effort to avoid the inevitable." Roubini and Setser (2004, p.354) also criticize the policy followed by the IMF , whereby " Argentina ... ended up receiving a significant loan to support an attempt to avoid both any exchange rate adjustment and meaningful debt reduction but nothing to support a transition to a sustainable real exchange rate and a more sustainable debt profile" . Why the fateful delay? Could it reflect perverse domestic incentives for economic management?

Cooper (1971) has noted that finance ministers typically lose their jobs after devaluation — and governments often fall as well. If the end of convertibility was seen as tantamount to political failure, the administration would have been sorely tempted to

[16]The case for *inflow* controls, like those used in Chile, has been made by Levy Yeyati (2005) – both as a preemptive measure to avoid the rapid build-up of speculative dollar liabilities and so that, in an panic, less-than-one-year investors cannot exit with all their assets.

[17]Technically one can modify the IPLM curve to

$$E_1 \quad = \quad (1-c)\frac{1+i*}{1+i_1}\frac{M_2^S}{L(Y_2,\bar{i_2})}$$

where $0 < c < 1$ indicates the degree of capital controls, see Aghion, Bacchetta & Banerjee (2001).

'gamble for resurrection', taking great risks with the country's future so as to defend the parity rather than looking at the expected economic costs and benefits of policy options. This interpretation of Argentine policy-making is attributed to Ken Rogoff who, when appointed chief economist at the IMF, argued against further lending in favor of devaluation and default — followed by IMF support , Blustein (2005, p.142). On this view, distorted political incentives may well have promoted delay, and IMF loans financed it.

VI Conclusions

Devaluation in emerging markets often leads to economic contraction, and in the Argentine case the end of Convertibility led to veritable economic collapse. In this paper we show how balance sheet models of crisis may be used to throw light on the issue.

After devaluation and default, the Argentine government tried to protect producers by a policy of asymmetric pesification which, in the absence of credible capitalization, bankrupted the banking system. Suitably adapted, the framework of Aghion, Bacchetta & Banerjee (2000) illustrates how high ex ante interest rates can have substantial adverse effect on the supply side and how asymmetric pesification of bank assets can — via a credit crunch — greatly exacerbate the fall of the currency and the depth of the recession. The speed of collapse and the level of unused resources implies that, as for the 1930s, one needs to model demand as well as supply: and the model is modified to do just this.

An issue for further investigation (briefly discussed in Appendix A) is the difference between traded and non-traded sectors in the rate of "pass-through". We note that the analysis of Carranza, Galdon-Sanchez & Gomez-Biscarri (2005), where "pass-through" in the latter case depends on the state of the economy, are broadly consistent with the account of collapse developed in this paper. [18]

Failure to replicate the successful cancelation of gold clause by President Roosevelt can be attributed to greater "dollarisation" of the economy and the serious loss of credibility by the quick succession of presidents appointed in the midst of the crisis. So we conclude that preemptive measures taken earlier in 2001 were needed to avoid disaster. But

[18] Their interesting analysis takes no account of singular aspects of the Argentine case considered here, however, i.e. asymmetric pesification and credit collapse.

preemptive measures required policy agreement between the IMF and the Argentine government on how to end convertibility. Could this episode have revealed an Achilles heel in the IMF policy of helping countries which help themselves — an agency problem which postpones corrective action until disaster is all but inevitable? The way in which strategic policy decisions involving the IMF are arrived at before and during such crises could repay further investigation.

VII *

References

Aghion, Philippe, Philippe Bacchetta & Abhijit Banerjee (2000), 'A simple model of monetary policy and currency crises', *European Economic Review* **44**(4-6), 728–738.

Aghion, Philippe, Philippe Bacchetta & Abhijit Banerjee (2001), 'Currency crises and monetary policy in an economy with credit constraints', *European Economic Review* **45**(7), 1121–1150.

Aghion, Philippe, Philippe Bacchetta & Abhijit Banerjee (2004), 'A corporate balance-sheet approach to currency crises', *Journal of Economic Theory* **119**, 630.

Blejer, Mario (2005), Managing argentina's 2002 financial crisis, *in* T.Besley & N. R.Zagha, eds, 'Development Challenges in the 1990s: Leading Policymakers Speak from Experience', World Bank.

Blustein, Paul (2005), *And the Money Kept Rolling in (and Out): Wall Street, the IMF and the bankrupting of Argentina*, first edn, Public affairs, New York.

