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THE TRANSMISSION OF FOREIGN FINANCIAL CRISES TO SOUTH AFRICA: A FIRM-LEVEL STUDY

W H Boshoff*

Abstract

The process of financial integration has increased the exposure of South African financial markets to foreign financial crises. This paper contributes to the understanding of crisis transmission by evaluating several hypotheses that claim to explain how financial crises are transmitted to South African financial markets. The study proceeds from a firm-level perspective, which it argues overcomes the potential loss of information when using aggregate economic data. Consequently, the different transmission hypotheses are evaluated for the East Asian, Russian and Argentinean crises using firm-level daily stock return data from the JSE Securities Exchange. A multivariate regression model, supplemented by sensitivity tests, forms the core of the empirical methodology.

1. Introduction

The financial integration of recent decades has had important benefits for emerging economies, but has also been associated with increased financial turbulence. South Africa has been no exception, with local financial markets severely affected by financial crises over the past ten years. These crises have motivated economists to study the dynamics and underlying causes of financial crises. This paper makes a modest contribution to this on-going academic project by investigating possible reasons for crisis transmission to South African financial markets from a firm-level perspective. It does so bearing in mind that the complexity of the crisis phenomenon requires extensive analysis and that the majority of studies are based on methodological approaches that differ from the one adopted in this paper. Nonetheless, it is argued that the results from this study may supplement the existing literature to help explain how financial crises are transmitted to the South African economy at large. In particular, the firm-level study of crisis transmission in this paper may offer an advantage over the use of aggregate statistics on account of the loss of information during compilation of national accounts.

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The specific goal of the paper is an empirical investigation of the channels of crisis transmission during the East Asian, Russian and Argentinean crises by means of a multivariate statistical analysis. Prior to this, the concept of "financial crisis" is given precise meaning and the possible channels of crisis transmission are discussed briefly.

2. Identifying financial crises

Over the past two decades, financial markets have become increasingly integrated. This is evident from increased institutional investment activity across nations, increased cross-border financing of mergers and acquisitions and a general relocation of financial risks by banks from their balance sheets to the security markets (Häusler, 2002). Given this increased integration, it is possible that country-specific financial crises, under particular conditions, may be transmitted to foreign financial markets. An investigation of crisis transmission, however, requires a clear distinction between contagious and non-contagious crises.

Depending on the size and speed of the impact of a particular financial crisis on foreign financial markets, two types of financial crisis can be identified. A contagious crisis is an event in a particular country that has a significant and immediate impact on markets in other countries – a process commonly termed financial contagion. Transmission, therefore, is "fast and furious" (Kaminsky, Reinhart and Vegh, 2003: 3-4). On the other hand, non-contagious crises are crises to which initial outside market reaction is slow and limited – even though, over a longer time period, the impact on outside markets may be large (Kaminsky, Reinhart and Vegh, 2003: 3-4). Although non-contagious crises have spillover effects, these do not initiate financial contagion.

Table 1 categorizes the major financial crises of the past decade. Note that the Brazilian crisis is included as a separate crisis event, even though it is related to the Russian crisis of the previous year (IMF, 1998: 30). This is due to similar problems of excessive external finance requirements, massive fiscal deficits and a shortening of public debt maturity periods. Additionally, the rise in international interest rates (following the Russian default) created unsustainable pressure on the Brazilian treasury (IMF, 1998: 30).

The international literature suggests two stylised facts useful in the identification of financial crises (both contagious and non-contagious): firstly, the size of capital flows to and from crisis markets and, secondly, the extent to which the pending disaster is anticipated.

As far as the size of capital flows are concerned, the contagious Mexican, East Asian and Russian crises seemed to occur during periods of increased international capital flows to emerging markets. The Brazilian, Turkish and Argentinean crises (all of which did not initiate contagion according to the definition in this paper) occurred during periods of lower levels of international capital flows to emerging economies (Kaminsky, Reinhart and Vegh, 2003: 13).

Table 1: Examples of contagious and non-contagious crises

Contagious crises		Non-contagious crises	
Crisis	**Year**	**Crisis**	**Year**
Mexico	1994	Brazil	1999
East Asia	1997	Argentine	2001
Russia	1998	Turkey	2002

Source: Own analysis from Forbes (2000)

With regard to the second classifying feature, it appears that broadly anticipated crises do not spread to other countries (Kaminsky, Reinhart and Vegh, 2003: 17). Argentinean credit ratings (a measure of crisis expectations) prior to and during the Argentinean crisis show large downward adjustments at short intervals – in contrast with the slower, smaller downgrades of ratings for Thailand and Russia (IMF, 1998: 17) prior to the East Asian and Russian crises respectively.

3. Channels of crisis transmission

Within this conceptual framework, several "transmission channels" have been proposed to explain how financial crises are transmitted (Forbes, 2001). Such transmission channels can be organised into three categories, namely trade linkages, financial linkages and linkages based on investor behaviour – each group offering a distinct explanation of why crises are transmitted across national borders.

Trade and financial linkages, as explained in the following paragraphs, constitute market-driven transmission linkages in the sense that crisis transmission is brought about by the discipline of market forces. However, an alternative body of theory explains the propagation of crises by reference to investor behaviour, rather than the functioning of markets. Due to the difficulty in testing such psychological phenomenon, this paper is restricted to testing for the plausibility of trade and financial linkages. Further elaboration on this fast expanding field is, therefore, not attempted.

3.1 Trade linkages

The first group of linkages that may explain the propagation of financial crises across borders are termed trade linkages. These can be further decomposed into two different sub-channels: the competition linkage and the domestic demand linkage.

The trade effect brought about by the competition sub-linkage occurs when a crisis country, following domestic financial problems, experiences either currency depreciation (within a floating exchange rate regime) or opts for devaluation of its currency (within a fixed exchange rate regime). The devaluation or depreciation reduces the export competitiveness of the countries with which it competes in so-

called third markets (Dornbusch, Park and Claessens, 2000: 180). This puts pressure on prices internationally – if the crisis country's exports in a particular production category are large enough. Put differently, other countries need not even compete with the crisis country in order for their export competitiveness to deteriorate (Forbes, 2001: 14).

The trade effects of financial crises are not limited to competition issues though, as domestic demand represents a second trade sub-linkage. A domestic financial crisis may affect local demand for imported goods, which will further affect nations exporting to the crisis country (Wincoop and Yi, 2000). However, the domestic demand linkage need not necessarily imply an adverse effect over longer periods (Forbes, 2001: 14). In the months and years following the crisis, if the currency depreciation or devaluation improves exports and general growth performance, the domestic demand effect could be positive (Gupta *et al*, 2000).

