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Speculative behaviour, debt default and contagion: A stylised framework of the Latin American Crisis 2001-2002

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Abstract[1]

This paper provides a model incorporating strategic speculative behaviour into a framework of debt default and contagion. A basic model of contagion shows how economies which appear fundamentally sound, can fail to meet foreign obligations when there are inter-linkages with a defaulting country. Introducing speculators into the framework increases the incidence of debt default and contagion. However, when these speculators view the economy with a degree of uncertainty, the likelihood of default and contagion is even greater. Speculators' perceptions over the state of the economy are therefore paramount when estimating the impact of a crisis on a region.

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1 Introduction

World events of the last decade have generated a large and growing literature focused on contagion and the transmission of crises from one country to another. Indeed, contagion has been identified in many of the emerging markets over the last decade (Glick and Rose, 1999) as well as in many developed economies (European Exchange Rate Mechanism in 1992). The general story is that a crisis in one country will ultimately lead to crises in other financial centres since they are not only inextricably linked via trade and finance channels but also by speculator perceptions. It has been shown that a crisis in one country can generate a change in sentiment among speculators regarding the neighbouring region hence other countries are also subject to attacks on their financial systems.

However, the events of 2001-2002 in Latin America are not completely supportive of this theory. The debt-default in Argentina which hit during November 2001 did not pose an immediate threat to its neighbours. Indeed, the Emerging Market Bond Indices (EMBI) spreads indicate no great increase following the crisis and the commentators at the time were quick to question why the Latin American contagion had not happened. It was attributed to the fact that investors were more "savvy" about the state of each country's fundamentals. This contradicts the Calvo and Mendoza (2000) argument where a crisis in one country acts as a "wake up" call to investors who view all other regional countries as homogenous. Conversely, during the latter half of 2002, as Argentinean fortunes worsened, EMBI spreads grew for many of the Latin countries and a regional crisis ensued.

A model is therefore needed that incorporates each scenario; the first in which a currency crisis is restricted to one country and the second in which it spreads throughout an entire region. To achieve this goal, the paper combines two influential models. It uses the inter-bank market framework of Elsinger et al (2002) to demonstrate how economies which initially appear solvent may be driven to default as a consequence of contagion. However, also built into this is the notion of common knowledge (from Morris and Shin, 1998) to illustrate the increased likelihood of contagion when speculators face uncertainty over the fundamental state of the economy.

The article is organised as follows. The next section outlines the situation facing Latin America in 2001-2002 ie an initial lack of contagion at the end of 2001 but increased contagion effects in the second half of 2002. Also presented is a summary of the literature that forms the basis of the model in this paper. The following section then sets up the framework describing the elements from each of the Morris and Shin and Elsinger approaches. Simulations are provided to contrast the frequency of contagion between two situations; the first in which each economy is viewed perfectly by all market participants; the second where the fundamentals are viewed with a degree of uncertainty. The paper then compares the level of the fundamentals required to trigger a crisis in each scenario. The final section contains concluding remarks incorporating policy implications.

2 Background

2.1 Summary of events in Latin America

November 2001 saw Argentina enduring a debt default, a devaluation of the peso and a total of four presidents in ten days. In short, it plummeted into a financial crisis from which it is yet to recover. In April 2002, banking and foreign exchange activity was suspended and in November 2002 it again defaulted on its $800m debt repayment to the World Bank having failed to re-secure IMF aid.

This generated concern not just for the state of the Argentinean economy but also for the impacts on its neighbours. Fear of contagion from an Argentinean collapse provoked an IMF aid program for Brazil as early as September 2001 since it had much in common with Argentina in terms of a high proportion of external liabilities to exports and high public debt. However, Brazil was not subject to crisis until the middle of 2002. Opinion polls suggested an upcoming change of leadership which triggered adverse market expectations and hence a rise in the EMBI spread. This culminated in a sharp devaluation of the real in June 2002 and a deepening financial crisis.

A second country at risk from contagion in the region was Uruguay. While it did not immediately succumb to crisis in 2001 following the collapse of the Argentinean economy, there is still some empirical evidence of regional contagion. A large proportion of the deposit holders in Uruguay were Argentineans (Mussa, 2002) and having seen the peso collapse, they were keen to transfer their funds into dollars. As a consequence, by June 2002, reserves had fallen by 40% and the currency peg was abandoned.

Venezuela was also in difficulty at this time but not as a consequence of contagion. It experienced political and civil unrest throughout 2002 culminating in a nationwide strike which was not resolved until February 2003. The impact on the economy (particularly with regard to its oil exports) is yet to be fully realised. However, it too abandoned its peg following a run on its currency and depletion of foreign exchange reserves.

The mood in mid 2002 in Latin America was summed up by events in Mexico. In a speech concerning public finances, the Mexican finance minister likened Mexico to Argentina prior to its crisis. This sparked a panic in the market and as a consequence President Vicente Fox had to issue a statement confirming the Mexican economy was solid. In short, Argentina's collapse did not cause an immediate panic in the neighbouring financial markets. However, as the crisis deepened, market sentiment for the region started to change and by mid 2002 EMBI spreads rose throughout Latin America with other countries heading into difficulty.

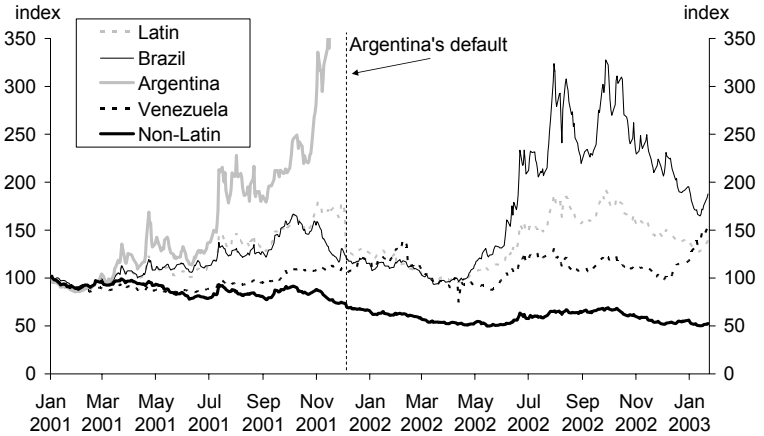
Figure 1 provides the Emerging Market Bond Indices of Latin America for the years 2001-2003. The base of January 2001 allows a comparison to be made across the countries in the region during Argentina's crisis period. An increase in this index implies that the bond spread is getting larger and hence that speculator sentiment in the country is deteriorating. Therefore a rise in the index implies an adverse change in sentiment for the bonds of that particular country. Clearly, at the time of the Argentinean debt default in 2001, the spreads for Venezuela and Brazil suggested no immediate danger from speculative attacks. However, by late 2002 indices for all of the Latin American countries were on the increase thus demonstrating a distinct fall in speculator sentiment. This supports the view that

during the 2001 crisis period, speculators distinguished between economies in the region (Vogel, 2001). However, by late 2002 there had been a mood shift and sentiment for all countries had deteriorated.

