A STUDY OF EXCHANGE RATE PASS-THROUGH IN UKRAINE

by

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Abstract

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This thesis investigates the effect of exchange rate fluctuations on domestic prices, exchange rate pass-through effect. An Error Correction model is estimated accounting for endogeneity of the money supply and the price level, long-run relationship between the exchange rate, money supply and the price level, and their deviations from it. The results show a smaller level of the pass-through in Ukraine than in the other developing countries.

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To Boris Uzvenko and Evgeniy Bandura, my grandfathers and prominent men.

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GLOSSARY

PTE. The effect of changes in the exchange rate of a domestic currency on the local prices for tradable and non-tradable goods.

Chapter 1

INTRODUCTION

During the last three decades economic globalization has continued to intensify volatility of the national currencies and other elements of the external sector such as net capital flows, foreign direct investments (for example Kahveci and Sayılgan (2006)). These tendencies highlighted the problem of the vulnerability of local prices to shocks. Since the 1970's it became clear that fluctuations in the exchange rate of local currency may accelerate or slow down inflation, influence domestic import-substituting production and change trade terms for local exporters. The transmission mechanisms of the pass-through of exchange rate to local prices emerged as a subject for academic insight for various countries, industries, products.

The notion of "pass-through effect" can be defined as the effect of changes in the exchange rate of a domestic currency on the local prices for tradable and non-tradable goods. Goldberg and Knetter (1997) narrowed the pass-through effect (or pass-through elasticity) (PTE) definition to the "imported goods prices change resulting from a one-percent change in the exchange rate between the exporting and importing countries".

Higher PTE means greater exposure of an open economy to the external shocks in the world prices. The exposure implies volatile local prices due to the exchange rate changes. For the monetary authorities, it is crucial to know the exact amount of PTE to predict domestic inflation of the import share of consumer goods and introduce adequate targeting policies.

Despite a great amount of empirical evidence for developed countries like Japan (Takagi and Yoshia 2001), the EU (Fouquin *et al.* 2001), Australia (Dwyer *et al.* 1993); emerging markets, such as Russia (Dobrynskaya 2005) and Belarus (Tsesliuk 2002), no works so far have thoroughly studied PTE in Ukraine. In this work, the PTE in the Ukrainian context will be estimated with emphasis on PTE for sectors producing tradable and non-tradable goods and services separately. This helps to identify more precisely the extent of PTE (as PTE should be much more substantial for tradable goods than for non-tradable goods). Given the significant share of imports in consumer goods in Ukraine (Petryk 2006), the PTE question is very relevant for Ukrainian policy makers.

The main hypothesis that is tested is whether there is a significant effect of exchange rate changes onto domestic prices of tradable and non-tradable consumer and producer goods and services in Ukraine. According to the theory (Devereux and Engel 2000) and a number of empirical works like Tsesliuk (2002) the speed of transmission of exchange rate shock to local prices in Ukraine is expected to be faster than in the countries with historically low inflation. Since historically high rates of inflation is generally a feature of developing countries such an outcome is justified by macroeconomic instability, weaker monetary authorities and, often, significant dollarization of the economy. Considering the battery of empirical works on emerging markets and adapting the methodology used in these works, we identify if and to what extent Ukraine is different from its Latin, Asian, CIS and Baltic peers.

Following the standard theoretical framework conventional for estimations of the PTE, M2 monetary aggregate is included to account for changes in monetary policy that could be endogenously related to the exchange rate as government may adjust money supply in order to conduct interventions. The data exhibits cointegration suggesting for presence of the long-run relationship. Therefore the

pass-through estimates are obtained from the Error Correction model following the 2-step Engle-Granger methodology.

For empirical estimation 1995-2009 monthly series of Ukrainian interbank exchange rate data are used to estimate the PTE as this type of data serves a sufficient indicator for economic agents to adjust behavior (as it is announced) and is not as fixed as the official exchange rate time-series. For local prices series the work uses the Ukrainian Statistical Committee's disaggregated CPI data for consumer goods and the aggregated PPI index for producer goods by industries.

In terms of theory it is interesting to examine how the established theoretical framework works for Ukraine; can the prices and exchange rate series be cointegrated alone (the case of Australia) or can they be cointegrated only in the equation with the other explanatory variables. The latter case, which is expected, implies that explanatory variables account for shocks (the case of Russia). From microeconomic viewpoint, some insight can be gained into industry specific characteristics accounting for different extents of the PTE, thus the estimates could be of potential interest to the real sector as a rule of thumb in developing pricing strategies and rough calculations of exchange rate risk. From macroeconomic point of view, this research could be useful for the authorities as an estimate of Ukraine's vulnerability to external shocks and for the Central bank for inflation targeting in Ukraine, as well as the exchange rate policy setup. The estimates could provide the authorities with a picture of most affected sectors. It could be also valuable for industrial and import regulation purposes as pass-through elasticities are helpful in setting trade regulations.

The rest of the paper proceeds as follows: chapter 2 provides a comprehensive literature review with empirical findings of previous studies. Theoretical background and derivation of the model is provided in chapter 3. Data

description and empirical analysis can be found in chapter 4. Empirical framework and estimation results are presented in chapter 5. Chapter 6 concludes.

Chapter 2

LITERATURE REVIEW

The study of the exchange rate pass-through effect is relatively new, though it has already acquired an extensive discussion in the literature due to its interest for both macro and industrial organization economists, and the importance to policy makers and business people. There is a large number of empirical works estimating PTE for different industries, types of products or countries and a few influential theoretical studies. First, the theoretical papers are considered, then - a strand of empirical works devoted to PTE estimations and explanations of its incompleteness. This section is concluded by results obtained for emerging markets.

Though earlier there were seminal empirical works trying to quantify PTE, for example Isaard (1977) and Feinberg (1986), a formal exhaustive analysis is done by Dornbush (1987). He adapts industrial organization models for macro pricing and considers PTE as a departure from the general equilibrium theory. The author first structures a theoretical framework that explains domestic price changes taking into account the extent of market concentration, degree of product homogeneity, substitutability and the relative market shares of domestic and foreign firms. He suggests a partial-equilibrium model with short term assumption of sticky wages and exogenous exchange rate. His theoretical framework predicts that the appreciation of the local currency should lead to a decline in the price of imports; with homogenous products local companies fully match the decline in price, in case of differentiated goods, the relative price of the imported products rises in response to devaluation. The extent of the change

directly depends on the degree of competition and on the number of domestic and foreign firms. The work is unique in its field as it advances the analysis of purchasing power parity using industrial organization models that before were fruitfully applied in trade theory and not macro-pricing.

Though the theoretical perspective was advanced by Dornbush in 1987, the earliest empirical evidence on the effect of exchange rate on domestic prices appeared in 1970th. Descriptive work of Isard (1977) considers exchange rate fluctuations and movements of US, German, Japanese and Canadian industrial prices finding roughly 30% pass through to prices of industrial produce. Isard considers PTE as a relaxation of the law of one price and its assumptions about perfect substitutability of foreign and domestic products, homogenous goods, absence of transportation costs and trade barriers. The four channels through which prices can be affected by currency fluctuations are stated by Woo *et al.* (1984) in an empirical work looking at exchange rate and inflation in the US. The channels are "the prices of imported consumer goods, which directly affect the consumer price index; the prices of imported inputs, which directly affect costs of production; aggregate demand via the trade multiplier i.e. exchange rate movements change the current account position, which in turn affects aggregate demand; foreign prices, which affect the prices of domestically produced competing goods". Feinberg *et al.* (1986) tests one of the hypothesis later formalized by Dornbush (1987). The authors argue that PTE is less complete with higher domestic market concentration as concentrated manufacturers differentiate their product from imports. Technically the authors set the model of k largest firms that act strategically and all the other price taking small firms. Assuming the quantity of imports supplied depends on the exchange rate and a measure of openness the authors derive an expression for price that inversely relates to the measure of market concentration. This hypothesis is supported by

the data for 41 West German industries measuring seller concentration by Herfindahl index.

It is crucial to note that after theoretical work by Dornbush (1987) and since the early 1990's up to 2005 there was a boom of empirical estimating the PTE for different industries and countries. There are works that look at PTE on consumer and producers prices separately, although the principal part of the existing research is focused on the PTE to import consumer prices. Goldberg and Knetter (1997) offer a meta-study of the PTE to consumer prices that concludes that deviation from the law of one price is largely a result of a third-degree price discrimination which is destination specific adjustments of markups over cost. The works on the PTE to producer prices for the US include Woo (1984), Phillips (1988), Feinberg (1986), Hooper (1989). The conclusion of this strand of the literature is that from 50 to 60% change in the nominal exchange rate passes to prices of manufactured imports. This estimate is robust across alternative functional forms of the import price or profit margin equation and across different estimation techniques. Foreign firms accept substantial changes in the profit margins on the export to a market where they want to maintain market shares. All the four works suggest that the pass-through relationship didn't change over the 1980's decade. Technically they stress on the importance of proxies for import prices and foreign costs for stability assessment.

Practically all the researchers noticed that the PTE is incomplete in real life, i.e. a 1% change in exchange rate will imply less than a 1% change in local prices. Thus, works emerged that try to explain why the PTE is incomplete. For example, the model of Obstfeld and Rogoff (2000) introduces shipping costs that are part of the price of imported goods and make them non-substitutable for the locally produced goods. One argument is that local goods are made of the limited amount of imported intermediate components and domestic raw materials or

non-tradable services such as distribution and marketing constitutes a major part in cost structure implying for incomplete PTE. A number of researchers (Bergin and Feenstra (2001), Bergin (2001), Corsetti and Dedola (2001), Bachetta and Wincoop (2002)), explain the incomplete PTE by imperfectly competitive market structure that assumes price discrimination or strategic pricing that implies an adjustment of price markups of exporters or importers according to the movements of the exchange rate. Finally, the local producer may replace the imported intermediary goods by the domestic inputs due to the exchange rate shock in this way limiting the contribution of imported inputs price change.

There are many works studying the PTE in different markets. All of them find that the PTE is incomplete. The majority of works looks at developed countries due to the quality of data and involvement into global trade flows, as well as floating exchange regimes. Menon (1995) provides an exhaustive meta-study of 43 studies on the North American market. The countries of the EU, Japan and Australia are among the well studied in terms of the PTE, for instance Feinberg (1986), Ohno (1990), Dwyer (1993), Fouquin *et al.* (2001), Takagi *et al.* (2001) and others. The evidence for emerging markets and transition economies follows below.

Garcia *et al.* (2001) estimate the structural equation in the spirit of new Phillips curve literature combining together output gap, wages, labor costs, the gap between actual and expected inflation for Chile. Instead of applying conventional two-step method that follows Engle-Granger cointegration analysis methodology, the authors employed uni-equational cointegration method to estimate the long-run relationship together with the dynamics. The result for Chile is 33% of local price rise due to rise in the exchange rate in the first two years, the other part of the shock transmits to prices in the long-run making the PTE complete. The

authors find positive dependence of exchange-rate-pass-through and economic activity and show that a negative output gap compensates the inflationary effect.

For Russia Dobrynska *et al.* (2005) found that a 50% of the PTE on consumer prices occurs almost entirely within one month. As expected consumer and food prices are highly exposed to exchange rate shocks as well as industries with high import share of raw materials and competitive market structure. In contrast to developed countries the authors shows that for Russia monetary policy should be taken into account while estimating the PTE elasticities, otherwise estimates are biased.

Tsesliuk (2002) provides estimates of the PTE for Belarus in the environment of local currency substitution by the US Dollar. Exchange rate pass-through is higher for PPI than for CPI in Belarus, the estimate for aggregate CPI declines from 14% in the 1st month to 11% in the 4th month. Using the approach of rolling regression the author succeeds in supporting the hypothesis that currency substitution positively influences pass-through of exchange rate.

The main difference between literature on developed and developing economies is empirically smaller extent and longer speed of pass-through for former ones.

There were found a few works that shed light on exchange rate pass-through effect for Ukrainian CPI and local fuel prices. Korhonen *et al.* (2005) is hardly the only work that provides a 63% pass-through 12-months estimate for Ukraine. The authors considered Ukraine as a part of panel of the CIS countries and used IMF's monthly nominal effective exchange rate data and aggregate CPI time series from 1999 to 2005. The authors found that the US inflation insignificantly impacts Ukrainian price level, 98% of the exchange rate movement is passed to local prices within 12 months and prices react asymmetrically to shocks: devaluations increase prices more than appreciations of the currency decrease

prices suggesting for market power of local retail structures. The work neither considered price indices of separate groups of goods nor it differentiated consumer versus producers' products. It didn't account for potential endogeneity problem between the money supply and the exchange rate, though it provides a good rule of thumb estimate despite the fact that the authors confirm the results to be far from robust. The usage of nominal effective (trade weighted) exchange rate was put under controversy by previous empirical works as the majority of agents refer to the official or the interbank exchange rate in their daily transaction.