Bonelli, Marcelo (2004), *Un País en Deuda*, 1a edn, Planeta, Buenos Aires.

Burstein, Ariel, Martin Eichenbaum & Sergio Rebelo (2004), 'Large devaluations and the real exchange rate', 2004 Meeting Papers from Society for Economic Dynamics.

Caballero, Ricardo & Arvind Krishnamurthy (2001), 'Interantional and domestic collaretal constraints in a model of emerging market crises', *Journal of Monetary Economics* (48), 515–548.

Calvo, Guillermo A., Alejandro Izquierdo & Ernesto Talvi (2003), 'Sudden stops, the real exchange rate, and fiscal sustainability: Argentina's lessons', NBER Working Paper No. w9828.

Calvo, Guillermo & Carmen Reinhart (2000), When capital inflows come to a sudden stop: Consequences and policy options, *in* P.Kenen & A.Swoboda, eds, 'Key Issues in Reform of the International Monetary and Financial System'.

Carranza, L., Jose E. Galdon-Sanchez & Javier Gomez-Biscarri (2005), 'Exchange rate and inflation dynamics in dollarized economies', Mimeo University of Navarra. Conference paper.

Céspedes, Luis, Roberto Chang & Andrés Velasco (2003), 'IS-LM-BP in the Pampas', *IMF Staff Papers* **50**(Special issue), 143–156.

Céspedes, Luis, Roberto Chang & Andrés Velasco (2004), 'Balance sheets and exchange rate policy', *American Economic Review* **94**(Special issue), 1183–1193.

Cooper, Richard (1971), 'Currency devaluation in developing countries', *Essays in International Finance* (86), 276–304. Princeton, NJ: Princeton University.

Escude, Guillermo J. (2004), 'Dollar strength, peso vulnerability to sudden stops: A perfect foresight model of Argentina's convertibility', mimeo, Banco Central de la República Argentina.

Frankel, Jeffrey A. (2004), 'Contractionary currency crashes in developing countries', Presented at The 5th Mundell-Fleming Lecture IMF Annual Research Conference. Conference paper.

Galiani, Sebastian, Eduardo Levy-Yeyati & Ernesto Schargrodsky (2003), 'Financial dollarization and debt deflation under a currency board', *Emerging Markets Review* **4**(4), 340–367.

Galindo, Arturo, Ugo Panizza & Fabio Schiantarelli (2003), 'Debt composition and balance sheet effects of currency depreciation: a summary of the micro evidence', *Emerging Markets Review* **4**(4), 330–339.

Gerchunoff, Pablo & Juan Llach (2003), *El Ciclo de la Ilusión y el desencanto*, 1a edn, Ariel, Buenos Aires.

Hausmann, Ricardo (2001), 'A way out for Argentina', Financial Times. London.

IADB (2004), Unlocking credit. economic and social progress in Latin America: 2005 report., Technical report, IADB, Washington DC.

Kohlscheen, Emmanuel. & Steve A. O'Connell (2004), 'A sovereign debt model with trade credit and reserves', Mimeo.

Kroszner, Randall (2003), 'Is it better to forgive than to receive? an empirical analysis of the impact of debt repudiation', mimeo, University of Chicago November.

Krueger, Anne & Matthew Fisher (2003), 'Building on a decade of experience: Crisis prevention and resolution', Paper presented at "International Financial Crises: What Follows the Washington Consensus?". Warwick University.

Krugman, Paul (1999), Balance sheets, the transfer problem, and financial crises, *in* P.Isard, A.Razin & A. K.Rose., eds, 'International Finance and Financial Crises: Essays in Honor of Robert P. Flood'.

Levy Yeyati, Eduardo (2005), 'Tras el canje de deuda vuelve el control de capitales versión 2005', Cronista Comercial. Buenos Aires. 26 Febrary.

Miller, Marcus (2001), 'Argentina should look to Roosevelt', Financial Times. London. Sep 10, p.20.

Miller, Marcus, Javier García-Fronti & Lei Zhang (2005), 'Credit crunch and keynesian contraction: Argentina in crisis', CEPR Discussion Paper No.: 4889. London, Centre for Economic Policy Research.

Miller, Marcus & Joseph Stiglitz (1999), 'Bankruptcy protection against macroeconomic shocks: The case for a 'super chapter 11", Unpublished manuscript presented at the World Bank Conference on Capital Flows, Financial Crises and Policies, April 1999.

