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CAN THE INTERDEPENDENCE EFFECT AND THE CONTAGION PHENOMENA BE RELATED WITH ONE ANOTHER?

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ABSTRACT

This study suggests an alternative approach to the transmission process of financial crises across emerging economies. This paper hypothesizes that the interdependence effect could become weaker, disappears completely or swerves during the crisis period due to the contagion phenomenon. The hypothesis put forward in this paper is of great importance in terms of policy implications inasmuch as it is supported by the data for many cases.

Keywords: Contagion, Interdependence, Outlier test, Financial crisis, Flight to Quality, VAR.
JEL Classification:G01, C12, C32.

1. INTRODUCTION

A growing literature concerning the transmission process of financial crises became prominent due to the reason that several financial crises experienced by certain emerging economies had followed the 1994 Mexican Peso Crises, or the 1997 East Asian crises. The answers to the question of why the transmission of financial crises across the economies occurs are generally summed up with two primary titles. The former is known as the interdependence or "*fundamentals-based contagion*", and the latter is labeled as the contagion or "*irrational phenomena*".Dornbusch *et al.* (2000) puts forward that normal interdependence among the economies can be explained by fundamentals-based contagion generally defined by macroeconomic fundamentals. On the contrary, macroeconomic Fundamentals are not sufficient to explain a distinct type of contagion that includes irrational phenomena. Masson (1998; 1999a; 1999b), Dornbusch *et al.* (2000), and Korkmaz (2012) can be seen for a detailed discussion regarding the transmission channels of a financial crisis across the economies.

This paper offers an alternative consideration for the transmission process of financial crises across emerging markets by relating the interdependence and the contagion phenomena. We hypothesized in such a way that an interdependence effect could weaken, even disappear completely and veer as well in a crisis period as a result of the contagion process. The confirmation of the aforementioned hypothesis gives rise to a very important policy implication: that the policy-makers are less likely to have the ability to prevent financial crises experienced

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outside from being transmitted into their own country, even if they could exactly predict the interdependence effect to exist.

2. MATERIAL AND METHOD

2.1. Material

The data employed in this paper is gathered largely from the Directions of Trade Balance Statistics and the International Financial Statistics databases of the International Monetary Fund[1]. Economies under investigation can be classified into two categories. The first group includes certain emerging markets where the contagion effect could be influential. The other group of economies consists of some industrialized ones that have the ability to generate the monsoonal effect, outlined by Masson (1998). The economies being studied are listed in Table 1:

Table-1. Economies Being Studied

Argentina	***European Union***	**Mexico**	***Sweden***
Belarus	India	Moldova	*Switzerland*
Brazil	Iran	Poland	Thailand
Bulgaria	Israel	Romania	Turkey
China	*Japan*	Russia	Ukraine
Croatia	Latvia	South Africa	*USA*
Czech Republic	Lithuania	Saudi Arabia	Egypt
Malaysia	South Korea		

This study considers an exchange market pressure index (EMP) to identify financial turbulence periods. Following by Eichengreen *et al.* (1996), EMPindexes are constructed as:

$$\mathbf{EMP_{i,t}} = \left[\left(\frac{\sigma_E}{\sigma_{NFA}+\sigma_I+\sigma_E} * \frac{\Delta E_t}{E_{t-1}}\right) + \left(\frac{\sigma_I}{\sigma_{NFA}+\sigma_I+\sigma_E} * \frac{\Delta I_t}{I_{t-1}}\right) - \left(\frac{\sigma_{NFA}}{\sigma_{NFA}+\sigma_I+\sigma_E} * \frac{\Delta NFA_t}{M_{t-1}}\right)\right] * \mathbf{100}$$

(1)

where(EMP_i) is the exchange market pressure index for economy (i), (E) is the nominal exchange rate per U.S. dollar, (I) is the domestic interest rate, (NFA) is the net foreign assets, and (M) is the money stock. Each EMP index is constructed as the sum of weighted average of devaluation (or revaluation) rate and percentage change in interest rate minus the contribution of net foreign assets to change in money stock. Standard deviations (σ) are utilized as weights in order to capture most of the fluctuations in the data. The EMP indexes are constructed for each of the economies for the period February 1999 to October 2008.