Holod's (2000) work is devoted to finding of behavioral relationships for monetary policy in order to infer about efficient intermediate targets for monetary policy. The author estimates VEC model of aggregate CPI, money supply M2 and nominal exchange rate on the sample of 1995-1999 monthly data from the National Bank and UEPLAC. The results show that exchange rate shocks influence price level behavior more significantly than the money supply. The work concentrates on the monetary policy and does not rigorously discuss the relationship between the exchange rate and the price level.

Despite the works of Holod (2001) and Korhonen *et al.* (2005), there were no works found providing detailed discussion of exchange rate effects onto domestic prices of separate tradable and non-tradable consumer and producer goods and services. This thesis is undertaking an attempt to close this gap. The distinction between tradable and non-tradable goods is made to explore if non-tradables exhibit vulnerability to exchange rate shocks by containing imported components or services.

Chapter 3

THEORETICAL BACKGROUND

This section explores the rationale of exchange rate effects for domestic prices. It starts with the fundamental theoretical models with strong assumptions predicting complete pass-through effect and proceeds to the models focused on issues that emerge from accounting for real world features.

The seminal fundamental model of international goods pricing is the law of one price (LOOP), implying that in an efficient market all identical goods must have only one price, in common currency. The required assumptions are profit maximization, costless transportation, distribution, and resale. Formally, if p – home currency price in country A and p* - home currency price in country B and E is the exchange rate of A's currency per unit of B's, then for i^{th} good the following relationship holds:

$$p_i = Ep_i^*; \quad (1)$$

On a country level a wide array of goods is considered by constructing a price index that ideally includes all the goods and services produced in the country but practically price of a basket of produces is considered. Comparing price levels between two countries composes the theory of Purchasing Power Parity (PPP). Absolute PPP predicts:

$$P_i = EP_i^*, \quad (2)$$

where P_i – price level in country A, P_i^* - price level in country B.

The relationship that ties together the price and exchange rate changes instead of levels is known as relative PPP.

$$\frac{E - E_{t-1}}{E_{t-1}} = \pi_A - \pi_B, \text{ where } \pi = \frac{P_t - P_{t-1}}{P_t}; \quad (3)$$

Thus, for PPP ratio to be preserved prices and exchange rates should change. If the price level of country A rises by 50%, then the exchange rate in this country should depreciate by 50%. On the other hand exchange rate appreciation in country A should be accompanied with the price decrease in this country in order for PPP to hold. The fluctuations should be to the full extent predicting the pass-through effect to be complete.

However, PPP theory has drawbacks that motivate theoretical explanations of PTE incompleteness. The drawbacks are based on relaxation of assumptions: presence of transport costs and trade barriers; imperfect competition and concentration; product differentiation and usage of different amounts of imported components or non-tradable goods and services in production and distribution.

Due to large number of assumptions to be relaxed and explanations for PTE incompleteness there is a significant amount of works developing country specific models and measures to capture the effect of relaxed assumptions.

This work uses a framework that does not look at the contribution of factors that make PTE incomplete and accepts a more general approach allowing to estimate PTE elasticities but not telling why the PTE is incomplete. This approach is conventional and used in empirical papers for the other countries Parsley *et al.* (1998), Phillips and Loretan (1991), Krugman (1978), Pigott, Rutledge and Willett

(1985), Hung, Kim, and Ohno (1993) or Popper and Lowell (1994). This is done for two reasons.

First, whilst including various factors accounting for particular characteristics of market structure and products, only few works include monetary policy. As shown below there could be an endogenous relationship between monetary policy and exchange rate. Second, it's illustrative to use conventional approach for the sake of better comparison of empirical results with the other countries for which the same approach was used.

As was shown in Parsley and Popper (1998) the price of both tradables and nontradables goods can be written as:

$$p_{it} = E\{ f_i[e_t, m(g_t), z_{it}] \mid I_t \}, \tag{4}$$

Where p_{it} is the price of the i^{th} good, e_t is the exchange rate, $m(g_t)$ – monetary policy implemented through the instrument g_t, z_{it} – vector of all the other factors affecting the price, I_t – available information at the moment of price setting.

Taking into account (4), the price depends on the exchange rate as

$$\gamma_i = \frac{\partial E\{ f_i[e_t, m_t, z_{it}] \mid I_t \}}{\partial e}; \tag{5}$$

When prices do not endogenously depend on the exchange rate fluctuations γ_i can be estimated as exogenous variable. The monetary policy may depend on exchange rate changes, sometimes implicitly. Alternatively, monetary policy can offset the exchange rate fluctuations and determine it. Thus prices and exchange rates could be endogenous, that biases the estimated pass-through elasticities if monetary policy variable is not included into regression equation. The bias is

more evident while exploring non-tradable services which do not contain imported inputs. Intuitively exchange rate fluctuation should not influence price of such services in the short-term. However changes in prices could still be in relation to change in the rate of exchange. An explanation for this is changed monetary policy, namely volume of a particular monetary aggregate, altered by the rate of exchange.

$$\frac{dp_{it}}{de_t} = \frac{\partial p_{it}}{\partial m(g_t)} \frac{dm(g_t)}{de_t}; \qquad (6)$$

This situation is relevant for Ukraine since the exchange rate has been maintained through Central Bank's interbank market interventions altering foreign currency reserves and money supply.

This suggests for inclusion of monetary aggregates to the estimated model, as done for example in Dobrynska *et al.* (2005).

Chapter 4

DATA AND DESCRIPTIVE ANALYSIS

From (4) the variables are tied with the data that are used in the empirical estimation. The choice of the dataset is guided by the previous literature experience and data availability for Ukraine. I start with the dependent variable, p_{it}, which represents price level in Ukraine. For the purpose of this work the price level is modeled in two ways.

First, I use monthly Consumer Price Index (CPI) and Producer Price Index (PPI) data reported by Ukrainian State Statistics Committee. The data used are monthly indices for individual products or services (e.g. bread, meat; primary education, higher education etc) as well as indices for product/service categories (e.g. food, non-alcoholic beverages; education etc) with the value of 100 in January 2001. Since after 2000 The State Statistics Committee changed the consumer basket structure, the sample of 108 monthly observations is available only over 2001-2010. This data is used to estimate the exchange rate pass-through on prices perceived by the majority of economic agents in the country as CPI and PPI include the goods and services that are used most of all by both consumers and producers.

The second type of price data is used to better explore the period of the highest variability of the exchange rate, precise the results and confirm estimates obtained from the 1st dataset. These data are ten-day absolute prices for 22 most fast moving individual food products that represent 23.04% of consumer basket used for CPI calculation. The data is provided by the Ministry of Agriculture from the

point it started to collect it, April 2008, up to date, March 2010. Since prior to 2008 the USDUAH exchange rate wasn't very volatile this creates threats for the estimates of the PTE. The period of 2008-2009 is the period of the highest currency volatility when the PTE was quite vivid for some products[1]. Thus tracking absolute prices of 22 individual products is expected to produce more reliable estimates.

There are three time series available to model the exchange rate and it's useful to choose the most relevant one.

The first one is official exchange rate series. The majority of works for developed economies use official exchange rate data as it generally coincides with the market rate. The works that research the pass-through in developing countries, however, have to face the difference between the official exchange rate and the market rate. This is the case for Ukraine where official exchange rate stayed constant for most of the time. Thus, alternative measures are adopted in the literature. The most common is to use the nominal effective (trade weighted) exchange rate time series computed by the IMF or BIS, as in Korhonen *et al.* (2005). But there is a penalty for this convenience: it's more logical to think that economic agents react to the changes in the exchange rate which are announced, i.e. official or interbank rates. Therefore the usage of nominal effective (trade weighted) exchange rate time series exhibits the long-run trend but could provide inexact short time estimates; still it's the second best solution for the economies with less variable exchange rate. Another and the optimal solution is to use the interbank market

[1] Looking at the recent crises experiences of the other countries, there a question might raise: whether prices were still rising during the crisis as people were losing jobs and income was falling. Ukrainian Statistics Committee reported that CPI totaled to 22.3% p.a. in 2008 and 12.3% p.a. in 2009. From the break-down of CPI by category it's seen that the prices of all the categories of products were rising monotonically. The authority also reported that in 2008 real disposable income of households grew by 9.6% but in 2009 – fell by 8.5%. This implies that the crises haven't distorted negative relationship between the exchange rate and the price level.

exchange rate since it clearly reflects the intents of economic agents – major importing and exporting companies as they ask their banks to purchase or sell the currency in the interbank market. Though the interbank rate in Ukraine is a quasi-fixed as it fluctuates around the official rate, it provides more variability and shows a direction of the currency interbank market. Moreover, the macroeconomic shocks to the exchange rate are first seen in the interbank market, which the NBU tries to keep in the band informally. The usage of interbank exchange rate is also adopted in developing countries literature as well as in this work (see for example Hyder and Shah (2004) for Pakistan and Van Minh (2009) for Vietnam).

Equation (4) contains variable z – vector of all the other factors affecting the price level in the country. It is a literature convention and a common sense to include the money supply as a monetary trigger of the price level; gross domestic product as a real driver of the prices in the economy and world oil prices as a world factor that influences domestic prices.

For the variable corresponding to the monetary policy the M2 stock is used as well as in Dobrynska *et al.* (2005), Parsley *et al.* (1998). Central Bank of Ukraine calculates M2 aggregate using the IMF methodology since 2002. The data before this point will be considered as the 2nd best source. M2 money aggregate includes money in circulation, current account balances and demand deposits in local and foreign currencies. Formally M2 aggregate equals money base times the money multiplier.

Since gross domestic product isn't reported on a monthly basis, I take monthly values of the index of industrial production as a proxy. Indeed, if transformed to quarterly basis and compared to GDP quarterly data, there's a correlation coefficient of 0.75 between index of industrial production and GDP.

Price of oil is the spot price of crude oil on New-York Mercantile Exchange (NYMEX), provided by Bloomberg.

For consistency it's convenient to have the variables in the same units of measure, i.e. indices with the same base year. Thus, performing basic arithmetic operations the variables are transformed into indexes with the value of 100 for December 2000. This transformation doesn't change the path of the variables and, hence, estimates and is completely in line with the majority of the empirical works.

The means and standard deviations of the raw data on hand are described by the tables A1, A2, A3.

The aggregate monthly CPI rose monotonically over the period under consideration with an average monthly CPI amounting to 0.9%, maximum of 3.8% and minimum of -1.8%. The category of the aggregate CPI that had the maximum average monthly growth rate is "Housing, water, gas, electricity" – driven by the increase in prices of sewerage services and gas. This is intuitive as these services are provided by natural monopolies that experience price-inelastic demand; gas has been imported from Russia with sharp occasional jumps in prices. The slowest price growth was in the "Clothes and Footwear" which is surprising as significant market share consists of imported. However, justification for this is a pricing-to-market behavior of Ukrainian apparel importers on the back of high demand elasticity and seasonal discount sales that do affect CPI calculations, as reported by the State Statistics Committee. The behavior of the other categories of Ukrainian CPI is shown on Figure 1. The dynamics of the UAH/USD exchange rate can be described by the Table 1.

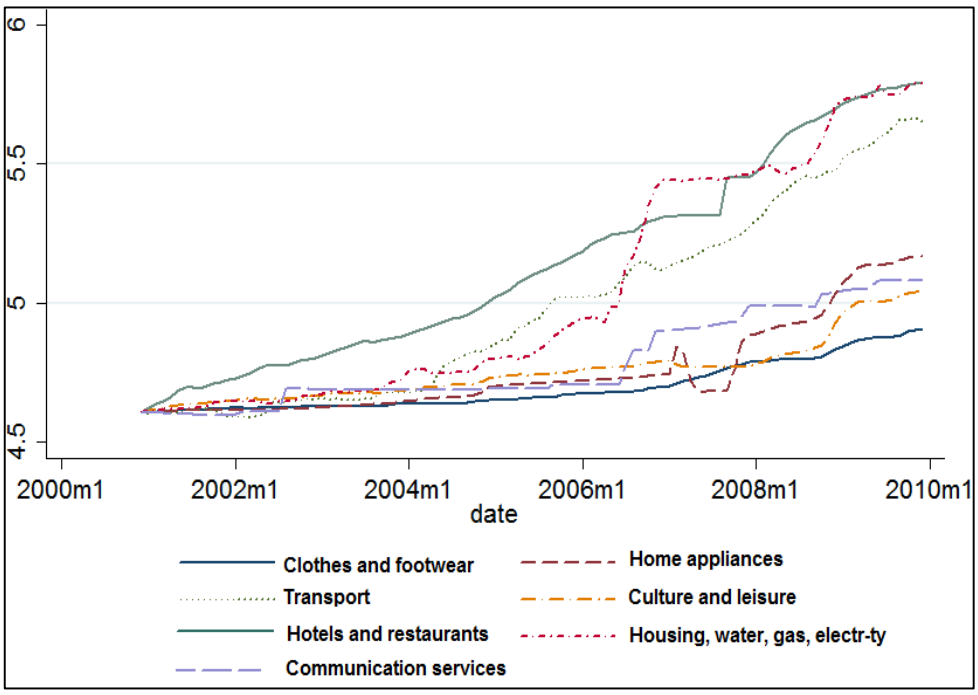

Figure 1. Dynamics of the main categories of Ukrainian CPI

Table 1. Dynamics of the interbank exchange rate by period

Time period	Dynamics	Mean	Std.dev
12M2001 - 4M2005	Stable	5.3346	0.043
5M2005 – 7M2005	Revaluation, 5.3%	5.0527	0.014
8M2005 – 4M2008	Stable	5.0296	0.020
5M2008 – 9M2008	Revaluation, 5.5%	4.7534	0.108
10M2008 – **12M2009**	Devaluation, 68%	7.7644	0.804
12M2001 – 12M2009	**Devaluation, 47%**	**5.5401**	**0.95**

Though the exchange rate time series had low volatility during the stability periods, the volatility of the overall time series is 0.95. The most crucial point of this work is that even during stability periods when the exchange rate fluctuated up to 10% or 55 kopecks on average, some part of this low volatility (for PTE being incomplete) could still be passed-through to the local prices, especially in the import sectors. This could be due to both actual expenses associated with altered trade terms or expectations of future changes. Moreover during 2001-2010 the exchange rate experienced periods of significant volatility, graphical representation of which can be found on Figure 2. These arguments suggest for the feasibility of statistical analysis. The variability of exchange rate versus variability of CPI is better seen in differences of logs on Figure 3. The dynamics of the other explanatory variables can be seen on Figure 4.

