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ABSTRACT

The thesis consists of four interrelated chapters. The first chapter, entitled “**Monetary Policy and the 2007-8 Global Financial Crisis: An Overview**” analyzes the run-up of the global financial crisis from monetary policy point of view. The main argument of the chapter is that, starting from the early 2000s the Federal Reserve System (Fed) started following loose monetary policies and provided the market with superfluous liquidity. Loose monetary policies, accompanied with easy access to home loans conducted to inflate housing bubble and expansion of subprime mortgages in the US. In the second stage, securitization of mortgages and regulators’ failure to keep pace with the financial innovation left the global financial system vulnerable to shocks. In such an environment bust of the housing bubble triggered the global financial crisis.

On the empirical side, we utilized Taylor rule due to its success in representing the Fed’s as well as other major central banks’ interest rate setting practices. We observed significant deviation of the Fed’s policy interest rates from the Taylor rule starting from early 2000. From 2002 to 2006 the Fed’s policy interest rates persistently remained below what the Taylor rule suggests. To be more concrete, we utilized cumulative sum (cusum) and Chow forecast tests and identified gradual structural break in the Fed’s policy interest rates in the run-up of the global financial crisis.

On the back of this finding, we conclude that the 2007-8 global financial crisis is another instance where prolonged loose monetary policy jeopardizes financial stability. Unconventional monetary policies during the crisis period and the Fed’s inclination to return to normal time policies as the economic situation improves are also discussed in this chapter.

The second chapter is entitled “**Monetary Policy Response to Exchange Rates: An Empirical Investigation**”. This chapter argues that while exchange rate stability concerns and its management play a significant role in practice, exchange rate arguments are often omitted out from monetary policy analysis even in open economy set ups. The omission is often justified by isomorphism between closed and open economies under certain conditions or by focusing on effects of exchange rate movements on inflation, which already entails a monetary policy response. In return, exchange rate does not enter the loss function of central banks as a separate argument; and simple interest rules, such as the Taylor rule, do not comprise exchange rate arguments even for small open economies.

In order to identify the role of exchange rate for monetary policy makers in open economies, we append exchange rate into a Taylor type of rule; and examine its effect on interest rate setting decisions of policy makers in the US, the UK, Canada, and Norway by utilizing General Method of Moments (GMM). The results suggest that for a relatively closed economy, such as the US, exchange rate movements do not lead to a significant response in the policy interest rates. Nevertheless, for open economies, both exchange rate variability and exchange rate levels are significant in the conduct of monetary policy.

Chapter three, **“Why Monetary Policy Makers Should be Concerned about Exchange Rate Stability: An Alternative Explanation”** is a sequel of the preceding chapter. The chapter argues that in spite of the policy makers’ tendency to mitigate exchange rate fluctuations, the present literature does not suggest a convincing argument in favor of exchange rate stability. Specifically, exchange rate stability is assumed to stimulate international trade, provide a more favorable environment for investment, and maximize household welfare. However, there is no strong theoretical or empirical finding that supports these arguments.

The chapter aims at contributing to the literature by suggesting an alternative explanation about the cost of exchange rate volatility based on the recent empirical findings that exchange rate volatility generates significant variability in trade flow (not in trade level, as there is no significant finding about it). We develop a two sector (producers and retailers) open economy model in order to explain how exchange rate volatility would generate some considerable cost on the real sector. For profit maximization, retailers need to adjust composition of their sales between domestic and imported goods as exchange rate fluctuates. In order to meet retailers’ demand, producers need to adjust their production or work with extra inventory, which incurs cost on producers.

The role of monetary policy makers in this environment is akin to optimal monetary policy in a New Keynesian model, where central banks respond to productivity shocks to stabilize firm markups in order to maintain price stability. In our model, by mitigating exchange rate variability, monetary policy makers eliminate the need for production and sales adjustments and let the economy to operate at natural level of employment. Hence, we conclude that an exchange rate variability concern should be inserted into central bank loss function together with inflation and output.

The last chapter of the thesis is entitled “**Macroeconomic Performance Index: A New Approach to Calculation of Economic Wellbeing**”. Since the rise of the global financial crisis there has been a revival of interest in performance indexes that measure the overall stance of the economy and the wellbeing of households. Such indexes typically consist of inflation rates, growth rates, employment rates and long term interest rates. We developed such an index by incorporating exchange rate and weighting each variable by the inverse of its variance in order to prevent the more volatile variable to dominate the index.

We refer this index macroeconomic performance index (MPI) and argue that it better explains economic stance, particularly of emerging market economies. We have calculated the index for Turkey, Poland and Brazil for the period 2001-2014. Our analysis of the index implies a non-linear structure and we analyze the behavior of the index by threshold autoregression (TAR) model. It is observed that MPI captures the economic situation, developments and responses to shocks quite successfully in each country. We have also examined the relationship of the MPI with consumer confidence index by Enders and Siklos methodology which analyzes the long term equilibrium relations between the nonlinear variables. The results indicate a long term relationship between the MPI and consumer confidence indexes in all three countries.