2.2 The literature on contagion and common knowledge

It is well documented that the IMF intervened to support Brazil and Uruguay over widespread concerns of contagion from the collapse of the Argentinean economy. However, of equal importance was market reaction to the implementation of these IMF programs. Mussa (2002) notes that IMF reforms for Brazil could be highly successful if speculator sentiment were favourable but potentially disastrous otherwise. As a consequence, this paper brings together models that consider market uncertainty and also contagion to explore the issue of Latin American countries in the 2001-2002 period.

Figure 1:
Emerging Market Bond Indices for Latin America, 2001-2003



Source: JP Morgan

A concise summary of the literature into currency crises and contagion may be found in Pesenti and Tille (2000) which describes the differing schools of thought regarding the *causes* of crises and also the various channels for their spread to other countries. Since there is considerable debate surrounding what actually constitutes contagion,[2] this paper will use it in its broadest sense to capture any financial, real or political links within a region.

It is a matter of some debate as to which channel of contagion is the most relevant for each of the Latin countries in a time of crisis. Glick and Rose (1999) find empirical support for contagion through the trade channel for a number of different crises worldwide between 1971 and 1997 noting in particular how they tend to be regional. However, Allen and Gale (2000) attribute the spread of crises between banks to financial linkages. Hernandez and Valdes (2001), meanwhile find that the relevant channel for contagion is region-dependent and also sensitive to how the crisis periods are measured. In short, the evidence is inconclusive and hence this calls for a model that captures each of the possible linkages; trade, financial or political.

The model by Elsinger et al (2002) is used in this particular framework since it is easily adapted to consider contagion in its broadest definition. The original paper considers the spread of liquidity crises in an inter-bank market. The roots of this type of approach lie in the story told by Diamond and Dybvig (1983) and more recently in Diamond and Rajan (2002). Banks fail for one of two reasons. First, they are fundamentally insolvent. Second, they are rendered insolvent by other banks that cannot clear their payments. This can generate a cascade of bank failures and, in the extreme, a complete collapse of a country's financial system. In this framework, the model is extended to consider *country* interdependence and hence a crisis in one country can induce crises elsewhere.

The currency crisis literature has also spawned a number of models which consider market uncertainty since speculators are not always

[2] A useful summary of the definitions is provided by the World Bank Group (2000).

perfectly informed. For instance, Calvo (1999) shows that a sale of emerging market securities by informed agents could be misinterpreted by uninformed agents as suggesting low returns from the market and thus cause a financial collapse. Berger and Wagner (2002) also consider contagion when there is uncertainty in private sector expectations. A mutual dependence of private sector expectations across countries implies that a crisis in one country will increase the probability of a crisis in the countries with which it is trading. This has implications for the maintenance of a pegged exchange rate regime since it is not only actual devaluations which spark crises elsewhere but also the likelihood of one.

However, while the above models provide a useful insight into speculative behaviour during a crisis period, it is argued that models of multiple equilibria are more appropriate than single equilibrium models in explaining the process of contagion. In an examination of emerging market crises of 1994-5 and 1997, Masson (1999) finds that single equilibrium models conditional on macroeconomic fundamentals alone do not capture all forms of contagion. He argues that a more useful model would incorporate multiple equilibria and self-fulfilling expectations. Both of these features are incorporated in the common knowledge literature which explicitly models the nature of speculator uncertainty. It demonstrates how the collapse of a currency may result from imperfect knowledge over the state of the economy's fundamentals (Morris and Shin, 1998) or the central bank's willingness to defend a currency peg (Allsopp, 2002).

This framework has formed the basis for a number of other more recent investigations. Prati and Sbracia (2002) build on the work of Morris and Shin (1998) and also Metz (2002) to provide a model considering uncertainty about fundamentals. They find that speculative attacks in six Asian countries depend not only on fundamentals but on the market's expectations of them.

In the Morris and Shin (1998) framework, multiple equilibria exist if investors have complete information. However, when investors each receive private signals concerning the state of an economy's fundamentals with a degree of error, then a unique equilibrium emerges. The bottom line is that exchange rate pegs could collapse for values of the fundamentals that would otherwise be consistent

with the peg if only a few or no speculators had attacked the currency. Arguably, this could explain the recent events in Latin America since the initial reaction to the Argentinean collapse was not a deterioration in speculator sentiment for all the nearby countries. The marked deterioration in Brazilian and Venezuelan bond spreads occurred much later with a depletion of their foreign currency reserves and an abandonment of their currency pegs.

The Morris and Shin framework therefore explains the onset of a crisis when there is uncertainty over how to interpret the state of the economy or a central bank's willingness to defend a currency. The model of Elsinger et al then shows how the crisis will unfold. As will be demonstrated later in the paper, a crisis may be restricted to one country alone. Equally, there are instances where contagion will develop and hence an entire region will be affected. It follows that a combination of these frameworks achieves the goal of being able to model each of the two scenarios seen in the Latin American countries in 2001 and 2002.

3 Model

3.1 Modelling contagion

A model to describe the Latin American experience needs to be sufficiently versatile to allow for the many different types of inter-linkages between countries. For instance, there are not only trade and financial linkages in the region but also political ties to consider.[3] The framework of Elsinger et al is useful for this purpose and is outlined in this section. The different channels for spill-over can be incorporated in matrix form showing the extent of the commitments between each country. For simplicity these will be considered in financial terms.

There are N countries in the region. Each country, $i \in N$ has a particular level of foreign exchange reserves reflecting its

[3] These are not only evident between the Latin countries but also with economies outside the region eg between Mexico and US.

fundamental state and its ability to defend a pegged exchange rate. This is denoted by θ_i. It also has liabilities to other countries denoted by l_{ij}. When the fundamentals of countries are strong, central banks are more able to meet their debt obligations and hence θ_i takes on a large value. Conversely, when fundamentals are poor, central banks are less equipped to manage their foreign debt.

The inter-linkages between countries in the region can therefore be described by an $N \times N$ matrix, L whereas the fundamental state of each economy is reflected in the vector, $\theta \in R^N$. This system is denoted by (L , θ) which shows that a country's financial viability is dependent on (a) its net indebtedness with other countries and (b) its fundamental state reflected in its stock of foreign exchange reserves. Each entry in the matrix, L, represents \$US billions. Rows indicate debt owed to other countries while columns indicate claims on other countries.

$$L = \begin{pmatrix} 0 & l_{12} & l_{13} \\ l_{21} & 0 & l_{23} \\ l_{31} & l_{32} & 0 \end{pmatrix} \qquad (1)$$

For example Country 1 owes $\$l_{12}$ billion to Country 2 and $\$l_{13}$ billion to Country 3. The zeros throughout the diagonals imply that the countries have no foreign debt with themselves. Conversely, Country 1 is owed $\$l_{21}$ billion dollars from Country 2 and $\$l_{23}$ billion from Country 3. It follows that total inter-country debt can be given by the vector $d = ((l_{12} + l_{13}),(l_{21} + l_{23}),(l_{31} + l_{32}))$. The vector, $\theta = (\theta_1, \theta_2, \theta_3)$ shows the level of foreign reserves held by each central bank and represents the fundamentals of the economy.

