Fundamental Exchange Rate Forecasting Models. Advantages and Drawbacks

Irena Mačerinskienė[1]

Andrius Balčiūnas[2]

Abstract **Many researchers prove that fundamental models do not provide accurate exchange rate forecasts. This paper presents the main fundamental exchange rate forecasting models and discusses the advantages and drawbacks of the mentioned models. The research should help to explain why the forecasts can be not accurate.**

Keywords – **Exchange rate determination models, Fundamental exchange rate models, Nominal exchange rate forecasting.**

I. INTRODUCTION

The foreign exchange market is unique by its liquidity, size (the largest market in the world) and heterogeneity of market participants. According to the latest data from the Bank for International Settlements (BIS), the average daily turnover in foreign exchange market in the month of April, 2013, was $5.3 trillion. It increased from $3.98 trillion in 2010 by 33%. Such turnover is created by a large variety of market participants: central banks, importers and exporters of goods and services, currency risk hedgers, foreign asset purchasers and sellers, dealers and brokers, speculators and investors, people who buy currency for traveling abroad. Increasing size of the market and variety of participants creates a demand for exchange rate forecasts.

The present foreign exchange system exists from the 1970-ies after the collapse of Bretton Woods system. There were various attempts to predict the future exchange rate by the academia. On the other hand, there is no agreement on the classification of the models used for predicting the exchange rates: some researchers classify them to technical, fundamental and alternative models [34], others include a fourth class which covers efficient market hypothesis models [7]. Technical models predict the future exchange rate based on the previous fluctuations of the same exchange rate (Neely, 1997), while fundamental models determine exchange rate by calculations based on macroeconomic variables. Alternative class covers other non-conventional models, efficient market hypothesis models assume that the fluctuations cannot be predicted.

Moreover, the researchers do not agree on which fundamental models are the most suitable for predicting the future exchange rate. Hsing (2010a) in his research on determination of USD/AUD exchange rate makes a conclusion, that uncovered interest rate parity model reflects exchange rate movements the best, followed by purchasing power parity, flexible price monetary and Mundell Fleming models. On the other hand, when the same author makes a research on RON/USD exchange rate, he concludes that the fluctuations of this exchange rate are mostly reflected by the same uncovered interest rate parity model, but the second best model is the flexible price monetary, followed by Mundell Fleming and purchasing power parity models [24]. Rasekhi and Rostamzadeh (2011) made a genetic algorithm based on various fundamental models for predicting EUR/USD exchange rate and noticed, that after the calculations by the algorithm were made, the largest part of the algorithm was taken by portfolio balance model, which means that this model is better for determining the exchange rate fluctuations than the other models, while relative purchasing power parity model comprises the smallest part of the algorithm. On the other hand, other researchers in the field say, that conventional fundamental models are not appropriate for predicting the exchange rate [40, 13, 3, 29]. The discussion is resumed by [12, 33], who say that these models show poor results because of the inappropriate judgment of the forecasts which are generated by the models. Engel et. al. (2007) draws the attention to alternative microstructure approach which was introduced by Lyons in the first part of 2000s.

Burkšaitienė (2009), one of the few researchers of the exchange rate forecasting field in Lithuania, shows the sequence of generating the forecasts by using fundamental models: 1. choosing the coefficients for the model; 2. the calculation of independent variables; 3. changing of the independent variables for better forecasting results. The researcher also states the drawbacks of forecasting exchange rates with using fundamental models: the set of the independent variables has to be predicted, the values of the parameters (coefficients) can change during the time.

The lack of success in exchange rate forecasting leads to doubts whether the models are appropriate for forecasting the exchange rates. It can be argued, that not the exchange rate, as an object, is impossible to predict, but the tools for predicting it are not sufficient enough. Therefore the **problem** arises: why do most of the fundamental exchange rate models fail to predict the exchange rates? **The object** of this paper is fundamental exchange rate forecasting models. **The aim** of the research is to present the reasons why do most of fundamental exchange rate forecasting models fail to predict the future exchange rate. **The objectives of the article are as follows:**

[1] Irena Mačerinskienė is with the Faculty of Economics and Finance Management, Mykolas Romeris University, Ateities st. 20 LT–08303 Vilnius, Lithuania

[2] Andrius Balčiūnas is with the Faculty of Economics and Finance Management, Mykolas Romeris University, Ateities st. 20, LT-08303 Vilnius, Lithuania

1) to clarify the classification of the exchange rate forecasting models;
2) to present the main fundamental exchange rate forecasting models;
3) to reveal the advantages and disadvantages of the main fundamental exchange rate forecasting models.

Methods of research: analysis and synthesis of scientific literature.

II. EXCHANGE RATE FORECASTING MODELS

There is no general classification of exchange rate forecasting models. As stated above, Burkšaitienė (2009) classifies the models of forecasting the future exchange rate as follows:

1)**Efficient market hypothesis models.** The main assumption is that currency market efficiency is strong and the exchange rate varies unpredictably. This means that random walk hypothesis is applied. The simplest version of the model can be written in a following equation:

$$S_t=E(S_{t+1}) \quad (1)$$

where S_t – exchange rate at period t, $E(St+1)$ – future exchange rate.

