Relative Importance of Monetary Transmission Channels: A Structural Investigation; Case of Brazil, Chile and Korea

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Abstract

In this paper we investigate empirically the relative importance of monetary transmission channels for Brazil, Chile and Korea. The study uses monthly data from the adoption of inflation targeting regime to 2009 M12. We use SVAR model, empirical results indicate that exchange rate channel and share price channels have higher relative importance than traditional interest rate and credit channel for industrial production, the results are not much different in case of inflation too, except for Korea. The high ranking of exchange rate and share price channel is in line with the results by Gudmundsson (2007) which finds that exchange rate channel might have overburdened in the wake of financial globalization.

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1. Introduction:

Monetary transmission mechanism was no less than a riddle even in closed economy but the openness of economies is making it more and more complex phenomenon. The reason is quite obvious, different channels of transmission working simultaneously and with varying lags. But on the other hand, the operating tool goes on changing more frequently, even it may adopt reverse direction before the full impact has been visualized by all the target variables. Despite all these problems there is consensus among the economist that monetary policy has at least short term effects on consumption and investment as documented by Taylor (1997). A thorough understanding of monetary transmission mechanism is necessary to implement and have desired results of monetary policy. Taylor (1995) defines monetary transmission mechanism as the processes by which changes in monetary policy decisions affect the rate economic activity – measured by output – and inflation. In the changing scenario of globalization it demands to have a look on the relative importance of transmission channels.

Furthermore, increasing number of countries have adopting inflation targeting regime; in the wake of increasing financial globalization, it has ignited a debate that how globalization is reshaping the transmission channels if it does so at all. Woodford (2007) considers three possible mechanisms that might lead to less control of monetary authority on inflation; (i) liquidity premia, a function of global liquidity, (ii) real interest rate dependence on global saving and investment rather than a balance in one country alone and (iii) making inflationary pressure a function of global slack rather than domestic output gap alone. However, the study concludes that there is little reason to expect that globalization should eliminate or even substantially weaken the influence of domestic monetary policy over domestic inflation. Felices et al. (2009) investigates the channels of transmission of financial crisis and concludes that EMEs bond markets and markets for risky debts in developed countries appear to be an important channel of transmission of financial crisis. But the focus of the study is not channels of monetary transmission mechanism within the economy. In another study Mamtaz and Surico (2007) conclude that expansionary policy in foreign block causes an appreciation in nominal exchange rate of UK. Expansionary demand shock in foreign block increase UK inflation and output growth. Boivin and Giannoni (2008) find no strong statistical evidence of significant change in the transmission of monetary policy of USA due to global forces. All these studies are about the co-movement of interest rates, or the transmission of financial shock form one country to the other. Secondly, these studies are about developed countries.

All the studies mentioned in the above paragraph are about developed economies and they do not talk about relative importance of the transmission channels. Against this backdrop the *objective of the study* is to investigate the relative importance of transmission channels from the commencement date of inflation targeting regime to the latest data available.

Another relevant question is that what, besides the papers mentioned in above material, motivates us to go for the investigation of the relative importance. Keeping aside the pressing need of thorough understanding of transmission channels to implement policy effectively, the following paragraphs reveal the *motivation of the study*.

As financial globalization increases, the currency value may become more responsive to interest rate differentials, thereby reinforcing the exchange rate channel of monetary transmission mechanism. Although there is a vast literature that exchange rate pass-through has decreased in many countries in recent decade yet the very existence of opposing forces in this regard cannot be ruled out. On the one hand, trade and financial globalization might have strengthened the exchange rate channel and on the other hand, reduction in pass-through due to competition might have weakened exchange rate channel. Gust et al. (2006) conclude in their theoretical model that simultaneous increase in trade openness and decline in pass-through is due to competition with the foreign firms. Besides this, there is now literature about the valuation channel that makes exchange rate important one, for instance, Lane and Milesi-Ferretti (2006). So it would be interesting to investigate that what happened to exchange rate channel in the recent years.

Similarly, financial globalization might be altering the evolution of liquidity and credit conditions. The lending activities of foreign banks might be less affected by the domestic conditions. They might be receiving from or sending funds to their parent banks offshore. This can lead to waning relationship between operating tool and the transmission variable (bank credit) and subsequently weakening of credit channel.

So for as interest rate channel is concerned, if the correlation between domestic saving and investment is weakening, there may be some signs of weakening interest rate channel.

Moreover, capital inflows can exert upward pressure on asset prices and thus can make the asset price channel stronger. If asset prices are claim, as is considered, on the future output then financial globalization may have strengthened asset price channel. Although a

qualification required, that there is a reasonable participation in the equity market. The increased price of shares can serve as collateral and thus can strengthen asset price channel.

The rest of the paper is as follows. In section 2, we summarize the theory of transmission channels; section 3 carries the literature review. The model and data issues are explained in section 4. Section 5 reports the effects the monetary policy shock. In section 6, we address the issue of robustness and final section concludes the results.

2. Theory of Transmission Channels:

In this section we provide theoretical underpinnings of monetary transmission mechanism. This section will rely heavily on Mishkin (1996). There are many channels of monetary transmission mechanism but we will explain here the four channels that this study is concerned about[1]. We believe that these four channels capture the essence of the transmission mechanism and provide a fair idea about the working of the economy.

2.1 Interest Rate Channel

According to the traditional interest rate channel an increase in the money supply lead to decrease in the real interest rate. The reduction in real interest rate is due to sticky prices, so this channel functions through the Keynesian argument of sticky prices. Although Keynes emphasize this channel operating through investment channel but later research recognized that consumers' decision about real-estate and durable expenditure are also investment decisions as emphasized by Mishkin (1996). The depressed level of real interest rate triggers investment (/consumption) and ultimately Gross Domestic Product (GDP). This channel implicitly assumes that central bank has the ability to influence long-term real interest rate through the manipulation of short-term real interest rate due to sticky prices. So this theory assumes that expectation hypothesis holds true. Theoretically this channel also circumvent the problem of lower zero bound. Expansion in money supply causes the expected price level to increase, despite the nominal interest rate at zero, hence increased expected inflation leads to lower real interest rate and stimulates spending. This channel is hallmark of *"money view"*.

[1] Mishkin in his book "The Economics of Money, Banking and Financial Markets" discusses the channels like traditional interest rate channel, exchange rate channel, Tobin's q theory, wealth effects, bank lending channel, balance sheet channel, cash flow channel, unanticipated price level channel, household liquidity effects channel. 7th edition, pp-619.

The interest rate channel works through the "IS" curve irrespective of the old Keynesian or new-Keynesian forward looking curve as Kuttner and Mosser (2002) write. In our study we capture this channel through bank lending rates. The *factors that strengthen the interest rate channel* are as follows: according to Bordon and Weber (2010) inflation targeting frame work can enhance the potency of interest rate channel. As the interest rate channel works through the bank-lending rate so competitive and strong banking sector also strengthens the interest rate channel. The speed with which policy rate is reflected in the retail rate, charged by commercial banks to its clients, also strengthens this channel. Coming to the financial globalization, it is conjecture that on one hand, it increases competition among the banks while on the other hand it may weaken the interest rate channel as banks operating in certain country can resort to its parent organization to generate funds or the firms can generate offshore funds. So it is an empirical question. Moreover, the size of the shadow banking is also, we think, crucial in this regard as they are not in the ambit of central bank so will not necessarily toe the line of the central bank. Another point worth mentioning here is the regime of our sample countries. Our sample includes inflation targeting countries, which respond to inflation deviation and output gap. This framework brings credibility and thus may strengthen interest rate channel.

2.2 Credit Channel

The broad credit channel comprises bank-lending channel and balance sheet channel. We explain each in turn. The bank lending channel operates through quantity of loans available to the economic agents (i.e. consumers and investors). Expansionary monetary policy increases supply of loans through the increase in reserves in private banks. This leads to an increase in borrowing, by the bank dependents, from the banks. This increased quantity of loans generates economic activity through enhanced consumption and investment and thus GDP. Due to imperfect financial markets – asymmetric information – the role of banks becomes more important and thus comes in the so-called balance sheet channel. The asymmetric information gives birth to moral hazard and adverse selection problem. As emphasized by Mishkin (1996) and Bernanke and Gertler (1995). Banks have comparative advantage in assessing the balance sheets of the borrowers and thus have the potential to mitigate adverse selection problem. As the expansionary monetary policy lowers nominal interest rate so it reduces the debt servicing burden of firms and households. This brings an improvement in the cash-flow of the borrowers and banks become willing to lend them. This leads to an increase

in quantity of borrowed loans by firms and households and subsequently in aggregate demand and output We emphasize that the earlier mentioned channel functions through bank lending rates while this one through quantity of loans. There are several *factors that determine the strength of this channel*. According to Putkuri (2003) larger size and lower degree of bank capitalization are strengthening factors in the bank lending channel. Development of securities market is another factor that determines the strength of the bank lending channel. As the well developed securities market reduces the dependence on bank financing of at least large firms. It is evident that size of firms in the economy also has a crucial role to play as small firms find it difficult to generate funds in the capital market; this point is well documented in the literature. The identification of loan supply effect and loan demand effect is very essential to gauge the impact of credit channel. Kashyap and Stein (1995), first highlighted this point.

2.3 Exchange Rate Channel

In an open economy and especially after the financial globalization exchange rate channel assumes more importance. In this channel, the monetary policy affects the economic activity (output) through net exports. This channel works through the uncovered interest rate parity condition. A negative interest rate differential (i.e. lower domestic interest rate) makes domestic currency deposits less attractive leading to a fall in the value of domestic currency. This, keeping the technicalities of Marshal-Lerner condition and elasticity of substitution between domestic and foreign goods aside, causes a rise in net exports. The *factors that determine the strength of this channel* as described by Boivin et al. (2010) are sensitivity of the exchange rate to the interest rate movements, and the size and the openness of the economy. The smaller and more open economy tend to see large impacts of this channel. Thought the story is not so simple, the debate of decreasing pass-through in recent years. The share of net exports in GDP also plays a vital role in determining the strength of ER channel. Moreover, a large body of literature documents that exchange rate pass-through has declined in recent years. This may lead to a decrease in relative importance of exchange rate channel. But contradictory views are also there, as Gudmudsson (2007) highlights.

2.4 Asset Price Channel

The asset price channel can be explained through Tobin's (1969) q-theory of investment. According to this theory q is defined as the stock market value of firm divided by replacement

cost of capital. A higher value of q means the market price of firm is high relative to the replacement cost of capital, so the acquisition of new plant and equipment capital, through issuing stock, is cheap relative to the market value of firm. That is to say, in case of expansionary monetary policy, interest rate falls and so is the required rate of return. The decrease in discount rate (i.e. required rate of return) increases the current valuation of share prices and consequently the value of Tobin's q. This leads to an increase in investment and hence in output. Besides firm's perspective, similar reasoning can be extended to household spending decisions. The expansionary monetary policy boosts the share prices and as a result, so does the household wealth. This increment in the household wealth stimulates aggregate demand and output. The following *factors determine the strength of the asset price channel:* The participation of households in the capital market. The generation of funds by firms through issuance of shares, and so the level of development of national stock market. We think, as the financial globalization can fetch funds from abroad, so the asset price channel may have become relatively more important in recent years, but, indeed, it is an empirical question.

3. Literature Review:

There exists a lot of literature about monetary transmission mechanism[2]. But the literature itself is very much diverse. Diverse in the sense that some papers talk at the macroeconomic level and try to gauge the transmission mechanism through the macro variables while the other dog further into the micro data and talk specifically about a channel but with the disaggregated data.