As in Elsinger et al a mechanism must be defined to settle payments in the event that countries cannot honour their debts. In their paper, default is resolved by the proportional sharing of the value of the debtor bank among its creditors. Clearly, when we consider

countries as a whole, this is not the typical outcome[4]. In the absence of a sovereign debt restructuring program, the nature of foreign law implies that it is a legal nightmare to resolve a country's debt defaults hence it is more often the case that none of the creditors receive their payments at least initially.[5] For these reasons, I report the results from each of the two approaches. Irrespective of the procedure adopted, the implication is that the resolution of insolvency determines actual payments between countries.

Using the proportional sharing of country value approach we get the following matrix $\Pi \in [0,1]^{N \times N}$ derived from L which normalises the cells by total obligations:

$$\Pi = \begin{pmatrix} 0 & l_{12}/(l_{12} + l_{13}) & l_{13}/(l_{12} + l_{13}) \\ l_{21}/(l_{21} + l_{23}) & 0 & l_{23}/(l_{21} + l_{23}) \\ l_{31}/(l_{31} + l_{32}) & l_{32}/(l_{31} + l_{32}) & 0 \end{pmatrix} \qquad (2)$$

where:

$$\pi_{ij} = \begin{cases} \dfrac{l_{ij}}{d_i} & \text{if } d_i > 0 \\ 0 & \text{otherwise} \end{cases} \qquad (3)$$

From this it is possible to describe a clearing payment vector which gives the total payments made by each country under the clearing mechanism. A clearing payment vector for the system is a vector $p_i^* = \min\left[d_i, \max\left(\sum_{j=1}^{N} \pi_{ji} p_j^* + \theta_i, 0 \right) \right]$. This implies that a country either honours its debts and hence $p_i^* = d_i$ or it defaults on its debts

[4] More likely is the imposition of a sovereign debt restructuring mechanism through which the defaulting country reaches an agreement with its creditors to meet its obligations. In return the existing rights of creditors to sue in court are suppressed at least for a given period.

[5] It has been noted that Argentina's debt is likely to take many years to resolve.

and hence $p_i^* = \max\left(\sum_{j=1}^{N} \pi_{ji} p_j^* + \theta_i, 0\right)$. Using an iterative process it is apparent that if all countries meet their debts there is no default and hence no contagion. However, if one country cannot meet its obligations, the clearing mechanism then calculates the proportional payments made to the creditor countries. This in turn has an impact on the fundamentals of those countries. In a second iteration of this process, the creditor countries only receive a proportion of the debts due to them. This means that, in turn, they may not be able to meet their own debts. If that is the case then they are rendered insolvent and their own debts are subject to proportional sharing among their creditors. This procedure is derived from Eisenberg and Noe (2001) who refer to it as the "fictitious default algorithm". They show that after N iterations at the most, it converges to the unique payment vector p^*.

In the extreme, countries which can readily meet their debt obligations for a given set of fundamentals still suffer a debt default when partner countries default on debts. In short, a country subject to default will render subsequent countries insolvent through contagion. Not only is it possible to identify those countries which will succumb to financial insolvency but also we can distinguish those countries which are prone to contagion. The usefulness of this is that it can act as an "early warning system" indicating countries which are financially vulnerable.

As in Elsinger et al this is illustrated using an example. L is a 4 x 4 matrix representing three regional economies, A, B and C with linkages to the rest of the world denoted by D all in $US billions.

$$L = \begin{pmatrix} 0 & 0 & 0 & 250 \\ 150 & 0 & 50 & 0 \\ 100 & 100 & 0 & 0 \\ 0 & 0 & 0 & 0 \end{pmatrix} \qquad (4)$$

There are two scenarios. The first one shows contagion when defaults are resolved through proportional sharing. By contrast, in

Scenario 2 the defaulting country pays none of its creditors. For each scenario, the L matrix remains the same but three different vectors of fundamentals are considered. In the first case, fundamentals are such that all countries meet their debt obligations and hence no default arises. In the second case, one country is subject to default but contagion does not occur since the remaining countries have sufficiently strong fundamentals to offset the loss. In the final case, contagion prevails since the remaining countries do not have strong enough fundamentals to meet their debts if one of the other countries defaults. The outcome is seen in table 1.

Table 1:
The frequency of debt default and contagion for different states of the economy

Case	Scenario 1 (Proportional sharing)	Scenario 2 (No payments to creditors)
No defaults	$\theta = (100,100,150,1000)$ $p^* = (250,200,200,0)$ No countries default	$\theta = (100,100,150,1000)$ $p^* = (250,200,200,0)$ No countries default
1 Default – no contagion	$\theta = (100,200,100,1000)$ $p^* = (250,200,150,0)$ Country C defaults	$\theta = (100,200,100,1000)$ $p^* = (250,200,0,0)$ Country C defaults
1 Default – contagion	$\theta = (100,100,100,1000)$ $p^* = (250,171.43,142.86,0)$ Country C defaults Country B defaults through contagion	$\theta = (100,100,100,1000)$ $p^* = (0,0,0,0)$ Country C defaults Countries B and A default through contagion

Notably, the model shows the circumstances under which defaults are restricted to one country and equally when they are subject to contagion. The distinction between scenarios 1 and 2 becomes all apparent when looking at the degree of contagion generated by a defaulting country. When default is resolved through proportional sharing only Countries B and C default. However, when none of the creditors of defaulting countries get paid, Country A is also rendered insolvent. This has policy implications for international

organisations such as the IMF or World Bank since an appropriate payments system could limit the damage of a debt crisis in a region and imply that a country could be spared the costs of default.

Clearly the preferable situation would be one of 'no default'. However, given that defaults are inevitable, it therefore seems that the best response for the countries themselves is to ensure that they are not vulnerable to contagion. This suggests a need not only for strong fundamentals to offset losses from defaulting partner countries but also diversification of foreign investment.

3.2 Modelling the onset of a crisis

Morris and Shin illustrate the importance of common knowledge in a model of currency crisis by comparing two situations. In the first instance, investors view perfectly the fundamentals of the economy. In the second instance, they observe the fundamentals with a degree of error. It is shown that when common knowledge holds, the model is characterised by multiple equilibria. Conversely, when there is a lack of common knowledge regarding the state of the economy, a unique equilibrium prevails. When the state of the economy exceeds a particular level, an attack will not occur. However, below this threshold, it becomes optimal for speculators to abandon the currency and as a consequence, the currency collapses.

Agents

The Morris and Shin framework is outlined as follows. The agents in the model consist of one central bank and Q speculators each with equal-sized holdings of the domestic currency. Each agent aims to maximise a payoff, the details of which will follow. The economy's exchange rate is assumed to be pegged at e^* and its fundamentals, θ, are uniformly distributed over the interval, $[0,1]$. In the absence of intervention, the exchange rate is a function of the fundamentals, $f(\theta)$ and lies at or below the pegged rate.

