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INTERNATIONAL FINANCIAL CONTAGION: WHAT DO WE KNOW?

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International Financial Contagion: What Do We Know?

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Abstract: This paper attempts a synthesis of theoretical and empirical work on international financial contagion. Although a professional consensus on the appropriate definitions of contagion has yet to emerge, we document substantial research progress towards this goal. On the empirical front, determining when returns are 'excessive' is a pre-condition for designing effective policy response to crises. At the theoretical level, tracing the observed herding behavior to market participants' uncertain beliefs and information asymmetries is a key element for understanding how contagious effects arise. It is argued that the recent focus on better understanding of high-frequency financial returns data and decision making at the market microstructure level are promising avenues for understanding the transmission of shocks across markets and countries.

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JEL Classification: E44, F34

1. Introduction

Use of the word 'contagion' to describe the international transmission of financial crises has become fraught with controversy, to the extent that some recent authors have seen fit to avoid using the word entirely; see Favero and Giavazzi (2002) and Rigobon (2003). The term evokes an emotive response among both producers and consumers of research on international financial markets, and there is no general agreement over its use.[1] Emotional responses stem in part from the borrowing of epidemiological terminology – contagion is intrinsically associated with disease, and even more dismally with death, as contagion was often used as a synonym for the Bubonic Plague in Europe as late as the 19th century. The term also implies, at least to some, that those who fall prey to financial crises do so through no fault of their own. However, this is an idea that some analysts are inclined to strongly resist: speculators appear to discriminate in choosing the countries they attack.

Against this background, in this paper we suggest that the World Bank's 'restrictive' definition of contagion is a useful benchmark.[2] This follows Eichengreen and Rose (1995) and Eichengreen, Rose and Wyplosz (1996), who propose that contagion refers to the association of excess returns in one country with excess returns in another country *after* controlling for the effects of fundamentals. This definition is closely related to 'true' contagion, as defined in Kaminsky and Reinhart (2000), arising in the absence of, or after controlling for, common shocks and all possible interconnection channels.

Even with agreement on this definition, there are formidable difficulties in reaching the appropriate set of fundamentals to use as control variables, suggesting that such models may not be effectively operational. On the counter side, recent empirical research proposes two alternative means. Dungey, Fry, Gonzalez-Hermosillo and Martin (2003) propose the use of latent factor models, which do not require the exact specification of the fundamental relationships, while Pesaran and Pick (2003) suggest controlling for

[1] For example, Pericoli and Sbracia (2001) provide an overview of the contagion literature containing five different classifications of contagion.
[2] The World Bank's definitions of contagion are available on the Internet at http://www.1.worldbank.org/economicpolicy/managing%20volatility/contagion/definitions.htm.

fundamental-based market interdependencies using trade flow data and examining contagion as transmissions above that. Each approach contains an implicit criticism of the other. The Dungey et al. framework suggests that the interdependencies captured in the data are insufficiently general, while Pesaran and Pick find that interdependencies are not sufficiently identified in the latent factor framework. Both methodologies have difficulty in identifying fundamental contagion from other transmissions – a problem highlighted by Dornbusch, Claessens and Park (2000).

A variation on the above definition is whether contagion represents the unanticipated transmission of shocks. When cross-country linkages countries are anticipated – for instance through trade and financial flows or other *a priori* links - then these represent fundamental linkages, hence they are not contagion. Arguably, the particular channel through which contagion is transmitted is equally important, such as through financial markets, trade relations, political linkages and expectations. Researchers emphasizing the importance of identifying the channels argue that this is a way of reassuring observers that underlying the estimated correlations is really the international transmission of financial stress, and not simply variables which are common across countries but omitted from the specification.

The choice of fundamentals is not independent of the problem at hand. The literature tends to adopt definitions of contagion specific to each application, and given the difficulties inherent in defining the appropriate control variables this may be appropriate. As a result, contagion may in fact be a concept that is defined relative to a *particular* set of fundamentals, so its appropriate definition is the co-movement of excess returns in one country with excess returns in another country after controlling for the effects of specified fundamentals. Contagion is then defined relative to the chosen fundamentals control group.[3]

Thus, any test for the presence of contagion is only as good as the fundamentals-based model determining cross-country output correlations, excess market returns, etc. An early theoretical account of contagion between two countries linked by their current and

[3] Thanks to David Vines for helpful discussions to clarify this point.

capitals accounts is Gerlach and Smets (1995). In empirical applications, researchers have used a number of alternative controls for representing fundamental variables. For example, Miller, Thampanishvong and Zhang (2003) use U.S. interest rates as a control variable, while Eichengreen, Wyplosz and Rose (1995,1996) employ an array of economic and political 'focus variables', including exchange rates and interest rates, CPI inflation, the current account and budget balances, stock market indices, and indicators of domestic credit and labor markets and political conditions; some of these are replicated in Pesaran and Pick (2003). In that respect, an advantage of latent factor models such as Dungey et al. (2003), Bekaert, Ng and Hodrick (2003) and Corsetti, Pericoli and Sbracia (2002) is that they do not require the particular observed fundamental relationships to be specified. The disadvantage is that the transmission channels for contagion are not specifically identified -- for example, is it through trade or financial flow issues. In other words, the mechanism by which the underlying fundamentals affect asset prices is not accounted for.

