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The Impact of the Subprime Crisis on the Industrial Sector of the Emerging Countries

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Abstract This paper describes an analysis of number of emerging countries so as to identify the impact of the subprime crisis on their industrial sector. Using the analysis of multivariate time series, we will try to examine the real impact of the crisis on the industrial sector in five emerging countries through five channels: the interest rate channel, the wealth impact channel, the bank lending channel, the shock and uncertainty channel and the trade channel, over the period 2002-2011. According to the estimates of the SVAR model, our key results indicate that emerging countries are expected to take political and economic measures to alleviate the negative effects of the subprime crisis on their industrial sector. In fact, we can say that our results empirically demonstrate that the financial channel is the most important for the emerging countries.

Keywords: *sub-prime crisis, emerging countries, SVAR, transmission channels*

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1. Introduction

The financial crisis of 2007, which caused the collapse of several U.S. and European banks and tightened the credit conditions, eventually spread to the real economy leading to an economic recession. The global financial crisis has hit emerging and developing economies extremely hard. Output, exports, remittance flows, aid and capital inflows have all been lower than expected.

For emerging market and developing economies, financial crisis is not a new phenomenon. Indeed, since the early 1990s countries as diverse as Mexico, Russia, a number of East Asian countries, Brazil, Turkey and Argentina have all been hit by either currency or financial crises, or both. Although country experiences have varied with regard to the source of difficulty in each episode, the problem of crises has been fairly similar. Not all the emerging countries were financially affected in the same way as the effects of the financial crisis on the real economy are different depending on the nature of the accumulation regime, the level of the short-term debt and the sign of the balance of current payments.

Several studies focused on the degree of exposure of the emerging economies to external shocks. In particular, the contagion phenomenal that appear after a crisis point to the growing influence of external, mainly financial, variables in the emerging countries [13]. The increasing openness of the emerging economies, both commercially and financially, as well as the episodes of the financial crisis showed the importance of external shocks. Moreover, the negative effects of these shocks spread from the financial sector to the real one, which leads to a significant slowdown of production. This phenomenon is explained by the lack of sustainability of the established exchange rate regimes during the last decade and the sensitivity of countries to external variations.

Similar, Dooley and Hutchinson [8] examined the transmission of shocks following the Subprime crisis. They find that emerging markets appeared to be somewhat insulated from the developments in the US economy from early 2007 to the middle of 2008. However, emerging markets did react quite strongly to a number of news events in the period after the summer of 2008. In a recent study, Didier, Hevia and Schmukler [7] find that though emerging economies could not shield themselves from the transmission of shocks arising from the global financial crisis of 2008-2009, they showed much more resilience during the crisis compared to the crises that occurred prior to the 2007.

In many recent studies, the causal relationship between financial crises and industrial sector has been invested. De and Chiranjib [6] attempted to analyze the impact of shocks of the global crisis on the Indian trade and industry. They used two models in their analysis: the technique of the panel data and the Autoregressive Vector (VAR). The panel estimation results show that a change in the trade pattern is positively associated with a change in that of the manufacturing sector. Hence, the results of the VAR technique indicated that the change in the composition of industry was significantly reflected in the exports to the United States, Japan, and the European Union at the time of crisis.

By the same reasoning, Al Qaisi's research [1] focused on the impact of the global financial crisis on the industrial sector in Jordan. Various financial ratios were estimated from the financial statements of the industrial firms for the period 2002-2008. The results showed that there was a negligible effect on the industrial sector in Jordan.

As described above, previous studies have dealt with financial and real canals, but only separately. In addition, opinions are divergent on which linkage is the more important. This paper therefore quantifies which transmission linkage had a major role to emerging economies during the recent US financial crisis. This subject is extremely important because it provides rich information for the debate about whether emerging markets have decoupled from advanced economies.

In this work, we discuss the problem of the impact of the subprime crisis on industrial sector through several transmission channels. The objective of this paper is to identify the different transmission mechanisms of the financial crisis that affected the industrial sector of five emerging countries (Brazil, Chile, China, Mexico and Turkey).

This paper presents development of dynamic measures for financial and real macroeconomic interdependences, based on the impulse responses and decomposition variance from the structural vector autoregressive (SVAR) model. This approach presents some advantages over a correlation approach. First, different from a correlation approach, the SVAR approach can simultaneously disentangle several structural shocks, such as financial and real shocks, in the same estimation model. Consequently, SVAR can quantify which transmission linkage had a major effect of financial crisis to macroeconomic variable of emerging economies. Second, a SVAR approach can analyze interaction between real and financial variables, which is an interest of this paper. However, because a simple correlation approach is specialized in analyzing contagion among financial variables, it does not provide a precise reflection of financial and real linkages. Third, our approach can assess the dynamic impact of financial crisis on emerging economies using impulse response analysis. Additionally, we can estimate the relative importance of financial and real linkage on macroeconomic variables by variance decomposition.

The remainder of the paper is organized as follows. Section 2 provides information related to the empirical model that is used in this analysis and the data. Section 3 presents empirical results and discusses the results briefly. Finally, Section 4 concludes the paper.

2. Assessment Procedure

2.1. The SVAR Model

The structural vector auto-regression (SVAR) model consists in converting residues originating from a canonical VAR [14] into structural shocks that could be economically interpreted. The shocks on the various variables in the VAR model are independent from one another. As a consequence, each shock will be affected by other shocks impacting the other variables. For this reason, it is difficult to analyze the impact of a shock considered in isolation on the system. The solution of this problem lies in the fact that the VAR model has a structure which consists in adding restrictions that transformed a VAR model into a structural one. These restrictions are mostly based either on the simultaneous impact of the shocks or on their long-term impact.

The Vector Autoregressive Representation (canonical VAR):

$$X_t = \sum_{h=1}^{p} A_h X_{t-h} + \varepsilon_t. \tag{1}$$

The A_h represent the matrix coefficients of the scale ones (k × k). ε_t is a white noise process of k dimension and variance-covariance matrix Σ.

The VAR structural representation is equivalent to the VAR in a reduced form the value of which appears in the estimation phase. The VAR structural model is represented as follows:

$$AX_t = \sum_{h=1}^{p} A_h^* X_{t-h} + Bw_t \tag{2}$$

with w_t a white noise and A * h the structural coefficients for h = 1,...., P. We multiply equation (2) by the opposite of matrix A, we obtain:

$$X_t = A^{-1} \sum_{h=1}^{p} A_h^* X_{t-h} + A^{-1} Bw_t. \tag{3}$$

Based on equations (8) and (10), the innovation vector of the VAR model is a linear combination of the structural innovations considered to be orthogonal, which means that the Σω variance-covariance matrix is a identified as $\sum_\omega = E(W_t, W_{t'}) = I$.