If the foreign exchange market is fully efficient, all the information is already reflected in current exchange rate. The exchange rate will change only when some new information will be announced. But nobody knows what the information will be and when it will be announced, therefore the exchange rate will change unpredictably. The future changes of the exchange rate are independent from the fluctuations of the past and it is impossible to predict them for the future. On the other hand, there are various research papers that provide evidence that some models, which can determine the exchange rate better than the random walk model, exist [12, 33];

2)**Fundamental models.** These models became popular in the second part of twentieth century mainly after the collapse of Bretton Woods system. The proposition of these models is that particular macroeconomic variables affect the exchange rate. Therefore the models are called as macroeconomic models [34]. The research of Meese and Rogoff (1983) which concludes that macroeconomic models are not appropriate for forecasting exchange rates is often cited in present economic literature;

3)**Technical models.** The fluctuation of the past exchange rate is used for forecasting future exchange rate. Some technical indicators might be applied as well. The parameters of the indicators can be optimized for seeking better forecasting results. Also new technical indicators can be created based on these models. On the other hand, as mentioned before, the prediction of the future exchange rate is based on the past performance of the same variable [34], which means that the main assumption is that the past will repeat itself, which is not always the case.

Moosa and Bhatti (2010) distinguish an **alternative** class of the models. These models were created as a response to unsuccessful performance of the main stream fundamental models. The models are: Microstructure model of exchange rates [28], Behavioral finance, Post-Keynesian, theory of chaos and others.

There is no clear opinion on which position should alternative models take in the general classification of the exchange rate forecasting models. By some part, the models incorporate the most underlying factors which affect the exchange rate (for example, order flow in case of microstructure approach incorporates beliefs of possible changes of macroeconomic variables, or expectations of international portfolio managers in the Post-Keynesian models – for further discussion on the models see below). On the other hand, many researchers while mentioning fundamental determinants have in mind the macroeconomic variables that affect the exchange rates. We classify the alternative models under fundamental models class, but not below the Macroeconomic models class. The classification of the models is presented in figure 1 below.

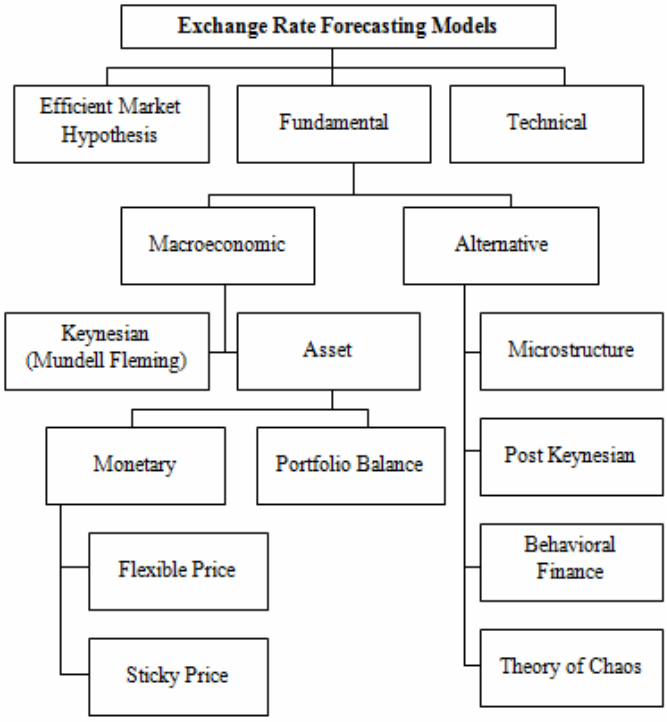

Fig. 1. Classification of exchange rate forecasting models

Before deeper analysis of fundamental models, purchasing power parity and interest rate parity models will be introduced, because they are parts of some fundamental models and also they are used as separate models for forecasting the exchange rate.

A. Theory of Purchasing Power Parity

One of the main theories of determination of the exchange rate is the theory of purchasing power parity (PPP) which after World War I was developed by Gustav Cassel [43]. The theory states that the prices of the same goods and services in various countries should be the same, if expressed in one currency. Therefore, the nominal exchange rate should be equal to the ratio of the prices of goods and services in the two countries. The two versions, absolute and relative, of the

theory exist. They are written in 2 and 3 equations respectively:

$$E_{a,b} = \frac{P_a}{P_b} \quad (2)$$

$$e_{a,b} = p_a - p_b \quad (3)$$

$E_{a,b}$ – is the exchange rate between country a and country b (the currency of country a is bought with the currency of country b which is the currency of home country; it means that when E is increasing, the value of the home country currency is decreasing), P_a – the price of goods and services in country a, P_b – the price of the goods and services in country b. In the 3rd equation e is the rate of change in the exchange rate, p_a and p_b – the rate of changes of the prices of goods and services in countries a and b respectively.

If the absolute purchasing power parity holds, the exchange rate between the two countries is equal to the ratio of the prices of goods and services of the two countries. When the relative purchasing power parity exists, the exchange rate is equal to the difference of the inflation rate between the two countries [41]. If the absolute purchasing power parity holds, the relative purchasing power parity will hold as well, because the changes of the nominal exchange rate may occur in different levels of the purchasing power [43].

Various researchers provide different results on whether purchasing power parity holds in the financial markets. While some scientists provide empirical evidence that the purchasing power parity holds in general [17], other researchers conclude that purchasing power parity exists in different time periods, but it holds only in the long period [41]. According to Haidar (2011), these are the main reasons why purchasing power parity may not hold:

1) The baskets (indexes) of consumer goods and services can be different in the compared countries;
2) Protectionist policy rules might be applied, for example, various taxes which prevent the free trade of goods between the countries;
3) The economies cannot be comparable in general (comparing developing economy to already developed one will not provide accurate results):
    a) The level of income in developed and developing economy is different, which is related to different level of labor productivity;
    b) Prices in the services sector might be different;
    c) The elasticity of the prices of the same goods can be different in a developed economy compared to a developing one.

It is also argued which basket of goods and services should be chosen to compare. Some scientists use the consumer price index, others use producer price index, wholesale price index or traded goods price index [17, 41]. Simpson and Grossman (2010) notice that the traded goods price index shows the best results in determining the future exchange rate.