The remainder of the paper is arranged as follows. Section 2 discusses how the known statistical properties of financial market data are incorporated into models and tests for contagion. Section 3 examines empirical issues in testing for contagion and defining crisis sample periods. This is followed in Section 4 by a discussion of the potential for contagion in different dimensions. In addition, a market participant's view on contagion may differ from that of a policy maker; this is discussed in Section 5, while Section 6 considers the role of IMF intervention. Section 7 offers some concluding remarks.

2. Capturing the Properties of Financial Market Data

If financial contagion is associated with excess returns, then the problem of defining these is immediately raised. To know when returns are 'excessive' requires an effective model of asset prices during normal times. At a minimum, the statistical properties of financial markets data need to be accommodated in any modeling exercise.[4] Empirical

[4] One set of stylized facts for contagion is the existence of strong regional effects in equity and currency market contagion, such as documented by Agenor, Miller, Vines and Weber (1999), Eichengreen (2002), Kaminsky and Reinhart (2002) and Krugman (2000). However, for bond market data this regionality does not seem to be present, a feature noted by Masson, Chakravarty and Gulden (2003) and confirmed in Dungey, Fry, Gonzalez-Hermosillo and Martin (2002) in a study of the Russian and LTCM crises.

distributions of daily financial market returns are typically non-normal and display volatility clustering (time-varying heteroscedasticity/GARCH effects) and fat tails (leptokurtosis). Thus, researchers proposing to model financial market processes should arguably be expected to reproduce these characteristics. The production of data distributions with fat tails requires some form of non-linearity, and introducing this constitutes an important strand of contagion research.

Non-linear models incorporate both the statistical properties and the observation that the propagation mechanism for shocks may differ between normal and crisis periods. One class of models, such as Bae, Karolyi and Stulz (2003) and Baur and Schulze (2002), examines relationships only in the tails of the distributions. In a variation on this, Quintos, Fan and Phillips (2001) view differences between non-turmoil and crisis periods as changes in the behaviour of the tails themselves. Others divide extreme observations from those in a 'usual' range using some form of threshold function between calm and crisis periods, such as is suggested by Pesaran and Pick (2003) and undertaken in earlier work in a linear model by Eichengreen, Rose and Wyplosz (1995,1996) and Favero and Giavazzi (2002). Pesaran and Pick separate contagion from interdependence by use of a model of transmissions in 'normal' times. Contagion is then represented non-linearly by the introduction of transmissions of relatively large shocks across countries, where the definition of a relatively large shock is determined by a threshold function.

Another source of concern in the existing literature on contagion is that the strong heteroskedasticity present in financial returns data is not treated consistently. For example, the initial model of Miller et al. (2003) cannot generate crises because it has no means of producing heteroskedasticity unless a market maker is present. On the other hand, Favero and Giavazzi (2002) use heteroskedasticity and non-normality to identify crisis periods, and Forbes and Rigobon (2002) identify the existence of contagion through a change in volatility.

This points to the importance of the definition of a crisis period in identifying contagion. A majority of researchers assume that contagion is a feature only of crisis data, and hence uses the presence of heteroskedasticity for identifying crises. Two broad methods of

crisis period identification are encountered in the literature. The first is *ad hoc* and usually event based (Forbes and Rigobon (2002), Dungey et al (2002)), while the second relies on identifying turbulence with higher volatility observations, based on thresholds determined from the sample (Favero and Giavazzi (2002), Eichengreen, Rose and Wyplosz (1995)). This method is subject to sample selection bias, to the extent that the volatility threshold is exogenous. Put differently, by raising the threshold level the analyst is selecting fewer 'crisis observations'. Research progress on endogenizing the process of separating crisis from non-crisis data in the sample would be a substantial step forward.

3. Market Interdependence and Crisis Thresholds

In order to isolate contagious effects, the relative strength of market interdependence and contagion need to be both modeled simultaneously and separately identified. Interdependence, as opposed to contagion, occurs if cross-market co-movement is not significantly bigger after a shock to one country, or group of countries. Controlling for this is easier in a bivariate setting with two countries and two asset markets than in a multivariate environment, although the resulting dynamics are not as rich.

There has been extensive evidence of rising correlation between international financial markets in recent decades, keeping pace with the trend towards capital account liberalization; see, for example, Longin and Solnik (1995). More recently, the bivariate test for significant changes in the conditional correlation between asset returns over non-crisis and crisis periods was popularised by Forbes and Rigobon (2001, 2002). Applications include Baig and Goldfajn (1999) and Ellis and Lewis (2000). This is the most common test in the literature; some of the relevant issues in running it are covered in Corsetti, Pericoli and Sbracia (2001), Loretan and English (2000) and Boyer, Gibson and Loretan (1999). The correlation test is a variant of the World Bank's 'very restrictive' definition of contagion, although in the majority of applications there is some attempt to control for (a limited set of) fundamentals.[5] Although existing applications are bivariate, Dungey et al (2003) show the multivariate equivalent.

[5] Butler and Joaquin (2002) conduct tests consistent with the 'very restrictive' definition of contagion, although their paper is not directly addressing this issue.

