The Role of Psychic Distance in Contagion:
A Gravity Model for Contagious Financial Crises

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October 2004

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Abstract

We synthesize the financial crisis contagion literature through the gravity model from physics and test the hypothesis that the severity of contagion relates positively to trade and financial linkages but negatively to psychic distance between countries, when macroeconomic fundamentals and institutional factors are controlled. The psychic distance variable, a behavioral predictor constructed along four dimensions including geographic distance, common language, development level and common membership, is of key interest in this study. Using data of financial crises originated in Mexico, Asia, Russia, and Brazil in the 1990s, we find empirical support for the hypothesis, particularly for the importance of psychic distance in analyzing financial crisis contagion.

JEL classification: F31; F32; F33; F41; G15

Keywords: Financial crisis, Contagion, Psychic distance

1. Introductio

The issue of "contagion" is highly topical in international finance since the 1990s, especially after the Asian financial crisis. According to Rigobon (2001), there is general agreement among economists on which events have constituted instances of contagion: the Debt crises in 1982, the Mexican Tequila effect in December of 1994, the Asian Flu in the second half of 1997, the Russian Cold in August 1998, the Brazilian Sneeze in January of 1999, and the NASDAQ Rash in April of 2000. However, there is no consensus on the definition of contagion, the channels through which shocks are accentuated and transmitted, or what determines the degree of contagion. For the definition of contagion, Masson (1998) first distinguishes between "fundamentals-based contagion" and "true contagion" or "pure contagion." As for the channels of contagion, there are financial channels related with the activities of banks, mutual funds, pension funds and insurance companies, etc., and trade channels (Kaminsky and Reinhart, 2000; Rijckeghem and Weder, 2001). Other causes of contagion are macroeconomic similarities, common shocks and shifts in investor sentiment (alternatively, market psychology, herd behavior, "rush for the exits," etc.) (see Caramazza et al., 2000). Even neighborhood effects were investigated by some studies (e.g., Hernandez and Valdes, 2001). Empirical studies of financial crisis contagion have been conducted along different directions. Initially weaknesses in macroeconomic fundamentals were considered as the most important.[1] Later on trade or financial linkages attracted more attention. Among them, financial linkages were found to be more relevant. Recently there appeared to be studies that focus on the role of visible similarities among

[1] From terminology's point of view, some argued, crises induced by common fundamental weaknesses are not really "contagious" since a crisis in one country does not cause a crisis in another *directly*.

emerging markets in explaining financial contagion (e.g., Ahluwalia, 2000). While these studies have contributed to the understanding of financial crisis contagion in various important aspects, there seems to be a lack of common thread to provide a unified framework for the analyses.

The purpose of this paper is to integrate the empirical work into a coherent structure to investigate the financial contagion effects. We follow Sachs et al. (1996) (hereafter referred to as the STV model) in combining the various explanatory variables in one linear regression framework, but differ from them in two aspects. First, we introduce a psychic distance variable to the analysis. The STV model advocates three intuitively reasonable fundamentals for financial crisis contagion: real exchange rate over-valuation, weakness in the banking system, and low international reserves (relative to broad money). In this paper, we specify a model with the same dependent variable as that of the STV model – the crisis index, but employ four categories of independent variables – the monsoonal effects, the spillover effects, institutional factors, and the psychic distance. Each category represents the explanation or one type of contagion discussed in the literature. The psychic distance variable is composed of various dimensions including geographic distance, cultural distance, development level, and membership and/or neighborhood effects. This variable is designated to account for the occurrence of the so-called "true contagion" – a cross market herding behavior in the format of speculation, mimic, or rush for exit, that is not related to a country's macroeconomic fundamentals, but due to changes in expectations based on incomplete information or in psychological perceptions.

Second, we adopt a gravity model to synthesize the explanatory variables used in the current literature. The gravity model from physics is widely used in social sciences. Various works use

gravitational forces to help explain the flows of migration and trade between different regions or countries (See Askari et al., 2003; Wall, 1999; Hufbauer et al., 1997). Such models have the advantage of classifying explanatory variables into "pull" and "push" factors for interactions between two regions or countries. We believe that the gravitational forces of interaction can also help explain the transfer of financial crisis among different regions or countries. The pull factors are international economic linkages, namely, trade linkages and financial linkages. The push factor is the psychic distance between countries, rather than geographic distance, although intuitively geographic distance can be considered as part of the psychic distance. Our hypothesis is that the severity of financial contagion is in direct proportion to the trade and financial linkages and inversely proportional to the psychic distance between the originating country and the country affected, when macroeconomic fundamentals and institutional factors are controlled.

The remainder of the paper is organized as follows. Section 2 reviews the theoretical and empirical literature on financial crisis and contagion. It also surveys the concept of psychic distance to provide a basis for inclusion of this variable in the current study. Section 3 presents the empirical strategy and data sources. The gravity model and the construction of the psychic distance variable are described in this section. The results of the statistical analysis are reported in Section 4. Section 5 summarizes and highlights our empirical findings.

2. Literature Review

The literature on financial contagion is an integral part of that on financial crisis. Empirical models of financial contagion are derived from theoretical models of financial crisis as well as

models of financial contagion. In this section, we survey the fundamental models of financial crisis and the different theories of financial contagion from which we derive our empirical model in the next section.

2.1. Models of Financial Crisis

The economic literature on financial crises has gone through at least two generations. The first generation models (FGMs), also referred to as the exogenous-policy models or models of speculative attacks, was pioneered by Krugman (1979) and refined by Flood and Garber (1984). The essence of these models is that currency crises are an unavoidable outcome of a deterioration of the fundamentals, typically due to inconsistency of economic policies. Domestic credit expansion, chronic structural imbalances such as persistent current account deficit, domestic fiscal imbalances, or combinations of these cause excess demand for foreign currency and deplete the country's international reserves. When the reserves are exhausted, the country will have no choice but let go of the fixed exchange rate regime, hence currency crises occur.

The second generation models (SGMs), exemplified by Obstfeld (1994, 1997), use a game-theoretic approach. These models focus on government optimization and view devaluation decision as a result of choosing between conflicting policy targets, such as achieving low unemployment, supporting sound financial system, stimulating economic growth, or even maintaining political integration with its "neighbors." According to these models, after balancing the costs and the benefits of a fixed exchange rate policy, devaluation can be a trade-off decision

in response to self-fulfilling speculative attacks. The models that center on the government's optimizing decisions were also called the "New Crisis Model (as in Krugman, 1996)."

Both FGMs and SGMs emphasize macroeconomic and financial fundamentals, which are essential in analyzing the spread of crises across countries. In Masson (1998), the term "monsoonal effects" is used to refer to the impact of policies undertaken by industrial countries on emerging markets. For example, financial crises may be due to common shocks such as the appreciation of the US dollar against exports of Southeast Asian countries in 1995-96. However, a country's vulnerability to such shocks is determined by its macroeconomic fundamentals. Besides "monsoonal effects," other general models or explanations of financial contagion are developed on the basis of FGMs and SGMs. Information cascades models are based on how the expectations are formed under the context of imperfect and asymmetric information. Spillover models focus on the economic and financial interdependence between countries. Other explanations investigate the effects of political/membership and institutional arrangements. These models are not mutually exclusive.

2.2. "Information Cascades" Models of Contagion

According to Drazen (2000), the best-developed general model of contagion is that of "information cascades," or less formally, information externalities. It is mainly manifested in the format of herding behavior, which is driven by the intent of investors to copy the behavior of

other investors who precede them across countries (Bikhchandani and Sharma, 2000).[2] Some justify herding behavior by information costs. Calvo and Mendoza (2000) use a standard mean-variance framework to show that the costs of verifying the validity of market rumors can lead to asset sales unrelated to real fundamentals.

Models of information externalities have been developed on various assumptions. King and Wadhwani (1990) assume that asset prices depe nd on an idiosyncratic and a common factor. "Signal extraction" occurs where a shock to the idiosyncratic factor in one market prompts investors to adjust positions in other markets because of uncertainty about the type of shock that has occurred. Other studies have incorporated incomplete information of speculators or investors' assessment of an economy's fundamentals. Morris and Shin (1998) base their model on the assumption that speculators have uniform prior probability distributions over the state of fundamentals that are updated according to the observation of a private signal. Sbracia and Zaghini (2001) further argue that not only the mean of speculators' probability assessment over the fundamentals matters. Uncertainty of the assessment also influences speculative attacks. Therefore, crisis is like a "wake up call" which induces financial markets to reassess other countries' fundamentals. Countries with weak macroeconomic and financial fundamentals can be more vulnerable to contagion effects from a shift in market sentiment or increased risk aversion.

Masson (1998) proposes a model where financial markets are subject to multiple equilibria. When fundamentals are good, there is a unique equilibrium in which the exchange rate is

[2] In this paper, herding behavior is not defined in its restrictive sense. For example, if A sells off its assets in Mexico, and B obviously follows this action by selling off in Argentina, then B is regarded as herding. We regard this behavior as "herding across markets."

maintained; when fundamentals deteriorate, the currency depreciates; when fundamentals fall in an "intermediate" range (the "ripe for attack" zone), either outcome is possible. He views contagion as a jump between equilibria triggered by a crisis elsewhere. As suggested by Masson (1998), only models of this type can produce pure contagion, which involves changes in expectations that are self-fulfilling and sometimes unrelated with economic fundamentals.

