Exchange Rate Pass Through In Romania

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Abstract

Using domestic price data for Romania, covering the period 2000M1 to 2011M12, I investigate the mechanism of transmission of exchange rate shocks into domestic inflation at import, producer and consumer level. My results show that exchange rate pass through is incomplete, both in the short term and on the long term, it decreases along the pricing chain and through time. Continuing with the analysis at import price level I observe that there is asymmetry in the exporter's behavior when it comes to the appreciation versus the depreciation of the domestic currency. Deepening the analysis at sectoral level I obtain a significant degree of heterogeneity among industries.

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1 Introduction

The importance of Exchange Rate Pass Through, although a very old phenomena, was much neglected by the economic literature in the past. Following the major changes that took place after the 70's when the Bretton Woods system collapsed and currencies were allowed to float free against one another, coupled with the countries' struggle for internal price stability and external competition, all this required a deeper understanding of the mechanism of domestic price adjustment to shocks in exchange rate.

For long time, Romania has been struggling with price inflation and huge deficits in the current account. The position of a small open economy in an ever integrated world economy leaves the country vulnerable to external shocks such as those affecting the exchange rate. Having as main goal, the price stability, and as main strategy the inflation targeting, the monetary authority in Romania pays great attention to movements in exchange rate and changes in the international price of different commodities such as energy or raw materials. This is done mainly on the belief that fluctuations in the exchange rate and international price changes affect the country's domestic prices and hence might interfere with banks objective. Moreover the decision of adopting euro in the years to follow poses great concern on the country's inflation sustainability.

It is for these two reasons that I considered to take a quantitative approach in understanding the mechanism of exchange rate transmission into domestic prices in Romania.

I decided to use two different methods with the benefit of giving a multidimensional perspective on the implications of the price adjustments to fluctuations in exchange rates.

The first approach makes use of the VAR methodology employing a model similar to McCharty (2000) and Hann (2003) "distribution chain model". My aim is to bring support to such theories that claim that ERPT declines along the pricing chain and when switching to a low inflation environment. Having in the view that a large part of imports in Romania come from the euro-zone countries I will also check how fluctuations in the euro currency transmit into domestic prices.

The second approach is a single equation estimation in which I will focus on the pass through to import prices. Firstly I will check if there is a long run relation between the variables of interest and afterwards I will derive the short-run dynamics. As the behavior of the agents might be different in case the exchange rate is appreciating or depreciating, or if prices are above or below the equilibrium level, I will allow for the possibility of asymmetry in the variables. I further continue the analysis at disaggregates level as I want to see if there is difference across industries in the size of ERPT. I am also interested in how much a change in the cost of their production is transmitted.

The results are in accordance with other literature findings, namely that ERPT decreases along the pricing chain and in a low inflation environment. In addition to this I find in Romania there is a substantial heterogeneity between the sectors and that agents' pricing strategy differs when it comes to the appreciation or the depreciation of the currency.

The paper is organized as follows. Section 2 presents the literature review emphasizing on one side on the theories put in front for explaining what drives ERPT and how, and on the other side on the methods and findings derived from the empirical literature. Section 3 contains an overview on Romania's economy and emphasizes the importance of the research question. Section 4 presents the methodology. In section 5 I describe the data and comment on the specification of the models and the results. Section 6 concludes.

2 Related literature

2.1 Theoretical approach

"The textbook theory defines the Exchange Rate Pass Through (ERPT) as being the percentage change in local currency import prices due to a one percent change in the exchange rate between the exporting and the importing countries." Goldberg and Knetter (1996)

The monetary approach in modeling the balance of payments and exchange rates paid little attention to the phenomena of ERPT into domestic prices. Relying on such assumptions as perfect competition, full flexibility in prices and the idea that PPP holds at all times, their models predict that no distortion in agent's choices can be brought by exchange rate fluctuations as prices would adjust immediately. They take as given the fact that the exporter will keep the price constant in spite of the movement in exchange rate.

Up to the 70's a large part of research was meant to validate the global monetarism approach and their theories of LOP and PPP. Following the move from fixed to floating exchange rates in the 70's, the attention of researchers was drawn by the potential role of the exchange rate in restoring equilibrium in the balance of payments and its effect on domestic inflation. If ERPT is complete (the exporter will not change his price) a depreciation in the domestic exchange rate would affect the international relative prices with a positive effect on the current account balance (imports would decrease and exports would increase). The effect on domestic inflation would be felt directly as imported goods are part of the final consumption. There is also an indirect effect: an increase in the price of imported intermediary input would increase the cost of domestic production with a further impact on consumer prices. The other extreme is when the ERPT is zero leaving no role for the exchange rate in absorbing the shocks on the balance of payments or aggregate activity. Whether or not this pass through of price increase is complete is the question of research.

The empirical literature consistently rejected the LOP and PPP on the short run[1] for a variety of goods and countries and evidence showed that ERPT is incomplete.

Models relying on imperfect competition and strategic behavior were developed as an explanation. The incompleteness of ERPT was due to the ability of the exporting firm to have some control over its price in the importing country.

One seminal paper is that of Dornbusch (1987) who employs a Cournot duopoly model to show that the ERPT of import prices depends on the degree of competition in the domestic market allowing the firms to adjust the mark-up (not just the prices) in case of an exchange rate shock. Similar to the above paper, Ohno (1999) employed a Cournot duopoly model to explain the observed asymmetry in the pricing behavior of US exporters who completely pass through the fluctuations in exchange rate, relative to the Japanese counterparts that choose to absorb a large part of the fluctuations. Their explanation is different as they show that in the presence of hysteresis and a fluctuating exchange rate, the magnitude of exchange rate fluctuations and firm's planning horizon determine the degree of pass through and the relative market share.

Importance was also given to the degree of substitution between goods, the share of non-traded goods in consumer's choices, invoice currency and the size of domestic market. Campa and Goldberg (2002) argue for the composition of trade and imports as a main determinant for the size of exchange rate pass through as well as for the observed decline of it as a country develops. His argument is that homogeneous goods are expected to have a large pass-through as the market power of firms is reduced in a highly competitive market. This is the case of manufacturing products that represent a large share in the imports in less developed countries. A

[1] On the long run evidence is not clear cut (see Taylor and Taylor(2004))

shift towards more heterogeneous imports, as a country develops, might be an explanation for a decrease in its ERPT.

Macroeconomist saw this as an evidence for slow adjustment of goods prices and introduced nominal rigidities and market imperfections in dynamic general equilibrium (DGE) models. Slow adjustment was seen to be due to the presence of menu costs and staggered contracts.

The New Open Economy Macroeconomic framework incorporated theories of pricing strategy from the part of the exporter, claiming that if the exporter would choose producer currency pricing then the price would be fixed in the exporter's currency, making the exchange rate fluctuation to be fully passed to prices in the importing country. On the other hand, practicing local currency pricing strategy would render prices immune to exchange rate fluctuations which would be fully absorbed by the exporter. In the first case ERPT would be complete while in the latter would be zero. In between there is incomplete pass through. What determines a producer to choose one or another strategy is a question of research.

One strand of literature linked such behavior with the stance of monetary policy: the rate of inflation and the exchange rate regime and to the role of expectations. A seminal paper is that of Taylor (2000) who developed a theoretical model and provided evidence from the structural change in US monetary policy to show that a shift to low inflation environment and a more credible monetary policy would reduce ERPT. This is because, if changes in exchange rate or in import prices are viewed to be persistent, firms will more likely change the prices then adjusts their margins. Devereux and Yetman (2002) developed a DGE model where they investigated the importance of slow price adjustment-because of menu costs- in explaining ERPT in an open economy. In the model the exchange rate is treated as endogenous to monetary policy. Their approach is noteworthy: first they estimate the average pass through elasticity and then regress it on various explanatory variables. The results show that ERPT is positively related to mean inflation and mean exchange rate depreciation in a non-linear way.

Bussiere and Peltonen (2008) highlighted the role of exchange rate as a nominal anchor for containing inflation. Pre-announced changes in exchange rate would immediately be reflected in prices of both traded and non-traded goods. From another perspective this means that a more flexible regime, with inflation targeting as main strategy to contain inflation, would lead to a lower ERPT as the link between non-traded goods prices and exchange rate fluctuations would be broken.

2.2 Empirical Methods and Findings

The empirical studies on ERPT are generally divided into two main approaches: models based on the VAR methodology introduced by McCarthy (1999) or single equations including variables in differences as in Campa and Goldberg (2002).

It is widely considered that most of the heterogeneity in the results is due to different estimation techniques, different variables employed and data coverage. There are however two main consensuses in the evidence: First one is that ERPT is higher in developing and emerging markets as compared to developed economies and it declines over time with the catching up process. The second is that it decreases along the pricing chain.

Bailliu and Fujii (2004) use dynamic panel data model to investigate the effect of transition to a low inflation environment induced by a shift in monetary policy. He looks at 16 industrialized countries and finds that a decline indeed occurred as the monetary policy gained credibility. A similar estimation is done by Jimboreanu (2011), this time on new member states of the European Union. She investigates the effect on ERPT of a shift to a lower inflation environment and finds such evidence only for imported prices both on the short term and on the long term.

Other models took into consideration a potential equilibrium between domestic prices, exchange rate and variables used as proxy for foreign cost of producuction. Wickremasinghe and Silvapulle (2004). Attention has been also given to potential asymmetries in the behavior of the agents allowing a different reaction in case the currency appreciates or depreciates, or there is some threshold below which changes would bring more costs than gain Al-Abri and Goodwin(2009). The evidence for such a co integration relation and asymmetries is not clear cut and it differs among countries and industries (Alvarez et al 2008).

Research on ERPT at sectoral prices of imports has received less attention. Widely cited papers and methodologies used in this respect are Campa and Goldberg (2002), Campa et al (2005). Employing such methodologies, Dolores (2009) uses single equation approach on new member states of the European Union and Turkey to show that there is high heterogeneity in ERPT in disaggregated import prices and across sectors and countries.

3 Romanian Economy and the Importance of ERPT

Relative to the European Union, Romania comes second with the lowest per capita GDP. It is also among the countries with the highest GDP growth rates (around 5%) the fastest credit growth and current account deficit, rapid wage increase and high inflation rate. Romania has been always dependent on imports, and most so in the last years as current account deficits exceeded levels of 10%. The high degree of openness, capital liberalization and fluctuation in the exchange rate leaves the economy vulnerable to external shocks.

Following 1990 Romania experienced a devastating hyperinflation as government spending was financed through printing money and due to a protective exchange rate regime. The high level of inflation (and of the interest rate) at the beginning of 2000 is just the fading out effect. Starting with 1997 Romania switched to a managed floating exchange rate regime and was using monetary targeting as an intermediary instrument to contain inflation. The inefficiency of this policy led the central bank to use the exchange rate as an anchor to deal with inflation trading off its external stabilizing role.

In 2005 inflation rate reached a one digit level, and continued to decrease. Many consider this recent stabilization as an achievement of the inflation targeting strategy adopted in august 2005. In addition to this the central bank decided to switch to a regime of soft manage with the euro becoming the main reference currency. "This liberalization managed to buffer an upward trend of appreciation in nominal terms of ron vis a vis the euro lowering the negative influence of the variation of some internationally prices on the local ones and decreased the inflation expectations." (BNR Working Papers (2008))

Having as main objective price stabilization, the central bank uses various instruments to achieve its inflation target. One of the instruments is the exchange rate. A list of exoneration clauses allows the bank to intervene on the exchange rate market in case of high fluctuations and in case of a substantial increase in the foreign price of raw materials, energy (and others).

With this framework in mind it is evident why, for designing a good monetary policy, it is particularly important to understand the mechanism of transmission of exchange rate shocks into domestic inflation. The empirical literature has shown that in a low inflation environment or when a country has an inflation targeting regime the exchange rate pass through tends to be lower (Taylor (2000)). In order to make the exchange rate an effective tool in containing inflation, "changes in nominal exchange rate have to be transmitted into domestic prices relatively fast and the relationship between the two has to be strong" (Bitans (2004)).

One second important reason for studying this issue, and more so recently, has to do with the future plan of the authorities to adopt the euro currency. This objective entails an entire process meant to achieve sufficient convergence both in real and nominal terms with the rest of the euro-zone economies. The risk of a strong appreciation of the currency before accession, associated with a high degree of ERPT might question the stability of inflation. The pressure arises both from demand factors due to low interest rates and credit growth, resulting in an overheated economy. Supply factors such as inter-sectoral differences in productivity can lead to a Balassa-Sammuelson kind of effect.

Having these two reasons in mind I decided to estimate in a quantitative analysis the relation between the nominal exchange rate and price levels in Romania.

4 Methodology employed

4.1 VAR analysis and "distribution chain model"

I will start the analysis by fitting a VAR model, similar to McCarthy (1999) and Hahn (2003) "distribution chain" model. The model is recursive by construction; basing the decision on economic theory the ordering goes from a truly exogenous variable – the supply shock – down to consumer prices which are affected by all the variables in the system.

The estimation is done by using a VAR in standard form:

$$Y_t = c + \sum_{i=1}^{p} \theta_i Y_{t-1} + e_t \qquad (4.1.1)$$

Where Y_t represents the $kx1$ vector of endogeneous variables, c is a $kx1$ vector of deterministic terms θ_i is kxk matrix of autoregressive coefficients and e_t is a $kx1$ vector of white noises processes. The identification of the underlying exchange rate shocks is achieved by applying the Cholesky decomposition to the variance covariance matrix of the reduced form residuals.

