An Econometric Approach to the Turkish Economy -A Research in the Mundell-Fleming Model Framework[1]

Türkiye Ekonomisi için Ekonometrik Bir Model Çalışması- Mundell-Fleming Modeli Çerçevesinde Bir İnceleme

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Abstract

In economic theory there is some general belief that General Equilibrium model is based on stronger theoretical pillars, whereas Keynesian models are better in empirical predictions especially for the developing countries. The MFM has shaped analytical thinking becoming the basic template during the 1960-70s as an extension of the IS-LM analysis to the open economy. Recent research on the model highly concentrates on the Trilemma Hypothesis which suggests that it is not possible to have all three of the stable exchange rate, monetary independence and financial integration policy choices together. Studies on world economies from 1820 on provide strong evidence supporting the theory. Previously extended form of the MFM has been estimated in Baştav (2006) in seven equations by the Johansen test for 1990-2002. There are goods, money, foreign exchange, labor markets with demand-supply equations as well as wage indexation and price level specifications on the supply side. The model allows for price and wage adjustment and there are altogether four price variables with the interest and exchange rates. Present study is an update of the model for the years 2003-2021 to test its validity in the new period. Results are quite explanatory for 1990s and 2000s both, with particular deviations in behavioral traits and coefficients naturally stemming from differences in policy choice during the two periods in question.

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[1] The paper is an extension of the theoretical and empirical framework of my PhD. thesis Baştav (2006), in Gazi University, Social Sciences Institute, Department of Economics titled "An Econometric Model of the Turkish Economy - A Research in the Framework of Monetary Sector and the Balance of Payments" to the current time period of 2003-2021, by estimation of the Mundell-Fleming model.
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Öz

Ekonomik teoride Genel Denge modelinin daha güçlü teorik temellere dayandığına, Keynesyen modellerin ise özellikle gelişmekte olan ülkeler için daha anlamlı sonuçlar verdiğine ilişkin yaygın bir kanı bulunmaktadır. Mundel-Fleming Modeli (MFM) IS-LM modelinin açık ekonomiye bir uzantısı olarak 1960-70'lerde analitik düşünceyi yönlendirerek temel şablon oluşturma anlamında öne çıkmıştır. Model üzerindeki son ampirik çalışmalar *istikrarlı döviz kuru, parasal bağımsızlık ile finansal serbestinin* üçünün birarada sağlanamayacağına ilişkin Trilemma Hipotezi üzerinde yoğunlaşmaktadır. Dünya ülkeleri üzerinde 1820'den bu yana yapılan araştırmalar hipotezin geçerliği hakkında güçlü kanıtlar sağlamaktadır. Bundan önce Baştav (2006)'da Türkiye ekonomisi için yedi denklemden oluşan genişletilmiş MFM, Johansen koentegrasyon yöntemiyle 1990-2002 dönemi için tahmin edilmiştir. Modelde *mal, para, döviz, işgücü* olmak üzere dört piyasa vardır ve arz-talep denklemleri ile arz tarafında ücret endekslemesi ve fiyat belirleme denklemleri yeralmaktadır. Genişletilmiş hali ile modelde *fiyat ve ücret esnekliğine* izin verilmekte, *faiz oranı* ve *döviz kuru* ile birlikte toplam dört fiyat değişkeni bulunmaktadır.

Jel Codes: *F41, E12, C51*
Keywords: *Açık Ekonomi Makroekonomik Teori, Mundell-Fleming Modeli, Trilemma Hipotezi, Johansen Koentegrasyon Testi, Ekonometrik Modelleme*

1. Introduction

Following collapse of the Bretton Woods system after 1973 world economies increasingly came to adopt liberal regimes both in terms of trade and capital account transactions. During the time flexible exchange rates were also preferred over fixed regimes with the expectations that they would better reflect developments in the real economy and relative price movements. Along with adoption of flexible rates capital account regimes were also liberated in four consecutive waves in 1968-72, 1973-74, 1979-80 and 1989-90.

Main theme of open economy models is balance of payments (BOP) accounts. Developments in the post 1973 period have increased importance of open economy theories and of the BOP in macroeconomic balance. On the Keynesian front these models have evolved as "elasticities approach", "Keynesian multiplier approach", "income-expenditures approach", "Cambridge school". Through the 1950-60s "economic policy approach" has evolved by the complementary works of Meade, Alexander, Tinbergen, Nurkse, Johnson, Corden, Mundell, Cooper into the infamous Keynesian Mundell- Fleming Model (MFM) (Baştav, 2006). There are different internal and external balance outcomes in the MFM depending on the *exchange rate regime adopted* and *degree of capital mobility*. Unlike the classical models, MFM considers for a wider set of expenditure shifting policies like depreciation, tariffs, subsidies etc. in addition to the monetary and fiscal policies (Argy, 1994).

On the right-wing monetary theory built on classical assumptions has emphasized the role of money in adjustment mechanisms making up for deficiencies of the early Keynesian models which had solely relied on real variables. However monetary approach has been criticized for overstating the role of money and ignoring the role of real variables. Also, assumption of full employment and concentration solely on the long run is not realistic especially for the

developing countries. What is more, these models totally ignore effects and importance of the fiscal policy and budget constraints.

The MFM model has shaped analytical thinking in the post-war period becoming the basic template as an extension of the Hicks-Hansen IS-LM framework to the open economy during the 1960-70s. Recent research on the model highly concentrates on the Trilemma Hypothesis developed by Mundel (1963) and Fleming (1962) in their independent studies which suggests that it is not possible to have all three of the *stable exchange rate, monetary independence and financial integration* choices together. Studies are quite comprehensive covering the developed (DC), developing (LDC) and emerging markets (EM) and the time period from 1820 to 2010s (Section 3); and results are strongly supportive of the Hypothesis.