The information externality argument may help explain some financial crises that occurred in the 1990s. With uncertainty about policymakers' commitment to defending a fixed exchange rate, the collapse of the exchange rate in one country, say Thailand, provides information that another country in similar macroeconomic circumstances is likely to abandon its fixed parity too. However, the extent of decline in other countries depends on the informational value attributed by investors, which varies across countries. For example, a negative shock in Thailand may provide more informational value (in the eyes of the investors) about other Southeast Asian nations than a shock in Mexico. Alternatively, investors tend to link the negative shock in Thailand to other emerging markets rather than industrialized countries. This hypothesis is justified by the fact that most episodes of financial crisis are regional. In the Asian episode, many crisis-affected economies are those that applied the so-called "East Asian Model" successfully over the last two decades. Hence we can assume that development patterns and thus macroeconomic circumstances are similar for countries in this region. Therefore, in investors' perceptions, the information conveyed by a crisis that takes place in the ground-zero country is heavily influenced by the relationship and/or similarity between the affected country in question and the originating country.

2.3. "Spillover" Models of Contagion

According to Drazen (2000), trade linkages have been at the center of "spillover" models of financial contagion. On the one hand, a devaluation forced by speculative attacks in one country would enhance its price competitiveness, thus may result in trade deficits and declining reserves for its trading partners. Meanwhile, a decrease in demand in the crisis country may also hurt its trade partners. Hence financial crisis can transmit from a crisis country to its trade partners directly. On the other hand, however, compared to bilateral trade linkages, multilateral linkages or third-party trade were found to be more relevant in most cases. Consider the Asian crisis again. Asian countries have significant exports to Japan and the U.S. while the bilateral trade volumes between crisis-affected countries were not very large. Asian countries compete with each other for the same markets and, in most cases, in the same product segments. It is possible that competitive devaluation expedited the contagion of crisis. Many empirical studies demonstrate the role of trade linkages in financial contagion. In Glick and Rose (1999), Kaminsky and Reinhart (2000), and Caramazza et al. (2000), both bilateral trade and third-party trade are examined. Although evidenced not as important as financial linkages, when financial linkages are controlled, trade linkages, especially the third-party trade linkage, still have explanatory power and should not be ignored.

More attention has been given to financial linkages in recent studies. Theoretically, Hernandez and Valdes (2001) summarize four ways that financial linkages can explain contagion. First, direct financial linkages, which refer to foreign direct investments (FDIs), connect corporate and financial sector returns across countries. Thailand's devaluation can drive

down the stock prices in Malaysia because it imposes losses on Malaysian corporations investing in Thailand. Second, many fund managers treat assets of different countries as complementary. Contagion occurs when fund managers rebalance their portfolios following a negative shock from one country to maintain fixed weights of assets in these countries. Third, after suffering a shock, financial institutions facing liquidity problems in one market could be forced to adjust positions in other markets, resulting in cross-market contagion. Fourth, information asymmetries and herding behavior produce co-movement across countries, as discussed in the information cascade models.

Except for FDI, the aforementioned explanations emphasize the financial linkages due to banking activities and the behavior of hedge funds, mutual fund and other institutional investors. The discussion of banking activities concentrates on the "common creditor" or "competition for funds" argument (Rijckeghem and Weder, 2001; Caramazza et al., 2000). If a bank is highly exposed to a crisis country, its adjustments to restore capital adequacy, meet margin calls, or rebalance its portfolios can reduce credit line to a second country, which has been in competition with the crisis country for funds from the bank. According to Caramazza et al. (2000), if the common creditor is the major lender to a crisis country, countries sharing the common lender may experience capital outflows irrespective of their macroeconomic fundamentals simply because their assets are viewed to be risky as well. This is more related with "wake up call" argument and herding behavior. In Kaminsky and Reinhart (2000)'s work, international bank lending and the potential for cross-market hedging are tested and common bank lending is concluded to be the most important channel for contagion. Given the huge size and volatility of

bank credits as well as the magnitude of losses by banks during crisis episodes, the common lender argument deserves further investigation.[3]

As for the behavior of mutual funds and hedge funds, some believe that "contagious selling" of higher-risk assets can be explained with the basic portfolio theory without recourse to market imperfection (Schinasi and Smith, 1999). For example, fund managers would rebalance their portfolios in a large scale when an adverse shock affects some assets' return distribution, when the return on the leveraged portfolio is less than the cost of funding due to liquidity consideration, or just to obey the "Value-at-Risk" portfolio management rules when a crisis takes place. On the other hand, bubbles or even irrational behavior on the part of investors is a major source of contagion. Christiansen (2000) argues that the presence of mutual funds, while lowering the transaction costs to small retail investors, might have magnified price fluctuations. Investors tend to withdraw funds from mutual funds in the case of significantly negative returns. This behavior is similar to that described by incomplete information or information cascade arguments. In this situation, risk management techniques can induce investors to treat groups of countries—especially emerging economies—indiscriminately, thus "herding across countries" occurs.

The role played by rating agencies may exacerbate such situations. Christiansen (2000) reports that the sovereign ratings on the terms at which money can be raised in global financial markets tend to amplify both the upturn and the downturn volatility. Such rating can be a source of

[3] For example, the flow of funds from banks to 29 emerging markets dropped from $120 billion in 1996 to -$29 billion in 1998 (Rijckeghem and Weder, 2001).

overshooting and contagion during bad times. Changes in risk ratings may be, again, based upon perceived similarities of countries, especially the grouping of countries according to regions, macroeconomic similarities or development level.

From the individual investor's point of view, herding can be a rational strategy. Bikhchandani and Sharma (2000) discuss the incentives for different types of herding behavior. The information asymmetry argument assumes that poorly-informed traders obtain cost-effective benefit by observing and copying better-informed investors' positions. Reputation-based herding occurs when there is uncertainty regarding the ability of the manager to manage the portfolio. In this case, conformity with other investment professionals would help. When an investor's compensation depends on how his performance compares to other investors' performance, he can end up with an inefficient portfolio, due to the so-called compensation-based herding. But collectively, according to the authors, herding behavior can precipitate bubble or irrational result, which in worse cases leads to financial contagion.

In sum, losses in one country spill over to other countries as creditors or investors try to retrench their portfolios, restore their capital-adequacy ratios or meet margin calls. Herding can play a role, too, mainly based upon the argument of perceived grouping of countries.

2.4. "Membership Contagion" and Other Explanations

Drazen (2000) proposes a model of "membership contagion," which is inherently political. It emphasizes the relevance of "…membership in a 'club', whether explicit or implicit, where the

benefits of membership are heavily political and the condition for membership is the maintenance of a fixed exchange rate (pp.10)." In this argument, investors presumably use the membership of a certain "club," not just macroeconomic similarity, as a relevant predictor of the probability distribution of a government's intention to devaluate.

Similarly, Hernandez and Valdes (2001) investigate the neighborhood effect on contagion. The relevance of geographic neighborhood is justified by arguing that financial links are due to institutional practices in international financial markets. That is, institutional investors treat all countries from the same region as equal, without accounting for the differences in their fundamentals.

Emerging markets as a group are viewed as a club that is more vulnerable to financial crisis. Ahluwalia (2000) indicates that contagious currency crises usually occur in emerging markets and initiates the concept of "discriminating contagion," which suggests that investors' confidence towards emerging markets is relatively thin thus their behavior more volatile. The implication is that the title of "emerging market" can be an indicator of investors' perception on the country, although there is no strong evidence in place that all emerging markets bear the same fundamental weaknesses.

The "discriminating contagion" argument is related to the well-accepted term "monsoonal effects" used by Masson (1998). As previously indicated, "monsoonal effects" refers to the fact that a common shock usually affects countries differently due to different macroeconomic fundamentals. While "discriminating contagion" may amplify the negative impact of

"monsoonal effects" by assuming irrational behavior in explaining the spread of crises, the macroeconomic fundamentals cannot be eliminated in a model of financial contagion, even when the contagion studied is a "pure" one.

2.5. Institutional Factors and Financial Crisis Contagion

Credible institutional arrangements can prevent crises from occurring. Christiansen (2000) finds that the principal triggers of risk clustering and herding behavior on the part of investors fall into two categories: (1) factors making investors perceive that a financial system (including the exchange rate regime of the country) are unable to sustain a massive withdrawal of funds; and (2) factors affecting transparency and, hence, giving rise to uncertainty and information asymmetries. Among a long list of the relevant factors, two institutional variables are more important and easily discernible – exchange rate regime and capital control.

Calvo (2001) asserts that the exchange rate system is the most important among institutions that can reduce emerging markets' vulnerability to external turmoil. Edwards (2000) concludes that countries with either a super-fix (through a currency board or dollarization) or a freely floating exchange rate system are less vulnerable to contagion. The reason is that only those two regimes meet the requirement of transparency and credibility. Capital control has drawn a lot of attention in the literature. The wave of financial liberalization and structural reforms undertaken by emerging countries in recent years attracted large capital inflows to emerging markets. But excessive degree of capital mobility of the 1990s may have contributed to emerging countries' increasing vulnerabilities. Some argue that countries with large inflows tend to experience sharp

corrections. When the liberalization was more limited and gradual, we may see smaller overshooting of capital inflows than in countries that have more aggressively liberalized the capital account (Bacchetta & Wincoop, 1998). So the degree of openness of the capital account is tested as a contributing factor of financial contagion in this study.