2.2. Method

The empirical methodology used in the paper is the three-step procedure of Favero and Giavazzi (i.e., *Outlier Test*). The Outlier Test offered by Favero and Giavazzi (2002) is the only method that can be employed to fulfill the main purpose of this study, due to the following reasons:

[1] The some of the data for the Israeli economy is gathered from the Central Bank of Israel.

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i) The Outlier Test focuses on each financial turbulence identified in the sample individually, so it is possible to compare a crisis period with non-crisis periods even for low frequency data similar to the one employed in this study.

ii) The Outlier Test allows us to take both crises and manias into account, so the perspective offered here can be tested for both mania and crisis periods.

Favero and Giavazzi (2002) suggest that the transmission process of financial crises across the economies may be non-linear. To model the possible non-linear transmission process of financial crises across economies, Favero and Giavazzi (2002) offer a simultaneous system of equations presented below:

$$\begin{bmatrix} 1 & \cdots & -\beta_{1i} \\ \vdots & \ddots & \vdots \\ -\beta_{i1} & \cdots & 1 \end{bmatrix} \begin{bmatrix} z_{1,t} \\ \vdots \\ z_{i,t} \end{bmatrix} = \begin{bmatrix} \gamma_{11} & \cdots & 0 \\ \vdots & \ddots & \vdots \\ 0 & \cdots & \gamma_{ii} \end{bmatrix} \begin{bmatrix} z_{1,t-1} \\ \vdots \\ z_{i,t-1} \end{bmatrix} + \left[I + \begin{bmatrix} a_{11} & \cdots & a_{1i} \\ \vdots & \ddots & \vdots \\ a_{i1} & \cdots & a_{ii} \end{bmatrix} \begin{bmatrix} d_{1,t} & \cdots & 0 \\ \vdots & \ddots & \vdots \\ 0 & \cdots & d_{i,t} \end{bmatrix} \right] \begin{bmatrix} \varepsilon_{1,t} \\ \vdots \\ \varepsilon_{i,t} \end{bmatrix} \quad (2)$$

where (z_i)'s are the performance indicators related to financial situations of the economies included in the sample, (β's, γ's and a's) are the parameter values of the system, (ε_i's) are the normally distributed econometric error terms, and (d_i)'s are exogenous dummy variables which are constructed by filtering the residuals from the VAR model of order one including all performance indicators in the sample:

$$d_{i,t} = \begin{Bmatrix} 1: \ |u_{i,t}| > 3\sigma^2_{u_{i,t}} \\ 0: \ \text{Otherwise} \end{Bmatrix} \quad (3)$$

Favero and Giavazzi (2002) advise that each of the positive and negative residuals from the VAR model should be focused on separately, so they can represent the financial crisis and mania periods, respectively. In this set up, if a positive (negative) residual exceeds the three standard deviation of its sample distribution, then the dummy variable takes the value of one for this period and zero for the other periods. In addition to that, a separate dummy variable should be constructed for each of the crisis and mania periods identified in the sample. Finally, the existence of the contagion is tested by the hypotheses below:

$$H_0: a_{ij} = 0 \text{ (for each } i \neq j)$$
$$H_1: a_{ij} \neq 0 \text{ (for each } i \neq j)$$

The null hypothesis above represents the non-existence of the contagion phenomenon, while the alternative implies its existence.

Although Favero and Giavazzi (2002) advise the Full Information Maximum Likelihood (**FIML**) method to estimate the simultaneous system of equations presented in (2), the system will be estimated via the iterative three-stage least squares (**3SLS**) method of Zellner and Theil (1962), based on the discussions made by Dhrymes (1973), Hausman (1975), and Amemiya (1977) on the relative efficiency of the FIML and (iterative) 3SLS estimators. The main conclusions of these discussions is summarized as follows:

i) The FIML and 3SLS estimators are asymptotically equivalent. The difference between the two is peculiar to only small samples.

ii) The FIML is more efficient estimator than the 3SLS estimator if the sample size is small. However, the relative efficiency of the FIML versus the 3SLS appears only when each equation in the system is truly specified and the residuals of the system are jointly normally distributed.