MFM has been studied in my PhD thesis dated 2006 where the extended form equations have empirically been estimated for the Turkish economy with the Johansen-Juselius cointegration model for the period spanning 1990m01 - 2002m12. Results are quite explanatory of the structural relations and adjustment mechanisms of the economy as in Table 5. Fiscal policy is effective in raising real demand in the goods market and there is stable money demand equation with unit income elasticity, with a high interest rate elasticity of -1.25. Unit price elasticity implies that there is no money illusion in the money markets as in equation two Table 5. The monetary reaction function is meaningful telling that money stock rises/falls in response to the level of the exchange rate in the markets and that there is dirty float regime. On the other hand, BOP equations do not make sense and do not give a glimpse of foreign exchange markets, possibly due to the volatile nature of the flows. Labor markets have high theoretical compliance, where supply has -0.30 real wage elasticity and wages are indexed to inflation with higher than unit coefficient. Last but not the least general price level is some weighted average of domestic and foreign goods prices, with the more dominant effect coming from domestic goods.

In this paper same model of the seven MFM equations are tested against the new time period of 2003m01 – 2021m03 for Turkey. Turkish economy is small and open with the export led growth model adopted from 1980s on. The study starts with a brief theoretical presentation of the MFM in section 2. Previous empirical findings of the MF theory are discussed in section 3. Section 4.1 presents seven equations of the extended model describing structural relations between the variables, and 4.2 follows with data analysis and unit root tests. Estimation results are evaluated in section 4.3.1, followed by 4.3.2 where findings are compared with those of the previous period. Final section is Conclusions.

Importance of this paper is testing validity of the Keynesian MFM framework for Turkey during the first two decades of the new millennium. Therefore, the model estimation provides empirical evidence for supporting or refuting the economic theory. Failure of monetary models in matching real-life facts have raised attention for Keynesian templates**.** Results of the MFM are quite explanatory for Turkey both for 1990s and 2000s in my PhD. thesis and in this paper with particular deviations in behavioral traits and coefficients, naturally stemming from differences in policy choice during the two periods in question.

2. Theoretical Background

Inspired by the works of Tinbergen, Meade has tried to merge Keynesian theory with general equilibrium in his study dated 1952. Meade has in return affected Alexander who has formed foundations of the income/expenditures approach. Through the 1950-1960s, the complementary works of Tinbergen, Meade, Alexander, Nurkse, Johnson, Corden, Mundell, Cooper on the "economic policy approach" of the Keynesian line have accumulated, leading the way to the (MFM) (or economic policy approach) which considers *the internal and external balance in the economy yielding* different policy outcomes depending on the exchange rate regime adopted (Baştav, 2006). Internal balance refers to maintaining *full employment and price stability* whereas external balance is about maintaining balance of payments.

The model assumes that maintaining "full employment" equilibrium and price stability in *goods market* and external equilibrium by the *balance of payments* works differently under *fixed [3] and flexible exchange rate* regimes. Although most countries have passed on to flexible rates in the post 1973 period there are stil others with the fixed rates like EU, China, Hong Kong, Bulgaria, Bosnia-Herzegovina. While the self-clearing classical equilibrium models only consider monetary and fiscal policies' effects on the adjustment mechanism; Mundell-Fleming model considers effects of expenditure shifting policies like devaluation, customs etc., in addition to the demand management policies. For each exchange rate regime consequences of the economic policy measures are examined for the three alternative cases of: *no capital mobility, limited capital mobility and perfect capital mobility*.

MFM describes the equilibrium process for a *small open economy*, in the *short run* for a time period of one year. The model is basicly an extension of the IS-LM Hicks-Hansen framework to the open economy in Keynesian spirit, which is accepted as a benchmark model for the open economy models in modern macroeconomics. In its very *basic form,* the model assumes prices and wages are fixed where aggregate supply is infinitely elastic and level of output is determined by demand. There are *goods, money, as well as foreign exchange markets* and balance of payments is comprised of current and capital accounts. Difference between the local and foreign interest rates is crucial, as well as the level of capital mobility which will determine the total net capital in/outflows of the country.

Following criticisms around MFM about fixed prices, the assumption was released and an extended form of the model was formulated to save it from being short sighted and temporary, for enabling conduct of more realistic economic policy analysis. Its relations have been revised and renewed with real exchange rate and money demand modifications and more importantly with addition of the *labor market relations* on the supply side. In its new form the model is comprised of four markets: *goods, money, foreign exchange and labor* with *wages and prices (domestic and general)* to be determined therein, in addition to the *interest and exchange rates* (Section 4.1).

MFM is simple, easily understood and explanatory having strongly proven to estimate correctly the consequences of one-year economic policy measures. Although strong in its empirical predictions the model has received criticisms on the theoretical platform that *small country assumption* is not realistic but rather restricting. Second important defect is

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[3] Fixed rate with sterilization, fixed rate without sterilization considered alternatively.

assumption of a *single composite good*, whereas other models differentiate between tradable and non-tradables or three composite goods: imports, exports and goods not subject to trade.

Expectations of foreign exchange and price level in financial markets are not considered which is subject of third criticism. Economic balance is achieved through the *comparative statics,* where a disturbance occurs pushing the economy out of equilibrium, after which a dynamic process reestablishes a new one. The economic equilibrium is **steady state** but procedure between the two points of equilibrium is out of concern of the model no regard for expectations which is considered important neglect in an open economy model.