The estimation of the VAR structural model is obtained by estimating matrices A and B to find out the $A^{-1}B$ relationship. The orthogonalization hypothesis about the innovations allows for the determination of the identification restrictions on the matrices. To estimate the equation system of the VAR structural model, the constraints imposed on matrices A and B should be identified.

In order to get the response functions to shocks and the decomposition of the variance of the forecasting error, the process should be written under the structural endless moving average form. For this purpose, an intermediate step is to reverse the canonical VAR model (1) on the basis of the "*Wold*" theorem to get the canonical VAR under the moving average form.

The canonical VAR equation can be written as follows:

$$A(L) X_t = \varepsilon_t \tag{4}$$

where L is the delay operator whose function is $L^K X_t = X_{t-1}$ and A indicates the matrix of the delay polynomials which takes the following form: $A(L) = I_K - A_1 L - A_2 L^2 - \cdots - A_p L^p$, with I_K representing the identity matrix of (K × K) dimension.

The average representation of the moving VAR takes into account the declining effect of all the innovations and models, in a simply way, as well as their impact on the components of the X_t vector.

The moving average representation or the dynamic "*Wold*" decomposition takes the following form:

$$X_t = \sum_{h=0}^{\infty} C_h \varepsilon_{t-h} = C(L) \varepsilon_t. \tag{5}$$

Based on these last equations (4 and 5), we found that $C(L) = A(L)^{-1}$ with $C(L) = I_K - C_1 L - C_2 L^2 - \cdots$. Using the dynamic multipliers, we can identify the responses of the X_{it} various sets to the ε_{js}, s ≤ t innovations:

$$C_{ij,t-s} = \frac{\partial X_{it}}{\partial \varepsilon_{JS}}. \tag{6}$$

The system responses to the *wjs* structural stimuli are identified by evaluating the structural dynamic multipliers $\theta_{tj,t-s}$, where $\theta = C_{t-s}A^{-1}B$. Therefore, the dynamics may be written in the form of a structural moving average as follows:

$$X_t = \sum_{h=0}^{\infty}(C_h A^{-1}B)((A^{-1}B)^{-1}\varepsilon_{t-h}) \quad (7)$$

$$X_t = \sum_{h=0}^{\infty}\theta_h \omega_{t-h}. \quad (8)$$

It can be concluded that:

$$\theta_{ij,t-s} = \frac{\partial X_{it}}{\partial \omega_{JS}}. \quad (9)$$

The SVAR is a model that identifies the shocks based on the impulse response functions and the variance decomposition of the forecasting error by imposing identification restrictions on matrices A and B.

2.2. Data, Variables and Sample

The choice of the variables and the study period was determined by the availability of the data in the selected period and for the studied six emerging countries. Also, this choice of variables is based on reports of studies by blot and al [2]. The data were collected on a monthly basis between January 2002 and December 2011 and obtained, on the one hand, from the IMF and the OECD and, on the other hand, from the central banks of the studied countries. The selected variables are defined as follows:

- *LIPI* is the natural log of industrial production index that represents a proxy of economic growth.
- *LIPC* is the natural log of the consumer price index that represents the price variable.
- *LEXP* is the natural log of exports that represents the commercial channel.
- *SPREAD* is the difference between the 3-month interbank rate and that of the Treasury bills. In addition, it is an indicator of the difficulties of refinancing of banks in times of crisis. The "*spread*" interbank variable is therefore a *proxy* of the (quantitative) liquidity problems faced by banks in times of crisis and therefore of the financial effect.
- *Volatility* is the stock price variable that is a proxy of uncertainty in the global economy which affects the spending decisions of the economic agents. It is calculated by the square residuals.
- *Performance* is the natural log of the changes of the stock prices that represent a proxy for the total wealth of the agents. In fact, the share prices are a good indicator of the wealth of the different private agents (companies, households and financial institutions). Moreover, the decrease of the stock prices creates some difficulties in funding companies and depreciates the balance of companies and financial institutions whose assets are estimated at their market value. This situation penalizes the different investment projects.

2.3. Results of the Unit Root Tests

Table 1. Results of the unit root tests

	ADF Test		PP Test		Integration order
	In level	In first difference	In level	In first difference	
Brazil					
LIPI	-3.055	-12.383[a]	-3.136	-12.383[a]	1
LIPC	-3.592[b]	-4.244[a]	-2.906	-4.366[a]	1
LEXP	-4.230[a]	-13.393[a]	-4.087[a]	-13.431[a]	0
SPREAD	-2.498[b]	-5.284[a]	-2.964[a]	-11.772[a]	0
Volatility	-6.557[a]	-11.290[a]	-6.539[a]	-56.747[a]	0
Performance	-9.242[a]	-9.923[a]	-9.446[a]	-31.714[a]	0
Chile					
LIPI	-2.188	-11.455[a]	-3.099	-18.007[a]	1
LIPC	-3.215[c]	-8.840[a]	0.271	-8.771[a]	1
LEXP	1.554	-18.690[a]	-3.039	-18.805[a]	1
SPREAD	-3.745[a]	-10.674[a]	-4.350[a]	-15.383[a]	0
Volatility	-9.855[a]	-10.340[a]	-9.873[a]	-74.083[a]	0
Performance	-8.602[a]	-10.934[a]	-8.701[a]	-45.898[a]	0
China					
LIPI	-4.046[a]	-11.694[a]	-6.824[a]	-22.420[a]	0
LIPC	-3.663[b]	-8.048[a]	-2.863	-8.090[a]	1
LEXP	-1.761	-1.271	-4.094[a]	-14.057[a]	1
SPREAD	-0.808	-12.520[a]	-0.731	-12.467[a]	1
Volatility	-3.561[a]	-10.102[a]	-9.296[a]	-64.459[a]	0
Performance	-5.968[a]	-11.517[a]	-10.545[a]	-25.777[a]	0
Mexico					
LIPI	1.553	-11.788[a]	1.375	-11.908[a]	1
LIPC	-4.385[a]	-2.833[c]	-2.934	-5.880[a]	1
LEXP	-2.847	-2.225[b]	-3.830[b]	-15.614[a]	1
SPREAD	-4.525[a]	-15.798[a]	-4.259[a]	-22.265[a]	0
Volatility	-7.397[a]	-11.779[a]	-7.375[a]	-52.661[a]	0
Performance	-9.434[a]	-11.775[a]	-9.653[a]	-23.682[a]	0
Turkey					
LIPI	1.850	-20.494[a]	-3.917[b]	-19.901[a]	1
LIPC	-3.680[b]	-6.985[a]	-3.792[b]	-6.887[a]	0
LEXP	2.247	-12.655[a]	-3.798[b]	-18.310[a]	1
SPREAD	-4.681[a]	-11.988[a]	-4.552[a]	-13.316[a]	0
Volatility	-10.171[a]	-12.066[a]	-10.189[a]	-35.955[a]	0
Performance	-9.273[a]	-15.357[a]	-9.392[a]	-32.663[a]	0

(a), (b) and (c) show significance at the levels of 1%, 5% and 10%, respectively.