Payoffs

The central bank derives a value, $v > 0$, from defending a pegged regime but also faces a cost, $c(\alpha,\theta)$, which varies with the size of the fundamentals, θ and the proportion of speculators abandoning

the currency, α. Defending the exchange rate peg yields a payoff of $v - c(\alpha,\theta)$ for the central bank while abandoning it gives a zero payoff. Each speculator observes a signal, x, drawn uniformly from the interval $[\theta-\varepsilon,\theta+\varepsilon]$ where ε represents a degree of error. When there is no uncertainty regarding the state of the fundamentals, ε takes on a value of zero. If the speculator attacks the currency, he/she incurs a transaction cost given by $t > 0$ which implies a payoff of $-t$ if the attack is subsequently defended. However, if the attack is successful and the peg is abandoned he/she earns $e^* - f(\theta) - t$.

Model sequence

(1) At the outset, the fundamentals are determined by nature and are uniformly distributed over the interval, $[0,1]$.

(2) Each speculator receives a signal, x, concerning the state of the fundamentals. This is drawn uniformly from the interval, $[\theta-\varepsilon,\theta+\varepsilon]$ and is identically and independently distributed across individuals conditional on θ. If common knowledge prevails, they observe the fundamentals perfectly but when they face uncertainty, the signal contains a degree of error. He/She then decides whether to attack the currency or not.

(3) The central bank observes the proportion of speculators abandoning the currency, α and decides whether to defend the peg. In equilibrium, the strategy for the government and speculators is such that no agent has an incentive to deviate.

Three categories of fundamentals

Morris and Shin denote $\underline{\theta}$ as the value of the fundamentals which solves $c(0,\theta) = v$. This represents the value of θ at which the central bank is indifferent between defending or abandoning the peg. Conversely, they denote $\bar{\theta}$ as the value of θ solving $f(\theta) = e^* - t$. Using these two thresholds it is possible to describe a tripartite distinction for the fundamentals when common knowledge prevails. For values in the interval, $[0,\underline{\theta}]$ the currency is unstable since the peg will collapse irrespective of the actions of speculators. Conversely, when the fundamentals fall in the interval, $[\bar{\theta},1]$, the currency is deemed stable. Even if all speculators attack the currency, the end result is a depreciation that is so small as to make

the payoff from abandoning the currency not worth the cost. The region, $\lfloor \underline{\theta}, \bar{\theta} \rfloor$ is termed "ripe for attack" since the central bank's decision to abandon the peg will depend on the proportion of speculators leaving the currency.

Common knowledge versus uncertainty

To understand the impact of common knowledge within the model, consider first the strategy of the central bank (known to all speculators) and hence the payoffs to speculators across all possible levels of the fundamentals.

The critical proportion of speculators needed to cause a currency to collapse is $a(\theta)$. In the unstable region this takes on a value of zero while elsewhere it is that value of α which solves $c(\alpha,\theta)=v$. It follows that the central bank will abandon the peg if α is greater than the critical mass, $a(\theta)$. Given the strategy of the central bank, it is possible to ascertain the payoffs between the speculators. In the model, $\pi(x)$ denotes the proportion of speculators to attack the currency when signal x is received. It follows that we can denote the proportion of speculators who attack the currency when the fundamentals are θ given the selling strategy, π, as $s(\theta,\pi)$. With signals uniformly distributed, this implies:

$$s(\theta,\pi)=\frac{1}{2\varepsilon}\int_{\theta-\varepsilon}^{\theta+\varepsilon}\pi(x)dx \qquad (5)$$

Now let $A(\pi)$ denote the event that the central bank abandons the peg when the speculators follow the strategy π. This is given by:

$$A(\pi)=\{\theta | s(\theta,\pi)\geq a(\theta)\} \qquad (6)$$

Payoffs to speculators from attacking the currency when the fundamentals are θ and sales of the currency are π can be defined as follows:

$$h(\theta,\pi)=\begin{cases} e^{*}-f(\theta)-t & \text{if } \theta\in A(\pi) \\ -t & \text{if } \theta\notin A(\pi) \end{cases} \qquad (7)$$

However, note that when speculators view the fundamentals with a degree of error, it is the *expected* payoff which is paramount in deciding whether to abandon the currency. The expected payoff conditional on signal x is the expectation of (7) and is described by:

$$u(x,\pi)=\frac{1}{2\varepsilon}\int_{x-\varepsilon}^{x+\varepsilon}h(\theta,\pi)d\theta=\frac{1}{2\varepsilon}\left[\int_{A(\pi)\cap[x-\eta,x+\varepsilon]}\left(e^{*}-f(\theta)\right)d\theta\right]-t \qquad (8)$$

The speculator's decision will therefore depend on whether $u(x,\pi)$ is positive or negative. For positive values, $\pi(x)=1$ and all speculators sell their holdings of the currency. For negative values, $\pi(x)=0$ and no speculators attack the currency.

Therefore the presence of a small amount of noise implies that the multiplicity of equilibria mentioned earlier disappears and there is a unique equilibrium. The main result of the Morris and Shin paper is to show that under imperfect information, a unique value of the fundamentals exists below which it is optimal for the central bank to abandon its currency peg. The reader is referred to Morris and Shin (1998) for a proof of this result.

3.3 Modelling the crisis and the resulting contagion under perfect and imperfect knowledge

Incorporating the Morris and Shin model into the Elsinger framework of contagion has significant implications for the frequency of initial speculative attacks and hence also on the likelihood of a regional crisis.

Agents

There are three types of agent in this model. As in the Morris and Shin framework there is a central bank which seeks to maximise its payoff. It attaches a value, $v > 0$, to maintaining a pegged exchange rate but incurs costs, $c(\alpha, \theta)$, from doing so. A speculative attack makes debt default more likely since it depletes reserves, reduces fundamentals and makes an economy less able to meet its commitments hence there is a positive value of maintaining the peg. The variable v is therefore the value of avoiding the risk of possible debt default. For simplicity it is assumed constant across all economies in the region.

The central bank's payoffs and costs are as stated earlier with the cost of defending a currency dependent on the proportion of speculators abandoning the currency and the size of the fundamentals. This does not incorporate any additional costs associated with debt default.

There are Q speculators each of equal size in terms of their holdings of domestic currency. As before, each speculator observes a signal, x, drawn uniformly from the interval $[\theta - \varepsilon, \theta + \varepsilon]$ where ε represents a degree of error and takes on a value of zero when fundamentals are viewed perfectly[6]. Abandoning the currency incurs a transaction cost of $t > 0$ and if the attack is subsequently defended, the speculator's payoff is $-t$. However, if the attack is successful and the peg is abandoned he/she earns $e^* - f(\theta) - t$. Speculators do not observe the liabilities of their country or its claims on other economies. As such, they are ignorant of the entries in the L matrix and base their decision purely on the fundamentals of their own economy seen in the vector, θ_i.