It can be concluded that purchasing power parity model is quite limited. The researcher cannot compare developing economy to the developed one (Haque et.al., (2013) prove it by finding that the purchasing power parity does not hold between U.S.A. ad emerging Asian countries), the price indexes, which are used for the comparison, must be composed of the same goods and services, protectionist policy cannot be applied to the compared countries (or if applied, it should be the same in both countries). Also, the question exist which price index should be chosen. The positive side of the model is that it is simple because there are not many independent variables. Although some limitations apply, relative purchasing power parity exists more often than absolute. Purchasing power parity is also used as an assumption to some of the fundamental models.

B. Theory of Interest Rate Parity

The main proposition of the theory is that the return on assets of different countries should be equal when calculated to the same currency. In other words, if the interest rate paid for foreign assets in foreign country is higher than the interest rate paid in home country for home country assets, the price of the foreign currency should drop compared to the price of the home country currency. The main conclusion of the interest rate parity is that high yielding currencies should get cheaper and low yielding currencies should get more expensive. Otherwise the arbitrage opportunity exist (in covered interest rate parity case), which will eventually be used by the speculators [39]. There are two forms of interest rate parity: covered interest rate parity (CIP) and uncovered interest rate parity (UIP).

The theory of covered interest rate parity states that when investing, the difference between the price of home currency compared to the price of foreign currency and the yield of interest rate is compensated by the change in the future exchange rate (which is measured by the price of a future contract):

$$1 + i_t^b = (1 + i_t^a)\frac{F_t}{S_t} \quad (4)$$

i_t^a is the interest rate in foreign country a at time t, i_t^b is the interest rate in home country b, F_t is the price of the future contract at time t. Uncovered interest rate parity holds most of the time [39].

No future contract is used in uncoverd interest rate parity. Possible future exchange rate is used instead:

$$1 + i_t^b = (1 + i_t^a)\frac{S_{t+1}}{S_t} \quad (5)$$

i_t^a is the interest rate in foreign country at time t, i_t^b is the home country interest rate, tS_{t+1} is the possible exchange rate for time $t+1$.

The uncovered interest rate parity holds rarely [11], although it should be the main condition for proving that foreign exchange market is efficient [39]. Uncovered interest rate parity is not an arbitrage condition, because it is related to possible future exchange rate which is unknown in the present.

There are two main conditions which apply to interest rate parity: free flow of capital and risk neutrality. But investors are not neutral to risk. That is the reason why covered interest rate parity usually holds while uncovered interest rate parity holds rarely [11].

As mentioned above, based on the rule of interest rate parity, the prices of low yielding currencies should increase while the prices of high yielding currencies should decrease. Although sometimes it is the opposite. Researches call it as interest rate parity puzzle or interest rate parity anomaly [5,

39]. These are the main reasons why deviations from the interest rate parity might occur [27]:

1) Deviations can be caused by irrational behavior of investors;
2) The data is inappropriate for the calculations;
3) Changes in regimes. This reason can be expanded to: slow adaptation of the investors; heterogeneous beliefs of the investors; composition of bubbles, during which exchange rates deviate from the fundamental background (the use of carry trade strategy by some of the market participants);
4) Risk premium. Deviation from uncovered interest rate parity serves as an additional compensation for the risk acquired.

The trading strategy, when the speculator buys high yielding currency by expecting for it to appreciate more (or sells low yielding currency by expecting it to depreciate), is called carry trade [30]. It can be the reason for further deviations from the interest rate parity and compositions of bubbles. Such trading is related to high level of risk, because it could lead to significant losses when the prices of the currencies will start to move to the parity [27].

Although some limitations exist, latest research show that deviations from the parity are not as large as used to be in the past [5]. It is mainly influenced by increasing turnover in the foreign exchange market and increasing share of participants, who profit from the deviations (e.g. investment funds, hedge funds, etc.). Boschen and Smith (2012) shows that in 1995 the turnover of these market participants composed approximately one fourth of the total market turnover, while in 2010, the part of these participants increased to half of the total turnover. Chinn and Liang (2009) proved that uncovered interest rate parity is appropriate for calculations based on longer time interest rate than shorter. Uncovered interest rate parity is used in some fundamental exchange rate models as a condition.

C. Macroeconomic Models

As stated above, these models are based on the assumption that present exchange rate is a reflection of particular macroeconomic variables. Depending on which variables influence the exchange rate, Moosa and Bhatti (2010) distinguish Keynesian and monetary models.

Mundell Fleming Keynesian model. This model was introduced in 1960-ies by R. Mundell ir M. Fleming before exiting the dollar standard, therefore the model is suitable for an economy with fixed or floating exchange rate and it allows to assess the influence of monetary and fiscal policies to gross domestic product. Mundell expanded the Keynesian IS-LM model by applying it to a small open economy (the country cannot affect the level of interest rate). Other assumption of the model is that there are no restrictions to capital movements (Huh, 1999). The model is also called as IS-LM-BP (as well as the flow) model and it can be written as follows:

$$Y = C(Y) + I(i) + G + NX(Y,S) \quad (6)$$

$$L(Y,i) = M/P \quad (7)$$

$$BoP = CA + KA \quad (8)$$

where Y is real income, C stands for household expenses (which depends on the real income), I is investments (negatively correlated to interest rate of the country), G is government expenses, NX is net export (which depends on real income and is negatively correlated to the exchange rate S). Equation 6 is the IS curve. Equation 7 is the money market (LM) equation: L is liquidity preference, M is money supply, P is price level. BoP is a balance of payments equation, where CA is the current account of balance of payments, KA is the capital and financial accounts. Some authors [22] expand the model by adding country risk to IS equation and the value of financial assets to IS and LM equations.