Disagreement exists on the importance of trade in the propagation of crises. Empirical evidence remains inconclusive on the matter – with definitional aspects usually to blame for contradicting results. Glick and Rose (1999: 613) (using aggregate data) and Forbes (2000) (using firm-level data) find evidence that trade effects are important in the transmission of financial crises. Baig and Goldfajn (1998) as well as Kaminsky and Reinhart (2003) disagree, pointing to the weak trade relations between nations affected by foreign crises (such as Hong Kong or Eastern Europe) and the original crisis country (in this case Thailand and Russia, respectively).

These conflicting findings have resulted in an intermediate view on the importance of trade in spreading contagion. Claessens and Forbes (2000) argue that studies limited to a particular linkage group, say trade linkages, experience problems with omitted-variable bias – as linkages are usually highly correlated and difficult to disentangle. They favour an inclusive approach that acknowledges the importance of all linkages – which includes, but is not limited to, trade.

3.2 Financial linkages

The difficulty in disentangling trade and financial linkages is illustrated by research conducted by Hernández and Valdés (2001: 5) who explain the transmission of contagion through financial linkages. They find that devaluation crises could also be propagated through financial linkages. For example, East Asian firms with Thai investments suffered losses with the devaluation of the Thai baht during 1997. This had adverse effects on stock prices outside of Thailand – which helped spread the crisis internationally (Dornbusch, Park and Claessens, 2000: 181). Financial linkages, therefore, form a second group of linkages that could explain crisis transmission. Similar to trade linkages, these linkages are also subdivided into two sub-channels: the credit linkage and the portfolio re-composition linkage.

3.2.1 Credit linkage

Goldfajn and Valdés (1997) were among the first to argue that financial institutions, when adversely affected by deposit withdrawals during a crisis, may liquidate loans to foreigners in order to maintain sufficient liquidity. Commercial banking provides supporting evidence in this regard. Prior to the East Asian financial market turmoil, countries affected by the Thai crisis formed sixty-five percent of the emerging market loans portfolio for Japanese banks and twenty-three percent of the portfolio for European banks. American banks, on the other hand, were much less exposed to East Asia.

These figures must be seen in light of the strong growth in international bank lending to East Asian countries – amounting to an annual increase of approximately US$40 billion for the period from 1994 to 1997. The famous Asian carry trade, by which international financial institutions borrowed in dollar and re-invested in short-term Thai debt instruments, played a significant role in the growth of bank lending to East Asia (OECD 1998). Following the demise of the Thai currency, these banks cut credit extension to East Asian companies – resulting in withdrawal of capital to the amount of US$47 billion (Kaminsky, Reinhart and Vegh, 2003: 19). A similar story plays out in the Russian case – Russia accounted for twenty percent of emerging market credit provided by German banks prior to the crisis (Kaminsky, Reinhart and Vegh, 2003: 20).

The proposition of a "credit crunch" (as this sub-channel is also known) is, however, not undisputed. Evidence on loan rationing following the East Asian crisis is contradicting. Kim (1999) finds significant evidence, while Ghosh and Ghosh (1999) do not find supporting results – both using similar methodologies.

3.2.2 Portfolio recomposition linkage

A closely related financial sub-linkage is that of portfolio recomposition. The theory holds that, during a financial crisis in a particular country, leveraged investors suffering adverse price movements in a particular asset will be faced by margin calls from clearinghouses. In order for them to pay the maintenance margin, the investors will be forced to sell some asset holdings (Kaminsky, Reinhart and Vegh, 2003: 7). The strategy, however, will be to sell assets other than those whose prices have already collapsed (that is, portfolios will be re-constituted). Suppose that the assets to be sold are from countries other than the one in crisis. Due to information asymmetries, the markets will not be able to distinguish between the countries in crisis and those not (Biekpe and Collins, 2003: 183). A sell-off to meet margin calls will therefore cause markets to punish countries other than the one in crisis – driving down asset prices in these countries and spreading the initial crisis across markets.

The importance of a portfolio recomposition channel in crisis transmission can be measured by the extent of liquidity in the particular market. Portfolio recomposition should, arguably, occur in markets that are fairly liquid (as measured by market breadth and depth). Liquidity was far greater for markets in Taiwan,

Singapore and Hong Kong than in other East Asian nations; a similar argument holds for Brazil in the context of Latin America (Kaminsky, Lyons and Schmukler, 2003). This may explain why these nations suffered the greatest withdrawals of mutual fund investment following the Thai and Mexican crises respectively.

4. Empirical methodology and data

The hypotheses of trade and financial linkages as explanations for the transmission of foreign financial crises to South Africa can be formally tested within a statistical model. This section describes the methodology employed in testing these hypotheses for both contagious crises (the Asian and Russian cases) as well as for a non-contagious crisis (the Argentinean case).

The assignment of a specific duration and dates to each crisis is arbitrary and subject to scrutiny (see Table 2 for the duration of different crises). This study follows the same period and dates for the Asian and Russian crisis as constructed by Forbes (2000), while the author's interpretation is used in determining the Argentinean crisis duration and dates. Alternative durations and dates are considered in the sensitivity tests that follow in Section 6.

Table 2: Duration of different crises

Crisis	Duration
Asian Crisis Phase 1	25 June 1997 - 16 September 1997
Asian Crisis Phase 2	1 October 1997 - 24 December 1997
Russian Crisis	17 August 1998 - 31 August 1998
Argentinean Crisis	30 November 2001 - 31 December 2001

The Asian crisis is subdivided into two phases. The first phase represents the period during which lower-income countries in East Asia (notably Indonesia, Malaysia, Thailand and the Philippines) suffered currency crises. This was initiated on 25 June 1997 when the Thai government refused to guarantee the solvency of an important financial institution and acknowledged a lack of sufficient reserves to maintain its fixed exchange rate regime. The second phase represents the period during which *higher*-income countries were hit by the financial turmoil.

The Russian crisis is dated as starting on 17 August 1998 when the government devalued the currency, defaulted on its treasury bills and imposed a ninety-day moratorium on foreign debt payments. The date of 30 November 2001 is used as the start of the Argentinean crisis in what had probably been a "semi-crisis" for a considerable period beforehand. On this date a run on Argentinean banks ensued, with central bank reserves plummeting by $2 billion on that day. Also, on that day, Argentinean president De la Rua announced a withdrawal limitation of $1000 on personal bank accounts.

4.1 The firm-level approach

The analysis employed here follows a similar study undertaken by Kristin Forbes (2000) at the Massachusetts Institute of Technology. Forbes utilizes firm-level data from over 10 000 companies in 46 countries to identify how international crises are transmitted and which type of companies are most affected by them. She tests for competition, domestic demand, credit and portfolio re-composition channels during the East Asian and Russian crises. The results in the coming sections will be compared with her findings.