The model is not stock but **flow balance model** in which *current account and budget balance are not maintained*, where economic units go on acquiring new stocks. Silence of the model as to how stocks are acquired and about the relation of stock formation and wealth, and the aggregate demand and wealth relation are subject to criticism. The only asset in money markets is money stock, and although existence of domestic and foreign bonds are implicity accepted, there is hardly any mention about demand for financial assets and their returns.

We do not describe all the possible theoretical outcomes of the MFM below, but rather give brief overview of the policy consequences in an economy with *flexible rates and perfect capital mobility* because of its relevance to the Turkish economy.

Tablo 1: Economic Policy Approach

1950-1960s → Keynesian Open economy Macroeconomic Model (IS/LM framework)
Goods Money   markets →   *maintain internal, external equilibrium* Fx Labor   Internal eqb   →   full employment y, stable p External eqb   →   maintain BOP For fixed and flexible rates, examines all of monetary and fiscal policy results under zero, limited, high and perfect capital mobility.

Criticisms → Flow model but stock formation and its relation to wealth is ignored;
 	
           Financial asset demands, and their yields not analyzed;
 	
            Expectations not considered;
 	
            One single composite good only.

2. 1. Mundell-Fleming Model with Perfect Capital Mobility and Flexible Exchange Rates

2. 1. 1. Monetary Policy

Whenever there is monetary expansion real money balances will rise, shifting the LM curve right, bringing higher income and fall in interest rates. At the new outcome goods and money markets are in equilibrium by the IS-LM schedule, however, fall of the domestic interest rate below world levels will trigger capital outflows leading to depreciation of the local currency. In the next round depreciation leads to a rise in net exports raising the level of income, shifting the IS curve further to the right to intersect with the LM curve at the initial world level of interest.[4]

Unlike the fixed exchange rate system, the outcome is *higher level of income* and *improvement in the current account*. The policy choice is at the discretion of the central bank who can apply monetary policy, without having to reverse the money stock (without need to provide for fixed rates). There is finally rise in money stock as well as (probably) depreciating local currency, with fixed prices.

2. 1. 2. Fiscal Policy

An expansionary fiscal policy will initially raise income and interest rates shifting the IS to the right. The rising interest rates above world level will trigger capital inflows, bringing appreciation, which in turn will deteriorate the trade balance and the current account. The initial increase in the level of output is wiped off by the fall in net exports. Fiscal expansion is not expected to have considerable favourable effect on the output and employment of the economy; *rather leading to appreciation and demand tilted towards foreign goods.*

The same outcome is observed with the increase for exports of the country at the initial stage. With an increase in total income, domestic interest rates rise to get the money market to equilibrium at the fixed level of money stock, which in turn trigger capital inflows, appreciating the local currency. Appreciation will raise imports, shrinking net exports, pulling total demand back to its initial level where interest rate hits the world level with no further capital inflows. At the end of the day, there is *appreciated currency with higher demand for imports eroding the initial increase in income*.

3. Previous Work on the Theory

Table 2: Empirical Research on Mundell-Fleming Model

Author(s)	Countries and Period	Method	Results
Fischer (2001)	103 countries (1973-2000)	Statistical Classifications	Trilemma Hypothesis supported. Hard pegs or float preferred; intermediate regimes are prone to crises.
Obstfeld and Taylor (2002)	DC/LDC (1820-2000)	Statistical Analysis-Regression-AR1	International capital mobility has evolved within framework of policy Trilemma

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[4] The exact outcome of the new income, interest rates depend on the exchange rate elasticities of exports, imports of course.

			constraining an open economy's choice of monetary regime.
Obstfeld et.al. (2005)	More than 100 countries (1870-2000)	Linear Regression	Trilemma trade-offs for international interest rates are largely borne out by history.
Aizenman et.al. (2008,2013)	179 countries (1970-2006)	Trilemma Indeces - Linear Regression	1) LDC's: managed float+IR; medium monetary indep; financial integration. 2) DC's: high fx stability; financial openness; low monetary indep. 3) Linear tradeoff exists between Trilemma choices.
Aizenman and Ito (2011)	DC's (1970-2010)	Trilemma Indeces - Linear Regression	EM's: managed float, high IR, intermediate levels of monetary indep and financial integration. IR accumulation brings stability.
Aizenman and Sengupta (2011)	India,China (1990-2011)	Trilemma Indeces - Linear Regression	China unique: fx stability predominant, no significant role for financial integration in Trilemma regression. India managed float, high IR, and intermediate levels of monetary indep and financial integration.
Hutchison et. al. (2012)	India (1996-2009)	Trilemma Indeces - Linear Regression	Tradeoff exists between Trilemma choices
Popper et.al. (2013)	177 countries (1970-2010)	GEE Estimation	Financial openness and fixed fx is the most stable Trilemma policy.
Ito and Kawai (2014)	78 countries (1970-2010)	SUR Estimation	ST deviations from Trilemma must be corrected, or else comes financial crisis.
Klein and Shambaugh(2015)	DC/LDC's (1973-2011)	Linear Regression	Capital controls or float gives monet indep. Partial capital controls no good. Some fx flexibility allows for monet autonomy, especially in EM and LDC's
Steiner (2015)	DC/LDC's (1970-2010)	Portfolio Balance Panel Model	Fx interventions effective in relaxing the Trilemma. Weighted sum of the three Trilemma goals increases in the degree of fx market intervention.
Jabiyev et.al. (2019)	Azerbaijan (1996-2015)	OLS	Support Trilemma Hypothesis
Studies on Turkey			
Civcir (1996)	(1960-1988)	Econometric Estimation	Short-term monetary,long-term Keynesian model valid for Turkey
Baştav (2006)	(1990-2002)	Econometric Estimation	MFM valid for Turkey, Dornbusch model not relevant.