Cabrera and Lagos (2000) finds weak effects of interest rate on output and inflation. The study uses SVAR model and data spans from 1986 to 1997. The study comprises the period before inflation targeting and the inflation targeting regime. The study is silent that how the structural break (of regime change) is accounted for. Betancour et al. (2006) uses reduced from VAR model. The authors examine that how "great moderation", inflation targeting and target for the structural fiscal surplus have impacted the monetary transmission mechanism. Study focuses on interest rate channel keeping other channels outside from its purview.

[2] Christiano, Eichenbaum and Evans (2000), Kim and Roubini (2000), Gottchalk and Moore (2OO1), Angeloni, Kashyap and Mojon (2003), Poland, Arnostova and Hurnik (2005), Dabla-Norris and Floerkemeier (2006) among others.

Gudmudsson (2007) using vector error correction model concludes that some evidence of weakening of interest rate channel and overburdening of exchange rate channel exist. In another study by Catao and Pagan (2010) authors use expectation-augmented SVAR and conclude that bank credit channel plays an important role. Furthermore, the study also concludes that impact of monetary policy is quite similar to the advanced economies. The study is about Brazil and Chile. Mukherjee and Bhattachariya (2011) who conduct a study for 9 industrial and 17 emerging and developing countries conclude that adoption of IT did not significantly alter the traditional keynesian interest rate channel in IT EMEs.

Rigobon and Sac (2003) conclude that stock market movements have significant effects on short-term interest rates and there exists a positive co-movement about them. This highlights that how interest rate can lead to movements in share prices and subsequently to changes and investment. One point of caution is that study is about US economy that enjoys high level of market capitalization relative to emerging market economies like Chile. Nonetheless, the role of asset price channels might have increased due to increasing level of globalization. As theory predicts that capital should flow from capital rich countries to capital scarce countries.

Poddar et al. (2006) finds little evidence that operating target has an impact on output. The study is about Jordan. However, the scope of the study only covers the traditional interest rate channel and other transmission channels have not been touched upon. In case of Brazil, Minella et al. (2009) argues that interest rate channel plays most important role in explaining output dynamics. However, in case of inflation exchange rate channel along with household interest rate channel plays an important role. For Chile, Alfaro et al. (2003) conclude that bank lending channel has significant impact on aggregate output. Using data from 1990 to 2002, study first identifies the shifts in loan supply curve, and then estimates VAR to test the significance of bank lending channel.

Against this backdrop, it is relevant to empirically investigate the relative importance of transmission channels. The studies that are close to our studies are Tang (2006), Ludvigson et al. (2002) and Ramey (1993). But none of these studies is about inflation targeting economy. Secondly, these studies use impulse response functions whereas out study relies on variance decomposition for quantification and subsequently ranking of the channels. Furthermore, we reiterate our departure from monetary aggregates on theoretical grounds, unlike these studies. We would also like to mention that this study tries to make theoretical link with the changes

in relative importance that is missing in the closely related studies mentioned earlier. So the sample countries with inflation targeting regime, the theoretical link with (financial) globalization and departure from conventional incorporation of money supply in the model *makes this study different* from the existing literature on this topic. The significance of the study is that it provides insight about the relative importance of transmission channels. The more information central banks have about the working of these channels, the better position in they are to conduct monetary policy in better informed environment.

All the studies mentioned earlier in the text, either talk about one or two monetary transmission channels. To the best of our knowledge there is no study about Brazil, Chile and Korea that takes into account all the transmission channels simultaneously and then ranks the relative importance of these channels. So the *contribution of this study* is; *firstly*, it takes into account all the four channels simultaneously, uses Structural VAR and ranks monetary transmission channels according to their impact on variation in the GDP and inflation. *Secondly*, this study does not take into account money supply variable like, M1 or M2. We just take interest rate. The reason is theoretical in nature. As countries in our sample are under inflation targeting regime and the role of money demand in inflation targeting regime is minimal[3]. As the inflation targeting countries use interest rate as primary monetary policy instrument, the economy's money demand will change in response to the changes in interest rate. In this case money supply becomes endogenous to the economy. *Thirdly*, the study relies on real interest rate channel to explain movements in consumption and investment, thus follows the theoretical underpinnings of new Keynesian.

4. The Model and Data Issues:

4.1 The SVAR Model

The Vector Autoregression (VAR) model has been extensively used in literature to measure the response of output and Consumer Price Index (CPI) to the shock in monetary instrument. The pioneer study by Sims (1980), has opened a new era for research in monetary economics. The typical variables in the VAR are interest rate, output and CPI are almost surely endogenous. In VAR model all variables are endogenous.

[3] Though there is criticism that in NK model that money supply is not explicitly there. So there is strong potential for money market disequilibrium.(source: Book Monetary Economics 2nd Edition Author Jagdish Handa pp-544). However, the proponent of NK model are of the view that interest rate set by the central bank corresponds to the money supply required in the economy and money demand adjusts itself to clear the money market, see Woodford (1998) and Rudebusch et Svensson (1998).

A relevant issue here is to uncover the parameters in structural form equation from the reduced from. There are several methods to this end. One method imposes restrictions on contemporaneous structural parameters. This method orthogonalizes reduced form disturbances using Choleski decomposition as by Sims (1980). This method demands a recursive structure. Moreover, the identification problem calls for a certain number of restrictions.

To identify the required restrictions, many studies rely on *recursive scheme.* The recursive identification with choleski decomposition. This statistical decomposition separates the estimated residuals from the reduced from representation of the structural model into orthogonal (uncorrelated) by restrictions imposed on the basis of an arbitrary ordering of the variables. This point has been emphasized by McCoy and McMohan (2000) among others. This identification scheme gives birth to a structure that results in being lower triangular, that is, the elements above the principal diagonal are zero. This identification scheme required the numbers of restrictions to be exactly identified as equal to n(n-1)/2. However, a criticism on the recursive ordering is that the results from the VAR can be dependent on the ordering of the variables. As every ordering of the variables brings different factorization, so it will be almost impossible to examine all of them for system with more than three variables. To circumvent this problem we use Structural VAR.

4.2 Identification Scheme

We construct a structural form model to identify the effects of monetary policy on real output and inflation. Structural VAR is a multivariate, linear representation of a vector of observable variables on its own lag. These models are called structural because of their economic interpretation. In these models the identification restrictions are used according to some economic theory.

Following Kim and Roubini (2000) we assume that the following structural form equation describes the economy

$$A(L)y_t = e_t \qquad 1$$

where A(L) is a matrix polynomial in the lag operator L, y_t is an n x 1 data vaector, and e_t is an n x 1 structural disturbances vector. e_t is serially orthogonal (uncorrelated) and var(e_t) =Λ

and Λ is a diagonal matrix. Diagonal elements are the variances of structural disturbances; therefore, structurally disturbances are assumed to be mutually uncorrelated. Contains shocks to a particular variable that are orthogonal to other shocks in the economy. This property of structural VAR makes it different from reduced from VAR and gives economic interpretation as it becomes easy to disentangle shocks from each other.

We can estimate the reduced form equation as

$$y_t = B(L)y_t + u_t \qquad 2$$

where B(L) is a matrix polynomial (without constant) in lag operator L and var(u_t) =∑. u_t is statistical innovation and is a white noise. Thus u_t are shocks not orthogonal to each other. That is

$$E(u_t u_t^{'}) = \sum$$

$$E(u_t u_{t+s}) = 0$$

for any non-zero s. ∑ is a positive definite matrix and shocks are linearly independent.

A relevant question here is how to recover the parameters in the structural form equation from the estimated parameters in the reduced from equation. There are methods that impose restrictions on only contemporaneous structural parameters. Cholesky decomposition is a popular and convenient one as used by Sims (1980). However, this decomposition method assumes a strict recursive ordering, that is, a Wold-causal chain. This statistical decomposition separates the estimated residuals from the reduced form representation of the structural model into orthogonal (uncorrelated) by restrictions imposed on the basis of an arbitrary ordering f variables. But any ordering of variables is not beyond criticism. To avoid this criticism Blanchard and Watson (1986), Bernanke (1986), and Sims (1986) suggest a generalized method, Structural VAR, which used *non-recursive* structure while still imposing restrictions only on contemporaneous structural parameters.

Let A_0 be the coefficient matrix, non-singular, on L^0 in A(L), that is, the contemporaneous coefficient matrix in the structural form, and let A^0(L) be the coefficient matrix in A(L) without contemporaneous coefficient A_0. That is,

$$A(L) = A_0 + A^0(L) \qquad 3$$

Following the equation described so for, the parameters in the structural form equation and those in reduced form equation are related by

$$B(L) = -A_0^{-1}A_0(L) \qquad 4$$

Additionally, the structural disturbances and the reduced from (statistical) residuals are related by $e_t = A_0 u_t$, which means

$$\Sigma = A_0^{-1}\Lambda(A_0^{-1})' \qquad 5$$

We can estimate the reduced form by maximum likelihood estimates. We can get point estimates of parameters and of the variance-covariance matrix $\sum$, but we need to impose the identification restrictions. Since $\sum$ contains nx(n+1)/2 parameters, we need at least nx(n+1)/2 restrictions to recover the structural form parameters. By normalizing n diagonal elements of A_0 to 1's , we need at least nx(n -1)/2 restrictions on A_0 to achieve identification. In the *recursive* VAR modeling A0 is assumed to triangular. However, in non-recursive or SVAR approach A0 can be of any structure as long as it has enough restrictions. It is worth mentioning that there are several ways to impose restrictions[4].

We can now recover the structural innovations e_t from residuals u_t. The next step is to obtain impulse response functions to trace out the effect of structural innovations on observed variables.

$$y_t = C + \sum_{i=0}^{\infty} \Phi i.\, e_{t-1} \qquad 6$$

The equation (6) is a moving average representation, where Φ_i are used to generate the effects of structural innovations on time path of data sequences. The set of these coefficients are called an impulse response functions Φ_{jk} (i) against i. Impulse Response function (IRF) gives visual representation of the behaviour of observed series in response to structural shock. More specifically, Φ_{jk} (i) represent the response of variable j to one unit impulse in variable k occurring i-th period ago. IRF are used to measure the effectiveness of a policy change. Besides, IRF we will also compute *forecast error variance decomposition.* As the objective of

[4] The four types of restrictions are short-run restrictions including Recursive-zero restriction and Non-recursive zero restrictions, then there is long-run restrictions and fourth type includes sign and shape restrictions.

the study is to rank the monetary transmission channels according to their relative importance, so the study will rank these channels on the basis of structural variance decomposition. The channel that will explain larger variation in the target variables like GDP and CPI will be ranked higher. According to Watson and Teelucksing (2002), the variance decomposition gives information about relative importance of each of the random innovations in the explanation of each variable in the system.

4.3 Data Description

We use monthly data from starting point of inflation targeting regime to the last month 2009. The data source is International Financial Statistics, (IFS), Bank for International settlements (BIS) and FRED data base. Our sample includes Brazil, Chile and Korea.