Forbes concludes that the origin of a particular company offers an important explanation of how the company will react to crises and argues that country-specific effects (as Forbes terms this phenomenon) can have a bigger impact than all of the transmission channels combined (see the abstract from Forbes (2000)). This provides the motivation for pursuing a study limited to the firms of a particular country – in this case, South Africa.

4.2 The data set

The McGregor BFA database is used to construct the firm-level data set. Data is obtained from income statements and balance sheets as well as general company information of thirty-two South African companies (primarily contained in the FTSE JSE Top 40 index of the largest 40 companies listed on the JSE Securities Exchange of South Africa) and is combined with daily stock returns. A list of the companies is provided in the Appendix. Companies are excluded from the data set on the basis of data anomalies as well as merger or unbundling activities.

Two potential concerns may arise when drawing inferences from a firm-level data set. The first is related to the exclusion of publicly owned firms as well as smaller firms on the JSE Securities Exchange. The second concern is the problem of accounting standards (Forbes 2000: 12). This concern, however, should not apply to this data set as all firms in the sample are listed on a single stock exchange where all companies are obliged to comply with accounting practices set by the JSE Securities Exchange SA (see Van Zyl and Gidlow, 2003: 289-295).

4.3 Channel dummy variables

For the econometric analysis a mathematical formulation is required for each of the four channels of crisis transmission. The competition channel hypothesis states that a crisis country with a depreciating currency will see its exports gain a competitive advantage. From a South African viewpoint, local firms competing with exports from the crisis country will see their share prices drop as investors anticipate the loss in local competitive advantage vis-à-vis the crisis country. The impact of this channel can be measured by identifying "major exports" – defined as goods and services in which crisis countries hold more than twenty percent of total international exports. A dummy variable is then constructed to identify all South

African firms competing with these major exports[1]. It should be noted that imports might also be utilized to measure the competition channel, although this is less common in the literature.

Major exports for the Asian and Russian cases are identified using the SIC (Standard International Classification) analysis by Forbes (2000: 16 and 53). In the Argentinean case, information from the International Monetary Fund and the World Bank are utilized. The problem with the Argentinean case is lack of access to up-to-date disaggregated export information; the classification in this case is proximate and subject to data quality and other definitional problems.

The hypothesis for the second channel, domestic demand, states that a financial crisis in a country reduces the profitability of companies operating in that country. Unfortunately, lack of region-specific (or even continent-specific) data prevent testing of this channel. Moreover, the domestic demand and competition channels may not be truly independent in the South African case. For example, in the Russian crisis, South African firms competing against mining exports may also have operations in Russia. In light of this potential danger, the exclusion of the domestic demand channel is problematic, but probably not devastating.

The third hypothesis of crisis transmission is the credit channel through which lenders in the crisis country are forced to liquidate loans made to foreigners, due to large deposit withdrawals. This implies that firms relying more heavily on short-term debt should be more vulnerable to a crisis. To test this channel, the ratio of net short-term debt to equity is used to construct a dummy variable to distinguish between those more and those less dependent on short-term financing.

The hypothesis of the portfolio re-composition channel holds that, after a crisis, investors may sell investments in markets not directly affected by a financial crisis so as to meet margin calls. The firm-level data set, as Forbes (2000: 19) notes, cannot be used directly to test for this. However, Falkenstein (1996) argues that investors prefer more liquid stocks. Now, if liquid stocks have a higher proportion of institutional owners, then highly liquid stocks may be affected by a portfolio re-composition. Share liquidity is defined as the amount of shares traded as a proportion of shares outstanding. A dummy variable is then constructed to separate highly and less liquid shares.

5. Multivariate analysis

The standard market returns model (Sharpe 1963) is used throughout the multivariate analysis. All results are obtained via the R statistical programming language (2003). The model is first estimated for the pre-crisis period:

$$R_{it} = \alpha_i + \beta_i R_{mt} + \varepsilon_{it} \quad \ldots (1)$$

[1] For example, mining companies will be the most important South African companies competing with large Russian and Argentinean mineral exports, while the SA conglomerates are the most important companies competing with the main East Asian exports.

where

$E(\varepsilon_{it}) = 0$; $var(\varepsilon_{it}) = \sigma^2_{\varepsilon_{it}}$; $i = 1,\ldots,N$; $t = 1,\ldots,P$

and where

R_{it} is the day t return for stock i, R_{mt} is the day t market return, ε_{it} is the disturbance for stock i over day t and the model is calculated for N firms and P days, where P refers to the number of pre-crisis days.

The component $\alpha_i + \beta_i R_{mt}$ in (1) represents that part of the return that can be systematically explained by the return on the market, while the component ε_{it} is the random part representing the part of the return unique to the security (Blake, 2003: 484). This unsystematic component (ε_{it}) is the main concern, as this study aims to test the potential of channel dummy variables (which depend on company characteristics) to explain the transmission of financial crises. Consequently, the parameters α_i and β_i in (1) are estimated for the *pre*-crisis period (denoted by $\hat{\alpha}_i$ and $\hat{\beta}_i$) and then used to calculate the excess returns ($\hat{\varepsilon}_{it}$) for the *crisis* period:

$$\hat{\varepsilon}_{it} = R_{it} - \hat{\alpha}_i - \hat{\beta}_i R_{mt} \qquad \ldots (2)$$

for $t = P+1,\ldots,P+C$; where C is the duration of the crisis in days.

The study then tests whether the different transmission channels (as defined previously) explain a significant portion of the variation in the excess returns during a crisis period. This takes the form of a second regression of the excess returns (from (2)) on the channel dummy variables measuring the exposure of each firm to the crisis transmission channels (Forbes, 2000: 22). There is one twist however – in order to obtain only a single estimate for the coefficients, the vector of *average* excess returns is used (Forbes, 2000: 23):

$$\hat{\varepsilon} = F \quad \theta + \nu \qquad \ldots (3)$$

where

$\overline{\hat{\varepsilon}}_i = \sum_{t=P+1}^{P+C} \hat{\varepsilon}_{it}$ is the *average* excess return for firm *i* during the *crisis* period

$\hat{\boldsymbol{\varepsilon}}' = \left[\overline{\hat{\varepsilon}}_1, \overline{\hat{\varepsilon}}_2, \ldots, \overline{\hat{\varepsilon}}_N \right]$ is the $1 \times N$ *vector* of these average excess returns for each firm during the crisis period

F is the $N \times K$ matrix of dummy variables

$\boldsymbol{\theta}$	is the $K \times 1$ parameter vector
$\mathbf{v}$	is the $N \times 1$ stochastic vector of disturbances assumed to be normally distributed

The above specification is estimated as a multivariate regression model – allowing equation-by-equation ordinary least squares (OLS) estimation (Johnson and Wichern, 2002: 384). However, Forbes (2000: 23) argues that OLS estimates are not consistent or efficient, as disturbances are not independent and identically distributed (IID) across firms (Forbes, 2000: 24). Consequently, the Gauss-Markov theorem no longer holds for the OLS estimators and another best linear unbiased estimator must be obtained (Hayashi, 2003: 55).

