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THE ROLE OF THE EXCHANGE
RATE IN POLAND'S ECONOMY
THE EMPIRICAL VERIFICATION OF THE DORNBUSCH
MODEL DURING THE PERIOD OF 2007 TO 2009

1. Introduction

Dornbusch's overshooting model of the exchange rate was specified in the mid-1970s[1] in a time of profound transformations in the post-World War II monetary system. The modern post-Bretton Woods freely floating exchange rates became common and the the process of capital flows got on its way. The outcome of these phenomena were relatively sharp and violent, as compared to fixed-rate systems, currency fluctuations.

Dornbusch's theory aimed to explain and interpret the character and factors that brought about those violent fluctuations and the answer to the problem evidently required analyzing the relationship between monetary policy and exchange rate changes in the context of an open economy.

In addition, Dornbusch described the impact of exchange rate changes on the real economy, or more precisely, upon the foreign trade turnover.

Dornbusch examined two crucial phenomena in the field of international finance:

1. the role and influence of the exchange rate in achieving an equilibrium in the domestic financial market;

2. the effectiveness of adjustment processes while using the classic relationship between the exchange rate and price.

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[1] Dornbusch, R., *Expectation and Exchange Rate Dynamics*, Journal of Political Economy, vol. 84, pp. 1161–76, 1976, and Dornbusch, R., *Exchange Rate Expectations and Monetary Policy*, Journal of International Economics, vol. 6, pp. 231–44, 1976.

In his model, Dornbusch was the first to make two fundamental assumptions:
– rational expectations of changes in exchange rates;
– sticky prices vis-a-vis financial assets prices.

The first assumption highlighted a dynamic character of exchange rate changes and the role of market operators' expectations. A certain regularity can be noted – financial market operators make financial decisions on the bases of predictions of exchange rate changes. An anticipated exchange rate, notwithstanding whether the forecast is correct or not, constitutes an important market parameter in determining the overall conditions of financial market stability and international capital flows.

With a sticky price assumption, commodity prices are less volatile than stock prices, which means that, in the short to medium runs, the exchange rate is more like the relationship between prices of domestic and foreign financial assets than commodity prices. Another consequence of accepting the sticky-price model is that in short-runs, nominal changes in the money supply are equal to the real ones.

Figure 1 Balance on Goods (deficit) EUR/PLN (a quarterly average)
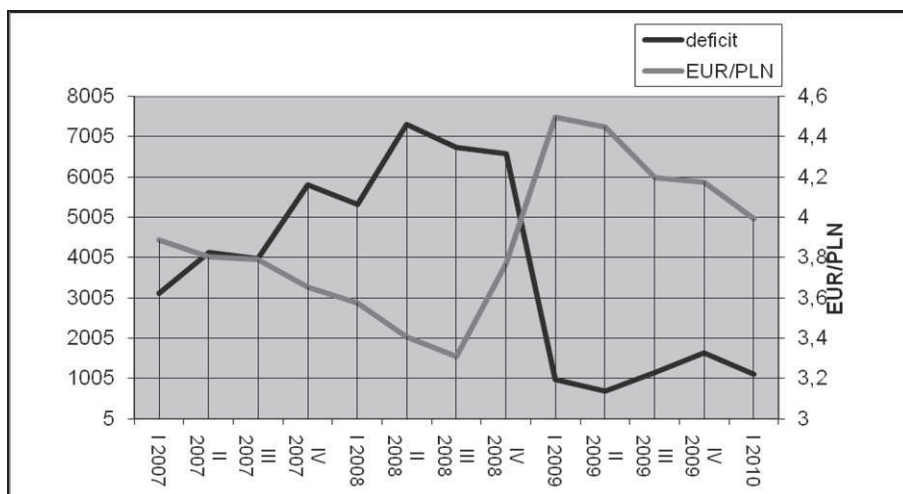
Source: The National Bank of Poland (NBP), Central Statistical Office of Poland (GUS)

The Dorbusch model provoked a heated debate and inspired many studies. Several attempts were made to statistically verify Dornbusch's hypothesis. The effects varied.[2] In the Polish economic literature any recommendations for the

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[2] Rogoff, K., *Why are G3 Exchange Rate Relationships so Fickle?*, Finance and Development, no. 2, June 2002.

implementation of the model's assumptions to describe and explain economic processes in Poland were rare and incomplete. About ten years ago, while being aware that not all of the conditions formulated by Dornbusch had been fulfilled in Poland's economy, I endeavored to present such an analysis.[3] Above all, it concerns a complete freedom in capital flows, as well as a level of development of the domestic financial market that would guarantee substitutability between domestic and foreign assets. Today, the situation looks different. It is my view that Poland's economy meets the standards of an open economy.

