Exchange Rate Pass-Through and Structural Macroeconomic Shocks in Developing Countries: An Empirical Investigation.

Barhoumi, Karim

GREQAM, Banque de France

October 2006

Exchange Rate Pass-Through and Structural Macroeconomic Shocks in Developing Countries: An Empirical Investigation.

Karim Barhoumi
GREQAM, Université de la Méditerranée Aix Marseille II, *Marseille, France*
and DAMEP-DIACONJ BANQUE DE FRANCE

October 13, 2007

Abstract

This paper investigates the exchange rate pass-through in 12 developing countries during the period 1980-2001 by adopting a new formulation . Rather than considering the traditional approach based on the exogenous exchange rate movement through correlation between exchange rate and prices, we focus on fundamental macroeconomic shocks that affect both exchange rate and prices. In order to do that, we employ long-run restrictions à la Blanchard and Quah (1989) to identify the different shocks through an open economic macroeconomic model (ISLM framework). We use two empirical methodology : Structural VECM methodology used by Jang and Ogaki (2004) and the common trends approach proposed by Warne et al (1992). This allows us to calculate the pass-through as the responses of the exchange rate, CPI and import prices to the supply, the relative demand, the nominal and the foreign prices shocks. We show that the pass-through ratio in developing countries is different when considering different structural shocks.

Key-words: Exchange rate pass-through, Developing countries, Long-run restrictions, Structural VECM, Common trend, Impulse response functions

JEL classification: C32,E31, F30

1 Introduction

The question of exchange rate pass-through is far from being a new one in the international macroeconomics literature. According to the official definition of the exchange rate pass-through (the percentage change in import prices caused by one percent change in exchange rate), recent theoretical and empirical studies assume exogenous exchange rate movements through the correlation between exchange rate and prices (import or CPI). More precisely, this approach is based on a reduced form where the import prices or the inflation rate depend on current changes in the nominal exchange rate and other control variables suggested by economic theory. Despite the fact that this approach has the merit to explain the exchange rate pass-through behavior and its determinants across countries and industries, it obscures the channels through which the exchange rate and prices are affected by structural macroeconomic shocks. More precisely, the reduced form approach provides very little insight about the way in which the degree of exchange rate pass-through depends on the nature of the shocks affecting the economy.

To tackle this problem, Shambaugh (2006) proposes a new formulation to analyze the pass-through. In this context, Shambaugh (2006) stipulates that the better issue is to take into account the importance of the macroeconomic shocks when we analyze the pass-through. More precisely, he focus on how fundamental macroeconomic shocks to the economy affect both exchange rate and prices.

Following Shambaugh (2006), we use this new formulation in order to analyze exchange rate pass-through in some developing countries. This idea is motivated by the fact that firstly, macroeconomic shocks such as supply or relative demand shocks are the main important sources of fluctuations for both nominal and real exchange rate and have important effects on both domestic and import prices in developing countries. Secondly, there are a few studies that investigate the exchange rate pass-through in developing countries, such as Garcia and Restrepo (2001), Goldfajn and Werlang (2000), Frankel, Parsley and Wei (2005) and Barhoumi (2006); but all these studies focus on the correlation between nominal exchange rates and prices (domestic or import prices) and do not address how macroeconomic shocks can affect both exchange rate and prices in order to measure the pass-through.

However, the main question is what is the appropriate theoretical framework and hence the empirical methodology that we can use. Indeed, the difficult methodology question is how we can identify the shocks that an economy faces. In this context, a large body of literature has been developed in order to investigate the effect of macroeconomic shocks (supply, demand and monetary shocks) on both exchange rate and prices, such as Clarida and Gali (1994) and Rogers (1999), among others. The common point of all these studies is twofold. Firstly, at the theoretical level, these studies use the Blanchard and Quah (1989) long-run restrictions in order to identify the different shocks through an open macroeconomic model (ISLM framework). Secondly, the long-run restrictions proposed by Blanchard and Quah (1989) are investigated through a Structural VAR.

In this paper, we use the Blanchard and Quah methodology in order to analyze the exchange rate pass-through for 12 developing countries. On the one hand, the theoretical framework is derived from the Clarida and Gali (1994) model in order to generate long-run restrictions. This allows us to calculate the pass-through as the responses of exchange rate, CPI and import prices to supply, relative demand, nominal and foreign prices shocks. On the other hand, taking into account the characteristics of our series (non-stationarity and cointegration), we employ two different methods proposed by Jang and Ogaki (2004) and Mellander, Vredin and Warne (1992) to evaluate the pass-through.

This chapter is organized as follows. In section 2, the theoretical framework is presented. In section 3, we describe the data. In section 4, we present the empirical methodologies used in our paper. In section 5, we comment the results. In section 6, we provide some concluding remarks.

2 Theoretical framework

2.1 The model

In order to analyze the exchange rate pass-through in our sample of countries, we use the Clarida and Gali (1994) and Shambaugh (2006) model as a starting point for our theoretical framework. The model is based on a simple aggregate demand equation, money demand equation, interest parity equation, import price setting process and the real exchange rate definition.

Aggregate demand equation:

$$y_t^d = \alpha(s_t - p_t + p_t^*) - \beta(i_t - E(p_{t+1} - p_t)) + rd_t \tag{1}$$

Money demand equation:

$$m_t - p_t = y_t - \lambda i_t \tag{2}$$

Uncovered interest parity equation:

$$i_t = i_t^* + E(s_{t+1} - s_t) \tag{3}$$

Real exchange rate definition:

$$q_t = s_t + p_t^* - p_t \tag{4}$$

Import price setting process:

$$pm_t = (s_t + cx_t^*)N_t{}^1 \tag{5}$$

where y_t^d is the output determined by demand, $y_t(steady - state) = y_t^d = y_t^s$ (the output determined by supply) , s_t is the nominal exchange rate, p_t is the domestic price level, p_t^* is the foreign price level, rd_t is the relative world demand for home and foreign goods, m_t is the money supply, i_t is the nominal interest rate, i_t^* is the foreign nominal interest rate, q_t is the real exchange rate, pm_t is the import price, cx_t^* is the cost of foreign exporters, N_t is the markup on imports. Except the interest rates, all variables are natural logs.

Before presenting the stochastic process that determines our variables, we discuss the different restrictions and assumptions that allows us to identify the structural shocks that affect the nominal exchange rate and domestic-import prices and, therefore to calculate the pass-through ratios.

2.2 The different restrictions

Following Clarida and Gali (1994) and Shambaugh (2006), we use these different long-run restrictions:

- Only supply shocks can affect industrial production (y) in the long run. This restriction implies that there is no long-run impact on the industrial production from a shock to relative demand.
- Only supply and relative demand shocks can have a long-run impact on the real exchange rate (q). On the one hand, a shock to relative demand will be detected by any long run change in the real exchange rate (q) which is not caused by changes to industrial production. On the other hand, a nominal shock would be some changes in prices not caused by supply or changes in the real exchange rate.

[1] $pm = (S.CX^*)^N$

- Supply, relative demand and nominal shocks can affect long run prices (domestic prices).
- Supply, relative demand, nominal and foreign prices shocks can change nominal exchange rate.
- All shocks cited above can change import prices in the long-run but, import price shocks cannot have long-run impact on the other variables.

2.3 The different assumptions

We assume that shocks to nominal exchange rate are namely foreign price shocks. This assumption is based on the following fact: if nominal exchange rate changes permanently without changing the real exchange rate or the domestic price, the change take place in both the foreign price and the nominal exchange rate. In this context, Campa and Goldberg (2002, 2004) use this assumption in order to generate the foreign price series information from domestic prices, real exchange rates and nominal exchange rates. More precisely, we write the real exchange rate as the following[2]:

$$q = s + p^{*} - p; \tag{6}$$

if Δq and Δp are both equal to zero, so, $\Delta s = -\Delta p^{*}$. Notice that nominal exchange rate shocks are identical to foreign price shocks.

We note that for small open economy, there is no independent monetary policy, so that in this case, we can assume that the foreign shock is at the same moment a shock on the preferences and a foreign monetary shock

We assume that a shock to import prices (a shock to the markup) does not affect the domestic prices in the long-run. According to Bacchetta and Van Wincoop (2002), Burstein, Eichenbaum and Rebelo (2002) and Obstfeld (2002), since that domestic prices are anchored by the money demand equation, only changes of the money supply or the production of the economy can change the prices. If we assume that, due to other factors than those cited above, the import price can change in the long-run, the economy adjusts in a direction that makes the overall price level not compatible with money demand. Given a change in import prices, the import quantities and, perhaps, the domestic prices, will change in a way that prevents the overall price to be consistent with the money demand equation.

2.4 The stochastic process of the variables

The stochastic processes that determine our variables are the following:

- The output determined by supply is y_t^s and a_t is a supply shock;

$$y_t^s = y_{t-1}^s + a_t. \tag{7}$$

- The worldwide shock to relative demand for domestic products against foreign products is called b :

$$rd_t = rd_{t-1} + b_t. \tag{8}$$

- A shock to the domestic money supply is c_t:

$$m_t = m_{t-1} + c_t. \tag{9}$$

- A shock to foreign price level is d_t :

$$p_t^{*} = p_{t-1}^{*} + d_t. \tag{10}$$

[2] All variables are in logs

2.5 The long-run equations

In the long run, we assume that prices are flexible; more precisely, we assume that there is a full adjustment at time t to any shock in period t. thus $p_t = E[p_{t+1}]$. According to this assumption, the expected difference between p_t and p_{t+1} caused by any shock will be zero. Then, we assume that the real interest rate is constant and we normalize it to zero. Thus, the long run interest rate is zero.

According to these assumptions, we can generate the following equilibrium equations for our variables:

$$y = y^s, \tag{11}$$

$$q = (y - rd)/\alpha, \tag{12}$$

$$p = m - y, \tag{13}$$

$$s = (y - rd)/\alpha + p - p^*, \tag{14}$$

and

$$pm = (s + cx^*)N. \tag{15}$$

Then, by adding the stochastic shock for each variable, we obtain the following long run equations:

$$y_t = y_{t-1} + a_t, \tag{16}$$

$$q_t = (y_{t-1} + a_t - rd_{t-1} - b_t)/\alpha, \tag{17}$$

$$p_t = m_{t-1} + c_t - (y_{t-1} + a_t), \tag{18}$$

and

$$s_t = [(y_{t-1} + a_t - rd_{t-1} - b_t)/\alpha] + [m_{t-1} + c_t - (y_{t-1} + a_t)] - \left[p^*_{t-1} + d_t\right]. \tag{19}$$

If we assume that cx^* is affected by the shock hitting p^*_t, the import price is given by the following expression:

$$\begin{aligned} pm_t \quad = \quad & ([(y_{t-1} + a_t - rd_{t-1} - b_t)/\alpha] + [m_{t-1} + c_t - (y_{t-1} + a_t)] \\ & - \left[p^*_{t-1} + d_t\right] + [cx^*_{t-1} + d_t]) \times N_t \end{aligned} \tag{20}$$

According to these equations, we can see that only a_t affects y in the long run. Only a_t and b_t affect q_t in the long run. Only c_t and a_t affect p_t in the long run. All these shocks (a_t, b_t, c_t) affect the exchange rate. Import prices, can react to all these shocks because the exchange rate can do it.

3 Data description and preliminary investigation

3.1 Data description

The main problem in empirical studies on developing countries is data availability. Due to the difficulty to find some variables such as the nominal effective exchange rate, we only consider a sample of 12 developing countries, namely Bolivia (Bol), Chile (Chi) , Colombia (Col), Ivory Coast (Iv Co), Iran (Ir), Malaysia (Mal), Morocco (Mor), Nigeria (Nig), Singapore (Singa), Tunisia (Tun), Uruguay (Uru) and Venezuela (Venez). The data are quarterly and span the period 1980:1-2001:4.