This model, differently from the purchasing power parity and interest rate parity models allows to forecast the exchange rate based on fiscal, monetary policies and changes in balance of payments. On the other hand, the model is complex, because all the independent variables have to be forecasted before determining the future exchange rate (Burkšaidienė, 2009) and periodicity of the data has to be the same. Moreover, as most of the macroeconomic models, the model presumes that the exchange rate adjusts instantaneously after a change in a macroeconomic variable.

Flexible price monetary model. Monetary (also called as asset) models were introduced in the second part of the 1970-ies, when it was noticed that Mundell-Fleming model does not perform well in a high inflationary environment [32]. The broadest version of the monetary model is the Frankel model, which can be written in the following equation [23]:

$$s = (m_a - m_b) - \alpha(y_a - y_b) + \beta(i_a - i_b) \quad (9)$$

where s is the exchange rate, m_a is money supply in country a, m_b is money supply in country b, $y_{a,b}$ are incomes in country a and b respectively, $i_{a,b}$ are the interest rates in countries a and b respectively (other authors use inflation rate instead, [23]). The equation is written in a logarithmic form.

Monetary approach states that the exchange rate is a ratio of the prices of currencies of two different countries, which is determined by using relative demand and supply of each of the currencies. The exchange rate is positively related to relative money supply (if money supply in country b is greater than in country a, the exchange rate will increase: currency of country b will depreciate against the currency of country a), negatively related to the difference between the income level and positively related to the interest rate, which is the uncovered interest rate parity condition (if the interest rate in country a will be greater than in country b, then the currency a will be cheaper than currency b), purchasing power parity is also assumed. This means that there exist one bond (country bonds are perfect substitutes) and one good.

This model is less complex than Mundell-Fleming, although it does not allow to assess the influence of fiscal policy to the exchange rate. Also the values of parameters α ir β can differ during the time [7]. The assumption is made that uncovered interest rate parity and purchasing power parity hold, although it is stated that there is little empirical evidence that both these parities hold in reality [47]. Moreover the model cannot determine all the volatility of exchanges rates (same as Mundell Fleming) – exchange rates fluctuate more than macroeconomic variables which are believed that can determine the exchange rate. Also the model states that the exchange rate adapts at the same moment when the macroeconomic variables change [46], although it does not happen in the reality [8]. These drawbacks of the model were the reason for the sticky price (also called as overshooting) model to be presented.

Sticky price monetary model. Sticky price monetary model was introduced by R. Dornbusch as another type of monetary models. It is stated that in short term the exchange rate overshoots its long term equilibrium rate if tools of expansionary monetary policy are applied. This "elegant" [36] model explains larger volatility of the exchange rates compared to other macroeconomic variables. The main assumption is that prices of goods and services are sticky, i.e. the prices do not fully react to the changes in macroeconomic variables in short term, therefore the exchange rate has to compensate the stickiness of the prices of goods and services. So, when the exogenous variable (monetary policy) changes, in short term the exchange rate reacts stronger (overshoots) than in flexible price monetary model and later when the prices of goods and services gradually adjust to the new macroeconomic environment, the exchange rate decreases to the new equilibrium. Uncovered interest rate parity is applied in the long term. The model is written in equation 10:

$$s = (m_a - m_b) - \alpha(y_a - y_b) + (\beta - 1/\theta)(i_a - i_b) \quad (10)$$

there is a new variable compared to the flexible price monetary model– θ. It is the coefficient of adjustment of the present exchange rate to its long term price. The equation is written in a logarithmic form.

In the long run the exchange rate is determined by purchasing power parity and based on relative supply of money, relative income and relative interest rate. Short term exchange rate differs from the long term equilibrium rate, but the former adjusts to the latter when the prices of goods and services reach new equilibrium.

Empirical research proves that this model cannot determine exchange rate appropriately [23, 34]. As stated in [6], delayed overshooting might occur, while Tu (2009) states that undershooting might occur or there might be no reaction of the exchange rate at all. Rogoff (2002) states, that the model shows only the main changes in exchange rates while it does not determine all other fluctuations of the exchange rate. Overshooting effect is not sufficient to explain the volatility of exchange rates [37].

Dornbusch model is more advanced than Frankel because of the attempt to explain greater volatility of exchange rates compared to macroeconomic fundamentals. It is also stated that purchasing power parity and uncovered interest rate parity hold only in long term, although researchers prove that Dornbusch model is not appropriate for determining the exchange rate. As in Frankel model the values of parameters α and β, and θ can differ during the time. Also it is not clear how long will it take to for the present exchange rate to adjust to the long term equilibrium rate, i.e. how long the overshooting will last.

Parallel to the Dornbusch model the Portfolio balance model was developed. The main proposition of the latter is that home country and foreign country bonds are not perfect substitutes.

Portfolio balance model. As stated above, one of the assumptions of previous models is that different countries' bonds are perfect substitutes, i.e. that there is one bond in the market. Portfolio balance model relaxes this assumption by proposing that the interest rate in separate countries might be different, that means that risk premia exists. Because the interest rate of bonds is different, the price of the bond must be different as well. Assumptions of free capital flow and small country are made [32].

In this model, agents of one country distribute their wealth between home and foreign country bonds and money. Agents accumulate more wealth when there is a surplus in current account. The wealth is invested in bonds of home and foreign countries. The model can be written by the following equations:

$$M = m(i, i^*)W, \quad (11)$$

$$B = b(i, i^*)W, \quad (12)$$

$$sF = f(i, i^*)W, \quad (13)$$

$$W = M + B + sF \quad (14)$$

where M is the amount of money in home country, B is the amount of home country bonds, F is the amount of foreign country bonds (denominated in foreign currency), S is the exchange rate, i and i^* are the interest rates in home and foreign countries respectively, W is wealth of home country agents, which is held in home currency in money, home bonds, and foreign bonds, which are denominated in foreign currency, m, b, f are parts of wealth, which are held in money, home bonds and foreign bonds respectively.