2.6. The Concept of Psychic Distance

Monsoonal effects, spillover effects and institutional factors in financial crisis contagion are relatively easy to be identified. However, the remaining explanations, such as membership effects, neighborhood effects, and macroeconomic similarities, are interrelated themselves and are much harder to isolate. These effects, as manifested by the herd behavior, reflect the behavioral aspects of financial crisis contagion. We take a behavioral approach to synthesize these effects by employing a composite variable – psychic distance.

Mishkin (2003) defines financial crisis as "a disruption to financial markets in which adverse selection and moral hazard problems become much worse, so that financial markets are unable to efficiently channel funds to those who have the most productive investment opportunities (pp.94)." The emphasis on adverse selection and moral hazard implies that behavioral approach may actually be providing an alternative tool for us to further explain the herding mentality during times of crisis.

There is a burgeoning literature on behavioral economics and behavioral finance in recent years. The basic argument is that a theory of complete rationality and the assumption of utility

maximization do not provide sufficient bases for explaining and predicting all economic behaviors. The financial system is far from efficient because human behavior only demonstrates bounded rationality. For example, individual investor's trading is often driven by irrational, sentimental shocks; institutional investors often exhibit herding behavior, etc. (Kim and Wei, 1999). On the basis of a fairly complete literature review, Shiller (1998) summarizes a dozen of behavioral principles. Among them some provide useful leads for the understanding of the herd mentality from human behavior's perspective. One of the major behavioral principles is related to "mental compartments," which we view as virtual categories assigned by human beings. According to Shiller (1998), there is "…a human tendency to place particular events into mental compartments based on superficial attributes (pp.18)." Instead of carefully analyzing the full picture of a country's macroeconomic fundamentals, investors may look at individual similarities independently. Therefore "people may tend to place their investments into arbitrarily separate mental compartments, and react separately to the investments based on which compartment they are in (pp.18)." As argued by Shiller (1998), mental compartments can result in overconfidence, and/or over- and under-reaction due to "representativeness heuristic," when in making probability estimates, investors overstress the importance of the categorization, neglecting evidence about the underlying probabilities. This may explain a general market overreaction or the excess volatility of speculative asset prices during crisis. "Magical thinking," as discussed in Shiller (1998), may play a role in deepening a crisis. If people believe the theories they may then behave in a way that leads things, say the market volatility, to actually move as hypothesized. The consistency of the correlations further reinforces the initial belief. Another relevant principle is attention anomalies, which highlights the impact of the change of public attention in investment decision making. Shiller (1998) believes that the volatility of speculative asset prices

is related to the capriciousness of public attention. Also he claims that the major crashes in financial markets can be viewed as phenomena of attention, in which "an inordinate amount of public attention is suddenly focused on the markets (pp.41)," sometimes on the markets in a specific region.

Based on the foregoing discussions of the behavioral principles, we envision the following picture of financial contagion from human behavior's perspective. Investors fit different countries into different mental compartments. When a country is hit by a financial crisis, due to representativeness heuristic and attention anomalies, other countries perceived to be in the same mental category are subject to an excess volatility in asset prices due to over-reaction on the part of investors. "Magical thinking" reinforces such turmoil. The behavioral principles borrowed from psychology provide a fresh insight in analyzing contagion, which reveals the role human behavior has played in the process of a financial crisis. Based on these principles, it is well justified to link herd mentality that takes over in crisis time with the concept of psychic distance, which can be considered as a continuous measure of mental compartments.

The concept of psychic distance was first proposed by Beckerman (1956) and later popularized by Johanson and Vahlne (1977). It has been widely applied in cross-cultural management theory and practice, and in explaining firms' internationalization process (O'Grady and Lane, 1996) and export market selection (Dow, 2000). Geographic distance, cultural distance (Hofstede, 1980, 1983; Kogut and Singh, 1988), and market similarity (Sethi, 1971) were all used as approximations of psychic distance based on the nature of the research. Other indicators or dimensions include level of economic development, level of education, language, etc.

(O'Grady and Lane, 1996). Accordingly, as stated by O'Grady and Lane (1996), the definition of psychic distance varies greatly within the literature, depending upon the way in which the concept is operationalized.

Psychic distance has been rarely applied in financial studies. We define it as the perceived degree of similarities in the characteristics of a country that can cause investors to "group" it alongside other countries exhibiting similar characteristics. This definition is quite similar to Ahluwalia (2000)'s "visible similarities." We emphasize, however, the role of *perceived* similarities in determining a country's vulnerability to financial contagions because such mental categorization is not solely based on the true and visible similarities in macroeconomic fundamentals. Psychic distance also captures the interactions among countries that may not be accounted for by Ahluwalia's visible similarities. Based on the literature review above, we incorporate the following dimensions to operationalize psychic distance in this study: economic development level, cultural distance, common membership, and geographical distance, etc.[4]

3. Empirical Strategy and Data

3.1. The Empirical Model

In their study of financial crisis contagion arising from the Mexican peso crisis in 1994, Sachs et al. (1996) adopt an empirical model that combines three explanatory factors in one linear

[4] One important dimension of psychic distance is macroeconomic similarity, which may overlap with the macroeconomic weaknesses measured by monsoonal effects. So in constructing the psychic distance variable it is not included.

regression – real exchange rate over-valuation, weakness in the banking system, and low international reserves (relative to broad money). While their findings have statistically significant explanatory power for financial crisis contagion, further investigation is needed based on our literature review in the previous section. We extend their study in three aspects – data sample, variable selection, and empirical framework. First, we expand the data coverage to include the four major episodes of financial crises in the 1990s, namely the Asian financial crisis, the financial debacles for Brazil and Russia, as well as the Mexican crisis. Second, we set up our empirical model with the same dependent variable as that of the STV – the crisis index, but employ four sets of independent variables that are derived from the literature reviewed in the previous section, which are specified as follows:

(1) Monsoonal effects, which refer to each country's weaknesses in macroeconomic fundamentals thus its vulnerability to a common shock originated from somewhere else in the world;

(2) Spillover effects due to financial and trade interdependence between two countries;

(3) Psychic distance, a variable measuring the perceived similarity across countries and composed of various dimensions including geographic distance, cultural distance, development level, and membership and/or neighborhood effects. The inclusion of the psychic distance variable in our analysis represents novelty in the study of contagion. It is designated to account for the occurrence of so-called true or pure contagion, presumably due to changes in expectations that are not related to a country's macroeconomic fundamentals; and

(4) Institutional factors, including exchange regime and capital control arrangements.

Third, we adopt the gravity model approach in synthesizing our empirical framework. Newton's theory of gravitation has been used for a long time in social sciences and is considered especially useful for the analysis of bilateral trade flows because it provides an empirically tractable framework.[5] The gravity model has two pillars: (1) the product of the masses of two celestial bodies and (2) the distance between the two bodies. For any pair of particles the force is directly proportional to the product of the masses (the pull factor) and inversely proportional to the square of the distance between them (the push factor). The simplest form of the gravity model for international trade posits that the volume of trade between any two trading partners is an increasing function of their national incomes, and decreasing function of the distance between them (Wall, 1999). We believe the gravity model also provides a coherent framework for the study of financial contagion, which in essence is an interaction among countries when financial crisis occurs. We view the "spillover effects," or the impact of financial or trade linkages among countries represent the pull factor and the psychic distance the push factors in our model, while controlling for monsoonal effects and the institutional factors.

Based on our foregoing discussions, we set up our multiple regression equation as follows:

$$CIND_i = \alpha + \beta_1 MonsoonalControls_i + \beta_2 Spillover_{ij} + \beta_3 PsychicDistance_{ij} + \beta_4 InstitutionalControls_i + \varepsilon_i \quad (1)$$

where ***CIND*** is the crisis index and the right-hand side variables correspond to the four categories of explanation. A higher value of ***CIND*** indicates a higher degree of severity in

[5] See Askari et al (2003) for a discussion of the application of the gravity model to international trade studies.

financial crisis. Here, country *i* is a country subject to contagion and *j* a "ground-zero" country, the country that triggers the wave of crisis in each episode. For country *i*, the severity of crisis is a function of its own fundamentals (the monsoonal effects), its linkages with country *j* (the spillover effects), its psychic distance to country *j* and its own domestic institutional factors. The direction and magnitude of $?_3$ will be of key interest as they are indications of the presence and severity of pure contagion. $?_3$ is important also because it is the only behavioral approach predictor in the model. Our hypothesis is that the severity of the contagion effect is in direct proportion to the trade and financial linkages and inversely proportional to the psychic distance between the originating country and the country affected, when macroeconomic fundamentals and institutional factors are controlled.