One technique to address these two problems is the generalized least squares (GLS) method. This method, though, requires the use of the sample covariance matrix for the disturbances to obtain the so-called feasible GLS (FGLS) estimators (Sefcik and Thompson, 1985: 323). Although the asymptotic properties of FGLS have been investigated, little is known about its finite-sample behaviour (Hayashi, 2003: 59; Sefcik and Thompson 1985: 323). Given the small size of the sample, this approach may prove not as useful in this particular study.

An alternative is the Sefcik and Thompson (1985) methodology. This technique uses a two-step procedure, which, under several mild regularity conditions, can be shown to be equivalent to the three-step procedure described in (1) to (3) (Forbes, 2000: 23).

This two-step procedure can be written as follows for a particular firm:

$$R_{it} = \alpha_i + \beta_i \quad R_{mt} + \gamma_i \quad \delta_t + \varepsilon_{it} \qquad \ldots (4)$$

$$\hat{\gamma}_i = f_i' \ \Psi + \eta_i \qquad \ldots (5)$$

for $i = 1,2,\ldots,N$ and $t = 1,\ldots,P,P+1,\ldots,P+C$

and where

δ_t	is a dummy variable equal to 1 during the crisis and 0 otherwise
γ_i	is the parameter representing that part of the return generated by the crisis
$\hat{\gamma}_i$	is the parameter estimated in (4)
f_i' : $1 \times K$	is a row vector of the K channel dummy variables for firm i
$\boldsymbol{\Psi}$: $K \times 1$	is the parameter vector
t	index for *entire* period (both pre-crisis period P and crisis period C) while other variables are defined as in (1) to (3).

Rewriting (5) as a stacked system for all firms:

$$\hat{\gamma} = F\Psi + \eta \qquad \ldots (6)$$

where

$\hat{\boldsymbol{\gamma}}' = \left[\hat{\gamma}_1, ..., \hat{\gamma}_N\right]$ is a vector containing the $\hat{\gamma}_i$ for all *N* firms

$F' = \left[f_1, ..., f_N\right]$ is a matrix containing the f_i for all *N* firms

The $\hat{\boldsymbol{\gamma}}$ for all *N* firms must correspond to the $\hat{\boldsymbol{\varepsilon}}$ in (3) and estimation of such a stacked system must render values for Ψ equal to the estimated values for $\boldsymbol{\theta}$ in (3).

So far we have introduced a two-step procedure that renders exactly identical estimates as the model in (1) to (3). Sefcik and Thompson (1985: 323) now propose dividing the sample of firms into different portfolios and then using these portfolios to estimate how firm characteristics (as measured by the dummy variables) affect share returns during a specific event (such as a financial crisis). This scaling of the sample from *N* firms to *K* portfolios is done using the scaling matrix $\mathbf{X}$. This matrix is obtained from the solution of the OLS normal equations as

$$\hat{\Psi} = (F'F)^{-1}F' \quad \hat{\gamma} = X \quad \hat{\gamma} \qquad \ldots (7)$$

where

$\mathbf{X} : K \times N$ is a matrix for which each row can be interpreted as an estimated weight of the impact of the firm characteristic k.

The weights implied in X can then be used to form K portfolios from the original N firms:

$$\mathbf{R}_K = \mathbf{X}\mathbf{R}_N \qquad \ldots (8)$$

where

$\mathbf{R}_K : K \times T$ is a matrix containing the returns for each portfolio

$\mathbf{R}_N : N \times T$ is the original returns matrix with element $R_{i\,t}$

$T = P + C$ is the length of the entire period

The above transformation is possible as X is constructed so that $XF = I : K \times K$ (Sefcik and Thompson 1985: 324) – implying that the crisis affects each portfolio only through the characteristic shared by each portfolio. The estimated returns $\mathbf{R}_K$ can then be inserted into (4) to calculate the estimated $\hat{\hat{\alpha}}_k$, $\hat{\hat{\beta}}_k$ and $\hat{\hat{\gamma}}_k$ parameters

(note the subscript *k* instead of i – implying that (4) now delivers K, instead of N, estimates). The $\hat{\hat{\gamma}}_k$ estimates can be shown to be unbiased and consistent estimates of the impact of the *K* firm characteristics on abnormal returns (Sefcik and Thompson, 1985).

5.1 Base regression results

We now proceed to the regression results for the base specification. Three versions of the model are shown in Tables 4 to 6. In Table 4, the model is run using both the Sefcik-Thompson method as well as the ordinary OLS method (which ignores the IID violations) and variables that may contaminate the crisis transmission variables are not controlled for. Note that the Sefcik-Thompson method provides parameter estimates exactly equal to the OLS estimates, because the coefficients for a portfolio (as described above in the outline of the method) are weighted averages of the individual coefficients for each firm contained in the portfolio (Sefcik and Thompson 1985: 324). Table 4 provide unsatisfactory results for the impact of the different transmission channels on abnormal stock returns. The absence of statistically significant transmission channels during the Asian crisis is disappointing. More unsettling, though, are statistically significant, but positive effects for the credit and portfolio recomposition channels during the Russian crisis and for the competition linkage during the Argentinean crisis.

Table 3: Industry groups

Industry Group	Description
1	Mining
2	Financial
3	Manufacturing & conglomerates
4	Food & beverages
5	Retail

Proximate variables, measuring phenomenon not directly observable, are necessarily subject to the possibility of information overlaps. Therefore, a number of controlling variables are introduced. The first controls for a rand hedging effect, which could be important during the Argentinean crisis period (following the sharp rand depreciation in the later parts of 2001). This is included in the base regression via a dummy variable taking a value of 1 if the particular firm has a strong foreign earnings base and 0 otherwise. Secondly, a variable controlling for a "FTSE JSE Top 40" effect is included to control for the possibility that firm size could interact with the transmission of shocks (Forbes, 2000: 39). To control for the impact of firm size, a dummy variable is added to the base regression to indicate whether a firm belongs to the top 40 largest firms or not. Finally, a set of dummy variables for various industry groups is included. While these variables may capture some of

the competitiveness effect, Forbes (2000: 40) notes that their inclusion did not affect the result for the competition channel in her study. Industry group 5 is the reference group. Table 3 summarises the different industry groups.