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CHAPTER I

I-MONETARY POLICY AND THE 2007-8 GLOBAL FINANCIAL CRISIS: AN OVERVIEW

ABSTRACT

This chapter analyzes the run up of the global financial crisis from monetary policy point of view. Utilizing Taylor rule, and cumulative sum and Chow forecast test, we show that starting from the early 2000s the Federal Reserve System (Fed) followed a loose monetary policy. We argue that prolonged loose monetary policy and easy credit policies in the financial system resulted in a housing bubble and the consequent 2007-8 global financial crisis. Unconventional monetary policies during the crisis period and the Fed's inclination to return to normal time policies as the economic situation improves are also discussed.

Jel Classification: E52, E58, G01

Keywords: Monetary Policy, Taylor Rule, Global Financial Crisis

1. Introduction

The 2007-8 global financial crisis was preceded by a two decades long tranquil period; designated as "the great moderation". Specifically, from the early 1980s the US (and to some extent other developed countries) experienced a more steady real GDP growth rate and low and stable inflation rate. In order to identify this era, for instance, Stock and Watson (2003) show that the standard deviation of growth of GDP (averaged four quarters) is one third less during 1984 to 2002 than it is during 1960 to 1983.

There are different views about what had generated the great moderation. Stock and Watson (2003) suggest that much of the drop in output and inflation volatility was due to smaller macroeconomic shocks (such as oil price shocks or productivity shocks) in this period. Davis and Kahn (2008) suggest that improved inventory control (supported by technological advances) is a major contributor to the decline in aggregate output volatility. Clarida, Gali and Gertler (2000) suggest that better monetary policies during this period resulted in reduced inflation and output volatility. The authors argue that lack of macroeconomic shocks may also

be effective in bringing about stable output growth; but better monetary policy making practices is necessary to generate steady low inflation.

While better monetary policies are considered to be a major source of the great moderation, deviation from good monetary policy making turns out to be the major driving force of the 2007-8 global financial crisis. This paper analyzes the run up of the financial crisis from monetary policy point of view. We argue that starting from the early 2000s the Federal Reserve System (Fed) started to follow loose monetary policies and provided the markets with superfluous liquidity. Excess liquidity, combined with easy credit policies, financial innovations and financial deregulation triggered the 2007-8 financial crisis.

In particular, loose monetary policy, accompanied with easy access to home loans, first conduced to inflate housing prices in the US. As inflationary pressures persisted, the Fed started increasing its policy interest rates. In return, subprime mortgages started to default and the housing bubble burst. In the meanwhile, mortgages were securitized and already held by investment banks and hedge funds throughout the world. The fact that investors or even the financial institutions themselves did not certainly know how much subprime mortgages they held in their portfolios led to mistrust and bank runs (in the form of withdrawal of repurchase (repo) agreements) in the financial markets. It was also realized that regulators could not keep pace with the financial innovation and many of the world's largest banks were caught up with dangerously low capitalization which was far from sufficient to absorb the losses that they had to undertake. In return, even some of the biggest global financial institutions either failed, bought by some other banks or taken over by government.

Despite its importance in the evolvment of the financial crisis, this paper does not analyze the financial regulation (or, deregulation) in depth. We rather intend to reveal the loose monetary policy practices in the run up of the crisis. In order to do so, we first show that, in normal times, the Taylor rule represents the Fed's (as well as many other central banks') interest rate setting practices quite well. Afterwards, using cumulative sum and Chow forecast tests, we show that the Fed diverged from the Taylor rule and moved towards a lax monetary policy starting from early 2000s. We argue that, it is the loose monetary policy that triggered the global financial crisis.

The paper is organized as follows. The following section starts with monetary policy analysis and the Taylor rule. Section 3 empirically shows the divergence from the Taylor rule and the emergence of the financial crisis. Section 4 discusses the transmission of lose monetary

policies to housing bubble. Section 5 discusses the unconventional monetary policy making during the crisis. The last section concludes.

2. Monetary Policy and the Taylor Rule

During the past few decades there has been substantial progress in monetary theory and a wide consensus on characteristics of good monetary policy making has emerged. For instance, there is an agreement on the necessity of central bank (CB) independence for good monetary policy performance. Or, for the general course of monetary policy many central banks today set price stability as their primary objective and they follow inflation targeting (IT) in order to maintain this objective. Maintaining maximum attainable level of employment is the other goal that major CBs assume. For instance, the Fed has a dual mandate of maintaining price stability and attaining maximum employment. The Bank of England's (BOE) core objective is price stability but the bank stresses that low inflation is not an end itself; according to the BOE, price stability is a precondition for achieving sustainable growth and a high level of employment.