As monthly GDP is not available so we use Industrial Production Index (IPI) as a proxy to economic activity, Consumer Price Index (CPI) for prices; both of these series have 2005 as base year. For loans we use credit to private sector from the banking system. As our sample countries, presumably, have less shadow banking system so we think that credit to private sector advanced by banking system is a representative variable to gauge the conditions of credit situation in the economy. This study does not use nominal value of loans as some studies do, rather it uses real loans. We believe that amount of real loans better explains variation in GDP and CPI. To make it real we deflate the nominal loans by CPI. Likewise, for the bank lending rate we use real bank lending rate. The data of real exchange rate has been taken from the BIS. It is real effective exchange rate and increase in the index means depreciation in the domestic exchange rate. The other variable in our model is share price. We use the share price in Index to capture the developments in the capital market. We use short-term nominal interest rate to capture the monetary policy stance. As we have already mentioned in the text that our choice of short term interest rate instead of monetary aggregate is because of (i) it is evident from the monetary policy reports that inflation targeters use short term interest rate as monetary policy tool. (ii) in the new Keynesian model the traditional money market equilibrium assumes less role and it is considered that each level of interest rate has a corresponding money supply and money demand equates to money supply to clear the money market. We would like to emphasize that sample period is characterized by single monetary policy regime – inflation targeting regime. Thus our results are not contaminated by the regime shift. Besides the variables described above to check the robustness we add world

oil price in term of US dollar in the model. All the variables, except policy rate and real bank lending rate, are seasonally adjusted and in (natural) logarithm from. The IPI for Brazil and Korea are seasonally adjusted at source.

Another issue is that vector autoregressive (VAR) should be used in level or difference. The literature is divided. There are three options; (i) make the variable stationary by taking the difference, (ii) follow the Sims et al. (1990) "The common practice of attempting to transform models to stationary form by difference or cointegration operators whenever it appear likely that data are integrated in many cases in unnecessary" (pp-136), (iii) use Vector Error Correction Model (VECM) applying cointegration technique. However, according to Ramaswamy and Sloek (1997), in the absence of a priori economic theory to guide for the number of long-run relationships and how to interpret them, it is realistic not to impose the restriction of cointegration on the VAR model. So there is no clear-cut guideline whether stationarity should be forced on the data or VAR in level should be preferred. All three options mentioned earlier in the text have their own pros and cons. Sims, Stock and Watson (1990), Bernanke and Blinder (1992), Sims (1992), Levy and Kalikias (1997) estimate VAR in level. Whereas Monticelli and Tristani (1999), use stationary variables in the VAR model. Peersman and Smet (2001) estimate the model in level. VAR should be estimated in level or first difference is a debatable point. This study will estimate SVAR in level. Needless to say that differencing brings the loss in information; secondly, by estimating VAR model in level we allow for implicit cointegration in the data as explained by Peersman and smet (2001).

Another issue that demands due attention is lag selection. Different lag selection criteria provides different lag order. For example, in case of Chile, likelihood ration test recommends 6 lags, whereas Final Predictor Errors test (FPE) and Akaike Information Criterion (AIC) suggest 3 lags, on the other hand, Schwartz Information Criterion (SIC) and Hannan-Quinn Information Cretion (HQ) propose 2 lags. To be sure about the robust health of our results we check the structural residuals. Though we have monthly data, yet because of relatively small sample size, we use 4 lags. The motivation for using 4 lags instead of 6 recommended by the likelihood comes from the fact that large number of parameters work as a penalty, and in our case we have 7x7 matrix, that is large enough for such a sample size as we are using.

4.4 Identification

As the objective of the study is to investigate the relative importance of transmission channels. So in our model, the data vector is {IPI, CPI, RL, RBLR, REER, SP, Discrate}, where IPI is industrial production index, CPI is consumer price index, RL is credit to private sector advanced by banking system, deflated by CPI to make it real so it is the real loans, RBLR is real bank lending rate, REER is real effective exchange rate – an increase in index is real depreciation of domestic currency, SP is the share price index and discount rate stand for the policy rate. Of course, for Chile it is discount rate, but for Brazil and Korea it is money market rate.

$$\begin{bmatrix} 1 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & A_{25} & 0 & 0 \\ 0 & 0 & 1 & A_{34} & 0 & 0 & 0 \\ 0 & A_{42} & 0 & 1 & 0 & 0 & A_{47} \\ A_{51} & A_{52} & 0 & 0 & 1 & A_{56} & A_{57} \\ 0 & A_{62} & A_{63} & A_{64} & A_{65} & 1 & A_{67} \\ A_{71} & A_{72} & 0 & 0 & 0 & 0 & 0 \end{bmatrix} \begin{bmatrix} u\ IPI \\ u\ CPI \\ u\ RL \\ u\ RBLR \\ u\ REER \\ u\ SP \\ u\ Discrate \end{bmatrix} = \begin{bmatrix} e\ IPI \\ e\ CPI \\ e\ RL \\ e\ RBLR \\ e\ REER \\ e\ SP \\ e\ Discrate \end{bmatrix}$$

First, we describe the reason of choice of these variables in the model, and then we will explain the restrictions imposed. The first two variables – industrial production index and consumer price index are target variables. Indeed, to check the relative strength of transmission channels we need intermediate variables. Each intermediate variable represents a certain transmission channel. Our intermediate variables are real bank lending rate, real bank loans, real exchange rate and share prices. These variables represent traditional interest rate channel, credit channel, exchange rate channel and share price channel respectively. Last but not least, we include the short term interest rate to measure the monetary policy stance. We reiterate, we do not include typical monetary aggregate variables like M1 or M2 as usually done in literature, for example, Kim and Roubini (2000), thus this study departs from the existing literature to the best of our knowledge. The reason of this departure has been explained earlier in the text.

Before coming to the explanation of identifying restrictions, we would like to mention that our restrictions are short term and contemporaneous, like Kim and Roubini (2000), restrictions are on the structural parameters of A_0 and no restrictions on lagged parameters. These contemporaneous restrictions enable us to derive reasonable economic structure. Furthermore, as lagged values enter each equation, thus all variables are linked together.

The first equation deals with the IPI, it responds to all the domestic variables only with a lag. This is in line with the Kim and Roubini (2000), as our study uses monthly data so the restriction is quite intuitive. Take the components of GDP, either it may be consumption or investment both are not instantaneous. Either the firm is increase the capacity or decide to utilize the existing capacity it takes time in decision making and keeping the monthly frequency in mind it is reasonable to restrict the first equation the way this study does. Similarly, the other target variable, CPI does not respond to domestic variables, except real exchange rate. Even the policy variable does not have any contemporaneous effect on target variables; this point has been emphasized by McCoy and McMohan (2000). Furthermore, it is not against the existing norms of modeling, in the sense that rigidity in output and consumer prices is well established because of existing of time dependent rules, like building and delivery lags, menu cost and price contract etc.

After these two target variable, we have four intermediate variables, the third equation describes the function of real loans. Real loans respond to real bank lending rate. There is time lag in signing a contract so loans are also quasi-rigid. We let the loans to response real bank lending rate on the assumption that there is a certain percentage of loans on flexible interest rate. In the fourth equation, we contend that real bank lending rate responds to CPI and policy rate. We think that in inflation targeting countries, in the presence of monthly inflation report and a projected inflation path in published form banks are in position to change their interest rate in response to CPI shock. Study also believes that banks are quick in translating policy rate into their lending rate. Here one thing is worth exploring; banks may be quick in translating policy rate in lending rate but slow in case of deposit rate. It depends upon the structure of the market and market competition etc.

According to our 5^{th} equation in the model, real exchange rate responds to output, CPI, share price and policy rate. By construction, the change in CPI brings change in real effective exchange rate. We think that in the era of financial globalization when stock exchanges are

well connected, foreign inflow in the domestic capital market appreciates the domestic currency. Keeping the discussion of central bank intervention aside. The changes in portfolio investment translate into nominal exchange rate and subsequently in real exchange rate, although one may contend that real exchange is determined by the real side of the economy. But we are not discussing about the equilibrium value of real exchange rate. Our underlying assumption here is that share price shock is due to capital inflows. A relevant question, what if share price changes due to domestic factors. We think it is worth exploring question.

In our 6^{th} equation share price is assumed to react in the same month to shock on CPI, RL, RBLR, REER and policy rate. It is a realistic assumption as share price is a financial variable and quick to react. One question may arise in mind that why we exclude output in this equation. For the two reasons, first generally when data is released, the data of industrial production index, unemployment and inflation is released simultaneously, and we think that investors use the information in the CPI, that has less chance to revise relative to IPI. We assume that central bank has more information relative to the market and in our model central bank react to the IPI in the same month, and SP react to the policy rate in the same month. So it is our contention that agents take the clue of IPI from the reaction of the central bank so they respond to policy rate and thus indirectly takes into account the IPI. In our opinion, in this way agents avoid the risk of overreaction to release of data of IPI that is prone to revision.

The last equation describes the reaction function of the central bank. Unlike Kim and Roubini (2000) in our model central bank responds to industrial production index and CPI. Our assumption is that as our sample consists of inflation targeting countries so the central bank is forward looking. In the inflation targeting countries, where the central banks have strong forecasting division, and fan charts about inflation path, it seems a reasonable assumption. Being a forward-looking, central bank responds to industrial production index and CPI contemporaneously. One idea was to peg the coefficient in the last equation according to the values well known in Taylor rule, but we preferred “let the data speak”.

In sum, we have two target variables, as it is common in the flexible inflation targeting regime, then we have four intermediate variables and each represents a monetary transmission channel and lastly we have policy variable. Real and nominal rigidities, informational advantage of central bank over private agents and inflation forecast targeting because of inflation targeting regime are our main assumption to impose restrictions for identification.

In table 1, we report the estimated contemporaneous coefficients in the structural model. Data are monthly and estimated period is 1999:1–2001:12 for Brazil, 1991:1–2009:12 for Chile and 1998:1–2009:12 for Korea. At the bottom of the table we report likelihood test of over-identifying restrictions. For Chile and Korea our identifying restrictions are not rejected at conventional 5 percent significance level, however, for Brazil it is almost valid at this conventional level.

Table 1: Contemporaneous coefficients in the structural model

	Brazil	Chile	Korea
A_{25}	.003(.029)	.26(.12)	.027(.017)
A_{34}	-.0005(.001)	-.0003(.0003)	-.007(.001)
A_{42}	47.27(66.31)	-118.18(2.66)	111.23(9.69)
A_{47}	-.63(.32)	-.69(.039)	-.058(.16)
A_{51}	.008(.15)	.11(.12)	-1.05(.47)
A_{52}	-.28(1.93)	-4.61(2.02)	1.33(2.36)
A_{56}	.63(.17)	.83(.19)	1.70(.63)
A_{57}	-.009(.008)	.0009(.001)	.001(.038)
A_{62}	-2.26(24.86)	16.71(2.51)	1169.85(21.10)
A_{63}	1.88(1.79)	2.13(.53)	573.78(71.05)
A_{64}	.030(.027)	.01(.003)	-1.43(2.56)
A_{65}	-4.26(5.08)	-1.99(.81)	-621.45(46.86)
A_{67}	-.015(.041)	-.007(.002)	11.26(5.40)
A_{71}	.31(1.58)	3.84(7.92)	-.91(.75)
A_{72}	.85(13.38)	43.68(2.47)	.64(5.29)
Likelihood test	$\chi^2(6) = 12.68$	$\chi^2(6) = 8.65$	$\chi^2(6) = 11.80$
Significance Level	0.0483	0.1941	0.0665

Standard Errors in Parenthesis

A_{71} (response of short term interest rate to output shock) and A_{72} (response of short term interest rate to inflation shock) are positive which means when there is an increase in output or CPI central bank increase the interest rate. However, in case of Korea there is negative sign with output.

5. The Effects of Monetary Policy Shocks

5.1 Expected dynamic responses after monetary policy shock

In this section, we discuss the expected movements of macro variables included in the model after different shocks. First we discuss the monetary shock, as we measure the monetary shock with innovation in interest rate, so an increase in the policy rate indicates tighter monetary policy stance. Theories are clear about the inflation; that after an increase in the interest rate inflation will decline. However, this clear-cut stance is absent in case of GDP. The behaviour of GDP depends upon the money neutrality, furthermore, there is almost consensus that money is neutral in the long run but empirical evidence required to prove that money is non-neutral in the short-run.