In addition to the four episodes of financial crises that took place in the 1990s, we construct a fifth data sample by stacking up all the observations over four episodes to see if there exist coherence and consistency across all the crisis episodes. In our samples, we include all the countries in the world as listed in International Financial Statistics (IFS), published by the International Monetary Fund (IMF). However, due to data availability, the actual number of observations used in each empirical test varies across data samples and are reported in the empirical results tables. Our data are mostly retrieved from the IFS database, unless otherwise specified in the ensuing discussions.

3.2. The Dependent Variable

In the STV model, the crisis index, $\boldsymbol{CIND}_i$, is a weighted average of the percentage depreciation of country i's exchange rate (***EXD***) and percentage loss in the country's international reserves (***RLOS***) over a certain time interval. To capture the overall volatility of the two indicators over the crisis period, we modify the construction of this variable by combining *the averages* of monthly percentage depreciation in the exchange rate and percentage loss in international reserves over a specific time interval. For each episode, a certain interval is selected as the period of crisis. According to common practice in the literature (see Ahluwalia, 2000), the starting point of each episode of interest is as follows: December 1994 for the Mexican crisis, July 1997 for the Asian crisis, August 1998 for the Russian crisis, and January 1999 for the Brazilian crisis. The crisis index is constructed using the intervals 1994M11 (November 1994; same interpretation afterwards) – 1995M4, 1997M5 – 1997M10, 1998M7 – 1998M10 and 1998M12 – 1999M2 for the four crises respectively.[6] Following Ahluwalia (2000) and Caramazza et al. (2000), to equalize the conditional variance of the two components, we weigh each component by the inverse of its variance divided by the sum of the inverses of the variances of the two components:

$$CIND = \left(1/\sigma^2_{EXD}\right)/\left(1/\sigma^2_{EXD} + 1/\sigma^2_{RLOS}\right) * EXD + \left(1/\sigma^2_{RLOS}\right)/\left(1/\sigma^2_{EXD} + 1/\sigma^2_{RLOS}\right) * RLOS \quad (2)$$

The exchange rate used is the end-of-period monthly exchange rate vs. the US dollar. The international reserves are defined as "Total Reserves minus Gold" in the IFS. The variances

[6] Alternative selections of intervals to construct the crisis index are available in the literature. Also there are alternative ways to compute the crisis index. For example, simply measures the depreciation of a country's currency (Ahluwalia, 2000; Caramazza, etc., 2000).

used for the equalization process (Expression (2) above), $?^{2}_{EXD}$ and $?^{2}_{RLOS}$, are calculated from the monthly percentage changes in the exchange rate and reserves over the 36 months prior to the occurrence of each crisis episode.

3.3. Monsoonal Effects

To account for the fundamental vulnerability to external financial shocks, we follow the conventional wisdom as well as making reference to the study by Ahluwalia (2000) in selecting the following measures into the set of macroeconomic control variables denoted as $MonsoonalControls_i$:

(1) Real effective exchange rate appreciation (***REER***). A real exchange rate appreciation indicates a loss of international price competitiveness. More importantly, it may also imply an exchange rate misalignment, which may be an indicator, perceived by the investors, of the pressure a government faces to adjust the nominal exchange rate. This variable is constructed as the ratio of the average real effective exchange rate 12 months before the crisis over the average in the previous 3 years.

(2) Ratio of international reserves relative to broad money (***RES_M2***). This is an indicator of the vulnerability of a country's financial system to a run by investors. The level of international reserves ("Total Reserves minus Gold" from the IFS, as described previously) over M2 (the sum of "money and quasi money" in the IFS) in December of the year prior to the crisis are used to construct this variable.

(3) Percentage change in the ratio of domestic claims to GDP (***CLM***). This variable measures the percentage change in the ratio of domestic credits to gross domestic product (GDP) over a two-year period ending in December of the year preceding the crisis year. Domestic lending boom would increase the vulnerability of the banks' portfolios to economic contractions. If a large proportion of the domestic banks' liabilities are denominated in the domestic currency, the government will be more willing to devaluate rather than bailing out domestic banks. The data source is termed as "Claims on the Private Sector at Current Prices" in the IFS.

(4) Current account balance as a percentage of GDP (***CA_GDP***) during the calendar year prior to crisis time. For one thing, the size of the current account deficit measures the extent to which the capital inflow is needed to cover the deficit. Alternatively, the current account balance in part determines a country's ability to repay foreign-denominated debt. Hence it is an essential determinant of foreign investors' confidence in an economy. For the other, a government is more likely to devalue its currency in the hope to boost exports when there is a huge current account deficit, especially for emerging markets that appreciate export-led-growth. The current account deficit can be viewed as an indicator of the adjustment in the real exchange rate needed to restore external balance.

3.4. Spillover Effects

For the spillover effects, we use measures for both trade and financial linkages. We adopt the indicator of trade competition in third markets (***TCOMP***$_{ij}$) used by Glick and Rose (1999), and build a measure of direct trade (***DTRD***$_{ij}$) to account for trade interdependence between the ground-zero country, j, and the affected country, i. These variables are constructed as follows:

$$TCOMP_{ij} \equiv \sum_{k} [(x_{jk} + x_{ik})/(x_j + x_i)][1 - |(x_{jk}/x_j) - (x_{ik}/x_i)|/((x_{jk}/x_j) + (x_{ik}/x_i))] \quad (3)$$

$$DTRD_{ij} \equiv (m_{ij} + x_{ij})/(m_i + x_i) \quad (4)$$

In Equation (3), k represents the most important trade partners for the ground-zero countries in the different crises episodes. Table 1 provides a list of the top exporting markets included as components of k for each originating country j in the calculations. x_{ik} denotes aggregate exports from country i to k and x_i is the aggregate exports from country i. $\boldsymbol{TCOMP_{ij}}$ reaches its highest value if country i has a similar exporting market structure as that of country j, where crisis initiated. Thus $\boldsymbol{TCOMP_{ij}}$ is a measure of trade competition in third markets between a ground-zero country j and an individual country (country i) that we are interested in.[7]

Expression (4) measures bilateral trade linkage between two countries. m_{ij} (x_{ij}) stands for country i's imports (exports) from (to) country j and m_i (x_i) is the total imports (exports) of country i. $\boldsymbol{DTRD_{ij}}$ measures the importance of country j as a bilateral trade partner for country i. All the bilateral trade data are obtained from IMF's *Direction of Trade Statistics (DOTS)* database.

[7] The Glick and Rose (1999) paper uses the absolute values of exports in the second component of the expression. Similar to the modification method adopted by Rijckeghem and Weder (2000) in their measurement of "competition for common lender", we replace the absolute values with the proportion values, which are the value of exports to a common third market over the total exports from a given country. Compared with the absolute values, the use of share values can measure the relative importance of a third market to a given country on the same scale. So the problem of vastly different exporting volume can be eliminated.

Table 1. Top Exporting Markets of Each Ground-zero County in the Four Episodes[a]

Mexico (1993)		Thailand (1996)		Russia (1997)		Brazil (1998)	
Partner	**Share[b]**	**Partner**	**Share[b]**	**Partner**	**Share[b]**	**Partner**	**Share[b]**
United States	83.3% (83.3%)	United States	18.0% (18.0%)	Ukraine	8.5% (8.5%)	United States	19.4% (19.4%)
		Japan	16.8% (34.8%)	Germany	7.7% (16.2%)	Argentina	13.2% (32.6%)
		Singapore	12.1% (46.9%)	United States	5.8% (22.0%)	Germany	5.9% (38.5%)
		Hong Kong	5.8% (52.7%)	Belarus	5.4% (27.4%)	Netherlands	5.4% (43.9%)
		Malaysia	3.6% (56.3%)	Netherlands	5.4% (32.8%)	Japan	4.3% (48.2%)
		China	3.4% (59.7%)	China	5.4% (38.2%)	Belgium-Luxembourg NS	4.3% (52.5%)
		United Kingdom	3.3% (63.0%)	Switzerland	4.7% (42.9%)	Italy	3.8% (56.3%)
		Netherlands	3.2% (66.2%)	Italy	4.4% (47.3%)	United Kingdom	2.6% (58.9%)
		Germany	2.9% (69.1%)	Japan	4.2% (51.5%)	France	2.5% (61.4%)
		Korea	1.8% (70.9%)	United Kingdom	3.4% (54.9%)	Paraguay	2.4% (63.8%)

[a] We include top ten exporting markets for each ground-zero country in the calculation of TCOMP except for Mexico, whose exports to the United States accounted for 83% of its total exports in 1993. Only the US is included in the calculation for the Mexican Episode. Data source: Direction of Trade Statistics, IMF.
[b] Cumulative shares in parentheses.

To account for the common bank lender argument for contagion, we adopt a variable measuring competition for funding from the same bank lenders (***BCOMP$_{ij}$***) used by Rijckeghem and Weder (2000):

$$BCOMP_{ij} = \sum_{c} [(b_{jc} + b_{ic})/(b_j + b_i)][1 - |(b_{jc}/b_j) - (b_{ic}/b_i)|/((b_{jc}/b_j) + (b_{ic}/b_i))] \quad (5)$$

Parallel to $\boldsymbol{TCOMP_{ij}}$, $\boldsymbol{BCOMP_{ij}}$ measures (debtor) country i's similarity in borrowing patterns to that of country j, in terms of shares in total borrowing. In Equation (4), c stands for the country of common lender, and b_{ic} represents bank lending from a country c to country i. The first component of the equation is a measure of the overall importance of the common lender for countries i and j. The second component captures the extent to which shares of borrowing from the same creditors are different. The most important common lenders included in the calculations are the U.S. and U.K. banks in the case of Mexico crisis, the Japanese banks during Asian crisis, the German banks during the Russian episode, and the U.S. and German banks in Brazilian episode (see Table 2). As in Rijckeghem and Weder (2000), data for this variable is obtained from the Bank for International Settlement (BIS) semi-annual consolidated database covering banking systems in 18 industrialized countries.