As indicated in the table above, the variables do not show the same integration order for all the countries. The methods used by Engle and Granger [9] and Johanson [12] to test the co-integration of the model variables aim to study the co-integration relationships and explain, from an economic perspective, the relationship between the variables. The stationary tests show that our variables do not have the same integration order [I (0) and I (1)], which implies that these long-term estimation techniques cannot be used.

On the other hand, it is necessary to use stationary variables with the SVAR model. Since the variables do not have the same integration order, it is necessary to use both the stationary in level and in first difference variables.

2.4. Specification of the SVAR Model

When estimating the VAR model, the problem of the optimal number of delays should be considered. In practice, the Akaike (AIC) and Schwartz (SBC) criteria are used to identify the number of the model "p" delays.

With the SVAR specification model in first difference, we have chosen the optimal number of delays for each country. The number of delays was set up at 7 for Brazil, 4 for Chile, 8 for China, 8 for Mexico and 8 for Turkey.

Figure 1 shows that the inverse root is within the circle for all the countries. Therefore, it can be concluded that the selected VAR is stationary.

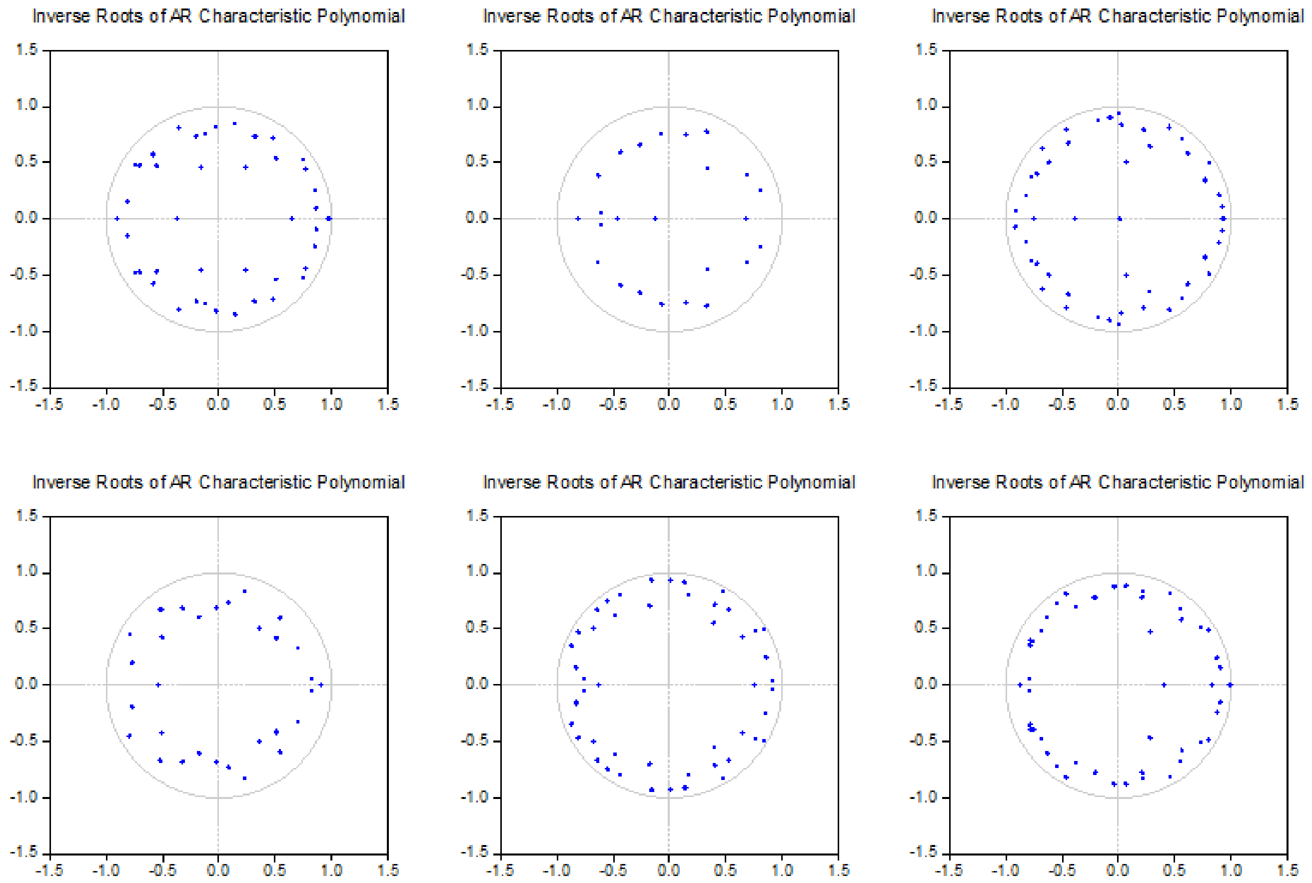

Figure 1. The reverse of the unit root for all the SVAR variables

3. Empirical Results

3.1. The Impulse Functions and Variance Decomposition

To determine the extent of the various shocks on the industrial production in the emerging countries, it is necessary to analyze the index response of the industrial production to the shocks on the various variables. The accumulated impulsive responses (represented by the solid lines) are shown over a 10-year horizon. All the shocks are standardized at 1% and the vertical axis indicates the percentage of the estimated variation of the variable in response to 1% of an impact on the index of the industrial production. In addition, the shocks are within the confidence interval (by broken lines), which makes us confirm that all the answers are meaningful.

To better pick out the effects of shocks to the variables and to the industrial production index, an analysis of the IPI variance decomposition was used. The results of this decomposition are presented for each country to clarify the share of each shock of the variables (CPI, EXP, SPREAD, volatility and performance) and explain the variation of the IPI variable. The estimation is made for a 10-year horizon to better understand the evolution of this share over time.