The model is built on the following rationing: at each stage of production, a company changes its prices according to expected changes in the economic environment as well as to unexpected shocks. The deviation in inflation level from its expected value is therefore influenced by supply, demand and external shocks as well as shocks taking place at a previous pricing stage. Any other deviation that was not accounted for by the above mentioned factors is said to be due to changes in the pricing power and mark-ups of firms at each stage.

$$\pi_t^{ip} = E_{t-1}(\pi_t^{ip}) + \alpha_1 \varepsilon_t^s + \alpha_2 \varepsilon_t^d + \alpha_3 \varepsilon_t^{ex} + \varepsilon_t^{ip} \qquad (4.1.2)$$

$$\pi_t^{ppi} = E_{t-1}(\pi_t^{ppi}) + \beta_1 \varepsilon_t^s + \beta_2 \varepsilon_t^d + \beta_3 \varepsilon_t^{ex} + \beta_4 \varepsilon_t^{ip} + \varepsilon_t^{ppi} \qquad (4.1.3)$$

$$\pi_t^{ppi} = E_{t-1}(\pi_t^{cpi}) + \gamma_1 \varepsilon_t^s + \gamma_2 \varepsilon_t^d + \gamma_3 \varepsilon_t^{ex} + \gamma_4 \varepsilon_t^{ip} + \gamma_5 \varepsilon_t^{ppi} + \varepsilon_t^{cpi} \qquad (4.1.4)$$

Following McCarthy (2000) I take the extra assumptions:

1) ε_t^s - the supply shocks are identified from the change in oil price level denominated in the local currency.

2) ε_t^d – the demand shocks are identified from the output gap(industrial production gap in my case) after taking into account the contemporaneous effect of the supply shock

3) ε_t^{ex} - the external shocks are identified from the dynamics of exchange rate appreciation after taking into account the contemporaneous effects of the supply and demand shocks.

$$\pi_t^{oil} = E_{t-1}\left(\pi_t^{oil}\right) + \varepsilon_t^s \quad (4.1.5)$$

$$\pi_t^{gap} = E_{t-1}\left(\pi_t^{gap}\right) + a_1\varepsilon_t^s + \varepsilon_t^d \quad (4.1.6)$$

$$\pi_t^{ex} = E_{t-1}(\pi_t^{ex}) + b_1\varepsilon_t^s + b_2\varepsilon_t^d + \varepsilon_t^{ex} \quad (4.1.7)$$

One of the advantages of this model compared to single equation based models previously used in the literature is that it allows for the exchange rate to be endogenously determined. This might be the case if we were to consider that by affecting the prices, the nominal exchange rates affect the mark-up of the companies, might affect the consumption or investment decisions of the agents with a further effect on other macro variables, changes that in turn will reflect in the nominal exchange rate. A second advantage of this methodology is that we can analyze the effect of exchange rate with the help of impulse response functions and explain how much each shock contributes to the forecasted error in each price. Moreover the specificity of the model allows us to compute not only the absolute values but also the relative ERPT in upstream and downstream prices. (Faruqee (2004))

The disadvantages reside in the assumptions of the model, namely the linear nature of the relation between the variables.

4.2 Single equation approach

The markup model is usually used to give an intuitive framework on the estimation setup. The model (similar to Campa and Goldberg, 2002) has in view the behavior of a foreign producer exporting to a domestic country. Assuming producer currency pricing, the import price should be equal to the export price if it were expressed in a common currency. Written in logarithm form we get:

$$p_t^m = ex_t + p_t^x \quad (4.2.1)$$

Where p_t^m is the import price expressed in domestic currency, ex_t is the spot nominal exchange rate expressed in units of domestic currency per unit of foreign currency and p_t^X is the export price expressed in foreign currency.

Assuming pricing to market and having into consideration that the exporter cares about his profits as well as about market share, he will set his price as a destination specific markup (μ^f) over its marginal cost of production(mc^f). The markup is considered to be sensitive to macroeconomic changes (demand pressure from competing products, price of domestic substitutes) as well as sensitive to exchange rate movements. It is also considered to have an industry fixed specific effect. I used producer price index as a proxy for the price of substitute goods and as a measurement of demand pressure from the importing country.

$$\mu_t^f = \varphi + \Phi ex_t + \gamma ppi_t \qquad (4.2.2)$$

Following Dolores (2009) I considered the marginal cost to be independent of the exchange rate and can be proxied by the world price of the product. Summing up, equation 4.2.1 can be estimated as:

$$p_t^m = \varphi + (1 + \Phi)ex_t + \delta p_t^f + \gamma ppi_t + \epsilon_t \qquad (4.2.3)$$

Coefficient "Φ" can be seen as reflecting the market power of the exporter. If it is zero, then a shock in exchange rate is fully passed to import prices and ERPT is complete. However, if the exporter chooses to react to the exchange movement in order to maintain the market share then he will adjust his markup. As he cannot influence the domestic conditions in the country all he can do is to change his reaction to the exchange rate. The extreme case is when he chooses to absorb all the variation in exchange rate making Φ to be one and the ERPT to be zero. An in between adjustment will lead to an incomplete pass through.

5 Data, empirical strategy and results

5.1 VAR analysis of ERPT along the pricing chain

Data Used

I used monthly data spanning period 2000M1 to 2011M12. The source of the data was International Financial Statistics, Eurostat, National Institute of Statistics and National Bank of Romania. In appendix A I attached the details on the data collected as well as the graphical representation. With the exception of the interest rate all variables were normalized, having as base year 2005, seasonally adjusted using Census X12 algorithm and transformed into logarithm.

1. **Crude oil** (petroleum) was used as proxy for the supply shock. The variable was expressed in dollars and transformed in national currency by using the historical monthly average spot rate.

2. **Industrial Production gap** was used as proxy for demand shocks. I would have preferred to use GDP gap, however this variable is not available at this frequency. Instead I used industrial production which is considered to be a good proxy due to the high correlation between the two. An H-P filter was applied and the gap was obtained by the deviation of the industrial production from its trend.

3. **Nominal Effective Exchange Rate** was used as proxy for external shocks. The variable is a weighted index of the Romanian currency exchange rate vis-a-vis 36 commercial partners. The variable was transformed to obtain domestic currency over foreign currency. An increase in NEER therefore is equivalent with depreciation in the domestic currency.

4. **Import price** is represented by the unit value index of imports, as this is the only variable available. The index is given as expressed in Euros. I transformed it into

domestic currency using historical monthly average Ron/euro exchange rate. Import prices (3 methods to compute it depending on the data source) computed as unit value index is compiled from detailed import trade data coming from administrative customs documents. “They are considered not to be price indexes because the changes in their value might be due both to prices and (compositional) quantity changes. However they are used by many countries as surrogates for price indices.”[2]

5. **Producer Price** is represented by the industry producer price index also known as the “output prices” and measure the monthly development of transaction prices of economic activities.

6. **Consumer Price** is proxied by the harmonized consumer price index and contains all products from the COICOP classification.

7. **Interest rate** is represented by the 3-month interest rate on inter-bank loans.

Data Properties

Before proceeding to estimation I check the nature of the variables. A.Table 2 from Appendix A shows the unit root test results of the Augmented-Dicky Fuller test (ADF) and the Phillips Perron (PPP) test. The results show that the real industrial production gap and the interest rate are I(0) processes while the rest of the variables are integrated of order 1. As a consequence, I choose to estimate the VAR in log difference for oil, exchange rate, and price indexes while the gap and the interest rate will be left in level.

[2] IMF Export and Import Price Manual (2009)

Model Specification

Having as baseline the above described model I choose to estimate different specifications as such:

VAR model 1: represents the McCarthy model with the endogenous vector of variables under the following order $Y_1 = [\Delta oil, \Delta gap, \Delta ex, \Delta ip, \Delta ppi, \Delta cpi]$

VAR model 2: with the following specification $Y_2 = [\Delta oil, i, gap, \Delta ex, \Delta ip, \Delta ppi, \Delta cpi]$

The motivation for including the 3-month interest rate is to model the behavior of the monetary authority. Having the obligation to attain a certain inflation target it is most likely that the behavior of the interest rate – which might reflect the monetary authority behavior-, is influenced and influences the rest of the variables in the model.

Dolores (2009) also points to the “arbitrage strategy” of investors taking advantage of the interest rate differential between countries. A large inflow of speculative capital will put pressure on the exchange rate.

Hann (2003) motivated the inclusion of the interest rate next in line after the oil variable in order to allow for a contemporaneous impact of monetary policy on the output gap due to the lagged availability of the GDP data. Moreover this allows for the possibility of a contemporaneous impact of real and nominal shocks on the exchange rate.

VAR model 3 with the following specification $X_1 = [\Delta oil, i, gap, \Delta ex, \Delta ip, \Delta ppi, \Delta cpi]$ $@\Delta p^f$.

This model is similar to the first on except that I include an exogenous variable-the foreign prices. In this way changes in external prices of the goods reflect the position of the trading partners and influence the domestic prices.

Finally all of the above models will be re-estimated using the ron-euro exchange rate. A large portion of imports in Romania comes from European Union therefore it is interesting to see how the volatility in euro will affect the domestic prices. Because of limited space I will not present these results in the paper, but make only short comments on them.

Robustness check

For robustness I changed the ordering of the variables in the Cholesky decomposition. My results did not suffer any meaningful change. Because of limited space I will not report the results in this paper; however they are available upon request.

Lag-Length selection

The number of lags to include in the VAR is chosen based on information criteria tests. I use the LR test criteria to pin down the exact number of lags in case the tests output conflicted. In all cases the lag length chosen was three.

Results and Interpretation

Impulse response functions – speed and size of ERPT

The first test statistic employed is the impulse response function. An essential feature of the model is that it allows me to trace down the time path effect of a shock in the nominal exchange rate on the price indexes.

The **speed of the pass through** is given by the number of periods after which the price inflation reverts to the long run level. Appendix B shows the impulse response of prices to a one standard deviation shock in the exchange rate. In case of model 1 and 3, the behavior of the variables is similar. The shocks present a significant persistence: it takes around 2 years for the import prices and up to 3 years for the producer and consumer prices to revert to the equilibrium level. Model 3 shows a puzzling picture as the interest rate seems to have little effect on both producer and consumer prices as seen in the persistence of the shocks.

In all three models, the initial impact is positive, as it was expected - an appreciation in the exchange rate leads to an increase in price levels.-and remains so for the period observed.

The **size of the pass through** is computed as the ratio of the cumulative response of the inflation to a standard deviation shock in the exchange rate innovation and the cumulative response of the exchange rate due to a standard deviation shock in the exchange rate innovation. If the prices change by the same proportion as the change in exchange rate the pass-through is said to be complete. Figure 5.1 depicts the accumulated nominal effective exchange rate pass through and the ron/euro exchange rate pass through to import, producer and consumer prices for up to a 50 months horizon. Detailed figures are presented in appendix B.

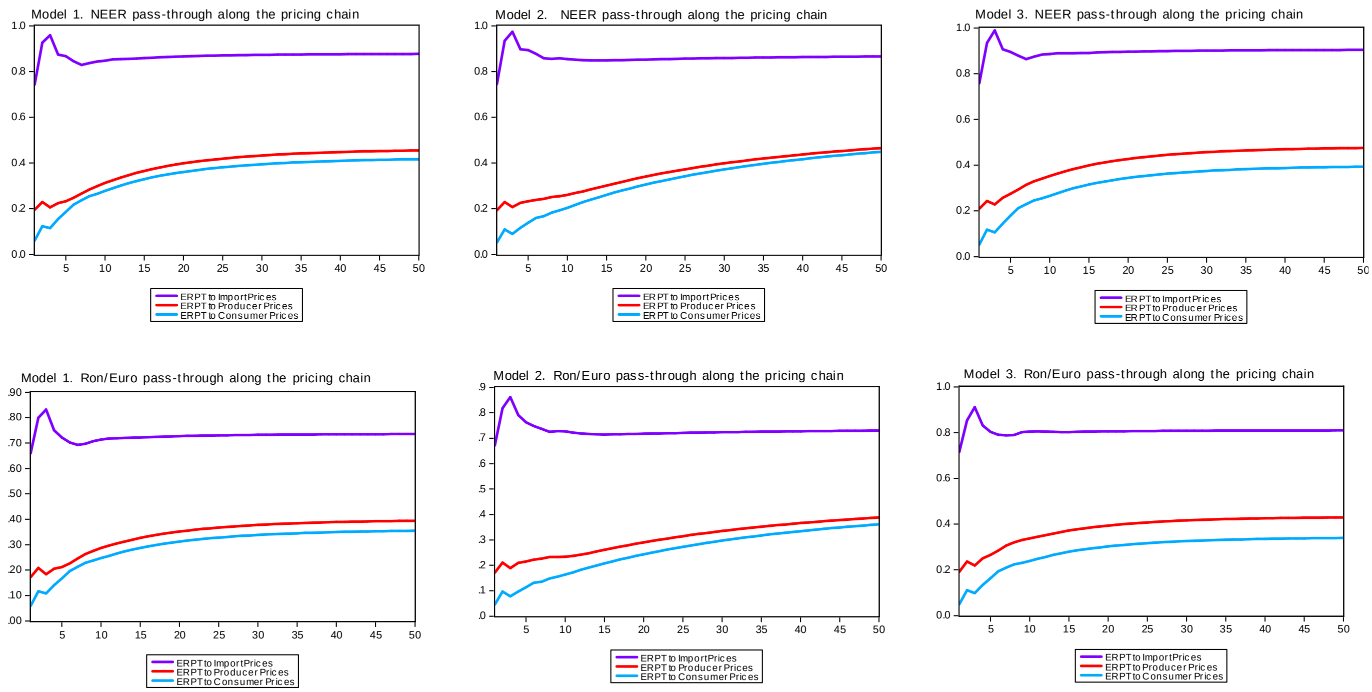

Figure 5.1 ERPT to consumer prices for up to 50 months horizon

We can see clearly in the picture that ERPT indeed declines along the pricing chain being substantially larger in the import prices, followed by the producer prices and the consumer prices. Campa and Goldberg (2002) argue for the role of distribution costs "which make up for an important component of the retail price of imported goods; as the distribution costs are probably insensitive to shocks driving the exchange rate or foreign costs, they help insulate the retail price of imported goods from the effects of exchange rate fluctuations". One second reason is that each price index contains different products that may or may not be affected by the exchange rate. As the figures show, ERPT is incomplete both on the short run and on the long run, however they are significantly higher than in developed countries - evidence that in emerging markets the ERPT is higher.