Then we come to the loans and bank lending rate. We expect that after tightening the monetary policy the quantity of loans go down as the credit view says, this has been documented by Bernanke and Blinder (1988). About the bank lending rate we think that it also toe the line of policy rate.

The case of exchange rate is complex one after the shock of policy rate. If the real rate increases after the increase in nominal interest rate, domestic currency will appreciate. So it depends upon Fisherian effect. If the expected inflation increases more than nominal interest rate leading to decrease in real interest rate then domestic currency will depreciate. In case of share price it is expected that an increase in the policy rate will decrease the share price, although it is a hot debate that to what extent interest rate can have impact on stock prices. According to Bernanke and Kuttner (2004) an unanticipated 25 basis-point cut in the federal funds rate is associated with about one percentage increase in the broad stock index. But question here is, is this effect symmetric for both type of shock? Can we equally assume that an increase in the interest rate brings down the stock index? We will rely on our empirical evidence, if it is strongly believed that an increase in the interest rate reduces the broad stock index then where do we fit the debate of should central bank target the share prices or not? Secondly, is this line of argument valid for every stage of business cycle, for example, when the mood of economic agent is vibrant and irrational exuberance prevails, will increase in interest rate reduce the share price index? But these questions are beyond the scope of this study and not directly relevant to our research question so we assume that an increase in interest rate will have some effect on the share price.

Now we move to the shock to the intermediate variables. As we have earlier in the text that each variable represent a transmission channel. There is almost no controversy that an increase in the loans will increase the economic activity and so does the inflation; similarly when the bank lending rate increases it depresses the economic activity and inflation. But this is not the case with exchange rate shock, so we explain the response of GDP and inflation in detail in case of a shock to exchange rate. The simple text book argument is that real deprecation brings competitive gains and improves foreign sector of the economy, but there also exist theoretical reasons that why depreciation can have contractionary impacts on the economy. First is the redistribution argument documented by Krugman and Taylor (1978). Second is the negative real balance effect due to higher price level and the third one is Marshal-Lerner condition. In case of inflation, real depreciation can lead to increase or decrease in inflation; it depends upon the composition of the CPI basket, the behaviour of tradables and non-tradables, as the prices for tradable goods and services are affected by changes in international price and exchange rates, whereas non-tradable goods and services are affected by domestic supply and demand condition. If the share of the tradable goods is higher in the basket real exchange rate depreciation will increase inflation. One can also explain this link through the trade balance dynamics, if real depreciation improves trade balance it will strengthen the domestic currency down the road and thus will reduce imported inflation and if it causes deterioration in the trade balance, and subsequently depreciation spiral it will increase the imported inflation. In this whole explanation we did not talk about the fiscal health of the economy that too has implications for the inflation.

What about the effects of increase in share prices on the macro variables? As it is generally said, stock exchange is a barometer of economic activity. The price of a stock is a claim on the future output, so it can be safely assumed that positive share price shock will lead to an increase in the future output, and so does the inflation. But in case of inflation we would like to mention a points highlighted by Palley (2006), according to which, there may be weak relationship in asset prices and inflation.

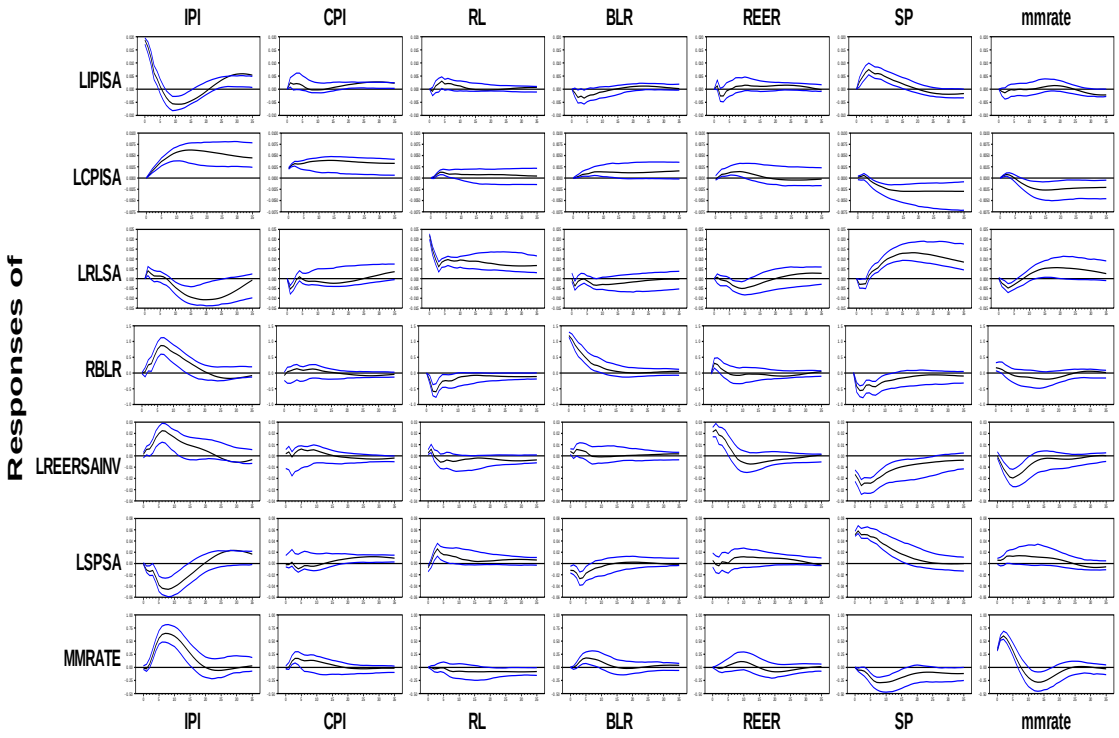
In sum, we expect that increase in policy rate depresses the inflation as well as output but the effect may be less pronounced in case of latter. Especially, as we have inflation targeting countries we expect a reasonably strong effect on inflation as even in flexible inflation targeting much weight is assigned to inflation so the guidepost for MP is inflation and so the

shock in policy rate should be effective enough to control inflation, which of these channels is most effective we will discuss this in the section where we rank the channels.

5.2 Empirical Results

Now we display the estimated impulse responses of Brazil, Chile and Korea in figure 1, figure 2 and figure 3 respectively.

Fig. 1. One S.D . shock with one-standard-error bands, country Brazil



In figure 1 we display the response of variables to one standard deviation impulse. Each column of the figure gives the impulse responses (over 36 months) to a one-standard-deviation positive shock to the variable labeled at the head of the column. The responding variables are named at the far left of each row. The confidence interval band in each graph is one-standard-error bands. We start explanation with the positive shock in the money market rate, as we have discussed earlier in the text that theory is skeptic about the response of output to interest rate shock. So is here, industrial production is almost flat and statistically insignificant, it seems that money is neutral even in the short run, however, in case of inflation

the effect is pronounced. The inflation declines after positive interest rate shock and statistically significant. The inflation registers declining trend almost for one year and then it becomes flat. Similarly, after the positive shock in interest rate real effective exchange rate observes appreciation. The effect is statistically significant for around 10 months, though after 5 months it starts shedding the gained appreciation and reverts back to the initial value around 30 months. The quantity of loans declined for 5 months, which is statistically significant and then it starts increasing but does not become significant statistically. Real bank lending rate increased initially for a short time, then it observed decline though it remained statistically insignificant. The response of share prices shows oddity, it observed an increase though insignificant statistically. Overall, the response to tight monetary policy is in line with the theory. It gives us confidence about the restrictions imposed.

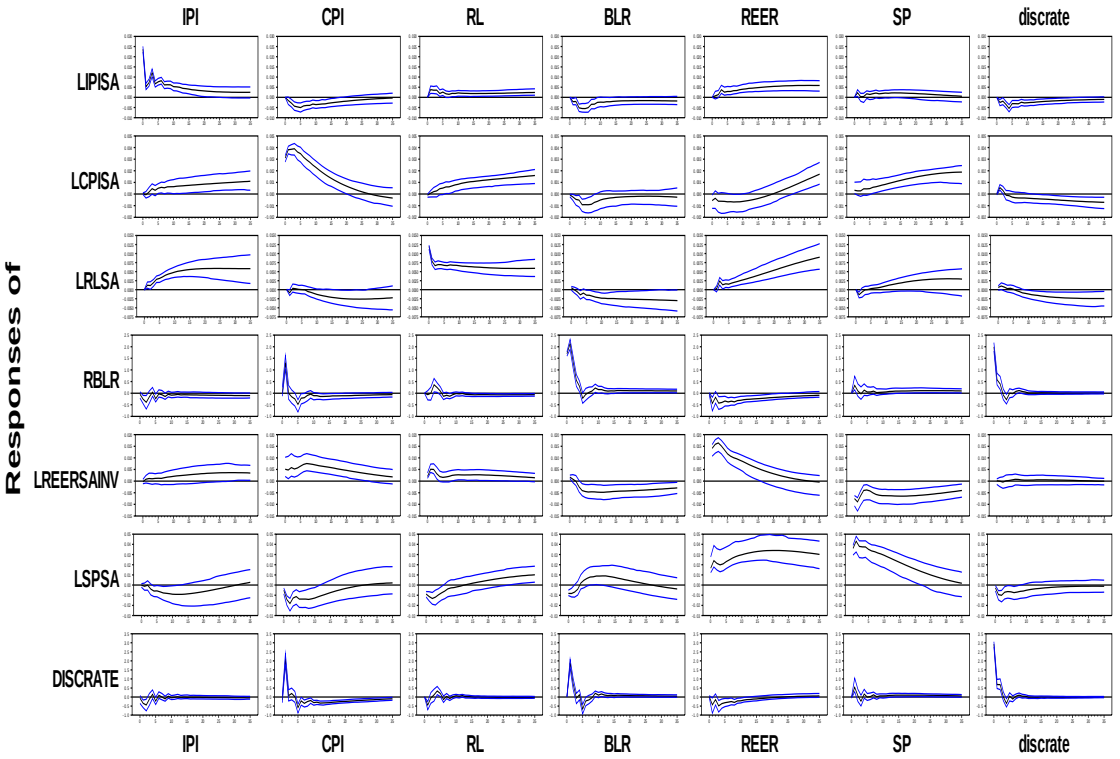
Positive shock in share price leads to an increase in industrial production index as well as the quantity of loans, quite intuitive. After the positive shock to share price, domestic currency appreciate in real terms, this can be explained as following, the increase in inflow beings port folio investment in domestic stock exchange, it leads to nominal appreciation of the currency, at the same time positive response of industrial production and depressed inflation improves the trade balance, these developments all together appreciate the domestic currency in real terms.

The impact of positive shock in real bank lending rate and real loans are economically significant for industrial production. However, in both cases, inflation is almost statistically insignificant for most of the time. It can be gleaned from here that share price channel and exchange rate channel seems strong relative to interest rate and credit channel, but we will see later when we talk about variance decomposition to rank these channels.

In figure 2 we display the results of Chile. After positive shock in discount rate, the level of industrial production decreased. The decline is statistically significant for about 20 months. The level of CPI showed an increase for a very short time, and then it observed a decline. The fall is economically significant since the beginning, however, it also becomes statistically significant around one year. The persistence decrease in the level of CPI after tight monetary policy reveals that central bank of Chile enjoys a strong negative relationship between inflation and interest rate. This makes Chile a successful inflation targeter.