The final group of agents are those foreign investors who have claims on the country's central bank. They have no strategic interaction within the model. Their purpose is purely to show a very basic inter-linkage between economies.

[6] As in the Morris and Shin framework an assumption is necessary regarding the size of the degree of error ie that $2\varepsilon < \min\{\underline{\theta}, 100 - \bar{\theta}\}$.

Fundamentals in the Model

In the Elsinger framework, a crisis is initially generated by fundamentals which are inconsistent with a country's foreign obligations. When fundamentals are weak and claims cannot be met, a country will default. Their approach can thus model a debt default, but says nothing about the central bank's decision to abandon a pegged exchange rate regime. This is the role of the Morris and Shin component of the model in which the θ_i vector represents the fundamentals of each different country. The θ of each country is uniformly distributed over the interval, $[0,200]$.

Sequence of events

The speculators base their decision of whether to abandon the currency on their observations of the fundamentals. These are viewed either with or without a degree of error depending on whether common knowledge prevails in the model. The central bank's decision regarding the defence of the peg depends on the percentage of speculators abandoning the currency, α. Notably, there is now an additional factor to consider; namely the link between the fundamentals and the liabilities to other economies. It is assumed that a speculative attack on the currency depletes the level of reserves and hence reduces the size of the fundamentals. In particular, the fundamentals will deplete by α. Clearly, this will influence the ability to manage foreign debt requirements, hence a debt default becomes more likely.[7]

The three categories for the fundamentals still exist when there is perfect information regarding the state of the fundamentals. When $\theta < \underline{\theta}$, then even if none of the speculators attack the currency, the central bank will still abandon the peg. However, as noted earlier, the rational strategy for the speculator is to attack when fundamentals fall below this level. Equally, when $\theta > \bar{\theta}$ and the fundamentals are sound, none of the speculators will attack the currency, since the fundamentals are strong enough to withstand a crisis even if all speculators chose to attack.

[7] If debt defaults were allowed to precede speculative attacks in this model, the fundamentals would fall to zero making an attack on the currency and the subsequent abandonment of the peg inevitable.

Once more the interesting case is where the fundamentals fall between $\underline{\theta}$ and $\overline{\theta}$. With common knowledge, the outcome depends on the proportion of speculators who attack the currency. Thus for perfect information, multiple equilibria exist. However, a unique equilibrium prevails when speculators view the fundamentals with a degree of error and hence there is always an incentive to attack the currency when fundamentals fall in this 'ripe for attack' region.

Unlike the Morris and Shin framework, the story does not end there. There are countries' liabilities with foreign investors to consider. Even when there is no speculative attack on a currency, there may still be a debt default. The only difference is that a debt default is more likely once a speculative attack has occurred since reserves will already be much reduced. We may therefore see one of four events occurring; a speculative attack and a debt default, a speculative attack and no debt default, no speculative attack and no default, no speculative attack and a debt default.

What is a currency crisis in this framework?

This brings into question the definition of a currency crisis. In this paper, it is defined as a speculative attack on the currency which causes a central bank to abandon its exchange rate peg. As a consequence the country may fall prey to debt default either as a consequence of reduced fundamentals or through contagion. This is termed a debt crisis. The speculative attack on the currency shows that a country which would otherwise have met its foreign obligations will be driven into default. The impact on the likelihood of debt crises and contagion may be seen by simulation. To form a comparison, the entries in the matrix L and vector θ_i will remain as before.

Simulation using figures from Elsinger Model

In order to provide a numerical simulation, functional forms need to be assigned to $c(\alpha,\theta)$ and $f(\theta)$. In the case of the cost function it is assumed that: $c=\alpha-\theta+\beta$. Thus the cost of defending a peg increases with the percentage of speculators attacking the currency and decreases with stronger fundamentals. The constant, β, ensures that in the worst state of fundamentals, the cost of defending the currency exceeds the value derived from it even when none of the

speculators attack. It also implies that in the best state of fundamentals, the cost of defending the currency outstrips the value if all speculators attack the currency. This is not crucial to the model. When $\beta=0$, this merely implies fewer instances in which speculative attacks are launched.

The exchange rate in the absence of central bank intervention, $f(\theta)$ is assumed to be less than the pegged rate, e^* but increasing in θ so that a higher floating rate is associated with stronger fundamentals. Again it takes on a simple form: $f(\theta)=y+\theta$ where the y parameter is included to show that even when fundamentals are at their lowest, the floating rate is non-zero.

The variables take on the following numerical values:[8]
$v=40$, $\beta=150$, $\alpha=[0,100]$, $\varepsilon=10$, $\theta=[0,200]$,
$y=10$, $t=20$.

Central bank strategy

The central bank will abandon the peg if $c(\alpha,\theta)>v$. Recall that $\underline{\theta}$ is the value of the fundamentals, θ, which solves $c(0,\theta)=v$ ie it is that value at which the central bank is just indifferent between defending the currency and maintaining it when none of the speculators attack the currency. In terms of the figures shown above this is where $\underline{\theta}=110$. Clearly the vectors of fundamentals given in Table 1 show a number of economies falling below this limit and hence these would be subject to speculative attacks. Conversely, $\overline{\theta}$ is the value of the fundamentals which solves $f(\theta)=e^*-t$. Beyond the level, $\overline{\theta}=190$, the central bank's costs of defending an attack on the currency will always fall short of the value even if all speculators were to abandon the currency.

[8] The qualitative results of the model are robust for other values of these variables. The only proviso is that the relationships already described in the paper are met.

Speculators' strategy

The speculators form their decisions based on the central bank strategy outlined above. If they view the fundamentals with perfect information, the payoff to attacking the currency will be:

$$h(\theta,\pi)=\begin{cases} e^{*}-f(\theta)-t & \text{if } \theta \in A(\pi) \\ -t & \text{if } \theta \notin A(\pi) \end{cases} \qquad (9)$$

It follows that, when common knowledge prevails, any value of the fundamentals below 110 implies that it is optimal to attack while any value exceeding 190 implies that it is always preferable not to attack. In the ripe for attack region, the decision to abandon the currency rests on the proportion of speculators who attack and hence nothing more can be said of this case.

When there is imperfect information among speculators the payoff from abandoning the currency is found by taking the expectation of $h(\theta,\pi)$ over all values of θ conditional on the signal received. The expected payoff is given by:

$$u(x,\pi)=\frac{1}{2\varepsilon}\int_{x-\varepsilon}^{x+\varepsilon} h(\theta,\pi)d\theta=\frac{1}{2\varepsilon}\left[\int_{A(\pi)\cap[x-\eta,x+\varepsilon]}\left(e^{*}-f(\theta)\right)d\theta\right]-t \qquad (10)$$

Any value of θ exceeding 190 produces a negative expected payoff, $u(x,\pi)$, hence it is optimal for each speculator to refrain from attacking when the fundamentals fall in this region. However, when the fundamentals fall below 190 the expected payoff is positive, even in the ripe for attack region and thus it is rational to attack.