Mussa, Michael (2002), 'Argentina and the Fund: From triumph to tragedy', Policy Analyses in International Economics No. 67, IIE, Washington D.C.

Powell, Andrew (2003), Argentina's avoidable crisis: Bad luck, bad economics, bad politics, bad advice, *in* S. M.Collins & D.Rodrik, eds, 'Brookings Trade Forum 2002. Currency Crises: What Have We Learned?'.

Rodriguez-Diez, Alejandro (2003), *Devaluación y pesificación*, Bifronte Editores, Buenos Aires.

Roubini, Nuriel & Brad Setser (2004), *Bailouts or Bil-ins? Responding to Financial Crises in Emerging Economies*, 1 edn, Institute for International Economics, Washington DC.

Stiglitz, Joseph (1999), 'Reforming the global economic architecture: Lessons from recent crises', *The Journal of Finance* (54), 1508–1521.

Sturzenegger, Federico (2003), *La Economía de los Argentinos*, 1a edn, Planeta, Buenos Aires.

Appendix

A Pass-through

While the ABB model rules out any adjustment of P_1 immediately after a devaluation, some pass-through of the exchange rate is typical in emerging market countries, Frankel (2004). Because pass-through raises the price level, however, the adverse balance sheet effects of the rise in the dollar will fall (relative to the fixed price case) for two reasons. First the real cost of foreign debt will rise less relative to retained earnings: and second the real cost of local currency debt will fall, instead of remaining constant. Together these imply that the investment effects of the ABB model can be overturned as pass-through becomes large relative to liability dollarisation. (This has provoked a good deal of debate and data analysis: the relevance of real debt effects for Latin American economies in general is considered in a special issue of the *Emerging Markets Journal* 4(4), December 2003.)

The logic is as follows. Let the balance sheet effect be denoted as D/P where D is the peso value of (non-financial) corporate debt and P the price level, and both depend on the exchange rate. The elasticity of real debt with respect to the exchange rate is the elasticity of the numerator less the elasticity of the denominator, where the former is approximately the share of debt in dollars — denoted by δ, and the latter (on assumptions spelt out below) is given by the share of traded goods in the price index, denoted ϵ. So the elasticity of real debt is simply $\delta - \epsilon$. *For devaluation to have adverse balance sheet effects on investment, therefore, the extent of liability dollarisation, δ, must exceed that of 'commodity' dollarisation, ϵ.* (How important the debt effect will be in affecting investment will, of course, depend on the debt/income ratio for non-financial firms, inter alia.)

As a then-highly-dollarised economy with a low ratio of exports to GDP, Argentina satisfied the above condition for adverse balance sheet effects to prevail. The proportion of bank borrowing in dollars was about 70% according to the IADB (2004, p.53), suggesting that δ is well above a half. Backing out the parameter ϵ from pass-through in the year after the end of convertibility suggests a value of about 0.3, see below. (Ironically enough,

as Galiani, Levy-Yeyati & Schargrodsky (2003) point out, the act of pesification reduced the degree of liability dollarisation for non-financial firms immediately after the Argentina peso was devalued: why this failed to rescue investment involves taking account of the banking crisis as in Section IV.)

Burstein, Eichenbaum & Rebelo (2004) who construct an open economy general equilibrium model that can account for the slow adjustment in non-tradable good prices after a large devaluation estimate that consumer prices rose by about 40% in the first year in response to a rise in the price of the dollar of more than 200%. As aggregate pass-through will reflect the share of traded goods in the price index, we can back out the value of ϵ on the simplifying assumption that there is complete pass-through for traded goods and none for non-traded. Formally, let the aggregate price level (P) be a weighted geometric average of tradable (P_T) and non-tradable (P_N) prices

$$P = P_T^{\epsilon} P_N^{1-\epsilon} \tag{6}$$

it follows that

$$\frac{P_t}{P_0} = \frac{1.4}{1} = \left(\frac{E_t}{E_0}\right)^{\epsilon} = \left(\frac{3}{1}\right)^{0.3} \tag{7}$$

i.e. $\epsilon = 0.3$.