Çörtük and Singh (2013)	(1998-2010)	Trilemma Indeces - Linear Regression	Financial openness, monet indep rise vs less fx stability alternate...
Çörtük et.al. (2012)	(2002-2012)	Trilemma Indeces - Regression- Kalman Filter	Linear trade-off exists between Trilemma choices. IR, required reserves mitigate Trilemma trade-off
Yalçıner et. al. (2017)	(2003-2017)	Linear Regression	Fear of float, intermediary fx regime is preferred, refutes Fischer (2001)
Tümtürk (2019)	(1970-2014)	Trilemma Indeces - Linear Regression	Trilemma constraint is binding, capital mobility and monetary autonomy policy combination between 2001 and 2014
Bozma and Künü (2020)	(1970-2015)	ARDL Bound Test	Fx stability and monet indep (capital controls) or financial openness and monet indep (flexible fx) needed for growth
Koç (2020)	(2011-2020)	ARDL Bound Test	Trilemma Hypothesis verified.

IR: international reserves.

Although there is rare work on full-fledged MFM estimation, there is much discussion and empirical research on its theoretical framework and assumptions. Many researchers have tested validity of the model especially in terms of Trilemma Hypothesis (impossible trinity) for different countries, during different time periods. One important full model estimation is realized in Civcir (1996), which econometrically estimates two alternative models, one monetary and the other Keynesian (MFM) and compares results of the two vis a vis adjustment mechanisms of the economy. In the similar study of my PhD. thesis Baştav (2006) I have estimated same models for Turkey for the high inflation period of the 1990s. Other than the two, studies on Turkey rather test validity of the Trilemma Hypothesis with index computations and linear regression. No matter coming up with different policy recommendations, studies provide strong evidence in favour of the Trilemma Hypothesis.

MFM studies about the world countries are many, the most relevant and recent of which are above. In Obstfeld et.al. there is comprehensive testing of the Trilemma Hypothesis for a wide range of countries developed, emerging as well as developing, which provide us with strong evidence of presence of the Trilemma over the century from 1820 on. Aizenman et.al. also provide long-term test for effectiveness of the Trilemma for the intensified capital flows period of post 1970 up until 2010s. Other researchers have also concentrated on post 1970 and/or post 1990s with comprehensive studies for a large number of countries. The Hypothesis is verified and proven in all the studies for each and every country almost, with the unique exception of China where there is no significant role for financial integration in the Trilemma regression.

4. Model and the Data

4. 1. Mundell Fleming Model with Wages and Prices

The extended MFM, with wages and prices included follows in the equations (4.1 - 4.7) below representing the *goods, money, foreign exchange and labor markets*. Foreign income and foreign interest rates are assumed constant and all variables are in logarithms except for the interest rate (r) and overall balance of payments (B/X).

The model is estimated for Turkey for the period 2003m01 - 2021m03, by **Johansen-Juselius cointegration method**, with Eviews 12 sofware. Turkey is a small open economy with *dirty float regime* under *perfect capital mobility*. Since variables are stationary of first order I(1), Johansen is the appropriate estimation method which will reveal structural relations between the dependent and independent variables, while testing for the long-run equilibrium relation between variables in each equation. The BOP equation is exceptionally estimated by OLS, for its variables are level stationary I(0). Results provide us with rather good fit of variables to the Keynesian assumptions of the model, which are quite explanatory for adjustment mechanisms of the Turkish economy.

goods market:

$$\lg_d = \alpha_1 (lfx - ldef) + \alpha_3 \, lgov - \alpha_4 \, r \qquad (4.1)$$

money market:

$$lm2_d = ldef + \alpha_5 \, lg - \alpha_{10} \, r \qquad (4.2)$$

$$lm2_s = lex - \Pi_1 (lfx - lfxlr) \qquad (4.3)$$

or equivalently:

$$lme = -\Pi_1 (lfx - lfxlr) \qquad (4.3.1)$$

foreign exchange market:

$$B / X = \alpha_{13} (lfx - ldef) - lg + \alpha_{14} \, r \qquad (4.4)$$

$$\alpha_{13} > \alpha_1$$

labor market:

$$\lg_s = -\alpha_9 (lw - ldef) \qquad (4.5)$$

$$lw = \Pi_2 \, lcpi \qquad (4.6)$$

$$lcpi = \alpha_{15} \, ldef + (1 - \alpha_{15}) \, lfx \qquad (4.7)$$

$$\lg_s = \alpha_9 (1 - \Pi_2 \, \alpha_{15}) \, ldef - \alpha_9 \, \Pi_2 (1 - \alpha_{15}) \, lfx \qquad (4.8)$$

$$\lg_s = -\alpha_9 (1 - \alpha_{15}) (lfx - ldef), \quad \text{for } \Pi_2 = 1 \qquad (4.9)$$

from (4.5) and (4.9) we get:

$$(lw - ldef) = (1 - \alpha_{15}) (lfx - ldef) \qquad (4.10)$$

equilibrium conditions:

lg $_d$ = lg $_s$

lm2 $_d$ = lm2 $_s$

Variables: (All variables are in logarithms except for r, B/X)

lg   real domestic output

lg $_d$ real aggregate demand

lg $_s$ real aggregate supply

r   interest rate

ldef   domestic prices

lfx   foreign exchange (TL value of one unit of foreign currency)

lgov   real government expenditure (fiscal policy)

lcpi   consumer price index (general price level)

lw   wage rate

lm2   money stock

lex   domestic credits (exogenous money and/or monetary policy instrument)

lme   endogenous money stock

B / X   BOP/total exports

lfxlr   target exchange rate

lfxr   real exchange rate (lfx – ldef)

Π_1 is foreign exchange elasticity, α_{14} degree of capital mobility, Π_2 is wage indexation. The model is presented by the real variables mostly. Real exchange rate is deflated by GDP deflator (home goods prices).