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iii) Both of the estimators are equivalent even for small sample sizes if each of the equations of the system is truly specified.

It is well known that the 3SLS is also an appropriate estimator for the situations that the right-hand side variables are correlated with the residual series that are both heteroskedastic and contemporaneously correlated with one another. Hence, it can be put forward that the 3SLS is more useful than the FIML.

3. RESULTS

The results from our application of the three-step methodology outlined in Favero and Giavazzi (2002) is summarized below:

i) We can see that there exist twenty-three financial turbulence periods in the sample, nine of which are experienced simultaneously in more than one economy.

Table-2. Determined Financial Turbulence Periods

POFT[1]	EEFT[2]	KFT[3]
January 2000	Belarus and Latvia	+, -
October 2000	Poland	-
November 2000	Switzerland	+
December 2000	S. Korea and Turkey	-, +
February 2001	Turkey	+
March 2001	Turkey	-
June 2001	Sweden and Switzerland	+, -
July 2001	Argentina	+
December 2001	S. Africa, Croatia, Sweden and Romania	+, -, -, +
March 2002	Argentina and Iran	+, +
May 2002	Argentina, Czech Rep. and Lithuania	+, -, -
September 2002	Brazil	+
January 2003	Thailand	-
March 2003	Lithuania	-
July 2003	Czech Rep., S. Korea and Thailand	+, -, +
December 2003	China	+
July 2004	Bulgaria	+
November 2005	Ukraine	-
March 2006	S. Arabia	-
November 2006	Romania	-
January 2007	Mexico	-
June 2008	S. Korea and Egypt	-, -
September 2008	India and Egypt	+, +

Notes:[1, 2, 3] represent, respectively, period of the financial turbulence, economies experiencing the financial turbulence and kind of the financial turbulence, while [+, -] imply that the related economy experienced a financial crisis and a mania, respectively.

ii) Almost all of the thirty economies in the model have a minimum of one interdependence relation from another, except for Argentina and Malaysia.

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Table-3. Estimated Interdependence Relations

to	from
Argentina	Japan (0.543)
Belarus	Brazil (0.419[a]), Israel (0.114[c]), Ukraine (0.235)
Brazil	Belarus (0.249[b])
Bulgaria	Croatia (0.109[a]), Israel (-0.035), Japan (0.260[c]), Lithuania (0.297[a]), Turkey (0.016[a]), Ukraine (0.186[b])
China	S. Africa (-0.100[a]), Israel (-0.006), Japan (0.136[a]), Korea (-0.018[b]), Turkey (0.003[b])
Croatia	Bulgaria (0.658[a]), S. Africa (-0.822[a]), Romania (0.192[a])
Czech Rep.	EU (0.610[a])
Egypt	Argentina (0.063[b]), Israel (-0.058[c]), Sweden (0.211[b]), Russia (-0.255), Thailand (-0.114[b])
EU	Czech Rep. (0.511[a]), India (0.316[a]), Sweden (0.085[b])
India	China (0.417[b]), S. Africa (0.203[a]), Lithuania (0.058), Egypt (-0.102[a])
Iran	Bulgaria (0.161[a])
Israel	Belarus (0.672[a]), Bulgaria (-0.654), Egypt (-0.909[b]), Turkey (0.040[c])
Japan	Mexico (0.052[c]), Turkey (-0.022[a]), Ukraine (-0.222[a])
Latvia	Moldova (-0.143[b]), Russia (0.297[b])
Lithuania	Bulgaria (0.665[a]), Russia (0.289[b]), Turkey (-0.031[a])
Malaysia	-
Mexico	Belarus (-0.177[b]), Israel (0.108[b]), Japan (0.618[b])
Moldova	Switzerland (0.191[a])
Poland	EU (0.596[a]), Sweden (0.156[a]), Russia (0.217[a])
Romania	Croatia (0.688[a]), Egypt (-0.493[b]), Thailand (0.263[b])
Russia	Latvia (0.152[b]), Poland (0.473[a])
S. Africa	EU (0.469[a]), USA (-2.670[a]), China (-1.360[a]), Croatia (-0.121[a]), Mexico (0.061), Ukraine (-0.207[a])
S. Arabia	Latvia (-0.507[a])
S. Korea	USA (-5.350[b]), Thailand (0.537[a])
Sweden	Belarus (0.068), Poland (0.559[a])
Switzerland	EU (0.359), Bulgaria (0.478[a])
Thailand	S. Korea (0.317[a]), Romania (0.047), Russia (0.356[c])
Turkey	USA (20.711[a]), Argentina (0.278[b]), Belarus (-0.936), Iran (1.846[b]), Israel (0.281[b]), Japan (-3.070[a])
Ukraine	Japan (-0.696[a]), Poland (0.537[a]), Turkey (-0.021[a])
USA	Bulgaria (-0.011), S. Korea (-0.006[a])