In the correlation testing approach, the issue of defining the crisis sample period again arises, because the sample is chosen to coincide with consensus dating of crises. Sample selection problems plague the empirical identification of contagion, underscored by the wide heterogeneity in the financial crises experience of different countries. Additionally, the sample size of crisis episodes is typically small, implying poor power properties. In many cases the thresholds used to identify crisis periods are not independent of the sample, for example Eichengreen, Rose and Wyplosz (1995,1996), Favero and Giavazzi (2002). Preferably, the choice of threshold should be modeled simultaneously with the choice of crisis period, as shown by Pesaran and Pick (2003). Correct identification of the threshold between non-crisis and crisis periods has direct implications for financial crisis prevention and management; this is discussed in Section 5.

Leading indicators of financial crises serve to avert policy makers to looming crises. They also present one means of identifying thresholds between non-crisis and crisis periods. This area of the literature combines fundamental indicators to provide a 'crisis vulnerability' index that could serve as an early warning system for public policy, as for example in Goldstein (1998) and Goldstein, Kaminsky and Reinhart (2000). The combination of fundamental variables with a threshold based on historical data is similar in intent to the approach used by Eichengreen, Wyplosz and Rose (1995,1996) to construct an exchange market pressure index.

Unfortunately, very few fundamental indicators are found to be statistically significant control variables in existing applications. In the historical analysis of Eichengreen, Rose and Wyplosz (1995, 1996) and related studies this was not such a large problem. Perhaps more disturbingly, crisis indicators based on fundamental indicators have also proved to have poor predictive power in forecasting financial crises; see, for example, Edison (2000) and Berg and Patillo (1999). This is reflected in the heterogeneity of currency crises' causes and features for different countries, documented in Frankel and Rose (1996), as well as in the unpredictability of reversals in short-term capital flows, emphasized by Calvo's (1998) *sudden stops*. Poor predictive power suggests that non-linearity and breaks in the generating processes of financial market data are pervasive, as

discussed earlier. Susceptibility to contagion is highly non-linear, and historical relationships – however robust – are not useful in predicting future financial crises.

More generally, models of financial contagion can be classified as fundamental or behavioural. In the first category the analysis is event-driven, where the event is usually a financial crisis. Examples include the applications of Glick and Rose (1999) and Van Rijikghem and Weder (2001) to shocks from a particular country identified as 'country zero'. On the other hand, behavioural models consider that changing beliefs and 'herding' underlie the transmission of shocks between countries. A good example is the situation presented by Miller, Thampanishvong and Zhang (2003) investigating the turmoil in Brazilian financial markets in 2001. Although turmoil existed in Brazilian financial markets, the feared event of sovereign debt default did not materialize. Consequently, there was no identifiable crisis event – rather, the turmoil was caused by fear of the potential cost of default. A useful distinction between the biological and behavioural models is that biological models tend to operate in a time series domain, following an event, whereas fundamental models operate in both time series and cross-section dimensions. This is the subject of the next Section.

4. Herding, Contagion and Models with Multiple Equilibria

The empirical contagion literature is frequently based on time series explorations. However, this may not be the appropriate dimension in all instances. For example, Masson, Chakravarty and Gulden (2003) suggest that contagion and herding by investors can be distinguished as they respectively belong to the time series and cross-section dimensions. However, although 'true' contagion – unanticipated transmission of shocks – is often associated with herding behavior, the latter need not be a necessary condition for contagion. Pesaran and Pick (2003) in particular suggest that herding and contagion can be separately identified, but modelled simultaneously.

In theoretical models, contagion is commonly identified as an equilibrium phenomenon. On the one hand, if contagion is due to herding, this can be viewed as a rational response on the part of investors when there are fixed costs of acquiring and processing country-

specific information, as in Calvo and Mendoza (2000). On the other hand, macroeconomic models with rational expectations generically have multiple solutions. It follows that researchers' different informational assumptions can have different implications regarding the number of equilibria. If a given set of fundamentals can give rise to multiple equilibria, then speculative attacks can be self-fulfilling and contagion can also be 'irrational', that is unanticipated. Within a cross-section, investors' behavior can be interpreted as jumps between different equilibria. The issue of multiplicity is critical for some models of contagion – for example, see Shiller's (2000) account of the U.S. stock market bubble in the late 1990s. The strength of the self-fulfilling mechanism for contagion may also be a potent explanatory factor underlying the collapse of the ERM in 1992-93; see Drazen and Masson (1994).

The issue of unique versus multiple equilibria relates to the debate between fundamental-based (first-generation) and beliefs-based (second-generation) models of currency crisis. The first originated with Krugman (1979) while the second can be traced to Flood and Garber (1984) and is closely associated with Obstfeld (1994, 1996). In fundamental-based models, the crisis occurs deterministically as foreign exchange reserves run out, but there is no contagion. Beliefs-based models can admit multiple equilibria and 'sunspots' leading to self-fulfilling beliefs and speculative attacks. In the context of currency crises, if market participants anticipate that a successful attack on a currency peg will alter exchange rate policy, it is *expected* future fundamentals conditional on an attack that are incompatible with the peg. In the time series domain, contagion to a country is then understood as jumps between multiple equilibria triggered by events elsewhere.