In the theoretical background, many CBs have adopted New Keynesian (NK) models as the main frame of their medium-scale models. The NK framework incorporates imperfect competition and staggered price adjustment into macroeconomic framework where rational agents solve inter-temporal optimization problems. More specifically, supply side of the NK model is composed of monopolistically competitive firms and Calvo type price or wage stickiness. On the demand side, Euler equation determines optimal intertemporal consumption allocation and a Taylor type interest rate rule determines policy interest rates (Blanchard and Gali, 2007). Hence, monetary policy in the NK model is represented by a Taylor rule.

2.1. The Taylor Rule

In his seminal paper, Taylor (1993) shows that the Fed interest rate setting policy can be described by adjustments in its policy interest rates in response to deviation of inflation from a target level and deviation of output from its natural level. This simple rule is actually composed of the two targets (or the dual mandate) of the Fed: maximum sustainable economic growth (or employment) and price level stability. The corresponding simple monetary policy specification reads:

$$(1) \quad i_t = r + \pi_t + g_\pi \bar{\pi}_t + g_y \bar{y}_t + \varepsilon_t,$$

where, i is the policy interest rate; r is the neutral real interest rate; π is the inflation rate; $\bar{\pi}$ is the deviation of inflation from its target level; \bar{y} is deviation of output from its natural level; and ε_t is stochastic error term. Taylor (1993) assumes the neutral real interest rate to be 2%.¹ The author uses CPI as inflation measure; and he takes the average CPI over the past four quarters in order to get a smoothed inflation measure. Target inflation rate is assumed to be 2%; this is also the official inflation target the Fed set in 2012.

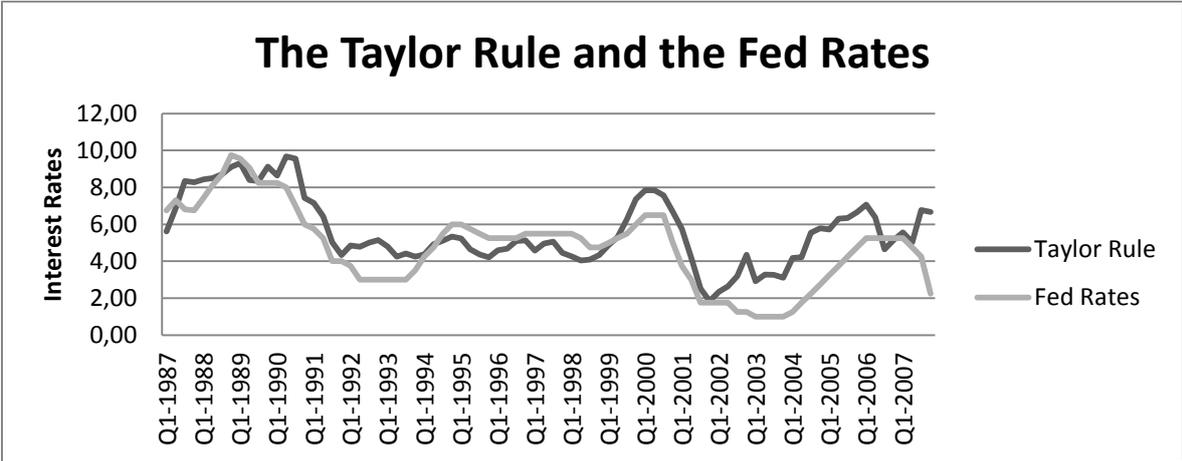
In the underlying loss function, the Fed minimizes the deviation of inflation from its target level and deviation of output from its natural level as in the following form:

$$(2) \quad \min \frac{1}{2} \gamma (\pi - \pi^*)^2 + \frac{1}{2} (y - y_n)^2$$

where π^* is the target level of inflation and y_n is the natural level of output.²

Taylor (1993) tests the above simple interest rate rule with coefficients $g_\pi = 0.5$ and $g_y = 0.5$ for the 1987-1992 period and shows that this rule closely corresponds to the Fed’s policy interest rates. We have re-calculated the Taylor rule (with coefficients as in Taylor (1993)) for the period 1987-2007. Figure 1 below is a generic comparison of the Taylor rule with the Fed rates in this period.

Figure 1. The Taylor Rule and the Fed Rates, Quarterly US Data (1987-2007)



¹ Average real interest rate over an appropriate period is considered to be a good proxy for the neutral real interest rate; and 2% is often considered to be a good measure for the US.

² Rotemberg and Woodford (1999) show that such a loss function may be obtained by quadratic approximation of a utility based welfare function, where households derive disutility from deviations from the efficient allocation. Nevertheless, as Woodford (2003) puts forward, despite the fact that Taylor rule has some characteristics of reaction function associated with optimal policies and in spite of its usefulness, Taylor type of rules are not substitutes for fully-fledged economic models.