We use the industrial production in place of real GDP y_t (in some case, we use Manufacturing Production or Crude Petroleum production, for further details see table 1). The rest of the variables are nominal effective exchange rate e_t (exchange rate index 1995=100), real effective exchange rate q_t (based on relative consumer price, index 1995=100), consumer price index p_t (Index Number 100) and import unit values series pm_t (index numbers 1995=100). All these variables are obtained from International Financial Statistics.

3.2 Preliminary investigation

As a preliminary step in our empirical investigation, we initially test for stationarity and cointegration. Firstly, we employed two different tests that methodologically complement each other. The first one is the Augmented Dickey-Fuller (ADF) unit root test, were the null is the nonstationarity. The ADF tests were further supplemented by a test constructed on the null hypothesis of stationarity, namely the Kwiatkowski-Phillips-Schmidt-Shin (KPSS). The results of the (non)stationarity tests have argued unanimously that the order of integration of all the variables to be 1 (see table 2)

Secondly, we test for cointegration by using two types of tests, the Johansen (1988) trace test and Saikkonen and Lütkepohl (2000) test. The results of the two tests indicate that all the countries have one cointegration vector (see table 3). The cointegration tests used in our empirical investigation have proposed tests are based on the following model:

$$y_t = D_t + x_t$$

where y_t is K-dimensional vector of observable variables, D_t is a deterministic term (e.g a linear trend term) and x_t is a VAR(p) process with vector error correction model (VECM) representation:

$$\Delta x_t = \Pi x_{t-1} + \Sigma_{j=1}^{p-1} \Gamma_i \Delta y_{t-j} + u_t$$

Here u_t is a vector white noise process with $u_t \sim (0, \Sigma_u)$. The rank of Π is the cointegrating rank x_t of and hence of y_t. Therefore the cointegration tests check the pair of hypotheses:

$$H_0(r_{0)} = rk(\Pi) = r_0 \ versus \ H_1(r_{0)} : rk(\Pi) > r_0 \ r_0 = 0, 1, ..., k-1. \quad (21)$$

In this context, Johansen (1988) and Saikkonen and Lütkepohl (1988) have proposed tests for the pair of hypotheses (21) by tacking into account some options such as seasonal dummy variables and impulse dummies. However, the Johansen trace test (1988) tacke into account the presence of trend breaks but it ignored by Saikkonen and Lütkepohl (1988) test.

4 Empirical methodology

The main goal of our empirical investigation is to find an exchange rate pass-through measure after the following shocks: supply, relative demand, nominal and foreign shocks. Indeed, the pass-through ratio is calculated follows;

$$Pass - Through \ ratio = \frac{\text{reaction of price to a shock } i}{\text{reaction of nominal exchange rate to a shock } i} \quad (22)$$

where i=supply, relative demand, nominal and foreign shocks.

To calculate the pass-through ratio, we need to investigate the impulse responses of the different shocks cited previously in the presence of cointegration. In this context, long-run restrictions have two implications for the identification of structural shocks in the presence of cointegration. First, structural shocks are decomposed into permanent shocks and transitory shocks, which depend on the number of common stochastic trends. As transitory shocks have non long run effects on the level of the considered variables, they give zero restrictions on the long run effects. Second, permanent shocks can be identified by means of long-run recursive assumptions. The causal ordering for permanent shocks, for instance, enables to identify and analyze impulse responses to each permanent shock. In effect, the empirical literature provides two main methods. The first one is based on calculating the impulse response function for a model in which the cointegrating vector is not identified; this method is proposed by Jang and Ogaki (2004) and Jang (2006). The second method, provides the impulse response functions under the assumption that the cointegrated vectors are identified; in this context, Warne, Mellander and Vredin (1992) derive the impulse functions from a common trend model.

4.1 Structural vector error correction : Jang and Ogaki (2004) method

Jang and Ogaki (2004) and Jang (2006) develop a method adapted to structural vector error correction models (VECMs) by means of long-run restrictions. King, Plosser, Stock and Watson (1991, KPSW) first extend the Blanchard and Quah (1989) method to structural VECM. The KPSW work is based on the assumption that cointegrated vectors are identified and estimated by using dynamic least squares for each cointegrating equation. Jang and Ogaki (2004) and Jang (2006) adopt the KPSW method with minimal assumptions. Therefore, when there is only one cointegration relation, or when cointegrating vector are known or identified, KPSW method can be considered as a special case of the Jang (2006) method. Indeed, it depends only on the assumption that permanent shocks are identified by means of long run restrictions. More precisely, this method is applicable to a model in which cointegrating vectors are not identified, which is the case in the first part of our thesis. In addition, the choice of the Jang and Ogaki (2004) and Jang (2006) method is motivated by the fact that it is straightforward to compute the impulse responses functions in presence of cointegration. Indeed, according to Park (1990) computing the impulse responses in level VAR (in presence of cointegration) can lead to the erroneous conclusion that all the shocks have only transitory effects in the long run (the unit roots are estimated with a bias toward zero). When we use a differenced VAR, we are in presence of an erroneous conclusion that all the shocks have permanent effects. To solve this problem, Jang (2006) and Jang and Ogaki (2004) estimate the parameters of interest using the VECM to avoid these potential errors. We note that through the two empirical methodologies, the long run restrictions are sensible to the ordering of the variables used in each model.

Following Jang and Ogaki (2004) and Jang (2006), we use these different steps in our empirical estimation. Firstly, we impose the long run restrictions described previously. Secondly, we convert the VECM to VAR models. Finally, in order to determine the pass-through ratio, we calculate the impulse responses for the four structural shocks.

4.1.1 The model

The vector autoregressive models originating with Sims (1980) have the following reduced form :

$$A(L)x_t = \mu + \varepsilon_t, \tag{23}$$

where x_t is a n×1 vector, $A(L) = I_n - \sum_{i=1}^{p} A_i L_i$, $A(0) = I_n$, and ε_t is a white noise with mean zero and variance Σ. From the reduced form of the VAR model, $A(L)$ can be re-parameterized as

$A(1)L+A^*(L)(1-L)$, where $A(1)$ has a reduced rank, $r \prec n$. Engle and Granger (1987) showed that there exists an error correction representation:

$$A^*(L)\Delta x_t = \mu - A(1)x_{t-1} + \varepsilon_t, \tag{24}$$

where $A^*(L) = I_n - \sum_{i=1}^{p-1} A_i^* L_i$, and $A_i^* = -\sum_{j=i+1}^{p} A_j$. Since x_t is assumed to be cointegrated and $I(1)$, Δx_t is $I(0)$, and $-A(1)$ can be decomposed as $\alpha\beta^{'}$, where α and β are $n \times r$ matrices with full column rank, r.

4.1.2 Long-run restrictions

As Δx_t is assumed to be stationary, it has a unique Wold representation:

$$\Delta x_t = \delta + C(L)\varepsilon_t, \tag{25}$$

where $\delta = C(1)\mu$ and $C(L) = I_n + \sum_{i=1}^{\infty} C_i L^i$. The above reduced form can be represented in structural form as:

$$\Delta x_t = \delta + \Gamma(L)v_t$$

with

$$v_t = \Gamma_0^{-1}\varepsilon_t,$$

where $\Gamma(L) = \Gamma_0 + \sum_{i=1}^{\infty} \Gamma_i L^i$, and v_t is a vector of structural innovations with mean zero and variance Σ_v.

Long-run restrictions are imposed on the structural form (Blanchard and Quah (1989)). Stock and Watson (1988) developed a common trend representation that was shown equivalent to a VECM representation. When cointegrated variables have a reduced rank r, there exist $k = n - r$ common trends. These common trends can be considered as generated by permanent shocks, so that v_t can be decomposed into $(v_t^{k'}, v_t^{r'})'$, in which v_t^k is a k-dimensional vector of permanent shocks and v_t^r is an r-dimensional vector of transitory shocks. As developed in King, Plosser, Stock and Watson (1989,1991), this decomposition ensures that:

$$\Gamma(1) = [A \;\; 0], \tag{26}$$

where A is an $n \times k$ matrix and 0 is $n \times r$ matrix with zeros, representing long-run effects of permanent shocks and transitory shocks, respectively. If there is more than one common trend ($k \geq 2$), a set of long-run restrictions must be imposed to isolate the effects of each permanent shock.

For our case, we consider five variables (y:industrial production, (see Appendix A for further details), q:real effective exchange rate, p:consumer price index, e: nominal effective exchange rate and pm:import unit values). More precisely, we have n=5, r=1 and hence k=4 (the four long run restrictions mentioned in subsection 2.5). This long run restrictions implies the following structure of the long run multiplier A:

$$x_t = \begin{bmatrix} y_t \\ q_t \\ p_t \\ e_t \\ pm_t \end{bmatrix}, \; v^k = \begin{bmatrix} v_t^1 \\ v_t^2 \\ v_t^3 \\ v_t^4 \end{bmatrix}, \; A = \begin{bmatrix} 1 & 0 & 0 & 0 \\ 1 & 1 & 0 & 0 \\ 1 & 1 & 1 & 0 \\ 1 & 1 & 1 & 1 \\ 1 & 1 & 1 & 1 \end{bmatrix}$$

where v_t^1 is the supply shock, v_t^2 is the relative demand shock, v_t^3 is the nominal shock and v_t^4 is the foreign shock.

In general, in order to identify permanent shocks, causal chains, in the sens of Sims (1980), are imposed on permanent shocks:

$$A = \widehat{A}\Pi, \tag{27}$$

where $\widehat{A}$ is an $n \times k$ matrix, and Π is $k \times k$ lower triangular matrix with ones on the diagonal.

4.1.3 Estimation of the model

This subsection explains how we can construct $\widehat{A}$ from the estimates of cointegrating vectors. Engle and Granger (1987) show that :

$$\beta^{'}C(1) = 0; \tag{28}$$

this implies that long-run effects are on cointegration relationships if variables are cointegrated. It follows from $\Gamma(1) = C(1)\Gamma_0$ and (26) that

$$\beta^{'}A = 0 \text{ or } \beta^{'}\widehat{A} = 0.$$

Let $\beta_\perp$ be a $n \times k$ orthogonal matrix of cointegration vectors, which satisfies $\beta^{'}\beta_\perp = 0$.Johansen (1995) proposes a method for choosing $\beta_\perp$:

$$\beta_\perp = (I_n - S(\beta^{'}S)^{-1}\beta^{'})S_\perp \tag{29}$$

where S is an $n \times r$ selection matrix, $(I_r\ 0)^{'}$, and $S_\perp$ is an $n \times k$ selection matrix, $(0\ I_k)^{'}$.

We note that β is identified up to the space spanned by α and β. This does not necessarily mean that each cointegrating vector is identified, because any linear combination of each cointegrating vector is a cointegrating vector. In this context, Jang and Ogaki (2004) do not require the identification of each vector, and provide more robust estimation avoiding potential misspecification.

In order to maintain Blanchard and Quah (1989) type long-run restrictions, we can normalize $\beta_\perp$ so that some parts of the matrix contain a $k \times k$ identity matrix . If $\widehat{\beta}_\perp$ is the normalized orthogonal matrix of cointegrating vectors, from $A = \widehat{A}\Pi$, we can choose the matrix. In this context, King, Plosser, Stock and Watson (1991) assume that $\widehat{A}$ is known a priori, and estimated by Dynamic OLS in each cointegrating equation:

$$\widehat{A} = \beta_\perp. \tag{30}$$

4.1.4 Identification of permanent shocks

In order to construct structural parameters with long-run restrictions, we can use the King, Plosser, Stock and Watson identification. More precisely, the main interest of this method is the identification of the permanent shocks but not of the transitory shocks. According to Jang and Ogaki (2001), we need to identify the first k columns of $\mathit{\Gamma}_0$ and the first k rows of Γ_0^{-1} for the identification of structural shocks only. In this context, it is necessary to decompose Γ_0 and Γ_0^{-1} as:

$$\Gamma_0 = [H \quad J]\,,\ \Gamma_0^{-1} = \begin{bmatrix} G \\ E \end{bmatrix} \tag{31}$$

where the matrices H, J, G and E have dimensions $n \times k$, $n \times r$, $k \times n$ and $r \times n$ respectively.