The SVAR modeling enables to decompose the variance of industrial production so that we can identify the IPI's function response to the structural shocks of the different variables on the basis of the number of years.

Brazil

It appears that industrial production in Brazil responds, with the expected sign, to the various shocks (Figure 2). A positive price shock leads to a rapid reaction (increase) of production. The latter increases during the first year following the rise in prices, then declines from the second year in response to the falling prices, to keep its initial value for almost 7 years.

A positive impact on exports leads to a rise of industrial production during the first three years. However, a negative shock reduces industrial production in the third year. Moreover, the industrial production index meets the various shocks connected with exports.

The industrial production index responds quickly to the unanticipated rise in the gap between the interbank rate over three months and that on the treasury bond of the central bank. This index declined during the first three years and then stabilizes after seven years. This result shows that the tensions on the interbank market have an important mechanism of the crisis transmission to the real economy for Brazil.

A doubt increase explains the decline of the industrial activity. The rise of unanticipated volatility leads to a decline of the industrial production index over three years followed by an improvement and a balance by the seventh year.

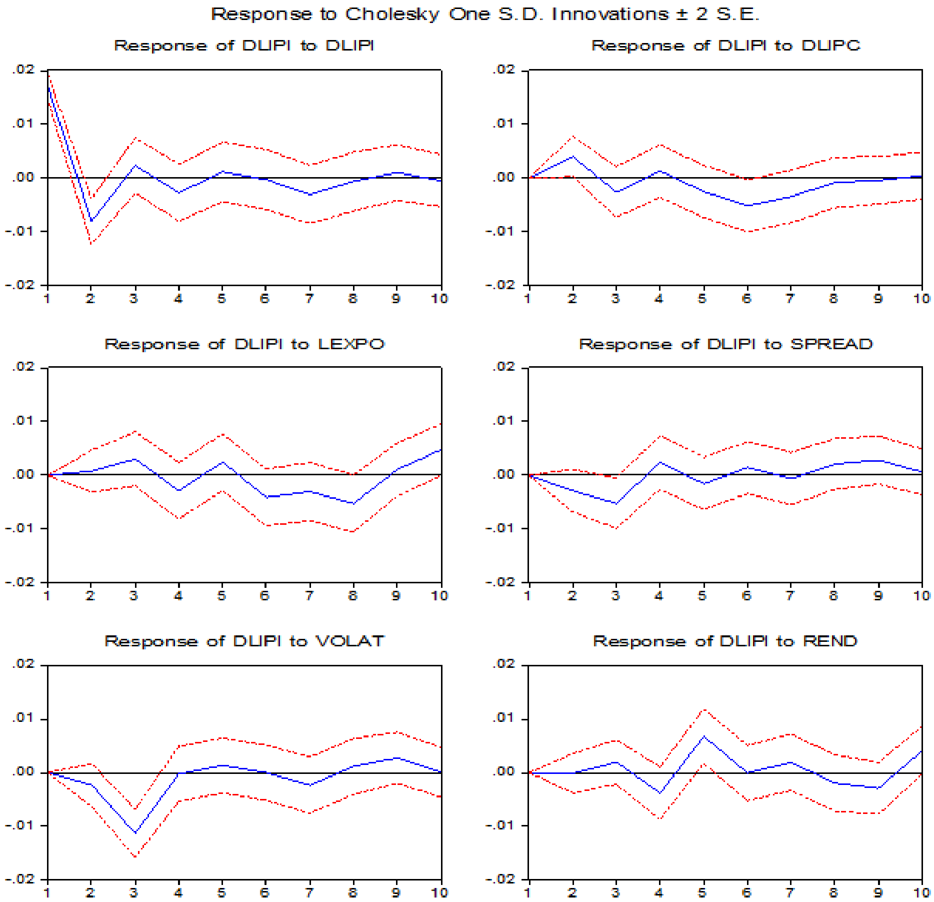

Figure 2. The impulse response of the various shocks to the IPI in Brazil

Finally, the industrial production response, due to a stock market shock, appears to be significant. It was stable during the first two years, and then fluctuated downward and upward during the eight remaining years. In fact, industrial production significantly improves during a positive shock and declines during a negative one (falling market performance).

Table 2. Decomposition of the forecasting error of the IPI variance (in %)

				Variance Decomposition of DLIPI			
Period	S.E.	DLIPI	DLIPC	LEXPO	SPREAD	VOLAT	PERF
1	0.017024	100.0000	0.000000	0.000000	0.000000	0.000000	0.000000
2	0.019611	92.12765	4.186464	0.156121	2.146644	1.378100	0.005023
3	0.023758	63.73764	4.055378	1.765948	6.245638	23.51992	0.675476
4	0.024540	60.95978	4.085637	3.010092	6.823209	22.05443	3.066856
5	0.025800	55.34601	4.650413	3.647751	6.513752	20.22001	9.622062
6	0.026672	51.80054	8.129632	5.758264	6.386935	18.92065	9.003979
7	0.027408	50.28361	9.285151	6.673552	6.097926	18.65466	9.005097
8	0.028091	47.91674	8.922399	9.820448	6.369141	17.93125	9.040029
9	0.028562	46.47613	8.651930	9.647348	7.155601	18.27609	9.792895
10	0.029260	44.31349	8.265596	11.82441	6.864086	17.41485	11.31757

According to Table 2, by the end of the first year, the IPI variable is explained only by itself, whereas the effects of the other variables appeared only from the second period. For a 3 year-period, more than 35% of the IPI variation were caused by shocks on the variables (CPI, EXP, SPREAD, Volatility and Performance) while the impact on industrial production is due to the remaining rate. During the fourth year, a small increase of the effect of shocks on CPI and volatility was observed beside a 3% increase of shocks on the EXP and on the combined performance due to the shock drop on industrial production and on the SPREAD.

The results found by decomposing the variance of the industrial production index revealed an important role of volatility. These results show that the volatility of the stock prices has an important role in changing the industrial production in Brazil, however, exports and stock price performance had a median contribution in this variation. Similarly, the contribution of the consumer price index and the interbank spread in this variation is even weaker.

Chile

For Chile (Figure 3), a positive price shock leads to a rapid increase in production. The industrial production index rises during the first year due to a price increase. However, as soon as the second year, it will be subject to changes because of the price decline and rise so that it can preserve its initial value by the seventh year.