Notes:[a], [b] and [c]refer to1%, 5% and 10% significance levels, respectively.

iii) Almost all of the twenty-three financial turbulences identified in the sample are contagious, except for December 2003 Chinese crisis and January 2007 Mexican mania.

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Table-4. Contagious Financial Turbulences

POFT[1]	EEFT[2]	EFTT[3]
January 2000	Belarus^{+} and Latvia^{-}	Brazil (-9.540^{b})
October 2000	Poland^{-}	Thailand (-7.033^{c})
November 2000	Switzerland^{+}	Turkey (49.316^{a})
December 2000	Korea^{-} and Turkey^{+}	USA (-0.489^{b}), Iran (6.390^{a}), Japan (4.254^{a}), Sweden (-9.484^{a}), Israel (-18.877^{b}), Moldova (-14.972^{a}), Poland (4.621^{a})
February 2001	Turkey^{+}	Japan (3.207^{c})
March 2001	Turkey^{-}	Sweden (-4.892^{b}), Switzerland (10.024^{a})
June 2001	Sweden^{+} and Switzerland^{-}	Belarus (-7.04^{c}), Romania (-13.608^{a})
July 2001	Argentina^{+}	Egypt (-5.226^{b})
December 2001	S. Africa^{+}, Croatia^{-}, Sweden^{-} and Romania^{+}	Argentina (-15.587^{a}), Latvia (7.716^{a}), Egypt (7.971^{b}), Russia (7.603^{a}), S. Arabia (9.597^{a})
March 2002	Argentina^{+} and Iran^{+}	Turkey (-547.832^{b})
May 2002	Argentina^{+}, Czech Rep.$^{-}$ and Lithuania^{-}	Japan (-3.599^{a})
September 2002	Brazil^{+}	Belarus (-12.155^{a})
January 2003	Thailand^{-}	Latvia (-3.988^{c})
March 2003	Lithuania^{-}	S. Africa (-3.011^{c}), India (3.604^{a}), Egypt (3.527)
July 2003	Czech Rep.$^{+}$, Korea^{-} and Thailand^{+}	Romania (-17.127^{a})
December 2003	China^{+}	-
July 2004	Bulgaria^{+}	Iran (-3.762^{a}), Lithuania (-11.315^{a}), Ukraine (-5.008^{b})
November 2005	Ukraine^{-}	S. Arabia (-8.394^{a})
March 2006	S. Arabia^{-}	Croatia (7.567^{c}), India (-2.842^{a})
November 2006	Romania^{-}	Israel (-15.453^{c}), Egypt (-9.361^{a})
January 2007	Mexico^{-}	-
June 2008	Korea^{-} and Egypt^{-}	Belarus (8.859^{b}), Israel (-40.374^{a}), Romania (-12.247)
September 2008	India^{+} and Egypt^{+}	Russia (4.012^{b}), Sweden (-7.870^{a})

Notes:[1, 2, 3] represent, respectively, period of the financial turbulence, economies experiencing the financial turbulence and kind of the financial turbulence, while $^{+, -}$ imply that the related economy experienced a financial crisis and a mania, respectively. Contagion parameters are in parentheses. Finally, ^{a}, ^{b} and ^{c}refer to1%, 5% and 10% significance levels, respectively.