Jang and Ogaki (2001) note that the permanent shocks are identified once H (or G) is identified, and that these two matrices have a one to one relation , G=$\Sigma_v^k H^{'}\Sigma^{-1}$, where Σ_v^k is the variance covariance matrix of permanent shocks, v_t^k.

Jang (2000) assumes that the variance matrix of permanent shocks is a $k \times k$ diagonal matrix, Λ. The structural parameters can be deduced as described in King, Plosser, Stock and Watson (1991). First, permanent shocks are uniquely identified once G is derived. The reduced form ECM in (24) is estimating using Johansen (1988) method. We can derive *C(L)* in moving average representation by inverting (24).

The Jang and Ogaki (2001) identification scheme follows King, Plosser, Stock and Watson (1991) and uses the results of Engle and Granger (1987):

$$C(1)\alpha = 0 \tag{32}$$

According to King, Plosser, Stock and Watson (1991), $C(1) = \widehat{\beta}_{\perp} D$ and $A = \widehat{\beta}_{\perp}\Pi$, where $\widehat{\beta}_{\perp}$ is an $n \times k$ matrix, Π is a $k \times k$ matrix and D=$\widehat{(\beta^{'}_{\perp}}\widehat{\beta}_{\perp})^{-1}\widehat{\beta}^{'}_{\perp} C(1)$. King, Plosser, Stock and Watson (1991) assume that the permanent shocks are mutually uncorelated and orthogonal to transitory shocks:

$$\Sigma_v = \begin{bmatrix} \Sigma_v^k & 0 \\ 0 & \Sigma_v^r \end{bmatrix}, \tag{33}$$

where Σ_v^k is a diagonal matrix denoted by Λ.

The order condition can be verified by the following three sets of restrictions:

- First, it follow from $C(1)\varepsilon_t = \Gamma(1)v_t$ that $\widehat{\beta}_{\perp} D\varepsilon_t = \widehat{\beta}_{\perp}\Pi v_t^k$. This implies the first set of restrictions:

$$\Pi \ \Sigma \ \Pi^{'} = D\Sigma D^{'}, \tag{34}$$

  where Π is assumed to be lower triangular matrix with ones on the diagonal. This conditions gives $\frac{k(k+1)}{2}$ restrictions for $\frac{k(k+1)}{2}$ unknown paramters Π and Λ, provided that Λ is diagonal, and yields unique solutions for Π and Λ. Let P be a lower triangular matrix chosen from the Cholesky decomposition of $D\Sigma D^{'}$. Then Π and Λ are uniquely determined by

$$\Pi = P\Lambda^{-1/2} \tag{35}$$

where $P = [diag(P)]^2$.

- Second, $C(1)\Gamma_0 = \Gamma(1)$ implies $C(1)H = \widehat{\beta}_{\perp}\Pi$, so that we have the second set of restrictions of the form:

$$DH = \Pi \tag{36}$$

  which gives k^2 restrictions on H, provided that Π has already been derived.

- Finally, (32) can be expressed as $\Gamma(1)\Gamma(0)^{-1}\alpha = 0$, so that G$\alpha = 0$. Since $G = \Lambda H^{'}\Sigma^{-1}$, we have the third set of restrictions of the form:

$$\alpha^{'}\Sigma^{-1}H = 0 \tag{37}$$

  which gives kr restrictions on H.

The above three set of restrictions give nk restrictions on H, and the model is just identified that only H is identified. Once the model (24) is estimated, we can compute all the structural parameters sequantially. The last two restrictions (36) and (37) yield:

$$H = \begin{bmatrix} D \\ \alpha^{'}\Sigma^{-1} \end{bmatrix}^{-1} \begin{bmatrix} \Pi \\ 0 \end{bmatrix} \tag{38}$$

and

$$G = \Lambda H^{'} \Sigma^{-1}. \tag{39}$$

Accordingly, the permanent shocks are identified by:

$$v_t^k = G\varepsilon_t. \tag{40}$$

The specific solutions for H and G under the form of matrices enable one to generalize the model. Jang (2001) considered a structural VECM in which structural shocks are partially identified using long-run restrictions and are fully identified by means of additional short-run restrictions (see Jang (2001) for the method of identification in structural VECMs with short-run and long-run restrictions).

To identify the k_{th} permanent shock, $\mathrm{v}_{t,k}^k$, we need *(k-1)* long-run restrictions. In this context, Jang and Ogaki (2004) note that we can compute the impulse responses to the k_{th} shock, as long as the k_{th} column of H, H_k, is identified. Analogous to (38), H_k is identified by:

$$H_k = \begin{bmatrix} D \\ \alpha^{'} \Sigma^{-1} \end{bmatrix}^{-1} S_k, \tag{41}$$

where S_k is an n-dimensional selection vector with one at the k_{th} row and zeros at other rows. Similarly, G_k is identified by:

$$G_k = \Lambda_{k,k} H^{'}_{k} \Sigma^{-1}, \tag{42}$$

and it follows from the identity relation of $GH = I_k$ that

$$\Lambda_{k,k} = (H_k^{'k} \Sigma^{-1} H_k)^{-1}, \tag{43}$$

where $\Lambda_{k,k}$ is the variance of the k_{th} permanent shock. Thus, the k_{th} permanent shock is identified by:

$$v_{t,k}^k = G_k \varepsilon_t \tag{44}$$

4.1.5 Impulse functions analysis

The final step, is the construction of all structural parameters for the impulse analysis, but it is not possible to invert VAR in level to MA representation, due to the presence of unit roots. To solve this problem, Lütkepohl and Reimers (1992) suggest an algorithm to get impulse responses recursively in a cointegrated system as follows:

First, we estimate the reduced form ECM in (24) to VAR in level representation in (23) using the following relations:

$$A_i = \left\{ \begin{array}{ll} I - A(1) + A_1^* & i = 2 \\ A_i^* - A_{i-1}^* & \text{for } 2 \preceq i \preceq p-1 \\ -A_{p-1}^* & i = p \end{array} \right\} \tag{45}$$

Because a Wold representation does not exist in the presence of a unit root, Lütkepohl and Reimers (1992) address that impulse responses can be recursively computed by:

$$\Psi_m = \Sigma_{i=1}^{p} \Psi_{m-l} A_l \quad m = 1, 2, 3, ... \tag{46}$$

and

$$\Phi_m = \Psi_m \Gamma_0 \tag{47}$$

where $\Psi_0 = I_n$, $\Phi_m = (\phi_{m,ij})$, and $\phi_{m,ij}$ is an m-step response of the i_{th} variable to the j_{th} innovation. The impulse response of permanent shocks is calculated by:

$$\Phi_m^k = \Psi_m H,\ \ m = 1, 2, ... \tag{48}$$

The impulse response function of the k_{th} permanent shock is uniquely calculated from:

$$\Phi_{m,k}^k = \Psi_m H_k,\ \ m = 1, 2, ... \tag{49}$$

where $\Phi_{m,k}^k$ is equivalent to the k_{th} column of Φ_m^k in (48).

Doan (1992) showed how to compute confidence intervals for impulse responses using Monte Carlo integration. Since this method was designed for VAR models rather than VECMs, the coefficients drawn from the posteriori distribution do not necessarily satisfy the restriction of (28) and (32), which Engle and Granger (1987) showed to be the core properties of VECMs. In this context, Jang and Ogaki (2004) stipulate that, if the method is applied to VECMs without any modification, it is no surprising to find huge confidence intervals caused by a few erroneous impulses responses. Jang and Ogaki (2004), suggest constrained Monte Carlo integration, in which coefficients in the VECM are restricted by the conditions of (28) and (32), and significance intervals are drawn by Monte Carlo integration with one standard deviation. for further details, see Jang and Ogaki (2004)).

4.2 The common trend approach

In order to obtain again a measure of pass-through ratio, we adopt in this second part the common trend model proposed by Mellander, Vredin and Warne (1992) and applied to a system of non stationary variables. The existence of long-run cointegrating relationships reduces the number of independent disturbances having a permanent effect on the level of the series. The common trend representation of the system allows to decompose the variables into a non stationary trend and a stationary transitory element. The former component captures the effect of only permanent shocks.

4.2.1 Common trend model estimation

According to Warne, Mellander and Vredin (1992), the structural model is presented as follows:

$$X_t = X_0 + \Upsilon\tau_t + \phi(L)v_t \tag{50}$$

where $X_t = (y_t, q_t, p_t, e_t, pm_t)$, L is the lag operator, i.e. $L^j x_t = x_{t-j}$ for any integer j and Υ is a $n \times n$ matrix.

The n dimensional vector sequence $\{v_t\}$ is assumed to be white noise with $\mathrm{E}[v_t] = 0$ and $\mathrm{E}\left[v_t v_t^{'}\right] = I_n$, the $n \times n$ identity matrix (here n=5). Furthermore, the $n \times n$ matrix polynomial $\phi(L) = \sum_{j=0}^{\infty} \phi_j \lambda_j$ is finite for all λ on and inside the unit circle, and X_0 is assumed to be stationary. In addition, $\phi(L)v_t$ is stationary.

The common trends are defined as the following:

$$\tau_t = \mu + \tau_{t-1} + \varphi_t \tag{51}$$

where τ_t is a k *(k=4)* dimensional vector of random walks with drift μ and innovation φ_t. Warne et al (1992) assume that the trend disturbance sequence $\{\varphi_t\}$ is white noise with $E[\varphi_t] = 0$ and $E\left[\varphi_t \varphi_t^{'}\right] = I_k$.

According to (50) and (51), the structural model can be written as follows:

$$X_t = X_0 + \Upsilon \left[\tau_0 + \mu t + \sum_{j=0}^{\infty} \varphi_j \right] + \phi(L) v_t. \tag{52}$$

Furthermore, whenever the number of common trends, k, is less than the number of variables, n, there are exactly r=n-k linearly independent vectors, that are orthogonal to the columns of the loading matrix Υ. In our case, r=*1*, n=*5* and k=*4*. In other words, there exists a $n \times r$ matrix α such that $\alpha^{'} \Upsilon = 0$.

In order to identify the different structural shocks, we start with the following VAR representation:

$$A(L)X_t = \rho + \varepsilon_t, \tag{53}$$

where $A(L) = I_n - \sum_{i=0}^{p} A_i \lambda^i$, ρ is $n \times 1$ and ε_t is an error term.

Under the assumption of cointegration it follows by the Granger Representation Theorem (GRT), that we can write an alternative form of (53), as a vector error correction (VEC) model:

$$A^*(L)\Delta X_t = \rho - \gamma z_{t-1} + \varepsilon_t, \tag{54}$$

where the polynomial matrix $A^*(\lambda) = I_n - \sum_{i=1}^{p-1} A_i^* \lambda^i$ is related to $A(\lambda)$ through $A_i^* = -\sum_{j=i+1}^{p} A_j$ for *i=1,...,p-1*. γz_{t-1} represents the correction of the change in X_t due to last period long run equilibrium error. The major difference between equations (53) and (54) is that the latter representation is conditioned on cointegration, while the former is consistent with unit roots.

The stationarity of ΔX_t allow us to define the following vector moving average (VMA) representation:

$$\Delta X_t = \delta + C(L)\varepsilon_t, \tag{55}$$

where $C(\lambda) = I + \sum_{j=1}^{\infty} C_j \lambda^j$.

In this context, Stock and Watson (1988) show that $C(\lambda) = C(1) + (1-\lambda)C^*(\lambda)$. Substituting equation (55) into (54) for $C(\lambda)$, we obtain:

$$X_t = X_0 + C(1)\xi_t + C^*(L)\varepsilon_t, \tag{56}$$

where $\xi_t = \rho + \xi_{t-1} + \varepsilon_t$ and $\delta = C(1)\rho$.