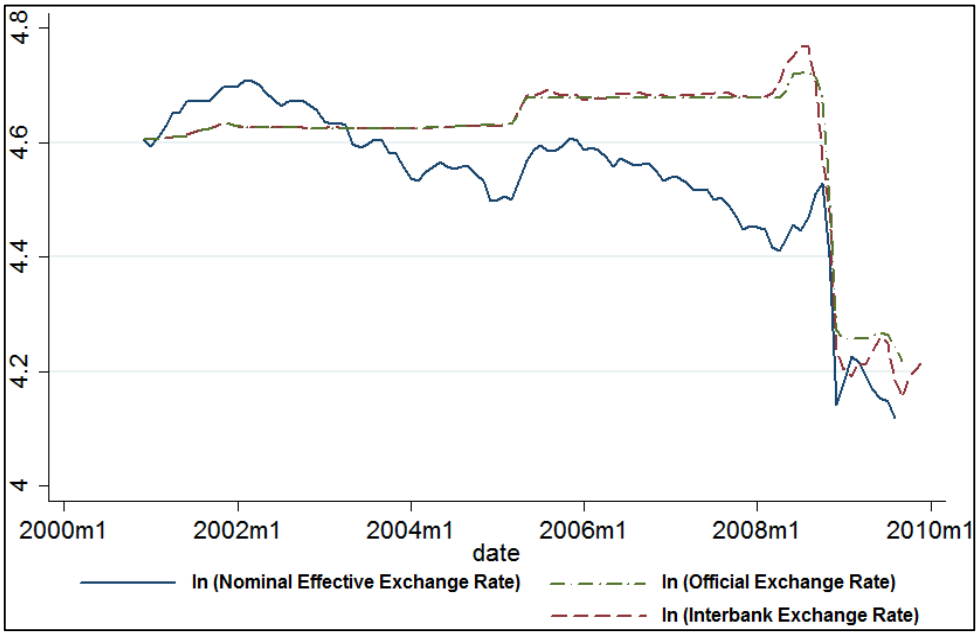

Figure 2. Dynamics of the official, effective and interbank exchange rates

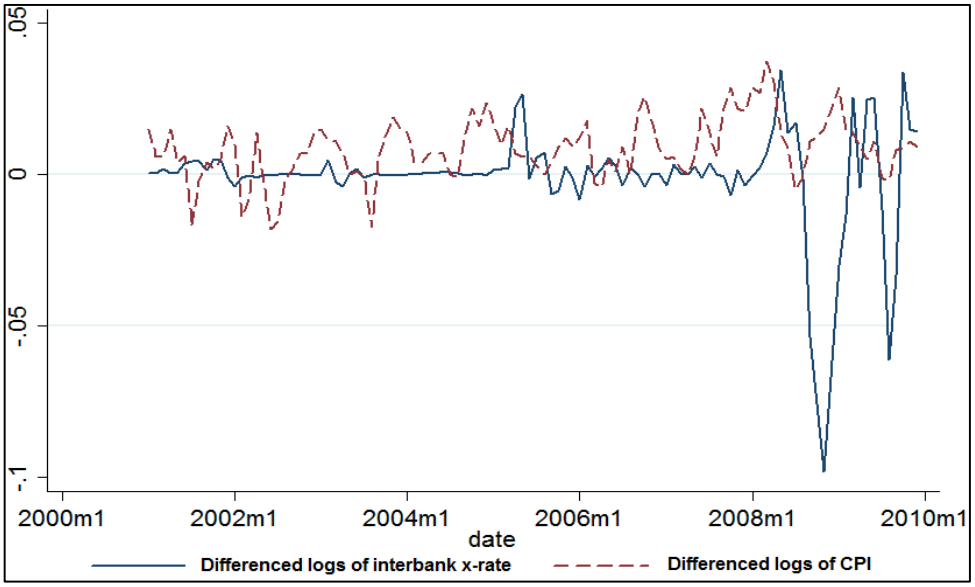

Figure 3. Dynamics of differences of the exchange rate and CPI

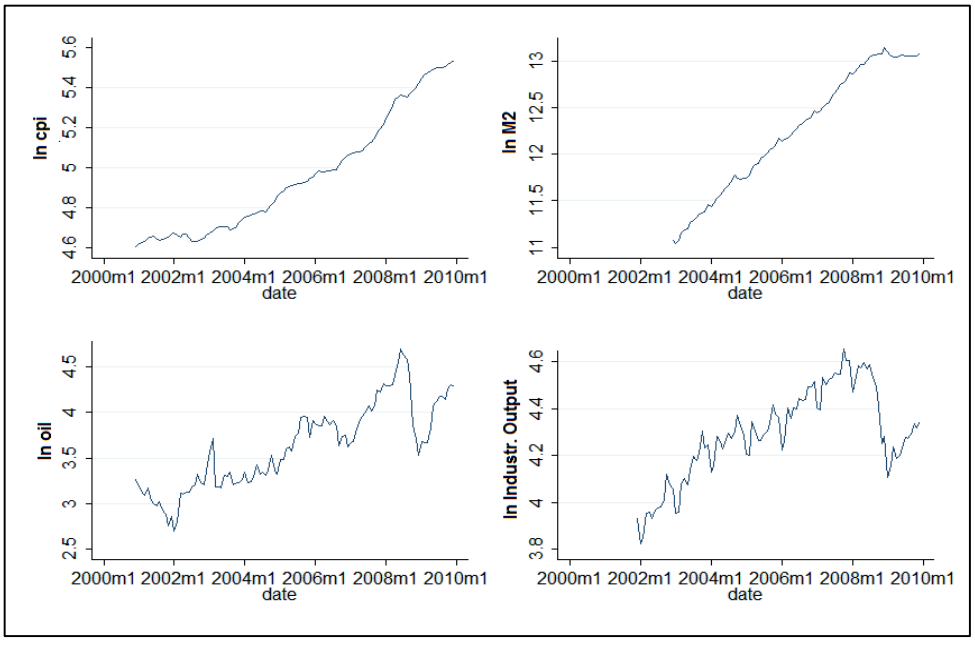

Figure 4. Dynamics of the other explanatory variables

The dynamics of the other explanatory variables had constant patterns before the credit crunch, except the CPI, and began to change in summer 2008. As noted in the Footnote 1, the monthly CPI was growing during the crises period as well, only slowing down to 12.3% p.a. in 2009 from 22.3% in 2008. The money mass M2 was growing on average 3% per month up to January 2008, after, the growth pace slowed to 0.8% per month and M2 amounted to 493 mln. Hryvnia in March 2010. Industrial output index and oil prices exhibited similar patterns of growth with fluctuations before the crises, dropping during the crises and continuing to grow at the same pattern during recovery.

Chapter 5

EMPIRICAL FRAMEWORK AND RESULTS

At the beginning of this section the estimation strategy is outlined briefly, more details on each step will be given in the respective paragraph. The section starts with the practical framework explaining what happens to the Ukrainian economy when an exogenous shock occurs to the exchange rate. Then, as expressions (5) and (6) suggest for simultaneous relationship between the variables, the choice of the model restricts to Vector Autoregressive Model (VAR) and Error Correction Model (VEC). On the next step the variables are checked for stationarity and cointegration. I discriminate between Vector Autoregressive Model (VAR) and Error Correction Model (VEC) based on the presence of the long-run relationship. Further, the number of lags to include in the model is chosen. Finally, an alternative dataset (with higher frequency) is used. The ERPT is estimated with the same technique on both the main and alternative datasets to check if the previous results are consistent. Discussion of the results concludes the section.

The National Bank of Ukraine has never been setting the exchange rate formally. However, it has been setting the official rate and exhorting commercial banks informally or through recommendations to fluctuate around this rate within a band. The NBU also actively acts in the interbank market to maintain the rate. For example, it sells the foreign reserves when Hryvnia devaluates due to some exogenous shock, as shown on Figure 5. The Bank sells reserves in exchange for the local currency, in this way both the assets and liabilities sides of its balance sheet decrease. As the liabilities decrease, the money base plunges as well. Since

broader money mass, M2, equals the money base times the money multiplier, M2 decreases as well. As a result, local prices should change, specifically, according to the monetarist theory and Holod (2000) – prices should decrease. On the other hand independent changes in the monetary policy may affect prices and the exchange rate. In turn, drastic shifts in prices due to supply side factors, for example, may lead to actions from the monetary authorities to adjust money supply and(or) exchange rate.[2]

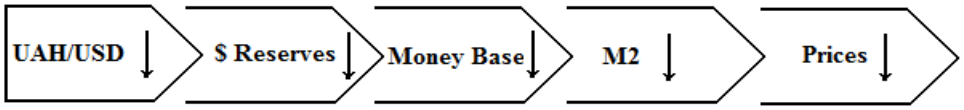

Figure 5. Chain of exogenous shock pass-through in Ukraine

The arguments above suggest that the exchange rate, money supply and the price level are endogenous in Ukraine.

As mentioned above, simultaneous relationship between the variables is also predicted by the theory, formalized by the expressions (5) and (6). The approach commonly applied in econometrics as well as in papers exploring the same issue is a Vector Autoregressive Model (VAR) or Error Correction Model (VEC) with lags of differenced variables according to Phillips *et al.* (1991) and Dobrynska *et al.* (2005). The difference between the approaches is, according to the theory, in cointegration of the variables, i.e. presence of such a relation that will ensure some long-term path with a number of short-term deviations.

[2] The most vivid example of the inflation stabilization episode that used the exchange rate as an anchor in

For logical flow of illustration I start by checking the variables for stationarity and cointegration and then proceed to determination of the number of lags.

There is a common convention in literature and a logical convenience to index key macroeconomic variables as inflation, exchange rate, money supply, GDP or industrial production. In this representation of the data (versus representation when inflation is taken as price growth rate) researchers repeatedly fail to reject unit roots, for example, Holod (2000), Dobrynska (2005), Korhonen (2005) – times-series stationarity for developing countries; Barhoumi (2005) – panel stationarity and cointegration for developing countries; Pappel (1997), and Chin and Meese (1993) - for developed countries. Though the data used contain indices, I do not rely on the previous works as there is a need to check not only for the presence of the unit root, but for order of integration of each variable and the order of cointegration, if any. For this purpose Augmented Dickey-Fuller (ADF) test is employed with post estimation for autocorrelation with the help of alternative Durbin-Watson test. The estimating procedure of the ADF test consists in estimating the following equation:

$$\Delta y_t = \alpha + \gamma y_{t-1} + \delta_1 \Delta y_{t-1} + ... + \delta_p \Delta y_{t-p} + \varepsilon_t, \qquad (7)$$

First, the equation (7) is estimated without lagged differences of the dependent variable. The result is checked for autocorrelation. If the null of no-autocorrelation is rejected, lagged differences are added to the equation (7) and autocorrelation is checked again. The results of ADF test are shown in Tables A4, A5, A6 and suggest that absolutely all the variables are integrated of order 1, i.e. I(1), that is the first difference is needed to transform the variable into stationary, that is the one with constant mean and variance over time.

Ukraine was 5.5% Hryvnia revaluation in April – July 2008.