Consider the next effect on the level of real bank lending rate and level of real loans. Tight monetary policy translates into an increase in real bank lending rate and a decline in real loans. A small increase in the initial period reminds us that it takes time to negotiate contracts.

Fig. 2. One S.D . shock with one-standard-error bands, country Chile



This is in line with our identifying restriction as real loans do not respond to policy rate simultaneously (means in the same month).

Now we explain the responses of target variables to the shocks in intermediate variables. A positive shock in price increases the level of industrial production as well as CPI. In case of IPI the response is statistically insignificant but quite significant statistically for CPI. It appears that share price channels assumes high ranking in case of CPI, we will come to this point in the relevant section. Moreover, the appreciation of domestic currency and increased level of loans are in line with economic intuition, that is, when an economy receives inflow that is very much possible in financial globalization, economy becomes overheated.

So for as positive shock in exchange rate is concerned, depreciation of real exchange rate has expansionary effect on the industrial production, the initial decrease in the inflation can be interpreted because of nominal rigidity, secondly, competition among firms due to real globalization might have made the firms more cautious regarding increasing prices. Thirdly, the credibility of the central bank due to successful inflation targeting might also have contributed to some extent. It is our conjecture, observing the significant and persistent response of industrial production, that ER channel will assume high ranking.

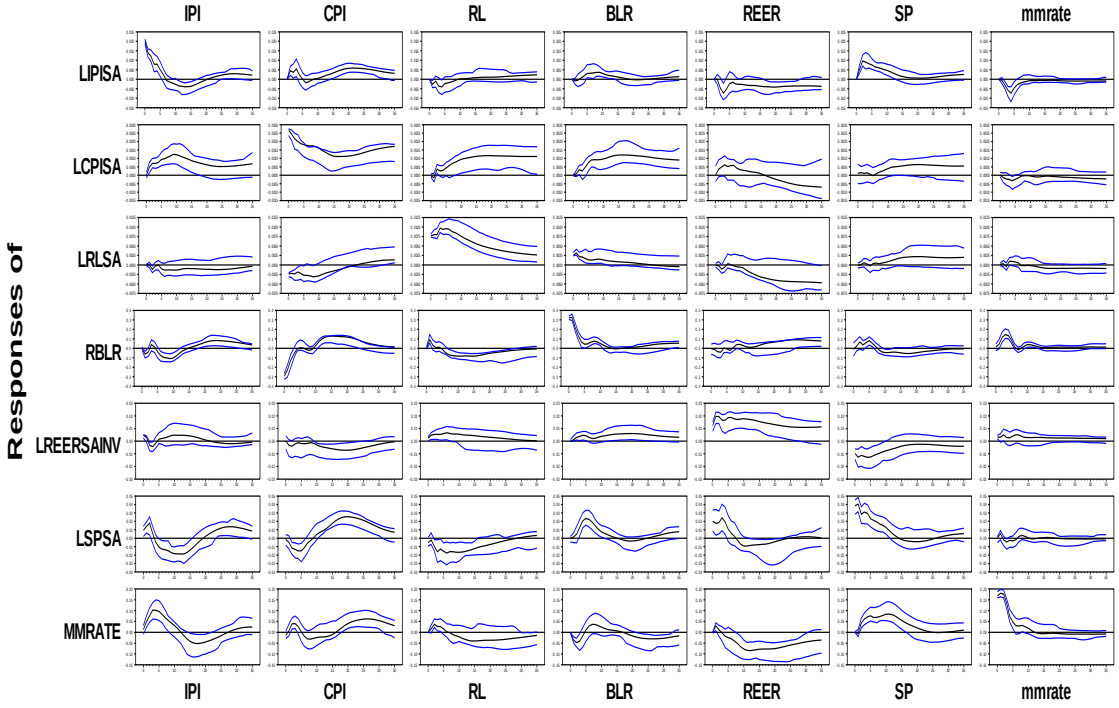
The response of IPI and CPI to the shock in RL and RBLR is also as the text book economics perceives. In case of a positive shock in real bank lending rate economic activity decreases and so is the case with CPI. Both are statistically significant for the first few months, though they remain economically significant for the longer horizon. The decline in level of real loans and appreciation in domestic currency is very intuitive; the one oddity is increase in share prices following the positive bank lending rate shock. The increase is CPI and IPI is also quite visible following the positive shock in real loans.

In figure 3 we show the results for Korea. Following a positive interest rate shock, level of industrial production declines, this decline is statistically significant for 5 months and IPI reverts back to the initial level after 10 months. Interestingly, CPI also registers a decline but it remains statically insignificant. Nevertheless, CPI shoed decline after interest rate shock. Real bank lending rate increase, real loans decrease, whereas, share prices and exchange rate experience little movement and remain statistically insignificant.

Among the intermediate variables, the response of IPI to share price shock is more pronounced and statistically significant also. After a positive shock in share prices IPI increase and reverts back to the initial level after one year. Depreciation is contractionary in Korea, though statistically insignificant, but it is more pronounced than response to real loans and real bank lending rate. We expect from the impulse response that ER channel assumes higher ranking than Interest rate channel and bank lending channel in case of industrial production. I case of CPI, the response is a little odd, but it is insignificant. Korea being a developed economy, it is not unusual that inflation is influenced by exchange rate.

The response of CPI to shocks in real loans is significant. Following a rise in loans CPI increases, so the credit channel should assume a high ranking in CPI. However, the response of CPI is strange after positive shock in real bank lending rate.

Fig. 3. One S.D . shock with one-standard-error bands, country Korea



In general, we have impulse responses in line with the theory, though some odd results do emerge in some cases. The overall behaviour of the variables confirms that our identification restrictions are very reasonable. In the next section we discuss the ranking of monetary transmission channels.

5.3 Ranking of Monetary Transmission Channels

Sims (1980) introduced Forecast Error Variance Decomposition (FEVD) technique. Amisano and Giannini (1997) describe it as a basic tool to provide complementary information for the better understanding of the dynamic relationship among the variables jointly analyzed in a VAR model. It determines the extent of the behaviour of each variable in the system affected by different structural innovations at certain horizons. Thus it allows us to compare the role of different variables in explaining the variation in a certain variable; we call this role a relative importance. Thus we rank the transmission channels according to this role. As our target variables are IPI and CPI so we assign relative importance to monetary transmission channels on the basis of their share in the variation in these target variables.

Table 1: Ranking of Transmission Channels on the basis of Variance Decomposition

Brazil						Chile						Korea					
	Channel		% Contribution at 36th-month				Channel		% Contribution at 36th-month				Channel		% Contribution at 36th-month		
Ranking	**IPI**	**CPI**		**IPI**	**CPI**	**Ranking**	**IPI**	**CPI**		**IPI**	**CPI**	**Ranking**	**IPI**	**CPI**		**IPI**	**CPI**
1	SP	IR	credit	3.74	5.50	1	ER	IR	credit	13.25	6.72	1	SP	ER	credit	6.67	2.70
2	ER	SP	IR chann	8.28	11.31	2	Credit	SP	IR chann	5.23	57.93	2	ER	SP	IR chann	7.38	3.28
3	IR	ER	ER chann	15.47	9.77	3	SP	ER	ER chann	27.22	12.05	3	IR	IR	ER chann	12.05	20.54
4	Credit	Credit	SP chann	17.64	11.10	4	IR	Credit	SP chann	6.50	13.69	4	Credit	Credit	SP chann	30.50	20.46

In table 1, we report the forecast error variance decomposition of industrial production and the forecast error variance decomposition of consumer price index due to four shocks; each of the shock represents a transmission channel. The numerical figure before the channel indicates the percentage fluctuation in the IPI and CPI respectively. The higher the fluctuation, the higher the relative importance of that channel for that variable. For example, in case of Brazil share price channel explains the 17.64% of industrial production fluctuation, at the horizon of 36-month. One question comes to mind that why 36-month horizon has been selected. There is no hard and fast rule, but we think that for inflation targeting countries even if we assume that central bank target the two-year ahead inflation, still we have one more year to translate the full impact of a shock. So we think that 36-month is a reasonable horizon to judge the efficiency of a channel. Kim and Roubini (2000) report the result for 48 months whereas Christiano and Eichenbaum (1992) for 10 quarters. There is no hard and fast rule but it is our conjecture that 3-year is a long enough horizon to take the peak effect of a shock. Similarly, ER shock explains 15.47% fluctuation in the industrial production, thus it claims the second place in ranking. The first ranking of share price channel may be due to some big firms raising funds from the stock market as it is generally assumed that small firms rely heavily on bank based system whereas large firm can generate funds from capital market. But this needs further investigation to substantiate the results with firm level data that what is the portion of equity finance and debt finance firm and what their share in total production. This question is beyond the scope of the study. However, it can be assumed safely that against the backdrop of financial globalization, share price channel might have assumed more importance. The second position of Exchange rate channel is understandable keeping in mind the long association of Brazil with the fixed exchange rate regime.

In case of CPI too, share price channel assumes the first ranking. It is also evident from the impulse response. Assuming that high inflows lead to increase in money supply, despite sterilization, interest rate goes down and inflationary pressure starts to build up. This line of argument is very much clear in impulse response. The interest rate channel is second in the ranking. We were expecting the exchange rate channel to be higher in ranking because of

peculiar characteristics of Brazil. However, the quantitative difference between the interest rate channel, which is second in ranking, is not much different from ER channel. Interest rate channel explains 4.73% variation in the consumer prices whereas the exchange rate channel explains 3.16% at the horizon of 36 month. Credit channel is the least important in Brazil.

In case of Chile, exchange rate channel explains 33.46% fluctuation in industrial production, whereas the credit channel explains 9.75%. The higher real openness (export + import/GDP) can explain the high importance of exchange rate channel in Chile. See table in Appendix for these ratio. Coming to the fluctuations in the CPI, share price channel explains 33.38% and ER channel explains 20.67%. When the economy is more open, the rest of the world inflation has sound impact on the domestic inflation. This translates through the channels that are attributed to open economy and those are share price and exchange rate channel. So the high ranking of share price and exchange rate channel is not odd in case of Chile. However, one might argue that Chile is among the pioneers who adopted inflation targeting regime and effective interest rate channel is key to successful inflation targeting. But against the backdrop of financial globalization it is also convincing that open economy channels – Share price channel and exchange rate channel – can assume relatively high importance. Though literature has been more focused towards tradition interest rate and credit channel, we think against the backdrop of financial globalization, now is high time to shift the focus towards share price and exchange rate channel also.

In case of Korea, share price channel explains the 33.19% fluctuations in the industrial production. The exchange rate channel assumes second place by explaining 6.24% fluctuations in industrial production, it is worth mentioning that quantitatively the difference between exchange rate channel and credit channel is not much. Credit channel explains 5.67% of the industrial production. A notable point is in the case of inflation, where the ranking is totally reverse, here the interest rate channel and credit channel assume the first and the second position respectively. Korea is an inflation targeter, developed economy so it can be assumed that very sophisticated banking sector translate the policy interest rate into bank lending rate efficiently and thus making the interest rate the most important in case of inflation, but the question is why this argument is not valid in case of industrial production. It is a riddle and demands further research.

In sum, this study finds share price and exchange rate channel more important. Here we would like to mention the results of Gudmundsson (2007) which finds that exchange rate channel might have overburdened in the wake of financial globalization. To be more confident about our results we check the robustness in the next section.