The success of the Taylor rule in matching the Fed's policy interest rates, its strength as a feedback rule in improving decision making process of policy makers, and its ease of use qualified the Taylor rule to emerge as a common characterization of the Fed's and other major central banks' interest rate setting behavior. Consequently, many scholars utilized the Taylor rule in their monetary policy analysis. For instance, using a Taylor type of rule, Clarida, Gali and Gertler (2000) study the conduct of monetary policy under different Fed chairs and the authors find substantial differences between pre and post 1979 periods. Specifically, the authors show that prior to 1979, in response to increases in expected inflation the Fed increased its (nominal) policy interest rates by less than the increases in expected inflation; in other words, the monetary policy was accommodative during this period. In the post-1979 period, the authors show, the Fed increased its nominal as well as real policy interest rates in response to increases in expected inflation; hence, the monetary policy was anti-inflationary and stabilizing in this period.

Clarida, Gali and Gertler (1998) also utilize a Taylor type rule to provide an insight for interest rate setting behaviors of G3 (Germany, Japan, US) and E3 (the UK, France and Italy) countries. The authors study the G3 countries in the post-1979 era in order to identify the features of effective monetary policy making; and they analyze the E3 countries in order to identify the problems of monetary policy making during the European Monetary System (EMS) era, which collapsed in late 1992.

Adam, Cobham and Girardin (2005) estimate reaction function of Bank of England (BOE) based on augmented Taylor rule in three sub periods: pre-European Exchange Rate Mechanism (ERM) (1985-1990), post-ERM (after 1992) and the period after BOE was given operational independence (in 1997). Results of the study suggest that institutional arrangements are decisive on policy reaction functions; BOE started to follow reaction functions similar to other developed countries' central banks (like those of G3) only after it gained operational independence. Likewise, Nelson (2000) and Taylor and Davradakis (2006) apply the Taylor rule to study the UK monetary policy. Demers and Rodrigues (2002) study the Canadian interest rate setting behavior within a Taylor rule framework.

Despite the success of the Taylor rule in predicting the Fed's (and other CBs') policy interest rates, empirical studies show that CBs' tend to move their interest rates gradually. Accordingly, there is a tendency in the literature to incorporate an interest rate smoothing

term into the Taylor rule.³ However, Rudebusch (2002, 2006) and Rudebusch and Wu (2008) argue that if policy interest rates move gradually, then interest rate changes should be predictable. The studies show, however, that financial market data indicates no predictability of interest rate changes; accordingly the authors conclude that there is no deliberate interest rate smoothing. Following this argument, we do not utilize an interest rate smoothing term in our analysis and employ a Taylor rule in its original form. A detailed discussion of interest rate smoothing is addressed in Appendix II to this chapter.

3. Empirical Analysis

A crucial point to be observed in Figure 1 above is that the Fed's policy interest rates persistently remained below what the Taylor rule suggests during the few years prior to 2007. More specifically, if one takes the interest rates implied by the Taylor rule as a basis, the Fed maintained a loose monetary policy from around 2002 onwards. In order to test the validity of this argument we first run an OLS regression and identify the Taylor rule coefficients. Afterwards we investigate whether if there was a structural break in the Fed policies prior to the crisis.

The Taylor rule we utilize is a standard one as in equation (1) above. Specifically:

$$(3) \quad Fed\ Rates_t = \beta_0 + \beta_1 * outputgap_t + \beta_2 * (inf_t - 2) + \varepsilon_t$$

The intercept coefficient, β_0 , is simply composed of neutral interest rate and inflation rate. This is actually the fictive Fed rate when output gap is zero and inflation is at its 2% target level.