Over the last three years the Polish economy has been characterized by a high variability of such parameters as the foreign exchange rate, current account balance of payments and a high level of CPI variability. I am convinced that Dornbusch's hypothesis is a very useful tool in explaining these phenomena.

The data presented in the graphs show clearly that important economic parameters are characterized by a relatively high level of liability, which evidently indicates that adjustment processes in the Polish market were very dynamic.

Figure 2 The annual price inflation rate in the EU (the annual data measured by the Harmonised Index of Consumer Prices (HICP)) and in Poland (the consumer price index(CPI))
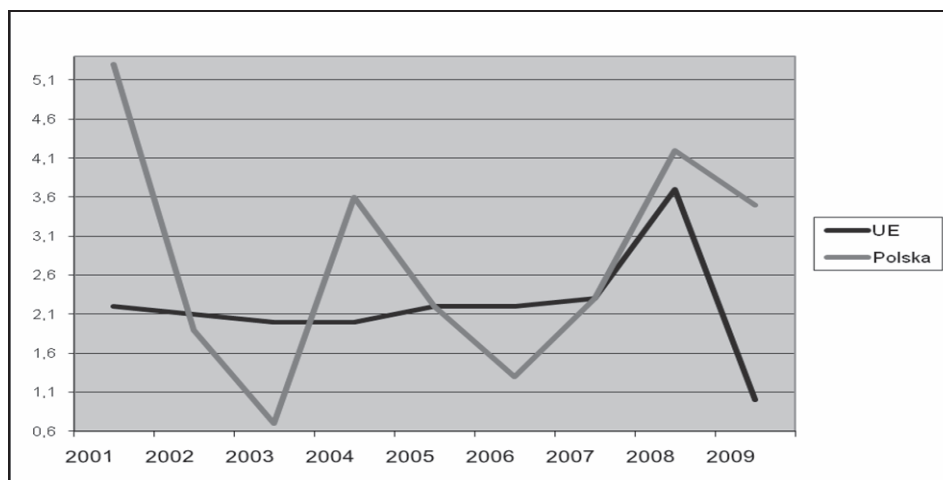
Source: The European Central Bank , Central Statistical Office of Poland (GUS)

The comparison of the price level variability in Poland and the European Union (with the exception of last year) shows that prices in Poland's economy played a crucial role in adjustment processes.

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[3] Bilski, J., *The Overshooting Results in Poland in 1999–2000*, in Enlarged Europe and Reginal Disparities, pp, 161–167, TEI Preveza 2004.

2.The Overshooting Model

Since the Dornbusch overshooting model has been fully described in the eco-
nomic literature, it is not my intention to present it at length. It should be noted,
however, that a different number of equations are used to describe the overshooting
model in different studies. And so, Obstfeld and Rogoff introduce four equations
that describe the mathematical relationship between the parameters of the model:
  – the 'uncovered interest parity' condition;
  – the money demand function and the financial sector equilibrium;
  – the real exchange rate determinant;
  – GDP determinants.
Some authors give up the third core equation of the Dornbusch model[4].
Kenneth Rogoff [5] is of the opinion that the analysis is factually correct if only
the first two equations are applied, that is:
  – the equation of the uncovered interest rate parity

$$\gamma = \gamma^* + x = \gamma^* + \theta \, (e' - e),$$

where
r – denotes the domestic interest rate
r* – is the foreign / world interest rate
x – is the expected depreciation of domestic currency
θ – is the coefficient of adjustment

The equation implies that depreciation expectations of domestic currency
are equal to the difference between domestic and foreign interest rates, that is,
the difference between the spot rate e and the forward rate e')
  – the demand for money and the financial sector equilibrium. Thus,

$$(2) \ m-p = \alpha\gamma + \beta y,$$

where
m – is the money supply
p – is the price level
α, β – are the positive parameters
βγ – the income elasticity of the money supply.

It can be deduced from the equation that a higher interest rate lowers the
demand for money, and a higher income level increases the demand for new
capital. The demand for money is proportional to the price level.