6. Robustness Check:

Table 2: Ranking of Transmission Channels on the basis of Variance Decomposition

Brazil						Chile						Korea					
	Channel		% Contribution at 36th-month				Channel		% Contribution at 36th-month				Channel		% Contribution at 36th-month		
Ranking	**IPI**	**CPI**		**IPI**	**CPI**	**Ranking**	**IPI**	**CPI**		**IPI**	**CPI**	**Ranking**	**IPI**	**CPI**		**IPI**	**CPI**
1	ER	SP	credit	3.49	4.57	1	ER	IR	credit	14.64	9.84	1	SP	ER	credit	6.43	4.53
2	SP	ER	IR chann	8.75	13.43	2	Credit	SP	IR chann	2.63	46.22	2	ER	SP	IR chann	6.83	5.96
3	IR	IR	ER chann	16.75	15.46	3	SP	ER	ER chann	22.59	11.85	3	IR	IR	ER chann	11.00	12.05
4	Credit	Credit	SP chann	13.63	25.42	4	IR	Credit	SP chann	8.20	13.43	4	Credit	Credit	SP chann	22.13	10.23

We add the world price of oil to check the robustness of our model. There is a criticism that monetary authority follows feedback rule by reacting to the news in the economy in setting the monetary policy as mentioned by Kim and Roubini (2000). So it becomes important to control for the systematic component of the policy rule to identify "exogenous" monetary policy changes. The inclusion of world oil price will serve as a proxy for negative and inflationary supply shock. The identification scheme is same except the addition of world oil price. As economies in our sample are small so it is safe to assume that they have no impact on world oil price. We put the world oil price equation in the beginning of our identification scheme and rest of the restrictions remains the same. Following Kim and Roubini (2000) industrial production, inflation, exchange rate and short term interest rate respond to shock in world oil price contemporaneously (in the same month). In addition, as we also have share price in our model so share price also respond to world oil price shock simultaneously. We believe that it is quite sensible to assume this. We report identification scheme and estimated structural coefficients in appendix; however, we explain the ranking of channels below in table 2.

As we have concluded earlier that open economy channels are gaining more relative importance, this conclusion in further strengthened by our robustness check. Although, there are some shuffles among the channels in ranking but general result of high importance of share price and exchange rate channel is intact. In case of Brazil, during the robustness check, exchange rate becomes second in ranking for the fluctuation in CPI; this makes sense that in

the presence of oil price shock exchange rate depreciation can put pressure on inflation and consequently making ER channel more important. Interestingly, in case of Chile, the ranking for the first two positions remains the same both for IPI and CPI. Similarly, in case of Korea, the open economy channels assume the same ranking for both the target variables.

7. Conclusion:

In this study we address the question; has financial globalization changed the relative importance of monetary transmission channels? We used monthly data for Brazil, Chile and Korea. The sample ranges from the commencement date of their inflation targeting to the last month of 2009. The study employs Structural VAR methodology at level and exploited Structural Variance Decomposition to rank the channels. The study uses real loans, bank lending rate, real effective exchange rate and share prices as intermediate variables and these variables represent credit channel, interest rate channel, exchange rate channel and asset price channel respectively.

Our identification scheme generates sensible monetary policy shock as the generated responses are in line with the general economic belief. The qualitative impact of monetary policy shock and other intermediate variables shocks on target variables – IPI and CPI – is what theory expects it to be. The statistically significant response of IPI in case of Chile and Korea to shock in policy variable indicates that identification scheme is not grossly at odds with economics priors. The study uses interest rate as policy variables and deviates from the general convention of using monetary aggregates and interest rate simultaneously, rather follow the new Keynesian style where money demand equates itself to the money supply that corresponds to the interest rate set by the central bank.

Exploiting the forecast error variance decomposition study concludes that share price channel and exchange rate channel are becoming more important. This is in line with tour economic intuition as we were expecting this phenomenon in the wake of increasing financial globalization. One might argue that the high ranking of exchange rate channel against the backdrop of general consensus of decreasing exchange rate pass-through is at odd. Look it this way, if the exchange rate pass-through is declining so does the inflation. If both the magnitudes are declining, on might still have high importance of exchange rate channel if inflation is declining at higher rate. Moreover, when the economies are becoming more and more interconnected; due to real openness exchange rate can assume high ranking and

because of financial openness share price can assume high ranking. Due to increasing financial globalization the relationship between domestic saving and domestic investment might be weakening and thus reducing the relative importance of traditional interest rate channel. Our results are very close to the Gudmundsson (2007) which finds that exchange rate channel might be overburdened in the wake of financial globalization.

At this juncture, it seems a theoretical puzzle that share price channel and exchange rate channel presume high relative importance than traditional interest rate and credit channel, it is our conjecture that now is the high time to dig further about open economy channels.

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Appendix A

Table A 1: Data Description and Sources				
Country	**Variable**	**Description**	**Source**	**Code**
Brazil	IPI	Industrial Production Index (2005=100), Seasonally Adjusted at source	IFS	22366..CZF...
	CPI	CPI (2005=100)	IFS	22364...ZF...
	Loans	Claims on Private Secor, deflated by CPI to make real	IFS	22322D..ZK...
	BLR	Lending rate, we made it real using CPI inflation	IFs	22360P..ZF...
	REER	Real Effective ER, CPI-based, Broad Indices (2005=100)	BIS	-
	SP	Share Price Index (2005=100), Period average	IFS	22362...ZF...
	mmrate	money market rate	IFS	22360B..ZF...
	RWTC	Crude oil, WTI Spot Price (Dollars per Barrel)	FRED Database	-
Chile	IPI	Manufacturing Index (2005=100)	IFS	22866EY.ZF...
	CPI	CPI (2005=100)	IFS	22864A..ZF...
	Loans	Claims on Private Secor, deflated by CPI to make real	IFS	22822D..ZK...
	BLR	Lending rate, we made it real using CPI inflation	IFS	22860P..ZF...
	REER	Real Effective ER, CPI-based, Broad Indices (2005=100)	BIS	-
	SP	Industrial Share Price Index (2005=100)	IFS	22862A..ZF...
	Discrate	Discount rate, end period per annum	IFS	22860...ZF...
	RWTC	Crude oil, WTI Spot Price (Dollars per Barrel)	FRED Database	-
Korea	IPI	Industrial Production Index (2005=100), Seasonally Adjusted at source	IFS	54266..CZF...
	CPI	CPI all cities (2005=100)	IFS	54264...ZF...
	Loans	Claims on Private Secor, we deflated by CPI to make real	IFS	54222D..ZF...
	BLR	Lending rate, we made it real using CPI inflation	IFS	54260P..ZF...
	REER	Real Effective ER, CPI-based, Broad Indices (2005=100)	BIS	-
	SP	Share Price Index (2005=100), Period average	IFS	54262...ZF...
	mmrate	money market rate (percent per annum)	IFS	54260B..ZF...
	RWTC	Crude oil, WTI Spot Price (Dollars per Barrel)	FRED Database	-

Seasonal Adjustment using X11 Method

Sample Size for Brazil1999:1 - 2009:12, for Chile 1991:1 - 2009:12 and for Korea 1998:1 - 2009:12

Table A 2: Descriptive Statistics Brazil								
	IPI	**CPI**	**LOANS**	**BLR**	**REERINV**	**SP**	**MMRATE**	**RWTC**
Mean	96.06150	91.09793	696552.6	56.50742	1.037898	104.4409	17.16704	48.20394
Median	95.95250	93.54800	532958.9	54.90000	1.014117	80.20950	16.79250	39.68500
Maximum	117.1750	121.7770	1535780.	103.0800	1.651255	258.4310	43.25000	133.8800
Minimum	77.92300	59.27400	305634.9	40.20000	0.711794	25.37000	8.650000	12.01000
Std. Dev.	10.36971	19.26685	386156.3	11.43164	0.207664	65.15893	5.503117	26.25111
Skewness	0.224769	-0.127357	1.007947	1.450761	0.487601	0.767364	1.648067	1.126466
Kurtosis	2.002352	1.662597	2.594671	6.177169	2.699381	2.285562	8.132999	4.005992

Table A 3: Descriptive Statistics Chile								
	IPI	**CPI**	**LOANS**	**BLR**	**REERINV**	**SP**	**DISCRATE**	**RWTC**
Mean	84.26453	84.95219	29331.49	14.25696	0.976487	70.07359	10.60747	35.97689
Median	81.21550	87.91950	24179.66	13.21900	0.983043	53.75000	7.956000	25.62000
Maximum	116.9000	121.9170	74717.61	43.74300	1.173709	168.7000	45.25700	133.8800
Minimum	46.04410	40.22000	4273.029	3.536000	0.814531	15.40000	0.481000	11.35000
Std. Dev.	14.44152	21.05368	20087.81	7.852245	0.079993	38.72773	8.718927	24.64824
Skewness	0.254267	-0.291815	0.809396	1.116563	0.006335	1.009496	1.473465	1.685439
Kurtosis	2.292633	2.295152	2.653482	4.217307	2.337628	2.812728	5.254883	5.638380

Table A 4: Descriptive Statistics Korea								
	IPI	**CPI**	**LOANS**	**BLR**	**REERINV**	**SP**	**MMRATE**	**RWTC**
Mean	90.50833	95.83537	680078.7	7.565694	1.144771	92.43820	5.062986	45.39083
Median	92.00000	95.30000	690663.0	6.720000	1.133209	81.23100	4.330000	34.55500
Maximum	129.3000	113.8000	1149870.	17.53000	1.698370	187.1080	25.63000	133.8800
Minimum	47.40000	81.20000	299427.0	5.400000	0.924385	29.14100	1.770000	11.35000
Std. Dev.	22.21238	9.970107	253656.3	2.686174	0.148269	39.86246	3.703413	26.81623
Skewness	-0.073360	0.187769	0.274451	2.346255	0.680587	0.565126	3.942138	1.115897
Kurtosis	2.050743	1.818813	2.075316	8.233369	3.964628	2.292436	19.15175	3.985604

Table A 5: Cointegration Tests for Brazil				
Unrestricted Cointegration Rank Test (Trace)				
Hypothesized		Trace	0.05	
No. of CE(s)	Eigenvalue	Statistic	Critical Value	Prob.**
None *	0.429635	226.2041	125.6154	0.0000
At most 1 *	0.396900	154.8963	95.75366	0.0000
At most 2 *	0.253866	90.67601	69.81889	0.0005
At most 3 *	0.209398	53.48404	47.85613	0.0135
At most 4	0.100908	23.64400	29.79707	0.2159
At most 5	0.072031	10.13496	15.49471	0.2705
At most 6	0.005033	0.640861	3.841466	0.4234

Trace test indicates 4 cointegrating eqn(s) at the 0.05 level

* denotes rejection of the hypothesis at the 0.05 level

**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)				
Hypothesized		Max-Eigen	0.05	
No. of CE(s)	Eigenvalue	Statistic	Critical Value	Prob.**
None *	0.429635	71.30781	46.23142	0.0000
At most 1 *	0.396900	64.22031	40.07757	0.0000
At most 2 *	0.253866	37.19197	33.87687	0.0194
At most 3 *	0.209398	29.84005	27.58434	0.0252
At most 4	0.100908	13.50904	21.13162	0.4066
At most 5	0.072031	9.494097	14.26460	0.2473
At most 6	0.005033	0.640861	3.841466	0.4234