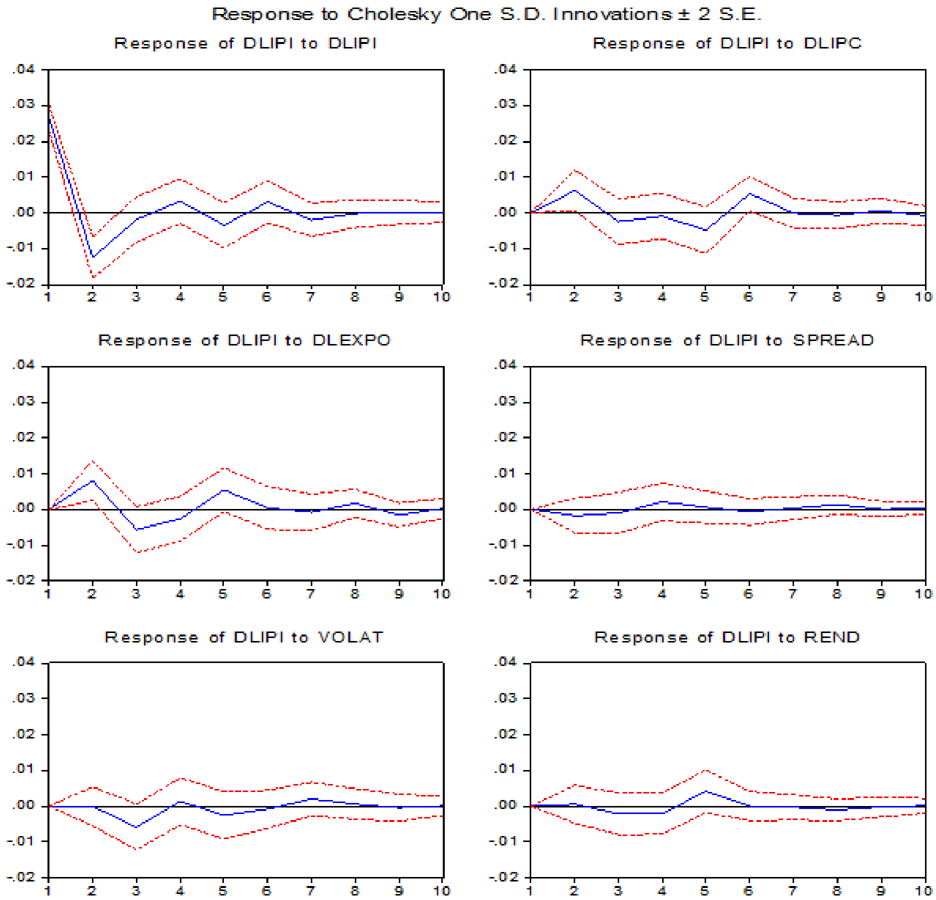

Figure 3. The impulse response of the various shocks to the IPI in Chile

A positive impact on exports implies an increase in the industrial production during the first two years. However, a negative shock reduces the industrial output during the third year. Then, a further increase in production has a positive impact in the fourth year. Moreover, the industrial production index remains stable during the remaining four years.

The industrial production index has not quickly responded to the unanticipated change in the difference between the three-month interbank rate and that of the treasury bond of the central bank, but remained stable for ten years. This result shows that the tensions on the interbank market are not a major transmission mechanism of the sub-prime crisis to the real economy of Chile.

The unanticipated volatility of the stock prices causes a reduction of the industrial production index from the second year and a rise from the fourth year. Similarly, it finds its balance from the sixth year. Regarding Chile, the increasing uncertainty due to the financial crisis has not led to a sharp collapse of the industrial activity.

Finally, the production reaction due to a stock market shock is a little significant. It remained stable during the first year but declined during the second year and rose again during the third year. As a matter of fact, it kept its initial value during the following seven years.

According to Table 3, during the first year, the IPI variable was explained only by itself. However, the effects of the other variables were significant only during the second period. For a three-year horizon, more than 17% of the IPI variations were due to shocks on the variables (CPI, EXP, SPREAD, Volatility and Performance), whereas the remaining part was related to shocks on industrial production. During the fourth year, a slight increase of the effect of shocks on all the variables was observed. From the fifth year, the shock contribution of all the variables stabilized helping achieve some kind of IPI balance.

The results obtained by decomposing the variance of the industrial production index confirm the fairly significant role of exports and CPI. These results also show that the SPREAD, volatility and performance did not have a significant role as determinants of the change in industrial production in Chile although their contribution to this variation was average.

Table 3. Decomposition of the forecasting error of the IPI variance (in %)

Variance Decomposition of DLIPI:

Period	S.E.	DLIPI	DLIPC	DLEXPO	SPREAD	VOLAT	PERF
1	0.026664	100.0000	0.000000	0.000000	0.000000	0.000000	0.000000
2	0.031247	88.97654	4.002275	6.671529	0.321494	0.000952	0.027215
3	0.032521	82.48222	4.273758	9.120624	0.384711	3.278621	0.460069
4	0.032960	81.26305	4.241700	9.510255	0.788158	3.356997	0.839840
5	0.034302	76.06488	5.974617	11.30088	0.762062	3.656602	2.240966
6	0.034865	74.38013	8.120106	10.95704	0.772930	3.600580	2.169216
7	0.034992	74.16239	8.063346	10.92835	0.779186	3.903295	2.163438
8	0.035088	73.75863	8.057280	11.10702	0.925443	3.909283	2.242341
9	0.035131	73.58287	8.064564	11.26843	0.924681	3.917270	2.242180
10	0.035142	73.53577	8.112815	11.26650	0.928705	3.914959	2.241246

China

In China (Figure 4), a positive impact on prices caused an increase of the industrial production which rose during the first year after the price decline. Moreover, from the second year, it declined in response to the price collapse, and then regained its initial value for almost 7 years.

Surprisingly, a shock to the Chinese exports resulted in only weak reactions of the industrial production over ten years. Actually, the shock to the Chinese exports has no great impact on the industrial production, which is not the case in practice. In fact, China's exports depend heavily on its industrial sector since its industrial production accounts for most of its exports.

Moreover, the industrial production index quickly responded to the unanticipated rise of the gap between the three-month interbank rate and that of the treasury bond of the central bank. It actually fell between the third and the sixth year, then stabilized four years later.

The uncertainty rise explains the decline of industrial activity. The uncertainty stability lasted for six years and then the increase of the non-anticipated volatility resulted in a decline of the industrial production index in the four remaining years.