Table 4: Base regression results for MSCI market index without controlling variables

Crisis	**Asian Crisis: Phase 1**		**Asian Crisis: Phase 2**		**Russian Crisis**		**Argentinean Crisis**	
Method	**Std[(b)]**	**S-T[(b)]**	**Std[(b)]**	**S-T[(b)]**	**Std[(b)]**	**S-T[(b)]**	**Std[(b)]**	**S-T[(b)]**
Regression Number	**-1**	**-2**	**-3**	**-4**	**-5**	**-6**	**-7**	**-8**
Constant	-0,0002 (-0,0005)	-0,0002 (-0,001)	-0,0002 (-0,0005)	-0,0002 (-0,0018)	-0,0179 (0.0033) ***	**-0,0179 (0.0053)** ***	-0,0022 (-0,0019)	-0,0022 (-0,0027)
Competition linkage	0,0003 (-0,0015)	0,0003 (-0,0017)	-0,0027 (0.0012) **	-0,0027 (-0,0019)	0,0104 (-0,0082)	0,0104 (-0,0073)	0,0086 (0.0018) **	**0,0086 (0.0037)** ***
Credit linkage	0,0005 (-0,0007)	0,0005 (-0,0008)	-0,004 (-0,0007)	-0,004 (-0,0011)	0,0091 (0.0048) *	**0,0091 (0.0009)** ***	-0,0051 (-0,002)	**-0,0051 (0.0023)** **
Portfolio recomposition linkage	-0,0001 (-0,0011)	-0,0001 (-0,001)	0,0016 (-0,0011)	0,0016 (-0,0012)	0,0077 (-0,0065)	**0,0077 (0,0641)** *	-0,0022 (0,0027) ***	-0,0022 (-0,002)
Total Days	309	309	309	309	260	260	269	269
Crisis Days	60	60	60	60	10	10	19	19

NOTES:

(a) Standard errors in parentheses: * is significant at 10% ** is significant at 5% *** is significant at 1%

(b) Std is the traditional OLS estimates which do not adjust for the cross-correlation in returns or heteroscedasticity

Table 5 show the results for the base regression after including the controlling variables. It confirms the earlier suspicion that the proximate variables for the transmission channels are reflecting other information.

None of the three channels turns out to be significant for the Asian crisis. This outcome corresponds exactly with results from the Forbes study for the first phase of the crisis. However, as far as the second phase is concerned, the findings by Forbes differ significantly from the outcomes of this study. She finds significant competition and portfolio recomposition effects. The absence of a significant trade channel should not be surprising, given that East Asia is not a major trading partner of South Africa (representing approximately 5.6% of exports in 2003[2]). It should be noted that the statistically significant and negative returns for companies in the

[2]Trade statistics from the Department of Trade and Industry (2004) indicate the following East Asian nations: Malaysia (0,8%), Korea (1,7%), Taiwan (2,3%), Thailand (1%), Indonesia (0,4%) and the Philippines (0,1%).

financial sector (during the first phase) does not represent a competition effect as South African financial institutions were not competing in East Asia (at least on a significant level) and that the negative returns possibly represent an international re-evaluation of banks[3]. While an insignificant competition channel seems plausible, the absence of a significant portfolio recomposition channel remains puzzling with no easy explanation.

Table 5: Base regression results for MSCI market index with controlling variables

Crisis	**Asian Crisis: Phase 1**	**Asian Crisis: Phase 2**	**Russian Crisis**	**Argentinean Crisis**
Method	**S-T[(b)]**	**S-T[(b)]**	**S-T[(b)]**	**S-T[(b)]**
Regression Number	**-9**	**-10**	**-11**	**-12**
Constant	0,002 (-0,0015)	-0,003 (-0,0021)	**-0,01** **(0.0056)***	-0,0049 (-0,003)
Competition linkage	-0,0013 (-0,0019)	-0,0019 (-0,0019)	-0,0035 (-0,0079)	0,0044 (-0,0034)
Credit linkage	0,0000 (0,0000)	0,0007 (-0,0014)	0,0045 (-0,0034)	-0,0022 (-0,0026)
Portfolio recomposition linkage	-0,0009 (-0,001)	0,0012 (-0,0012)	0,0027 (-0,0055)	-0,0014 (-0,0022)
Rand hedging effect	0,0000 (0,0000)	0,0006 (-0,0011)	0,0022 (-0,0035)	0,0014 (-0,0026)
FTSE JSE Top 40 effect	0,0000 (-0,0012)	**0,0024** **(0,0014)***	-0,0045 (-0,0045)	-0,0003 (-0,0028)
Industry group 1	0,0001 (-0,0016)	-0,0005 (-0,0017)	**0,0124** **(0.0064)***	0,0057 (-0,0038)
Industry group 2	**-0,0024** **(0.0015)***	0,0015 (0.0016)	-0,0096 (0.0063)	0,0024 (0.0032)
Industry group 3	-0,0023 (-0,0014)	0,0001 (-0,0015)	-0,0092 (-0,0056)	-0,0015 (-0,0036)
Industry group 4	-0,001 (-0,0014)	0,0002 (-0,0014)	0,0014 (-0,0047)	-0,0001 (-0,0029)

NOTES:

(a) Standard errors in parentheses: * is significant at 10% ** is significant at 5% *** is significant at 1%

(b) S-T is Sefcik and Thompson's method as discussed

[3] A primary cause of the Asian crisis was an overextended banking system with insufficient weighting of downside risks (OECD, 1998: 9).

For the Russian crisis Forbes finds highly significant competition effects, while our investigation does not. Again, South Africa's low trade volumes with Russia (representing only 0,2% of exports in 2003[4]) may motivate this. Furthermore, mining houses, the industry group with the highest competitive exposure to Russia, seem to fare significantly better than other industries during the crisis period. This is probably due to the 1998 rand depreciation[5] (IMF, 1998: 34) favouring export-oriented industries such as mining houses.

Results for the Argentinean case should be read with the definition of the crisis in mind. The Argentinean crisis has been labelled a "spillover" (or "non-contagious") event, as opposed to the "contagious" Asian or Russian crises. This implies that international investors will have had enough time to adjust their portfolios in anticipation of an Argentinean collapse. Our results confirm this classification as no transmission channel turns out to be significant.