Max-eigenvalue test indicates 4 cointegrating eqn(s) at the 0.05 level

* denotes rejection of the hypothesis at the 0.05 level

**MacKinnon-Haug-Michelis (1999) p-values

Table A 6: Cointegration Tests for Chile				
Unrestricted Cointegration Rank Test (Trace)				
Hypothesized		Trace	0.05	
No. of CE(s)	Eigenvalue	Statistic	Critical Value	Prob.**
None *	0.297113	235.4931	125.6154	0.0000
At most 1 *	0.256891	156.8723	95.75366	0.0000
At most 2 *	0.175591	90.66076	69.81889	0.0005
At most 3	0.121984	47.60205	47.85613	0.0528
At most 4	0.049673	18.59184	29.79707	0.5226
At most 5	0.027280	7.230262	15.49471	0.5510
At most 6	0.004752	1.062295	3.841466	0.3027

Trace test indicates 3 cointegrating eqn(s) at the 0.05 level

* denotes rejection of the hypothesis at the 0.05 level

**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)				
Hypothesized		Max-Eigen	0.05	
No. of CE(s)	Eigenvalue	Statistic	Critical Value	Prob.**
None *	0.297113	78.62078	46.23142	0.0000
At most 1 *	0.256891	66.21151	40.07757	0.0000
At most 2 *	0.175591	43.05870	33.87687	0.0031
At most 3 *	0.121984	29.01022	27.58434	0.0326
At most 4	0.049673	11.36157	21.13162	0.6112
At most 5	0.027280	6.167967	14.26460	0.5918
At most 6	0.004752	1.062295	3.841466	0.3027

Max-eigenvalue test indicates 4 cointegrating eqn(s) at the 0.05 level

* denotes rejection of the hypothesis at the 0.05 level

**MacKinnon-Haug-Michelis (1999) p-values

Table A 7: Cointegration Tests for Korea				
Unrestricted Cointegration Rank Test (Trace)				
Hypothesized		Trace	0.05	
No. of CE(s)	Eigenvalue	Statistic	Critical Value	Prob.**
None *	0.667658	295.4925	125.6154	0.0000
At most 1 *	0.334960	142.3712	95.75366	0.0000
At most 2 *	0.261044	85.67195	69.81889	0.0016
At most 3	0.141433	43.62219	47.85613	0.1181
At most 4	0.075504	22.42598	29.79707	0.2754
At most 5	0.047729	11.51360	15.49471	0.1818
At most 6 *	0.033357	4.715713	3.841466	0.0299

Trace test indicates 3 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)				
Hypothesized		Max-Eigen	0.05	
No. of CE(s)	Eigenvalue	Statistic	Critical Value	Prob.**
None *	0.667658	153.1213	46.23142	0.0000
At most 1 *	0.334960	56.69925	40.07757	0.0003
At most 2 *	0.261044	42.04976	33.87687	0.0043
At most 3	0.141433	21.19620	27.58434	0.2645
At most 4	0.075504	10.91239	21.13162	0.6561
At most 5	0.047729	6.797885	14.26460	0.5133
At most 6 *	0.033357	4.715713	3.841466	0.0299

Max-eigenvalue test indicates 3 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Table A 8: Lag Order Selection Criteria for Brazil					
Lag	**LR**	**FPE**	**AIC**	**SC**	**HQ**
0	NA	6.22e-09	0.969478	1.128687	1.034152
1	2635.355	1.87e-18	-20.95878	-19.68510*	-20.44138
2	188.2000	7.37e-19	-21.89506	-19.50692	-20.92494*
3	72.64822	8.11e-19	-21.81698	-18.31437	-20.39413
4	75.70987	8.35e-19	-21.82360	-17.20652	-19.94803
5	89.28894	7.07e-19*	-22.04792	-16.31638	-19.71964
6	65.03757	7.64e-19	-22.06053	-15.21453	-19.27952
7	44.07765	1.06e-18	-21.86585	-13.90538	-18.63212
8	75.78278*	9.01e-19	-22.20662*	-13.13168	-18.52017

* indicates lag order selected by the criterion
LR: sequential modified LR test statistic (each test at 5% level)
FPE: Final prediction error
AIC: Akaike information criterion
SC: Schwarz information criterion
HQ: Hannan-Quinn information criterion

Table A 9: Lag Order Selection Criteria for Chile					
Lag	**LR**	**FPE**	**AIC**	**SC**	**HQ**
0	NA	2.15e-08	2.207968	2.315947	2.251572
1	4310.039	4.96e-17	-17.67695	-16.81312	-17.32811
2	248.4361	2.31e-17	-18.44338	-16.82369*	-17.78931*
3	91.96544	2.27e-17*	-18.46240*	-16.08686	-17.50309
4	53.11918	2.70e-17	-18.29505	-15.16366	-17.03052
5	67.52494	2.95e-17	-18.21658	-14.32934	-16.64681
6	65.65463	3.23e-17	-18.14206	-13.49896	-16.26705
7	63.22744	3.55e-17	-18.06853	-12.66958	-15.88829
8	69.94553*	3.71e-17	-18.05219	-11.89738	-15.56672

Footnote is same as under table A 8.

Table A 10: Lag Order Selection Criteria for Korea					
Lag	**LR**	**FPE**	**AIC**	**SC**	**HQ**
0	NA	1.03e-11	-5.433762	-5.283846	-5.372840
1	3013.053	1.27e-21	-28.25265	-27.05332*	-27.76528
2	146.8888	7.78e-22	-28.74602	-26.49728	-27.83219
3	99.33895	6.79e-22	-28.89683	-25.59867	-27.55654
4	106.7894	5.28e-22	-29.17427	-24.82671	-27.40753
5	104.8349	3.98e-22	-29.50203	-24.10505	-27.30884
6	154.9182	1.65e-22	-30.44723	-24.00084	-27.82758
7	98.63400	1.19e-22	-30.87355	-23.37775	-27.82745
8	102.7623*	7.58e-23*	-31.45375*	-22.90853	-27.98119*

Footnote is same as under table A 8.

Appendix B

$$\begin{bmatrix} 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ A_{21} & 1 & 0 & 0 & 0 & 0 & 0 & 0 \\ A_{31} & 0 & 1 & 0 & 0 & A_{36} & 0 & 0 \\ 0 & 0 & 0 & 1 & A_{45} & 0 & 0 & 0 \\ 0 & 0 & A_{53} & 0 & 1 & 0 & 0 & A_{58} \\ A_{61} & A_{62} & A_{63} & 0 & 0 & 1 & A_{67} & A_{68} \\ A_{71} & 0 & A_{73} & A_{74} & A_{75} & A_{76} & 1 & A_{78} \\ A_{81} & A_{82} & A_{83} & 0 & 0 & 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} u\,wtc \\ u\,IPI \\ u\,CPI \\ u\,RL \\ u\,RBLR \\ u\,REER \\ u\,SP \\ u\,Discrate \end{bmatrix} = \begin{bmatrix} e\,wtc \\ e\,IPI \\ e\,CPI \\ e\,RL \\ e\,RBLR \\ e\,REER \\ e\,SP \\ e\,Discrate \end{bmatrix}$$