For the import prices the initial shock results in a pass through slightly higher than 80% and in 3 months it amounts to 95% reverting on the long run to its initial level. The lagged overshooting is a bit puzzling. One might think that importers have a hard time to foresee the evolution of the exchange rate or of domestic conditions.

For producer and consumer prices, the three models show different results. The first and the third model present a hyperbolic evolution as the ERPT increases with up to 15 percentage points during the observed period and remains at that level. The short term response of producer prices and consumer prices are 20% respectively 6%. In the first model we see that in the following 5, 10 months the ERPT size is the same in both prices, as the speed of accumulation was faster in the first periods for the consumer prices. However it does not exceed the producer ERPT and on the long run they slightly diverge. In case of model 3, the ERPT in producer and consumer prices is higher and it accumulates at the same rate for both prices. The inclusion of foreign costs seams to increase the pass through for both prices, but less so for consumers.

In model two the short term pass through for producer and consumer prices is 20% and 6%. In the long run there is an opposite picture to model 1, namely the ERPT rate of accumulation in consumer price is higher and on the long run the level accumulated is the same as producer prices. However the size seams to continually increase for both. This is evidence for different price adjustment mechanism.

A similar accumulation picture arises in the case of ron/euro exchange rate. The magnitude to import prices is 10 percentage points lower however in case of producer and consumer is the same. One explanation for this might be that many goods in the consumer basket and producer indexes are actually invoiced in Euros.

Variance Decomposition

The second test statistic employed is the variance decomposition. This shows the "importance of the different external shocks for the development of price indices". The magnitude of difference between the models is not much, but some interesting changes did occur. The noteworthy observations are:

1. Consumer prices are seen to have a high persistence as it explains 80% of its forecast variance declining to 60% after one year. There is a slightly lower persistence in the producer prices 60% declining to 47% and the lowest persistence is in import prices 34% declining to 25%.

2. What is interesting to observe is that inflation has a lagged high (and increases with the time) explanatory power for producer prices than the other way around. This can be explained by a large share of import goods consumed by the agents than import goods that enter into production. This is also reflected in the fact that the effect is larger(almost twice) than the import price effect and on the long term, CPI explains more of the variance in PPI than exchange rate does.

3. NEER explains almost 53% of the variance of import prices in the short run and increases slightly on long term. It explains16% of the variance of producer prices and actually decreases slightly in the long term. It explains 4% of the variance in CPI and it increases to 13% in one year. Again we can see that the share of the exchange rate on forecasted variance of the prices decreases along the pricing chain.

4. The importance of import prices for consumer prices is more so highlighted by the fact that import prices explain more of consumer price variance than producer prices do, and

significantly more in case of model 2. This means that the indirect channel of price transmission from IP to CPI is more important than the direct one from PPI to CPI.

Rolling Window VAR

Considering the substantial changes in the economic environment that have taken place, one might be curios to ask whether ERPT has remained constant or it actually decreased as inflation became more stable. In order to see this I use a rolling analysis technique, estimating the model over a rolling window of fixed size. I chose 63 months as the window size and I moved it through the sample at 4 month step resulting in a total of 20 estimates.

If the parameters changed at some point during the sample, then this instability will be captured by the rolling estimates. Figure 5.2 below shows the short term ERPT (1M) in import prices, producer prices and consumer prices.

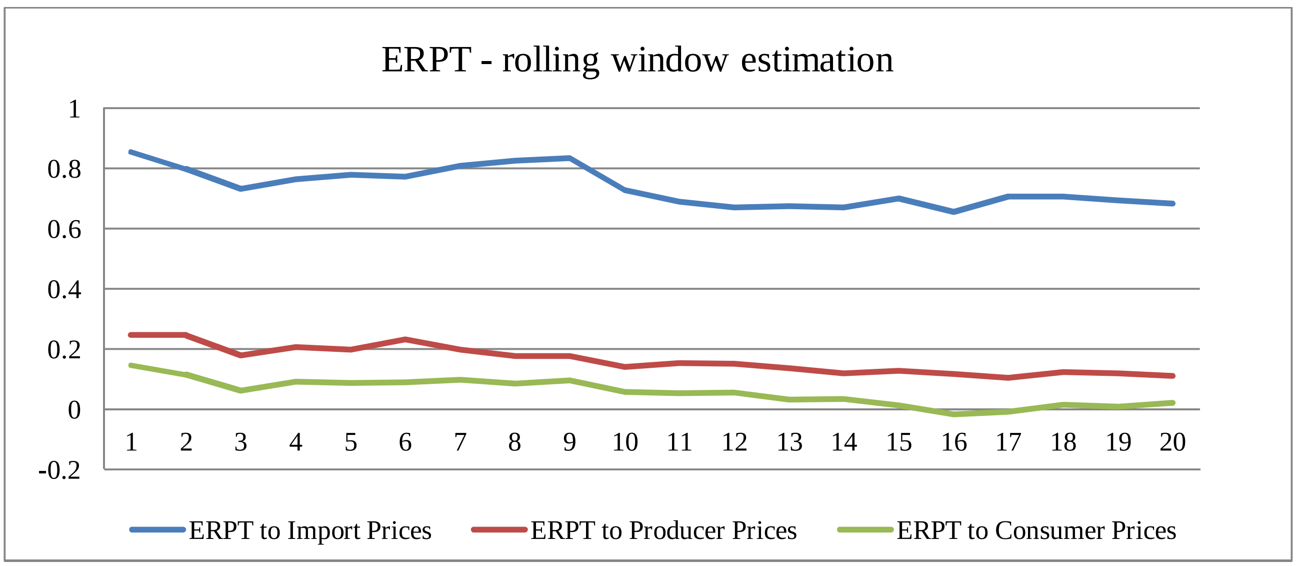

Figure 5.2 ERPT - rolling window estimation

Except for consumer prices, the impulse response of the variables was highly significant (B.Table 2 Appendix B). The impulse response of consumer prices however seem not to be significant for the 3rd observation and the last 7 observations. As we can see in the figure for the import price index, producer price index and consumer price index(even ignoring the insignificant coefficients) the ERPT has declined and became more stable in the last years This comes as a confirmation for Taylor (2000) theory that ERPT is lower in a low inflation environment.

5.2 Single equation approach. Exchange rate and foreign price pass through into import prices

There are four reasons for which I choose to continue the analysis in detail at import price level. First it has to do with the fact that an exchange rate shock is transmitted directly into inflation via imported goods which are part of the final consumption. As the previous analysis showed, the import prices seem to explain more of the consumer price variance than the producer prices do. Therefore computing the change in import prices is of relevance for understanding further movements in inflation.

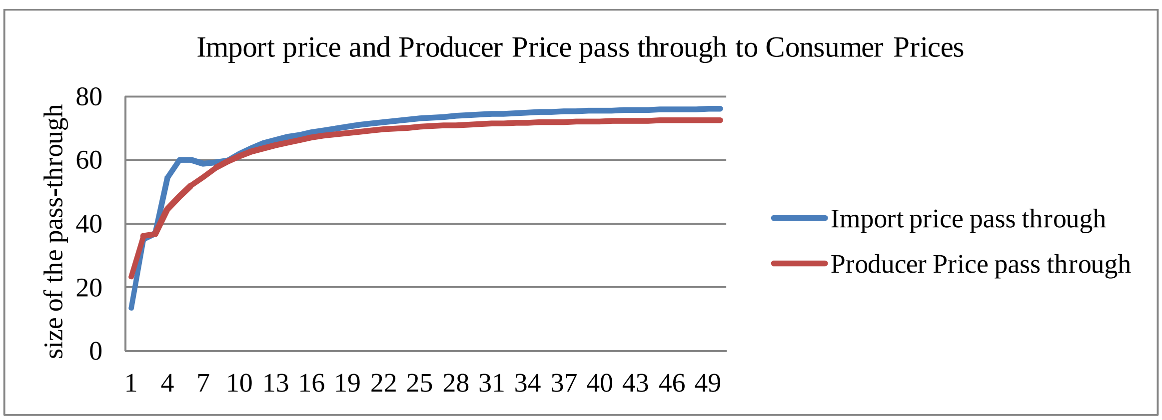

Figure 5.3 Import price and Producer Price pass through to Consumer Prices

Using Model 3 from the previous part I plotted in the picture the import price pass through and producer price pass through in the consumer price index. Although the initial response is a bit higher for the PPI shock from the 2nd month onward the pass through of the import price is much higher, and remains so on the long horizon.

The second reason is due to the indirect effect of an exchange rate shock: a large part of goods used as intermediary into production are imported. An increase in their price would lead to an increase in the cost of production leading to an increase in producer prices with further effects on consumer prices.

The third reason has to do with the specification of the model. As I take into consideration changes in the international cost of the goods (proxied by changes in their international price), it is interesting to see how this is passed to the price of imports. This is because, as mentioned in section 3, the central bank is interested in the foreign prices of such commodities as raw materials and energy, therefore knowing the elasticity of domestic prices to changes in the prices of such goods is of great interest.

The forth reason is that it might well be that the pass through differs across industries, therefore it is worth knowing which one is more sensitive and this way to be able to design more targeted policies.

Data used

For data availability constraints I used monthly data spanning the period 2000M1 to 2011M12. The source of the data was International Financial Statistics (from IMF), Eurostat and Eurostat Comext data base. Variables have been normalized to 2005=100, seasonally adjusted and transformed into logarithms. For **producer prices** and **exchange rate** I used the same data as in the VAR specification.

For **import prices** and **foreign prices** I used as proxy the unit value index of imports of Romania and respectively the unit value index of exports of the Euro-zone. I used monthly indices corresponding to the 1-digit level of disaggregation in the SITC classification and categorized them in 4 industries as it follows: Food industry SITC 0-1, Raw Materials Industry SITC 2, Energy Industry SITC 3, and Manufacturing Industry SITC 5-8.

Similar to Dolores (2009) I proxied the marginal cost with the export price of products of the Eurozone. As she mentions, “if there is possible integration in the world market, there exist a single international market for the product, regardless of product origin, destination market or currency denomination. In this sense measuring the world price should be the same when expressed in a common currency”.

Long run and short run relationship

The ADF test and PP test showed that the variables are integrated of order (1). One might wonder if there is actually a long run equilibrium relation. Engel–Granger tests (Appendix C, Table 1) show that there is indeed a vector of co integration except in the raw materials industry. The long term coefficients as resulting from the FMLS estimation of equation 4.2.3 in levels are presented below.

Table 5.1 Long Run Elasticity

	IP aggregate	IP food	IP energy	IP manufacturing
NEER	0.834 (-0.03)	0.648 (-0.049)	1.05 (-0.105)	0.998 (-0.026)
FP	0.814 (-0.074)	1.039 (-0.109)	0.951 (-0.054)	0.627 (-0.076)
PPI	0.265 (-0.017)	0.243 (-0.029)	0.156** (-0.073)	0.148 (-0.014)
constant	-4.212 (-0.372)	-4.296 (-0.533)	-5.367 (-0.381)	-3.56 (-0.376)
period	2000m2-2011m12	2000m2-2011m12	2000m2-2011m12	2000m2-2011m12

all coefficients are significant at 1%
** significant at 5%
standard errors ()

For the aggregate import price I get similar results as in the VAR approach: ERPR is 80% and is incomplete. At disaggregate import price level in the energy and manufacturing sector ERPT is complete while in the food sector it is only 65%.

What is interesting to observe is that in the energy sector the coefficient for foreign price is also statistically weakly not different from 1 and equal to the exchange rate coefficient. At the aggregate level the two coefficients, for the exchange rate and foreign price are equal. All this is evidence for a weak form of PPP in the energy sector and at the aggregate level.