In the **first** equation representing the goods market, **real demand** (lg) is positive function of real exchange rate (lfx-ldef) and real government expenditure (lgov) and negative function of the rate of interest, by theory. Variables except the interest rate are in logarithms. Exchange rate is calculated as a basket average of TL equivalent of US$ and euro rates.

Second equation (4.2) is the **classical money demand** function. Here real money balances are positive function of real income (lg) and negative function of domestic rate of interest (r). Interest rate is taken as up to three-month term deposits rate which represents market rates also containing the risk premium. *Third* equation is the monetary reaction function (4.3) where **endogenous money supply** (lme) is function of the difference between exchange rate and target exchange rate (lfx - lfxlr). **Endogenous money** (lme) *in equation three* is obtained by deducting exogenous component of money, (total domestic credits) from the money supply. Accordingly, as the exchange rate is below target monetary authority will raise money supply; if above, will contract the money in circulation. Target exchange rate is computed under the

assumption that the exchange rate will rise (fall) by amount of the rise (fall) in the money supply, M2.[5] The Π_1 coefficient is measure of the exchange rate flexibility in the model.[6]

The **overall balance of payments** (4.4) is expressed as ratio of total exports. The BOP is composed of a *current account* and a *capital account*. Current account is positive function of the real exchange rate, and negative function of real income. Capital account is in turn determined by the interest rate which provokes inflows when interest rate rises and outlows during a fall. The foreign income and interest rate are assumed constant and are not included in the model. α_{14} is the measure of capital mobility in the economy.

There are three supply side (4.5-4.7) equations representing labor markets. In equation (4.5) **real supply** is negative function of the real wage rate (lw - ldef). Equation (4.6) is about wage indexation indicating the extent to which wages are indexed to the general price level. If $\Pi_2 = 1$ there is perfect indexation of wages to prices. General price level of the economy is expressed by the consumer price index (lcpi). In equation (4.7) general price level is a weighted average of the price of home goods (ldef) and of the imported goods (lfx). Home goods price index is taken as the GDP deflator series. Imported goods prices are essentially foreign price of imports plus the exchange rate, however since foreign prices are assumed constant, they are simply expressed as function of the foreign exchange rate (lfx).

From (4.5) - (4.7) by substitution we reach the supply equation (4.8) of the economy above. With $\Pi_2 = 1$, there is perfect indexation of wages to prices and (4.8) will reduce to (4.9).

Equation (4.9) tells us about the relation between real exchange rate and production. It is evident that output will only change by the real exchange rate when there is perfect indexation. Whenever local currency depreciates level of output will decline, whenever there is appreciation, output will rise. We also know from equation (4.5) above that, output will only fall when there is a fall in real wages. The relation is easily followed in equation (4.10) where we have substituted (4.5) in (4.9).

$$(\text{lw}_t - \text{ldef}_t) = (1 - \alpha_{15}) (\text{lfx}_t - \text{ldef}_t) \qquad\qquad (4.10)$$

In (4.10) with a depreciation (appreciation) of the local currency, real wages show parallel rise (fall) and output declines (increases) in production markets.

4. 2. Data and Unit Root Tests

Nominal and 2009 based real GDP series (lg), real government expenditure (lgov), CPI nominal wage rate (lwn) are obtained from State Institute of Statistics Database (TÜİK), whereas upto three month interest rates (r), exchange rates (lfx), money stock (lm2), domestic credits (lex), overall balance of payments over exports (B/X) are from Central Bank of Turkey (TCMB) EVDS

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[5] Target exchange rate(fxlr) is computed by adding the percentage rise in money supply M2 "p" to previous term exchange rate: fx(-1)+p*fx(-1), where p=log(M2/M2(-1)).

[6] $\Pi_1 = 0 \rightarrow$ fixed exchange rate regime with flexible or perfect sterilization.

$\Pi_1 \rightarrow \infty \rightarrow$ fixed exchange rate regime where money supply is used to reach target exchange rate.

$0 < \Pi_1 < \infty \rightarrow$ managed float regime (intermediary regime) where Π_1 is the degree to which monetary policy is used to reach foreign exchange target.

database, in monthly frequency and corrected for seasonality, for the period spanning 2003m01 – 2021m03.

GDP, real government expenditure and wage rate series are intrapolated from quarterly to monthly frequency.[7] The domestic goods price index is obtained by dividing the 2009 based real GDP by the nominal series. Wage rate is calculated by dividing the total income received by employees by the number of people employed. Exchange rate is taken as a basket time series: average of the US$ and euro rates, in terms of TL as explained above.

All variables are in logarithms except the interest rate (r) and BOP (B/X).