Table 2. Top Bank Lenders for Each Ground-zero County in the Four Episodes[a]

Mexico (1993)		**Thailand (1996)**		**Russia (1997)**		**Brazil (1998)**	
Lender	**Share[b]**	**Lender**	**Share[b]**	**Lender**	**Share[b]**	**Lender**	**Share[b]**
United States	34.3% (34.3%)	Japan	54.41% (54.41%)	Germany	41.30% (41.30%)	United States	17.4% (17.4%)
United Kingdom	15.5% (49.8%)					Germany	15.4% (32.8%)

[a] Data source: Statistical annex of "The BIS Consolidated International Banking Statistics" (formerly known as "The Maturity, Sectoral and Nationality Distribution of International Bank Lending"), BIS, various issues.
[b] Cumulative shares in parentheses.

3.5. Psychic Distance

Our construct for the psychic distance variable, $\boldsymbol{PDIST_{ij}}$, is a single ordinal scale that combines some single indicators used in the literature. The essential building blocks for the scale are the standardized values for four sub-factors, including geographic distance, common language, development level and common membership. The weights for each dimension are equal. All the sub-factors are objective measures.

Geographic distance ($\boldsymbol{GDIST_{ij}}$) is approximated by the Great Circle Distance between the capital cities of two countries of interests.[8] Physical distance is a typical variable in international trade studies using gravity model and often used to reflect the perception that geographically adjacent countries are more likely to share similarities than others. Sharing a common border and being in the common continental region may increase perceived closeness.

Cultural differences or similarities play a major role in determining the psychological distance. Language is an essential indicator of culture. We use whether or not countries share a common language as a proxy for cultural distance. $\boldsymbol{COML_{ij}}$ is set to be one if country i and ground-zero country j share a same official or primarily spoken language. Otherwise, it is zero.[9]

It is a stylized fact that most crisis-affected countries in the 1990s are less developed countries (LDCs) and/or emerging markets. LDCs with a demonstrated potential for economic expansion

[8] Great circle distance is the smallest distance between two points on a sphere. It is often used to measure the distance between two locations on the surface of the earth.

[9] Based on Hofstede's (1980, 1983) cultural dimensions theory, Kogut and Singh (1988) develop a four dimensional cultural scale as a measure of cultural distance. However, Hofstede's (1980, 1983) studies only provide the cultural scale for about 50 countries. The data for Russia, one of the ground-zero countries, is not available. It is not possible to calculate the cultural distance between Russian and other countries based on the scale provided by the Hofstede studies. So we only use common language as an indicator of cultural distance due to the data limitation.

are typically entitled as "emerging." It is arguable whether the term "less developed countries (LDCs)" or "emerging market" is a synonym of bad macroeconomic fundamentals that need to be developed. However, according to the "discriminating contagion" argument, the name "emerging market" itself can increase the volatility simply by the negative information conveyed by the title (see Ahluwalia, 2000), as the term "emerging" implies a status as being in transition, increasing in size, activity, or level of sophistication. All the four originating countries in our sample, Mexico, Thailand, Russia, and Brazil, are generally considered as leading emerging markets. Investments in emerging markets have the potential to generate high returns in a relatively short period of time. Meanwhile, however, there is a higher level of risks involved in these investments as they are subject to various macroeconomic weaknesses as well as unexpected political and economic turmoil. In investors' perception, upheaval in one emerging market can serve as a "wake up call" for other emerging markets as well as other LDCs. Per capita income is the most important indicator to measure a country's development level.[10] We use the difference of GDP per capita in dollars between two countries immediately before the respective crises to measure the development level aspect of psychic distance, denoted as $\boldsymbol{DDIST_{ij}}$.

"Membership effect" distinguishes the role played by political and economic integration at regional or global levels. We have seen a certain level of political integration in Europe over the past decades. But a more prevailing trend is toward regional integration at the economic perspective. We incorporate the common regional bloc membership with the ground-zero

[10] As a convention, if a country's per capita income does not achieve the World Bank's threshold for a high-income country, this country can be regarded as an emerging market.

countries as a sub-factor ($COMM_{ij}$) of psychic distance, since such common membership may induce coordinated efforts or common reaction on the part of the governments to maintain "integration," thus increase the perceived similarity between two countries. $COMM_{ij}$ is set to be one if country i and ground-zero country j share at least one common membership at the regional or global level.

Table 3. Countries with the Smallest Psychological Distance from the Ground-zero Countries[a]

Mexico	Thailand	Russia	Brazil
Costa Rica	Malaysia	Kazakhstan	Cape Verde
El Salvador	Philippines	Kyrgyz Republic	Paraguay
Colombia	Lao PDR	Tajikistan	Colombia
Panama	Cambodia	Latvia	Venezuela, RB
Guatemala	Vietnam	Lithuania	Chile
Venezuela, RB	Indonesia	Belarus	Angola
Honduras	Sri Lanka	Estonia	Peru
Dominican Republic	Bangladesh	Ukraine	Bolivia
Chile	India	Moldova	Ecuador
Ecuador	Korea, Rep.	Armenia	Argentina

[a] Data for GDIST is obtained from John A. Byers, Swedish University of Agricultural Sciences at Alnarp at the following website: http://www.vsv.slu.se/johnb/java/lat-ong.htm.
Data for COML is from the following website: http://www.infoplease.com/ipa/A0855611.html.
Data for COMM is calculated from GDP per capita, PPP (current international dollar) based from the World Bank's World Development Indicators database. We use the 1994 data for the Mexican episode, the 1996 data for the Asian crisis, the 1997 data for the Russian crisis, and the 1998 data for the Brazilian episode.
Information on COMM is available at the World Development Indicators by the World Bank.

Before adding up the sub-factors, we transform each data into a standardized value with a mean of zero and a unit standard deviation:

$$PDIST_{ij} \; ? \; GDIST_{ij} \; ? \; COML_{ij} \; ? \; DDIST_{ij} \; ? \; COMM_{ij} \qquad (6)$$

where $GDIST_{ij}$~N(0,1), $COML_{ij}$~N(0,1), $DDIST_{ij}$~N(0,1), $COMM_{ij}$~N(0,1). Table 3 provides a list of countries that are psychologically the closest to each crisis-triggering country according to our calculation.

3.6. Institutional Factors

Information on exchange rate regime and capital control is obtained from the IMF Annual Report on Exchange Arrangements and Exchange Restrictions. We include two dummy variables for the exchange rate regime factor to see if a rigidly fixed or a freely floating exchange rate system would affect the chance of being affected by a crisis. ***EXRFX*** would be set as one if the exchange rate for a country was pegged to another currency (other currencies) as of the year-end before each episode. ***EXEFL*** has a value of one if exchange regime for a country is free floating. Intermediate arrangements, such as pegged-but-adjustable and managed floating and (narrow) bands, are not accounted for by the above two variables. For foreign exchange restrictions, ***CACON*** takes the value of one if a country was restricting payments for current transactions. Dummy variable ***KACON*** is set to be one if a country imposed restrictions on capital account

transactions, including those on capital market securities and money market instruments, at the end of the year before a certain episode.

4. Empirical Results

Table 4. Countries with the Highest Value of Crisis Index in Each Crisis Episode [a]

	Mexican Crisis[c]	**Asian Crisis[c]**	**Russian Crisis[c]**	**Brazilian Crisis[c]**
1	Mexico (0.080)[b]	Lao People's Dem.Rep (0.093)	Russia (0.238)[b]	Brazil (0.215)[b]
2	Brazil (0.048)	Thailand (0.079)[b]	Ukraine (0.133)	Suriname (0.147)
3	Sudan (0.035)	Indonesia (0.077)	Belarus (0.076)	Ecuador (0.124)
4	Congo, Dem. Rep. Of (0.034)	Malaysia (0.058)	Ecuador (0.074)	Georgia (0.121)
5	Chad (0.027)	Philippines (0.052)	Kyrgyz Republic (0.071)	Romania (0.073)
6	Suriname (0.024)	Sudan (0.047)	Lao People's Dem.Rep (0.049)	Croatia (0.057)
7	Uruguay (0.018)	Turkey (0.038)	Israel (0.046)	Turkey (0.049)
8	Hungary (0.018)	Cambodia (0.038)	Romania (0.045)	Russia (0.040)
9	Philippines (0.018)	Kenya (0.032)	Burundi (0.043)	Peru (0.038)
10	Ghana (0.017)	Colombia (0.025)	Colombia (0.041)	Ukraine (0.037)
11	Spain (0.015)	Mauritania (0.023)	Mexico (0.039)	Czech Republic (0.036)
12	Romania (0.013)	Zimbabwe (0.022)	Uganda (0.026)	Poland (0.034)

[a] Due to data availability, not all the countries in the table are included in the regression analysis.
[b] Crisis Indices of ground-zero countries are presented in the table but are not included in the regression analysis, since we are only interested in the severity of crisis in the contagion affected countries.
[c] Calculated values of crisis index in the parenthesis.