The model implies that it only takes a small degree of uncertainty in speculators' perceptions for a crisis to be triggered for values of the fundamentals that would otherwise be sound. The full impact of these speculative attacks, both with and without common knowledge of the fundamentals, can be seen in the model of contagion. The same vectors of fundamentals are used as in table 1. The difference

is that each value is compared with the critical values of $\underline{\theta}$ and $\overline{\theta}$ under perfect and imperfect information. If it falls in the crisis region, then the value of the fundamentals is reduced by the percentage of speculators attacking the currency. The country then needs to meet its debt obligations. At this point, debt default may arise.

Common knowledge

When speculators observe fundamentals with no degree of error, it is optimal to attack the currency if the fundamentals fall below 110. Referring back to table 1, Country A is always subject to attack, Country D (representing the rest of the world) is never attacked, Country B is attacked in Cases 1 and 3 when its fundamentals are just 100 and Country C is attacked in Cases 2 and 3 when its fundamentals are 100. However in Case 1, its fundamentals fall in the 'ripe for attack' region hence whether it is initially attacked or not depends on the proportion of speculators to attack the currency. However, this becomes immaterial when contagion is examined since Country C falls prey to debt default as a consequence of contagion. Indeed, compared with table 1 it is apparent that allowing for speculative behaviour in the foreign exchange markets implies a higher incidence of debt default than when speculative behaviour is not incorporated.

Table 2:
The frequency of debt default and contagion for different states of the economy when speculators have perfect knowledge of fundamentals

Case	Scenario 1 (Proportional sharing)	Scenario 2 (No payments to creditors)
1 Default – two cases of contagion	$\theta = (0,0,150,1000)$ $p^* = (150,85.71,171.43,0)$ Country B defaults Countries A and C default through contagion	$\theta = (0,0,150,1000)$ $p^* = (0,0,0,0)$ Country B defaults Countries A and C default through contagion
1 Default – one case of contagion	$\theta = (0,200,0,1000)$ $p^* = (175,200,50,0)$ Country C defaults Country A defaults through contagion	$\theta = (0,200,0,1000)$ $p^* = (0,200,0,0)$ Country C defaults Country A defaults through contagion
3 Defaults – no cases of contagion	$\theta = (0,0,0,1000)$ $p^* = (0,0,0,0)$ Countries A, B and C default	$\theta = (0,0,0,1000)$ $p^* = (0,0,0,0)$ Countries A, B and C default

Imperfect knowledge

Under imperfect information, the same scenario prevails as shown in table 2 with one main exception. In Case 1, it becomes optimal for speculators in Country C to attack their currency since fundamentals fall in the 'ripe for attack' region. It follows that reserves are depleted and hence the fundamentals fall from 150 to 50. The vector of fundamentals is given by $\theta = (0,0,50,1000)$ and the clearing payment in each scenario becomes $p^* = (0,0,0,0)$. In this particular instance, all countries default immediately with none subject to contagion.

It has been shown that incorporating speculative behaviour into the basic contagion framework increases the frequency of debt defaults among economies. This also makes contagion more likely since countries' fundamentals are weakened through speculative attacks. When we then distinguish between the nature of information received by speculators, it is shown that imperfectly viewed fundamentals cause an even greater incidence of initial defaults of countries since speculative attacks becomes more frequent. Therefore, the overall impact of combining strategic speculative behaviour with a model of country indebtedness is to cause considerably more instances of debt default than if the basic foreign debt inter-linkages were viewed in isolation.

4 Policy implications

The simulations in the previous section produce a number of important policy implications from the perspective of individual economies and also for outside bodies such as the World Bank or IMF. Since two models have been combined to explain an initial currency crisis and then its spread through contagion, the related policy recommendations may be broadly divided into two categories. The first concerns the early part of the model whereby the onset of a crisis is related to uncertainty regarding the state of the economy and hence the amount of reserves held to defend an attack. The second refers to the latter part of the model ie the contagion aspect wherein a crisis spreads to neighbouring economies. Therefore, this section discusses the policy implications for the different economic agents in each section of the framework.

4.1 Intervention by the IMF and World Bank

An important issue generated by the simulations is the degree to which the World Bank or IMF should intervene to support countries that would otherwise experience balance of payments difficulties. This is particularly relevant when there is uncertainty among speculators regarding the state of the economy since according to the model this makes an attack on a currency more likely.

One of the roles of the IMF is "to provide temporary financial assistance to countries to help ease balance of payments adjustment" hence this would suggest a need to intervene in support of countries susceptible to attack. However, the evidence suggests that high levels of outside financial assistance do not necessarily add credence to a country's policies. As has already been stated, (Mussa, 2002), a more relevant factor is the market's interpretation of the funding. As an illustration consider table 3 which provides a summary of IMF total fund credit and loans outstanding to the Latin American countries across the period. This may be viewed in conjunction with table 4 showing the Fund account arrangements with each of the countries detailed and figure 1 showing EMBI spreads. Clearly, there were considerable disbursements across the region during the period as indicated by the growing levels of outstanding loans to the Fund. However, while spreads appeared to narrow in the first half of 2002, they rose thereafter.

How might this be interpreted? One possibility is that the initial loan disbursements by the IMF were interpreted positively by speculators as support for the countries in question. Hence IMF funding may have had the effect of deferring a currency crisis in Brazil. However, when Argentina sank further into crisis, the mood among speculators deteriorated and hence additional funding acted as a negative signal for the state of each economy.

What then should be the advice for these bodies? Clearly the market reaction to financial assistance is relevant when making a decision concerning intervention. In terms of the simulation, outside financial assistance may have the effect of increasing uncertainty regarding the state of the economy and thus generate speculative attacks. Conversely, if the markets interpret the loan as a vote of confidence

in the country, uncertainty may be reduced and the incidence of attacks decreased. The implication here is that market sentiment must be gauged prior to any decision-making regarding funding.

Table 3:
Total IMF loans outstanding for the Latin American economies

Quarter	Total IMF Loans Outstanding (Millions SDRs)				
	Argentina	***Brazil***	***Mexico***	***Uruguay***	***Venezuela***
Q1 2001	5843	1357	0	114	112
Q2 2001	6609	2958	0	114	56
Q3 2001	11322	6634	0	114	12
Q4 2001	11121	6634	0	114	0
Q1 2002	10950	6566	0	250	0
Q2 2002	10790	10891	0	744	0
Q3 2002	10645	13105	0	1333	0
Q4 2002	10548	15320	0	1319	0
Q1 2003	10672	18192	0	1523	0

Source: IMF International Financial Statistics.