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[4] Tu, W., Feng, J., An *Overview Study on Dornbusch* Overshooting Hypothesis. 110.
International Journal of Economics and Finance, vol. 1, pp. 110–116, Feb. 2009.
[5] Rogoff, K, Dornbusch *Overshooting Model After Twenty-Five Years*, JMF Staff Papers,
vol. 49, special issue, 2002.

Verification of the Dornbusch's hypothesis in the context of Poland's economy requires yet another specification, that concerning the duration of the overshooting phase. In general, the matter is omitted in the debate. While analyzing the assumptions underlying the model, we can indirectly set strict time limits for the duration of overshooting. I believe that the overshooting phase should not take longer than approximately one year. There are three good reasons that support this view.

– In the long-run changes in the exchange rate and prices are proportional to the changes in the money supply (the neutrality of money);

– The price stickiness phenomenon in the commodity market should not take longer than a few months. It is rather improbable that during that time nominal commodity prices would not react efficiently to the changes in exchange and interest rates and the money supply

– Overshooting is defined as a violent phenomenon in the financial market, which by its nature should not take too long. The prolonged duration of overshooting signifies that the economy fails to respond to monetary stimuli and does not initiate adjustment processes.

There still remains a question of relation between overshooting and a long-run period. On accepting the principles of the Dornbusch model, one can assume that a long-run equilibrium is created by stronger or weaker overshootings and undershootings. These processes can be compared to a condition of man's body characterized by high fever. Nagging headache and other symptoms may be quite unpleasant but they are essential in the immune defense against invading disease.

3. Dornbusch's Overshooting Model in Poland's Economy

Our statistical verification methodology of the Dornbusch model will be applied to find relations between changes in the money supply and subsequent changes in the demand for financial assets. The purpose of the study is to determine the role of the exchange rate in the process of reaching equilibrium in the financial market in an open economy. Another key area of our study is an accurate evaluation of exchange rate policies and their impact on the realization of an outer equilibrium of Poland's economy, seen above all as the foreign exchange balance.

In the study, a statistical analysis of economic processes was used from a model perspective.

The potential weaknesses of the method are well-understood. The processes under discussion are unusually dynamic and difficult to depict with the use of a standard framework designed to illustrate the relations of variables of financial markets.

In the study, data from September 2007 to December 2009 have been adopted. Three sub-periods of nine-month duration and of different characteris-

tics of economic processes have been singled out. The time course of a real overshooting spanned a period from July 2008 to March 2009. During that time the zloty depreciated nearly 15 percent against the euro (the peak: 13 June 2008 – 3.3712, and the lowest level: 17 February 2009 – 4.8795).

The period prior to overshooting (September 2007 to June 2008) was the time of initiating the processes that led to the occurrence of the phenomenon. The situation in the financial market between April 2009 and December 2009 reflects the time when Poland was in the process of regaining equilibrium in the financial market and when the zloty appreciated to the level that was determined by the pace of growth rate of the M3 money supply.

In the study changes in the following economic indicators will be analysed:

– The basic economic indices: the euro/zloty exchange rate, the M3 money supply, the Consumer Price Index (CPI), the average yields of five-year Treasury bonds, the central bank interest rate, the foreign trade balance.

– The auxiliary indicators: the share of foreign assets in creating the M3 money supply, the prices on the stock market, the (NBP, ECB, Fed) interest rate differentials.
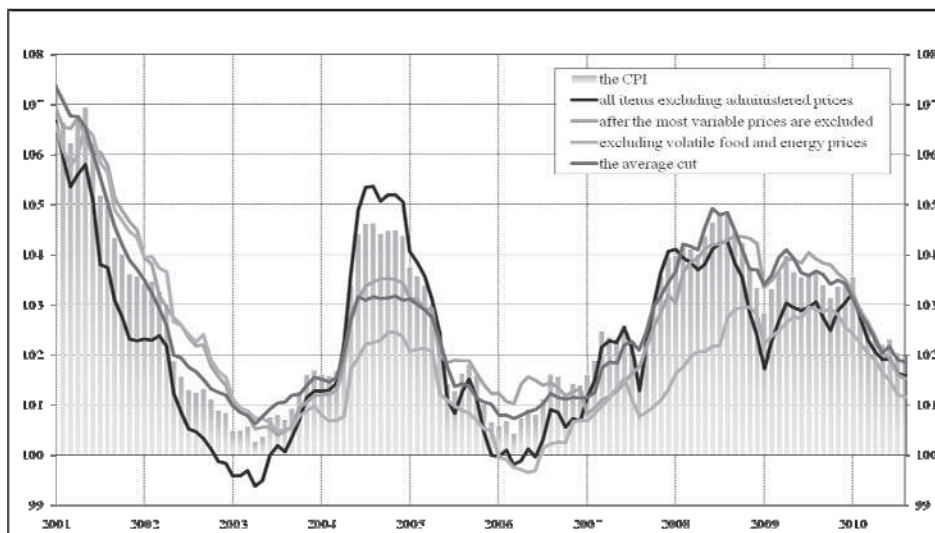
3.1. The Preliminary Period from September 2007 to June 2008