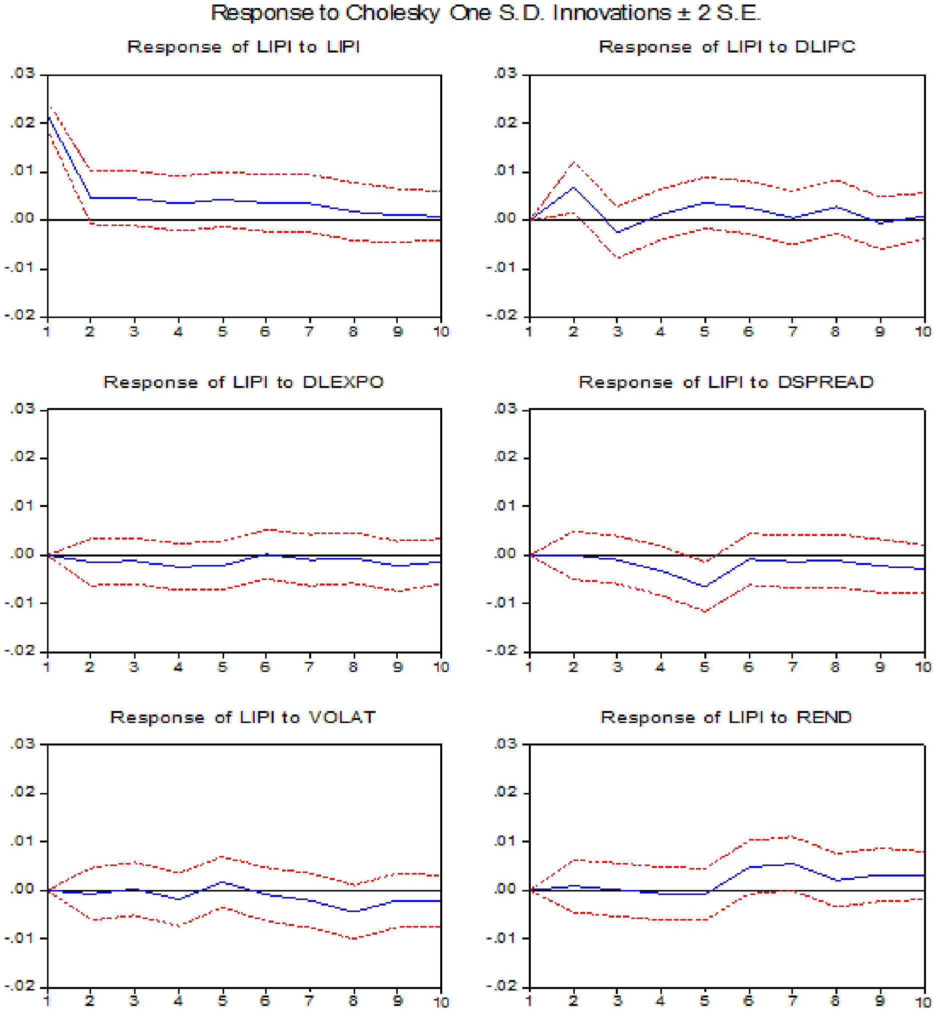

Figure 4. The impulse response of the various shocks to the IPI in China

The production reaction to a shock market stock is insignificant. It had been stable for the first five years, then rose in the five remaining years. Actually, industrial production grows significantly when there is a positive shock (increase in the performance).

According to Table 4, during the first year, the IPI variable was explained only by itself. However, the effects of the other variables were observed only in the second period. For a three-year horizon, more than 9% of the IPI variations were due to a single shock on the CPI variable. On the other hand, shocks to industrial production are caused by the remaining rate. During the fifth year, a 6% increase of the shock effect on the SPREAD was observed although the other shocks rose at a small proportion.

Table 4. Decomposition of the forecasting error of the IPI variance (in %)

Variance Decomposition of LIPI:

Period	S.E.	LIPI	DLIPC	DLEXPO	DSPREAD	VOLAT	PERF
1	0.021706	100.0000	0.000000	0.000000	0.000000	0.000000	0.000000
2	0.023288	90.83222	8.550303	0.369453	1.69E-05	0.100107	0.147896
3	0.023898	89.81548	9.185189	0.586566	0.158281	0.110493	0.143990
4	0.024583	86.81863	8.928463	1.486480	1.857076	0.698239	0.211110
5	0.026191	79.17273	9.794126	1.937524	7.752810	1.059642	0.283172
6	0.027013	76.16921	10.12656	1.828553	7.379996	1.096947	3.398732
7	0.027910	72.87298	9.518576	1.829377	7.128137	1.579680	7.071254
8	0.028556	69.98068	10.01140	1.784105	6.956961	3.975443	7.291409
9	0.028994	68.00712	9.753598	2.318127	7.315865	4.334466	8.270821
10	0.029430	66.10238	9.560683	2.444372	8.003269	4.757553	9.131747

The results achieved by decomposing the variance of the industrial production index show the important role of both the CPI and Performance. These results also indicate that the variation of the consumer price index plays an important role as a determinant of the industrial production variation in China. Similarly, the contribution of both the stock price returns and the SPREAD in this variation is remarkable. However, the contribution of exports and volatility in this variation is even weaker.

Mexico

For Mexico (Figure 5), a negative price shock led to a rapid decline of industrial production. In fact, the industrial production index dropped as soon as the second year due to the price decline. However, it had been stable until the seventh year then dropped again due to the price decline.

An export positive impact led to the rise of the industrial output during the third year. However, a negative shock reduced the industrial output for the seven remaining years.