Table 4:
IMF account arrangements with the Latin American economies 2000-2003

Country	IMF Account Arrangements
Argentina	Standby Arrangement – Mar 10 2000 to Jan 23 2003. Amount = 16937 Million SDR of which Supplemental Reserve Facility – Jan 12 2001 – Jan 11 2002. Amount = 6087 Million SDR
Brazil	Standby Arrangement – Sep 14 2001 to Sep 5 2002. Amount = 12144 Million SDR of which Supplemental Reserve Facility – Sep 14 2001 – Sep 5 2002. Amount = 9951 Million SDR Standby Arrangement – Sep 6 2002 to Dec 31 2003. Amount = 22821 Million SDR of which Supplemental Reserve Facility – Sep 6 2002 – Sep 5 2003. Amount = 7610 Million SDR
Mexico	None
Uruguay	Standby Arrangement – May 31 2000 to Mar 31 2002. Amount = 150 Million SDR Standby Arrangement – Apr 1 2002 to Mar 31 2005. Amount = 2128 Million SDR of which Supplemental Reserve Facility – Apr 1 2002 – Aug 8 2002. Amount = 129 Million SDR
Venezuela	None

Source: IMF International Financial Statistics.

4.2 Transparency

The model suggests that an economy with strong fundamentals and hence considerable reserves with which to defend a speculative attack has an incentive to make this public knowledge. A clear announcement of the quantities of reserves held by the authorities has the effect of reducing uncertainty thereby making an attack on the currency less likely.

Conversely, when reserve holdings are small and fundamentals weak, the advice is reversed. It is not within a monetary authority's interest to make public the fact that it has little ability to defend an attack on its currency. There is therefore a need for individual monetary authorities to ensure not only that there are adequate provisions of foreign exchange reserves but also that this is made public knowledge in order to reduce the likelihood of an attack on a currency.

In terms of the data, it is very difficult to measure the transparency of each individual monetary authority. However, ex post measures of international reserves are relatively easy to find. Table 5 reports an absolute measure of international reserves together with reserves as a proportion of the money supply. Together these indicators allow a comparison between countries of the relative ability to withstand a currency crisis and hence a depletion of reserves. For Argentina this depletion is apparent. However, in the case of Uruguay this does not occur until early 2002. Venezuela also experiences a significant drop in reserves at this point with a similar pattern observed for Brazil in later quarters of 2002. Even Mexico experiences a drop in reserves in the second quarter of 2002.[9]

Again the salient feature here is the delay before other economies succumb to crisis. Notably, with the exception of Argentina, all the countries in the sample accumulated further reserves by the first quarter of 2003 thus providing a signal of recovery from crisis.

[9] A note of caution is needed here. While the ratio of total reserves to money supply is useful for identifying those countries with a relatively small proportion of reserves to defend a crisis, it is highly sensitive to changes in the exchange rate. Total reserves are given in terms of SDR whereas M2 is expressed in terms of national currency. Therefore an apparent increase in the ratio following the crisis is actually due to depreciating currencies in terms of SDR rather than an improvement in the real proportions of reserves.

Table 5:
Total reserves for the Latin American economies and as a proportion of the money supply

Quarter	Total Reserves minus Gold (Millions SDRs)									
	Argentina		***Brazil***		***Mexico***		***Uruguay***		***Venezuela***	
	Res.	$\frac{RES}{M2}$	*Res.*	$\frac{RES}{M2}$	*Res.*	$\frac{RES}{M2}$	*Res.*	$\frac{RES}{M2}$	*Res.*	$\frac{RES}{M2}$
Q1 2001	17388	0.25	27082	0.24	31915	0.34	2115	0.26	9554	0.61
Q2 2001	16921	0.24	29806	0.27	32721	0.32	2219	0.28	8397	0.54
Q3 2001	15947	0.26	30964	0.32	33209	0.34	2133	0.27	6950	0.48
Q4 2001	11580	0.2	28439	0.24	35600	0.32	2464	0.31	7352	0.43
Q1 2002	10279	0.46	29341	0.24	37050	0.34	1760	0.24	4936	0.39
Q2 2002	7251	0.45	31457	0.32	34217	0.37	1091	0.19	5744	0.69
Q3 2002	7119	0.42	28909	0.36	35237	0.38	553	0.11	6165	0.77
Q4 2002	7716	0.4	27718	0.31	37214	0.39	566	0.11	6243	0.62
Q1 2003	7672	0.34	30709	0.34	39222	0.42	571	0.12	7223	0.84

Source: IMF International Financial Statistics.

4.3 Fixed versus flexible exchange rate regimes

There is already a considerable literature debating the relative merits of fixed and flexible exchange rates with the results of this model supporting much of what has already been argued. The framework is set up with a fixed regime in mind hence the monetary authorities are required to measure the costs of maintaining a peg against the benefits. In particular, it is assumed that the exchange rate lies above that which would exist if the peg were abandoned. Furthermore, the benefit to abandoning a currency increases the larger is this disparity. It follows that monetary authorities need access to considerable foreign exchange reserves if they are to successfully defend an attack on the currency. The stronger are the country's fundamentals, the more plentiful are these reserves.

What does this suggest for policy? First, a fixed exchange rate regime implies a need to hold large levels of reserves. Second, when choosing a fixed exchange rate, there is an obvious need to peg this

at a sustainable level. In terms of the model, the greater the difference between the fixed exchange rate and the shadow rate which would exist in the absence of intervention, the greater the incentive for speculators to attack a currency. The collapse of a number of exchange rate regimes (including the European ERM in 1992) may be attributed to an inappropriate choice of exchange rate peg and hence this warrants further consideration for the Latin American economies.

4.4 Capital controls

A further strand of the literature that has been subject to debate has been that of capital controls. In terms of the framework outlined here, the imposition of a Tobin tax has the effect of deterring a crisis by increasing the cost to speculators of attacking a currency. In the extreme, a sufficiently high level of capital controls implies that a crisis can be averted even when the fundamentals are weak. An argument can therefore be made for capital controls since this form of regulation has the effect of "buying time" so that the monetary authorities can implement measures to fix the fundamentals. In this framework, such measures would deter an imminent crisis and allow the authorities time not only to raise their levels of reserves but also to assess their obligations to other countries and hence the risk of crisis contagion.

4.5 Foreign currency exposure

One of the most important policy implications revealed by the framework concerns the nature of a country's debt obligations. The model tells us that it is not necessarily the *level* of debt which is an issue (although excessive debts will play a role) but its *composition*. This brings into consideration the inter-linkages between countries in a region and, in particular, the balance sheets of monetary authorities with regard to neighbouring economies. The argument here is that if one particular economy suffers a crisis then it will be unable to meet its obligations thus rendering default to its counterparts. Therefore, the model implies that default is minimised by diversifying risks rather than relying solely on one partner. However, this warrants further investigation.

Intuitively one can imagine instances when diversification will not save an economy from default. For example, a large outside shock would damage the balance sheets of *all* economies in a region regardless of how well diversified each might appear on first inspection. While this was not the case of Latin America in 2001-2, it is still worthy of consideration by policymakers.

A second possibility concerns underlying credit links between economies in a region. The monetary authorities' balance sheets may appear well-diversified. However, each may rely on particular banks and organisations both within and outside the area and hence are highly interdependent. The implication here is that in evaluating the reliability of investments in a region, it is more appropriate to consider the indebtedness of the region as a whole rather than for each individual economy.