Figure 3 The M3 money supply index
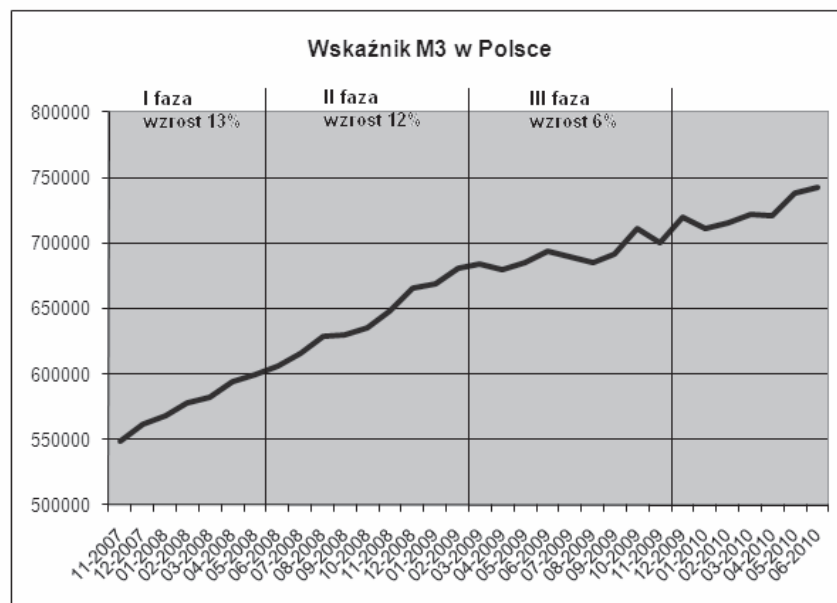
Source: The National Bank of Poland (NBP)

Figure 4 The CPI indices and the base inflation indices and all base inflation measures calculated
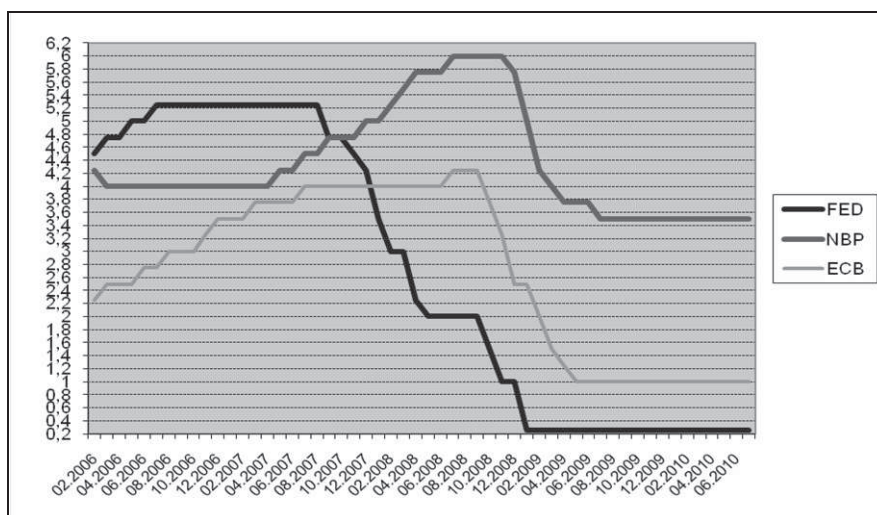on the twelve-month scale (the same month of the previous year = 100)

Source: The National Bank of Poland (NBP)

1 the CPI; 2 all items excluding administered prices; 3 after the most variable prices are ex-
cluded; 4 excluding volatile food and energy prices; 5 the average cut.
Source: The National Bank of Poland (NBP)