The demand for assets depends on the interest rate of home country, interest rate of foreign country and the level of wealth. Exchange rate and home interest rate are endogenous factors. All other variables are exogenous. Current account surplus increases the price of home country currency (the exchange rate decreases). Therefore it is possible to buy more bonds. Excess money are invested to foreign bonds, the increased demand of foreign bonds lowers the interest rates, what leads to the appreciation of the price of foreign currency, therefore the demand for bonds stabilizes and new equilibrium exchange rate is reached.

Although portfolio balance model is more advanced than other monetary models because the uncovered interest rate parity is relaxed, in literature the model is criticized because investments can only be held in foreign and domestic bonds and domestic money and foreigners are assumed to hold no assets in the domestic economy [1], and the question on which data should be used for the calculations persist [15]. As other fundamental models, this one cannot forecast the exchange rate appropriately as well.

D. Alternative Models

As a response to poor results of main stream macroeconomic exchange rate models, some alternative models were created.

Microstructure model. Microstructure model, presented by Lyons (2001) offers a new approach to exchange rate determination. It states that the exchange rate is affected by micro factors (i.e. order flows of the market participants) which carry information about macroeconomic fundamentals and other variables which affect the exchange rate. The model relaxes these main restrictions of previous macroeconomic models:

1) Information. Information in currency exchange is asymmetric. Some market participants can reach the information which is unknown for other participants. Dealers from the order flows of their clients can learn about their expectations and make conclusions whether the exchange rate is too high or too low;

2) Participants. Market participants are different and have different motives. Participants, who can reach only public information, interpret the changes in the exchange rate differently than those who have private information. These differences also can be caused because of different trading motives – as stated above, some market participants seek to hedge currency risk, others to speculate, etc.;

3) Institutions. The trading mechanisms are different and they affect the market prices differently. According to Lyons (2001), the currency exchange has two tiers: in the first level the other market participants trade with dealers while in the second level dealers trade between other dealers.

Microstructure approach puts emphasis on dealers' (marketmakers') role in the currency market, because these participants, as stated in the first point, have additional information about their clients positions and can use the information as an additional indicator of price. Second picture shows how exchange rate is affected by non-dealers and dealers decisions.

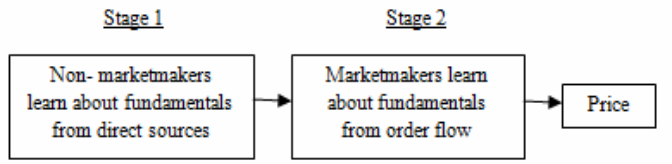

Fig. 2. Determining the exchange rate in microstructure model

In Stage 1 the participants of foreign exchange market learn about possible price fluctuations from various sources by performing fundamental analysis, etc., while in Stage 2 market makers learn about fundamentals from their clients' (stage 1) order flow and adjust their own positions. Then the price is determined.

The order flow can be positive (long position) or negative (short position). Based on this information dealers can make conclusions about possible market fluctuations and quote corresponding quotes (bid and offer prices for the currency pairs).

Lyons connects asset model with his microstructure approach and gets a model, which can determine the exchange rate in shorter and in longer time frame (from one day to a month) [13].

$$\Delta E_t = f(i, m, z) + g(X, I, Z) + \varepsilon_t \quad (15)$$

ΔE_t is the change of the exchange rate for a certain period of time, *i*, *m*, *z* are the parts of before mentioned macroeconomic model (*i* is interest rate, *m* is money supply, *z* is other variables of macroeconomic models), *X* is the order flow in the microstructure model, *I* are open dealers positions in the microstructure model, *Z* stands for other microeconomic factors, ε_t is the residual which shows the change in exchange rate, which is not reflected by macro and micro factors.

The main drawback of microstructure models is the access and the compatibility of the data [10, 26, 38]. Not all the data can be suitable for the exchange rates to forecast [14] – it depends on the nature of the data: does the order flow reflect commercial or non-commercial orders, are the flows between the dealers or between retail clients and dealers, etc. Also, according to Sager and Taylor (2008), more minor (tick by tick) data, which is hard to access, is required for the model to work, and the fact that the data can mostly be accessed by some largest banks denies the possibility of forecasting the exchange rates for the academia by using this model. Sager and Taylor (2008) also pay attention that it is not worth to fully rely on the data provided by the intermediary which are composed to an index. Bailliu, King (2005) states that research of order flow is "promising", because order flow allows to determine the affect of news to the currency price, which size of the orders affect the price, etc. Vitale (2007) also points out that appropriate model and appropriate data is required. This type of models is quite new (it was introduced in 2000s) therefore it is another reason why more empirical research has to be made on the microstructure approach [35, 38, 45].

Microstructure model is more advanced than other fundamental models because micro approach is used: it is tried to determine the exchange rate by quantifying the demand and supply of a particular currency, which emerges from the actions of market participants. The model allows to deeper research of the underlying forces of exchange rate movements. Although the model can determine the exchange rate better than other models, the main drawback is related to the nature of the overt the counter foreign exchange market: the coverage of the data (it is impossible at the moment to collect all the order flow of the foreign exchange market), nature of the data (market participants are heterogeneous, therefore their order flow will differ depending on the clients of the source of the data), accessibility (the data can only be reached by the largest dealers and is not distributed for public).