In summary, no transmission channel appears to be statistically significant for any of the crises – in stark contrast with the findings by Forbes. However, this deviation from the results obtained by Forbes should be carefully interpreted – given the exclusively South African data sample. On the one hand, the small size of the sample may lead to less correct inferences than the Forbes sample. Alternatively, the results may confirm that the impact of a crisis is ultimately country-specific and that inferences from country-specific studies may differ from a multi-country sample such as the Forbes sample.

5.2 Diagnostic tests

Before proceeding to sensitivity testing, two aspects of the proposed model should be confirmed. Firstly, it is tested whether the proposed firm characteristics combined with the controlling variables captures all of the systematic information contained in the data. Put differently, we test whether the residuals in equation (6) contain any anomalies. Secondly, it is investigated whether the residuals from the initial equation (equation (4)) are auto-correlated – recall the earlier assumption of no autocorrelation (similar to Forbes (2000)).

The residuals of equation (6) are inspected by first attempting a normal quantile plot for each crisis event (see Figure 1). Figure 1 indicates that the general pattern of the residuals is consistent with the assumption of normality. This is confirmed by the Jarque-Bera (1987) normality test procedure (Table 6). The null hypothesis of normally distributed residuals cannot be rejected at a significance level of ten percent for any of the crisis events. To confirm that no other anomalies exist, the residuals are plotted against the predicted values (see Figure 2). The horizontal bands show that no abnormalities are to be found in the residuals for any of the Asian, Russian or Argentinean crises.

[4] See trade statistics from the Department of Trade and Industry (2004).

[5] The Rand depreciated by twenty percent against the US dollar between end-May and August 1998.

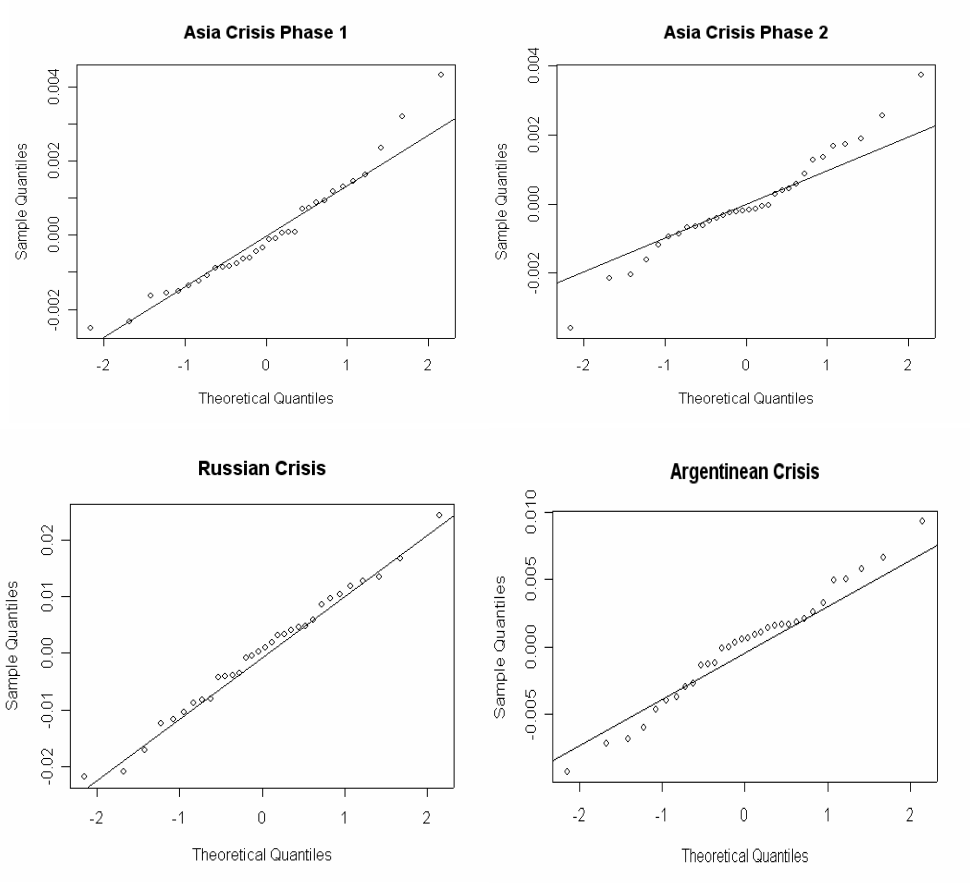

Figure 1: Normal quantile-quantile plot of residuals

Table 6: Jarque-Bera test for normality

Crisis	Jarque-Bera test statistic	p-Value#
Asian Crisis Phase 1	4,186309	0,123298
Asian Crisis Phase 2	1,021529	0,600370
Russian Crisis	0,141624	0,931637
Argentinean Crisis	0,143410	0,930805

The Jarque-Bera test is a large sample test and may not be as accurate due to the small size of our sample