The long run equation sais that if the adjustment of prices to shocks would be immediate then import prices would follow their long run equilibrium. However, in reality there are rigidities in the mechanism of adjustment. The dynamic equation for adjustment towards long run equilibrium is:

$$\Delta IP_t = \beta_o + \beta_1 EC_{t-1} + \sum \alpha_i \Delta EX_{t-i} + \sum \delta_i \ \Delta FP_{t-i} + \sum \gamma_i \Delta PPI_{t-i} + \sum \tau_i \Delta IP_{t-(i+1)} + \varepsilon_t$$

where EC_{t-1} represents the lag residuals from the co integration equation. It is used as an error correction in the dynamic equation and β_1 shows how much of the deviation is corrected each period. Lagged values for import prices $\Delta IP_{t-(i+1)}$ are introduce in order to account for inflation persistence. The short term ERPT is given by the coefficients in front of the exchange rate ΔEX_{t-i} and foreign price pass through is given by the coefficients on ΔFP_{t-i}. Here "i" takes values from 0 to how many lags are significant. Appendix C shows the output of the estimated equations together with the test statistics.

In the energy industry, fitting a short term model for import energy prices on the whole sample was not successful. All tests performed were good with the exception of the normality test (J-B was 37). Performing a Chow break-point test, I reject the hypothesis of no structural break at 5% for period 2003m8. One cause might be that the period 1997 up till 2007 (when it was completed) it was a period of energy market liberalization. As it can be that a new long term relation was determined. I decided to re-estimate the long term equation as well on 2004m1 2011m12 sample.

For manufacturing industry I get the same problem with the normality test. The Chow break-point test is rejected and I decide to re estimate for the period 2004m1 to 2011m12. A long term relation however for this period was not found.

Table 5.2 Short term exchange rate and foreign price pass through

	ΔIP aggregate	ΔIP food	ΔIP raw mat.	ΔIP energy	ΔIP manufact
ΔNEER	0.729	0.683	0.58	1.1	1.4
ΔFP		0.47		1.2	
period	2000m5-2011m12	2000m5-2011m12	2000m5-2011m12	2004m2-2011m12	2004m2-2011m12

In the energy sector the pass through for both foreign prices and exchange rate is complete in the short run, evidence that the market is highly competitive. In the manufacturing industry although international price fluctuations are not transmitted on the short term the exchange rate pass through is complete as well, showing a lack of pricing to market behavior.

In the food industry ERPT is incomplete and is at the same level as on the long run while for foreign price pass through the short term is 50% half of the long term relation. For raw materials the pass through is the lowest and international price fluctuations are not transmitted in the short run. This is evidence for market disequilibrium namely low competition in the domestic production of such goods. Exchange rate pass through is indeed higher for homogeneous products such as energy and manufacturing and lower in the case of more heterogeneous products as the exporters have a higher market power. In the food industry it is likely that competition among foreign firms relative to domestic ones is higher as the more integrated markets are and the higher the degree of competitiveness the smaller is the ERPT.

Asymmetric behavior

One interesting question is whether agent's behavior is consistent when faced with different conditions in the market. If for example the exchange rate pass through is different depending whether the currency depreciates or appreciates or where the price was before, this might be evidence for an asymmetric behavior.

Asymmetry in the error correction

In checking for asymmetry I will make use of Granger and Lee(1989) asymmetric error correction model. Using Wolffram segmentation I divide the error correction term into positive and negative values and then plug the two new variables EC^{+} and EC^{-} in the dynamic equation instead of the initial EC which was implicitly symmetric.

$$EC^{+} = \begin{cases} EC_t \; if \; EC_t > 0 \\ 0 \; otherwise \end{cases}$$

$$EC_t^{-} = \begin{cases} EC_t \; if \; EC_t < 0 \\ 0 \; otherwise \end{cases}$$

Asymmetry in the error correction term means that I allow the speed of adjustment to differ in case the price was initially above or below the equilibrium level. The null hypothesis of asymmetry: the coefficients on the two new variables are the same ($\beta^{+} = \beta^{-}$) is tested by using Wald test.

Table 5.3 Testing for asymmetry in the error correction

	EC_t^-	EC_t^+
ΔIP_t	-0.197*	-0.128
st errors	0.103	0.125

*significant at 10%

My sample contains 74 observations when the price is above equilibrium and 69 observations when the price is below. Results of the estimation are presented in Appendix C, table 7.

With an insignificant coefficient for EC_t^+ and a significant one for EC_t^- I might be inclined to conclude that indeed there is asymmetry in the adjustment to equilibrium. However performing the Wald test I obtained that statistically the two coefficients are not different.

Asymmetry both in the error correction and exchange rate movements

Cramon-Taubadel and Loy(1997) suggest for more complex dynamics effect by including both asymmetry in exchange rate and in the error correction. This reduces basically to replacing the symmetric terms into the dynamic equation with the asymmetric variables. The symmetry hypothesis becomes: the coefficients on error correction are equal and also the coefficients on exchange rate are equal. To allow for asymmetry in exchange rate, I use the same methodology as in the above estimation: I create two variables, A for when Ron appreciates and D for when the Ron depreciates. My sample contains 59 periods of appreciation and 84 periods of depreciation episodes.

$$A_t = \begin{cases} 1 \; if \; \Delta NEER_t < 0 \\ 0 \; otherwise \end{cases}$$

$$D_t = \begin{cases} 1 \; if \; \Delta NEER_t > 0 \\ 0 \; otherwise \end{cases}$$

The asymmetry hypothesis becomes: both the coefficients on the error correction and the coefficients on exchange rate are equal. This time, Wald test shows that at 10% level of significance I can reject the null hypothesis of symmetry, therefore agents do respond differently in case the currency appreciates or depreciates. Details on the estimation output are in Appendix C, table 8.

Asymmetry in exchange rate

I estimate the equation this time allowing just for the exchange rate to be asymmetric: I replace the exchange rate variable with the "A" and "D" variables created for the previous estimation. Using a Wald test I check whether the coefficients (or the sum) are equal for the two variables. Results are presented in Appendix C, table 9.

The Wald test shows that the hypothesis for symmetry can be rejected at 5% level of significance. Exchange rate pass through is complete when Ron appreciates and just 53% in depreciation time. There are different reasons for such a behavior:

When the currency depreciates the price of exports is higher. Therefore one reason for the observed asymmetry can be that in order to preserve their market share, exporters will choose to adjust their markups and not to pass fully the increase in price, which means pricing to market behavior. It is also well known that prices are rigid downwards. Moreover, as in appreciation they managed to attract a larger share of the market segment, this will act as a buffer in depreciation time.

A second reason can be that exporters expect more for the currency to appreciate than depreciate so that they perceive depreciations as outlived and don't react fully to them. However such an explanation is less likely in the case of Romania.

6 Conclusions

The aim of this paper was to investigate the mechanism of transmission of exchange rate changes into domestic prices in Romania. For this purpose I made use of both multivariate and univariate approaches.

Through the help of a VAR model I looked into the transmission of exchange rate shocks along the pricing chain, from import to producer and to consumer prices. My results come in support to the existing theory in this field and empirical findings on Romania (i.e Cozmanca and Manea (2010)). Exchange Rate pass through is incomplete in the short term and on long term and it decreases along the pricing chain. With the help of the rolling VAR technique I checked the stability of the coefficients through time and found out that indeed there seems to be a decline in ERPT in the last years confirming Taylor's theory that a more stable inflation environment is associated with a lower ERPT.

The univariate approach, in which I allow for a co integration relation between the variables and analyze the short term dynamics, give similar results in terms of ERPT at import price level. Performing the analysis at disaggregated import prices I find a high degree of heterogeneity between industries both on the short run and on the long run.

Investigating further on the consistency of the exporters' pricing strategies in different economic situations I introduced asymmetries into the model. The equation estimated for testing the behavior of the agents when the price is above or below the equilibrium did not show any asymmetry. Further asymmetric coefficients introduced into the model showed that indeed there is asymmetry in the behavior of the agents. In case of a depreciation of the ron currency the agents pass through just 60% of the exchange rate fluctuation while in case of an appreciation of the exchange rate the ERPT is complete.

From the policy maker's point of view such findings are relevant. Firstly, the degree of exchange rate pass through is an indicator of the structure and competitiveness of local industries as well as the market power of international exporters. Secondly, macroeconomic shocks from outside the world affect the exchange rate and the pressure it puts on the domestic prices is largely dependent on the degree of pass through.

The monetary authority in Romania is aware of the fact that fluctuations in the exchange rate and international price changes affect the country's domestic prices. Having as main goal, the price stability, and as main strategy the inflation targeting the monetary authority pays great attention to movements in exchange rate and changes in the international price of different commodities such as energy or raw materials. In this respect my analysis brought quantitative support for their actions.

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Appendices

Appendix A

A.Table 1 Data used

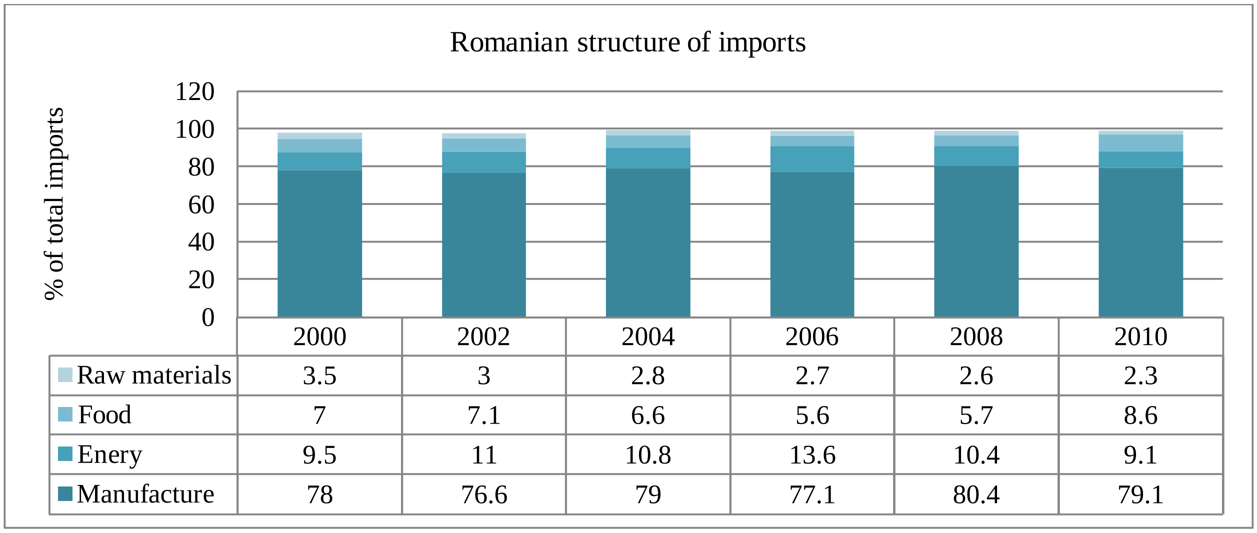
Indicator	Source	Details
Crude oil (petroleum) USD based Price Index,	IMF	The variable has been transformed into RON, has been normalized (2005=100) and seasonally adjusted and transformed into logarithm.
Industrial Production Gap	Eurostat	The variable was obtained by applying a H-P filter to the real seasonally adjusted Industrial Production Index. The Index was deflated using Producer Price index and normalized (2005=100).
Nominal Effective Exchange Rate	Eurostat	The variable was transformed into domestic currency /foreign currency exchange rate. It was then normalized (2005=100), seasonally adjusted and transformed into logarithm.
Ron/Euro exchange rate	BNR	The variable represents historical average monthly value of domestic currency/foreign currency. It was normalized, seasonally adjusted and transformed into logarithm.
Unit Value Index of Import Prices denominated in US dollars	Eurostat	The variable was transformed into domestic currency using average monthly RON/euro exchange rate. It was then normalized (2005-100) seasonally adjusted and transformed into logarithm.
Producer Price Index	Eurostat	The variable was normalized (2005=100) seasonally adjusted and transformed into logarithm.
Harmonised Consumer Price Index	Eurostat	The variable was normalized (2005=100) seasonally adjusted and transformed into logarithm.
Interest Rate	BNR	Short term (3M) inter-bank interest rate.
Unit Value Index of Imports for Food (SITC1-0) [Ro]	Eurostat Comext	The variable was transformed in domestic currency, normalized (2005=100) seasonally adjusted and transformed into logarithm.
Unit Value Index of Imports for Raw Materials (SITC 2) [Ro]	Eurostat Comext	The variable was transformed in domestic currency, normalized (2005=100) seasonally adjusted and transformed into logarithm.

Unit value Index of Imports for Energy (SITC-3) [Ro]	Eurostat Comext	The variable was transformed in domestic currency, normalized (2005=100) seasonally adjusted and transformed into logarithm.
Unit Value Index of Imports for Manufactures (SITC 5-8) [Ro]	Eurostat Comext	The variable was transformed in domestic currency, normalized (2005=100) seasonally adjusted and transformed into logarithm.
Unit Value Index of Exports for Food (SITC1-0) [euro-zone]	Eurostat Comext	The variable is expressed In Euros. It was normalized (2005=100) seasonally adjusted and transformed into logarithm.
Unit Value Index of Exports for Raw Materials (SITC 2) [euro-zone]	Eurostat Comext	The variable is expressed In Euros. It was normalized (2005=100) seasonally adjusted and transformed into logarithm.
Unit value Index of Exports for Energy (SITC-3) [euro-zone]	Eurostat Comext	The variable is expressed In Euros. It was normalized (2005=100) seasonally adjusted and transformed into logarithm.
Unit Value Index of Exports for Manufactures (SITC 5-8) [euro-zone]	Eurostat Comext	The variable is expressed In Euros. It was normalized (2005=100) seasonally adjusted and transformed into logarithm.