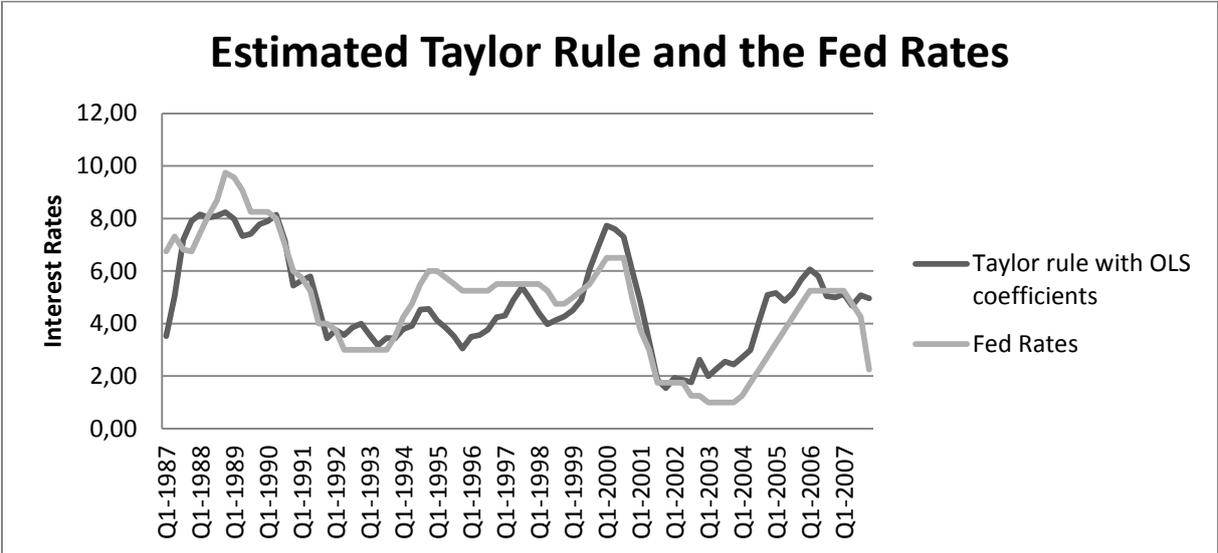
Data

There has been some controversy on whether to use past data or forecast variables in Taylor rule analysis. Taylor (1993) uses lagged values of inflation in his analysis and states that lagged inflation rate serves as a proxy for expected inflation. Taylor (1999) shows that, regarding impacts of policy rules there is not much difference between using inflation forecasts and using past variables. Similarly, Clarida, Gali and Gertler (2000) consider forward looking specifications to be more plausible in their monetary policy analysis, but the authors show that their key results hold also with backward looking specifications. Moreover,

³ See for instance Clarida, Gali and Gertler (1998, 2000) or Sack (2000) for smoothing terms in central bank reaction functions.

stable, interest rate increases should be greater than the rise in inflation.⁷ The OLS output is in accordance with our expectations as well as with the Fed rates, as depicted in Figure 2 below.

Figure 2. (OLS) Estimated Taylor Rule and the Fed Rates, Quarterly US Data (1987-2007)



We now turn to analyze whether if there was a structural break in the Fed policies before the crisis. That is, we would like to see if the Fed started following a loose monetary policy in the run up of the crisis. Initially, we would like to see if there is any indication of structural break in the implied monetary policy making of the Fed. Brown, Durbin and Evans (1975) propose to calculate cumulative sum (CUSUM) of the recursive forecast errors in order to identify gradual changes in a model. Formally,

$$CUSUM_N = \sum_{i=1}^N \frac{\varepsilon_i(1)}{\sigma_\varepsilon} \quad N = n, \dots, T - 1$$

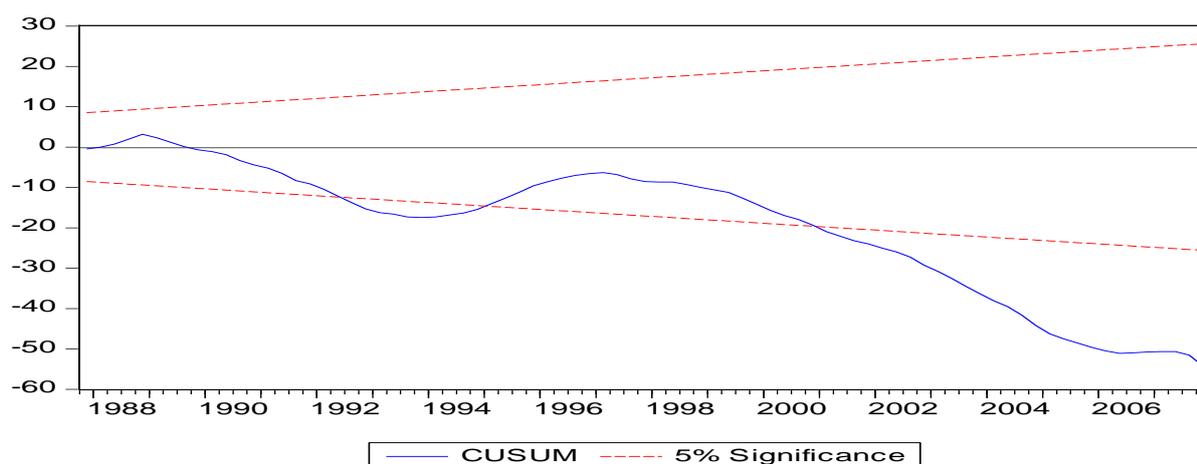
where, n is the date of the first forecast error, T is the last observation in the data set, and σ_ε is the standard deviation of the forecast errors.

If CUSUM is statistically different from zero, the procedure implies a structural break in the model. The CUSUM analysis of our model, with 5% significance level is given below. Figure 3 indicates that starting from 2001 there is a gradual change in our model.⁸

⁷ See, for instance, Woodford (2003; p.91).