With this in mind, consider table 6 showing each country's net foreign assets as a proportion of the economy's money supply. This ratio is commonly used as a measure of foreign currency exposure. A fall in this value is associated with a deterioration in an economy's net foreign asset position. While the international financial statistics of the IMF do not specify cross-border liabilities and claims for each country in the region, the available data give an idea of the degree of foreign currency exposure.

Not surprisingly, Argentina's ratio of net foreign assets to M2 is negative throughout the period. However, for Brazil and Uruguay this stays fairly constant from 2001 to 2002 possibly as a consequence of continued IMF support. In the case of Mexico the decline in the ratio is not seen until 2002 but remains positive throughout. At first glance Venezuela appears to be an outlier. It too experienced crisis but appeared to have a foreign exposure very similar to that of Mexico. A likely explanation for this result is that the Venezuelan economy relies heavily on the oil industry and hence reaps considerable foreign return from this market.

In short, the data confirms that each economy exhibited a degree of foreign currency exposure at the time of the Argentinean crisis. However, for those countries receiving outside aid, the ratio of net foreign assets to M2 did not decline dramatically over the period.

Furthermore, the results are consistent with the argument that the initial crisis in Argentina did not have immediate impacts on its neighbours. Reserves did not deplete in the region until 2002 at which time net foreign assets also fell.

Table 6:
Net foreign assets of the Latin American economies as a proportion of the money supply

	Net Foreign Assets as a Proportion of the Money Supply $\frac{NFA}{M2}$				
	Argentina	***Brazil***	***Mexico***	***Uruguay***	***Venezuela***
Q1 2001	-0.06	-0.09	0.04	0	0.05
Q2 2001	-0.07	-0.11	0.05	0	0.06
Q3 2001	-0.09	-0.1	0.11	0	0.05
Q4 2001	-0.13	-0.07	0.08	-0.01	0.03
Q1 2002	-0.31	-0.07	0.05	0.03	0.05
Q2 2002	-0.44	-0.1	0.07	0.04	0.07
Q3 2002	-0.41	-0.1	0.03	0.08	0.08
Q4 2002	-0.35	-0.08	0.06	0.14	0.07
Q1 2003	-0.28	-0.1	0.02	0.06	0.09

Source: IMF International Financial Statistics.

5 Conclusion

The purpose of this research was to design a stylised framework that could help to explain the events of 2001-2 in Latin America. In particular, the model needed to capture two features; first why the initial collapse of the Argentinean economy was not immediately followed by contagion in the region; second, why a number of economies in the region were instead subject to speculative attacks in 2002.

A model of contagion alone is shown to be useful in examining the spread of debt default across countries in the region (for instance between Argentina and Uruguay). However, it fails to explain a crucial aspect of the crises; namely strategic speculative behaviour. Hence the framework adopted in this paper incorporates the role of speculators.

Using the model one may argue that during 2001, many of the Latin American countries had strong enough fundamentals to deter an attack and withstand the collapse of a close financial or trading partner. However, during the following year, fundamentals deteriorated and hence the economies were vulnerable to attack from speculators and an inability to meet debt obligations.

What are the implications for policy? First, the contagion model suggests that economies should diversify their trade and financial links rather than rely on one close partner. It is apparent that a debt default by one economy increases the likelihood of default in neighbouring home economies. Furthermore, a strengthening of the fundamentals would also be recommended as a long-term prescription.

However, when the strategic behaviour of speculators is included in the framework, it is not just the soundness of the fundamentals which counts but the speculators' perceptions of them. As noted earlier, the lack of contagion during 2001 was attributed to positive speculator sentiment (Vogel, 2001), hence its role in a model of currency crisis should not be underestimated.

For instance, when the state of the economy is viewed perfectly, then if the fundamentals fall within a particular interval, the currency becomes vulnerable to attack ie if a large enough proportion of speculators attack a currency, the peg will be abandoned. However, if speculator sentiment is high, an economy can maintain its currency peg yet still have fundamentals of this magnitude. By contrast, if the economy is viewed with uncertainty, there is an even greater incentive to ensure that fundamentals are sound and do not fall in this region. If they do, a speculative attack is optimal and as a consequence, debt default is more likely. The policy advice is then apparent; the state of the economy is crucial not just to avoid the obvious default on foreign obligations but also to deter the possibility of speculative attacks on a currency. The Latin American central banks will be well aware of these issues. The task now is to re-build sound fundamentals and policy credibility from crisis-ridden economies.

References

Allen, F, and D Gale (2000), "Financial contagion," *Journal of Political Economy* 108 (1), 1-33.

Allsopp, L (2002), "Common knowledge and the value of defending a fixed exchange rate – an explanation of a currency crisis," *Journal of Macroeconomics* 24(1), 67-79.

Berger, W and H Wagner (2002), "Spreading currency crises: the role of economic interdependence," *IMF Working Paper* 144.

Calvo, G (1999), "Contagion in Emerging Markets: When Wall Street is a Carrier," University of Maryland, mimeo.

Calvo, G and E Mendoza (2000), "Rational contagion and the globalization of securities markets," *Journal of International Economics* 51(1), 79-113.

Diamond, D D and P H Dybvig (1983), "Bank runs, deposit insurance and liquidity," *Journal of Political Economy* 91, 401- 19.

Diamond, D D and R G Rajan (2002), "Liquidity shortages and banking crises," *NBER Working Paper* 8937.

Eisenberg, L and T H Noe (2001), "Systemic risk in financial systems," *Management Science* 47, 236-49.

Elsinger, H, A Lehar and M Summer (2002), "Risk assessment for banking systems," *Oesterreichische Nationalbank Working Paper* 79.

Fiess, N (2003), "Capital flows, country risk and contagion" *World Bank Policy Research Working Paper* 2943.

Glick, R and A Rose (1999), Contagion and trade: why are currency crises regional? *Journal of International Money and Finance* 18(4), 603-617.

Hernandez, L F and R O Valdes (2001), "What drives contagion: trade, neighborhood, or financial links?" *IMF Working Paper* 29.

Masson, P (1999), "Contagion: macroeconomic models with multiple equilibria," *Journal of International Money and Finance* 18(4), 587-602.

Metz, C E (2002), "Private and public information in self-fulfilling currency crises," *Journal of Economics* 76(1), 65-85.

Morris, S and H S Shin (1998), Unique equilibrium in a model of self-fulfilling crises. *American Economic Review* 88, 587-97.

Mussa, M (2002), "Latin American Economic Crisis. Testimony Before Subcommittee on International Trade and Finance Senate Committee on Banking, Housing and Urban Affairs."

Pesenti, P and C Tille (2000), "The economics of currency crises and contagion: an introduction," *Federal Reserve Bank of New York* Economic Policy Review.

Prati, A and M Sbracia (2002), Currency crises and uncertainty about fundamentals," *IMF Working Paper* 3.

World Bank Group (2000), Definitions and Causes of Contagion. http://www1.worldbank.org/economicpolicy/managing%20volatility/contagion/definitions.html