*seasonal adjustment was done in Eviews using Census X12 method

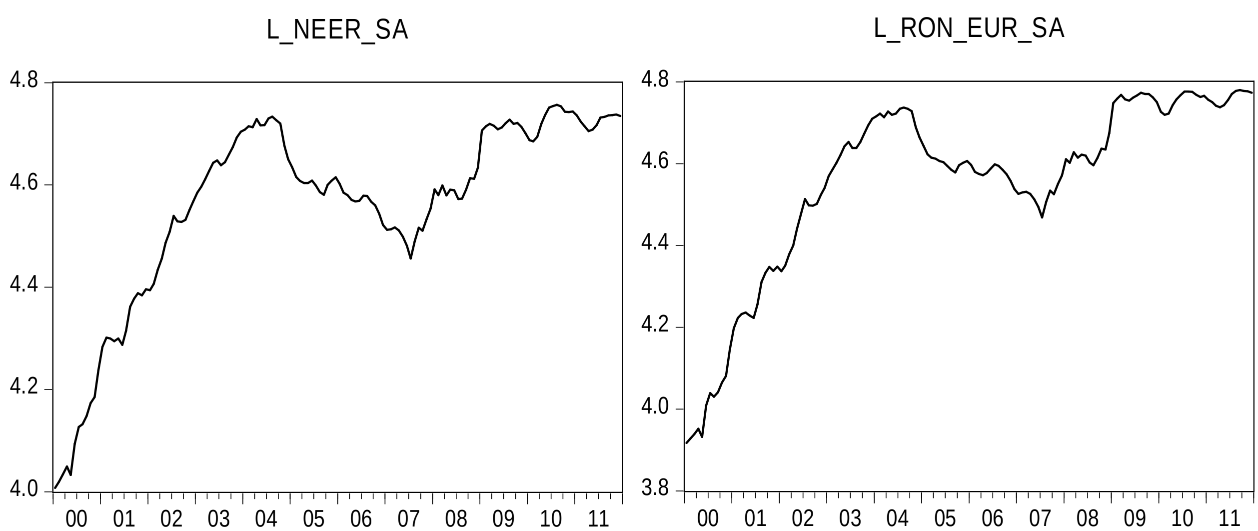
[] – reporting country

A.Figure 1 Romanian structure of imports

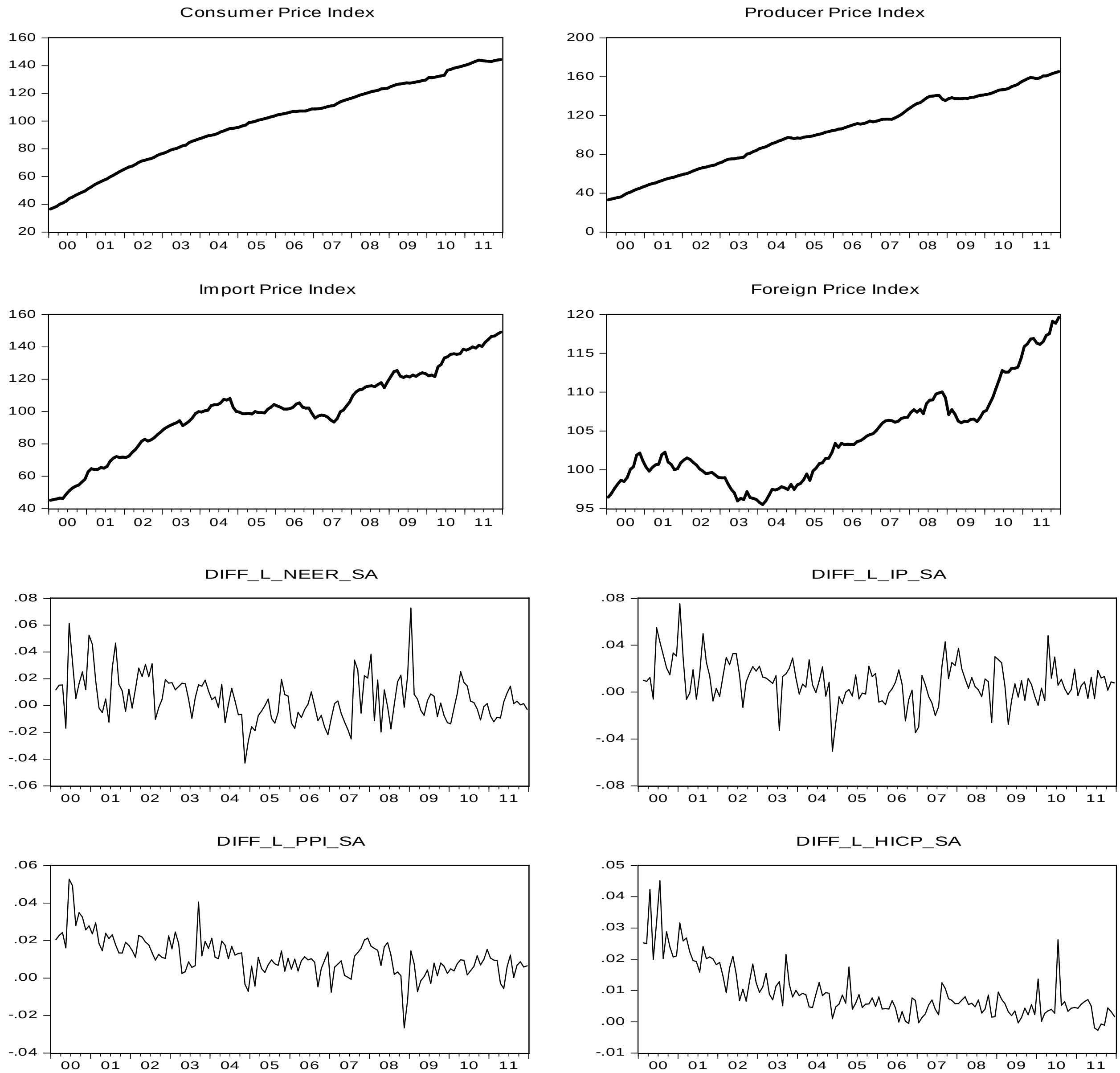


	2000	2002	2004	2006	2008	2010
Raw materials	3.5	3	2.8	2.7	2.6	2.3
Food	7	7.1	6.6	5.6	5.7	8.6
Enery	9.5	11	10.8	13.6	10.4	9.1
Manufacture	78	76.6	79	77.1	80.4	79.1

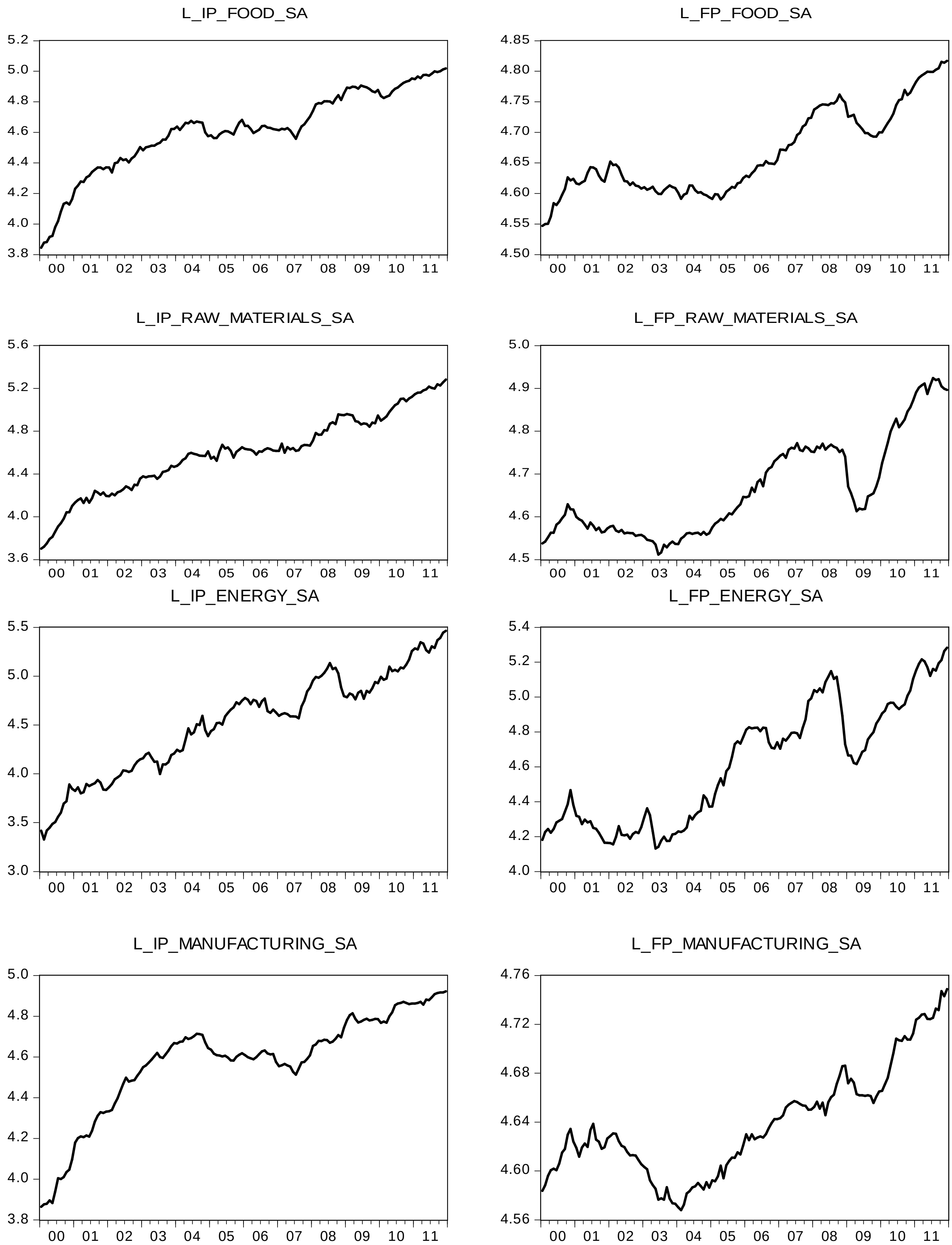
A.Figure 2 Graphical representations of the data



A.Figure 3 Evolution of indices and first differences



A.Figure 4 Graphical representations of the data (continuation)



A.Table 2 Unit Root Test on the variables

Variable	Notation	ADF test I(0)	ADF test I(1)	PP test I(0)	PP test I(1)	Decision
log(oil)	l_oil_sa	0.7082	0.0000	0.6838	0.0000	I(1)
Gap	rip_gap	0.0002	0.0000	0.0000	0.0000	I(0)
log(neer)	l_neer_sa	0.9912	0.0000	0.9943	0.0000	I(1)
log(ron/euro)	l_neer_ron_euro_sa	0.9897	0.0000	0.9951	0.0000	I(1)
log(fp)	l_fp_sa	0.9899	0.0000	0.9765	0.0000	I(1)
log(ip)	l_ip_sa	0.9996	0.0000	1.0000	0.0000	I(1)
log(ppi)	l_ppi_sa	0.9999	0.0273	1.0000	0.0000	I(1)
log(cpi)	l_hicp_sa	0.9644	0.0001	1.0000	0.0069	I(1)
I	i	0.0009	0.0000	0.0003	0.0000	I(0)
log(ip_food)	l_ip_food_sa	1.0000	0.0000	0.9996	0.0000	I(1)
log(fp_food)	l_fp_food_sa	0.8867	0.0000	0.8692	0.0000	I(1)
log(ip_rm)	l_ip_rm_sa	1.0000	0.0000	1.0000	0.0000	I(1)
log(fp_rm)	l_fp_rm_sa	0.8856	0.0000	0.9655	0.0000	I(1)
log(ip_energy)	l_ip_energy_sa	0.9995	0.0000	0.999	0.0000	I(1)
log(fp_energy)	l_fp_energy_sa	0.956	0.0000	0.9698	0.0000	I(1)
log(ip_manufact.)	l_ip_manufact_sa	0.9977	0.0000	0.9996	0.0000	I(1)
log(fp_manufac.)	l_fp_manufac_sa	0.9802	0.0000	0.9955	0.0000	I(1)