After checking for the order of integration for individual variables, the order of cointegration between the set of variables is checked. In general, cointegration of variables suggest for a presence of a long-run association between them. Technically, the variables are cointegrated when their linear combination is stationary, even though individually variables are not stationary. Testing for cointegration is crucial to discriminate between VAR analysis or VEC model. If there are one or more cointegration equations, VAR model can be transformed into VEC in order to account for the long-run relationship, according to Engle and Granger (1987). Intuitively it's quite reasonable to expect the presence of the long-run association between the price level, exchange rate and money supply. Such relationship was found for example for Russia in Dobrynska *et al.* (2005). In order to check for cointegration I follow the Engle-Granger methodology and check the linear combination of the variables under consideration for stationarity. Technically the linear combination to be checked is the residual term from equation (8):

$$p_t = \beta_0 + \beta_1 e_t + \beta_2 money_t + \beta_3 gdp_t + \beta_4 oil_t + \varepsilon\,, \qquad (8)$$

The residual from (8) is saved and checked for stationarity with the help of the Dickey-Fuller that is augmented with lagged differences in the case of autocorrelation. The output results of the test show that the aggregate CPI is cointegrated with the exchange rate, the money supply, industrial output index and oil prices. 42 out of 61 categories of CPI form the long-run relationship with the variables, as well as PPI and ultimately all of its categories.

Presence of the cointegration implies that Error Correcting model (ECM) should be used instead of VAR to fit the data better. By exhibiting cointegration the dataset doesn't allow to reject the hypothesis that the variables fluctuate around some long-run relationship.

After defining that variables at hand are I(1) and they exhibit cointegration, it's possible to proceed to the choice of number of lags to be included into the model. Though there is no strict decision rule about the lag number selection, the number of lags in this work will be defined by 1) considering the test statistics, 2) literature experience, and 3) common sense related to the dataset peculiarities and the speed of processes' adjustment in Ukraine. Consider the test statistics values. It is shown in Enders (2004) that after transformation from VAR to VEC, the latter models have one lag less. Thus, the number of lags for VAR model is computed and is shown in Table 2. The number of lags from the table should be decreased by one and used for the Error Correction model.

Table 2. Information criteria for VAR systems with 1 – 4 lags

lag	LL	LR	df	p	FPE	AIC	HQIC	SBIC
0	771.879				3.20E-15	-19.172	-19.1123	-19.0231
1	830.386	117.02	25	0.000	1.40E-15	-20.0097	**-19.6515***	**-19.1164***
2	862.573	64.373	25	0.000	1.20E-15	-20.1893	-19.5328	-18.5517
3	893.208	**61.269***	25	0.000	**1.0e-15***	**-20.3302***	-19.3752	-17.9482
4	907.041	27.666	25	0.323	1.40E-15	-20.051	-18.7976	-16.9246

Sample: 2003m5 2009m12

Number of obs = 80

From the table it's seen that three tests suggest for 3 lags, while two tests suggest for two lags. The literature experience suggest to include 2-5 lags: 4 lags for Belarus in Tsesliuk (2002), 2 lags for Russia, Ukraine, Armenia and Georgia Korhonen and Wachtel (2005), 3 lags for Ukraine, Holod (2000), 5 lags for the exchange rate variable and 2 lags for the other explanatory variables in Dobrynska *et al.* (2005). The former work accepts a more rational approach in terms of saving degrees of freedom by including different lag lengths for different variables. The same approach is accepted in this work and two lags are used for

the exchange rate variable (as suggested by the three statistics) and 1 lag for all the other explanatory variables.[3]

After having identified that the variables are I(1), there is a cointegration between them, the model to be used is Error Correction model with two lags of the exchange rate variable and one lag of all the other explanatory variables, it's possible to proceed to estimation.

As was mentioned above, in order to estimate the Error Correction Model (ECM), the 2-step Engle-Granger methodology is followed for the computational convenience, for, it allows including the variables with different lag lengths easily. For illustrational purposes the methodology for general price level, CPI as a dependent variable, is explained and then estimates for all the products/services' price levels are provided. The first step is to derive the long run relationship, which is the residual term from the equation below:

$$p_t = \beta_0 + \beta_1 e_t + \beta_2 money_t + \beta_3 gdp_t + \beta_4 oil_t + \varepsilon\,, \qquad (9)$$

where all the variables are in levels and in logs.

In the second step a modified ECM is constructed that includes lagged residuals obtained from the first step as a long run relationship. The second step equation estimates short-term deviations from the equilibrium which are pass-through effects attributed to the respective month. The equation estimated on the second step is:

[3] Though the number of lags of the exchange rate variable is two, in fact the dynamics is explored over three periods as besides the lagged differences current difference of the variable is included. Thus the period that is explored is three month or one quarter, which is relevant for Ukraine as it's justifiable to expect that in this country, as in the other developing countries (see literature review), the speed of adjustment is sudden.

$$\Delta p_t = \sum_{i=0}^{3} \beta_{1i} \Delta e_{t-i} + \sum_{i=0}^{2} \beta_{2i} \Delta money_{t-i} + \beta_3 \Delta gdp_{t-1} + \beta_4 \Delta oil_{t-1} + \beta_5 \varepsilon_{t-1} + \upsilon_t, \quad (9)$$

where all the variables are in logs, β10 is the estimate of the pass-through effect in the current month. The PTE is incomplete if the shocks to the exchange rate result in less than proportional change in the price level, as described by literature. Technically this means that $\sum_{i=0}^{3} \beta_{1i} < 1$.

The results obtained from equation (9) for CPI categories are presented in Table A9; for PPI categories - in Table A10. Let's discuss the results for CPI and PPI separately.

Out of 62 CPI categories estimate of the exchange-rate pass-through is significant only for 22 categories, including the general CPI level. The most plausible hypothesis for the small number of significant estimates is low variability of the exchange rate time-series. This hypothesis is justified if look at the estimates of the ERPT at the 3rd lag (exchange rate change that occurred at t-3), and notice that this estimate for 58 regression out of 62 was -0.117, however it was significant only in 15 cases out of 58. So, probably the estimate of the EPRT in the 3rd month after shock is indeed -11.7% even being statistically insignificant. The 22 CPI categories for which ERPT estimates are significant are shown on the Figure 6 with respective ERPT estimates.

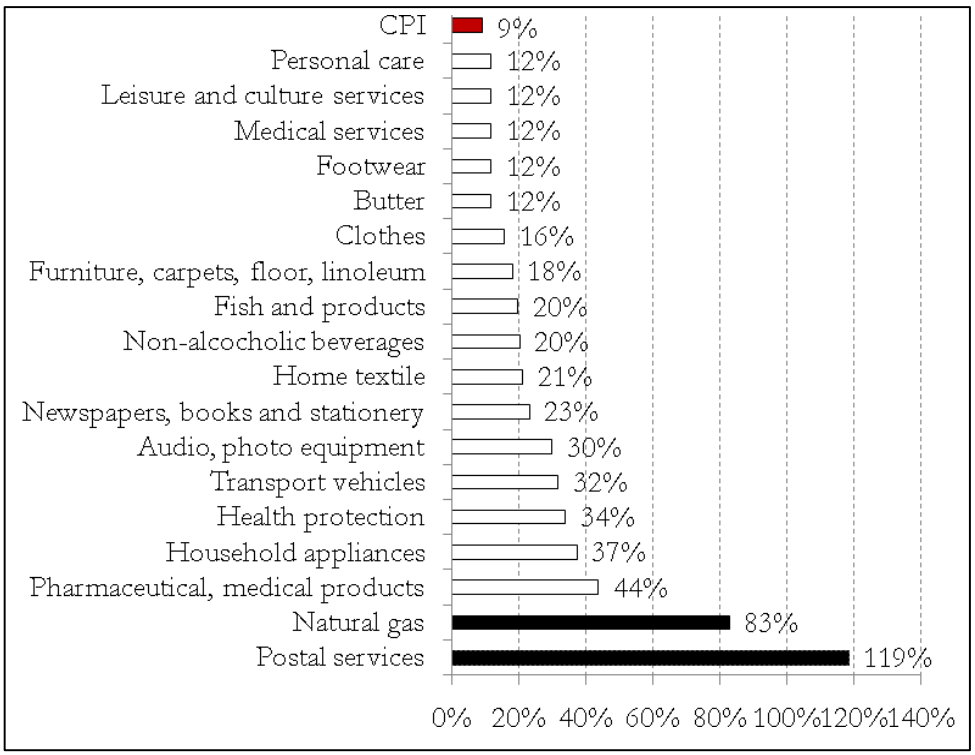

Figure 6. Pass-through effect estimates of CPI by category

Two outlier categories should be noted at once - postal services and natural gas price, with ERPT estimates of higher than 119% and 83% respectively. The prices for these goods and services are set administratively (refer to Figure 7 to see the sharp price increases) as the state is the natural monopoly in both sectors. Thus, the estimate has nothing to do with the ERPT and is a simple coincidence of administrative price increases with the exchange rate movement. This is a vivid example of correlation and not of causality!

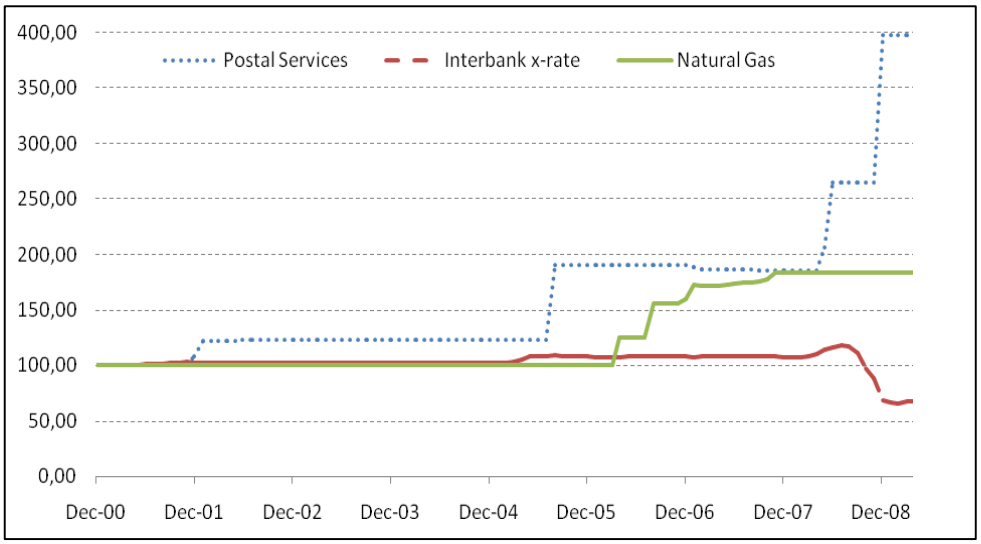

Figure 7. Dynamics of administratively set prices and the exchange rate

The ERPT estimates of all the other categories are consistent with expectations and the literature, Russia for example, Dobrynska *et al.* (2005). Pharmaceutical and medical products, and health protection are sectors with both significant share of imported goods and inelastic demand. Household appliances, audio and photo equipment, transport vehicles, leisure and culture, books and home textile are all tradable goods and sectors with high shares of imported goods. Though clothes and footwear sectors have also high shares of imported goods, the ERPT estimates for these sectors are relatively low. The explanation for this is high demand elasticity that possibly leads to pricing-to-market behaviour when sellerssellers adjust their price markups in order to retain customers or inventory turnover ratios. Seasonal discounts and sales effects are also included by the state statistics committee during CPI calculations. Leisure and culture services and personal care services exhibit comparatively lower ERPT estimates that is due to the non-tradable nature of these services. However, 11.7% is a significant ERPT

estimate for these sector that suggest for possible presence of imported components in these services (imported whisky, foreign chief-cooks for leisure category; imported equimpent and personal care substances for personal care category).

Consider ERPT estimates for PPI categories that are shown on Figure 8.