To test our hypothesis, it is a necessary condition that an interdependence relationship from the emerging market experiencing the financial turbulence to the other market infected with the aforementioned financial turbulence exists. It has been determined that there exist ten cases where the hypothesis of this paper can be tested. After some calculations presented in Table 2, we can conclude that the hypothesis of this paper is validated for all ten cases. In eight of the ten cases, we found evidence implying that the interdependence effect experienced in the non-turbulence periods could veer during the turbulence period as a result of the contagion process.

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The other cases imply that the interdependence effect could disappear as a result of the contagion process:

Table-5. Testing Results

	Interdependence Effect*	**Contagion Effect***	**Net Effect***	**Result***
Belarus to Brazil (January 2000 Crisis)	7.139 (0.249*28.672)	-9.450	-2.311	Veering
Argentina to Egypt (July 2001 Crisis)	1.114 (0.063*17.677)	-5.226	-4.112	Veering
Argentina to Turkey (March 2002) Iran to Turkey	9.420 (0.278*33.884) + 536.296 (1.846*290.518)	-547.832	-2.116	Disappearing
Brazil to Belarus (September 2002 Crisis)	4.443 (0.419*10.604)	-12.155	-7.712	Veering
Lithuania to India (March 2003 Mania)	-0.670 0.058*11.553	3.604	2.934	Veering
Thailand to Romania (July 2003 Crisis)	3.461 (0.263*13.161)	-17.127	-13.666	Veering
Bulgaria to Iran (July 2004 Crisis)	1.216 (0.161*7.554)	-3.762	-2.546	Veering
Bulgaria to Lithuania (July 2004 Crisis)	5.023 (0.665*7.554)	-11.315	-6.292	Veering
Egypt to Israel (June 2008 Mania)	22.515 (-0.909*-24.769)	-40.374	-17.859	Veering
Egypt to Romania (June 2008 Mania)	12.211 (-0.493*-24.769)	-12.247	-0.036	Disappearing

Notes: The interdependence effects are calculated by multiplying the interdependence coefficient of the economy infected with the turbulence by the current value of the performance indicator of the economy experiencing the aforementioned turbulence. The contagion effect equals to the related contagion coefficients from the estimation of the restricted simultaneous system equations. The net effects represent the sum of interdependence and contagion effects. If the net effect is positive (negative) whereas the interdependence effect is negative (positive), we can conclude that the interdependence effect veered. If the net effect is positive (negative) but smaller than the positive (negative) interdependence effect (absolutely), we can conclude that the interdependence effect weakened. Lastly, if the net effect is near to zero or smaller than the ten percent of the interdependence effect, we can conclude that the interdependence effect has disappeared.

Although there is no evidence for the weakening of the interdependence effect by this application, it should be noted that it is possible for such a situation to appear. For example, Korkmaz (2012) can be applied to demonstrate such evidence. Moreover, it should be noted that the evidence for the disappearing of the interdependence effect is the distinguishing feature of the present paper.

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Table-6. Testing Results for the Flight to Quality Hypothesis

EEFTP0T[1]	EFTT[2]	Result
Belarus+ and Latvia- (January 2000)	Brazil (-9.540[b])	Indefinite
Poland- (October 2000)	Thailand (-7.033[c])	No
Korea- and Turkey+ (December 2000)	Iran (6.390[a]), Israel (-18.877[b]) Moldova (-14.972[a]), Poland (4.621[a])	Indefinite
Argentina+ (July 2001)	Egypt (-5.226[b])	Yes
S. Africa+, Croatia- and Romania+ (December 2001)	Argentina (-15.587[a]), Latvia (7.716[a]), Egypt (7.971[b]), Russia (7.603[a]), S. Arabia (9.597[a])	Indefinite
Argentina+ and Iran+ (March 2002)	Turkey (-547.832[b])	Yes
Brazil+ (September 2002)	Belarus (-12.155[a])	Yes
Thailand- (January 2003)	Latvia (-3.988[c])	No
Lithuania- (March 2003)	S. Africa (-3.011[c]), India (3.604[a])	No, Yes
Czech Rep.+, Korea- and Thailand+ (July 2003)	Romania (-17.127[a])	Indefinite
Bulgaria+ (July 2004)	Iran (-3.762[a]), Lithuania (-11.315[a]), Ukraine (-5.008[b])	Yes, Yes, Yes
Ukraine- (November 2005)	S. Arabia (-8.394[a])	No
S. Arabia- (March 2006)	Croatia (7.567[c]), India (-2.842[a])	Yes, No
Romania- (November 2006)	Israel (-15.453[c]), Egypt (-9.361[a])	No
Korea- and Egypt- (June 2008)	Belarus (8.859[b]), Israel (-40.374[a]), Romania (-12.247)	Yes, No, No
India+ and Egypt+ (September 2008)	Russia (4.012[b])	Indefinite