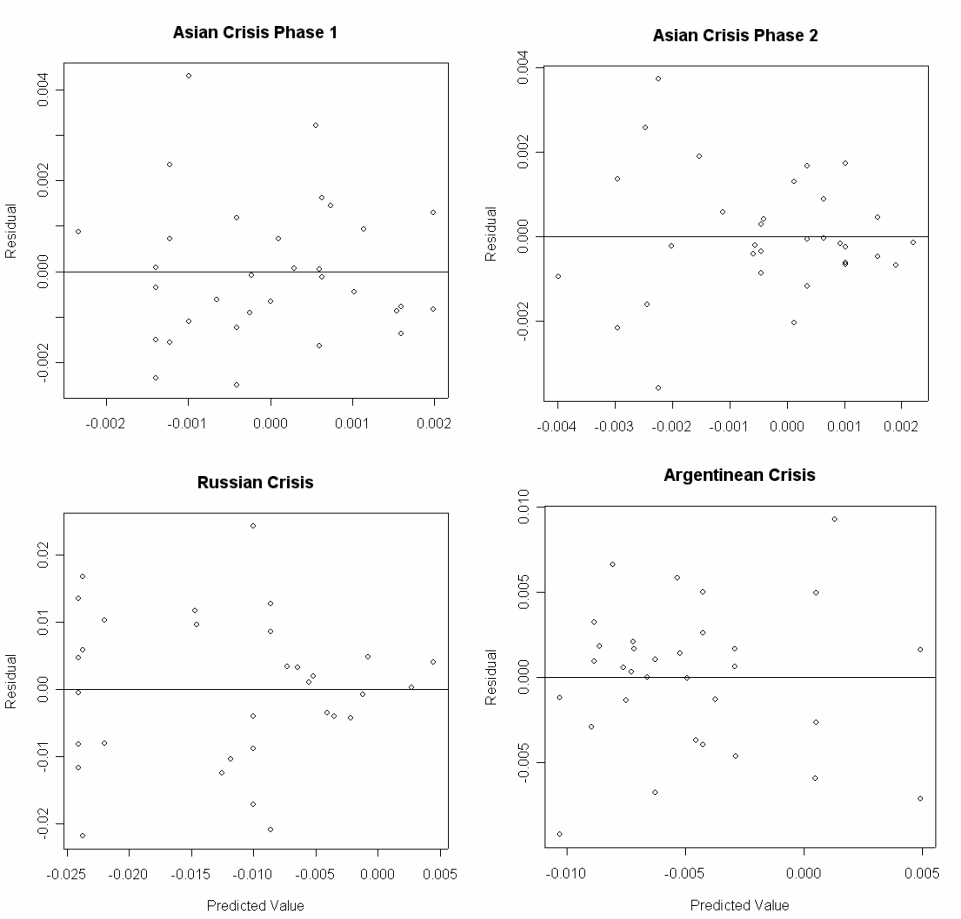

Figure 2: Scatter diagram of residuals against predicted values

Next, tests for the presence of autocorrelation in the residuals of the original equation (4) are conducted in the following manner. First, the Durbin-Watson statistic is calculated for each firm separately. Thereafter, the proportions of firms falling inside and outside of the range of 1.574 and 2.426 are obtained. This is the range inside of which the null hypothesis of no autocorrelation (positive or negative) cannot be rejected. It is clear from Table 7 that autocorrelation is not a substantial problem for the majority of firms across all crisis events under consideration. This confirms that no adjustment to the model is needed to correct for autocorrelation.

In the light of the satisfactory outcome of the selected informal and formal diagnostic procedures, the last component of the study, namely the sensitivity analysis, is attempted.

Table 7: Proportion of firms with Durbin-Watson *d* statistics[#] in particular ranges of significance

Range[##]	Asia Phase 1	Asia Phase 2	Russia	Argentina
$d < 1.574$	12,50%	6,25%	6,25%	0%
$1.574 < d < 2.426$	87,50%	93,75%	93,75%	100%
$d > 2.426$	0%	0%	0%	0%

Notes: # The critical values apply to a 5% significance level (Gujarati 2003: 970)

1.574 represents the upper critical value and 2.426 is 4 minus this upper critical value

6. Sensitivity testing

The findings in the previous part are based on particular definitions and simplifying assumptions. In order to assess the robustness of the results, a series of sensitivity tests are performed.

6.1 Sensitivity test I: a different market index

The market index utilized for the preceding results is the Emerging Market Index from Morgan Stanley Capital International (MSCI) in dollar terms, converted to South African rand using the daily spot exchange rate. While a global market index, such as the MSCI index, appears to allow abnormal returns from country-specific studies to be compared, the conversion of the index to local currency introduces exchange rate volatility, which differs across countries. To test the sensitivity of inferences for the choice of market index, the JSE All Share Index (ALSI) is considered as an alternative. The results are quoted in Table 8 (controlling variables are included, but not reported). The outcome confirms the robustness of the results, as the statistical significance of the transmission channels are unaffected by the new choice of market index.

6.2 Sensitivity tests II: changing crisis durations

All of the previous regressions have assumed a particular time length for the different crises. This necessitates a set of sensitivity tests to establish whether results are robust with respect to the assumed time length. Forbes (2000: 34) provides several reasons for pursuing such a duration analysis. There are no clear end dates for the crises – as can be recalled, particular crisis durations were assumed. Second, different transmission channels should be stronger over different durations. The portfolio recomposition channel, for example, should have only a short-term impact as it is based on liquidity shortages.

To test whether the base results are affected by these factors, the model is estimated with the same starting dates, but with crises lasting for different periods shorter than the original duration (see Table 9).

Table 8: Base regression results for JSE market index

Crisis	Asia1	Asia2	Russian	Argentina
Regression Number	**-13**	**-14**	**-15**	**-16**
Constant	**0,0025 (0.0013)***	-0,0023 -0,0014	-0,0018 -0,0046	**-0,0061 (0.0028)****
Competition linkage	-0,0012 (-0,0018)	-0,0024 (-0,0018	-0,0054 (-0,0081)	0,0036 (-0,0033)
Credit linkage	-0,0005 (-0,0012)	0 (-0,0013)	0,0028 (-0,0035)	-0,0016 (-0,0025)
Portfolio recomposition linkage	-0,0008 (-0,001)	0,0013 (-0,0012)	0,0075 (-0,0053)	-0,0002 (-0,0022)

Crisis	Asia1	Asia2	Russian	Argentina
Total Days	309	309	260	269
Crisis Days	60	60	10	19

NOTES:

(a) Standard errors in parentheses: * is significant at 10% ** is significant at 5%

(b) The methodology used is that of Sefcik and Thompson

For the first phase of the Asian crisis none of the coefficients are significant for any of the time periods of one, two, four, six or eight weeks. This corresponds with the results from Forbes as well as the initial findings for the base duration of 12 weeks. Results for the second phase of the Asian crisis are unsettling, as effect of the portfolio recomposition channel appears to have a significant positive effect at duration of two weeks. However, the remaining coefficients over all time periods are not significant – corresponding with the regression results for the base time period.

The Russian crisis is a particularly difficult case as far as variation in the crisis period is concerned. Durations longer than the original time period of two weeks cannot be tested for in an unbiased manner. This is due to the collapse of Long-Term Capital Management about one month after the start of the Russian turmoil (Dungey *et al*, 2002: 3). The results for a crisis period of one week, instead of two, are similar to the base specification.

Findings for the non-contagious crisis in Argentina are more interesting. Significant and positive competition effects turn up for crisis lengths of one and three weeks. Even after controlling for a rand hedging effect, it may well be that the dramatic fall of the rand, occurring during the Argentinean crisis, had a significant impact on the stock performance of mining companies (who were the only South African companies with a significant South American exposure). Surprisingly, the effect of the credit channel appears to be significant and negative,

although more robust evidence is required before making any large-scale inferences.