⁸ An event like breakdown of the Bretton Woods System or the Exchange Rate Mechanism would indicate a discrete (rather than gradual) change.

Figure 3. CUSUM Analysis for Parameter Stability



The CUSUM analysis provides a good reason to suspect a structural break in our model. To be more concrete, we next run a Chow forecast test in order to see if the Fed’s policy interest rate setting policy is sufficiently different during 1987-2002 and during 2003-2007 periods. The null hypothesis of the Chow forecast tests is that there is no structural change in the equation. The test results are presented in Table 1.

Table1. Chow Forecast Test Results

Chow Forecast Test			
Equation: TAYLOR			
Specification: FEDRATES=C(1)+C(2)*OUTPUTGAP+C(3)*(AVGCPI-2)			
Test predictions for observations from 2003Q1 to 2007Q4			
	Value	df	Probability
F-statistic	2.040887	(20, 61)	0.0174
Likelihood ratio	43.03407	20	0.0020

Both the F-statistics and the likelihood ratio statistics reject the null hypothesis that there is no structural change in the interest rate setting function before and after 2003.⁹ Hence, at 5% significance level both the CUSUM test and the Chow forecast tests indicate a structural break in the Taylor rule indicated Fed policies around 2003.

As the two tests that we have run above indicate a structural break around 2003, we generated dummy variables with zeros for the period 1987 to 2003 and ones from 2003 onwards and re-

⁹ The F-statistic is based on comparison of the restricted and unrestricted sum of squared residuals; $F = \frac{[(SSR - SSR_1 - SSR_2)/k]}{[(SSR_1 + SSR_2)/(n - 2k)]}$ where, n is number of observations and k is number of variables. Since P-value, 0.0174 is smaller than 5%, we reject the null hypothesis.

run the OLS regression. The coefficients of the Taylor rule with dummy variables are given below; the standard error of each regression coefficient is given in parenthesis.

$$(5) \quad Fed\ Rates_t = 3.91 + 0.71(outputgap_t) + 1.12(inf_t - 2) - 1.44(dummy)$$

(0.17) (0.06) (0.11) (0.25)

($R^2 = 0.79$)

The regression results indicate that the Fed rates from 2003 to 2007 were 1.44 points lower compared to the period 1987-2003. Hence, our findings are in accordance with the arguments that the Fed was following extra loose monetary policy prior to crisis.

4. Loose Monetary Policy and the Crisis: The Transmission Mechanism

The empirical analysis above implies that the Fed indeed followed a loose monetary policy in the run up of the crisis. As depicted in Figure 2, in 2002-2003 the Fed moved its policy interest rate against what the Taylor rule indicates; that is, while the Taylor rule indicates a rise in the interest rates, the Fed decreased its policy interest rate in this period. The Fed's tendency to loosen monetary policy in this period could be explained by the burst of the dot-com bubble in early 2000s and the Fed's aversion for a recession or deflation due to the corresponding stock market crash. From 2004 onwards, the Fed started increasing its policy interest rates even if the rises were rather moderate and the interest rates remained below what the Taylor rule suggests.

The Fed's chairman at the time, Ben Bernanke objects to the criticisms that the Fed followed a loose monetary policy in this period. Bernanke (2010) argues that, the interest rates at the time were in line with their inflation expectations and feedback rules. Even if it is so, then the Fed's expected inflation rate turns out to be too low in order to maintain a stable monetary policy. Furthermore, during his tenure as the chairman of the Fed, Alan Greenspan tended to provide extra liquidity to the market whenever there is downturn in the financial markets until the market outlook improves. This policy perspective came to be known as the "Greenspan put"¹⁰. Hence the motivation of the Fed to follow loose monetary policy from 2000 onwards could well be to avoid the financial market downturn due to burst of dot-com bubble.

¹⁰ "put" here refers to a put option, which can be exercised if prices fall below a certain value.

The following section briefly discusses the overall perception of monetary policy during Greenspan period.

4.1. Perception of Monetary Policy Making during Greenspan Period

The period we cover in our analysis roughly corresponds to the Alan Greenspan's term at the Board of Governors of the Federal Reserve System as the chairman. Thus, a brief analysis of the Greenspan's overall approach (or how it is perceived by the markets) to monetary policy making as the chairman of the Fed would provide further insight to our analysis. Greenspan took the position as the chairman of the Fed in August 1987. Just after two months, in October 1987, Greenspan encountered with the first stock market turmoil of his term at the Fed. October 19, 1987 is referred to as Black Monday; the day that the Dow Jones Index lost 22.6 percent of its value.¹¹

In a paper that discusses the causes of the 1987 market crash and the role that the Fed played during the crisis, Carlson (2006) points out deteriorating macroeconomic outlook in the US, globally rising interest rates, US's growing trade deficit and corresponding need for higher interest rates. The author argues that, the Fed responded to the market crash actively by providing highly visible liquidity to the market; lowering the federal funds rate; conducting more expansive open market operations at earlier-than-usual times; temporarily liberalizing the rule that prevents the Fed lending to Treasury from its portfolio; and encouraging commercial banks to extend lending to other financial market participants (specifically, to brokers and dealers). The author concludes that these committed responses by the Fed helped the financial markets to return to their regular functioning.