Table 3: Unit Root Test Results

Variables	Test Statistic Values					
	ADF		PP		KPSS	
	I(0)	I(1)	I(0)	I(1)	I(0)	I(1)
I (0) Variables						
(r) interest rate	**-5.37**		**-4.67**		0.75	**0.51**[1]
(B/X) BOP/exports	**-6.22**		**-13.32**		0.94	**0.50**[1]
I (1) Variables (in logarithms)						
($lg_{d,s}$) real output (demand,supply)	-0.67	**-4.55**	-1.31	**-7.53**	1.91	**0.15**
(lfx) exchange rate	2.16	**-11.33**	2.11	**-9.92**	1.70	**0.65**
(lfxr) real exchange rate	-1.82	**-11.93**	-1.92	**-10.33**	0.52	**0.55**[1]
(lgov) real gov expend	-0.68	**-6.36**	-1.12	**-9.72**	1.91	**0.11**
(lm2) money stock	-2.10	**-15.21**	-2.16	**-15.21**	1.84	**0.43**
(lme) endog money stock [2]	-3.02	**-15.65**	-3.02	**-15.62**	0.34[2]	**0.23**[2]
(lfxlr) target exch rate	1.85	**-20.03**	2.95	**-20.30**	1.68	**0.73**[1]
(lw) wage rate	-0.83	**-5.26**	-1.19	**-6.28**	1.83	**0.25**
(lcpi) cons price index	2.89	**-8.71**	2.41	**-10.81**	1.90	**0.53**[1]
(ldef) domestic prices	1.81	**-3.22**	2.78	**-6.14**	1.90	**0.68**[1]

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[7] Results of the model were essentially same when equations were alternatively estimated with the monthly industrial production index series instead of GDP.

Schwarz Info criterion is used to choose the lag length of the ADF test whereas Bartlett Kernal spectral estimation method with Newey-West bandwidth is used for the PP test. KPSS tests null hypothesis of stationarity. Tests are at 5% level of significance. Bold test statistics signify stationarity.[1] Stationary at 1% level.[2] Test with trend and intercept.

4. 3. Estimation Results:

4.3.1. Estimation Results for 2003 – 2021

Table 4: Estimation Results of the Mundell-Fleming Model [1] [2] [4]

The goods market   lg = **2.80 lfxr** + 0.58 lgov - **0.15 r**   **(0.94)**   (0.68)   (0.03)   *LR test gives 1 cointegrating equation.*

The money market
 lm2 = **1.67 ldef** + **0.44 lg** − **0.01 r**
     (0.07)   **(0.12)**   **(0.002)**
 LR test gives 2 cointegrating equations.
 	
 lm1 = **-0.33 @trd** + 15,20 ldef + **47.56 lg** - **0.95 r**
     (0.15)   (14.84)   **(16.48)**   (0.15)
 LR test gives 1 cointegrating equation.
 	
 lme **= - 409 lfx + 409 lfxr**
     (24.82)   **(24.77)**
 LR test gives 2 cointegrating equations.
 The foreign exchange market
 B/X = **2.90 d(lfxr)** − **3.99 d(lg)** − 0.002 r + 0.07dummy
     (0.50)   **(2.03)**   (0.002)   (0.03)
 R^2: 0.18 $\bar{R}^2$: 0.17   DW: 1.81

The labor market
 lg = **-0.90 lw** + **0.90 ldef** + 0.01 @trend [3]
     (0.24)   **(0.53)**   (0.003)
 LR test gives 2 cointegrating equations.
 	
 lw = **1.03 lcpi**
     (0,07)
 LR test gives 2 cointegrating equations.
 	
 lcpi = 0.50 + **0.89 ldef** + **0.16 lfx**
     (0.26)   **(0.06)**   **(0.06)**
 LR test gives 2 cointegrating equations.

[1] Foreign exchange market equation is estimated with OLS. [2] Bold variables are significant at 5 percent level with the t-test and economically meaningful. [3] Home goods prices (ldef) is significant at 10 percent level. [4] Goods market total demand, labor market total supply are estimated with post 2008m11; money demand lm2 with post 2005m11; foreign exchange market equation is estimated with post 2013m04 dummy variables.

In the first equation of the goods market, **real demand** (lg) is positive function of real exchange rate (lfxr) and negative function of the interest rate (r), as per theory. One percent rise in real exchange rate will raise real income by 2.8 percent, whereas one percent rise in interest rates will bring 0.15 percent decline. Equation has been estimated by Johansen cointegration method**.** As per estimation results fiscal variable has proven statistically insignificant.

The *second and third* equations estimated in Table 4 represent the money market. As per the second equation **nominal money demand** is positive function of the domestic price level and real income whereas it is negative function of the interest rate. GDP deflator (ldef) is chosen to represent the price level in the economy in natural logarithm, whereas interest is upto three-month deposit rates. Estimation results point at 1.67 price elasticity of money which is economically meaningful, also significant. Income elasticity of money is also significant and less than unity. During the period money demand is negatively related to the interest rate as expected, which is low as -0.01 percent. During the period *interest rate* is the major policy instrument *of inflation targeting* regime, which is set to signal inflation expectations to the market; with free float (although with interventions by the Central Bank) and liberal capital flows. *Estimation results reveal cointegrating relation pointing at long-term equilibrium between the money demand and dependent variables. Cointegrating equation from Johansen test implies that exogenous shocks to the system will get variables back to equilibrium in the long run.* Although stable money demand equation for the developing countries (stable long-term relation with income and interest rates) is not usual; the equation provides us with one.

When money demand equation is estimated with M1 income variable is significant, with higher elasticity. It is not a surprise that there is higher interest elasticity of -0.95 percent.