Table 4 lists the counties with the highest values of ***CIND*** (the "crisis index") in each episode. As a commonly used measure, the ordinal index ***CIND*** captures the exchange rate depreciation and loss in international reserves during the crisis time.[11] To see how this index correlates with the proposed explanatory variables, we obtain the Pearson correlation coefficients for all the five samples, which are presented in Table 5. Correlations between the crisis index and most of the explanatory variables are statistically significant at the 90% level or better. Among the monsoonal effects variables, the change of real effective exchange rate (***REER***) shows statistical significance in three of the four crisis episodes (the Mexican, Russian and Brazilian crises). The correlations are positive, as expected. The ratio of international reserves over broad money (***RES_M2***), the domestic lending boom variable (***CLM***) and the current account balance over GDP (***CA_GDP***) are significantly correlated with ***CIND*** in at least one of the four episodes. The signs of these correlations are consistent with rational expectation as indicated previously. For variables that account for the spillover effects, we find significant and positive correlation coefficients for "direct trade linkage" (***DTRD***) for the Asian and Russian samples, "trade competition in third markets" (***TCOMP***) for the Asian crisis, and "competition for funding from the common bank lender" (***BCOMP***) for the Mexican and Asian samples. Among the institutional factors, fixed exchange rate regime (***EXRFX***) is found to be significantly and negatively associated with the crisis index in all the episodes except the Russian crisis. On the contrary, floating exchange rate (***EXRFL***) is positively related with ***CIND*** in the Mexican and Asian samples. However, current account constraints (***CACON***) and capital account constraints

[11] Although commonly used, ***CIND*** is not a perfect measure of the severity of financial crisis. For example, in the Mexican episode, the Tequila effect triggered a severe banking crisis in Argentina. But Argentina is not on the list probably because the effect of banking crisis is not explicitly captured by the index. Other possible outcomes of a financial crisis, such as a sharp decline in stock market price or other asset market prices, are not incorporated in the index, either. But overall, as shown in table 4, the majority of the obvious victims of each episode appear on the list as expected.

(***KACON***) do not show any statistical significance in any individual episode. The psychic distance variable (***PDIST***) shows statistically significant and negative relation with the severity of crisis in all four episodes. The correlation is the strongest for the Asian sample, whose correlation coefficient is a negative 66 percent at the 99.9 percent confidence level. For the pooled sample, significant relationship is detected for three of the macroeconomic factors (***REER***, ***RES_M2*** and ***CLM***), all the spillover variables, fixed exchange rate regime, current account restrictions, and the psychic distance variable. All the statistically significant coefficients show the expected signs.

Table 5. Correlation Coefficients between the Dependent Variable and the Explanatory Variables[a]

	CIND (Mexican)	**CIND (Asian)**	**CIND (Russian)**	**CIND (Brazilian)**	**CIND (Pooled)**
REER	.291*	.146	.542***	.505***	.346***
M2_RES	-.327**	.063	-.190	-.214	-.133*
CLM	.174	.384**	.228†	.167	.206***
CA_GDP	-.138	-.037	.002	-.259†	-.076
DTRD	-.033	.389**	.530***	-.076	.206***
TCOMP	.179	.444***	.091	-.135	.112†
BCOMP	.347**	.441***	.179	-.136	.140*
EXRFX	-.303**	-.349**	-.116	-.311*	-.253***
EXRFL	.305**	.290*	-.199	-.166	-.021
CACON	.082	.022	.163	.153	.161**
KACON	.028	-.020	.047	.122	.055
PDIST	-.285*	-.664***	-.466**	-.331**	-.319***
# of Observations	43	39	38	36	156

[a] ***p<.01, **p<.05, *p<.10, and †p<.20.

Our correlation analysis provides a basis for selecting variables, among all the possible candidates discussed so far and listed in Table 5, to enter into our regression analysis. Variables

that are not statistically correlated with the dependent variable are removed in the regressions. Some of the explanatory variables are believed to be correlated among themselves. For example, countries in the same region usually trade more with each other, and/or at the same time compete for the same exporting markets as well as for funds from the same creditor, thus leading to high correlations between ***TCOMP*** and ***BCOMP***, the measures for competition for the same trade market and common lender respectively. High correlation between trade and financial linkages is well documented by previous work (e.g., see Kaminsky and Reinhart, 2000). Psychic distance is correlated with these trade or financial interdependence variables probably because ***PDIST*** has a geographic approximation dimension. To detect multicollinearity, we obtain the correlation matrix of the regression variables for each of the five samples. As shown in Tables 6-10, statistically significant correlations do exist among the explanatory variables in each sample, particularly among ***DTRD***, ***TCOMP***, ***BCOMP*** and ***PDIST***, as expected. Some of the correlation coefficients are higher than 50 percent, which suggests that a potential multicollinearity problem needs to be addressed on related variables.

Table 6. Correlation Matrix of Key Regression Variables (the Mexican Crisis)[a]

	CIND	**REER**	**M2_RES**	**BCOMP**	**EXRFX**	**EXRFL**	**PDIST**
CIND	1.000						
REER	.291*	1.000					
M2_RES	-.327**	-.429***	1.000				
BCOMP	.347**	.360**	-.305**	1.000			
EXRFX	-.303**	-.240	.260*****	**-.566*****	1.000		
EXRFL	.305**	.098	-.131	.310**	-.497***	1.000	
PDIST	-.285*	-.205	.131	**-.574*****	.181	-.115	1.000

[a] ***p<.01, **p<.05, and *p<.10. In bold are the coefficients that are higher than .500, where multicollinearity might be a concern.

Table 7. Correlation Matrix of Key Regression Variables (the Asian Crisis)[a]

	CIND	CLM	DTRD	TCOMP	BCOMP	EXRFX	EXRFL	PDIST
CIND	1.000							
CLM	.384**	1.000						
DTRD	.389**	.091	1.000					
TCOMP	.444***	.168	**.573*** **	1.000				
BCOMP	.441***	-.109	**.572*** **	**.662*** **	1.000			
EXRFX	-.349**	-.219	-.226	.315*	-.222	1.000		
EXRFL	.290*	.249	-.071	.101	.040	-.343**	1.000	
PDIST	-.664***	-.127	**-.613*** **	**-.511*** **	**-.525*** **	.143	.057	1.000

[a] ***p<.01, **p<.05, and * p<.10. In bold are the coefficients that are higher than .500, where multicollinearity might be a concern.

Table 8. Correlation Matrix of Key Regression Variables (the Russian Crisis)[a]

	CIND	REER	CLM	DTRD	PDIST
CIND	1.000				
REER	.542***	1.000			
CLM	.228	.119	1.000		
DTRD	.530***	.258	.436***	1.000	
PDIST	-.466***	-.385**	-.355**	**-.675*** **	1.000

[a] ***p<.01, **p<.05, and *p<.10. In bold are the coefficients that are higher than .500, where multicollinearity might be a concern.

Table 9. Correlation Matrix of Key Regression Variables (the Brazilian Crisis)[a]

	CIND	REER	CA_GDP	EXRFX	PDIST
CIND	1.000				
REER	.505***	1.000			
CA_GDP	-.259	-.325*	1.000		
EXRFX	-.311*	-.211	-.002	1.000	
PDIST	-.331**	-.370**	.300*	.193	1.000

[a] ***p<.01, **p<.05, and *p<.10. In bold are the coefficients that are higher than .500, where multicollinearity might be a concern.

Table 10. Correlation Matrix of Key Regression Variables (the Pooled Sample)[a]

	CIND	REER	M2_RES	CLM	DTRD	TCOMP	BCOMP	EXRFX	CACON	PDIST
CIND	1.000									
REER	.346***	1.000								
M2_RES	-.133*	-.350***	1.000							
CLM	.206***	.152*	-.088	1.000						
DTRD	.206***	.133*	-.046	.148*	1.000					
TCOMP	.112	.113	.078	.050	.269***	1.000				
BCOMP	.140*	.119	-.149*	.149*	.320***	.452***	1.000			
EXRFX	-.253***	-.197**	.174**	-.173**	-.208***	-.207***	-.321***	1.000		
CACON	.161**	.131	-.169**	-.003	.036	-.021	-.107	.031	1.000	
PDIST	-.319***	-.174**	.053	-.062	-.368***	-.466***	-.461***	.112	-.075	1.000

[a] ***p<.01, **p<.05, and *p<.10. In bold are the coefficients that are higher than .500, where multicollinearity might be a concern.