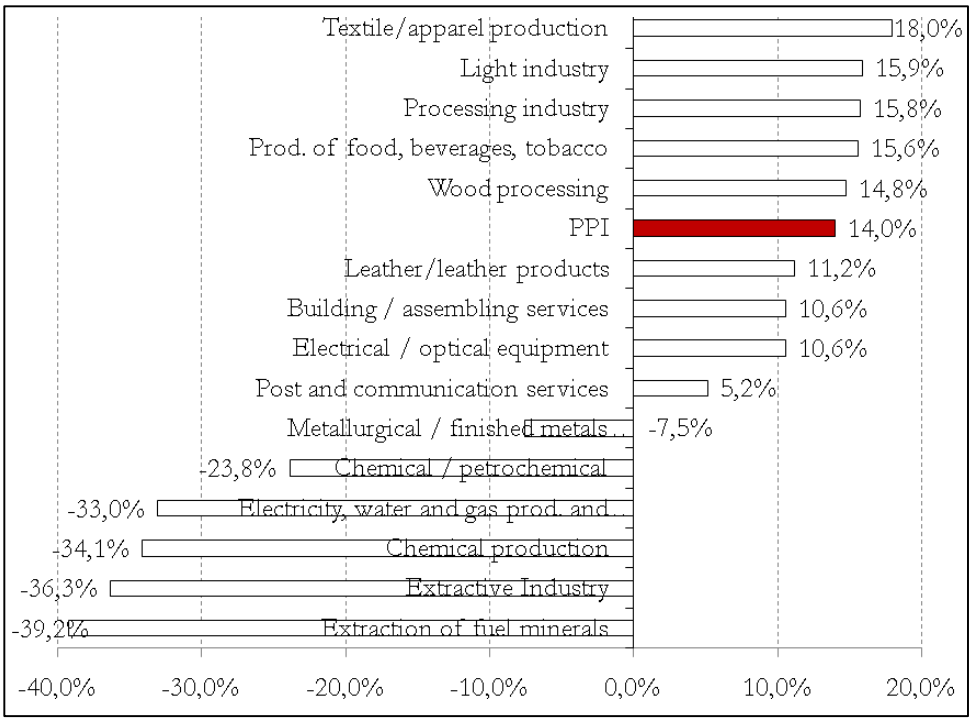

Figure 8. Pass-through effect estimates of PPI by category

Out of 23 ERPT effects estimated for different components of the PPI index only 16 are significant. The EPRT estimates for the PPI categories are in line with the literature as well as with the intuition: textile and apparel sector as well as the

light industry have the largest ERPT estimates that is explained by the imported raw materials (textile) and equipment; construction and assembling services and production of national electrical and optical equipment have the lowest pass-through due to the non-tradable nature of sectors. Though there are 5 categories that showed an interesting effect that is inverse to the pass-through effect, i.e. the prices in these sectors decline when Hryvnia devaluates (prices should increase with devaluation according to the essence of the ERPT). The possible explanation for such a finding is that as the 5 sectors exhibiting "inverse" ERPT are sources of raw materials, that are the main Ukraine's export articles (Metallurgical products, chemicals, products of extractive industry), then the trade terms for the producers in those industries become better with Hryvnia devaluation[4]. According to Medyna, (2002) there is no pricing-to-market effect and "Ukrainian exporters completely pass-through exchange rate changes to prices in foreign market currency". To maintain their competitive position in the home market, producers adjust their home price markups which is captured by the estimate of the ERPT for these 5 sectors.

The results of the ERPT estimates for Ukrainian CPI and PPI suggest for the following empirical findings. The ERPT in Ukraine is incomplete both for CPI and PPI individual goods and service. The pass-through to consumer prices (measured by the CPI), 9.1%, is lower than the ERPT to producers' prices (PPI), 14.0%. However, the maximum ERPT estimates for individual categories of CPI are higher than those of PPI, 43.8% for Pharmaceuticals (CPI component) and 18.0% for Textile/Apparel production (PPI component). Consistent with the developing markets literature, the exchange rate shocks have the fastest speed of pass-through to consumer prices in the 1st month as shown in Table 3.

[4] According to the State Statistics Committee, the TOP-3 sectors of the Ukrainian economy with the largest shares in the export were (average over 2009): Non-precious metals and products made of it – 28% (out of

Table 3. The speed of the pass-through to the local prices

	Month 1	Month 2	Month 3
Consumer Prices	-0.295	-0.225	-0.115
Producer Prices	+0.219	-0.102	-0.142

"-" means pass-through
"+" means pricing-to-market

In the Table 3 the speed of the pass-through is measured by the monthly pass-through averaged across the categories. The speed of pass-through declines as time passes for consumer prices and increases with time for producer prices reaching its peak in the 3rd month. For producer prices the pass-through effect in the 1st month is insignificant while markup adjustment effect is large.

Finally, since the monthly exchange rate time series exhibit low variability, this may cast a doubt on the above estimates. To check whether the above estimates are close to the truth, the alternative dataset is used. The alternative dataset is a high frequency panel data for prices of the 22 major food articles that comprise 23% of the CPI and are observed every 10 days. The sample spans the period from April 10th, 2008 to March 20th, 2009, when the Hryvnia exchange rate fluctuated much with standard deviation of 0.804 devaluating by 68%. The models that capture the same effects are estimated on both the main (monthly) dataset and on the alternative (high frequency) dataset to see the possible differences.

Since the data on the money supply and industrial output index are reported on the monthly basis, and estimation of the Error Correction Model for the panel data is quite a tedious task, Arellano-Bond dynamic estimator GMM panel-data model is applied allowing for endogeneity of the variables. The choice of the

total export), Mechanical equipment and parts – 14%, Mineral products – 12%. Textile imports amounted to 3% of the total country's imports.

model is also guided by Bailliu and Fujii (2004) that confirms that estimation of the random- and the fixed-effects model will produce biased results when regressing on the lagged dependent variable.

Consequently, the money supply, industrial output index and the long-run relationship term are dropped. As mentioned above, failure to include the monetary policy will lead to a biased ERPT estimate for Ukraine. This bias is accepted for both models, so their results are expected to be similar. For the main (monthly) dataset two models are estimated: simple OLS and VAR model. For the alternative (high frequency) dataset Arellano-Bond technique is applied. The VAR model is expected to demonstrate a bias caused by failure to account for endogeneity between the variables in the OLS. The OLS and the Arellano-Bond models are estimated in the form:,(10)

$$\Delta \ln CPI_t = \gamma_0 \Delta \ln CPI_{t-1} + \gamma_1 \Delta \ln XRate_t + \varsigma$$

The VAR model is estimated in the form of the system of (11) and (12):

$$\Delta \ln CPI_t = \varphi_0 \Delta \ln CPI_{t-1} + \varphi_1 \Delta \ln XRate_t + \xi \quad (11)$$

$$\Delta \ln XRate_t = \lambda_0 \ln XRate_{t-1} + \lambda_1 \Delta \ln CPI_t + \vartheta \quad (12)$$

The estimation results of the three models are in the Table 4.

Table 4. Estimation results for the main and alternative datasets

Dataset	**Monthly**		**High-Frequency**
Regressor / Model	**OLS**	**VAR**	**Arellano-Bond**
$\Delta \ln (CPI_{t-1})$	0.762 [12.565]***	0.75 [12.334]***	0.934 [60.472]***
$\Delta \ln (XRate_t)$	**-0.049** [-1.889]*	**-0.052** [-2.021]*	**-0.099** [-1.969]*
R^2	0.6138	0.6154	
p-value	0	0	0
N obs.	107	107	658

t statistics in brackets

* p<0.05, ** p<0.01, *** p<0.01

The difference in the estimation results of OLS and VAR suggest that there is a bias if the endogeneity is not accounted. The difference between the estimates of VAR and Arellano-Bond could be due to either omission of the monetary policy or dataset differences. The omission of the monetary policy will lead to a larger downward bias in the VAR as it was estimated over the period of 2001-2009 when money supply fluctuated significantly. Instead, the money supply remained stable over 2008-2009, the time span for the Arellano-Bond estimation. Anyway, the magnitude differ of the ERPT effect has the same order that allows to think that all the results obtained from the monthly dataset used in this work are not as bad as it seems at the first sight.

Chapter 6

CONCLUSION

This work analyzes the sensitivity of the Ukrainian consumer and producer prices to the shocks in the exchange rate, the pass-through effect. The pass-through effect is explored for prices of both individual products and services and aggregate product categories comprising CPI and PPI.

The main hypothesis that was tested is whether there is a significant effect of exchange rate changes onto domestic prices of tradable and non-tradable consumer and producer goods and services in Ukraine. The obtained results for the aggregate price indices (CPI and PPI) suggest that the extent of the pass-through is higher for PPI than for CPI, 14% and 9% respectively. This result is more often found in literature for developed countries. The findings for the aggregate indices are lower than suggested by developing countries literature that finds at least 30% PTE in developing countries.

Different individual sectors of Ukrainian economy have different levels of PTE. Higher PTE is observed in the industries with low demand elasticity and competition (the PTE in Pharmaceutical and medical products is 44%) and in the sectors with high import share (PTE in Home appliances sector, transport vehicles, audio and photo equipment is larger than or equal to 30%). Lower PTE is observed in the industries with either competitive market structure (PTE for Clothes sector is 16%, for Footwear – 12%) or for the industries with low share of imported goods or intermediate components; sectors that produce non-tradable goods (Leisure and culture, personal care services PTE is 12%). In terms

of the speed of adjustment, the highest PTE on consumer prices occurs in the first month and diminishes by the fourth month following the shock. This finding is in line with the literature for developing countries that suggest that the majority of adjustments occur within 3 to 6 months. A counter intuitive finding is that prices of products included in PPI decline with the devaluation of the local currency (instead of increase, expected by the common sense and the literature). Such a result can be explained by the markup adjusting behavior of the producers right after the shock. In the 2nd and 3rd months the relationship of the exchange rate and the producer prices is as predicted.

The main shortcoming of the estimation– low variability of the exchange rate time-series was mitigated after using the alternative high frequency dataset. After estimating the same effect on both datasets estimates of the same order were obtained. This suggests that estimates are qualitatively the same and results obtained from the original data are not incorrect.

The results of this work have direct practical application showing Ukraine's vulnerability to external shocks. The estimates could provide the authorities with a picture of the most affected sectors and facilitate in inflation forecasting.

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APPENDIX

Table A1. Descriptive statistics of CPI and explanatory variables

	Mean	**Std.dev**
CPI aggregate index	148.9	47.1
Official exchange rate	101.3	10.5
Nominal effective x-rate	94.4	11.5
Interbank exchange rate	100.3	12.8
Money stock M2	394.7	231.8
Industrial output index	74.8	13.13
Spot Oil price	45.3	20.48

Table A2. Descriptive statistics of CPI by category

CPI by category	**Mean**	**Std.dev**
Food and non-alcoholic beverages	153.6	50.9
Food	156.1	53
Non-alcoholic beverages	129.1	33.6
Alcoholic bevarages, tobacco	128.5	34.9
Clothing and footwear	110.1	10.1
Housing, water, electricity, gas and other types of fuel	169.6	75.6
Household articles, domestic appliances and current	117.9	22
Health protection	135.6	32.4
Transport	155.6	57.5
Communications	121.5	20.6
Recreation and culture	116.9	13.8
Education	163.8	55.1
Restaurants and hotels	183.1	69.8
Miscelaneous goods and services	132.4	38.6
		109

Table A3. Descriptive statistics of PPI by category

PPI by category	Mean	Std.dev
Extractive industry	155.2021	55.4569
Extractive industry, energy minerals	160.4635	56.07006
Extractive industry, non-energy minerals	135.6316	42.28249
Processing industry	131.1045	43.17903
Processing of food, beverages and tobacco products	112.0261	16.99321
Light industry	177.5836	78.19733
Production of textile, apparel and wool products	121.2169	25.98907
Production of leather and leather products	137.4082	39.91512
Wood processing and products from wood	161.8196	63.39126
Pulp-and-paper industry	126.2411	27.29705
Chemical and petrochemical industry	118.4903	17.48766
Other non-metal and mineral production	169.3817	64.38794
Mettalurgy and metal products production	183.145	74.73427
Machine building	133.765	45.60399
Electronic, electric and optical equipment production	112.5331	40.76954
Gas, water and energy generation and distribution	169.0078	61.56801
Observations		**85**

Table A4. Results of ADF test for stationarity of regressors

Variable	ADF τ -statistics[(1)]	Alternative DW p-value[(2)]	Number of lagged differences
d.ln (x-rate)	[5.618]***	0.1376	0
d.ln (M2)	[8.64]***	0.6074	0
d.ln (GDP)	[10.677]***	0.5759	0
d.ln (OIL)	[9.505]***	0.7007	0

Absolute value of t statistics in brackets

* significant at 10%; ** significant at 5%; *** significant at 1%

(1)Significance of the τ -statistics is evaluated against specific distribution, known as Dickey-Fuller Table.

(2)p-value of the alternative Durbin-Watson test for autocorrelation with H0: no autocorrelation.