*MacKinnon(1996) one-sided p-values

Appendix B

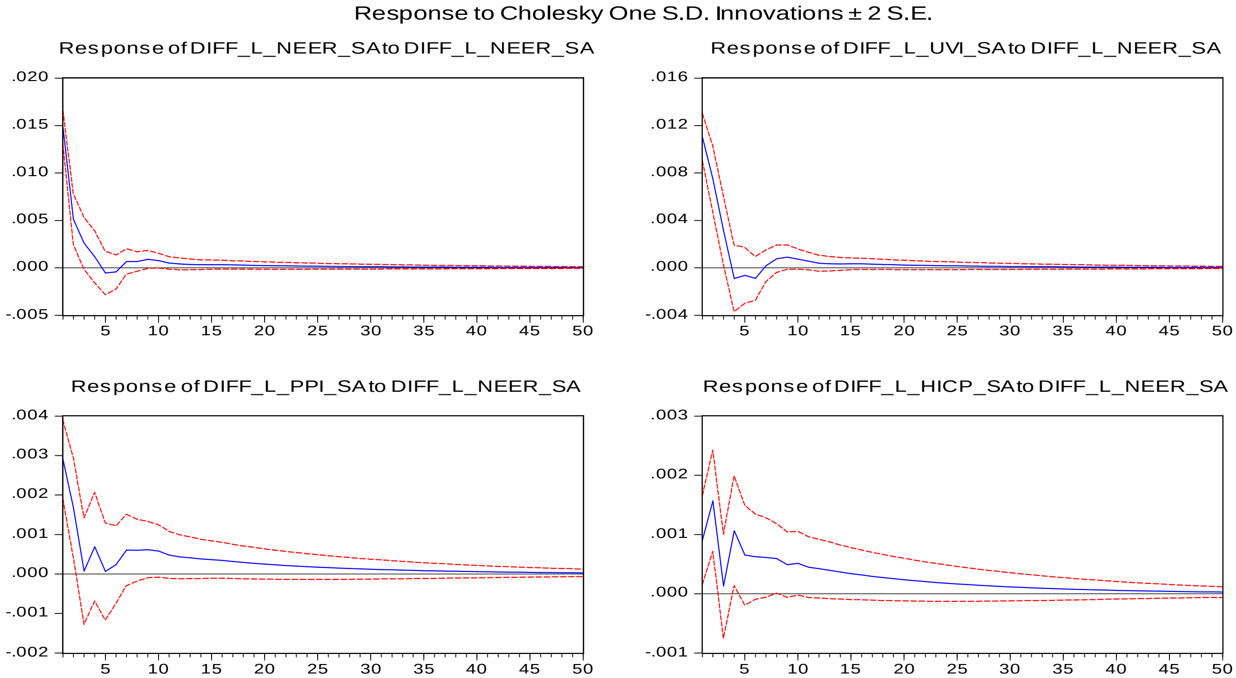
B.Table 1 Estimation of model 1 $\boldsymbol{X_1} = [\Delta \boldsymbol{oil}, \boldsymbol{gap}, \Delta \boldsymbol{NEER}, \Delta \boldsymbol{ip}, \Delta \boldsymbol{ppi}, \Delta \boldsymbol{cpi}]$

VAR Lag Order Selection Criteria
Endogenous variables: DIFF_L_OIL_SA RIP_GAP DIFF_L_NEER_SA DIFF_L_UVI_SA DIFF_L_PPI_SA DIFF_L_HICP_SA
Exogenous variables: C
Sample: 2000M01 2011M12 Included observations: 135

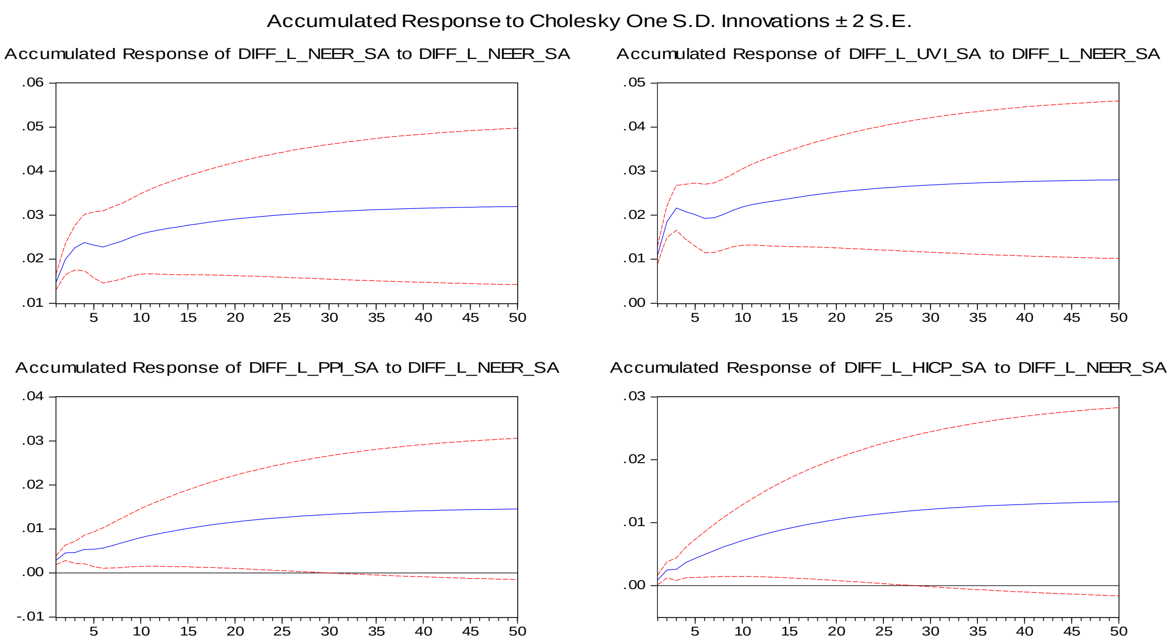
Lag	LogL	LR	FPE	AIC	SC	HQ
0	1503.721	NA	9.31E-18	-22.18846	-22.05934	-22.13599
1	1670.209	315.7098	1.35E-18	-24.12161	-23.21774*	-23.75430*
2	1708.136	68.55007	1.31E-18	-24.15016	-22.47156	-23.46802
3	1747.967	68.45028*	1.25e-18*	-24.20692*	-21.75357	-23.20995
4	1776.582	46.63248	1.42E-18	-24.09751	-20.86943	-22.78571
5	1804.434	42.9128	1.64E-18	-23.9768	-19.97398	-22.35017

* 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

B.Figure 1 **Impulse response of nominal effective exchange rate, import prices, producer prices and consumer prices to one S.D increase in exchange rate**



B.Figure 2 **Accumulated impulse response of nominal effective exchange rate, import, producer and consumer prices to one S.D increase in exchange rate**

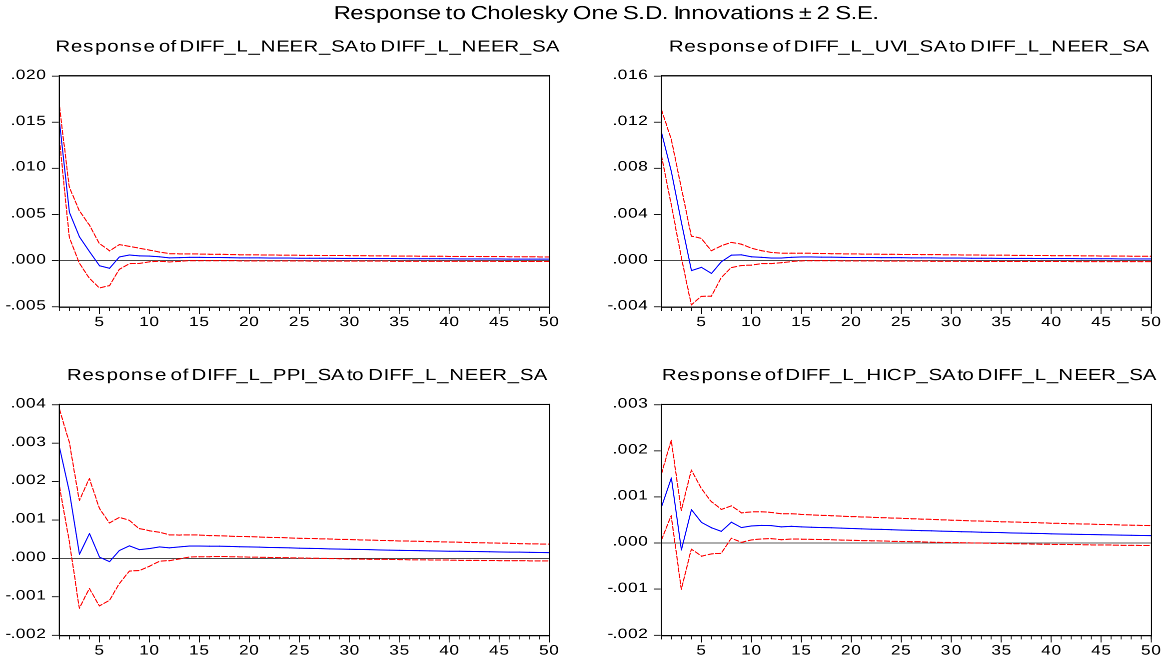


B.Table 2 Estimation of model 2 $\boldsymbol{X_1} = [\Delta \boldsymbol{oil}, \boldsymbol{i}, \boldsymbol{gap}, \Delta \boldsymbol{NEER}, \Delta \boldsymbol{ip}, \Delta \boldsymbol{ppi}, \Delta \boldsymbol{cpi}]$

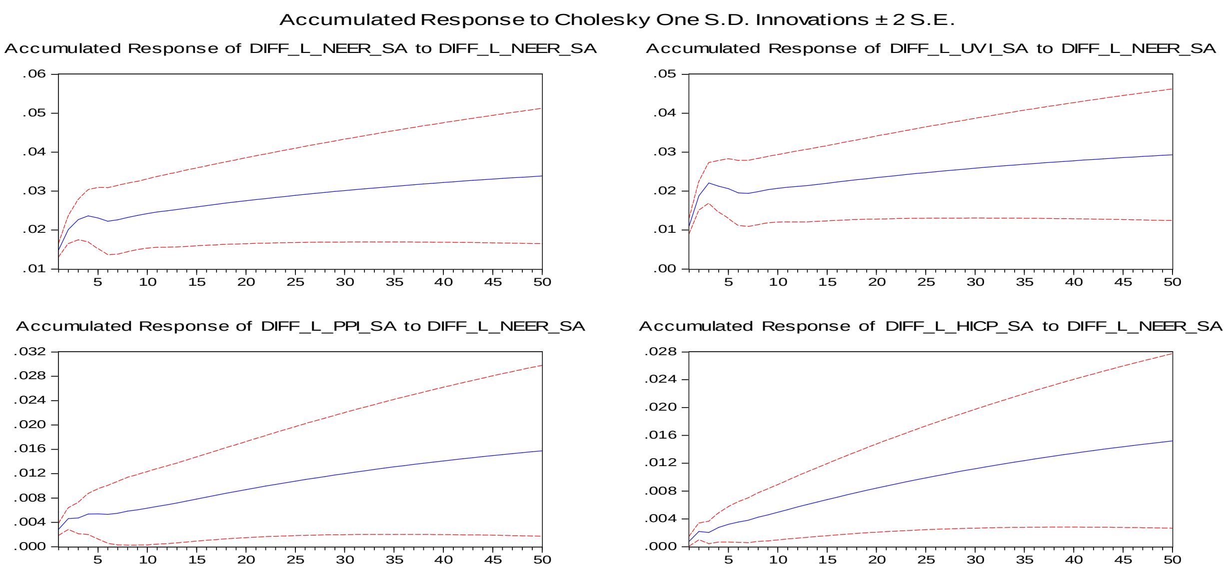
VAR Lag Order Selection Criteria						
Endogenous variables: DIFF_L_OIL_SA I RIP_GAP DIFF_L_NEER_SA DIFF_L_UVI_SA DIFF_L_PPI_SA DIFF_L_HICP_SA Exogenous variables: C						
Sample: 2000M01 2011M12 Included observations: 135						
Lag	LogL	LR	FPE	AIC	SC	HQ
0	1050.216	NA	4.58E-16	-15.45505	-15.30441	-15.39383
1	1511.538	867.969	1.02E-18	-21.56352	-20.35837*	-21.07378*
2	1569.873	103.707	8.92e-19*	-21.70182*	-19.44216	-20.78356
3	1609.641	66.57401*	1.04E-18	-21.56505	-18.25088	-20.21826
4	1650.412	64.0269	1.20E-18	-21.44315	-17.07448	-19.66784
5	1695.5	66.1281	1.33E-18	-21.38518	-15.962	-19.18135

* indicates lag order selected by the criterion

B.Figure 3 **Impulse response of nominal effective exchange rate, import prices, producer prices and consumer prices to one S.D increase in exchange rate**



B.Figure 4 **Accumulated impulse response of nominal effective exchange rate, import, producer and consumer prices to one S.D increase in exchange rate**