Table 11. Estimation Results for Gravity Model of Contagious Financial Crisis[a]

	CIND (Pooled)		CIND (Mexican)		CIND (Asian)		CIND (Russian)		CIND (Brazilian)	
	Without PDIST	**With PDIST**	**Without PDIST**	**With PDIST**	**Without PDIST**	**With PDIST**	**Without PDIST**	**With PDIST**	**Without PDIST**	**With PDIST**
Intercept	-.045*** (.015)	-.034** .015	-.014 (.012)	-.015 (.012)	.006 (.005)	.013*** (.005)	-.105*** (.024)	-.085*** (.026)	-.075 (.041)	-.056 (.043)
REER	**.045*** (.014)**	**.041*** (.013)**	.013 (.011)	.008 (.011)			**.093*** (.023)**	**.075*** (.024)**	**.087** (.040)**	**.068† (.042)**
M2_RES	.000 (.000)	.000 (.000)	**-.000† (.000)**	**-.000† (.000)**						
CLM	**.011† (.007)**	**.011† (.007)**			-.002 (.011)	.004 (.012)	**.038*** (.014)**	**.036** (.014)**		
CA_GDP									.035 (.050)	.053 (.054)
DTRD	**.527*** (.164)**	**.419** (.164)**			.096 (.218)	-.050 (.228)	**.223† (.135)**	**.225† (.142)**		
TCOMP	-.003 (.013)	-.014 (.014)			.004 (.018)	-.015 (.018)				
BCOMP	-.002 (.017)	-.017 (.017)	-.000 (.017)	Removed due to high VIF[b]	**.049** (.021)**	.014 (.021)				
EXRFX	**-.007* (.004)**	**-.009** (.004)**	.000 (.005)	.005 (.004)	**-.008* (.005)**	**-.011** (.004)**			-.003 (.010)	-.003 (.010)
EXRFL			**.006† (.005)**	**.006† (.004)**	.000 (.005)	.000 (.005)				
CACON	**.006* (.004)**	**.005† (.004)**								
PDIST		**-.002*** (.001)**		**-.001*** (.000)**		**-.003*** (.0001)**		**-.003** (.002)**		**-.003† (.002)**
F-Statistic	5.98***	6.51***	1.89†	3.19**	3.11***	4.56***	9.04***	7.44***	1.75†	2.01†
R-Square	.25	.29	.17	.21	.16	.28	.28	.32	.09	.14
No. of Observations	156	156	51	66	102	90	75	67	59	56

[a] Pooled OLS. Standard errors in parenthesis. ***p<.01, **p<.05, *p<.10, and †p<.20.

[b] Before this variable is removed, it is not significant either.

Table 11 reports estimates of our empirical model from the OLS regressions for the pooled sample and the four sub-samples. Due to data availability, each regression involves different numbers of observations, as reported in the table. First we run the regressions without the psychic distance variable, ***PDIST***. Then we add ***PDIST*** to the regression to see if it increases the explanatory power of the model. Multicollinearity diagnostics are performed in the process by estimating the variance inflation factor (VIF) for all the independent variables. We find that none of the VIF values exceeds three, which is well below the rule-of-thumb threshold value of ten that is indicative of a multicollinearity problem (Neter et al., 1985). To stay on the safe side, however, we follow another rule-of-thumb by comparing a variable's VIF with the VIF calculated from the R-square of the model as a whole, i.e., $1/(1-R^2)$, for the following four variables: ***DTRD***, ***TCOMP***, ***BCOMP*** and ***PDIST***, as correlation analysis indicates that multicollinearity is most likely to be exiting among these variables.[12] As a result, in the Mexican case, we removed the ***BCOMP*** variable in our estimation since when PDIST is present, the VIF values related to the common lender variable was relatively high and the removal of this variable leads to a higher R-square and lower VIF values in general.

As Table 11 shows, our estimation generates a number of interesting results for the control variables, namely, monsoonal effects and institutional factors. Among the variables for macroeconomic fundamentals, or the monsoonal effects, the real exchange rate variable ***REER*** obtains positive and statistically significant coefficients for the Russian, Brazilian, and the pooledsamples, showing that a more overvalued currency does lead to more severe financial

[12] The rule is that any variables whose VIF values exceeding the model's VIF are more closely related to the other independent variables than they are to the dependent variable. Thus, variables whose VIF values exceed the model's VIF value are likely candidates for suffering from multicollinearity.

crisis. This finding is consistent with that obtained in the STV study. The results for the percentage change in the ratio of domestic credits to gross domestic product, ***CLM***, are less consistent across sample. The coefficient is positive and statistically significant at the 99% level for the Russian sample and at the 85% for the pooled sample. The other two monsoonal effects variables – the ratio of international reserves to broad money (***RES_M2***) and the current account balance as a ratio to GDP (***CA_GDP***) show little statistical significance in their estimated coefficients, although they bear the expected signs.

For the institutional factors, our estimates present mixed findings. A fixed exchange rate regime seems to have deterring effect on financial crisis contagion, as the coefficients for the Asian and the pooled samples are negative and statistically significant at the 95% level when the psychic distance variable is included in the regressions (see Table 11). The coefficient for this variable is also negative for the Brazilian sample but with no statistical significance. The variable in the Mexican sample bears the "wrong" sign but at no statistical significance either. The findings in general confirm the conclusion by Edwards (2000) that a super-fix exchange rate system is less vulnerable to contagion. The results seem to suggest that as long as the market participants perceive a given fixed exchange rate as appropriate and not yet in the "ripe for attack" zone, fixing the rate can actually reduce speculative activities that are not related to macroeconomic fundamentals and protect a country from the negative impact brought by the turmoil somewhere else. A case in point is China during the Asian crisis. China essentially was maintaining a fixed exchange rate against dollar and keeping tight control on capital account transactions, which may otherwise destabilize the target peg, at the same time. Many believe that this combination of the foreign exchange policy is one of the main reasons why China survived

the crisis. Surprisingly, the capital control variable (***CACON***) in our regression, by itself, does not appear to help explain the occurrence of financial contagion. It is used only in the pooled sample and its coefficient is slightly positive at some statistical significance. This result is contrary to the belief that when financial liberalization is more limited there is smaller overshooting in capital flows (Bacchetta and Wincoop, 1998). However, the insignificant results we found on the capital controls variables are consistent with those of Caramazza et al. (2000). A floating exchange rate regime appears to be unrelated to the financial crisis contagion since its coefficients in the Mexican and the Asian samples, the only samples that employ the variable, register little statistical significance.

The spillover effects, or the trade and financial linkages variables, represent one of the two important aspects of our empirical framework formulated after the gravity model. They show some support for the hypothesis that closer linkages lead to greater contagion. The direct trade linkage variable, ***DTRD***, is statistically significant for the pooled sample and, to a lesser degree, the Russian sample, suggesting that a currency crisis in one country results in an increased trade deficit and a loss in international reserves on the part of its trading partners. This result is not robust for the Asian sample, as the coefficient for this variable presents no statistical significance. We find some support for the common lender variable, ***BCOMP***, in the Asian sample when the psychic distance variable is not included in the regression. Meanwhile, there is no evidence that third market trade competition, ***TCOMP***, has any impact on financial crisis contagion. The finding that third market competition for trade market and for funds has little or no relevance to financial crisis is contrary to what has been found in previous studies. For example, Rijckeghem and Weder (1999) document that the bank-lending channel had a

pronounced effect in contagion during Asia financial crisis. This finding is also at odds with our correlation analysis where these variables show statistically significant relations with our dependent variable – the crisis index in some cases (see Table 5).

It is interesting to note that, for the Asian sample, the variable for the common lender competition, ***BCOMP***, loses statistical significance when the psychic distance variable is added to the regression. In other words, with the presence of an instrument that combines the geographic distance, developmental level, language similarity and economic integration, the presumably relevant bank lending channel no longer plays a role in explaining the spillover effect during the Asian financial crisis. This observation suggests that the behavioral factor – psychic distance, rather than the "real" economic linkages as highlighted in other studies, may be the real contributor to financial contagion in some crisis episodes. Therefore, financial contagions can be partly attributed to irrational herd behavior of financial agents who assess financial stability on the basis of perceived similarity, rather than financial linkage through a common lender, or trade linkage through competition in the same third market.

The significance of the psychic distance variable is obvious in all the samples. Its coefficients are negative and statistically significant at the 95% level for all the samples except for the Brazilian one, which is significant at the 85% level. This finding provides strong support for the hypothesis that financial crisis is less contagious with greater psychic distance between countries or, conversely, that countries that are believed to be more psychologically close are prone to financial contagion. Of all the components of the psychic distance variable – cultural distance as measured by common language, common membership, geographical proximity, and the

similarity in economic development levels, the importance of the latter two are particularly self-explanatory. As Table 4 indicates, Latin American countries were more affected by the Mexican and Brazilian crises, South East Asian countries by the Asian financial crisis, and East European countries by the Russian financial crisis. Those countries that were affected severely were at more or less the same economic development levels – in most cases developing countries or transitional economies are among those most severely affected.

The contribution of the psychic distance variable to our empirical analysis is further evidenced by the increase in the F statistics and the coefficients of determination of our regressions. The global F tests show that when the psychic distance variable is included in our regressions, the significance levels increase in three samples while remaining at the highest level (99%) for the other two. Also, the empirical model can explain more variance by the inclusion of the psychic distance variable in all five samples. This is particularly so in the case of the Asian crisis where the coefficient of determination of the model increases from 16 percent to 28 percent.