An important factor being glossed over in this simple calculation is the sectoral variation in pass-through. This is analysed by Carranza, Galdon-Sanchez & Gomez-Biscarri (2005) who assume traded goods are priced in dollars but pass-through in the non-traded goods sector is endogenous: it depends on the state of the economy, with low pass-through when demand is depressed. With devaluation large enough to trigger significant bankruptcy, the prediction of their analysis is consistent with the model we use here: low output and low pass-through. For an explicit two-sector analysis of the Argentine case, see Escude (2004) .

B Contraction under the dollar peg

That economic recession led to higher not lower interest rates in the highly indebted Argentine economy, and that recession was met with policies which increased tax and decreased public expenditure are identified by Gerchunoff & Llach (2003, p456) as two

important 'crisis propagation mechanisms'. These could be incorporated in the model as follows.

Corporate Tax

Assuming that corporate tax is levied at a given rate of τ on the firm's realized profits. Introducing taxes reduces the investment in period 1, which in turn affects negatively the output in period 2:

$$Y_2 = \sigma(1+\mu)(1-\alpha-\tau)\left[Y_1 - (1+r_0)D^C - (1+i^*)\frac{E_1}{P_1}(D_1 - D^C)\right]. \tag{8}$$

Public debt

As in Aghion, Bacchetta & Banerjee (2001), the consolidated government financing equation can be written as

$$P_t(g_t - t_t) + \left[X^G(1+i_{t-1}) + (1-X^G)(1+i^*)\frac{E_1}{E_{t-1}}\right] d_t^G P_{t-1} = (d_{t+1}^G + s_t)P_t - E_t\Delta R_t \tag{9}$$

where g_t and t_t are real government expenditure and taxes, d_t^G is the government debt held by private individuals in period t and X^G is the fraction of its domestic component, s_t is the real seignorage, P_t is price level at t. Dividing both sides of (9) by P_t and omitting reserve changes yield

$$(g_t - t_t) + \left[X^G(1+r_{t-1}) + (1-X^G)(1+i^*)\frac{E_1}{P_t}\right] d_t^G = d_{t+1}^G + s_t. \tag{10}$$

Country risk

To capture the default risk for the dollar debt, we introduce risk premium to both the interest paid by government (π^G) and the interest rate paid by the firm (π^P). In the presence of such risk premium, the government budget (10) constraint becomes

$$(g_t - t_t) + \left[X^G(1+r_{t-1}) + (1-X^G)(1+i^*+\pi^G)\frac{E_1}{P_t}\right] d_t^G = d_{t+1}^G + s_t. \tag{11}$$

The output in period 2 becomes

$$Y_2 = \sigma(1+\mu)(1-\alpha-\tau)\left[Y_1 - (1+r_0)D^C - (1+i^*+\pi^P)\frac{E_1}{P_1}(D_1 - D^C)\right]. \tag{12}$$

Pre-collapse contraction of supply

The first contractionary mechanism identified by Gerchunoff and Llach is the high sovereign spreads force the government to increase corporate tax to maintain the "zero deficit" commitment with the IMF Blustein (2005, p.136 and p.138), as can be seen from the following accounting equation from (11)

$$(g_t - t_t) + \left[X^G(1 + r_{t-1}) + (1 - X^G)(1 + i^* + \pi^G)\frac{E_1}{P_t} \right] d_t^G = d_{t+1}^G + s_t = \mathrm{C}onstant. \quad (13)$$

where the first term is the primary deficit and the second term represents the interest payment on public debt. Assuming that the sum of terms is fixed, the only way to adjust to rising interest costs is to run a primary surplus — by raising corporate taxes for example.

The second mechanism is the high credit risk π^P (risk over American companies) and the high peso interest r_0 also reduce corporate profits available for investment. Increasing τ, r_0 and π^P will lead to less investment in period 1, ceteris paribus, less output in period 2, as can be seen from the W equation (12).

C Pesification of corporate liabilities

Assuming that dollar-denominated corporate debt is pesified at $\hat{E}_1$, the W^F-curve becomes

$$Y_2 = \sigma(1 + \mu)(1 - \alpha) \left[Y_1^D - (1 + r_0)D^C - (1 + i^*)\frac{\hat{E}_1}{P_1}(D_1 - D^C) \right], \quad (14)$$

where Y_1^D, as defined in (4), is the aggregate demand in period one at the exchange rate of $\hat{E}_1$. Provided that pesification of corporate debt has no effect on the credit multiplier, aggregate demand will increase for prices of the dollar greater then $\hat{E}_1$, i.e., the W^F-curve becomes vertical which limits the output losses when devaluation occurs.