Active Fed policies under Greenspan continued also in the course of 1998 liquidity crunch. In 1997 a local currency and financial crisis emerged initially in Indonesia and later on spread to other Southeast Asian countries. Subsequently in 1998, crisis in Russia and Brazil triggered a financial meltdown and investors' confidence in the financial markets all around the world was shaken.¹² According to Corsetti, Pesenti and Roubini (1999) the Fed's active policies were again decisive in reassuring market confidence in the aftermath of the 1998 liquidity crunch. The authors argue that the Fed signaled its commitment to prevent both domestic and global financial crisis by cutting its policy interest rates twice (and once unexpectedly).

¹¹ Setting the Record Straight on the Dow Drop (1987, October 26)

¹² For a detailed discussion on the 1998 liquidity crunch see, for instance, Corsetti, Pesenti and Roubini (1999).

The Fed's active policy responses to limit the market crash of 1987 and to minimize effects of the liquidity crunch of 1998 is argued to lead investors to believe that the Fed takes decisive action to prevent market from falling but not to stop it rising. In other words, whenever there is a crisis or a market downturn, markets started to expect that the Fed would inject liquidity to the markets until the market outlook improves. This policy perspective came to be known as the "Greenspan put".¹³ As market participants increasingly started to believe that monetary policy would come to rescue (or bear the burden) whenever there is a market downturn, Greenspan put is considered to generate "moral hazard". In this vein, Miller, Weller and Zhang (2002) argue that Greenspan put played a key role in the boom in the internet and technology sectors' stocks from late 1990s to 2000, or the dot-com bubble.

Initial emergence of the dot-com bubble could partially be explained by positive expectations about the internet companies; rise in number of internet users from the mid-1990s and commercial growth of the internet boosted future profit expectations of internet companies. Nevertheless, Calabria (2011) notes that gradual reduction in the Fed's and discount rates in the fall 1998 indicates start of divergence of the internet companies' stocks from the overall-market in an upward direction. The author argues that due to the weakness in non-internet stocks and favorable borrowing costs led non-internet companies to retire or repurchase stocks; however, internet companies kept on issuing new stocks. Ljungqvist and Wilhelm (2003) note that high returns on initial public offerings (IPOs) of internet companies in that period is considered as an indication of dot-com bubble.¹⁴ Specifically, the authors note that while the first-day returns on IPOs averaged about 17 percent in 1996; first-day returns on internet IPOs averaged 89 percent during 1999 and 2000. Moreover, it was despite the fact that internet related sectors in aggregate had negative earnings during that period (Ofek and Richardson, 2002). In spite of the weak fundamentals of internet companies, Miller, Weller and Zhang (2002) argue that market participants were pricing a Greenspan put; i.e., stocks were valued "as if market participants were in the possession of an undated put with an exercise price some fixed fraction of the last peak" (p, C174).

While interest rate cuts of the Fed in response to liquidity crunch in 1998 was crucial in the rise of the dot-com bubble; the Fed's interest rate rises in 1999 and 2000 (from 5% to 6.5% in six times) in order to cool down the economy had a strong influence in the burst of the bubble.

¹³ Miller, Weller and Zhang (2002).

¹⁴ Pilbeam and Nagle (2009), Calabria (2011) also analyze the dot-com bubble from returns on IPO point of view.

A similar mechanism was also in effect in the run up of the global financial crisis. In order to avoid financial market downturn following the dot-com bubble, the Fed maintained loose monetary policy particularly in 2002-2003. Low interest rates and easy credit policies fueled a boom in the housing market; as inflation scares arose, the Fed increased interest rates; and defaults in mortgages marked the beginning of the global financial crisis.

4.2. Loose Monetary Policy, Easy Credit Policies and Financial Deregulation

There is ample evidence to show that prolonged loose monetary policy jeopardizes financial stability. For instance, Taylor (2009) argues that monetary excesses were the main cause of the housing boom; and the collapse of the housing market was the main driving force of the financial turmoil in 2007-2008. Ahrend, Cournede and Price (2008) also find that periods in which short term interest rates remain below what the Taylor rule suggests are generally correlated with imbalances in housing markets. Regarding the effect of monetary policy on easy credit policies, Jimenez et al. (2014) find that lower policy interest rates induce banks to expand credit to riskier agents.