Models of Post-Keynesian approach. The developer of this type of models is J. T. Harvey. He states that the exchange rate is affected by international supply and demand for each currency. The demand is determined by import, foreign direct investment, portfolio investments and management of foreign currency reserves. Special role is played by portfolio investments, as the main factor of currency demand, which depends on expectations. The main difference, according to Harvey (1999), between Post-Keynesian and neoclassical approach is that neoclassics do not separate portfolio investments from foreign direct investments. While the difference between these investments is that portfolio investments include expectations, which according to Harvey are important in determining the exchange rate. Therefore in the Post-Keynesian model the exchange rate is mainly affected by change in moods of international portfolio managers, when portfolio investments are the source of short term income. On the other hand, it is stated that the only reason, why the currency is bought, is because of the demand for assets of the foreign country and agents do not hold currency for currency speculation purposes. Harvey (2005) compared the results of Post-Keynesian model to the results of neoclassic monetary model and made a conclusion that Post-Keynesian model can determine the present exchange rate better. Moosa (2007) agrees on that conclusion.

The positive attribute of the model is that it assesses the expectations for the future of the economy of the country; on the other hand, the model states that the currency is bought only for purchasing assets of the foreign country, therefore the model covers only one part of the participants of the foreign

exchange market. This model did not attract a lot of attention from the academia as compared with other mainstream models.

Behavioral finance models. The main argument of behavioral finance is that agents do not behave rationally. Moosa, Bhatti, (2010) state that de Grauwe and Grimaldi specifies these main attributes of behavioral finance approach: agents understand, that the world is too complex therefore they use simple rules for decision making; agents regularly assess their rules for decision making and changes them to ones that give them more satisfaction; the decisions are assessed according to the experience which was gained in the past.

Moosa and Bhatti (2010) shows two stages of the process of decision making: in the first stage the agents create the rules for forecasting based on simplified information they have; in the second stage the agents check the rules by doing a back-test (checking how these rules determined the exchange rate in the past). Then, if more profitable rules are found, the agents switch to the more profitable ones.

Other attribute of behavioral finance approach is that the exchange rates make bubbles (deviate from the fundamental equilibrium exchange rate). In a certain time fundamental changes will force the exchange rate to fall and the drop will be sudden, because it will be noticed by fundamental and technical traders.

The positive side of these models is that the psychology of market participants is addressed, although only one segment, the speculators, of market participants is covered.

Theory of chaos models. They state that the exchange rates are related to their determinant variables in non-linear links (opposite to all models discussed above). If chaotic behavior is found, the exchange rate could be forecasted by using mathematical models [18]. On the other hand, there is no clear opinion whether the theory of chaos exists in the currency market. Gilmore (2001) states that the exchange rates do not move chaotically, while [18] found chaotic behavior of USD/EUR currency pair. Sorin (2008) agrees that there is no unanimous opinion whether the chaotic behavior of exchange rates exits. Moosa and Bhatti (2010) conclude that there is no great attention given to the theory of chaos approach while seeking to forecast the exchange rate.

Above mentioned models are the main fundamental models used to forecast exchange rates. On the other hand, as noted in the introduction, researchers claim, that none of the models can fully predict the future exchange rate. The only model which might provide sufficient forecasting results is the microstructure approach model. The reasons why most of the models fail to forecast exchange rates are presented in the next section.

III. Positive and negative sides of fundamental models for determining future exchange rate

As mentioned above, most of the models performed poorly in the field of forecasting exchange rates. Therefore the authors of the article present a table where the drawbacks and advantages of the models are listed (see Table I in the next page).

The above listed drawbacks above are the reasons why particular fundamental models might fail to perform well in the reality. Moreover, there are drawbacks which are related to other models – for example, flexible price monetary model assumes that uncovered interest rate parity and purchasing power parity hold; it is proved that these two parities do not hold or hold only in the long run, therefore the results of flexible price model might be wrong because of the key assumptions are invalid [4]. On the other hand, there are some obstacles, which relate to all of the models when predicting the exchange rate:

1) Appropriateness of the data. If the period, from which the data is collected, is wrong, the model can provide false results. Kohler (2008) calls it as sampling bias. Burkšaitienė (2009) notices that the values of particular model's parameters can change during the time because of the regime changes in particular country. Bailliu, King (2005) calls it as "parameter instability";

2) For all macroeconomic models the independent variables have to be forecasted before forecasting the exchange rate. If the forecasts of the independent variables are wrong, the forecast of the exchange rate will be wrong as well [7];

3) Most of the models (except for sticky price model and microstructure model) state that the exchange rate adapts at the same moment when the macroeconomic variables change, although it does not happen in the reality [8].

By far the microstructure approach has the least amount of drawbacks and the predictions of this model, based on Rime, et. al. (2007), are the most promising. On the other hand, the forecasts of the uncovered interest rate parity might become more accurate in the future as well, because of the structural shifts in the exchange market [5].

IV. Conclusions

Rapidly increasing turnover in the foreign exchange market leads to great demand for exchange rate forecasts. On the other hand, most of the fundamental models fail to predict the future exchange rate. But firstly, before deeper exploring this problem, the classification of the exchange rate determination models was reviewed in this paper. Based on the analysis and synthesis of the literature, the classification of alternative models was clarified: the models were classified under fundamental models' class.

After presenting the main exchange rate determination models, the conclusion is made that none of the models can predict the exchange rate appropriately. All of the models have some drawbacks. On the other hand, microstructure approach is the most promising at the moment, because it relaxes many assumptions of other fundamental models. Although, the model is quite new and the nature of the foreign exchange market does not allow to fully test the model (to access all the necessary data) for its abilities to predict the exchange rate.

The advantages and drawbacks for every model were distinguished. Also the obstacles which affect all of the exchange rate determination models were determined.