Notes: [1, 2, 3] represent, respectively, period of the financial turbulence, economies experiencing the financial turbulence and kind of the financial turbulence, while [+, -] imply that the related economy experienced a financial crisis and a mania, respectively. Contagion parameters are in parentheses. The cases written in bold refer to the cases that the perspective offered by the study on the contagion process is found to be valid. Finally, [a], [b] and [c] refer to 1%, 5% and 10% significance levels, respectively.

4. DISCUSSION

Empirical results give also some opportunities to test for the "*flight to quality*" hypothesis. There are sixteen cases that asymmetric contagion appears or "*flight to quality*" hypothesis is valid. In these situations, a mania (crisis) in any economy leads to performance indicators of any other economy to increase (decrease), as presented in Table 2. A few words should be expended to compare the flight to quality hypothesis with the alternative perspective offered by the study on the transmission process of financial crises. The following explanations and examples should be

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sufficient to discuss and show the differences and similarities between the aforementioned two perspectives:

i) The necessary condition for the perspective adopted here to be valid is that an interdependence effect from the economy experiencing a financial turbulence to the economy infected with the aforementioned turbulence exists. Such a necessity is not needed for the flight to quality hypothesis to be valid.

ii) There exist eleven and three cases to test for the flight to quality hypothesis and the perspective offered here, respectively.

iii) The flight to quality hypothesis can be accepted, whereas the perspective offered by the study is rejected or cannot be tested

iv) The perspective offered here can be accepted, whereas the flight to quality hypothesis is rejected.

For the seven of the aforementioned sixteen financial turbulence periods, the flight to quality hypothesis is found to be valid, as can be seen from the Table 12. The five of the sixteen financial turbulence periods are marked as "Indefinite" because of their being experienced as mania and crisis in different emerging markets contemporaneously.

5. CONCLUSION

An existing interdependence effect could strengthen or remain unchanged in response to a financial crisis is already emphasized by some researchers, e.g. Forbes and Rigobon (2002). Furthermore, the contagion mechanism could work asymmetrically across markets that can be separated into different groups is shown by Favero and Giavazzi (2002). However, this study offers an alternative perspective on the transmission process of financial crises across the emerging markets. It can be hypothesized in such a way that an interdependence effect could weaken, even disappear completely and veer as well in a crisis period as a result of the contagion process. This confirmation of the aforementioned hypothesis gives rise to a very important policy implication: that policy-makers are less able to prevent financial crises experienced outside from being transmitted into their own country, even if they could exactly predict the interdependence effect to exist. For a moment, let the policy-maker in economy A predict exactly that economy A has a positive interdependence effect from economy B, and economy B is about to experience a financial crisis. In such a situation, the policy-maker designs a policy response for economy A to cancel the effect of the expected financial crisis in economy B by considering the interdependence effect from economy B to economy A. If the interdependence effect experienced in non-crisis periods weakens, disappears completely or veers during the crisis period as a result of the contagion phenomenon, this policy response may turn to be an inefficient or a faulty one ex-post, even though it is efficient ex-ante. Although there is no evidence implying the disappearing of the interdependence effect in this application, it should be noted that such a situation is not impossible to appear (Korkmaz, 2012).

On the other hand, it can be claimed that policy-makers could predict the contagion effect as well as the interdependence effect to occur by utilizing an existing method, for example, *Threshold Test* of Pesaran and Pick (2007). However, we should keep in mind that there is no guarantee that

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all financial turbulences experienced in any economy is always transmitted to another market in the same way.

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