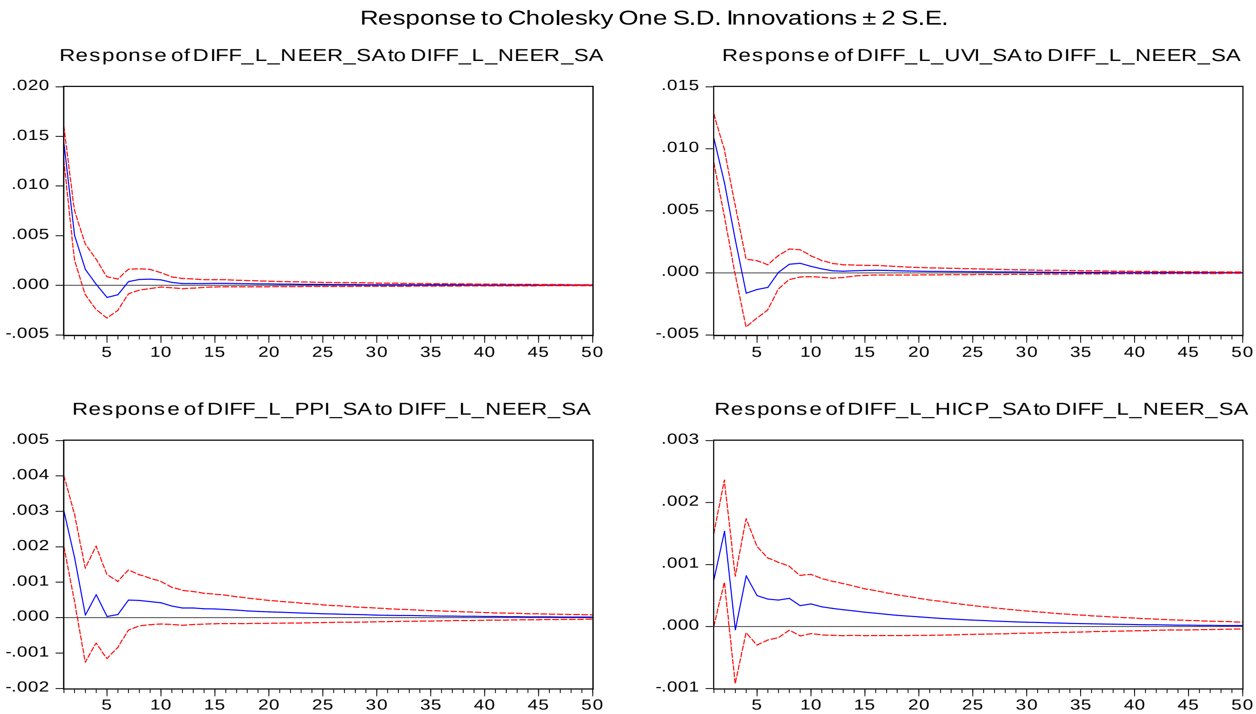


B.Table 3 Estimation of model 3: $\boldsymbol{X_1} = [\Delta \boldsymbol{oil}, \boldsymbol{gap}, \Delta \boldsymbol{NEER}, \Delta \boldsymbol{ip}, \Delta \boldsymbol{ppi}, \Delta \boldsymbol{cpi}]$ + exogeneous foreign price

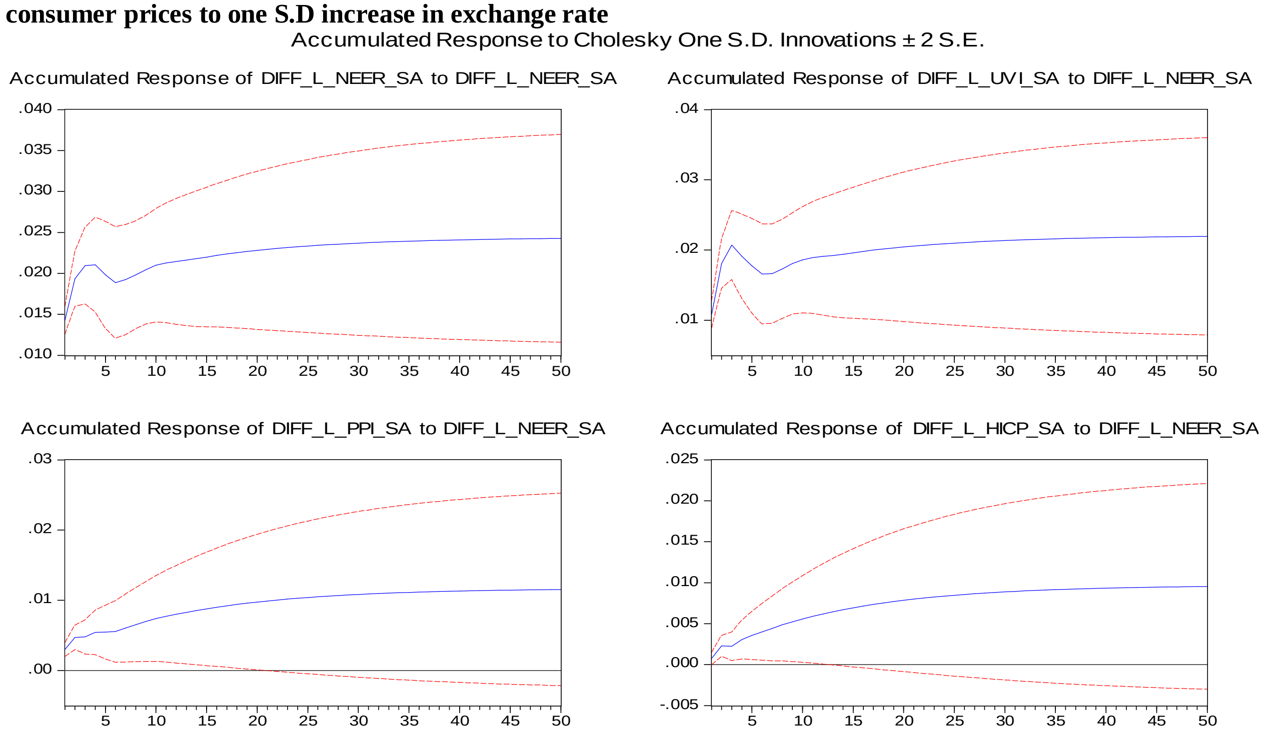
VAR Lag Order Selection Criteria						
Endogenous variables: DIFF_L_OIL_SA RIP_GAP DIFF_L_NEER_SA DIFF_L_UVI_SA DIFF_L_PPI_SA DIFF_L_HICP_SA Exogenous variables: C diff_l_fp_sa						
Sample: 2000M01 2011M12 Included observations: 135						
Lag	LogL	LR	FPE	AIC	SC	HQ
0	1521.961	NA	7.76E-18	-22.3698	-22.11155	-22.26485
1	1678.386	294.3096	1.31E-18	-24.15386	-23.12088*	-23.73409*
2	1716.604	68.51054	1.27E-18	-24.18673	-22.37901	-23.45212
3	1755.26	65.85782*	1.23e-18*	-24.22608*	-21.64361	-23.17663
4	1782.942	44.70179	1.41E-18	-24.10285	-20.74564	-22.73858
5	1809.789	40.96612	1.66E-18	-23.96725	-19.8353	-22.28814

* indicates lag order selected by the criterion

B.Figure 5 **Impulse response of nominal effective exchange rate, import prices, producer prices and consumer prices to one S.D increase in exchange rate**



B.Figure 6 **Accumulated impulse response of nominal effective exchange rate, import, producer and consumer prices to one S.D increase in exchange rate**



B.Table 4 ERPT to prices at different time Horizon

ERPT to Import Prices	1M	3M	6M	24M	36M	50M
MODEL 1	0.74	0.96	0.84	0.87	0.87	0.88
MODEL 2	0.74	0.97	0.88	0.86	0.86	0.87
MODEL 3	0.76	0.99	0.88	0.9	0.9	0.9

ERPT to Producer Prices	1M	3M	6M	24M	36M	50M
MODEL 1	0.2	0.21	0.25	0.42	0.44	0.46
MODEL 2	0.19	0.21	0.24	0.37	0.42	0.47
MODEL 3	0.21	0.23	0.29	0.44	0.47	0.48

ERPT to Consumer Prices	1M	3M	6M	24M	36M	50M
MODEL 1	0.06	0.12	0.22	0.38	0.4	0.42
MODEL 2	0.05	0.09	0.16	0.34	0.4	0.45
MODEL 3	0.05	0.11	0.21	0.36	0.38	0.39

B.Table 5 Variance Decomposition

	% of Import price forecast variance attributed to different shocks						
	Oil shock	IP Gap	Interest	NEER	Import Price	Producer Price	Consumer Price
Model 1							
1M	20.21	0.65		16.98	3.33	58.83	0
6M	22.99	0.94		14.47	6.41	39.62	15.58
12 M	20.36	1.02		14.64	7.01	35.84	21.12
MODEl 2							
1M	19.71	0.14	0.91	16.55	3.51	59.18	0
6M	23.76	0.98	0.96	14.81	7.58	40.76	11.15
12 M	22.93	1.65	1.21	14.71	8.08	39.26	12.16
MODEl 3							
1M	20.14	0.67		18.09	3.03	58.07	0
6M	23	0.89		15.12	6.34	39.52	15.13
12 M	20.27	0.87		14.39	7.52	36.28	20.67

	% of producer price forecast variance attributed to different shocks						
	Oil shock	IP Gap	Interest	NEER	Import Price	Producer Price	Consumer Price
Model 1							
1M	2.21	0.65		16.98	3.33	58.83	0
6M	22.99	0.94		14.47	6.41	39.62	15.58
12 M	20.36	1.02		14.64	7.01	35.84	21.12
MODEl 2							
1M	19.71	0.14	0.91	16.55	3.51	59.18	0
6M	23.76	0.98	0.96	14.81	7.58	40.76	11.15
12 M	22.93	1.65	1.21	14.71	8.08	39.26	12.16
MODEl 3							
1M	20.14	0.67		18.09	3.03	58.07	0
6M	23	0.89		15.12	6.34	39.52	15.13
12 M	20.27	0.87		14.39	7.52	36.28	20.67

	% of producer price forecast variance attributed to different shocks						
	Oil shock	IP Gap	Interest	NEER	Import Price	Producer Price	Consumer Price
Model 1							
1M	0.7	0.1		4.1	6.4	6.9	81.8
6M	1.7	0.4		13.9	10	10	63.9
12 M	1.4	0.3		14.9	9.8	11.2	62.5
MODEl 2							
1M	0.6	0	0	3.4	9	6.2	80.8
6M	2.3	3.2	0.6	12.3	15.5	7.4	58.7
12 M	2.2	4.9	0.6	13.7	14.7	8.4	55.4
MODEl 3							
1M	0.5	0		2.9	7.1	7.9	81.6
6M	2.4	0.2		10.8	11.7	12	62.9
12 M	2.1	0.2		10.6	12.1	13.1	61.9

B.Table 6 Rolling VAR - Impulse Response Estimation to a st. deviation shock in NEER

	NEER	IP	PPI	CPI
step 1	0.01586	0.01357	0.00390	0.00231
s.e	0.00146	0.00159	0.00089	0.00062
step 2	0.01614	0.01287	0.00397	0.00185
s.e	0.00144	0.00152	0.00085	0.00062
step 3	0.01342	0.00981	0.00239	0.00083
s.e	0.00120	0.00131	0.00076	0.00058
step 4	0.01251	0.00957	0.00259	0.00114
s.e	0.00111	0.00129	0.00076	0.00056
step 5	0.01281	0.00998	0.00254	0.00112
s.e	0.00114	0.00125	0.00076	0.00054
step 6	0.01115	0.00862	0.00258	0.00101
s.e	0.00099	0.00119	0.00078	0.00052
step 7	0.01038	0.00839	0.00206	0.00102
s.e	0.00092	0.00120	0.00079	0.00054
step 8	0.01089	0.00900	0.00192	0.00094
s.e	0.00097	0.00122	0.00080	0.00053
step 9	0.01309	0.01092	0.00231	0.00126
s.e	0.00117	0.00132	0.00080	0.00049
step 10	0.01471	0.01070	0.00206	0.00087
s.e	0.00131	0.00132	0.00077	0.00048
step 11	0.01466	0.01011	0.00225	0.00079
s.e	0.00131	0.00131	0.00076	0.00046
step 12	0.01555	0.01043	0.00235	0.00087
s.e	0.00139	0.00127	0.00078	0.00046
step 13	0.01592	0.01074	0.00219	0.00053
s.e	0.00142	0.00144	0.00065	0.00041
step 14	0.01615	0.01082	0.00193	0.00057
s.e	0.00144	0.00149	0.00063	0.00041
step 15	0.01539	0.01076	0.00196	0.00020
s.e	0.00137	0.00152	0.00064	0.00039
step 16	0.01479	0.00969	0.00175	-0.00025
s.e	0.00132	0.00145	0.00064	0.00044
step 17	0.01425	0.01007	0.00149	-0.00011
s.e	0.00127	0.00151	0.00061	0.00053
step 18	0.01499	0.01058	0.00186	0.00022
s.e	0.00134	0.00156	0.00062	0.00053
step 19	0.01469	0.01019	0.00174	0.00015
s.e	0.00131	0.00157	0.00061	0.00054
step 20	0.01444	0.00986	0.00160	0.00031
s.e	0.00129	0.00155	0.00064	0.00056

Appendix C

C.Table 1 Engle-Granger Cointegration test

		Value	Prob.*
IP aggregate	tau-statistic	-4.5057	0.0213
	z-statistic	-34.9142	0.0202
IP food	tau-statistic	-3.9315	0.0875
(2000m1-2011m12)	z-statistic	-27.6522	0.0807
IP raw materials	tau-statistic	-2.8364	0.5287
(2000m1-2011m12)	z-statistic	-16.6651	0.4445
IP energy	tau-statistic	-6.4424	0.0000
(2000m1-2011m12)	z-statistic	-64.3722	0.0000
IP energy	tau-statistic	-4.3833	0.0785
(2004m1-2011m12)	z-statistic	-36.8636	0.0278
IP manufacturing	tau-statistic	-4.2751	0.0391
(2000m1-2011m12)	z-statistic	-31.9535	0.0363
IP manufacturing	tau-statistic	-3.80501	0.2332
(2004m1-2011m12)	z-statistic	-27.0494	0.1634

*MacKinnon (1996) p-values.