Figure 5 The Fed, NBP and FCB rates

Source: The National Bank of Poland (NBP), Fed, ECB rates

The period was characterized by the following changes in macroeconomic indices:

1. The accelerated money supply growth in the market, reflected in the rise of the M3 by 13 percent during the period under study.[6]

2. Paradoxically, at the time the Polish currency saw fast appreciation of 10 percent in reference to the euro.

Figure 6 Graph: five year bonds. The range of data from 3 September 2009 to 14 July 2010. Primary market
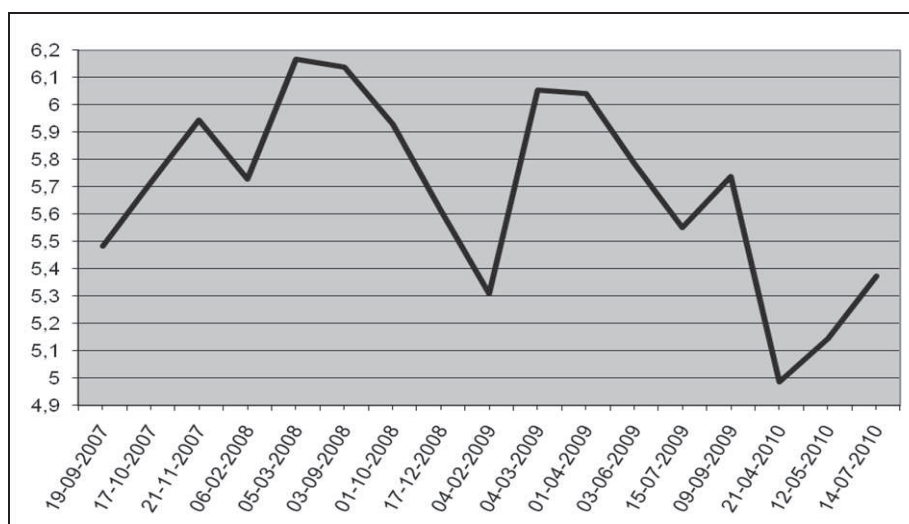
Although at variance with the assumptions of the Dornbusch model, such behaviour of the Polish zloty can be justified due to the following factors:

1. During the time under study inflationary processes intensified. The country's CPI grew from 1.5 percent to 4.8 percent, which means that the nominal money supply growth was not equal to the real one. A major part of the growth of the M3 supply became neutralized by a rise in commodity prices.[7]

2. In response to an increase in the M3 money supply the NBP tightened the monetary policy and raised interest rates by 125 base points. At the same time, the Federal Reserve System suddenly lowered the Fed interest rate, with the ECB rate remaining at invariable level. The final result was as follows: the real NBP, ECB and Fed interest rate differenitial increased rapidly.[8]

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[6] cf. Fig. 3

[7] cf. Fig 4

[8] Fig. 5

3. Hypothetically, a rise in differential should lead to an increase in the demand for the Polish Treasury bonds and a decrease in their profitability. However, it was quite the opposite. The demand for Treasury bonds declined, which is expressed by an increase in their yield. [9]

4. The resulting situation is expounded by Dornbusch'e rational expectation of domestic currency depreciation. In the period under study, there began a sudden withdrawal of foreign investors from the Polish financial market. A decreasing share of foreign assets in creating the M3 supply, which declined from 24 percent to 15 percent, is evidently the best proof of that.

The first to respond was the stock market where the basic indicators had already begun to decline in October 2007.

5. In the situation presented here it looks as if nothing could stop a sharp depreciation of domestic currency. The described phenomenon will create proper conditions for the occurrence of overshooting result.

The situation described above is illustrated in Figures 7 and 8.