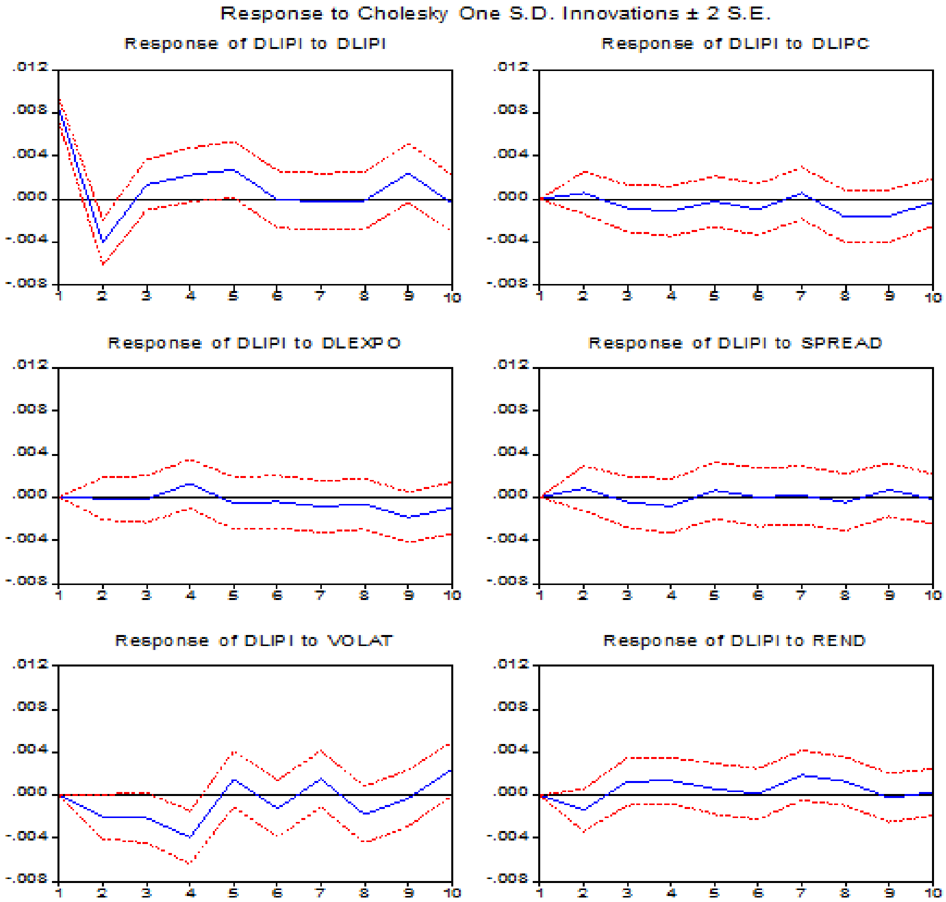

Figure 5. The impulse response of the various shocks to the IPI in Mexico

The industrial production index did not quickly react to the unanticipated changes of the gap between the three-month interbank rate and the one of the central bank Treasury bond. It had been stable for a decade. This may show that the interbank market difficulties do not explain the subprime crisis contagion to the real Mexican economy.

The increase of the stock market price unanticipated volatility caused the industrial production index to decline until the fourth year. Consequently, industrial production had upward and downward variations over the six remaining years. For the Mexican case, the increased uncertainty of the stock market led to the decline of the industrial activity.

Finally, industrial production was significantly impacted after a stock market shock. In fact, it dropped in the first year, and then rose as soon as the second year. This increase lasted for the remaining eight years. As a consequence, it appears that industrial production improved significantly after a positive shock and a dropped after a negative one (falling stock returns).

According to Table 5, and during the first year, the IPI variable is explained only by itself. Nevertheless, the effects of the other variables are noticed only during the second period. For a three-year horizon, more than 11% of the IPI variations are due to shocks to the volatility and return variables, whereas the remaining proportion is related to the shocks to industrial production. During the fifth year, a 10% increase in the effect of shocks on volatility is observed whereas the other shocks increased a little. From the sixth year, the contribution of shocks all the variables rose slightly increase helping achieve some kind of IPI balance.

The results set out by the variance decomposition of the industrial production index emphasize the important role of the stock price volatility. These results show that the CPI, the EXP and the stock price returns did not played a significant role as determinants of the industrial production change in Mexico whereas the SPREAD contribution to this variation is negligible.

Table 5. Decomposition of the forecasting error of the IPI variance (in %)

Variance Decomposition of DLIPI:							
Period	S.E.	DLIPI	DLIPC	DLEXPO	SPREAD	VOLAT	PERF
1	0.008254	100.0000	0.000000	0.000000	0.000000	0.000000	0.000000
2	0.009552	92.37333	0.352011	0.018849	0.751614	4.396050	2.108146
3	0.009998	86.08651	1.036954	0.050143	0.877850	8.420675	3.527865
4	0.011206	72.47464	1.828863	1.286131	1.247549	18.88093	4.281891
5	0.011675	72.20903	1.720032	1.426735	1.439095	19.00403	4.201087
6	0.011788	70.83141	2.351301	1.526524	1.411695	19.74782	4.131248
7	0.012075	67.54852	2.448919	1.978644	1.365526	20.37392	6.284466
8	0.012415	63.90990	4.132873	2.136459	1.427846	21.36717	7.025753
9	0.012906	62.66072	5.316853	4.072502	1.603893	19.81542	6.530603
10	0.013189	60.09832	5.143287	4.486559	1.552100	22.42719	6.292549

Turkey

A price shock in Turkey (Figure 6) produced a rapid response (rise) of industrial production, which increased during the fourth year, due to the price rise, then dropped from the fifth year, because of the price collapse, and finally regained its initial value for almost five years.