We can write the reduced form as follows:

$$X_t = X_0 + C(1) \left[\xi_0 + \rho t + \sum_{j=1}^{t} \varepsilon_j \right] + C^*(L)\varepsilon_t. \tag{57}$$

Warne (1993) finds that the equality of the trend components implies that:

$$\Upsilon \varphi_t = C(1)\varepsilon_t, \ \Upsilon\Upsilon^{'} = C(1) \sum C^{'}(1), \ \Upsilon \mu = C(1)\rho. \tag{58}$$

The structural permanent shocks vector is expressed as:

$$\varphi_t = (\Upsilon\Upsilon^{'})^{-1}\Upsilon^{'} C(1)\varepsilon_t \tag{59}$$

4.2.2 Shocks identification

Now, we need to identify the nk parameters of Υ, in order to determine the long run effect of the permanent shocks. In this context, the common trend model for our developing countries can be written as follows:

$$\begin{pmatrix} y \\ q \\ p \\ e \\ pm \end{pmatrix} = X_0 + \begin{pmatrix} \Upsilon_{11} & \Upsilon_{12} & \Upsilon_{13} & \Upsilon_{14} \\ \Upsilon_{21} & \Upsilon_{22} & \Upsilon_{23} & \Upsilon_{24} \\ \Upsilon_{31} & \Upsilon_{32} & \Upsilon_{33} & \Upsilon_{34} \\ \Upsilon_{41} & \Upsilon_{42} & \Upsilon_{43} & \Upsilon_{44} \\ \Upsilon_{51} & \Upsilon_{52} & \Upsilon_{53} & \Upsilon_{54} \end{pmatrix} \begin{pmatrix} \tau_{o,t} \\ \tau_{d,t} \\ \tau_{f,t} \\ \tau_{n,t} \end{pmatrix} + \phi(L)v_t. \quad (60)$$

The identification procedure is based on the long-run restrictions determined jointly by the estimation of the cointegrating vector α and the choice of the matrix A_0 (which verifiy the constraint that $\alpha^{'}\Upsilon = 0$). More precisely, this identification scheme allows us to interpret the four permanent shocks as supply shock, demand shock, foreign shock and nominal shock.

To identify the elements of the matrix, on the one hand, we use the different long run restrictions mentioned previously. On the other hand, we follow Blanchard and Quah (1989) by assuming that the long-run effects of demand shock on y_t are not important with regard to the supply shock effects. So, the demand shock has only a transitory effect on the level of production. The theoretical constraint imposed on the matrix Υ in order to verify $\alpha^{'}\Upsilon = 0$, offers the additional restrictions that allow us to identify completely the common trend model. The additional restrictions are $\Upsilon_{12} = 0$, $\Upsilon_{13} = 0$, $\Upsilon_{14} = 0$, $\Upsilon_{23} = 0$, $\Upsilon_{24} = 0$ and $\Upsilon_{34} = 0$. Taking into account the technical constraint, the matrix Υ can be written:

$$\Upsilon = \begin{pmatrix} 1 & 0 & 0 & 0 \\ -\frac{\alpha_1+\alpha_2}{\alpha_2} & 1 & 0 & 0 \\ 1 & -\frac{\alpha_1+\alpha_2+\alpha_3}{\alpha_3} & 1 & 0 \\ 1 & 1 & -\frac{\alpha_2+\alpha_3+\alpha_4}{\alpha_4} & 1 \\ 1 & 1 & 1 & -\frac{\alpha_2+\alpha_3+\alpha_4+\alpha_5}{\alpha_5} \end{pmatrix}$$

4.2.3 Impulse response functions

In contrast to Jang (2006) and Jang and Ogaki (2004), Warne et al (1992) provide an algorithm to compute impulse responses without converting VECM to level VAR following the scheme in Warne (1991). Indeed, Warne et al (1992) calculate the impulse response functions from the moving average representation in (55). To calculate the impulse responses associated with the shock to the common trends, we need to put additional restrictions on the model: $v_t = \left[\varphi_t^{'}\Psi_t^{'}\right]^{'} = F\varepsilon_t$, $F = \left[F_k F_r^{'}\right]^{'}$, and $R(L) = C(L)F^{-1}$.

Then (55) can be written as:

$$\Delta X_t = \delta + R(L)\left[v_t + \Psi D_t\right] \quad (61)$$

where $\Psi = F_\rho^*$, φ_t denotes the k-dimensional common trends innovation vector, as before, and the $r\times 1$ vector Ψ_t may be considered of as transitory innovations. In addition, we know that $\Upsilon\varphi_t = C(1)\varepsilon_t$, so

$$F_k = (\Upsilon\Upsilon^{'})^{-1}\Upsilon^{'}C(1). \quad (62)$$

In order to calculate impulse responses from (61), we need to estimate the other blocks of full covariance matrix for v_t. Therefore, Warne et al (1992) assume that the permanent and the transitory innovations are independent, i.e.

$$E\left[\varphi_t \Psi_t^{'}\right] = (\Upsilon\Upsilon^{'})^{-1}\Upsilon^{'} C(1)\Sigma F_r^{'} = 0. \tag{63}$$

As shown by Engle and Granger (1987), $C(1)\gamma = 0$. Therefore,

$$F_r = Q^{-1}\gamma^{'}\Sigma^{-1} \tag{64}$$

will satisfy (63). In this context, the $r \times r$ matrix Q may be chosen so that the covariance matrix of the transitory innovations is diagonal. According to Warne et al (1992), these assumptions will be sufficient to calculate impulse responses with respect to the permanent innovations φ. To identify and interpret any independent influences from the transitory disturbances, one would have to be more specific about the structure of Q. However, its structure is irrelevant to the question about the roles of permanent shocks. Warne et al (1992), follow King et al (1991) and Shapiro and Watson (1988) and restrict their attention to the permanent innovations. This methodology is motivated by the fact that economic theory generally has more to say about long-run relationships than about short-run dynamics.

4.3 Confidence intervals for the impulse response functions

Another important feature appears when we calculate the impulse response functions through the two empirical methodologies is the interval confidence interval obtained through the different shocks. In this context, the interpretation of structural impulse response functions in the framework of VAR based on cointegration and vector error correction models (VECMs), becomes a standard practice to report confidence intervals (CIs) around the point estimates to assess the estimation uncertainty. Different methods for the construction of the impulse response functions intervals have been suggested in the literature. CIs may be based on the asymptotic distributions of the impulse responses (Lütkepohl (2005)), on Monte Carlo integration methods (Sims and Zha (1999)) and on various variants of bootstrap methods (Lütkepohl and Wolters (2001)). In the context of SVECMs with long run restrictions, four methods have been used in applied works. The first one is based on a generalization of the asymptotic intervals given by Lütkepohl and Reimers (1992) and Vlaar (2004a). In effect, in the presence of long run restrictions, a correction of the asymptotic distribution is needed, which takes the stochastic nature of the identifying restrictions into account. Empirical applications of this method include Coenen and Vega (1999) and Vlaar (2004b). As an alternative to the asymptotic intervals, bootstrap methods have been used in the context of SVECM. In particular, the standard percentile interval of Efron and Tibshirani (1993), the Hall percentile interval and the studentized Hall interval (Hall (1992)) have been used in Lütkepohl and Wolters (2003), Brüggemann (2004) and Breitung et al (2004) (these three bootstrap versions are available for SVECMs with long run restrictions in form of the menu driven software JMULTI (www.jmulti.com)).

To evaluate the performance of these different methods, Brüggemann (2006) compare the finite sample properties of the described CI construction methods for SVECMs with long run restrictions. he conducts a Monte Carlo study using a large number of data generating process obtained by estimating SVECMs from the empirical literature. Brüggemann (2006) finds that the applied researchers should choose between the asymptotic and the Hall bootstrap percentile intervals in SVECMs with long run restrictions. In contrast, the standard (Efron) percentile bootstrap interval may be less suitable for applied work as it is less informative about the sign of the underlying impulse response function. More precisely, comparing CIs responses to permanent shocks , which is the case of this chapter, Brüggemann (2006) finds that asymptotic and Hall bootstrap intervals have similar coverage rates and indicate the right sign of the underlying response equally often. For our empirical exercise, we use the Hall bootstrap percentile intervals.

5 Empirical results

5.1 Impulse response function results

Before beginning the analysis of the pass-through ratio across the different countries, we are going to focus first of all on the reaction of variables to various shocks. We calculate the impulse response functions for the four shocks (demand, supply, nominal and foreign) to each variable, following Shambaugh (2006), we focus on the impulse response function of (p_t, pm_t and e_t) by using the Hall bootstrap procedures with 100 replications (the 5^{th} and 95^{th} percentiles), in order to test the significance of the results in two periods: period 1(as the cotemporaneous response or short run exchange rate pass-through) and period 5 (as the long run exchange rate pass-through). In this context, we note that due to the non normal distribution of the sample, the point estimate is not necessarily in the middle of the confidence interval. We show that in many countries the shock effects are consistent with most international theory.

Firstly, the demand shocks, explained by a fall in relative demand that generate a real exchange rate depreciation, raise both domestic and import prices ($\Delta p \geq 0$ and $\Delta pm \geq 0$) and depreciate the nominal exchange rate ($\Delta e \geq 0$), between period 5 and 1 (see tables 1 and 5). Secondly, the supply shocks lower both domestic and import prices ($\Delta p \leq 0$ and $\Delta pm \leq 0$) for five countries (Ivory coast, Iran, Morocco, Nigeria and Uruguay) by the Jang and Ogaki (2004) method, seven countries by the Warne et al (1992) method (Bolivia, Iran, Malaysia, Morocco, Nigeria, Tunisia and Uruguay) and appreciate the nominal exchange rate ($\Delta e \leq 0$) between the two periods for four countries by he Warne et al (1992) method (Colombia, Ivory Coast, Tunisia and Uruguay) and five countries by the Jang and Ogaki (2004) method (Bolivia, Colombia, Tunisia, Uruguay and Venezuela , see tables 2 and 6).

Thirdly, we show that the nominal shock increase all the nominal variables (p_t, pm_t and e_t) in some countries. In effect, by using Jang and Ogaki (2004) method, (see tables 3 and 7) we show that nominal variables rise on 8 countries (Bolivia, Chile, Ivory Coast, Iran, Morocco, Nigeria, Tunisia and Uruguay), but when we turn to Warne et al (1992) method, we show respectively an increase on domestic price increases for all the countries, on import price for seven countries (Chile, Iran, Morocco, Nigeria, Tunisia, Uruguay and Venezuela) and on nominal exchange rate for four countries (Colombia, Singapore, Tunisia and Uruguay).

Finally, when we look at the foreign shocks (seen as a depreciation of the home nominal exchange rate), we show that it rises both domestic and import prices between period 1 and period 5. More precisely, the two empirical methodologies employed allow us to conclude that domestic prices (CPI) rise more than the import prices (see tables 4 and 8).

5.2 Pass-through ratio across countries

Through the two empirical methodologies, we calculate the pass-through ratio after the four shocks for two different horizons: one period and five periods. In this context, despite the fact the two methodologies generate, in some cases, contradictory results (see table 9 and 10 that show the pass-through ratios corresponding to (22)), we find that [3]:

- Now, we turn to the pass-through ratio across the different countries see (table 9 and 10). We remark that the pass-through ratio is different with respect to different shocks. More precisely, we find that the response to supply shocks, nominal shocks and foreign shocks are very important in the considered countries. Pass-through ratio into both CPI and import prices are in general greater than one: it is the full pass-through (the exchange rate does not respond much to these different shocks but prices do;. in this case the pass-through ratio may be in excess of one). The main explanation of these finding are twofold. On the one hand, developing countries face larger shocks, in particular supply and nominal shocks; on the other hand, the economies in developing countries are in general unstable

- Secondly, the effect of demand shocks on both consumer prices and import prices is also much larger. Indeed, by using the Jang and Ogaki (2004) method see table 9, we show that the pass-through ratio into import prices after one period (the immediate effect) varies from 141.5% for Chile to 393.9% for Singapore. The pass-through to CPI varies from -200.0% for Iran to 147.5% for Morocco. In addition, we look to the pass-through ratio after five periods; we find also a higher ratio. In effect, the pass-through into CPI varies from -190.7% for Iran to 633.4% for Morocco; besides the pass-through into import prices varies from -214.2% for Iran to 1494.5% for Singapore. By using the Warne et al (1992) see table 10, on the one hand, we find that the pass-through ratio into import prices after one period varies from -214.2% for Colombia to 309% for Singapore. The pass-through into CPI varies from -1350% for Morocco to 408.4% for Chile. On the other hand, after five periods the pass-through into CPI varies from -409.2% for Chile to 48.5% for Singapore. Moreover, the pass-through into import prices varies from -291.8% for Iran to 271.1% for Singapore. The principal explanation for these findings is that a high inflation environment during this period characterizes developing countries. In addition, these results are not surprising; on the one hand, they confirm the Taylor hypothesis (2001): the exchange rate pass-through is higher on a higher inflation environment. Moreover these finding consolidate some empirical results about the developing countries such as Frankel, Parsley and Wei (2005) and Barhoumi (2006). More precisely, these empirical works showed that inflation is an important exchange rate determinant and pass-through ratio is higher in developing countries characterized by an inflation high level.