Figure 7. Financial market in the period from September 2007 to June 2009
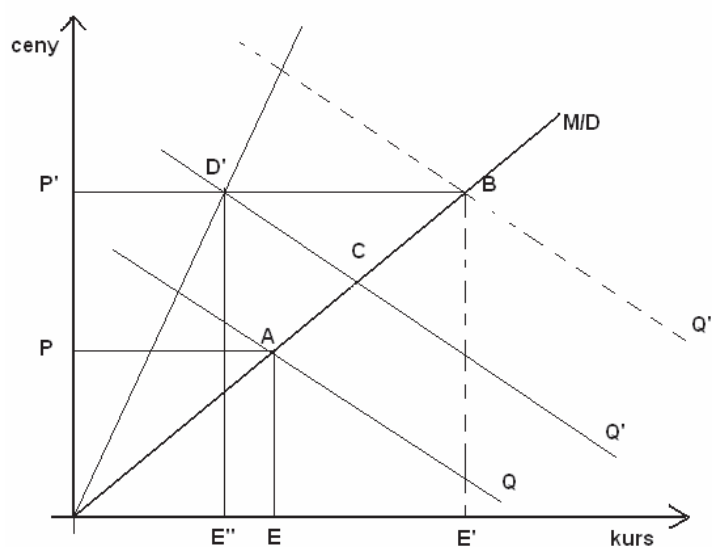
Source: based upon my own survey

1. The X-axis: the euro/zloty exchange rate; 2. The Y-axis: the CPI price index; 3. The money supply M (45˚); 4. The Q curve: a financial market equilibrium where the money supply is determined; 5. The demand curve for financial assets – D, at an equilibrium point M (the initial state) overlaps D

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[9] Fig 6

The processes illustrated in Figure 7:

1. It is assumed that at a starting point state (September 2007) the money supply A at prices P and the exchange rate E guarantees a state of financial market equilibrium Q. The money supply coincides with the demand for financial assets.

2. There occurred an increase in the money supply to the point B, the CPI prices rose to P'. In 'normal' conditions the exchange rate of Poland's currency should depreciate to the point E' (the dashed line). The point B is a theoretical point of equilibrium of the money demand and supply. However, it remains only a theoretical point, since, as it appears from the description, in the period in question, the central bank restricted the money demand (an increase in interest rates) and additionally, there was a substantial outflow of capital abroad.

3. In such a situation the demand curve for financial assets shifts to the left (D') and at the price P' determines the exchange rate at point E''. The rate is in particular the relationship between domestic asset prices and foreign asset prices.

4. The financial market disequilibrium is illustrated by the shift of the straight line Q^1 to the point C, which causes a shortfall in the money supply C–B. The hypothetical equilibrium curve should cross at the point Q'' (the dashed line).

The second phase of the first stage.

1. An increase in financial asset / bond prices, as well as the shrinking of the money supply from a real perspective (the growth P') changes gradually the money supply/demand set-up. The curve Q' shifts gradually to Q'', D' to D, E'' to E, which is illustrated by Fig 8.

Figure 8. The second phase of the first stage
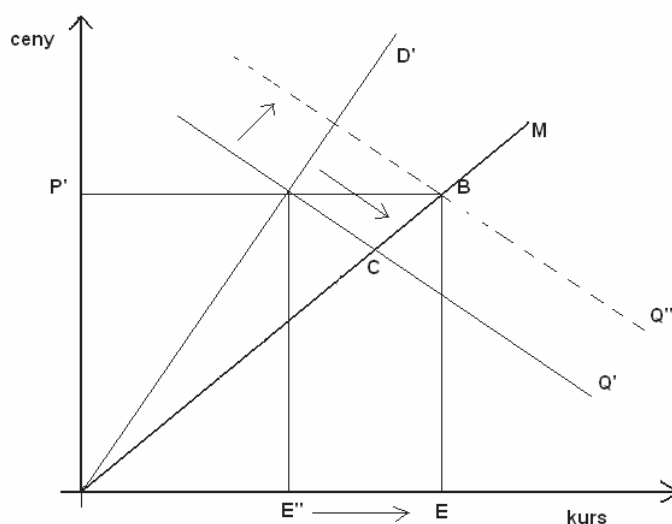
Source: my own survey

3.2. The overshooting period from July 2008 to March 2009

The period is characterized by the following changes in macroeconomic indices:

1. The growth rate of the supply of money remains high; in the period under discussion the M3 index increased by 12 percent.

2. A fast depreciation of the zloty against the euro and the U.S. dollar begins.

3. The CPI index declines from 4.7 percent to a level of 3.7 percent in January 2009, in order to reach a level of 4 percent. I consider this as a situation that is close to the sticky price model.

4. Over the first five months the NBP interest rate remains at a level of 6 percent, and then rapidly declines to 4 percent, that is, by 200 base points.

On summing up the index changes as presented above, it must be stated that the relationships between the indices were standard and in accord with the assumptions of the Dornbusch model.