TABLE I
ADVANTAGES AND DISADVANTAGES OF EXCHANGE RATE DETERMINATION MODELS

Model	Advantages	Drawbacks
Purchasing Power Parity	- Holds in the long run although it is not clear for how long the deviation from the parity will last and how large the deviation will be; - Only price indexes of goods and services are used for calculations, which makes model less complex compared to other models	- The components of compared baskets of goods and services must be the same; - Protectionist policy cannot be applied to the compared countries; - It is not clear which basket of goods and services should be used for comparison; - The economies must be comparable.
Uncovered Interest Rate Parity	- The deviations from the parity are not as large as they used to be in the past, therefore forecasting results might be more accurate in the future	- The assumption that investors are neutral to risk is false; - Investors are irrational [27] and heterogeneous beliefs lead to formation of bubbles (i.e. great deviations from uncovered interest rate parity which are supported by carry trade)
Mundell-Fleming	- Allows to assess the impact of fiscal and monetary policy to the exchange rate	- The model is highly complex because of the amount of different variables which have to be predicted
Flexible Price Monetary	- Allows to assess the impact of monetary policy to the exchange rate - Predicts the direction of change properly [33]	- The assumptions are made that uncovered interest rate parity and purchasing power parity exist (although there is little evidence that they both hold in reality [47])
Sticky Price Monetary	- Tries to explain why exchange rates are more volatile than the macroeconomic variables; - Purchasing power parity holds in long term	- The aspect of overshooting is doubted: it is unclear how long the overshooting will last, delayed overshooting might occur [6], or there might be no overshooting at all [44]; overshooting effect is not sufficient to explain the volatility of exchange rates [37]
Portfolio Balance	- Assumes that investors are risk averse	- The investments can only be held in foreign and domestic bonds and domestic money, foreigners are assumed to hold no assets in the domestic economy [1]
Microstructure Approach Model	- Relaxes most of the assumptions of other fundamental models; - Allows to measure the impact of news and other particular factors to exchange rate fluctuations	- The nature of the foreign exchange market does not allow to collect all of the information about order flow, market participants are heterogeneous, therefore their order flow will differ; - The data can only be reached by the largest dealers and usually is not distributed for public; - Lack of empirical research in the field of microstructure models [35, 38, 45]
Post-Keynesian Approach Model	- Assesses the expectations for the future of the economy	- Assumes that currency is bought only for buying assets in the foreign country
Model of Behavioral Finance	- Addresses the psychology of market participants	- Covers only one segment of market participants – speculators and investors
Theory of Chaos Models	- States that the exchange rates are related to their determinant variables in non-linear links	- Assumes that market moves in chaotic behavior, although it was proven that the assumption is false

REFERENCES

[1] Argy, V. (1989), Financial Integration, Short Run Exchange Rate Volatility in Portfolio Balance Models. *Australian Economic Papers*, June, pp. 29-38.

[2] Bank for Internatioal Settlements. Triennial Central Bank Survey. Foreign exchange turnover in April 2013: preliminary global

[3] Bacchett, P., van Wincoop, E. (2006). Can information heterogeneity explain the exchange rate determination puzzle? *American Economic Review*, Vol. 96, Issue 3, pp. 552-576.

[4] Bailliu, J., King, M. R. (2005), What Drives Movements in Exchange Rates? *Bank of CanadaRevew*, Autumn, pp. 3-16.

[5] Boschen, J. F., Smith, K. J. (2012). The Uncovered Interest Rate Parity Anolamy And Foreign Exchange Market Turnover.

International Business & Economics Research Journal, Vol. 11, Issue 3, pp. 299-306.

[6] Breedon, F. (1998). Sterling's rise: A case of delayed overshooting? *Economic Outlook*, 4-7.

[7] Burkšaitienė, D. Tarptautiniai finansai. I dalis. Kaunas: Technologija, 2009.

[8] Chin, L., et. al. (2007). The monetary model of exchange rate: evidence from The Philippines. *Applied Economics Letters*, Vol. 14, Issue 13, pp. 993-997.

[9] Chinn, C., Liang, H. (2009). The Long-Run Uncovered Interest Rate Parity in View of a Trading Strategy. *Applied Economics*, Vol. 41, Issue 21, pp. 2927-2739.

[10] Chinn, M.D., Moore, M. (2011). Order Flow and the Monetary Model of Exchange Rates: Evidence from a Novel Data Set. *Journal of Money, Credit & Banking (Willey-Blackwell)*, Vol. 43, Issue 8, pp. 1599-1624.

[11] Eaton, J., Turnovsky S. J. (1983). Covered Interest Parity, Uncovered Interest Parity and Exchange Rate Dynamics. *The Economic Journal*, Vol. 93, Issue 371, pp. 555-575.

[12] Engel, Ch., et. al. (2007). Exchange Rate Models Are Not as Bad as You Think. *NBER/Macroeconomics Annual*, Vol 22, Issue 3, pp.381-441.

[13] Evans, D., Lyons, R.K. (2002). Order Flow and Exchange Rate Dynamics. *Journal of Political Economy*, Vol 110, Issue 1, pp. 170-180.

[14] Evans, M. D. D., Lyons, R. K. (2006). Understanding Order Flow. *International Journal of Finance and Economics*, Vol. 11, Issue 1, pp. 3-23.

[15] Faust, et. al. (2002). Exchange rate forecasting: the errors we've really made. *Journal of International Economics*, Vol. 60, Issue 1, pp. 35-59.

[16] Gilmore, C. G. (2001). An examination of nonlinear dependence in exchange rates, using recent methods from chaos theory. *Global Finance Journal*, Vol. 12, Issue 1, pp. 139-151.

[17] Haidar, J. I. (2011). Currency Valuation and Purchasing Power Parity. *World Economics*, Vol. 12, Issue 3, pp. 1-12.

[18] Hanias, M.P., Curtis, P.G. (2008). Time Series Prediction of Dollar\Euro Exchange Rate Index. *International Research Journal of Finance and Economics*, Issue 15, pp. 232-239.