- Finally, as mentioned above, when we turn to both pass-through resulting from nominal and foreign shocks, we find that the two empirical methodologies do not give in few cases the same results see tables 9 and 10); more precisely, we show that the pass-through ratios are different in sign. For example, we obtain by the Jang and Ogaki (2004) method a pass-through ratio relative to nominal chock, for Chile and Morocco respectively equal to -42.7% and 160.8%, while by the Warne et al (1992) method, we obtain respectively 79.6% for Chile and -512.5% for Morocco. Note that we observe also the same differences on pass-through relative to supply and foreign chocks. We think that these differences are due to the calculation method of the impulse functions. As mentioned previously, the construction of the impulse response functions derived from the Jang and Ogaki (2004) method are different from those obtained by the Warne et al (1992) method. Indeed, the former method calculate the impulse response functions by converting the

[3] For the Jang and Ogaki (2001)'s procedure, the programs are available at http://economics.sbs.ohio-state.edu/ogaki/econ894/jang-ogaki.htm. For the Warne et al (1992)'s procedure, we use the program available at http://www.texlips.net/svar/source.html

VECM representation to level VAR and by using constrained Monte Carlo integration without identifying the cointegrating vectors. On the opposite, the latter builds the impulse responses from a moving average representation and uses the Lütkepohl and Reimers (1992) algorithm suitable for a cointegrated framework with Gaussian innovations.

6 Conclusion

This chapter investigates the exchange rate pass-through behavior in developing countries by adopting a new pass-through formulation. Rather than considering the traditional approach based on correlation between exchange rate and prices (domestic and import prices), we calculate the pass-through ratio as the reaction of both nominal exchange rate and prices to four macroeconomic shocks. In order to do that, we use a data set of 12 developing countries over the period 1980-2001 and we employ long-restrictions following Blanchard and Quah (1989) in order to identify the reaction of both exchange rate and prices to supply, demand, nominal and foreign shocks. Then, we calculate the pass-through ratios through two empirical methodologies, the structural VECM à la Jang and Ogaki (2004) and the common trends approach proposed by Mellander, Vredin and Warne (1992) using the impulse response functions. Although that both empirical methodologies present in few cases conflicting pass-through (opposite exchange rate pass-through sign) for supply, nominal and foreign shocks, we show that the shocks generate pass-through coefficient larger than one (a complete pass-through). In particular, we find that the pass-through resulting from demand shock is the highest. These results are consistent with the results of Frankel, Parsley and Wei (2005), Barhoumi (2006) and Barhoumi and Jouini (2006), which showed that inflation is an important exchange rate determinant and the pass-through ratio is higher in developing countries characterized by higher inflation level. In addition the chapter results have some implication for economic policy in developing countries. Due to the fact that different shocks will generate different exchange rate pass-through ratios and that pass-through analyzes are very important for both trade and monetary policy; it is important for both institutions and policy makers in developing countries to take into account the importance of some macroeconomic shocks before making any decision such as the choice of monetary policy (inflation targeting) or exchange rate regimes (exchange rate flexibility).

References

[1] Bacchetta, P,. Van Wincoop, E,. (2002). "A theory of the currency denomination of International Trade" Manuscript, November

[2] Barhoumi, K. (2006), "Differences in Long Run Exchange Rate Pass-Through Into Import Prices In developing Countries: An Empirical Investigation." Economic Modelling, 23, 926-951

[3] Barhoumi, K, and Jouini, J. (2006), "Revisiting the Decline in the Exchange Rate Pass-Through: Further Evidence from Developing Countries." Working Papers GREQAM, 2006-29.

[4] Blanchard, O. and Quah, D. (1989),"The Dynamic Effects of Aggregate Demand and Supply Disturbances," American Economic Review 79, 9/1989, pp665-673.

[5] Campa, J.M,. and Goldberg, L.S,. (2004). Exchange Rate Pass-Through into import prices. Discussion Paper No. 4391. Centre for Economic Policy Research.

[6] Campa, J.M,. Goldberg, L.S,. (2002). "Exchange Rate Pass-Through into import prices: A Macro or Micro Phenomenon?" Federal Reserve Bank of New York, mimeo.

[7] Clarida, R and Gali, J. (1994), "Sources of Real Exchange Rate Fluctuations: How important are nominal shocks?" NBER Working Papers 4658, National Bureau of Economic Research.

[8] Engle, R .F, Granger, C, (1987). Co-Integration and Error Correction: Representation, Estimation, and Testing. Econometrica, 55, 251-276.

[9] Frankel, J, Parsley, D, Wei, S.J, (2005). "Slow Passthrough Around the World: A New Import for Developing countries?," National Bureau of Economic Research Working Paper 11199.

[10] Garcia, C.J,. Restrepo, J.E,. (2001). Price Inflation and Exchange rate pass-through in Chile. Central Bank of Chile Working Paper,128

[11] Goldfajn, I, Werlang, S.R.C, (2000). The Pass-through from Depreciation to Inflation: A Panel Study. Banco Central Do Brasil Working Paper n°5.

[12] Jang, K., (2001) . Impulse Response Analysis with Long Run Restrictions on Error Correction Models. Working Paper No. 01-04, Ohio State University, Department of Economics

[13] Jang, K. (2006),"An Alternative Approach to Estimation of Structural Vector Error Correction Models with Long-Run Restrictions," Economics Letters,Volume 90, Issue 1, pp126-13.

[14] Jang, K and Ogaki, M. (2001), "User Guide for VECM with Long-Run Restrictions," Department of Economics, The Ohio State University, manuscript.

[15] Jang, K and Ogaki, M. (2004), "The Effects of Monetary Policy Shocks on Exchange Rates: A Structural Vector Error Correction Model Approach," Journal of Japanese and International Economies 18, pp99-114.

[16] Johansen, S. (1988), "Statistical Analysis of Cointegration Vectors," Journal of Econometric Dynamics and Control, 12, 231-254.

[17] King, G, Plosser, I, Stock, H and Watson, W. (1991), "Stochastic Trends and Economic Fluctuations," American Economic Review, American Economic Association, vol. 81(4), pp 819-840, September.

[18] Kwiatkowski, D., Phillips, P. C. B., Schmidt, P. and Shin, Y. (1992), "Testing the null hypothesis of stationarity against the alternative of unit root," Journal of Econometrics, 54, pp159-178.

[19] Mellander, E., Vredin, A and Warne, A. (1992), Stochastic Trends and Economic Fluctuations in a Small Open Economy, Journal of Applied Econometrics, 7(4), 369-394.

[20] Park, J.Y. (1990), "Maximum Likelihood Estimation of Simultaneous Cointegrated Models," Manuscript, Cornell University.

[21] Rogers, J. (1999), "Monetary Shocks and Real Exchange Rates," Journal of International Economics 49, no.2, pp269-288.

[22] Shambaugh, J. (2006), "A New Look at Pass-through" Forthcoming on Journal of International Money and Finance.

[23] Said, SE, Dickey, D.A. (1984). Testing for Unit Roots in Autoregressive-Moving Average Models of Unknown Order, Biometrika 71, 599-607.

[24] Saikkonen, P and Lutkepohl, H. (2000), "Testing for the Cointegrating Rank of a VAR Process with an Intercept," Econometric Theory, Cambridge University Press, vol. 16(3), pp373-406,

[25] Taylor, J,. (2000), "Low inflation, Pass-through, and the Pricing Power of Firms". European Economic Review, Vol **44**, 1389-1408.

[26] Weber, A,.(1997), "Sources of Purchasing Power Parity Disparities between the G3 economies" Journal of the Japanese and International Economies, 11, pp548-583.

Appendix A. Data Sources and Preliminary Tests

Country	Industrial Production
1-Bolivia	Crude Petroleum production prices
2-Chile	Manufacturing Production
3-Colombia	Manufacturing Production
4-Ivory Coast	Industrial Production
5-Morocco	Manufacturing Production
7-Malaysia	Manufacturing Production
8-Tunisia	Industrial Production
9-Iran	Crude Petroleum production
10-Singapore	Manufacturing Production
11-Uruguay	Manufacturing Production
12-Venezuela	Crude Petroleum production

Table 2: Stationnarity tests

	ADF test				
Country	y_t	q_t	p_t	e_t	pm_t
Bol	I(1)	I(0)	I(1)	I(0)	I(1)
Chi	I(1)	I(1)	I(1)	I(1)	I(0)
Col	I(1)	I(1)	I(1)	I(1)	I(1)
Iv Co	I(1)	I(1)	I(1)	I(1)	I(1)
Ir	I(1)	I(1)	I(1)	I(1)	I(1)
Mal	I(1)	I(1)	I(1)	I(1)	I(1)
Mor	I(1)	I(0)	I(0)	I(1)	I(1)
Nig	I(1)	I(1)	I(1)	I(1)	I(1)
Singa	I(1)	I(1)	I(1)	I(1)	I(1)
Tun	I(1)	I(1)	I(0)	I(1)	I(1)
Uru	I(0)	I(1)	I(1)	I(1)	I(1)
Venez	I(1)	I(1)	I(1)	I(1)	I(1)

	KPSS test				
Country	y_t	q_t	p_t	e_t	pm_t
Bol	I(0)	I(0)	I(1)	I(0)	I(1)
Chi	I(1)	I(1)	I(1)	I(1)	I(1)
Col	I(1)	I(1)	I(1)	I(1)	I(1)
Iv Co	I(1)	I(1)	I(1)	I(1)	I(1)
Ir	I(1)	I(1)	I(1)	I(1)	I(1)
Mal	I(1)	I(1)	I(1)	I(1)	I(1)
Mor	I(1)	I(0)	I(1)	I(1)	I(1)
Nig	I(1)	I(1)	I(1)	I(1)	I(1)
Singa	I(1)	I(0)	I(1)	I(1)	I(1)
Tun	I(1)	I(1)	I(1)	I(1)	I(1)
Uru	I(0)	I(0)	I(1)	I(1)	I(1)
Venez	I(1)	I(0)	I(1)	I(1)	I(1)

Table 3 :Cointegration test results

	Bolivia		Colombia		Chile	
r_0	Johansen	Saikkonen Lütkepohl	Johansen	Saikkonen Lütkepohl	Johansen	Saikkonen Lütkepohl
0	140.73	80.37	148.81	80.97	146.71	157.59
1	70.88	42.53	55.90	42.18	54.00	41.04
2	32.97	26.32	33.07	22.17	33.22	24.13
3	17.50	12.31	18.14	7.24	18.64	11.04
4	5.42	1.73	6.03	0.01	5.02	0.03
	Ivory Coast		Iran		Malaysia	
r_0	Johansen	Saikkonen Lütkepohl	Johansen	Saikkonen Lütkepohl	Johansen	Saikkonen Lütkepohl
0	178.74	85.22	112.74	95.63	118.99	58.53
1	91.01	39.76	52.96	43.12	53.98	30.01
2	33.68	21.04	23.23	14.22	26.90	17.18
3	18.75	5.85	12.95	4.07	14.13	4.99
4	7.53	0.24	3.13	0.12	4.41	0.01
	Morocco		Nigeria		Uruguay	
r_0	Johansen	Saikkonen Lütkepohl	Johansen	Saikkonen Lütkepohl	Johansen	Saikkonen Lütkepohl
0	128.82	72.45	93.26	68.17	114.53	69.49
1	51.28	40.11	53.01	45.38	58.75	43.67
2	39.24	19.28	25.84	21.53	32.33	18.80
3	18.76	9.80	14.78	10.50	18.66	10.41
4	6.20	1.83	6.59	2.78	8.81	0.51
	Venezuela		Singapore		Tunisia	
r_0	Johansen	Saikkonen Lütkepohl	Johansen	Saikkonen Lütkepohl	Johansen	Saikkonen Lütkepohl
0	117.87	77.42	109.11	57.22	115.27	70.36
1	58.64	39.28	54.52	34.40	57.11	39.80
2	30.46	26.17	27.18	11.65	34.99	23.05
3	14.67	10.73	10.16	8.25	17.42	5.73
4	4.06	0.62	3.62	3.61	4.58	4.57

Note:Critical values for Johansen and Saikkonen and Lütkepohl are available in the appendix.