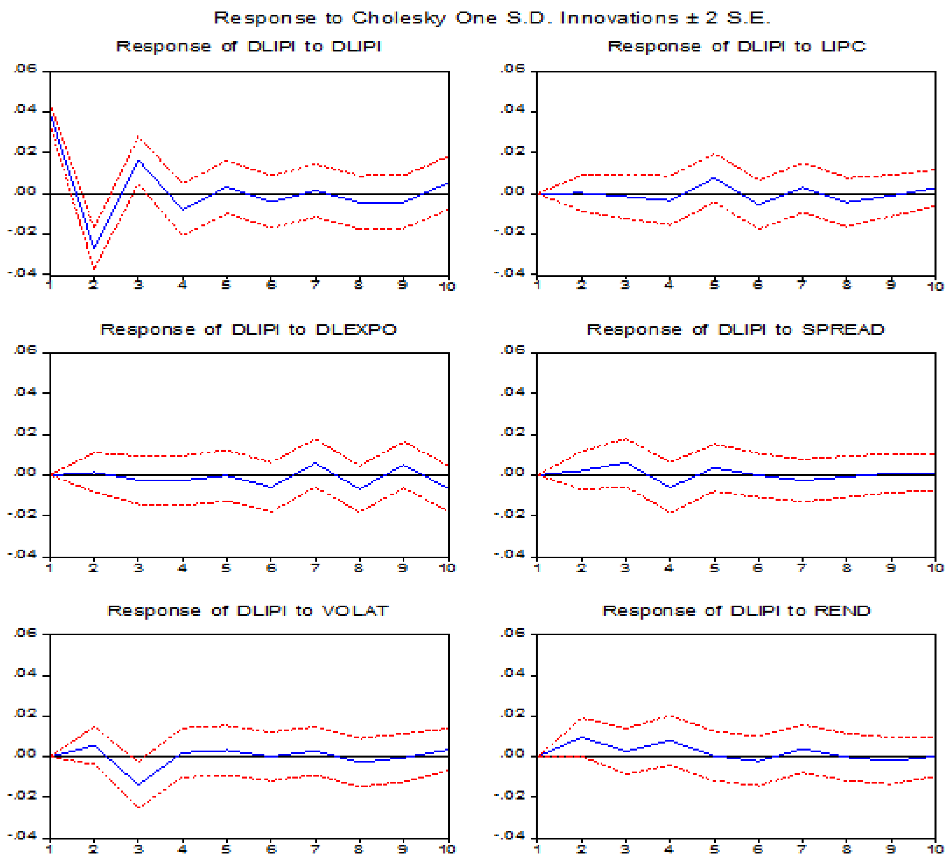

Figure 6. The impulse response of the various shocks to the IPI in Turkey

A positive impact on exports led to an increase of industrial production in the sixth year. However, a negative shock reduced industrial production in the seventh year. Moreover, the industrial production index met the various exports shocks.

The industrial production index itself quickly reacted to the unanticipated widening of the gap between the three-month interbank rate and that of the central bank Treasury bond. In fact, this index increased over the first three years, then dropped in the fourth year and finally a stabilized six years later.

A doubt mount can justify the decline of the industrial activity. The volatility rise led to an unanticipated drop of the industrial production index during the second year. Furthermore, it improved and regained its equilibrium during the eighth year.

Finally, the industrial production reaction to a stock market shock seems to be significant. It actually had upward fluctuations during the first five years and then stabilized during the five remaining years. Finally, industrial production improved significantly during a positive shock (increase of stock market returns).

On the basis of Table 6, during the first year, the IPI variable was explained only by itself. However, the effects of the other variables were not revealed until the second period. For a three-year horizon, more than 10% of the IPI variations are caused by shocks to the volatility and performance variables, whereas the remaining portion was due to industrial production. During the fifth year, a small increase of the shock effect on the SPREAD, the volatility and returns was observed. Moreover, a 1% increase of each shock on the CPI and EXP is associated with a shock decline on industrial production.

Table 6. Decomposition of the forecasting error of the IPI variance (in %)

Variance Decomposition of DLIPI:							
Period	S.E.	DLIPI	LIPC	DLEXPO	SPREAD	VOLAT	PERF
1	0.039376	100.0000	0.000000	0.000000	0.000000	0.000000	0.000000
2	0.049135	94.66098	0.003442	0.073882	0.196162	1.258882	3.806653
3	0.054112	87.25549	0.072065	0.262619	1.441580	7.589834	3.378417
4	0.055790	84.06236	0.430474	0.481510	2.551846	7.271988	5.201822
5	0.056626	81.93731	2.308048	0.469614	2.876963	7.356150	5.051917
6	0.057385	80.29233	3.141756	1.537738	2.801674	7.163268	5.063230
7	0.058039	78.55647	3.331448	2.528705	2.942598	7.248823	5.391957
8	0.058819	77.02603	3.760133	3.784985	2.884894	7.291665	5.252291
9	0.059235	76.43938	3.738082	4.459765	2.872279	7.195957	5.294533
10	0.060013	75.24647	3.852174	5.567948	2.836351	7.338591	5.158462

The results achieved after decomposing the variance of the industrial production index show the volatility quite important role compared to the other shocks. These results also indicate that the stock price volatility is an important determinant of the industrial production change in Turkey.

3.2. Interpretation of the Results

How important are financial shocks for the fluctuation of industrial sector in emerging economies during the Subprimes crisis? It can be expected that the impacts of crisis related shocks are time-variant and that they depend strongly on financial and economic conditions. The variation of industrial sector in emerging economies after the recent financial crisis is the target of interest here. Regarding financial and trade linkage with the US, our empirical result is consistent with those of preceding studies and reconfirms that the US financial shock has a marked impact on emerging economies.

But, despite extant research, it is still unclear whether countries are exposed to the financial shock through a single channel or through multiple channels. In this paper, we find that each country is affected by the transmission of the negative shocks to their industrial sector through a number of financials channels (financial and trade channel). In the recent literature, if we compare ours results with those that analyze the transmission of the shock in the Asian countries and according to Gimet [11], financial linkage with Asian countries declined and became less important for transmission of the recent US Financial Crisis. Given the predominant influence of the US financial shock in the Asian financial market, stock markets in Asian economies tend to track closely with changes in the US market. Therefore, for example, as reported by Chiang and al. [5], Yiu and al. [15], and Fujiwara and Takahashi [10], in the stock and bond markets, the US and Asia have been closely interconnected. Moreover, interdependence in financial markets is a strengthening trend.

According to our empirical results, we can interpret our results as follows. Although the financial channel is the more important channel for all the countries studied. In fact, Bui and al [4] argue that, in the context of the economic crisis that started in 2007, the financial markets related shocks have been important, particularly those from the US and the UK. These financial shocks help explain global movements in economic activity.

More recently, Berkman, Gelos, Rennhack and Walsh (2012) investigate the channels of shock transmission to emerging economies and report that though financial factors played a major role in transmitting the impact of the global financial crisis, trade linkages also seem to have played a key role in transmission of shocks particularly for non emerging market developing countries.

4. Conclusion

The obtained results through the SVAR model showed that for each studied country, there is a relevant channel in the transmission of the crisis to its industrial sector. An inflation shock has a recessive impact on industrial production for all the countries. A shock to exports causes a shrinking of industrial production for Brazil, Chile, Mexico and Turkey, which is not the case for China. A shock to the interbank market has a negative impact on industrial production in Brazil, China and Turkey.

However, in Chile and Mexico, no effect is found. Moreover, an increase the stock price volatility explains the degradation of industrial activity in Brazil, China, Mexico and Turkey, but no effect in Chile is observed. Finally, the industrial production reaction to a negative stock market shock causes deterioration for all the countries, with the exception of Mexico.

Actually, these countries, as an integrated group in the global economy, were affected by the disruptions caused by the subprime crisis. Although considering the financial variables helps a better understanding of the impact of the financial shocks on the emerging markets, the macroeconomic consequences of these shocks are not yet fully analyzed. Therefore, we find it necessary to deepen this study through the integration of new information variables or regional variables so as to take into account the regional relationships between the emerging countries.

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