However, there now appears to be a consensus that a unique equilibrium may be an artefact of the unrealistic treatment of expectations; see Jeanne and Masson (2000), Kehoe (1996) and Krugman (1996, 2000). One source of multiplicity is that expectations can also be formed at the time of the financial crisis, rather than fixed beforehand. Multiplicity is also sensitive to the policy maker having a short-term expansionary motive. In the context of emerging markets this can be rationalized by policy makers' preference for fiscal seigniorage (Calvo and Reinhart (2002)); it is, however, by no means universally applicable.

With complete and symmetric information there can be self-fulfilling beliefs underlying the occurrence of financial crises. Along these lines, Jeanne and Masson (2000) and Masson (1999a,b,c) generate multiple equilibria in currency crises. In contrast, Allen and Gale (1998, 2000) focus on real, as opposed to financial, contagion acting through incomplete markets for interregional claims on liquidity, akin to cross-border deposit insurance. Their approach is characterized by complete information and is restricted to liquidity crises with no currency component, in the tradition of Diamond and Dybvig (1983) and Diamond (1991). In that framework, the mismatch of long-dated assets and short-dated liabilities generates rational, that is anticipated, contagion in any equilibrium of the model.

The fact that the onset of contagion is rationally anticipated generates a role for the central bank as a lender of last resort whose mission is to complete markets.[6] In that regard, the conventional view is that the benefits of more international capital market integration outweigh the costs (Rogoff (1999)). Recent work has questioned this by highlighting the adverse side effects of more interconnectedness. Kodres and Pritsker (2002) show that contagion can arise in rational equilibrium if investors engage in cross-market hedging of their portfolios' exposures to shared macroeconomic risk factors. The severity of contagion then depends on different markets' sensitivities to the shared macroeconomic risks, as well as on the degree of information asymmetry in each market. As cross-market hedging normally requires moderate to high correlation between countries' financial markets, the implication is that higher co-movement between asset returns makes contagion *more* likely; see also Kyle and Xiong (2001) and the discussion of Cohen and Shin (2003) below.

In understanding the onset of financial crises and contagion, the informational structure underlying expectations formation is also important *per se*, that is over and above the timing issues discussed earlier. A key paper in this area is Morris and Shin (1998): these authors show the assumption that fundamentals are common knowledge is crucial for multiple equilibria to arise in self-fulfilling currency crisis models. If market players have higher orders of uncertainty about other players' beliefs – i.e., everyone may know that

[6] On lender of last resort issues see Gale and Vives (2002) and Goodhart and Illing (2003).

the fundamentals are sound, but not everyone may know that everyone knows this – then a unique equilibrium is obtained as a function of macroeconomic fundamentals and relevant financial state variables. This finding suggests the need for transparent policy and wide information dissemination to prevent crises. More generally, Allen, Morris and Shin (2003) show that market prices are biased towards the public information set. In turn, that set is the intersection of all market participants' private information sets, hence the role for policy makers to create more common knowledge and bring observed prices closer to their true fundamentals-driven value.[7]

5. Market Participants versus Policy Makers: Different Perspectives?

A particular problem for identifying the process of herding in the data is the endogenous process of price discovery in the markets. In real time, price discovery impacts on the transmission of shocks, as in Farmer and Joshi (2002). To this end, a promising approach would be to examine crises using very high frequency data at an intra-day level. The importance of market microstructure issues is omitted from lower frequency applications. In that regard, Cohen and Shin's (2003) VAR model of tick-by-tick U.S Treasury data finds that trades (order flow) and price changes may exhibit *positive* feedback in periods of market stress. This highlights the possibility of spillover effects and contagion occurring at the microstructure level during market turbulence. Moreover, such contagion is entirely consistent with sophisticated traders' rational decision making in the presence of binding stop-loss constraints on trading positions.

More generally, at any time horizon the loss functions of individual market participants and policy makers are likely to be different, making a uniform assessment of contagion difficult. From a market participant's individual perspective, *any* trading day can be a 'crisis' if an incorrect positioning/trading decision has been taken. In that sense, their individual loss function can be thought of as being symmetric.[8] In contrast, in the case of the policy maker the loss function is likely to be asymmetric. *Ceteris paribus*, relatively

[7] See also Morris and Shin (2002), Samet (1998) and Townsend (1983) on the difference between individual expectations and aggregate (market) expectations.
[8] In practice, the application of institution-specific thresholds is likely to introduce asymmetries.

more weight will be placed on avoiding a precipitous financial market downturn in order to avoid systemic risk.[9]

The above observations suggest that, although policy makers generally wish to reduce the probability of extreme market movements, they are asymmetrically concerned with avoiding extreme negative outcomes. Examples of public policy actions to limit the risk of systemic failure are the adoption of electronic program-driven 'stops' in equity market trading, and the Federal Reserve's decision to act as a co-ordinator of the private sector bailout of the Long Term Capital Management investment fund (LTCM) in September 1998. The potential for crises may raise the *ex ante* real interest rate on financial assets and thus impose real economic costs; see Greenspan (1999).

Early academic work on financial crises and contagion was motivated by the question of whether other countries were suffering unnecessarily for crimes they did not commit. This line of reasoning has been applied by Sachs, Tornell and Velasco (1996) following the Mexican currency and debt crisis and the deep and protracted recession in Indonesia following the Asian crisis examined in Radelet and Sachs (1998). This was amply demonstrated during the Russian crisis of 1998: the Russian government bond default was the first 'nuclear power' default and the establishment of this precedent led to a massive reassessment of risk in global financial markets, and subsequently to the onslaught of the LTCM crisis.