A rise in the M3 supply with the occurrence of price stickiness in the commodity market caused that the nominal money supply was equal to the real one, which should result in changes in central bank interest rates and domestic currency depreciation. The reduction of central bank interest rates is accompanied by similar changes in the ECB and the Fed, with the final result being that the interest rate differentials remain at a similar level.

The situation presented above is accompanied by the following processes:

1. An outflow of foreign capital from the financial market in Poland continues, which is evidenced by a decline in the share of foreign assets in creating the M3 from 15 per cent to 7.7 per cent over the period under discussion.

2. There is an increase in the demand for the Treasury bonds, which is manifested in a decrease in their yield rate. Once again we have to deal here with 'Dornbusch's paradox': the demand for financial assets that is induced by the expectations of the zloty appreciation in relation to the euro and the US dollar.

Market operators expect that the zloty becomes overvalued, which is illustrated by Figure 9.

3. In the first quarter of 2009, the foreign trade balance improves at a high rate. Figure 1

Figure 9. A situation in the financial market during overshooting
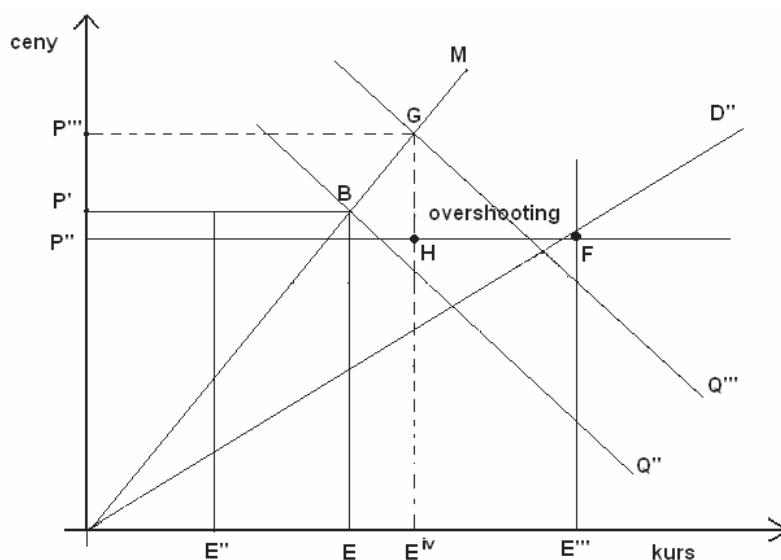
Source: my own survey

The graph shows the following processes:

1. The money supply rises from B to G.

2. Prices decline from P' to P''.

3. The demand curve for financial assets shifts to D", the result of the change is the zloty's depreciation to the point E'''. This extraordinary change of the exchange rate enables achieving an equilibrium in the financial market at the price P'' and the money supply F. A currency rate functions as a shock absorber of changes in financial markets.

4. A more than proportional depreciation of the zloty is the overshooting determined by H and F.

With no overshooting taking place, the market would gain an equilibrium at point G and at prices P''' and the exchange rate E^{IV}.

3.3. The recovery period from April 2009 to December 2009

The period has been defined as the time of recovering the state of equilibrium in Poland's economy. It is important that financial market adjustment processes were transferred to the real sphere (foreign trade)

Changes in macroeconomic variables in the studied area:

1. The growth rate of the M3 money supply declines to the level of 6 percent.

2. CPI declines from 4 per cent to 3 percent (a non-standard behaviour, at variance with the assumptions of the model.) [10]

3. The Polish zloty appreciated against the euro from 4.7 to 4.0 percent.

4. Poland's foreign trade deficit stabilized at a level of one billion zloty (a quarterly average).

5. The stability of the NBP interest rate maintains its previous differential in relation to the Fed and ECB.

6. After short-term movements upward, the yield rate of Treasury bonds declines gently, which signifies a slow increase in the demand for financial assets.

A sharp decrease in the growth rate of the money supply means that a smaller scale demand guarantees equilibrium in the financial asset market. In other words, the fall of bond yields can be triggered by a lower demand for scrip. Tendencies in capital flows change with new reality. Foreign investors are returning to the Polish portfolio market. The expected changes in the zloty rate stabilize, which is reflected in oscillating changes that have taken place in the euro/zloty system since the beginning of 2010.

An outline of the changes is illustrated in Figure 10.