Table A5. Results of ADF test for stationarity of regressands (CPI)

Differenced logs of variable,	**ADF τ - statistics**	**Alternative DW p-value[(2)]**	**Number of lagged differences**
CPI	[5.021]***	0.1795	0
Food and Non-alcocholic	[4.26]***	0.15	0
Food	[4.38]***	0.18	0
Bread and bread products	[4.62]***	0.51	0
Bread	[4.60]***	0.55	0
Macaroni foods	[6.68]***	0.33	0
Confectionary from flour	[5.43]***	0.44	0
Meat and products	[3.84]***	0.08	0
Fish and products	[4.77]***	0.02	0
Milk,cheese and eggs	[4.67]***	0.35	0
Milk	[6.75]***	0.06	3
Cheese and dairy	[4.49]***	0.07	1
Eggs	[6.90]***	0.37	0
Oil and fats	[7.64]***	0.19	0
Butter	[4.873]***	0.39	2
Oil	[5.270]***	0.23	1
Other edible animal fat	[4.50]***	0.07	0
Fruits	[6.67]***	0.61	0
Vegetables	[6.832]***	0.89	0
Potatoes	[7.30]***	0.76	0
Sugar	[9.027]***	0.97	0
Confectionaries from	[7.62]***	0.95	0
Non-alcocholic beverages	[3.411]***	0.58	0
Alcocholic beverages,	[4.15]***	0.84	0
Clothes and footwera	[4.115]***	0.79	1
Clothes	[4.167]***	0.18	1
Footwear	[6.041]***	0.28	1
Housing, water,	[4.159]***	0.72	1
Housing fee	[11.02]***	0.61	0
Housing maintenance	[2.983]	0.45	4
Water supply	[5.175]***	0.39	1
Sewerage	[10.81]***	0.22	0
Electricity	[10.32]***	0.75	0
Natural gas	[10.40]***	0.38	0
Hot water, heating	[5.97]***	0.12	0
Homeware, repairs	[4.551]***	0.39	1

Table A5. Continued

Differenced logs of variable	**ADF τ - statistics**	**Alternative DW p-value[(2)]**	**Number of lagged differences**
Household appliances	[4.21]***	0.07	0
Health protection	[4.47]***	0.13	0
Pharmaceutical, medical	[5.176]***	0.75	1
Medical services	[4.02]***	0.40	0
Transport	[6.18]***	0.06	0
Purchasing of transport	[7.16]***	0.38	0
Fuel and oils	[6.40]***	0.20	0
Transport services	[6.11]***	0.55	0
Railway passenger	[7.80]***	0.81	0
Road passenger transport	[7.79]***	0.20	0
Communication services	[8.98]***	0.42	0
Postal services	[10.04]***	0.88	0
Telephone / public	[8.72]***	0.41	0
Leisure and culture	[4.510]***	0.91	1
Audio, photo equipment	[5.588]***	0.09	1
Leisure and culture	[4.22]***	0.86	0
Newspapers, books and	[3.77]***	0.78	0
Education	[10.68]***	0.66	0
Pre-school and primary	[7.60]***	0.18	0
Secondary education	[10.40]***	0.51	0
Higher education	[10.81]***	0.54	0
Restaurants and hotels	[8.81]***	0.43	0
Different goods and	[2.08]**	0.70	0
Personal care	[2.26]**	0.04	0

Table A6. Results of ADF test for stationarity of regressands (PPI)

Differenced logs of variable	ADF -statistics	Alternative DW p-value[(2)]	Number of lagged differences
PPI	[4.632]***	0.260221	0
Extractive Industry	[6.421]***	0.484744	0
Mining of fuel minerals	[6.57]***	0.18495	0
Mining of other minerals	[7.97]***	0.743081	0
Processing industry	[3.88]***	0.026122	0
Prod. Of food, beverages, tobacco	[3.98]***	0.581417	0
Light industry	[5.11]***	0.104798	0
Textile/apparel production	[5.62]***	0.290004	0
Leather/leather products	[3.744]**	0.9548	0
Wood processing	[6.67]***	0.97508	0
Pulp and paper industry	[8.24]***	0.865967	0
Coke / oil processing products	[5.33]***	0.122735	0
Chemical / petrochemical	[5.78]***	0.7074	0
Chemical production	[5.67]***	0.663916	0
Rubber and plastics production	[6.14]***	0.316215	0
Metallurgical / metal production	[4.18]***	0.035546	0
Machine building	[5.72]***	0.14341	0
Equipment production	[6.63]***	0.807155	0
Electrical / optical equipment	[8.00]***	0.192594	0
Trasnport vehicles production	[6.64]***	0.35129	0
Electricity, water and gas prod.	[9.32]***	0.308848	0
Building / assembly services	[3.93]***	0.745194	0
Post and communication services	[9.18]***	0.882367	0

Table A7.Cointegraion results for CPI by category

Variable	ADF τ -statistics	Alternative DW p-value[2]	Number of lagged
CPI	[4.049]***	0.1701	1
Food and Non-alcocholic	[3.28]***	0.159489	0
Food	[3.33]***	0.171587	0
Bread and bread products	[2.44]	0.577	1
Bread	[2.572]*	0.5715	1
Macaroni foods	[2.246]	0.2741	0
Confectionary from flour	[2.45]	0.183459	0
Meat and products	[2.07]	0.193721	0
Fish and products	[2.70]***	0.47109	0
Milk,cheese and eggs	[4.282]***	0.0558	1
Milk	[5.109]***	0.1429	1
Cheese and dairy	[4.144]***	0.7782	1
Eggs	[3.812]***	0.1854	1
Oil and fats	[2.50]*	0.297671	0
Butter	[3.824]***	0.6559	1
Oil	[2.02]	0.135971	0
Other edible animal fat	[2.552]	0.5384	1
Fruits	[4.086]***	0.7883	1
Vegetables	[3.197]**	0.675	1
Potatoes	[2.35]	0.489531	0
Sugar	[3.912]***	0.3892	1
Confectionaries from sugar	[3.638]***	0.7839	1
Non-alcocholic beverages	[4.444]***	0.3211	1
Alcocholic beverages,	[3.86]***	0.053378	0
Clothes and footwera	[2.66]***	0.772391	0
Clothes	[3.74]***	0.085571	0
Footwear	[3.23]***	0.052204	0
Housing, water, electricity,	[2.00]	0.372781	0
Housing fee	[2.40]	0.27085	0
Housing maintenance and	[2.228]	0.1016	1
Water supply	[2.16]	0.119395	0
Sewerage	[2.36]**	0.24112	0
Electricity	[2.08]	0.82164	0
Natural gas	[2.66]***	0.526826	0
Hot water, heating	[2.15]	0.037962	0
Homeware, repairs	[4.367]***	0.2162	1
Furniture, carpets, floor,	[4.860]***	0.5836	1

Table A7. Continued

Variable	ADF τ -statistics	Alternative DW p-	Number
Pharmaceutical, medical	[5.173]***	0.6193	1
Medical services	[4.645]***	0.1708	1
Transport	[4.245]***	0.3359	1
Purchasing of transport	[5.01]***	0.05578	0
Fuel and oils	[1.94]	0.308554	0
Transport services	[3.34]***	0.171293	0
Railway passenger services	[2.687]	0.9658	1
Road passenger transport	[4.36]***	0.178678	0
Communication services	[1.95]	0.197028	0
Postal services	[3.18]***	0.296628	0
Telephone / public	[2.09]	0.501843	0
Leisure and culture	[3.054]	0.3507	1
Audio, photo equipment	[3.951]***	3.951	1
Leisure and culture services	[2.508]	0.444	1
Newspapers, books and	[3.84]***	0.108874	0
Education	[3.58]***	0.269983	0
Pre-school and primary	[3.841]***	0.0744	1
Secondary education	[3.85]***	0.222951	0
Higher education	[4.14]***	0.176895	0
Restaurants and hotels	[4.501]***	0.2974	1
Different goods and	[3.09]***	0.054179	0
Personal care	[4.478]***	0.5957	1

Table A8. Cointegration results for PPI by category

Variable	ADF τ - statistics	Alternative DW p-value[(2)]	Number of lagged differences
PPI	[3.041]**	0.6202	1
Extractive Industry	[3.28]***	0.129365	0
Mining of fuel minerals	[4.04]***	0.050402	0
Mining of other minerals	[3.20]***	0.267926	0
Processing industry	[2.864]*	0.7831	1
Prod. Of food, beverages,	[2.60]**	0.206756	0
Light industry	[3.812]***	0.6691	1
Textile/apparel	[3.561]***	0.5558	1
Leather/leather products	[3.40]***	0.081784	0
Wood processing	[2.28]**	0.022344	0
Pulp and paper industry	[3.60]***	0.40394	0
Coke / oil processing	[1.95]*	0.805508	0
Chemical / petrochemical	[4.535]***	0.334	1
Chemical production	[4.394]***	0.2776	1
Rubber and plastics	[1.95]*	0.074126	0
Metallurgical / metal	[3.131]**	0.372	1
Machine building	[3.488]***	0.8051	1
Equipment production	[3.68]***	0.022767	1
Electrical / optical	[3.33]***	0.734708	0
Trasnport vehicles	[2.421]	0.453	1
Electricity, water and gas	[2.61]**	0.612106	0
Building / assembly	[3.883]***	0.171	1
Post and communication	[2.87]***	0.658358	0

Table A9. ERPT estimations for CPI by category

	x-rate(T)	x-rate(T-1)	xrate(T-2)	M2(T)	M2(T-1)	Oil(T)	Oil(T-1)	GDP(T)	GDP(T-1)	LR(T-1)	R2	p-value	N of obs
	β10	β11	β12	β20	β21	β30	β31	β41	β42	β50			
CPI	0.02	-0.06	-0.09	0.14	0.13	0.00	0.00	-0.02	-0.03	-0.03	0.30	0.00	83
	[0.38]	[-1.08]	[-2.01]**	[3.08]***	[2.97]***	[0.30]	[0.27]	[-0.97]	[-1.30]	[-0.64]			
Food and Non-alcocholic beverages	0.08	-0.05	-0.11	0.16	0.16	0.01	0.00	-0.03	-0.03	-0.01	0.30	0.00	83
	[1.142]	[-0.653]	[-1.723]	[2.388]*	[2.372]*	[0.456]	[0.202]	[-0.844]	[-1.031]	[-0.286]			
Food	0.09	-0.05	-0.11	0.16	0.16	0.01	0.00	-0.03	-0.04	-0.02	0.29	0.00	83
	[1.142]	[-0.621]	[-1.516]	[2.292]*	[2.334]*	[0.421]	[0.100]	[-0.830]	[-1.038]	[-0.382]			
Bread and bread products	0.07	-0.01	-0.12	0.18	0.12	0.00	0.02	0.00	0.02	0.01	0.28	0.01	83
	[0.860]	[-0.067]	[-1.707]	[2.597]*	[1.767]	[-0.162]	[1.028]	[0.073]	[0.490]	[0.237]			
Bread	0.03	0.01	-0.12	0.19	0.11	-0.01	0.01	-0.03	0.03	-0.02	0.20	0.07	83
	[0.304]	[0.090]	[-1.397]	[2.268]*	[1.302]	[-0.468]	[0.573]	[-0.735]	[0.642]	[-0.543]			
Macaroni foods	0.02	0.01	-0.12	0.12	0.18	-0.01	0.00	0.04	0.03	-0.02	0.23	0.03	83
	[0.154]	[0.107]	[-1.314]	[1.485]	[2.184]*	[-0.305]	[0.169]	[0.836]	[0.767]	[-0.540]			
Confectionary from flour	-0.02	-0.06	-0.12	0.22	0.10	0.01	0.02	-0.04	0.00	-0.03	0.30	0.00	83
	[-0.273]	[-0.741]	[-1.152]	[3.143]**	[1.446]	[0.585]	[0.891]	[-1.018]	[0.006]	[-0.697]			
Meat and products	0.06	-0.07	-0.12	0.17	0.24	0.04	0.02	-0.01	-0.03	-0.02	0.40	0.00	83
	[0.700]	[-0.782]	[-0.754]	[2.230]*	[3.226]**	[1.983]	[1.167]	[-0.352]	[-0.700]	[-0.494]			
Fish and products	0.08	-0.20	-0.12	0.17	0.16	0.01	0.04	-0.04	-0.08	-0.04	0.51	0.00	83
	[1.234]	[-2.775]**	[-1.915]	[2.827]**	[2.657]**	[0.442]	[2.442]*	[-1.274]	[-2.622]*	[-1.118]			
Milk,cheese and eggs	-0.12	0.05	-0.12	-0.01	0.21	-0.06	-0.03	0.00	0.00	-0.06	0.17	0.18	83
	[-0.797]	[0.308]	[-0.022]	[-0.081]	[1.490]	[-1.760]	[-0.925]	[-0.019]	[-0.044]	[-1.120]			