C.Table 2 Short Run Dynamic Equation Estimates. Aggregate import prices

Dependent variable: DIFF_L_IP_SA
Estimation period :2000m5-2011m12

Variable	Coefficient	Std. Error	Prob.
C	0.00	0.0014	0.7483
EC(-1)	-0.177	0.0516	0.0008
DIFF_L_NEER_SA	**0.602**	0.0751	0.0000
DIFF_L_NEER_SA(-1)	**0.30**	0.0852	0.0006
DIFF_L_NEER_SA(-2)	0.066	0.0520	0.2072
DIFF_L_NEER_SA(-3)	**-0.173**	0.0534	0.0015
DIFF_L_PPI_SA	0.492	0.1177	0.0001
DIFF_L_IP_SA(-1)	-0.187	0.0806	0.0219
White st errors			
R-squared	0.76		
Adjusted R-squared	0.747		
S.E. of regression	0.009		
Sum squared resid	0.011		
D-W	1.98		
J-B	2.58		
Ramsey RESET Test	t-statistic	1.7918	
Breusch-Godfrey Serial Correlation LM Test:			
F-statistic	0.6831	Prob. F(2,130)	0.5068
F-statistic	1.4026	Prob. F(3,129)	0.245
F-statistic	2.2681	Prob. F(4,128)	0.0654

Null hypothesis: Complete ERPT

Wald Test: C(3)+C(4)+C(6)=1

Test Statistic	Value	df	Probability
t-statistic	-2.2052	132	0.0292
Chi-square	4.8629	1	0.0274

C.Table 3 Short Run Dynamic Equation Estimates. Food import prices

Dependent variable DIFF_l_IP_FOOD_SA
Estimation period : 2000m5-2011m12

Variable	Coefficient	Std. Error	Prob.
C	0	0.00208	0.9684
EC_FOOD(-1)	-0.192	0.04846	0.0001
DIFF_L_NEER_SA	**0.683**	0.08880	0.0000
DIFF_L_FP_FOOD_SA	0.479	0.19554	0.0157
DIFF_L_PPI_SA	0.436	0.18151	0.0176
DIFF_L_PPI_SA(-1)	-0.202	0.17817	0.2580
DIFF_L_PPI_SA(-2)	0.446	0.17510	0.0121
DIFF_L_PPI_SA(-3)	-0.355	0.16320	0.0314
R-squared	0.5410		
Adjusted R-squared	0.5167		
S.E. of regression	0.0148		
Sum squared resid	0.0290		
D-W	1.9690		
J-B	0.4200		
Ramsey RESET Test	t-statistic	1.185067	
Breusch-Godfrey Serial Correlation LM Test:			
F-statistic	0.02336	Prob. F(2,130)	0.9769
F-statistic	0.05141	Prob. F(3,129)	0.9845
F-statistic	0.0386	Prob. F(4,128)	0.9971

C.Table 4 Short Run Dynamic Equation Estimates. Raw materials import prices

Dependent Variable D_l_IP_RAW_MATERIALS_SA
Estimation period: 2005m1-2011m12

Variable	Coefficient	Std. Error	Prob.
C	0.01	0.00266	0.0002
DIFF_L_NEER_SA	**0.587**	0.14438	0.0001
D_L_IP_RAW_MATERIALS_SA(-1)	-0.211	0.07985	0.0092
R-squared	0.1311		
Adjusted R-squared	0.1186		
S.E. of regression	0.0291		
Sum squared resid	0.1175		
D-W	2.04		
J-B	1.05		
Ramsey RESETTest	t-statistic	0.139173	
Breusch-Godfrey Serial Correlation LM Test:			
F-statistic	1.3323	Prob. F(2,137)	0.2673
F-statistic	1.091	Prob. F(3,136)	0.3552
F-statistic	0.9423	Prob. F(4,135)	0.4416

C.Table 5 Short Run Dynamic Equation Estimates. Energy import prices

Dependent variable DIFF_L_IP_ENERGY_SA
Estimation period 2004m2-2011m12

Variable	Coefficient	Std. Error	Prob.
C	-0.213	0.0593	0.0005
EC_ENERGY(-1)	-0.311	0.1018	0.0030
DIFF_L_NEER_SA	**0.606**	0.2487	0.0168
DIFF_L_NEER_SA(-1)	**0.504**	0.2273	0.0292
DIFF_L_FP_ENERGY_SA	*0.951*	0.0966	0.0000
DIFF_L_FP_ENERGY_SA(-1)	*0.249*	0.1221	0.0449
DIFF_L_PPI_SA	1.154	0.6039	0.0593
DIFF_L_IP_ENERGY_SA(-1)	-0.002	0.0044	0.6158
DIFF_L_IP_ENERGY_SA(-2)	-0.316	0.0968	0.0016
R-squared	0.7611		
Adjusted R-squared	0.7389		
S.E. of regression	0.0277		
Sum squared resid	0.0661		
D-W	1.95		
J-B	0.61		
Ramsey RESET test	t-statistic	1.009	
Breusch-Godfrey Serial Correlation LM Test:			
F-statistic	0.1422	Prob. F(2,84)	0.8677
F-statistic	0.1473	Prob. F(3,83)	0.9311
F-statistic	0.2256	Prob. F(4,82)	0.9233

Chow Breakpoint Test: 2003M08
Null Hypothesis: No breaks at specified breakpoints
Equation Sample: 2000M04 2011M12

F-statistic			1.9075
Log likelihood ratio	18.4224	Prob. F(9,123)	0.0568
Wald Statistic	17.1677	Prob. Chi-Square(9)	0.0306

C.Table 6 Short Run Dynamic Equation Estimates. Manufacture import price

Dependent variable DIFF_L_IP_MANUFACTURING_SA
Estimation period 2004m2-2011m12

Variable	Coefficient	Std. Error	Prob.
C	0.000	0.0019	0.9775
DIFF_L_NEER_SA	0.778	0.0764	0.0000
DIFF_L_NEER_SA(-1)	0.404	0.1280	0.0022
DIFF_L_PPI_SA	0.128	0.1963	0.5169
DIFF_L_PPI_SA(-1)	-0.202	0.2320	0.3853
DIFF_L_PPI_SA(-2)	0.269	0.1562	0.0883
DIFF_L_PPI_SA(-3)	0.036	0.1549	0.8145
DIFF_L_PPI_SA(-4)	-0.179	0.1194	0.1365
DIFF_L_PPI_SA(-5)	0.334	0.1631	0.0437
D_L_IP_MANUFACTURING_SA(-1)	-0.227	0.1255	0.0742
White standard errors			
R-squared	0.7541		
Adjusted R-squared	0.7284		
S.E. of regression	0.0082		
Sum squared resid	0.0057		
D-W	2.04		
J-B	2.25		

Ramsey RESET Test	t-statistic	1.0428	
Breusch-Godfrey Serial Correlation LM Test:			
F-statistic	0.407061	Prob. F(2,84)	0.6669
F-statistic	0.300068	Prob. F(3,83)	0.8253
F-statistic	0.226791	Prob. F(4,82)	0.9227

Chow Breakpoint Test: 2003M07
Null Hypothesis: No breaks at specified breakpoints
Equation Sample: 2000M07 2011M12

F-statistic	2.419492	Prob. F(10,118)	0.0118
Log likelihood ratio	25.73896	Prob. Chi-Square(10)	0.0041
Wald Statistic	32.84169	Prob. Chi-Square(10)	0.0003

C.Table 7 Asymmetry in the error correction term

Dependent variable: DIFF_L_IP_SA
Estimation period: 2000m5-2011m12

Variable	Coefficient	Std. Error	Prob.
C	-0.0002	0.0021	0.9223
POSITIVE*EC(-1)	**-0.1281**	**0.1257**	**0.3101**
NEGATIVE*EC(-1)	**-0.1969**	**0.1039**	**0.0603**
DIFF_L_NEER_SA	0.5656	0.0671	0.0000
DIFF_L_NEER_SA(-1)	0.3959	0.0916	0.0000
DIFF_L_NEER_SA(-2)	0.0423	0.0606	0.4867
DIFF_L_NEER_SA(-3)	-0.2247	0.0636	0.0006
DIFF_L_PPI_SA	0.5271	0.1460	0.0004
DIFF_L_PPI_SA(-1)	-0.1344	0.1336	0.3161
DIFF_L_PPI_SA(-2)	0.2005	0.0959	0.0385
DIFF_L_PPI_SA(-3)	0.1933	0.1086	0.0776
DIFF_L_PPI_SA(-4)	-0.2259	0.1053	0.0338
DIFF_L_IP_SA(-1)	-0.2226	0.0856	0.0104
White st. errors			
R-squared	0.7768		
Adjusted R-squared	0.7556		
S.E. of regression	0.0089		
Sum squared resid	0.0099		
D-W	1.94		
J-B	1.2300		

Ramsey RESET test	t-statistic	1.4179	
Breusch-Godfrey Serial Correlation LM Test:			
F-statistic	0.838846	Prob. F(2,124)	0.4346
F-statistic	0.932033	Prob. F(3,123)	0.4275
F-statistic	2.078006	Prob. F(4,122)	0.0878

Null Hypothesis: there is symmetry

Wald Test: c(2)=c(3)

Test Statistic	Value	df	Probability
t-statistic	0.3343	126	0.7387
Chi-square	0.1118	1	0.7381

C.Table 8 Asymmetry in both error correction and exchange rate

Variable	Coefficient	Std. Error	Prob.	
C	0.0025	0.0022	0.2598	
POSITIVE*EC(-1)	**-0.1625**	0.1256	0.1982	
NEGATIVE*EC(-1)	**-0.1904**	0.1049	0.0719	
APPRECIATION	**0.8228**	0.1498	0.000	
APPRECIATION(-1)	**0.2852**	0.1475	0.0555	
DEPRECIATION	**0.4605**	0.0770	0.0000	
DEPRECIATION(-1)	**0.3780**	0.1080	0.0007	
DEPRECIATION(-2)	**0.0527**	0.0776	0.498	
DEPRECIATION(-3)	**-0.2693**	0.0888	0.0029	
DIFF_L_PPI_SA	0.5278	0.1573	0.0011	
DIFF_L_PPI_SA(-1)	-0.1247	0.1342	0.3545	
DIFF_L_PPI_SA(-2)	0.1563	0.0946	0.101	
DIFF_L_PPI_SA(-3)	0.1862	0.1093	0.0909	
DIFF_L_PPI_SA(-4)	-0.1870	0.1093	0.0897	
DIFF_L_UVI_SA(-1)	-0.1920	0.0838	0.0236	
White st. errors				
R-squared	0.779782			
Adjusted R-squared	0.754919			
S.E. of regression	0.008871			
Sum squared resid	0.009759			
D-W	1.94			
J-B	0.79			
Ramsey Reset test	t-statistic	0.0775		
Breusch-Godfrey Serial Correlation LM Test:				
F-statistic	1.548846	Prob. F(2,122)		0.2166
F-statistic	1.277509	Prob. F(3,121)		0.2852
	2.15379	Prob. F(4,120)		0.0783

H0 there is symmetry

Wald Test:

Null Hypothesis: C(2)=C(3), C(4)+C(5)=C(6)+C(7)+C(9)

Test Statistic	Value	df	Probability
F-statistic	2.4392	(2, 124)	0.0914
Chi-square	4.8785	2	0.0872

C.Table 9 Asymmetry in exchange rate

Dependent variable: DIFF_L_IP_SA
Estimation period: 2000m5-2011m12

Variable	Coefficient	Std. Error	Prob.	
C	0.003	0.0018	0.0944	
EC(-1)	-0.183	0.0505	0.0004	
APPRECIATION	**0.859**	0.1455	0.0000	
APPRECIATION(-1)	**0.283**	0.1468	0.0559	
DEPRECIATION	**0.474**	0.0797	0.0000	
DEPRECIATION(-1)	**0.341**	0.1063	0.0017	
DEPRECIATION(-2)	**0.044**	0.0738	0.5476	
DEPRECIATION(-3)	**-0.192**	0.0769	0.0140	
DEPRECIATION(-4)	**-0.102**	0.0511	0.0488	
DIFF_L_PPI_SA	0.524	0.1487	0.0006	
DIFF_L_PPI_SA(-1)	-0.096	0.1246	0.4424	
DIFF_L_PPI_SA(-2)	0.164	0.0920	0.0776	
DIFF_L_UVI_SA(-1)	-0.197	0.0830	0.0191	
white st errors				
R-squared	0.776746			
Adjusted R-squared	0.755483			
S.E. of regression	0.008861			
Sum squared resid	0.009894			
D-W	1.96			
J-B	1.37			
Ramsey reset test	t-statistic	0.129459		
Breusch-Godfrey Serial Correlation LM Test:				
F-statistic	1.891162	Prob. F(2,124)		0.1552
F-statistic	1.535016	Prob. F(3,123)		0.2088
F-statistic	2.410475	Prob. F(4,122)		0.0528

Null hypothesis: there is symmetry

Wald Test:	Null Hypothesis: C(3)+C(4)=C(5)+C(6)+C(8)+C(9)		
Test Statistic	Value	df	Probability
t-statistic	2.5296	126	0.0127
Chi-square	6.3988	1	0.0114