In addition to the international implications of crises, there is also potential contagion across different asset classes within a country. The effects can be substantial; for examples, see Dungey and Martin (2001) and Bekaert, Harvey and Ng (2003). At a theoretical level, balance sheet considerations such as extensive liability dollarization can generate 'twin crises' rippling from the currency to the banking and corporate sector (Chang and Velasco (2000a,b), Kaminsky and Reinhart (1999)). An important direction for future research thus involves combining cross-asset and cross-border transmissions. When crises are transmitted across asset markets and borders simultaneously, the

[9] In closed-economy monetary policy models, such asymmetries may stem from central banks disliking recessions more than than booms. This provides a rationale for "opportunistic" loss functions suggested by Orphanides, Small, Wieland and Wilcox (1997); see also Tambakis (2002).

implications for both portfolio management and international financial regulation are enormous.

The potentially asymmetric loss function of policy makers notwithstanding, crises and contagion may also yield positive outcomes. Contagion of other processes, such as structural policy reform, can be beneficial to the operation of an economy. Conversely, the threat of financial contagion can destabilise an already fragile macroeconomic environment, as was the case with reforms in Brazil following the turmoil associated with the 2001 presidential election; see Miller et al (2003).

Assessing the effectiveness of policy interventions to reduce contagion is hampered by the lack of a counterfactual. For example, as noted earlier, turmoil in Brazil prompted the 2001 presidential election candidates to sign a joint letter of agreement with the IMF on debt reform. The crisis may have resolved without the intervention of the IMF: although there was no crisis in this instance, perhaps there would not have been one anyway. In the financial turmoil in Indonesia, Korea and Thailand in 1997-98, it is not clear whether the involvement of international institutions improved the final outcomes. The heterogeneity in actual crises may render programs of reform that work in some cases detrimental in others, a charge often levied at IMF involvement in Indonesia. These observations suggest that policy makers need to retain a flexible and evolving approach to assistance in these situations.

6. Financial Crisis Prevention and Management: The Role of the IMF

The preceding discussion suggests that successful policies in one circumstance may prove disappointing in another. The recent literature on the International Monetary Fund's role in preventing crises stresses the value of a joint commitment by the country and the Fund. This can be critical in catalyzing capital flows to enhance countries' access to capital markets.

In Tirole's (2002) terminology, the IMF is a *delegated monitor* whose role is to mediate between the country and foreign investors. On the one hand, the presence of a bailout facility afforded by the program constitutes *ex ante* moral hazard; see Eichengreen and

Ruhl (2001). On the other hand, if they reduce *ex post* inefficiency, programs can improve incentives for preventative action and catalyze private sector lending. The impact IMF programs have on international bond spreads charged at issuance, alongside macroeconomic determinants of such spreads, has been studied by Eichengreen and Mody (2001) using transactional data. It appears that the IMF's catalytic finance approach is effective provided the deterioration of foreign exchange reserves and debt levels is not irreversible.[10] Moreover, large programs tend to be more successful when the money committed is not actually used. *Inter alia*, this suggests that precautionary deployment of Fund lines of credit is valuable. In other words, catalytic finance works when a financial crisis and insolvency are not imminent, so that private sector creditors are galvanized by official assistance.

The distinction between crisis prevention and crisis management is inextricably linked to crisis and non-crisis period identification. Whereas in the realm of crisis prevention it may be beneficial to improve the quality or quantity of publicly available information, the release of more information during a crisis may actually worsen it; see Danielsson and Zigrand (2003) and relatedly Morris and Shin (2002). Therefore, effective policy assessment requires correctly identifying exact changeover points, the same problem as establishing correct thresholds and sample periods discussed earlier. Classifying these points incorrectly can have undesirable results, including regulations paradoxically reinforcing crisis events. Regulatory environments need to take into account not just the means by which crises are prevented (for example, maintaining high capital adequacy ratios) but also the impact of those same regulatory structures during a crisis period.

With hindsight, understanding the role of crisis policies informs the actions of future policy makers. For example, why did the precommitment of presidential candidates in the Brazilian elections in 2001 calm the situation, albeit with resolution uncertainty? Policy makers need to weigh the determinants of successful policies. Although there may be common themes across financial crises, there is also significant heterogeneity. As a

[10] See also Corsetti, Guimaraes and Roubini (2003) and Morris and Shin (2003).

result, successful past policies will not always provide the appropriate answer, particularly in an environment of volatile short-term capital flows; see also Section 3. Policy guidelines require a forward-looking approach explicitly recognizing that crises are likely to occur and play out differently over time. This need may occasionally conflict with the IMF's desire to have a "consistent implementation" of the framework for granting countries access to its resources (IMF 2003).

7. Conclusion

Containing the likelihood of contagious financial crises is a pressing policy issue at both national and international levels. As yet, there is no professional consensus on the appropriate definitions of what constitutes a financial crisis or contagion, despite substantial research progress towards these goals. We know that financial crises and contagion are intrinsically linked, and that contagious effects arise when crises are propagated across countries or markets after controlling for fundamental linkages and interdependencies. We also know that these transmissions may spread further through mechanisms such as cross-market hedging.