Figure 10. A situation in the financial market during a recovery period
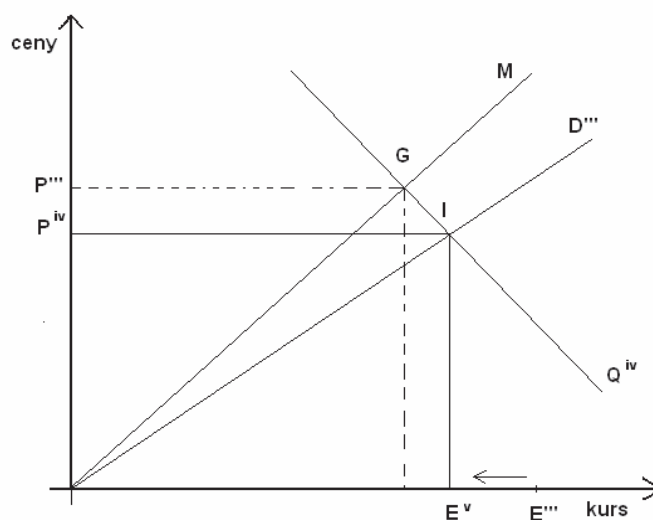
Source: my own survey

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[10] e.g. described in Caves, R..E., Frankel, J.A., Jones, R.W., *World Trade and Payments*, HarperColinsPublishers, New York 1990.

The changes in macroeconomic variables as described above are illustrated in Figure 10:

1. The money supply remains at the point G. For simplicity's sake, the small rise in the M3 supply has not been considered in the chart.

2. The prices decrease from point P'''to point P^{IV}.

3. The demand curve for financial assets shifts slowly from D'' to D'''.

4. The euro/zloty rate appreciates from E''' to E^{IV}.

5. The financial market reaches a point that is close to an equilibrium state in I, at the rate E^{IV}, the prices P^{IV} and the demand for assets D'''.

Thus, the outline presented above closes a cycle of adjustments that have taken place in the financial market. The final phase is the situation that is close to the point of equilibrium. Its characteristic feature is the fact that the expectations of exchange rate changes stabilize and we have to deal with the problem of oscillating changes in the euro/zloty rate.

4. Conclusions

1. The findings above indicate that the Dornbusch model explains in a proper way exchange rate changes in Poland's currency during the years 2008 to 2009. The overshooting of August 2008 to March 2009 was positively verified.

2. The Dornbusch model and the statistical data presented above determined a crucial role of the expectations of the exchange rate in achieving financial market equilibrium. It is a vitally important conclusion from the view point of Poland's monetary policy. One must remember that the domestic financial market is a relatively young and shallow market. Thus the possibilities of achieving equilibrium through changing the exchange rate stabilize the conditions of its functioning. Maintaining equilibrium without the flexibility of the zloty exchange rate would involve higher costs.

3. The analysis of statistical data revealed that Poland's economy in the field of foreign trade responded to the exchange rate changes in a model way. A simple adjustment mechanism, the rate / price, worked rather efficiently, thus enabling to restore equilibrium in the trade balance. It is an important conclusion which has wide applicability to all sorts of different problems since it proves that the exchange rate channel plays a significant role in creating an outer equilibrium.

4. Our research has not confirmed the commonly held thesis that the exchange rate volatility (overshooting) is the economy's reaction to slow adjustment in commodity price changes, when the original impulse is a rise in the money supply. In the analysed period, the Polish economy was characterized by a high elasticity of prices and exchange rates.[11]

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[11] Dornbusch, R., Fisher, S., Startz, R., *Macroeconomics*, McGraw-Hill, N.Y., 200, p. 534.

The conclusions presented above are important from the point of view of Poland's accession to the euro zone, as they are a proof that changes in exchange rates may constitute a significant factor for achieving an equilibrium in the financial market and the real sphere.

It would probably be possible to achieve these effects employing some other economic policy instruments, however, doubtless, that would be a very complicated process that would impose considerable costs on the Polish economy, such as the reduction of the so-called inner absorbtion.

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(Summary)

The paper aims to statistically verify the assumptions of the Dornbusch model in Poland's economy in the years from 2007 to 2009. The study determines the role of the exchange rate in achieving equilibrium in the financial market in Poland and the effectiveness of the exchange rate adjustment mechanism: the rate – price in achieving the equilibrium of trade balance. The conclusions allow us to formulate recommendations as regards the role of the exchange rate in economic policy, which has a significant meaning in the process of Poland's accession to the euro zone.