Fig. 2 B. One S.D . shock with one-standard-error bands, country Brazil

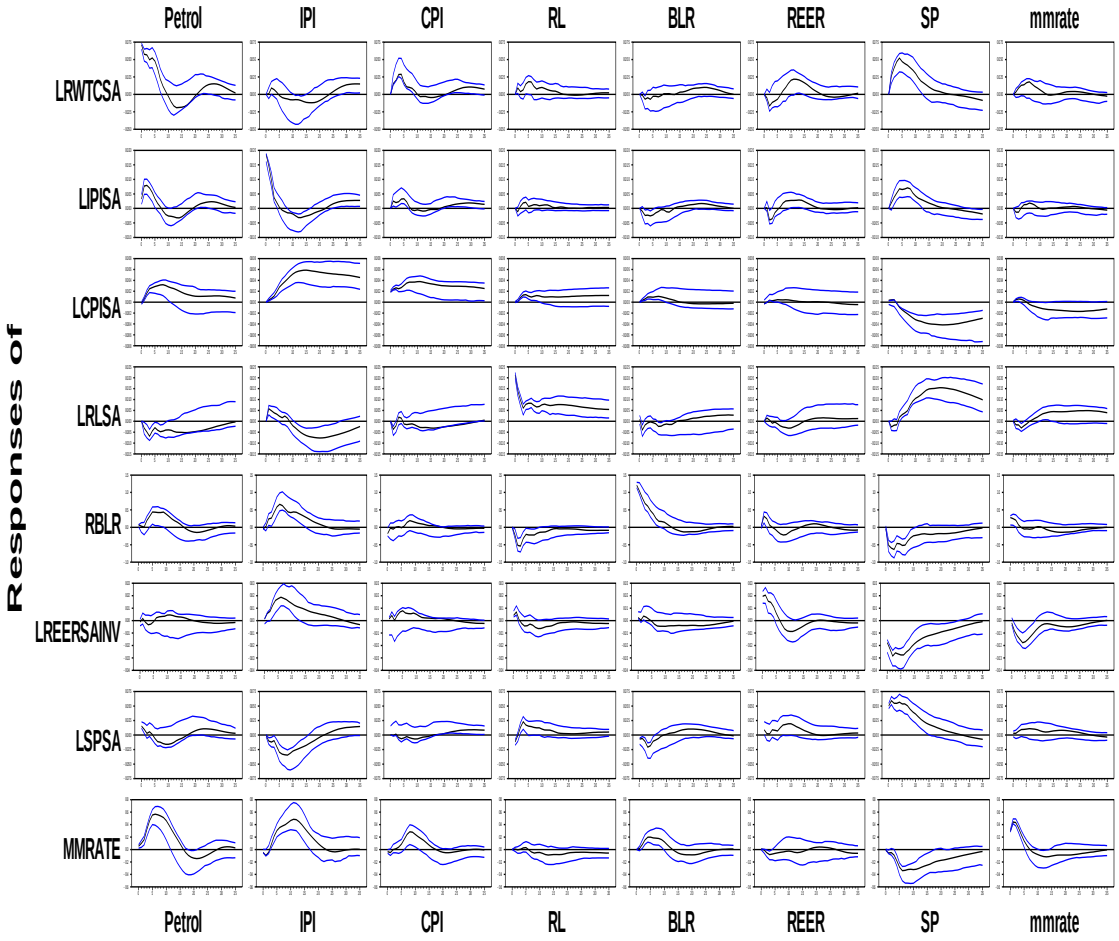


Fig. 3 B. One S.D . shock with one-standard-error bands, country Chile

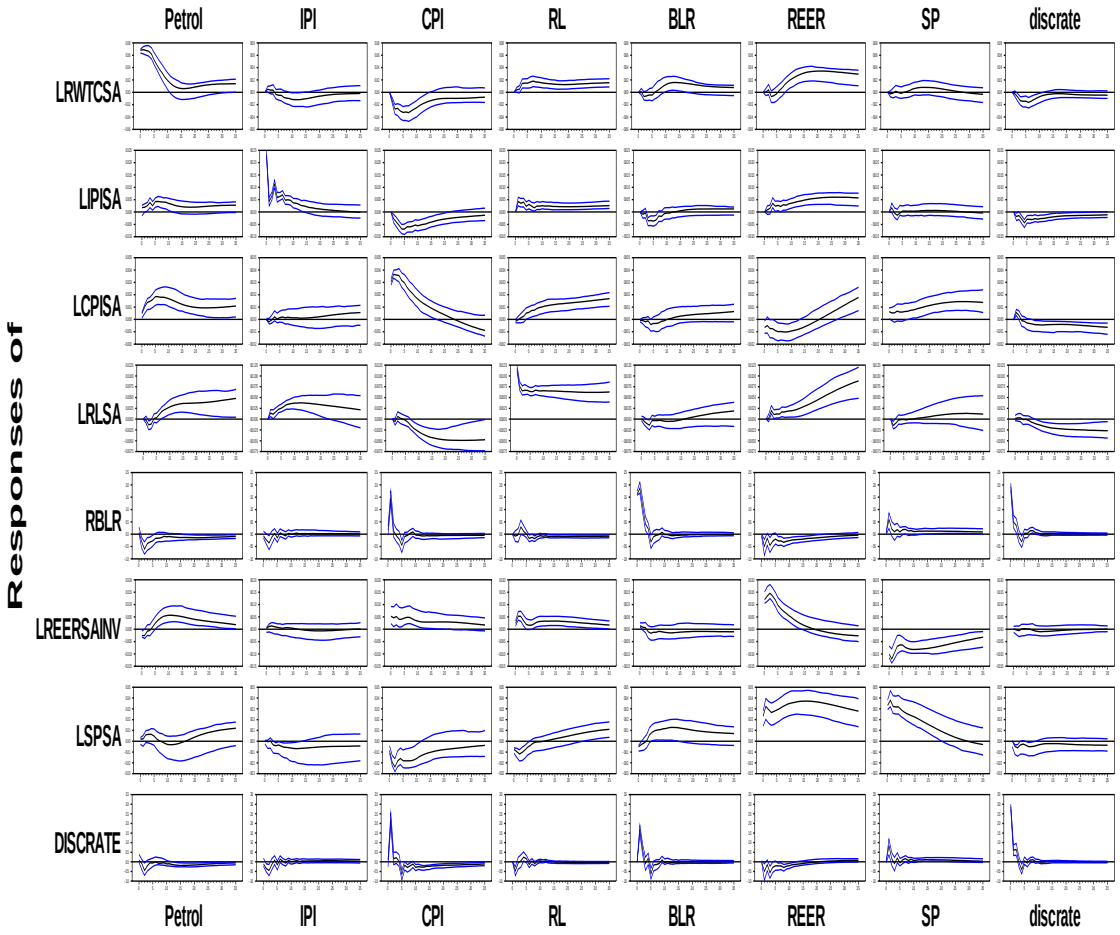


Fig. 4 B. One S.D . shock with one-standard-error bands, country Korea

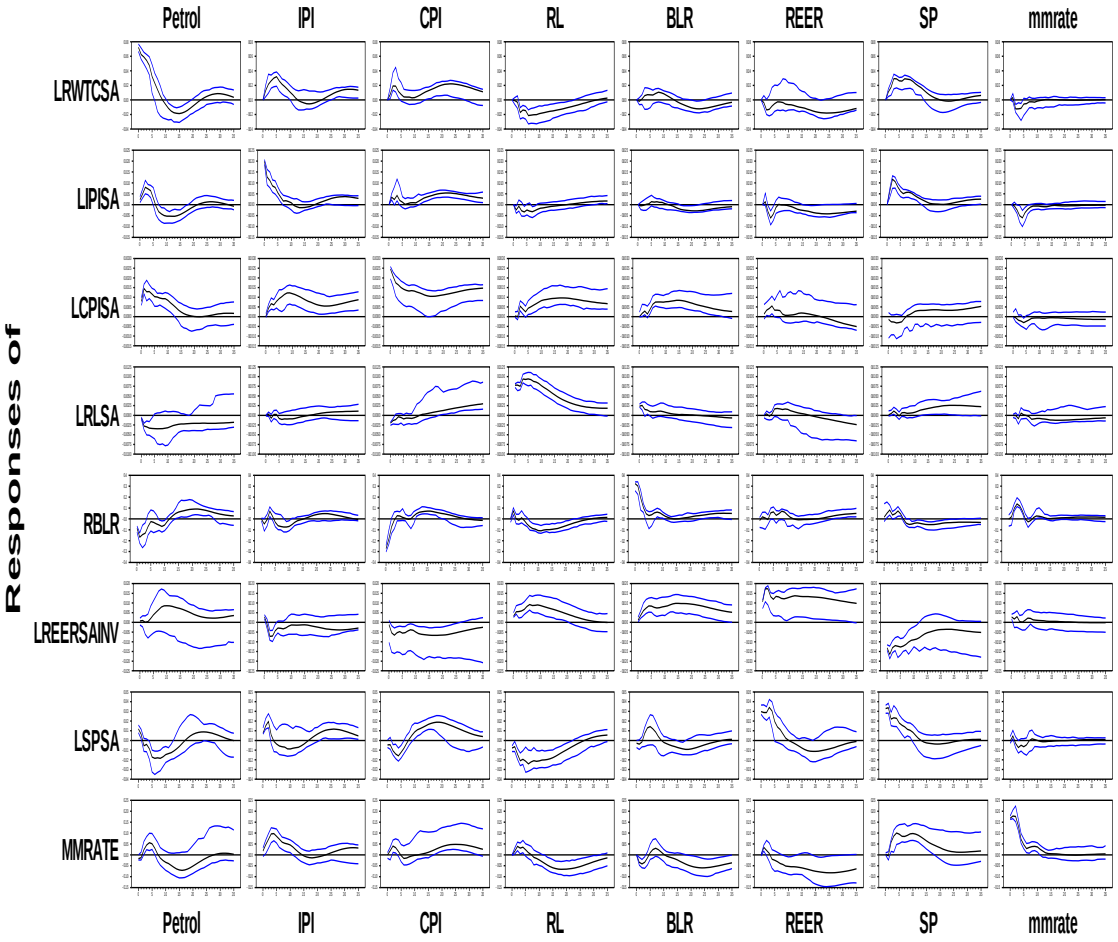


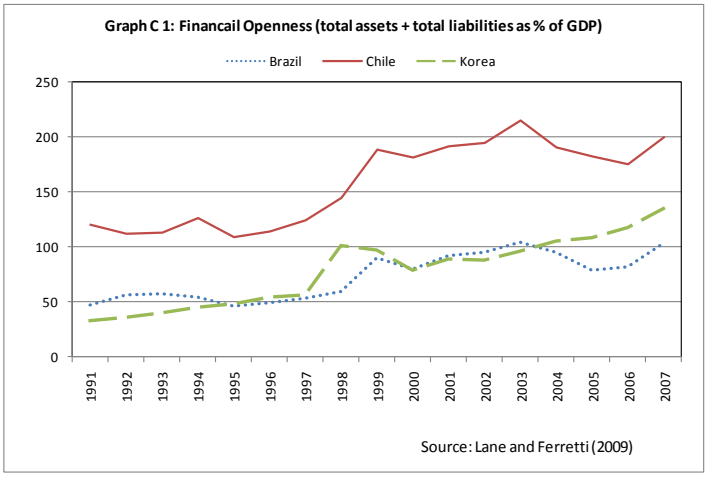
Table 1 B

Contemporeneous Coefficients in the Structural Model

	Brazil	**Chile**	**Korea**
A_{21}	-0.046 (.022)	-0.014 (0.023)	-0.0337 (0.022)
A_{31}	0.0015 (.0029)	0.0019 (0.006)	-0.010 (0.002)
A_{36}	-0.027 (0.020)	0.218 (0.112)	-0.0013 (0.0159)
A_{45}	-0.0008 (0.0015)	-0.0002 (0.0003)	-0.007 (0.0016)
A_{53}	99.37(1.55)	-115.17 (51.89)	111.98 (10.25)
A_{58}	-0.76 (0.35)	-0.67 (0.039)	-0.076 (0.16)
A_{61}	-0.14 (0.059)	0.031 (0.040)	-0.34 (0.172)
A_{62}	0.1023 (0.16)	0.1065 (0.1172)	-1.27 (0.598)
A_{63}	0.76 (2.05)	-3.54 (1.97)	3.93 (3.24)
A_{67}	0.66 (0.15)	0.807 (0.299)	1.944 (0.793)
A_{68}	-0.003 (0.009)	0.0006 (0.001)	-0.0164 (0.0422)
A_{71}	-0.416 (0.26)	-0.145 (0.102)	32.80 (26.80)
A_{73}	-33.90 (31.98)	17.9 (7.20)	1262 (2.45)
A_{74}	2.46 (1.99)	2.31 (0.89)	1366 (134)
A_{75}	0.031 (0.026)	0.009 (0.004)	1.05 (5.94)
A_{76}	-4.098 (4.32)	-2.43 (1.31)	-1429 (118)
A_{78}	-0.027 (.052)	-0.006 (0.004)	20.80 (11.17)
A_{81}	-0.72 (0.39)	-3.43 (2.90)	0.19 (0.20)
A_{82}	1.27 (1.50)	2.31 (8.17)	-0.77 (0.70)
A_{83}	14.08 (13.57)	18.01 (89.02)	-0.34 (5.58)
Likelihood test	χ^2 (8)=8.99	χ^2 (8)=18.26	χ^2 (8)=13.51
Significance Level	0.3428	0.01935	0.0954

Standard errors in parenthesis

Appendix C



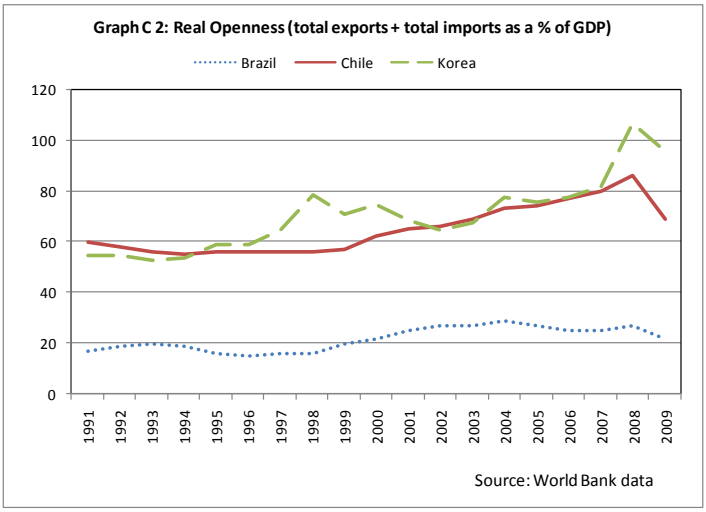


Table C 1: Market Capitalization as a % of GDP						
Year	**Brazil**	**Chile**	**Korea**	**UK**	**USA**	**France**
1991	10.5	76.9	31.3	93.6	69.0	27.9
1992	11.6	66.6	32.4	84.9	71.7	25.6
1993	22.7	93.5	38.4	117.4	78.0	35.2
1994	34.6	123.7	45.3	114.1	72.5	33.0
1995	19.2	103.5	35.2	121.7	93.4	33.2
1996	25.8	87.0	24.9	142.7	109.5	37.6
1997	29.3	87.0	8.9	146.9	137.0	47.4
1998	19.1	65.3	35.1	163.1	153.9	67.5
1999	38.8	93.5	88.8	195.2	178.9	101.3
2000	35.1	80.3	32.2	174.4	152.6	109.1
2001	33.6	82.1	43.6	147.2	135.4	87.8
2002	24.6	70.7	43.3	115.6	104.8	66.6
2003	42.5	116.6	51.2	132.2	128.7	75.7
2004	49.8	122.4	59.4	127.9	138.2	75.8
2005	53.8	115.4	85.0	134.1	134.9	83.0
2006	65.3	118.9	87.8	155.2	145.7	107.7
2007	100.3	129.6	107.1	137.3	142.5	107.3
2008	35.7	77.7	53.1	69.7	82.1	52.7
2009	73.2	130.2	100.3	128.7	107.4	75.1

Data source: World Bank