However, we claim that broad agreement can be obtained on the following points:

(i) Crises are in some way associated with an increase in the conditional volatility of financial market returns.

(ii) The association of excess returns in one country or market with excess returns in another country *after* controlling for fundamentals (excess co-movement) is consistent with financial market contagion.

New models will undoubtedly be required with the advent of new crises. However, some of the salient aspects outlined in this paper are likely to recur. These include: the fundamental linkages, the means of transmission across countries and asset classes, the statistical properties of the data, the simultaneous identification of contagion, interdependency and herding and the endogenous identification of crisis and non-crisis periods from sample data. Each of these issues is extremely important

for assessing the appropriate policy response to prevent crises and adequately managing those that occur.

REFERENCES

Agenor, P.R., Miller, M., Vines, D. and Weber, A. (eds.), *The Asian Financial Crisis: Causes, Contagion and Consequences*, Cambridge, UK: Cambridge University Press.

Allen, F. and Gale, D. 1998. "Optimal Financial Crises", *Journal of Finance* 53, 1245-1284.

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

Allen, F., Morris, S. and Shin, H.S. 2003. "Beauty Contests, Bubbles and Iterated Expectations in Asset Markets", unpublished manuscript.

Bae, K.H., Karolyi, G.A. and Stulz, R.M. 2003. "A New Approach to Measuring Financial Contagion", *Review of Financial Studies*, forthcoming

Baig, T. and Goldfajn, I. 1999. "Financial Market Contagion in the Asian Crisis", *IMF Staff Papers* 46, 167-195.

Baur, D. and Schulze, D. 2002. "Coexceedances in Financial Markets – A Quantile Regression Analysis of Contagion", mimeo, University of Tuebingen.

Bekaert, G., Harvey, C.R. and Ng, A. 2003. "Market Integration and Contagion", *Journal of Business*, forthcoming.

Berg, A. and Patillo, C. 1999. "Are Currency Crises Predictable? A Test", *IMF Staff Papers* 46, 107-38.

Boyer, B.H., Gibson, M.H. and Loretan, M. 1999. "Pitfalls in Tests for Changes in Correlations", Federal Reserve Board International Finance Division, Working Paper 597R.

Butler, K.C. and Joaquin, D.C. 2002. "Are the Gains from International Portfolio Diversification Exaggerated? The Influence of Downside Risk in Bear Markets", *Journal of International Money and Finance* 21, 981-1011.

Calvo, G. 1998. "Capital Flows and Capital-Market Crises: The Simple Economics of Sudden Stops". *Journal of Applied Economics* 1, 35-54.

Calvo, G. and Reinhart, C. 2002. "Fear of Floating", *Quarterly Journal of Economics* 107, 379-408.

Calvo, G. and Mendoza, E. 2000. "Rational Contagion and the Globalization of Securities Markets", *Journal of International Economics* 51, 79-113.

Chang, R. and Velasco, A. 2000a. “Banks, Debt Maturity and Financial Crises”, *Journal of International Economics* 51, 169-194.

Chang, R. and Velasco, A. 2000b. “Financial Fragility and the Exchange Rate Regime”, *Journal of Economic Theory* 90, 1-34.

Cohen, B. and Shin, H.S. 2003. “Positive Feedback Trading Under Stress: Evidence from the US Treasury Securities Market”, LSE working paper, June.

Corsetti, G., Pericoli, M. and Sbracia, M. 2002. “Some Contagion, Some Interdependence: More Pitfalls in Testing for Contagion”. University of Rome III working paper.

Corsetti, G., Pericoli, M. and Sbracia, M. 2001. “Correlation Analysis of Financial Contagion: What One Should Know Before Running a Test”. University of Rome III working paper.

Corsetti, G., Giumaraes, B. and Roubini, R. 2003. “The Tradeoff Between an International Lender of Last Resort to Deal with Liquidity Crisis and Moral Hazard Distortions: A Model of the IMF’s Catalytic Finance Approach”, available at http://www.stern.nyu.edu/globalmacro/

Corsetti, G., Pesenti, P. and Roubini, R. 1999. “The Asian Crisis: An Overview of the Empirical Evidence and Policy Debate”, in Agenor, P.R., Miller, M., Vines, D. and Weber, A. (eds.), *The Asian Financial Crisis: Causes, Contagion and Consequences*, Cambridge ,UK: Cambridge University Press, 127-166.

Danielsson, J. and Zigrand, J. 2003, “What Happens When You Regulate Risk? Evidence From A Simple Equilibrium Model”, LSE working paper.

Danielsson, J. and Shin, H.S. 2003. Endogenous Risk. Unpublished manuscript, LSE.

Diamond, D. 1991. Debt Maturity Structure and Liquidity Risk. *The Quarterly Journal of Economics* 106, 709-737.

Diamond, D. and Dybvig, P. 1983. Bank Runs, Deposit Insurance and Liquidity. *Journal of Political Economy* 91, 401-419.

Drazen, A. and Masson, P.R. 1994. Credibility of Policies versus Credibility of Policymakers. *Quarterly Journal of Economics* CIX, 735-754.

Dornbusch, R., Park, Y.C. and Claessens, S. 2000. “Contagion: Understanding How it Spreads”, *The World Bank Research Observer* 15, 177-197.