Our result suggests that much of the change in investors' expectation when financial crisis occurs in a particularly country is probably related to a "psychological distance" factor, which is essentially not linked to macroeconomic fundamentals, trade linkages and international banking activities. Perceived "similarity" leads to the perception of increased risk of "similar" countries. That is, investors tend to believe that a country "similar" to the crisis country is equally vulnerable and equally likely to suffer from withdrawals of funds and speculative attacks.

5. Concluding Remarks

The objective of this paper is to investigate the factors that contribute to financial crisis contagion. We synthesize the literature on contagion by combining all major explanatory variables into an adapted gravity model borrowed from physics. Our hypothesis is that financial crisis contagion is positively related to trade and financial linkages and negatively related to psychic distance between crisis-originating countries and crisis-affected countries, when macroeconomic fundamentals or monsoonal effects and institutional factors are controlled. The psychic distance variable is of key interest in our study since it has not been employed specifically in prior studies. Our empirical test is carried out using data from the four financial crises in the 1990s, namely the Mexican, Asian, Brazilian, and Russian crises, where financial crisis contagion has been believed to be prevalent. An overall sample pooling data for all the four crisis episodes is included in our empirical analysis along with the four individual samples.

Our empirical work yields a number of interesting findings. First, we find that, among all the macroeconomic fundamentals, the real exchange rate has the most significant relevance to contagion. When a country's currency is more overvalued, the country is more likely to be affected by a financial crisis occurring in other countries. International reserves relative to broad money and domestic credit expansion are also found to be contributing to financial crisis contagion although the statistical significance varies across samples. Second, a fixed exchange rate system shows a negative and significant impact on contagion for the pooled sample, suggesting that such a system has some preventive power over contagion. On the other hand, other institutional variables, such as a floating exchange rate system or capital controls, are found to be insignificant. Third, we find evidence that direct trade linkages, one of designated "pull"

factors in our gravity model, are a significant contributing factor to contagion in the Russian and the pooled samples. This finding suggests that close trade partners are more likely to be affected when one of the partners suffers from financial crisis. The significance of variables showing competition for common trade markets and common fund lenders is not robust, though. Finally, the psychic distance variable is found to be the single most significant factor among all the variables, contributing to the overall explanatory power of the model. The robustness of this finding across all samples provide clear and strong evidence that financial crisis contagion is a result of herding behavior among investors who make decisions based on perceived similarities among countries. The finding also shows the importance of the psychological perceptions in investors' behavior that leads to financial contagion. Moreover, the behavioral approach we have adopted in this study seems to shed new light to the analysis of financial crisis contagion.

Appendix

Symbolic notations used in the article:

CIND	Crisis index
EXD	Exchange-rate depreciation
RLOS	Loss in international reserves
REER	Real effective exchange rate appreciation
RES_M2	Ratio of international reserves relative to broad money
CLM	Percentage change in the ratio of domestic claims to GDP
CA_GDP	Current account balance as a percentage of GDP
TCOMP	Trade competition in third markets
DTRD	Direct bilateral trade linkage
BCOMP	Competition for funding from the same bank lenders
PDIST	Psychic distance
GDIST	Geographic distance
COML	Common language (Cultural distance)
DDIST	Difference in development level
COMM	Common membership
EXRFX	Rigidly fixed exchange rate regime
EXEFL	Freely floating exchange rate system
CACON	Current account restriction
KACON	Capital account restriction

References

Ahluwalia, P., 2000. Discriminating Contagion: An Alternative Explanation of Contagious Currency Crises in Emerging Markets. IMF Working Paper 00/14.

Askari, H., Forrer. J, Teegen, H., Yang, J., 2003. U.S. Economic Sanctions: Philosophy and Efficacy. Praeger Books, Westport, CT.

Bacchetta, P., Wincoop, E. V., 1998. Capital Flows to Emerging Markets: Liberalization, Overshooting, and Volatility. NBER Working Paper 6530.

Beckerman, W., 1956. Distance and the Pattern of Inter-European Trade. Review of Economics and Statistics 38 (1), 31-40.

Bikhchandani, S., Sharma, S., 2000. Herd Behavior in Financial Markets: A Review. IMF Working Paper 00/48.

Calvo, G. A., Mendoza, E. G., 2000. Rational Contagion and the Globalization of Securities Markets. Journal of International Economics 51 (1), 79-113.

Calvo, G. A., 2001. Capital Markets and the Exchange Rate with Special Reference to the Dollarization Debate in Latin America. Journal of Money, Credit and Banking 33 (2), 312-334.

Caramazza, F., Ricci, L., Salgado, R., 2000. Trade and Financial Contagion in Currency Crises. IMF Working Paper 00/55.

Christiansen, H., 2000. International Financial Contagion. Financial Market Trends 76, 65-108.

Dow, D., 2000. A Note on Psychological Distance and Export Market Selection. Journal of International Marketing 8 (1), 51-64.

Drazen, A., 2000. Political Contagion in Currency Crises. In: Krugman, P. (Ed.), Currency Crises. University of Chicago Press, Chicago, pp. 47-70.

Edwards, S., 2000. Interest Rates, Contagion and Capital Controls. NBER Working Paper 7801.

Flood, R., Garber, P., 1984. Collapsing Exchange Rate Regimes: Some Linear Examples. Journal of International Economics 17, 1-13.

Glick, R., Rose, A., 1999. Contagion and Trade: Why Are Currency Crises Regional. Journal of International Money and Finance 18 (4), 603-617.

Hernandez, L. F., Valdes, R. O., 2001. What Drives Contagion: Trade, Neighborhood, or Financial Links? International Review of Financial Analysis 10 (3), 203-218.

Hofstede, G., 1980. Cultural Consequences: International Differences in Work Related Values. Sage Publications, Beverly Hills, CA.

Hofstede, G., 1983. The Cultural Relativity of Organizational Practices and Theories. Journal of International Business Studies 14 (2), 75-89.

Hufbauer, G. C., Elliott, K. A., Cyrus, T., Winston, E., 1997. US Economic Sanction: Their Impact on Trade, Jobs and Wages. Institute for International Economics Working Paper.

Johanson, J., Vahlne, J., 1977. On the Internationalization Process of Firms: A Critical Analysis. Journal of International Business Studies 8 (1), 23-32.

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

Kim, W., Wei, S., 1999. Foreign Portfolio Investors Before and During a Crisis. NBER Working Paper 6968.

King, M., Wadhwani, S., 1990. Transmission of Volatility Between Stock Markets. Review of Financial Studies 3 (1), 5-33.

Kogut, B., Singh, H., 1988. The Effect of National Culture on the Choice of Entry Mode. Journal of International Business Studies 19 (3), 411-32.

Krugman, P., 1979. A Model of Balance-of-Payment Crises. Journal of Money, Credit and Banking 11 (3), 311-325.

Krugman, P., 1996. Are Currency Crises Self-Fulfilling? NBER Macroeconomics Annual, 345-378.

Masson, P., 1998. Contagion. Moosoonal Effects, Spillovers, and Jumps Between Multiple Equilibria. IMF Working Paper 98/142.

Mishkin, F. S., 2003. Financial Policies and the Prevention of Financial Crises in Emerging Market Countries. In: Feldstein, M. (Ed.), Economic and Financial Crises in Emerging Market Countries. University of Chicago Press, Chicago, pp. 93-130.

Morris, S., Shin, H. S., 1998. Unique Equilibrium in a Model of Self-fulfilling Speculative Attacks. American Economic Review 88(3), 587-597.

Neter, J., Wasserman, W., Kutner, M. H., 1985. Applied Linear Statistical Models (2nd ed.). Irwin, Homewood, IL.

O'Grady, S., Lane, H. W., 1996. The Psychic Distance Paradox. Journal of International Business Studies 27 (2), 309-333.

Obstfeld, M., 1994. Risk-taking, Global Diversification, and Growth. American Economic Review 84, 1310-1330.

Obstfeld, M., 1997. Destabilizing Effects of Exchange Rate Escape Clauses. Journal of International Economics 43 (1), 61-77.

Rigobon, R., 2002. Contagion: How to measure it? In: Edwards, S., Frankel, J. (Eds.), Preventing Currency Crises in Emerging Markets. The University Chicago Press, Chicago, pp 269-334.

Rijckeghem, C. V., Weder, B., 2001. Sources of contagion: is it finance or trade? Journal of International Economics 54 (2), 293-308.

Sachs, J., Tornell, A., Velasco, A., 1996. Financial Crises in Emerging Markets: The Lessons from 1995. Brookings Paper 27(1), 147-199.

Sbracia, M., Zaghini, A., 2001. Expectations and Information in Second Generation Currency Crises Models. Economic Modelling 18(2), 203-222.

Schinasi, G. J., Smith, R. T., 2000. Portfolio Diversification, Leverage, and Financial Contagion. IMF Staff Papers 47 (2), 159-176.

Sethi, S. P., 1971. Comparative Cluster Analysis for World Markets. Journal of Marketing Research 8, 348-354.

Shiller, R. J., 1998. Human Behavior and the Efficiency of Financial System. NBER Working Paper 6375.

Wall, H. J., 1999. Using the Gravity Model to Estimate the Costs of Protection. Review of the Federal Reserve Bank of St. Louis, 81 (1), 33-40.