Theoretically money stock is sum of the exogenous and endogenous components of money as in the **monetary reaction function** (money market second equation) . Exogenous component is "domestic credits" under control of the monetary authority, whereas endogenous component is function of the difference between the current and the target exchange rate. Whenever current exchange rate is below the target rate, money supply is expected to increase by money creation; whenever it is above target, money supply should decline. During the estimation domestic assets are deducted from money supply M2 and endogenous money (lme) is estimated against the current (lfx) and target exchange rates (lfxlr). Results obtained comply with the theoretical assumptions that endogenous money is negative function of the exchange rate, and positive function of target exchange rate. Exchange rate elasticity Π_1 is measured as -409 pointing at managed float, where the monetary authority intervenes at times to the exchange rate which is principally flexible. *There are two cointegrating equations from Johansen tests indicating that exogenous shocks to the system will eventually fade to get the variables back to equilibrium and that there is long-run equilibrium between the variables.*

Since **overall balance of payments** and interest rate are stationary at levels, I(0) and real exchange rate (lfxr) and (lg) are at the first level I(1), difference of the latter two variables are taken and BOP is estimated by ordinary least squares (OLS) with post 2013m04 dummy. The equation is free from serial correlation and heteroscadasticity. One percent increase of real foreign exchange growth brings 2.9 percent rise in overall BOP. Similarly, when real income growth rises one percent, BOP declines by 4.0 percent. Coefficients of the difference of

exchange rate and income are with expected signs and are significant. Results of the estimation point at importance of real income of the economy, as production is almost 70 percent dependent on imported goods, the BOP deteriorates as the growth rates soar and the economy expands. The equation also reveals relevance of the rate of increase of exchange rate in creating BOP surplus, meaning the current balance is improving with higher depreciation. Interest rate variable possesses wrong sign and is statistically insignificant. OLS results do not capture relation of the capital account with the interest rate probably due to the high volatility and rather speculative nature of the flows.[8] The BOP equations could better be determined in a dynamic model considering for the expectations and autoregressive behavior.

Estimation results of **supply equation** comply with the MFM that supply is negative function of the real wages. As independent variables are decomposed into *nominal wages* and *home goods prices*, both variables come out with economically meaningful and statistically significant coefficients. *Real wage elasticity of production is -0.90 percent and presence of cointegration by Johansen test point at existence of long-run equilibrium between wages and production.*

The second equation of the labor markets tells us that nominal wages are indexed to the price level. Results of the estimation reveal that Π_2 = 1,03 and **wages are indexed to prices** in Turkey. Coefficient of the (lcpi) of 1.03 points at almost perfect indexation, revealing the long-run wage behaviour of the economy.

In the last equation of the labor markets lcpi = α_{15} ldef + (1 - α_{15}) lfx , **general price level** cpi is the *weighted average of home goods* and *imported goods* in the economy. The equation is estimated logarithmically and results reveal that domestic goods prices are 0.89 percent explanatory of the general price level, whereas imported goods are 0.16 percent. Both coefficients are economically meaningful and statistically significant. Although exchange rate pass through is important in the inflation process in Turkey, home goods prices through the production process have dominant effect on the general price level.[9] Empirical results reveal that long run real market input-output processes, production costs etc. are more effective on prices rather than short run money market fluctuations. *Estimation results reveal long run equilibrium relation between the cpi and home goods prices and exchange rates.*

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[8] The volatility is related to the facts like domestic and international politics, geopolitical risk factors and socioeconomic environment, country indebtedness and risk premium, transactions costs, financial markets motives, trade-off between real and financial sector investments etc.

[9] Due to the high share of imported intermediary goods of course, there is implicit exchange rate effect.

4.3.2. Estimation Results for 1990 – 2002 Period

Table 5: Estimation Results of the Mundell-Fleming Model [1] [2] [4]

The goods market
lg = -0.52 – 0.16 lfxr + **0.30 lgov** $_+$ 0.35 r
(0.12)   **(0.02)**   (0.07)
LR test gives 4 cointegrating equatios.
The money market
lm2 = **1.07 ldef + 1.04 lg − 1.25 r**
(0.01)   **(0.09)**   **(0.35)**
LR test gives 2 cointegrating equations.
lme **= - 17.39 lfx + 17.30 lfxr**
(6.10)   **(6.10)**
LR test gives 3 cointegrating equations.
The foreign exchange market
ca = 337.47 – 10.34 fxr **– 1,027.18 g** + 1.04 ar(1) - 0.12 ar(2) - 0.33 ar(3)
(234.77) (16.53) **(513.62)** (0.09)   (0.13)   (0.10)
R^2 : 0.51 $\overline{R^2}$: 0.49   DW: 1.83   F: 30.55
cap = -10.47 r + 51.25 fxr (+1) + 0.20 ar(1) + 0.27 ar(3) - 0.23 ar(6)
(4.96)   (32.81)   (0.07)   (0.08)   (0.08)
R^2 : 0.23 $\overline{R^2}$: 0.21   DW: 1.93   F: 10.71
The labor market
lg = **-0.30 lw + 0.30 ldef**
(0.02)   **(0.02)**
LR test gives 2 cointegrating equations.
lw = **1.27 lcpi**
(0,09)
LR test gives 1 cointegrating equation.
lcpi = -0.37 + **0.88 ldef + 0.15 lfx**
(0.25) **(0.12)**   **(0.11)**
LR test gives 3 cointegrating equations.

[1] Foreign exchange market equation is estimated with OLS. [2] Bold variables are significant at 5 percent level with the t-test and economically meaningful .

The MFM has proven quite explanatory of the basic structural relations as well as adjustment mechanisms of the Turkish economy both for 1990-2002 and 2003–2021. Below follows a comparison of its findings with those previously obtained in the PhD. Thesis Baştav (2006).

Results of the **real demand** equation are totally different from that of the 1990s that in the previous term demand has only responded to fiscal policy with 0.30 elasticity. This is juxta opposite in the new term with the **exchange and interest rate effective**, whereas real government expenditures are insignificant. Currently there is Keynesian monetary transmission mechanism where interest elasticity of money demand is low, but income rises

with the fall in interest rates. Also, depreciation raises real demand with high elasticity by the rise in foreign demand boosting real income.