Appendix A:Pass-through ratio results

Table 1 Demand shock 1period

	Jang and Ogaki		
Countries	p_t	pm_t	e_t
Bol	0.3032 [0.1388,0.4808]	0.0386 [0.0048,0.0832]	-0.0511 [-0.0879,0.0161]
Chi	-0.0097 [-0.0149,-0.0043]	-0.0442 [-0.0683,-0.0200]	0.0642 [0.0461,0.0888]
Col	0.0017 [-0.0006, 0.0048]	0.0002 [-0.0027, 0.0033]	0.0046 [0.0008, 0.0099]
Iv Co	-0.0027 [-0.0066,0.0013]	-0.0246 [-0.1046,0.0316]	0.0597 [0.0378,0.0993]
Ir	-0.0026 [-0.0089,0.0009]	-0.0055 [-0.0175,0.0010]	0.0013 [-0.0007,0.0067]
Mal	-0.0005 [-0.0026,0.0013]	-0.0142 [-0.0323,0.0046]	0.0326 [0.0190,0.0440]
Mor	-0.0009 [-0.0016,-0.0002]	-0.0331 [-0.0662,-0.0013]	0.0002 [-0.0002, 0.0005]
Nig	-0.0061 [-0.0122,0.0011]	0.0019 [-0.0111,0.0172]	0.1531 [0.0868,0.2358]
Singa	0.0005 [-0.0004,0.0017]	0.0099 [0.0050,0.0172]	0.0033 [0.0007,0.0066]
Tu	-0.0014 [-0.0055,0.0029]	0.0072 [-0.0142,0.0314]	0.0242 [0.0176,0.0330]
Uru	-0.0149 [-0.0292,0.0003]	0.0365 [0.0106,0.0676]	0.0851 [0.0611,0.1284]
Venez	-0.0133 [-0.0213,-0.0053]	-0.0180 [-0.0402,0.0025]	0.0221 [0.0038,0.0410]

Warne et al			
Countries	p_t	pm_t	e_t
Bol	0.4388 [0.1819,0.7134]	0.0745 [0.0236,0.1582]	-0.1149 [-0.2110,0.0595]
Chi	-0.0253 [-0.0377,-0.0120]	-0.0637 [-0.1039,-0.0213]	0.1125 [0.0867,0.1520]
Col	0.0017 [-0.0006,0.0048]	0.0002 [-0.0027,0.0033]	0.0529 [0.0451,0.0701]
Iv Co	-0.0056 [-0.0142,0.0044]	-0.0223 [-0.1622,0.0641]	0.1174 [0.0861, 0.1911]
Ir	-0.0026 [-0.0089,0.0009]	-0.0082 [-0.0288,0.0036]	0.0040 [-0.0017,0.0193]
Mal	-0.0002 [-0.0041,0.0029]	-0.0261 [-0.0609,0.0100]	0.0653 [0.0382,0.0879]
Mor	-0.0027 [-0.0048,-0.0005]	-0.0647 [-0.1309,-0.0006]	0.0002 [-0.0002,0.0005]
Nig	-0.0061 [-0.0122,0.0011]	0.0053 [-0.0307,0.0489]	0.3004 [0.1703,0.4689]
Singa	0.0005 [-0.0004,0.0017]	0.0130 [0.0065, 0.0248]	0.0033 [0.0007, 0.0066]
Tu	-0.0014 [-0.0055,0.0029]	0.0087 [-0.0221,0.0441]	0.0431 [0.0340,0.0582]
Uru	-0.0214 [-0.0460,0.0048]	0.0365 [0.0106,0.0676]	0.1450 [0.1122,0.2156]
Venez	-0.0133 [-0.0213,-0.0053]	-0.0200 [-0.0512,0.0114]	0.0221 [0.0038,0.0410]

Table 2:Supply shock 1 period

	Jang and Ogaki		
Countries	p_t	pm_t	e_t
Bol	-0.0102 [-0.0600,0.0538]	0.0287 [0.0047,0.0582]	0.0538 [0.0129,0.0958]
Chi	0.0077 [0.0031,0.0133]	-0.0011 [-0.0152,0.0141]	-0.0053 [-0.0202,0.0112]
Col	-0.0039 [-0.0067,-0.0015]	0.0009 [-0.0059,0.0062]	-0.0073 [-0.0146,0.0037]
Iv Co	0.0067 [-0.0013,0.0126]	-0.0654 [-0.1580,0.0079]	-0.0098 [-0.0223,0.0118]
Ir	-0.0094 [-0.0178,0.0018]	-0.0028 [-0.0124,0.0073]	0.0015 [-0.0196,0.0417]
Mal	-0.0017 [-0.0035,0.0003]	0.0397 [0.0252,0.0579]	0.0007 [-0.0052,0.0070]
Mor	-0.0045 [-0.0064,-0.0020]	0.0466 [0.0225,0.0761]	-0.0006 [-0.0040,0.0030]
Nig	-0.0152 [-0.0286,-0.0028]	0.0326 [-0.0172,0.0686]	0.0270 [0.0004,0.0646]
Singa	0.0033 [0.0017, 0.0049]	0.0097 [0.0035,0.0172]	0.0038 [-0.0006,0.0100]
Tu	-0.0009 [-0.0038,0.0027]	-0.0005 [-0.0219,0.0167]	-0.0002 [-0.0036,0.0043]
Uru	0.0083 [0.0016,0.0173]	0.0826 [0.0570,0.1177]	-0.0081 [-0.0325,0.0184]
Venez	0.0028 [-0.0053,0.0136]	-0.0113 [-0.0314,0.0112]	0.0106 [-0.0225,0.0390]

Warne et al			
Countries	p_t	pm_t	e_t
Bol	-0.0255	0.0572	0.1134
	[-0.1010,0.0625]	[0.0078,0.1149]	[0.0525,0.1858]
Chi	0.0126	-0.0050	-0.0067
	[0.0052,0.0218]	[-0.0264,0.0202]	[-0.0315,0.0211]
Col	0.0007	0.0008	-0.0112
	[-0.0061,0.0063]	[-0.0095,0.0083]	[-0.0221,0.0064]
Iv Co	0.0091	-0.0639	-0.0133
	[-0.0039,0.0179]	[-0.2401,0.0878]	[-0.0345,0.0215]
Ir	-0.0132	0.0005	0.0001
	[-0.0288,0.0086]	[-0.0175,0.0202]	[-0.0777,0.1400]
Mal	-0.0035	0.0792	0.0015
	[-0.0071,0.0006]	[0.0513,0.1142]	[-0.0105, 0.0141]
Mor	-0.0071	0.0963	-0.0016
	[-0.0107,-0.0020]	[0.0479, 0.1577]	[-0.0080, 0.0052]
Nig	-0.0152	0.0606	0.0392
	[-0.0286, -0.0028]	[-0.0293, 0.1245]	[-0.0036, 0.1019]
Singa	0.0044	0.0153	0.0037
	[0.0020, 0.0071]	[0.0053,0.0279]	[-0.0035, 0.0130]
Tu	-0.0009	-0.0005	-0.0002
	[-0.0038, 0.0027]	[-0.0219, 0.0167]	[-0.0036, 0.0043]
Uru	0.0136	0.1725	-0.0125
	[0.0023,0.0275]	[0.1372,0.2230]	[-0.0489,0.0275]
Venez	0.0046	-0.0184	0.0162
	[-0.0071, 0.0199]	[-0.0426, 0.0179]	[-0.0280, 0.0575]

Table3 Nominal shock 1 period

	Jang and Ogaki		
Countries	p_t	pm_t	e_t
Bol	0.1424 [0.0893,0.2121]	-0.0361 [-0.0682,0.0075]	-0.1404 [-0.1930,-0.0803]
Chi	0.0153 [0.0139,0.0201]	0.0390 [0.0268,0.0596]	-0.0125 [-0.0174,-0.0102]
Col	0.0172 [0.0152,0.0229]	-0.0035 [-0.0092,0.0034]	0.0186 [0.0087,0.0337]
Iv Co	0.0263 [0.0162,0.0387]	-0.0060 [-0.0622,0.0738]	-0.0392 [-0.0885, 0.0202]
Ir	0.0435 [0.0352,0.0551]	0.0237 [0.0135,0.0352]	-0.0049 [-0.0258,0.0197]
Mal	0.0051 [0.0041,0.0065]	-0.0155 [-0.0289,-0.0028]	-0.0040 [-0.0056,-0.0028]
Mor	0.0099 [0.0080,0.0121]	0.0438 [0.0182,0.0615]	-0.0019 [-0.0066,0.0037]
Nig	0.1163 [0.0769,0.1718]	0.0202 [-0.0179,0.0573]	-0.0354 [-0.0640,-0.0182]
Singa	0.0061 [0.0048,0.0084]	-0.0064 [-0.0116,0.0018]	0.0043 [-0.0004,0.0092]
Tu	0.0369 [0.0270,0.0523]	0.0093 [-0.0137,0.0362]	0.0015 [-0.0031, 0.0093]
Uru	0.0206 [0.0155,0.0296]	0.0187 [-0.0085,0.0400]	0.0216 [0.0070,0.0374]
Venez	0.0389 [0.0274,0.0583]	0.0592 [0.0330,0.0997]	-0.0788 [-0.1223, -0.0552]

Warne et al			
Countries	p_t	pm_t	e_t
Bol	0.2763 [0.1765,0.4082]	-0.0724 [-0.1366,0.0127]	-0.2715 [-0.3770,-0.1577]
Chi	0.0304 [0.0259,0.0419]	0.0652 [0.0476,0.0968]	-0.0357 [-0.0549,-0.0225]
Col	0.0314 [0.0287,0.0394]	-0.0052 [-0.0138,0.0056]	0.0327 [0.0166, 0.0559]
Iv Co	0.0462 [0.0295,0.0662]	-0.0031 [-0.1272,0.1352]	-0.0849 [-0.1845,0.0429]
Ir	0.0850 [0.0681,0.1040]	0.0452 [0.0264,0.0652]	-0.0086 [-0.0494,0.0395]
Mal	0.0107 [0.0089,0.0136]	-0.0292 [-0.0554,-0.0047]	-0.0079 [-0.0111,-0.0057]
Mor	0.0205 [0.0175,0.0250]	0.0888 [0.0381,0.1236]	-0.0040 [-0.0134,0.0074]
Nig	0.2195 [0.1470,0.3242]	0.0444 [-0.0245,0.1136]	-0.0578 [-0.1071,-0.0252]
Singa	0.0112 [0.0089,0.0150]	-0.0069 [-0.0142,0.0054]	0.0068 [0.0006,0.0138]
Tu	0.0369 [0.0270,0.0523]	0.0022 [-0.0390,0.0384]	0.0015 [-0.0031, 0.0093]
Uru	0.0392 [0.0327,0.0528]	0.0187 [-0.0085,0.0400]	0.0216 [0.0070,0.0374]
Venez	0.0624 [0.0486,0.0840]	0.0998 [0.0588,0.1627]	-0.1374 [-0.2133, -0.0886]