Dungey, M., Fry, R.A., Gonzalez-Hermisillo, B. and Martin, V.L. 2002. “International Contagion Effects from the Russian Crisis and the LTCM Near-Collapse”, *IMF Working Paper* WP/02/74.

Dungey, M., Fry, R.A., Gonzalez-Hermisillo, B. and Martin, V.L. 2003. “Empirical Modelling of Contagion: A Review of Methodologies”, mimeo, ANU and CERF.

Dungey, M. and Martin, V.L. 2001. "Contagion Across Financial Markets: An Empirical Assessment", mimeo, ANU.

Edison, H. 2000. "Do Indicators of Financial Crises Work? An Evaluation of an Early Warning System", Federal Reserve Board Working Paper in International Finance No. 2000-675.

Eichengreen, B. 2002. *Financial Crises and What to Do About Them*. Oxford, UK: Oxford University Press.

Eichengreen, B. and Mody, A. 2001. "Bail-Ins, Bail-Outs and Borrowing Costs", *IMF Staff Papers* 47, 155-187.

Eichengreen, B., Rose, A.K. and Wyplosz, C. 1995. "Exchange Market Mayhem: The Antecedents and Aftermath of Speculative Attacks", *Economic Policy* 21, 249-312.

Eichengreen, B., Rose, A.K. and Wyplosz, C. 1996. "Contagious Currency Crises", *NBER Working Paper* 5681.

Eichengreen, B. and Ruhl, C. 2001 "The Bail-In Problem: Systematic Goals, Ad Hoc Means", *Economic Systems*, 25, 3-32.

Ellis, L. and Lewis, E. 2000. "The Response of Financial Markets in Australia and New Zealand to News About the Asian Crisis", BIS Conference on International Financial Markets and the Implications for Monetary and Financial Stability, Basle, 25-26 October 1999, Vol. 8.

Farmer, J.D. and Joshi S. 2002. "The Price Dynamics of Common Trading Strategies", *Journal of Economic Behavior and Organization* 49, 149-171.

Favero, C.A. and Giavazzi, F. 2002. "Is the International Propagation of Financial Shocks Non-Linear? Evidence from the ERM", *Journal of International Economics* 51, 231-246.

Flood, R. and Garber, P. 2002. "Gold Monetization and Gold Discipline", *Journal of Political Economy* 92, 90-107.

Frankel, J.A. and Rose, A. 1996. "Currency Crashes in Emerging Markets: An Empirical Treatment", *Journal of International Economics* 41, 351-366.

Forbes, K. and Rigobon, R. 2001. "Measuring Contagion: Conceptual and Empirical Issues", in Claessens, S. and Forbes, K. (eds.), *International Financial Contagion*, Kluwer Academic Publishers.

Forbes, K. and Rigobon, R. 2002. "No Contagion, Only Interdependence: Measuring Stock Market Co-Movements", *Journal of Finance* 57, 2223-2261.

Gale, D. and Vives, X. 2002. "Dollarization, Bailouts, and the Stability of the Banking System", *Quarterly Journal of Economics* 117, 467-502.

Gerlach, S. and Smets, F. 1995. "Contagious Speculative Attacks", *European Journal of Political Economy* 11, 5-63.

Glick, R. and Rose, A.K. 1999. "Contagion and Trade: Why are Currency Crises Regional?", *Journal of International Money and Finance* 18, 603-617.

Goldstein, M. 1998. "The Asian Financial Crisis: Causes, Cures and Systemic Implications", *Policy Analysis in International Economics*, 55, Institute for International Economics, Washington, D.C.

Goldstein, M., Kaminsky, G.L. and Reinhart, C.M. 2000 "Assessing Financial Vulnerability: An Early Warning System for Emerging Markets", Institute for International Economics, Washington, D.C.

Goodhart, C. and Illing, G. (eds.) 2003. *Financial Crises, Contagion, and the Lender of Last Resort: A Reader*. Oxford: Oxford University Press.

Granger, C., B. Huang and Yang, C. 2000. "Bivariate Causality Between Stock Prices and Exchange Rates in Asian Countries", *The Quarterly Review of Economics and Finance* 40, 337-354.

Greenspan, A. 1999. "Risk, Liquidity and the Economic Outlook", Business Economics, 34 (1), 20-24.

IMF (2003) Communiqué of the International Monetary and Financial Committee of the Board of Governors of the International Monetary Fund,Washington, D.C. April 12, 2003

Jeanne, O. and P. Masson, 2000. "Currency Crises, Sunspots and Markov-Switching Regimes", *Journal of International Economics* 50, 327-350.

Kaminsky, G.L. and Reinhart, C.M. 2000. "On Crises, Contagion and Confusion", *Journal of International Economics* 51, 145-168.

Kaminsky, G.L. and Reinhart, C.M. 1999. "The Twin Crises: The Causes of Banking and Balance of Payments Problems", *American Economic Review* 89, 473-500.

Kaminsky, G.L. and Reinhart, C.M. 2002. "The Centre and the Periphery: Tales of Financial Turmoil", mimeo, George Washington University.

Kaminsky, G.L. and Schmukler, S.L. 1999. "What Triggers Market Jitters? A Chronicle of the Asian Crisis", *Journal of International Money and Finance* 18, 537-560.

Kehoe, T. 1996. Comment on P. Krugman: Are Currency Crises Self-Fulfilling? *NBER Macroeconomics Annual,* MIT Press, Cambridge, MA: 378-392.