Table A9. Continued

	x-rate(T)	x-rate(T-1)	xrate(T-2)	M2(T)	M2(T-1)	Oil(T)	Oil(T-1)	GDP(T)	GDP(T-1)	LR(T-1)	R2	p-value	N of obs
	β10	**β11**	**β12**	**β20**	**β21**	**β30**	**β31**	**β41**	**β42**	**β50**			
	-0.10	-0.05	-0.12	0.24	0.07	0.00	0.00	-0.08	-0.02	-0.08	0.13	0.41	83
Milk	[-0.563]	[-0.265]	[-0.630]	[1.539]	[0.468]	[-0.041]	[0.042]	[-1.023]	[-0.300]	[-1.297]			
	0.03	-0.02	-0.12	0.21	0.11	0.00	0.00	-0.07	-0.04	-0.04	0.16	0.22	83
Cheese and dairy	[0.256]	[-0.170]	[-1.124]	[1.968]	[1.075]	[-0.058]	[-0.003]	[-1.194]	[-0.672]	[-0.764]			
	-0.63	0.34	-0.12	-0.57	0.88	-0.20	-0.13	0.16	0.02	-0.12	0.31	0.00	83
Eggs	[-1.647]	[0.841]	[0.929]	[-1.649]	[2.544]*	[-2.449]*	[-1.660]	[0.893]	[0.137]	[-1.872]			
	0.03	0.02	-0.12	0.06	0.40	0.04	0.01	0.11	-0.03	-0.03	0.14	0.29	83
Oil and fats	[0.150]	[0.085]	[-0.549]	[0.291]	[1.974]	[0.891]	[0.146]	[1.006]	[-0.336]	[-0.645]			
	0.02	-0.13	-0.12	0.18	0.12	0.00	0.01	-0.02	0.00	-0.07	0.23	0.03	83
Butter	[0.163]	[-0.951]	[-2.117]*	[1.584]	[1.011]	[0.020]	[0.210]	[-0.333]	[-0.066]	[-1.299]			
	0.19	0.08	-0.12	-0.02	0.19	0.03	0.04	0.08	0.00	0.00	0.32	0.00	83
Oil	[1.682]	[0.641]	[-0.495]	[-0.150]	[1.880]	[1.345]	[1.628]	[1.486]	[0.070]	[-0.078]			
Other edible	-0.03	0.06	-0.12	0.11	0.58	0.01	0.00	0.13	-0.05	0.01	0.18	0.13	83
animal fat	[-0.110]	[0.234]	[-0.578]	[0.501]	[2.639]*	[0.233]	[-0.042]	[1.133]	[-0.471]	[0.342]			
	0.28	-0.18	-0.12	0.27	0.26	-0.03	-0.04	-0.02	-0.01	-0.16	0.16	0.20	83
Fruits	[0.979]	[-0.621]	[-0.599]	[1.086]	[1.013]	[-0.510]	[-0.681]	[-0.118]	[-0.069]	[-2.661]**			
	0.75	0.03	-0.12	0.29	-0.25	-0.01	-0.09	-0.48	-0.22	-0.09	0.13	0.40	83
Vegetables	[1.441]	[0.062]	[-1.062]	[0.629]	[-0.546]	[-0.125]	[-0.787]	[-2.028]	[-0.926]	[-1.811]			
	0.88	-0.01	-0.12	0.63	-0.91	-0.03	-0.13	-0.45	-0.21	-0.08	0.16	0.19	83
Potatoes	[1.467]	[-0.011]	[-1.004]	[1.168]	[-1.687]	[-0.230]	[-0.992]	[-1.630]*	[-0.790]	[-1.955]			
	0.02	0.08	-0.12	0.25	-0.15	0.07	-0.03	0.03	0.02	-0.22	0.11	0.50	83
Sugar	[0.042]	[0.160]	[0.003]	[0.609]	[-0.374]	[0.678]	[-0.276]	[0.166]	[0.084]	[-2.912]**			

Table A9. Continued

	x-rate(T)	x-rate(T-1)	xrate(T-2)	M2(T)	M2(T-1)	Oil(T)	Oil(T-1)	GDP(T)	GDP(T-1)	LR(T-1)	R2	p-value	N of obs
	β10	β11	β12	β20	β21	β30	β31	β41	β42	β50			
Non-alcocholic beverages	0.03	-0.09	-0.12	0.11	0.08	0.01	0.02	-0.01	0.00	0.04	0.62	0.00	83
	[0.771]	[-2.041]*	[-6.414]***	[3.116]**	[2.246]*	[1.487]	[1.958]	[-0.625]	[-0.117]	[0.978]			
Alcocholic beverages, tabacco products	-0.12	-0.01	-0.12	0.10	0.06	0.01	0.03	-0.01	0.01	-0.03	0.25	0.02	83
	[-1.580]	[-0.100]	[-1.390]	[1.615]	[1.086]	[0.545]	[1.647]	[-0.190]	[0.171]	[-0.488]			
Clothes and footwera	-0.02	-0.04	-0.12	0.05	0.02	0.00	0.00	0.00	0.01	0.00	0.56	0.00	83
	[-0.962]	[-2.245]*	[-4.338]***	[3.284]**	[1.607]	[1.110]	[0.828]	[-0.328]	[1.341]	[-0.025]			
Clothes	-0.02	-0.04	-0.12	0.02	0.01	0.00	0.00	0.00	0.01	-0.02	0.66	0.00	83
	[-1.310]	[-3.073]**	[-5.077]***	[2.411]*	[0.905]	[0.639]	[0.246]	[-0.193]	[1.128]	[-0.349]			
Footwear	-0.02	-0.02	-0.12	0.03	0.00	0.00	0.00	0.00	0.02	-0.05	0.50	0.00	83
	[-1.056]	[-1.273]	[-4.397]***	[2.564]*	[0.151]	[0.738]	[0.042]	[0.440]	[2.889]**	[-0.982]			
Housing, water, electricity, gas and other types of fuel	-0.16	-0.05	-0.12	0.15	0.18	-0.02	-0.01	0.01	-0.05	-0.05	0.28	0.01	83
	[-1.327]	[-0.375]	[-0.651]	[1.465]	[1.738]	[-0.752]	[-0.407]	[0.193]	[-1.001]	[-1.567]			
Housing fee	0.11	-0.14	-0.12	0.28	0.19	-0.03	0.03	-0.05	-0.03	-0.07	0.26	0.01	83
	[0.804]	[-0.983]	[-0.931]	[2.359]*	[1.593]	[-1.166]	[0.881]	[-0.839]	[-0.454]	[-1.781]			
Housing maintenance and renovation	-0.06	0.01	-0.12	0.09	0.11	0.01	0.00	-0.04	-0.04	-0.03	0.30	0.00	83
	[-0.952]	[0.112]	[-1.616]	[1.723]	[2.162]*	[0.691]	[-0.221]	[-1.517]	[-1.433]	[-0.903]			
Water supply	0.13	-0.18	-0.12	0.32	0.18	0.01	0.02	-0.06	0.02	-0.03	0.37	0.00	83
	[1.190]	[-1.524]	[-1.697]	[3.264]**	[1.835]	[0.333]	[0.714]	[-1.116]	[0.387]	[-0.687]			
Sewerage	0.24	-0.23	-0.12	0.40	0.22	0.01	0.02	-0.10	-0.01	-0.04	0.33	0.00	83
	[1.533]	[-1.434]	[-1.669]	[2.933]**	[1.592]	[0.147]	[0.665]	[-1.466]	[-0.131]	[-1.123]			

Table A9. Continued

	x-rate(T)	x-rate(T-1)	xrate(T-2)	M2(T)	M2(T-1)	Oil(T)	Oil(T-1)	GDP(T)	GDP(T-1)	LR(T-1)	R2	p-value	N of obs
	β10	β11	β12	β20	β21	β30	β31	β41	β42	β50			
Electricity	0.20	-0.02	-0.12	0.17	0.13	-0.06	0.00	-0.01	-0.10	-0.07	0.14	0.33	83
	[1.283]	[-0.128]	[-0.289]	[1.208]	[0.883]	[-1.825]	[-0.048]	[-0.095]	[-1.396]	[-1.878]			
Natural gas	-0.83	0.22	-0.12	0.08	0.32	0.01	0.00	0.19	-0.13	-0.13	0.21	0.05	83
	[-2.302]*	[0.592]	[-0.219]	[0.259]	[0.985]	[0.114]	[-0.055]	[1.127]	[-0.821]	[-2.213]*			
Hot water, heating	-0.19	-0.20	-0.12	0.18	0.13	-0.06	-0.06	-0.04	-0.08	-0.07	0.17	0.16	83
	[-0.682]	[-0.668]	[0.084]	[0.687]	[0.493]	[-0.912]	[-0.964]	[-0.313]	[-0.633]	[-1.773]			
Homeware, repairs	-0.08	-0.10	-0.12	0.09	0.00	0.01	0.00	-0.03	-0.04	-0.14	0.20	0.08	83
	[-0.739]	[-0.936]	[-0.667]	[1.004]	[-0.015]	[0.336]	[-0.022]	[-0.643]	[-0.869]	[-2.069]*			
Furniture, carpets, floor, linoleum	-0.02	-0.07	-0.12	0.05	0.02	0.00	0.00	-0.01	-0.01	-0.01	0.60	0.00	83
	[-0.853]	[-2.615]*	[-4.033]***	[2.499]*	[1.182]	[0.055]	[-0.320]	[-1.264]	[-0.481]	[-0.229]			
Home textile	-0.03	-0.10	-0.12	0.04	0.01	0.01	0.01	0.00	0.01	0.03	0.70	0.00	83
	[-1.380]	[-4.193]***	[-5.117]***	[2.478]*	[0.508]	[1.501]	[1.574]	[-0.513]	[1.244]	[0.559]			
Household appliances	-0.12	-0.14	-0.12	0.05	0.00	0.00	0.00	-0.01	0.00	-0.05	0.78	0.00	83
	[-4.914]***	[-4.858]***	[-2.975]**	[2.272]*	[0.127]	[0.680]	[-0.073]	[-0.459]	[0.258]	[-1.049]			
Health protection	0.06	-0.22	-0.12	0.06	0.11	0.01	0.02	-0.02	-0.02	-0.04	0.70	0.00	83
	[1.439]	[-4.857]***	[-4.615]***	[1.649]	[2.922]**	[0.955]	[1.699]	[-1.282]	[-0.967]	[-0.865]			
Pharmaceutical, medical products	0.10	-0.42	-0.12	0.07	0.08	0.02	0.03	-0.01	0.00	0.03	0.80	0.00	83
	[1.994]*	[-7.794]***	[-6.314]***	[1.839]	[2.015]*	[1.678]	[2.674]**	[-0.507]	[-0.021]	[0.648]			
Medical services	0.02	-0.03	-0.12	0.12	0.14	0.00	0.01	-0.03	-0.03	-0.07	0.51	0.00	83
	[0.435]	[-0.661]	[-2.475]*	[3.101]**	[3.512]***	[0.032]	[0.865]	[-1.522]	[-1.452]	[-1.220]			
Transport	0.02	-0.10	-0.12	0.20	0.13	0.02	0.01	-0.05	0.00	-0.17	0.52	0.00	83
	[0.373]	[-1.535]	[-1.017]	[3.749]***	[2.341]*	[1.343]	[1.014]	[-1.677]	[0.079]	[-3.091]**			

Table A9. Continued

	x-rate(T)	x-rate(T-1)	xrate(T-2)	M2(T)	M2(T-1)	Oil(T)	Oil(T-1)	GDP(T)	GDP(T-1)	LR(T-1)	R2	p-value	N of obs
	β10	β11	β12	β20	β21	β30	β31	β41	β42	β50			
Purchasing of transport vehicles	0.10	-0.30	-0.12	0.14	0.09	0.01	0.02	-0.04	0.03	-0.17	0.76	0.00	83
	[2.314]*	[-5.660]***	[-3.653]***	[3.655]***	[2.364]*	[1.365]	[1.560]	[-2.164]*	[1.336]	[-2.636]*			
Fuel and oils	0.27	-0.20	-0.12	0.10	0.27	0.05	0.14	0.03	0.05	-0.06	0.29	0.00	83
	[1.247]	[-0.872]	[-0.831]	[0.534]	[1.360]	[1.062]	[3.037]**	[0.331]	[0.537]	[-1.355]			
Transport services	-0.08	-0.04	-0.12	0.30	0.12	0.01	-0.01	-0.11	0.00	-0.07	0.34	0.00	83
	[-0.830]	[-0.445]	[-0.261]	[3.568]***	[1.351]	[0.289]	[-0.402]	[-2.527]*	[0.036]	[-1.506]			
Railway passenger services	-0.08	0.10	-0.12	0.17	0.12	-0.01	0.00	-0.04	0.02	-0.07	0.12	0.45	83
	[-0.582]	[0.647]	[-0.703]	[1.345]	[0.921]	[-0.344]	[-0.142]	[-0.627]	[0.301]	[-1.646]			
Road passenger transport	-0.11	-0.06	-0.12	0.24	0.12	0.01	-0.04	-0.07	-0.03	-0.18	0.38	0.00	83
	[-1.166]	[-0.628]	[0.434]	[3.051]**	[1.520]	[0.433]	[-2.152]*	[-1.769]	[-0.680]	[-2.677]**			
Communication services	-0.07	-0.05	-0.12	0.09	0.02	-0.01	0.02	-0.01	0.01	-0.05	0.16	0.22	83
	[-1.041]	[-0.756]	[0.256]	[1.642]	[0.415]	[-0.522]	[1.290]	[-0.309]	[0.474]	[-1.614]			
Postal services	0.31	-1.19	-0.12	0.13	0.22	0.00	0.10	-0.03	0.04	-0.15	0.37	0.00	83
	[1.123]	[-4.028]***	[0.726]	[0.527]	[0.891]	[0.073]	[1.646]	[-0.207]	[0.346]	[-2.448]*			
Telephone / public telephone services	-0.07	-0.04	-0.12	0.05	0.03	-0.01	0.02	0.01	0.01	-0.06	0.09	0.68	83
	[-0.811]	[-0.428]	[0.499]	[0.726]	[0.415]	[-0.707]	[0.918]	[0.256]	[0.394]	[-1.692]			
Leisure and culture	-0.09	-0.09	-0.12	0.04	0.02	0.00	0.00	0.00	0.00	-0.04	0.73	0.00	83
	[-3.896]***	[-3.585]***	[-3.814]***	[2.074]*	[1.127]	[0.342]	[0.384]	[-0.413]	[-0.026]	[-1.128]			
Audio, photo equipment	-0.14	-0.16	-0.12	0.02	-0.02	0.00	0.00	0.00	0.00	-0.07	0.82	0.00	83
	[-6.129]***	[-6.292]***	[-1.535]	[1.126]	[-0.973]	[0.835]	[-0.837]	[-0.112]	[-0.069]	[-1.392]			
Leisure and culture services	-0.01	-0.05	-0.12	0.07	0.11	-0.01	0.00	-0.01	-0.01	-0.04	0.40	0.00	83
	[-0.163]	[-1.061]	[-2.595]*	[1.712]	[2.561]*	[-0.981]	[0.094]	[-0.450]	[-0.515]	[-1.106]			