In the previous study period price elasticity of money demand is 1,07 implying absence of money illusion. The decade has also incurred higher than unit interest elasticity of 1.25, considering for the monetary policy which has offered high positive real interest in response to high inflation. During the 1990s interest rates have floated freely, with liberal capital flows where money stock has also adjusted to fluctuations of the exchange rate. High real interest rates have resulted in switching from money to other financial assets when interest rises and in high money demand when interest falls. Although effective in financial markets, interest rate has no significance in demand equation 4.1, and there is no monetary transmission to affect real income. On the other hand, fiscal policy is effective during the 1990s.

There is ***stable money demand equation*** in both sub-periods with long-term relation between the variables, however high interest elasticity of the previous term with -1.25 has fallen to -0.01 (When estimated with M1 the current period interest elasticity well *rises to -0.95* percent). Also, the income elasticity of money has fallen by half to 0.44 in contrast to higher price elasticity of money. Money demand responds to the price level rather than income in the financial markets recently.

As for the **monetary reaction function** (4.3), endogenous component of the money stock rises/falls in response to the target exchange rate in the financial markets. Also, high exchange rate elasticity for both periods is indicative of the dirty float regime.

The **foreign exchange** equations in both MFM models are estimated by OLS since BOP is level stationary I(0). In the previous model BOP has been estimated in two separate equations as the *current* and *capital account*, whereas it is one single equation currently. Formerly only the *income variable* has proven meaningful in the current account, with the exchange rate insignificant; *capital account* without any meaningful relation with the *interest rate*. Similarly ultimate BOP equation has responded to the *income growth variable* and also to *the difference of the real exchange rate*, whereas *interest rate* is insignificant. Income demonstrates itself as important in the foreign accounts, complying with the stylized fact that Turkish economy grows with foreign deficit. Although the exchange rate and interest rates do not show up in BOP equation, they are highly significant in *real demand* (4.1), which in turn is significant in the foreign exchange market. Thus, there follows an indirect causality between the two variables and BOP. The highly volatile and speculative nature of the capital flows blocks the BOP relation with the interest rate during both terms.

Labor market equations are strongest part of the MFM explaining behavior on the producers' side, with wage indexation and pricing relations in the Keynesian framework. In this regard the real wage elasticity is -0.30 in the previous and -0.90 in the recent period, with the firms giving increasing response to production costs recently. Recently wage indexation existed in both models old and new with 1.27 and 1.03 (almost perfect indexation) respectively. Rise of real wages have declined during the recent period. Last but not the least general price level is determined with almost identical motives, without much structural change in the supply side with the more dominant effect coming from *domestic production costs*, with 0.88 (0.89)

percent respectively in the old and the new model, with the foreign *prices* only with 0.15 (0.16) percent weighted average effect.

5. Conclusion

In economic theory there is outspread belief that General Equilibrium model is based on stronger theoretical pillars, whereas Keynesian models are better in empirical predictions especially for developing countries. Although monetary models have been criticized for their assumptions of perfect competition, full employment, and emphasis on the long run, their practical appeal and ease of monetary data collection have made them attractive templates imposed upon the LDC's during stabilization programs of international institutions like the IMF. However, failure and crises faced during implementation of these models by the borrower countries have shaken their credibility, raising voice of the critics against them.

The MFM has evolved through the years from 1950s by collective work of economists becoming one important benchmark model explaining behavioral reactions of the open economy in the post 1973 period when capital accounts were liberated and flexible exchange rates adopted. There is bulk of empirical research on the MFM in the post 2000s, testing validity of the Trilemma Hypothesis developed by Mundel (1963) and Fleming (1962). Studies involve wide range of world countries developed, developing and emerging during 1820-2015; while those on Turkey cover the 1970-2020 period. Studies building on indices of policy choices and making use of linear regression equations (OLS, SURE, GEE etc.) provide results highly supportive of the Trilemma Hypothesis.

Findings of the MFM in this paper for 2003-2021 and in Baştav (2006) for 1990-2002 are also supportive of the Keynesian theory. Results of the two sub-periods show both parallels and differences in their equations. In the 1990s *fiscal policies* are dominant in raising demand, whereas high interest elasticity of money only acts in financial markets to switch demand between money and financial assets. On the contrary low money market interest elasticity, but significant interest coefficient in real demand equation in the 2000s (Table 4 first equation) point at endogenous money creation within the inflation targeting regime and effective interest rate transmission in the real sector, which finally raises demand. Depreciation of the TL also has expansionary effect on income by raising foreign demand.

There is stable money demand during both periods, a good result for an emerging market economy. Recently income elasticity is low with higher price elasticity in return. Monetary reaction function implies that money creation is related to the level of the exchange rate and there is managed float. BOP equation is chaotic in the previous term, but is responsive to income, exchange rate growth recently. Interest rate, capital account relation is shadowed by highly speculative nature of the flows, but *income variable is effective on BOP*.

Supply side has the strongest and most stable block of equations where real wage elasticity is higher with -0.90 in the recent period, with the firms cutting back on production upon higher costs. Structural trait of the Turkish economy "wage indexation" shows in both models with almost perfect indexation of 1.03 in the recent term. General price level is determined almost identically in both models with 0.89 percent weight from *domestic*, and 0.16 from *foreign prices*.

The Keynesian behavioral traits of Turkey are worth noting as an emerging market, which have prevailed during the 1990s as well as during the two decades of the new millennium up until 2021. One drawback of the model is its comparative static nature that does not take into account forward and backward-looking variables versus the fashionable DSGE models of the times.

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