Kodres, L.E. and Pritsker, M. 2002. "A Rational Expectations Model of Financial Contagion", *Journal of Finance* 57, 768-799.

Krugman, P. 1979. "A Model of Balance-of-Payments Crises", *Journal of Money, Credit and Banking* 11, 311-325..

Krugman, P. 1996. "Are Currency Crises Self-Fulfilling?", *NBER Macroeconomics Annual*, Cambridge, MA: MIT Press, 345-378.

Krugman, P., 2000 (ed.) *Currency Crises*. Chicago: The University of Chicago Press.

Kyle, A. and Xiong, W. 2001. "Contagion as a Wealth Effect", *Journal of Finance* 56, 1401-1440.

Longin, F. and Solnik, B. 1995. "Is the Correlation in International Equity Returns Constant?: 1960-1990", *Journal of International Money and Finance* 14, 3-26.

Loretan, M. and English, W. 2000. "Evaluating 'Correlation Breakdowns' During Periods of Market Volatility", Federal Reserve Board International Finance Division, Working Paper 658.

Masson, P. 1999a. "Contagion: Macroeconomic Models with Multiple Equilibria", *Journal of International Money and Finance* 18, 587-602.

Masson, P. 1999b. "Contagion: Monsoonal Effects, Spillovers, and Jumps Between Multiple Equilibria", in Agenor, P.R., Miller, M., Vines, D. and Weber, A. (eds.), *The Asian Financial Crisis: Causes, Contagion and Consequences*, Cambridge ,UK: Cambridge University Press.

Masson, P. 1999c. "Multiple Equilibria, Contagion and the Emerging Market Crises", *IMF Working Paper* 99/164.

Mody, A. and Saravia, D. 2003. "Catalyzing Private Capital Flows: Do IMF-Supported Programs Work as Commitment Devices?", *IMF Working Paper* WP/03/100

Masson, P., Chakravarty, S. and Gulden, T. 2003 "The Normal, the Fat-Tailed, and the Contagious: Modeling Changes in Emerging Market Bond Spreads", Brookings Institution working paper.

Miller, M., Thampanishvong, K. and Zhang, L. 2003 "Learning to Forget? Contagion and Political Risk in Brazil", CERF Contagion Conference paper, Cambridge, UK.

Morris, S. and Shin, H.S. 1998. Unique Equilibrium in a Model of Self-Fulfilling Currency Attacks. *American Economic Review* 88, 587-597.

Morris, S. and Shin, H.S. 2002. "The Social Value of Public Information", *American Economic Review* 92, 1521-1534.

Morris, S. and H.S. Shin 2003. "Catalytic Finance: When Does it Work?", Cowles Foundation Discussion Paper #1400.

Obstfeld, M. 1994. The Logic of Currency Crises. *Cahiers Economiques et Monetaires*, Paris, Banque de France 43, 189-214.

Obstfeld, M. 1996. "Models of Currency Crises with Self-Fulfilling Features", *European Economic Review* 40, 1037-1047.

Orphanides, A., Small, D., Wieland, V. and Wilcox, D. 1997 “A Quantitative Exploration of the Opportunistic Approach to Disinflation”, Fed Working Paper 1997-36.

Pericoli, M. and Sbracia, M. 2001. “A Primer on Financial Contagion”, *Banca d’Italia Temi di Discussione* No. 407.

Pesaran, M.H. and Pick, A. 2003. “Econometric Issues in the Analysis of Contagion”, unpublished manuscript, University of Cambridge.

Radelet, S. and Sachs, J. 1998. “The East Asian Financial Crisis: Diagnosis, Remedies, Prospects”, *Brookings Papers on Economic Activity* 0(1), 1-90.

Quintos, C., Fan, Z. and Phillips, P.C.B. 2001. “Structural Change Tests in Tail Behaviour and the Asian Crisis”, *Review of Economic Studies* 68, 633-663.

Rigobon, R. 2003. “On the Measurement of the International Propagation of Shocks: Is the Transmission Stable?” *Journal of International Economics*, forthcoming.

Rogoff, K. 1999. “International Institutions for Reducing Global Financial Instability”, *Journal of Economic Perspectives* 13, 21-42.

Sachs, J., Tornell, A. and Velasco, A. 1996. “Financial Crises in Emerging Markets: The Lessons from 1995.” *Brookings Papers on Economic Activity*, 1, 146-215.

Samet, D. 1998. “Iterated Expectations and Common Priors”, *Games and Economic Behavior* 24, 131-141.

Shiller, R. 2000. *Irrational Exuberance*. Princeton, NJ: Princeton University Press.

Tambakis, D.N. 2002. “Expected Social Welfare under a Convex Phillips Curve and Asymmetric Policy Preferences”, *Journal of Money, Credit and Banking* 34, 434-449.

Tirole, J. 2002. *Financial Crises, Liquidity, and the International Monetary System*, Princeton, NJ: Princeton University Press.

Townsend, R. 1983. “Forecasting the Forecasts of Others”, *Journal of Political Economy* 91, 546-588.

Van Rijikghem, C.V. and Weder, B. 2001. “Sources of Contagion: Is it Finance or Trade?”, *Journal of International Economics* 54, 293-300.

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