Table 9: Sensitivity tests: Varying crisis period length (with controlling variables not indicated here)

Crisis	Constant	Competition Linkage	Credit linkage	Portfolio recomposition linkage
Asian Crisis: Phase 1				
1 week	**0,0056 (0.0032)***	-0,0066 (-0,0042)	-0,0009 (-0,0027)	-0,0011 (-0,0023)
2 weeks	0,0046 (-0,0045)	-0,0095 (-0,0059)	0,0001 (-0,0037)	0,0003 (-0,0032)
4 weeks	**0,0052 (0.0023)****	-0,0031 (-0,003)	0,0000 (-0,0019)	-0,0008 (-0,0016)
6 weeks	0,0031 (-0,0019)	-0,0015 (-0,0025)	0,0001 (-0,0016)	-0,0019 (-0,0012)
8 weeks	0,0026 (-0,0017)	-0,0018 (-0,0022)	-0,0002 (-0,0014)	-0,0016 (-0,0012)
12 weeks (base)	0,002 (-0,0015)	-0,0013 (-0,0019)	0,0000 (0,0000)	-0,0009 (-0,001)
Asian Crisis: Phase 2				
1 week	0,0042 (-0,0047)	-0,001 (-0,0053)	-0,0038 (-0,0038)	0,0031 (-0,0033)
2 weeks	0,0008 (-0,0032)	-0,0006 (-0,0037)	0,0000 (-0,0026)	**0,0062 (0.0024)*****
4 weeks	**-0,0081 (0.0031)*****	-0,0024 (-0,0029)	0,0064 (-0,0022)	-0,0005 (-0,0019)
6 weeks	-0,0012 (-0,0027)	-0,0036 (-0,0025)	0,0001 (-0,0019)	-0,0004 (-0,0016)
8 weeks	-0,0034 (-0,0024)	-0,0028 (-0,0022)	0,0007 (-0,0017)	0,0002 (-0,0014)
12 weeks (base)	-0,003 (-0,0021)	-0,0019 (-0,0019)	0,0007 (-0,0014)	0,0006 (-0,0011)
Russian Crisis				
1 week	-0,0028 (-0,0077)	0,0181 (-0,0108)	0,0112 (-0,0047)	-0,005 (-0,0074)
2 weeks (base)	**-0,01 (0.0056)***	-0,0035 (-0,0079)	0,0045 (-0,0034)	0,0027 (-0,0055)
Argentinean Crisis				
1 week	**-0,0141 (0.0055)****	**0,0116 (0.0064)***	-0,0056 (-0,0049)	0,0015 (-0,0043)
2 weeks	**-0,0125 (0.0039)*****	0,0053 (-0,0046)	-0,005 (-0,0035)	0,0015 (-0,003)

3 weeks	**-0,006 (0.0034)***	**0,0092 (0.0038)****	**-0,0057 (0.0029)****	-0,0018 (-0,0025)
4 weeks (base)	-0,049 (-0,003)	0,0044 (-0,0034)	-0,0022 (-0,0026)	-0,0014 (-0,0022)

NOTES

(a) Standard errors in parentheses: * is significant at 10%, ** at 5%, *** at 1%

(b) Only the Sefcik-Thompson estimates are reported

(c) The starting date for each crisis is kept constant, while ending dates are varied

6.3 Sensitivity test III: redefining transmission channels

The final sensitivity test is related to the dummy variables approximating the transmission channels. Alternative proxies, however, are not easy to construct due to the small size of the dataset. Narrower SIC classification seems out of place for a sample of 32 companies and is not attempted. As far as an alternative credit channel proxy is concerned, the ratio of debt to total assets, instead of the ratio of debt to equity, is utilized. As Table 10 shows, a redefinition for this key variable does not yield an outcome different from the base specification.

Table 10: Sensitivity test: Redefining proximate variables (with controlling variables not indicated here)

Crisis	Asia1	Asia2	Russian	Argentina
Constant	0,0021 (-0,0015)	-0,0029 (-0,002)	**-0,0198 (0.0056)*****	**-0,0136 (0.0063)****
Competition linkage	-0,0008 (-0,0018)	-0,0021 (-0,0019)	-0,009 (-0,084)	0,0019 (-0,0036)
Credit linkage	-0,0003 (-0,0012)	0,0008 (-0,0015)	0,0039 (-0,0035)	-0,0019 (-0,0022)
Portfolio recomposition linkage	-0,0006 (-0,0013)	0,0000 (-0,0015)	**0,0163 (0,0056)****	0,0082 (-0,0059)
Total Days	309	309	260	269
Crisis Days	60	60	10	19

NOTES:

(a) Standard errors in parentheses: * is significant at 10% ** is significant at 5% and *** is significant at 1%

(b) The methodology used is that of Sefcik and Thompson

The portfolio recomposition channel is the more interesting case. Forbes proposes that a highly liquid stock should rather be identified as one with non-zero returns for at least three quarters of the trading days prior to the crisis. A dummy variable,

separating highly and less liquid shares, is then constructed. The Asian and Argentinean results are similar to the base results. The findings for the Russian crisis, however, indicate a significant, but positive, portfolio recomposition effect. The proxy proposed by Forbes seems to capture some other information not relevant to this investigation. Specifically, the proxy appears to isolate those stocks with very few days of zero returns. Stocks exhibiting this characteristic are either performing exceptionally well or doing very poorly. Consequently, the alternative proxy does not measure liquidity better than the base proximate variable – which considers the volume of shares traded versus total shares outstanding.

7. Conclusion

Given the rough proxies and small sample of companies, it appears that trade and financial linkages do not offer compelling explanations for the impact of international crises on larger South African firms and, ultimately, the South African economy. While financial and trade linkages may be important in explaining crisis transmission on a global level, these linkages may have been less important when limited to a South African study.

The absence of systematic financial and trade channels could support the notion that international crises have been transmitted to this country due to investor herding behaviour, rather than weak South African macro-economic fundamentals. More research in this field of "behavioural finance" will have to be undertaken.

However, as financial integration continues and information asymmetries disappear, it is probable that fundamental economic linkages will become more, and not less, important as explanations for the transmission of future financial crises to South Africa. This, together with massive stock-market datasets that are becoming available, bode well for future crisis research to be based on microanalysis.

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APPENDIX: LIST OF COMPANIES*

- Anglo American plc
- Richemont Securities AG
- SABMiller plc
- Sasol Ltd
- Standard Bank Group Ltd
- Firstrand Ltd
- Anglogold Ashanti Ltd
- Absa Group Ltd
- Sappi Ltd
- The Bidvest Group Ltd
- Imperial Holdings Ltd
- Nampak Ltd
- Pretoria Portland Cement Company Ltd
- Nedcor Ltd
- MTN Group Ltd
- RMB Holdings Ltd
- Liberty Group Ltd
- Venfin Ltd
- Investec Ltd
- Impala Platinum Holdings Ltd
- Pick n Pay Stores Ltd
- Naspers Ltd
- Tiger Brands Ltd
- Amalgamated Beverage Industries Ltd
- Barloworld Ltd
- Shoprite Holdings Ltd
- Dimension Data Holdings plc
- Edgars Consolidated Stores Ltd
- JD Group Ltd
- AVI Ltd
- Reunert Ltd
- Afrox Healthcare Ltd

* Names of companies as at year-end 2003 or earlier.