[19] Haque, M. A., Boger,G. (2013). An Empirical Test of Purchasing Power Paity: Does it Hold between U.S.A. and Emerging Asian Countries. *Journal of International Business Research*, Vol. 12, Issue 1, pp. 39-45.

[20] Harvey, J. T. (2005). Post Keynesian versus Neoclassical Explanation of Exchange Rate Movements: A Short Look at the Long Run. Pp. 1-27.

[21] Harvey, J. (1999). The nature of expectations in the foreign exchange market: A test of competing theories. *Journal of Post Keynesian Economics*, Vol. 21, Issue 2, pp. 181-200.

[22] Hsing, Y. (2006). Analysis of Short-term Exchange Rate Movements in Korea: Application of an Extended Mundell-Fleming Model. *Global Economic Review*, Vol. 35, Issue 2, pp. 145-151.

[23] Hsing, Y. (2010a). Analysis of movements in the AUD/USD exchange rate: comparison of four major models. *Applied Economics Letters*, Vol. 17, Issue 6, pp. 575-580.

[24] Hsing, Y. (2010b). Analysis of the Behavior of the RON/USD Exchange Rate: A Comparison of Major Models. *International Review of Applied Financial Issues & Economics*, Vol. 2, Issue 2, pp. 272-284.

[25] Huh, H. (1999). How well does the Mundell-Fleming model fit Australian data since the collapse of Bretton Woods? *Applied Economics*, Vol. 31,Issue 3 pp. 397-407.

[26] Jalil, A., Feridun, M. (2010). Explaining exchange rate movements: an application of the market microstructure approach on the pakistani foreign exchange market. *Journal of Developing Areas*, Vol. 44, Issue 1, pp. 255-265.

[27] Kohler, D. (2008). Betting Against Uncovered Interest Rate Parity. Disertation of St. Gallen, Gradduate School of Business Administration, Economics, Law and Social Sciences (HSG), 2008.

[28] Lyons, R. K. Rates, Microstructure Approach to Exchange. Massachussetts, MIT Press, 2001.

[29] Meese, R. A., Rogoff, K. (1983). Empirical exchange rate models of the seventies. Do they fit out of sample? *Journal of International Economics*, pp. 3-24.

[30] Mollick, A. V., Assefa, T., A. (2013), Carry-trades on the yen and the Swiss franc: are they different? *Journal of Economics & Finance*, Vol. 37, Issue 3, pp. 402-423.

[31] Moosa, I. A. (2007). Neoclassical versus Post Keynesian models of exchange rate determination: a comparison based on nonnested model selection tests and predictive accuracy. *Journal of Post Keynesian Economics*, Vol. 30, Issue 2, pp. 169-185.

[32] Moosa, I. A.; Bhatti, R. H. The Theory and Empirics of Exchange Rates. Singapore, World Scientific Publishing Co., 2010.

[33] Moosa, I., Burns., K., 2013, The monetary model of exchange rate is better than the random walk out-of-sample forecasting. *Applied Economics Letters*, Vol. 20, Issue 14, pp. 1293-1297.

[34] Rasekhi, S., Rostamzadeh, M. (2011). Fundamental Modeling Exchange Rate using Genetic Algorithm: A Case Study of European Countries. *Journal of Economics & Behavioral Studies*, Vol. 3, Issue 6352-359.

[35] Rime, D., et. al. (2007). Exchange Rate Forecasting, Order Flow and Macroeconomic Information. *Journal of International Economics*, Vol. 80, Issue 1, pp. 3-39.

[36] Rogoff, K. (2002). Dornbusch's Overshooting Model After Twenty-Five Years. *IMF Working Paper*, Vol. 39, Issue 2, pp. 1-40.

[37] Rogoff, K. (1999). Monetary Models of Dollar/Yen/Euro Nominal Exchange Rates: Dead or Undead? *The Economic Journal*, Vol. 109, Issue 459, pp. 655-659.

[38] Sager, M., Taylor, M.P. (2008). Commercially Available Order Flow Data and Exchange Rate Movements: Caveat Emptor. *Journal of Money, Credit and Banking*, Vol. 40, Issue 4, pp. 583-625.

[39] Sarno, L. (2005). Viewpoint: Towards a solution to the puzzles in exchange rate economics: where do we stand? *Canadian Journal of Economics*, Vol. 38, Issue 3, pp. 673-708.

[40] Sarno, L., Taylor, M. The economics of exchange rates. New York, Cambridge University Press, 2002.

[41] Simpson, M.W., Grossman, A. (2010). Can a Relative Purchasing Power Parity-Based Model Outperform a Random Walk in Forecasting Short-Term Exchange Rates? *International Journal of Finance and Economics*, Vol. 16, Issue 4, pp. 375-392.

[42] Sorin, V. (2008). Chaos Models in Economics. *Economic Science Series*, Vol. 17, Issue 2, pp. 959-964.

[43] Taylor, A. M., Taylor, M. P. (2004). The Purchasing Power Parity Debate. *Journal of Economic Perspectives*, Vol. 18, Issue 4, pp. 135-158.

[44] Tu, W. (2009). An Overview Study on Dornbusch Overshooting Hypothesis. *International Journal of Economics and Finance*, Vol. 1, Issue 1, pp. 110-116.

[45] Vitale, P. (2007). A guided tour of the market microstructure approach to exchange rate determination. *Journal of Economic Surveys*, Vol. 21, Issue 5, pp. 903-934.

[46] Wilson, I. (2009). The Monetary Approach to Exchange Rates: A Brief Review and Empirical Investigation of Debt, Deficit, and Debt Management: Evidence from the United States. *The Journal of Business Industry*, Vol. 8, Issue 1, pp. 83-99.

[47] Yong, C., Ling, O. W. (2000). PPP and the Monetary Model of Exchange-Rate Determination: The Case of Singapore. Pp. 131-150.