Table A9. Continued

	x-rate(T)	x-rate(T-1)	xrate(T-2)	M2(T)	M2(T-1)	Oil(T)	Oil(T-1)	GDP(T)	GDP(T-1)	LR(T-1)	R2	p-value	N of obs
	β10	**β11**	**β12**	**β20**	**β21**	**β30**	**β31**	**β41**	**β42**	**β50**			
Newspapers, books and stationery	0.01	-0.12	-0.12	0.08	0.06	0.01	0.01	-0.02	-0.02	0.01	0.56	0.00	83
	[0.191]	[-3.256]**	[-3.253]**	[2.792]**	[2.139]*	[1.122]	[1.588]	[-1.603]	[-1.088]	[0.293]			
Education	-0.14	-0.05	-0.12	0.16	0.10	-0.05	0.00	0.00	-0.04	-0.27	0.23	0.03	83
	[-1.037]	[-0.360]	[0.772]	[1.335]	[0.789]	[-1.726]	[-0.063]	[-0.048]	[-0.680]	[-3.253]**			
Pre-school and primary education	0.05	-0.02	-0.12	0.20	0.16	0.00	0.00	-0.08	-0.05	-0.14	0.36	0.00	83
	[0.635]	[-0.197]	[-0.423]	[2.762]**	[2.188]*	[0.219]	[-0.237]	[-2.137]*	[-1.456]	[-2.568]*			
Secondary education	-0.17	-0.05	-0.12	0.18	0.11	-0.05	0.00	0.00	-0.05	-0.30	0.25	0.02	83
	[-1.121]	[-0.334]	[0.729]	[1.348]	[0.835]	[-1.632]	[-0.113]	[-0.008]	[-0.798]	[-3.499]***			
Higher education	-0.22	-0.05	-0.12	0.23	0.07	-0.06	-0.03	-0.02	-0.06	-0.39	0.27	0.01	83
	[-1.254]	[-0.263]	[0.754]	[1.456]	[0.462]	[-1.656]	[-0.729]	[-0.248]	[-0.708]	[-4.113]***			
Restaurants and hotels	0.02	0.00	-0.12	0.25	0.10	0.00	-0.02	-0.05	-0.01	-0.20	0.37	0.00	83
	[0.241]	[0.046]	[-0.933]	[3.628]***	[1.505]	[0.150]	[-1.026]	[-1.502]	[-0.313]	[-2.958]**			
Different goods and services	-0.03	-0.08	-0.12	0.11	0.12	0.01	0.02	-0.02	-0.03	0.04	0.57	0.00	83
	[-0.668]	[-1.823]	[-3.565]***	[3.132]**	[3.139]**	[0.557]	[2.065]*	[-1.063]	[-1.527]	[1.163]			
Personal care	0.00	-0.07	-0.12	0.10	0.08	0.01	0.01	-0.02	-0.01	0.02	0.54	0.00	83
	[-0.007]	[-1.629]	[-4.678]***	[2.775]**	[2.319]*	[1.022]	[1.430]	[-1.019]	[-0.347]	[0.545]			

Table A10. ERPT estimations for PPI by category

	x-rate(T)	x-rate(T-1)	xrate(T-2)	M2(T)	M2(T-1)	Oil(T)	Oil(T-1)	Output(T)	Output(T-1)	LR(T-1)	R2	p-value	N of obs
	β10	β11	β12	β20	β21	β30	β31	β41	β42	β50			
PPI	0.10	0.04	-0.14	0.20	0.19	0.01	0.05	0.01	0.02	-0.01	0.51	0.00	82
	[1.450]	[0.538]	[-2.180]*	[3.163]**	[2.992]**	[0.475]	[2.929]**	[0.400]	[0.596]	[-0.169]			
Extractive Industry	0.36	-0.01	-0.10	0.41	0.20	0.00	0.05	-0.05	0.03	-0.12	0.35	0.00	82
	[2.253]*	[-0.058]	[-0.698]	[2.786]**	[1.361]	[-0.089]	[1.347]	[-0.599]	[0.367]	[-1.754]			
Mining of fuel minerals	0.39	-0.12	-0.09	0.39	0.15	0.00	0.05	0.01	0.04	-0.23	0.47	0.00	82
	[2.916]**	[-0.830]	[-0.730]	[3.182]**	[1.237]	[-0.037]	[1.716]	[0.180]	[0.731]	[-2.750]**			
Mining of other minerals	0.37	0.21	-0.20	0.49	0.24	0.01	0.01	-0.18	-0.01	-0.14	0.19	0.11	82
	[1.301]	[0.703]	[-0.778]	[1.915]	[0.927]	[0.117]	[0.100]	[-1.387]	[-0.047]	[-2.027]*			
Processing industry	0.12	-0.03	-0.16	0.19	0.17	0.02	0.05	0.03	0.03	-0.01	0.54	0.00	82
	[1.796]	[-0.394]	[-2.567]*	[3.086]**	[2.848]**	[1.591]	[3.364]**	[0.790]	[0.963]	[-0.135]			
Prod. Of food, beverages, tobacco	0.03	-0.03	-0.16	0.14	0.13	0.01	0.02	0.00	-0.02	0.01	0.48	0.00	82
	[0.505]	[-0.585]	[-3.363]**	[2.981]**	[2.863]**	[1.162]	[2.113]*	[0.079]	[-0.782]	[0.209]			
Light industry	-0.07	-0.05	-0.09	0.10	0.04	0.00	0.01	-0.02	0.00	-0.01	0.59	0.00	82
	[-2.234]*	[-1.496]	[-3.595]***	[3.858]***	[1.483]	[0.571]	[1.558]	[-1.556]	[-0.345]	[-0.240]			
Textile/apparel production	-0.10	-0.05	-0.09	0.10	0.05	0.00	0.01	-0.01	-0.01	-0.03	0.57	0.00	82
	[-2.749]**	[-1.415]	[-2.737]**	[3.463]***	[1.524]	[0.133]	[1.855]	[-0.932]	[-0.491]	[-0.566]			

Table A10. Continued

	x-rate(T)	x-rate(T-1)	xrate(T-2)	M2(T)	M2(T-1)	Oil(T)	Oil(T-1)	Output(T)	Output(T-1)	LR(T-1)	R2	p-value	N of obs
	β10	β11	β12	β20	β21	β30	β31	β41	β42	β50			
Leather/leather products	-0.01	-0.01	-0.11	0.09	0.01	0.01	0.00	-0.04	0.00	-0.08	0.47	0.00	82
	[-0.255]	[-0.339]	[-4.087]***	[3.299]**	[0.531]	[1.610]	[-0.656]	[-2.703]**	[-0.050]	[-1.275]			
Wood processing	0.06	-0.15	-0.02	0.14	0.12	0.01	0.01	-0.03	0.00	-0.06	0.47	0.00	82
	[1.311]	[-2.842]**	[-0.416]	[3.248]**	[2.596]*	[0.683]	[1.038]	[-1.409]	[-0.172]	[-1.134]			
Pulp and paper industry	-0.07	-0.02	-0.07	0.03	0.10	0.00	0.02	-0.03	0.00	-0.14	0.39	0.00	82
	[-1.599]	[-0.422]	[-1.561]	[0.672]	[2.287]*	[0.228]	[2.379]*	[-1.249]	[0.025]	[-2.236]*			
Coke / oil processing products	0.34	-0.28	0.10	0.34	0.19	0.05	0.22	0.11	0.19	-0.04	0.57	0.00	82
	[1.807]	[-1.407]	[0.584]	[2.010]*	[1.150]	[1.181]	[5.359]***	[1.231]	[2.232]*	[-1.052]			
Chemical / petrochemical	0.24	0.02	-0.18	0.07	0.26	-0.01	0.02	-0.02	-0.01	-0.06	0.30	0.00	82
	[2.246]*	[0.164]	[-1.912]	[0.764]	[2.804]**	[-0.379]	[0.696]	[-0.366]	[-0.169]	[-1.018]			
Chemical production	0.34	0.04	-0.23	0.04	0.34	-0.01	0.02	-0.03	-0.01	-0.06	0.31	0.00	82
	[2.576]*	[0.281]	[-1.943]	[0.325]	[2.869]**	[-0.302]	[0.631]	[-0.457]	[-0.112]	[-1.051]			
Rubber and plastics production	-0.09	-0.03	-0.05	0.15	0.15	0.00	0.01	0.00	-0.02	-0.04	0.47	0.00	82
	[-1.617]	[-0.509]	[-0.953]	[3.069]**	[3.051]**	[-0.096]	[0.703]	[-0.044]	[-0.825]	[-1.049]			
Metallurgical / metal production	0.36	0.10	-0.29	0.23	0.24	0.04	0.04	0.04	0.03	-0.04	0.42	0.00	82
	[2.569]*	[0.707]	[-2.232]*	[1.858]	[1.868]	[1.333]	[1.343]	[0.568]	[0.514]	[-0.954]			

Table A10. Continued

	x-rate(T)	x-rate(T-1)	xrate(T-2)	M2(T)	M2(T-1)	Oil(T)	Oil(T-1)	Output(T)	Output(T-1)	LR(T-1)	R2	p-value	N of obs
	β10	β11	β12	β20	β21	β30	β31	β41	β42	β50			
Machine building	0.00	-0.02	-0.05	0.10	0.11	0.00	0.02	-0.01	-0.01	0.01	0.36	0.00	82
	[-0.086]	[-0.469]	[-1.285]	[2.483]*	[2.781]**	[0.204]	[1.624]	[-0.395]	[-0.312]	[0.204]			
Equipment production	-0.02	-0.03	-0.05	0.07	0.14	0.00	0.01	-0.03	-0.01	-0.05	0.46	0.00	82
	[-0.372]	[-0.638]	[-1.420]	[1.930]	[4.028]***	[0.413]	[0.722]	[-1.423]	[-0.677]	[-0.888]			
Electrical / optical equipment	-0.01	-0.11	-0.02	0.12	0.07	0.01	0.02	-0.03	-0.01	-0.07	0.53	0.00	82
	[-0.259]	[-2.858]**	[-0.515]	[3.769]***	[2.275]*	[1.704]	[2.026]*	[-1.584]	[-0.297]	[-1.220]			
Trasnport vehicles production	0.01	0.017	-0.068	0.149	0.082	-0.003	0.02	0.002	-0.001	0.006	0.207	0.061	82
	[0.137]	[0.222]	[-1.021]	[2.278]*	[1.261]	[-0.217]	[1.268]	[0.053]	[-0.019]	[0.162]			
Electricity, water and gas prod.	-0.16	0.33	-0.04	0.13	0.25	-0.05	0.01	-0.02	-0.02	-0.08	0.25	0.02	82
	[-1.093]	[2.213]*	[-0.296]	[1.006]	[1.934]	[-1.488]	[0.472]	[-0.260]	[-0.253]	[-1.748]			
Building / assembly services	0.11	0.01	-0.11	0.30	0.27	-0.02	0.02	0.01	-0.02	-0.02	0.70	0.00	71
	[1.972]	[0.244]	[-2.129]*	[5.432]***	[4.695]***	[-1.175]	[1.063]	[0.462]	[-0.834]	[-0.316]			
Post and communication services	0.01	-0.05	0.02	0.00	0.01	0.00	0.01	-0.01	-0.01	-0.13	0.21	0.06	82
	[0.395]	[-2.322]*	[0.895]	[-0.057]	[0.341]	[0.231]	[1.435]	[-0.834]	[-0.953]	[-2.414]*			