Table 4: Foreign shock 1 period

	Jang and Ogaki		
Countries	p_t	pm_t	e_t
Bol	0.0112 [-0.0012,0.0247]	-0.0002 [-0.0215,0.0279]	0.0957 [0.0861,0.1453]
Chi	0.0002 [-0.0024,0.0040]	0.0070 [-0.0026,0.0171]	0.0232 [0.0154,0.0354]
Col	-0.0016 [-0.0073,0.0030]	0.0020 [-0.0009,0.0053]	0.0178 [0.0142,0.0274]
Iv Co	-0.0011 [-0.0045, 0.0013]	-0.0056 [-0.0681,0.0527]	0.0113 [0.0028,0.0277]
Ir	-0.0058 [-0.0111,-0.0003]	-0.0055 [-0.0144,0.0033]	0.1338 [0.0835,0.2145]
Mal	0.0001 [-0.0004,0.0006]	0.0003 [-0.0008,0.0018]	0.0051 [0.0044,0.0062]
Mor	-0.0001 [-0.0009,0.0008]	-0.0088 [-0.0335,0.0202]	0.0184 [0.0158,0.0222]
Nig	0.0067 [0.0020,0.0133]	-0.0021 [-0.0120,0.0120]	0.0306 [0.0226,0.0474]
Singa	0.0008 [-0.0003,0.0019]	-0.0011 [-0.0104,0.0073]	0.0186 [0.0166,0.0249]
Tu	-0.0031 [-0.0070,0.0005]	-0.0152 [-0.0371,0.0117]	0.0090 [0.0066,0.0135]
Uru	-0.0008 [-0.0082,0.0065]	-0.0146 [-0.0300,0.0065]	0.0459 [0.0307,0.0691]
Venez	0.0060 [-0.0052,0.0188]	-0.0161 [-0.0447,0.0172]	0.0576 [0.0531,0.0741]

	Warne et al		
Countries	p_t	pm_t	e_t
Bol	0.0314 [-0.0037,0.0690]	-0.0006 [-0.0416,0.0556]	0.2039 [0.1886,0.2978]
Chi	0.0002 [-0.0024,0.0040]	0.0140 [-0.0047,0.0363]	0.0373 [0.0277,0.0520]
Col	-0.0016 [-0.0104,0.0052]	0.0063 [-0.0016,0.0169]	0.0293 [0.0255,0.0402]
Iv Co	-0.0027 [-0.0066,0.0013]	-0.0228 [-0.1514,0.1022]	0.0207 [0.0124,0.0379]
Ir	-0.0058 [-0.0111,-0.0003]	-0.0048 [-0.0201,0.0098]	0.2647 [0.1686,0.4237]
Mal	0.0001 [-0.0004,0.0006]	0.0003 [-0.0008,0.0018]	0.0103 [0.0087,0.0123]
Mor	-0.0001 [-0.0009,0.0008]	-0.0173 [-0.0665,0.0404]	0.0368 [0.0316,0.0444]
Nig	0.0067 [0.0020,0.0133]	-0.0058 [-0.0335,0.0318]	0.0677 [0.0564,0.1009]
Singa	0.0008 [-0.0003,0.0019]	-0.0017 [-0.0193,0.0179]	0.0325 [0.0301,0.0413]
Tu	-0.0031 [-0.0070,0.0005]	-0.0152 [-0.0371,0.0117]	0.0134 [0.0111,0.0183]
Uru	-0.0068 [-0.0196,0.0035]	-0.0146 [-0.0300,0.0065]	0.0818 [0.0632,0.1137]
Venez	0.0060 [-0.0052,0.0188]	-0.0279 [-0.0678,0.0202]	0.1210 [0.0980,0.1706]

Table 5: Demand shock 5 periods

Jang and Ogaki			
Countries	p_t	pm_t	e_t
Bol	0.6942 [0.3930,1.0856]	0.0449 [-0.0428,0.1215]	-0.4895 [-0.7466,-0.1832]
Chi	-0.0267 [-0.0406,-0.0160]	-0.0556 [-0.0886,-0.0256]	0.0598 [0.0338,0.0959]
Col	0.0079 [0.0026,0.0155]	0.0044 [-0.0023,0.0135]	0.0065 [0.0019,0.0131]
Iv Co	-0.0025 [-0.0083,0.0053]	-0.0208 [-0.0904,0.0345]	0.0602 [0.0342,0.1001]
Ir	-0.0124 [-0.0411,0.0006]	-0.0163 [-0.0446,-0.0055]	0.0065 [-0.0019,0.0278]
Mal	-0.0031 [-0.0066,0.0004]	-0.0227 [-0.0459,0.0011]	0.0325 [0.0177,0.0447]
Mor	-0.0042 [-0.0076,-0.0012]	-0.0383 [-0.0729,-0.0039]	0.0007 [-0.0007,0.0024]
Nig	-0.0205 [-0.0412,0.0030]	0.0064 [-0.0314,0.0584]	0.1672 [0.0751,0.2519]
Singa	-0.0003 [-0.0025,0.0020]	0.0102 [0.0032,0.0186]	0.0037 [-0.0023,0.0093]
Tu	0.0005 [-0.0068,0.0093]	0.0010 [-0.0185,0.0267]	0.0328 [0.0186,0.0481]
Uru	-0.0299 [-0.0615,0.0007]	0.0184 [-0.0107,0.0497]	0.0951 [0.0624,0.1523]
Venez	-0.0455 [-0.0812,-0.0249]	-0.0432 [-0.0855,-0.0100]	0.0446 [0.0129,0.0919]

Warne et al			
Countries	p_t	pm_t	e_t
Bol	2.7394 [1.5054,4.3195]	0.2463 [-0.0494,0.5587]	-1.3381 [-2.0320,-0.4438]
Chi	-0.1199 [-0.1772,-0.0663]	-0.2798 [-0.4481,-0.1362]	0.3644 [0.2439,0.5338]
Col	0.0265 [0.0078,0.0527]	0.0107 [-0.0149,0.0433]	0.1925 [0.1202,0.2820]
Iv Co	-0.0118 [-0.0379,0.0180]	-0.1119 [-0.5470,0.1586]	0.3548 [0.2271,0.5849]
Ir	-0.0377 [-0.1299,0.0055]	-0.0575 [-0.1637,-0.0123]	0.0197 [-0.0065,0.0885]
Mal	-0.0088 [-0.0245,0.0060]	-0.1046 [-0.2269,0.0169]	0.1955 [0.1115,0.2653]
Mor	-0.0129 [-0.0232,-0.0032]	-0.2103 [-0.4122,-0.0157]	0.0022 [-0.0023,0.0075]
Nig	-0.0703 [-0.1413,0.0063]	0.0218 [-0.1153,0.2097]	0.9519 [0.4937,1.4435]
Singa	0.0016 [-0.0068,0.0105]	0.0553 [0.0216,0.0989]	0.0204 [-0.0003,0.0452]
Tu	-0.0016 [-0.0293,0.0341]	0.0133 [-0.0732,0.1206]	0.1640 [0.1070,0.2291]
Uru	-0.1213 [-0.2440,0.0000]	0.1252 [-0.0159,0.2652]	0.5137 [0.3548,0.7994]
Venez	-0.1600 [-0.2734,-0.0900]	-0.1714 [-0.3429,-0.0353]	0.1860 [0.0523,0.3656]

Table 6: Supply shock 5 periods

Jang and Ogaki			
Countries	p_t	pm_t	e_t
Bol	0.0019 [-0.1169,0.1577]	0.0289 [0.0038,0.0607]	0.0403 [-0.0764,0.1607]
Chi	0.0203 [0.0132,0.0339]	0.0065 [-0.0091,0.0306]	0.0122 [-0.0118,0.0361]
Col	0.0122 [0.0063,0.0190]	0.0091 [-0.0025,0.0235]	-0.0171 [-0.0346,0.0033]
Iv Co	0.0048 [-0.0058,0.0142]	-0.0172 [-0.1218,0.0822]	-0.0096 [-0.0356,0.0170]
Ir	-0.0309 [-0.0503,-0.0075]	-0.0264 [-0.0505,0.0003]	0.0099 [-0.0231,0.0698]
Mal	-0.0015 [-0.0045,0.0021]	0.0405 [0.0202,0.0637]	0.0008 [-0.0058,0.0072]
Mor	-0.0117 [-0.0153,-0.0071]	0.0353 [0.0077,0.0705]	0.0006 [-0.0045,0.0055]
Nig	-0.0514 [-0.0984,-0.0005]	0.0439 [-0.0449,0.1247]	0.0624 [0.0090,0.1406]
Singa	0.0074 [0.0042, 0.0110]	0.0115 [0.0044,0.0210]	0.0117 [0.0038,0.0224]
Tu	-0.0005 [-0.0030, 0.0041]	0.0010 [-0.0104,0.0142]	-0.0014 [-0.0067,0.0058]
Uru	0.0164 [0.0024, 0.0437]	0.5332 [0.4196,0.7241]	-0.0199 [-0.0512,0.0196]
Venez	0.0099 [-0.0151,0.0453]	-0.0088 [-0.0450,0.0351]	0.0053 [-0.0488,0.0503]

Warne et al			
Countries	p_t	pm_t	e_t
Bol	-0.0327 [-0.4753,0.5662]	0.1724 [0.0257,0.3555]	0.2911 [-0.1298,0.7079]
Chi	0.0779 [0.0493,0.1273]	0.0150 [-0.0571,0.1130]	0.0169 [-0.0797,0.1137]
Col	0.0343 [0.0140,0.0547]	0.0256 [-0.0245,0.0785]	-0.0689 [-0.1280,0.0162]
Iv Co	0.0235 [-0.0245,0.0643]	-0.0533 [-0.5973,0.4267]	-0.0390 [-0.1372,0.0828]
Ir	-0.1050 [-0.1781,-0.0282]	-0.0702 [-0.1565,0.0230]	0.0171 [-0.1197,0.2712]
Mal	-0.0098 [-0.0223,0.0042]	0.2399 [0.1428,0.3600]	0.0045 [-0.0329,0.0425]
Mor	-0.0434 [-0.0587,-0.0237]	0.2540 [0.0996,0.4316]	-0.0009 [-0.0246,0.0235]
Nig	-0.1763 [-0.3358,-0.0104]	0.2223 [-0.1243,0.4911]	0.2454 [0.0432,0.5591]
Singa	0.0295 [0.0163,0.0433]	0.0610 [0.0270,0.1058]	0.0419 [0.0101,0.0899]
Tu	-0.0028 [-0.0150, 0.0166]	0.0051 [-0.0498,0.0603]	-0.0048 [-0.0263,0.0245]
Uru	0.0726 [0.0125, 0.1570]	0.5332 [0.4196,0.7241]	-0.0839 [-0.2307,0.0970]
Venez	0.0315 [-0.0500,0.1380]	-0.0618 [-0.2053,0.1067]	0.0510 [-0.1812,0.2628]

Table 7: Nominal shock 5 periods

Jang and Ogaki			
Countries	p_t	pm_t	e_t
Bol	0.1619 [0.0975,0.2493]	-0.0358 [-0.0676,0.0098]	-0.1624 [-0.2326,-0.0881]
Chi	0.0136 [0.0060,0.0244]	0.0405 [0.0238,0.0645]	-0.0318 [-0.0607,-0.0129]
Col	0.0155 [0.0103,0.0226]	-0.0060 [-0.0149,0.0033]	0.0196 [0.0064,0.0393]
Iv Co	0.0286 [0.0141,0.0421]	-0.0215 [-0.1009,0.0584]	-0.0168 [-0.0559,0.0327]
Ir	0.0514 [0.0401, 0.0794]	0.0323 [0.0152,0.0578]	-0.0090 [-0.0360,0.0228]
Mal	0.0030 [0.0008,0.0053]	-0.0221 [-0.0395,-0.0075]	-0.0040 [-0.0067,-0.0012]
Mor	0.0071 [0.0022,0.0099]	0.0394 [0.0099,0.0629]	-0.0015 [-0.0067,0.0040]
Nig	0.1478 [0.0923,0.2176]	0.0104 [-0.0484,0.0968]	-0.0660 [-0.1253,-0.0308]
Singa	0.0061 [0.0034,0.0092]	-0.0080 [-0.0163,0.0002]	0.0064 [-0.0016,0.0149]
Tu	0.0201 [0.0133,0.0281]	0.0070 [-0.0128,0.0257]	-0.0009 [-0.0088,0.0120]
Uru	0.0471 [0.0345,0.0699]	0.0171 [-0.0183,0.0474]	0.0399 [0.0157,0.0798]
Venez	0.0617 [0.0340,0.1145]	0.0729 [0.0362,0.1389]	-0.0878 [-0.1534,-0.0329]

Warne et al			
Countries	p_t	pm_t	e_t
Bol	0.9002 [0.5528,1.3601]	-0.2161 [-0.4076,0.0515]	-0.8943 [-1.2369,-0.5016]
Chi	0.0885 [0.0573,0.1336]	0.2283 [0.1458,0.3476]	-0.1521 [-0.2681,-0.0825]
Col	0.0896 [0.0742,0.1219]	-0.0272 [-0.0686,0.0157]	0.1125 [0.0458,0.2100]
Iv Co	0.1589 [0.0855,0.2330]	-0.0809 [-0.5000,0.3606]	-0.2283 [-0.5186, 0.1283]
Ir	0.2790 [0.2244,0.3893]	0.1616 [0.0859,0.2639]	-0.0384 [-0.1744,0.1279]
Mal	0.0257 [0.0177,0.0356]	-0.1081 [-0.1953,-0.0246]	-0.0239 [-0.0349,-0.0149]
Mor	0.0530 [0.0353,0.0659]	0.2527 [0.0941,0.3686]	-0.0106 [-0.0399,0.0231]
Nig	0.7719 [0.5074,1.1351]	0.0980 [-0.1450,0.4201]	-0.2842 [-0.5243,-0.1428]
Singa	0.0359 [0.0259,0.0508]	-0.0381 [-0.0764,0.0069]	0.0319 [-0.0036,0.0692]
Tu	0.1161 [0.0832,0.1630]	0.0253 [-0.0982,0.1279]	0.0020 [-0.0340,0.0582]
Uru	0.1811 [0.1368,0.2591]	0.0827 [-0.0457,0.2052]	0.1681 [0.0751,0.3071]
Venez	0.2864 [0.1857,0.4800]	0.3816 [0.2270,0.6850]	-0.4848 [-0.7964, -0.2873]

Table 8:Foreign shock 5 periods

Jang and Ogaki			
Countries	p_t	pm_t	e_t
Bol	0.0375 [-0.0074,0.0819]	0.0002 [-0.0226,0.0292]	0.0663 [0.0306,0.1454]
Chi	0.0050 [-0.0045,0.0178]	0.0140 [-0.0086,0.0479]	0.0461 [0.0187,0.0844]
Col	0.0032 [-0.0046,0.0111]	0.0123 [0.0046,0.0294]	0.0253 [0.0104,0.0497]
Iv Co	-0.0354 [-0.0839,0.0281]	0.0051 [-0.0833,0.0869]	0.0147 [-0.0037,0.0509]
Ir	-0.0278 [-0.0536,-0.0032]	-0.0297 [-0.0590,-0.0019]	0.1454 [0.0805,0.2364]
Mal	0.0004 [-0.0016,0.0027]	0.0014 [-0.0041,0.0083]	0.0051 [0.0041,0.0063]
Mor	-0.0006 [-0.0042,0.0036]	-0.0096 [-0.0358,0.0178]	0.0185 [0.0155,0.0225]
Nig	0.0227 [0.0094,0.0452]	-0.0071 [-0.0385,0.0351]	0.0149 [-0.0112,0.0397]
Singa	0.0015 [-0.0009,0.0040]	-0.0022 [-0.0121,0.0063]	0.0186 [0.0166,0.0249]
Tu	-0.0067 [-0.0130,0.0008]	-0.0121 [-0.0308,0.0113]	0.0090 [0.0066,0.0135]
Uru	0.0412 [0.0135,0.0759]	-0.0131 [-0.0499,0.0297]	0.0606 [0.0226,0.1053]
Venez	0.0189 [-0.0066,0.0550]	-0.0130 [-0.0537,0.0371]	0.0633 [0.0268,0.1189]

Warne et al			
Countries	p_t	pm_t	e_t
Bol	0.0587 [-0.0061,0.1288]	-0.0001 [-0.1302,0.1693]	0.5047 [0.3946,0.8690]
Chi	0.0117 [-0.0197,0.0528]	0.0605 [-0.0268,0.1890]	0.1910 [0.0960,0.3217]
Col	0.0022 [-0.0274,0.0258]	0.0355 [0.0061,0.0875]	0.1248 [0.0759,0.2153]
Iv Co	-0.0037 [-0.0138, 0.0057]	0.0111 [-0.4012,0.4025]	0.0771 [0.0016,0.2085]
Ir	-0.0844 [-0.1626,-0.0081]	-0.0879 [-0.1758,0.0055]	0.8291 [0.4937,1.3357]
Mal	0.0013 [-0.0051,0.0084]	0.0042 [-0.0124,0.0254]	0.0308 [0.0257,0.0379]
Mor	-0.0020 [-0.0129,0.0110]	-0.0545 [-0.2063,0.1175]	0.1107 [0.0941,0.1340]
Nig	0.0780 [0.0308,0.1550]	-0.0242 [-0.1381,0.1205]	0.1467 [0.0564,0.2654]
Singa	0.0062 [-0.0017,0.0156]	-0.0081 [-0.0555,0.0355]	0.1122 [0.0959,0.1536]
Tu	-0.0277 [-0.0542,-0.0001]	-0.0594 [-0.1446,0.0514]	0.0559 [0.0332,0.0879]
Uru	0.0894 [0.0031,0.1882]	-0.0816 [-0.1882,0.0799]	0.3108 [0.1692,0.4957]
Venez	0.0639 [-0.0274,0.1935]	-0.0884 [-0.2874,0.1249]	0.3819 [0.2316,0.6359]

Table 9:Pass-through ratios Jang and Ogaki (2004) method.

		S		D		N		F	
Country		p_t	pm_t	p_t	pm_t	p_t	pm_t	p_t	pm_t
Bol	period 1	-0.189	0.533	-0.771	-0.702	-1.014	0.257	0.117	-0.020
	period 5	0.047	0.717	-0.784	-0.091	-0.996	0.220	0.565	0.003
Chil	period 1	-1.452	0.202	0.380	1.415	-0.650	-1.681	0.008	0.301
	period 5	1.663	0.532	0.554	0.771	-0.427	-1.273	0.128	0.303
Colom	period 1	-0.126	0.217	0.369	0.043	0.924	-1.417	-0.536	0.112
	period 5	-0.713	-2.111	1.215	0.676	0.790	-0.306	0.126	0.486
Iv- Co	period 1	-1.634	1.352	-0.045	-0.412	-0.670	0.153	3.179	-0.495
	period 5	-0.511	1.791	-0.041	-0.345	-0.807	0.607	2.069	0.346
Ir	period 1	-6.266	-1.866	-2	-4.230	-2.585	-4.836	-0.043	-0.041
	period 5	-3.121	-2.666	-1.907	-2.507	-3.257	-3.588	-0.191	-0.204
Mal	period 1	-2.428	56.710	-0.015	-0.435	-1.275	3.875	0.019	0.058
	period 5	-1.875	50.625	-0.095	-0.698	-0.75	5.525	0.078	0.274
Mor	period 1	7,5	-1.406	1.475	-1.227	-2.513	-23.052	-0.005	-0.478
	period 5	-19,5	-0.801	6.334	-0.673	1.608	-26.266	-0.032	-0.518
Nig	period 1	-0.562	1.207	-0.039	0.012	-3.285	-0.570	-0.105	-0.068
	period 5	-0.823	0.703	-0.122	0.038	-2.239	-0.157	-0.225	-0.476
Singa	period 1	0.868	2.552	0.151	3.939	1.418	-1.488	0.043	-0.059
	period 5	0.632	0.982	-0.081	14.945	0.953	-1.251	0.074	-0.108
Tun	period 1	4.5	2.5	-0.057	0.297	12.4	6.2	-0.344	-1.688
	period 5	0.357	-0.714	0.015	0.030	-22.333	-7.777	-0.644	-1.163
Urug	period 1	-1.024	-10.197	-0.175	0.428	0.953	0.865	-0.017	-0.318
	period 5	-0.824	-4.723	-0.314	0.193	1.180	0.428	0.679	-0.216
Venez	period 1	0.264	-1.066	-0.601	-0.814	-0.493	-0.751	0.104	-0.279
	period 5	1.867	-1.660	-1.020	-0.968	-0.702	-0.830	0.298	-0.205

Table 10:Pass-through ratios Warne et al (1992) method

		S		De		N		F	
Country		p_t	pm_t	p_t	pm_t	p_t	pm_t	p_t	pm_t
Bol	period 1	-0.224	0.504	-0.897	-0.648	-0.990	0.266	0.153	-0.002
	period 5	-0.112	0.592	-8.938	-0.184	-1.117	0.241	0.694	-0.001
Chi	period 1	-1.880	0.746	4.084	3	0.960	-0.733	0.0501	0.375
	period 5	2.999	0.887	-4.092	-2.998	0.796	-1.500	0.404	0.316
Col	period 1	-0.062	-2.121	0.032	-2.142	0.960	-0.159	-0.054	0.215
	period 5	-0.497	-0.371	0.137	-2.528	0.796	-0.241	0.017	0.284
Iv Co	period 1	-0.684	1.065	-0.047	-0.189	-0.544	0.036	-0.053	-1.101
	period 5	-0.602	4.465	-0.033	-0.315	-0.696	0.354	-0.047	0.143
Ir	period 1	-132	5	-0.65	-2.05	-9.883	-5.255	-0.021	-0.018
	period 5	-6.140	-4.105	-1.913	-2.918	-7.265	-4.208	-0.101	-0.106
Mal	period 1	-2.333	52.8	-0.003	-0.399	-1.354	4.523	0.009	0.029
	period 5	-2.177	53.311	-0.045	-0.535	-1.075	3.696	0.042	0.136
Mor	period 1	4.4375	-9.266	-13.5	-9.168	-5	-9.371	-0.002	0.470
	period 5	48.222	-9.204	-5.863	-9.197	-5.125	-9.184	-0.018	-0.492
Nig	period 1	-0.387	1.545	-0.020	0.017	-3.797	-0.768	0.098	-0.682
	period 5	-0.718	0.905	-0.073	0.022	-2.716	-0.344	0.531	1.355
Singa	period 1	1.189	4.135	0.363	3.090	1.647	-1.014	0.024	-0.052
	period 5	0.704	1.455	0.485	2.710	1.125	-1.194	0.055	-0.072
Tun	period 1	4.5	2.5	-0.032	0.201	8.386	0.5	-0.231	-1.134
	period 5	0.583	-1.062	-0.009	0.081	58.05	12.65	-0.495	-1.062
Uru	period 1	-1.088	-13.8	-0.147	0.251	1.814	0.865	-0.083	-0.178
	period 5	-0.865	-6.355	-0.236	0.243	1.077	0.491	0.287	-0.262
Venez	period 1	0.283	-1.135	-0.601	-0.904	-0.454	-0.726	0.049	-0.230
	period 5	0.617	-1.211	-0.860	-0.921	-0.590	-0.787	0.167	-0.231