In this vein, Calomiris (2009) suggests that in addition to low short term interest rates, the yield curve was virtually flat during the 2002-2005 period and low interest rates encouraged extraordinary expansion in the housing market and hence overpricing of houses. Regarding easy credit policies, due to long-standing national goal of providing home ownership to all Americans, there was political pressure in terms of extending mortgages to promote affordable housing on government sponsored enterprises that provide funding for new home mortgages (namely, Fannie Mae and Freddie Mac) (Calomiris, 2009; Gorton and Metrick, 2012).

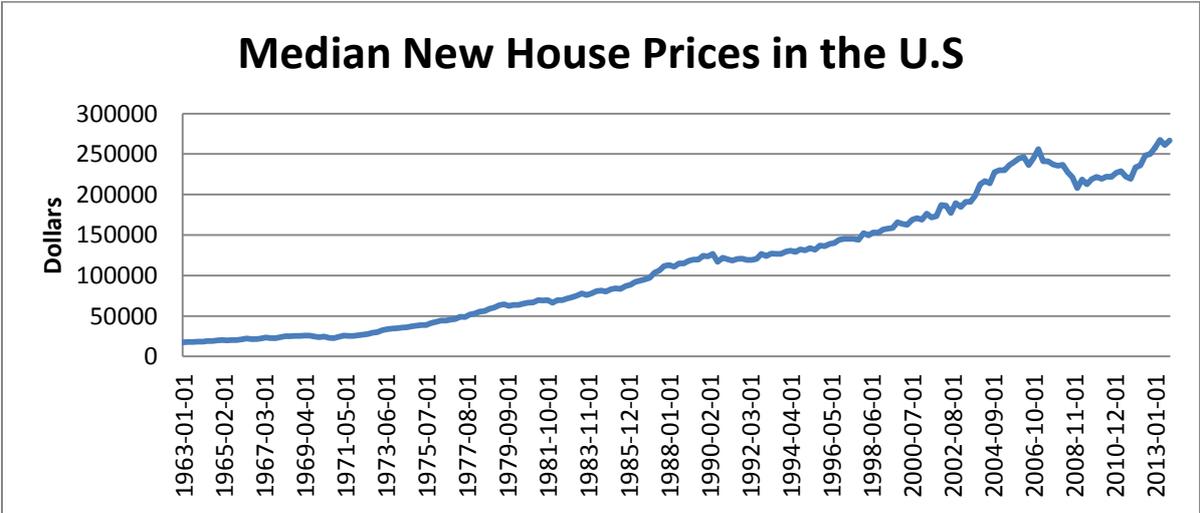
Gorton and Metrick (2012) further define the subprime mortgage securitization as a financial innovation that provided housing finance to people with poor credit histories and lack of sufficient income and assets. Specifically, the authors explain the securitization mechanism in the shadow banking system as follows:¹⁵ Mortgages were first sold in residential mortgage backed securities (MBS) which involves pooling mortgages together and selling the pool to special purpose vehicle which finance their purchase by issuing investment-grade securities in the capital markets. They suggest that, owing to this innovation a total of USD 2.5 trillion

¹⁵ Shadow banking system (i.e., financial institutions like investment banking and the hedge funds) carry out functions very similar to traditional banks but they are largely unregulated. Hsu and Moroz (2009) define shadow banking as “shadow banks are entities that fund illiquid assets with short-term liabilities and yet remain outside of the banking regulation”.

subprime mortgages were originated in the years 2001-2006, and almost half of it was generated in 2005-2006 by refinancing of previous mortgages.

Hence, owing to loose monetary policy, easy credit policies and financial innovations, there has been extra ordinary escalation in the house prices starting from early 2003, which peaked around 2006 (figure 4).¹⁶ In the meanwhile, however, monthly payments for adjustable rate mortgages were increasing together with the rising Fed rates. As subprime mortgage borrowers started to default, house prices started to plunge and financial institutions that held subprime mortgages started announcing losses. While MBS were presented as low-risk securities, with the nationwide crash of housing market in the US, it was realized that MBS were no safer than the subprime mortgages. In return, even determining the worth of MBS became a challenge and financial institutions' balance sheets and their overall stance fell under suspicion. Consequently, lenders were no more willing to provide financing to MBS at historical spreads; and illiquidity of the MBS forced the U.S government to seize Fannie Mae and Freddie Mac (Gorton and Metrick, 2012).

Figure 4. Median Sales Prices for New Houses Sold in the United States



Source: Data from Federal Reserve Bank of St. Louis.

Because MBS were already traded in global financial markets, panic in the world financial system started when Lehman Brothers collapsed in September 2008. Takeover of Bank of America by Meryl Lynch and bailout package in order to rescue AIG were the aftershocks to the global financial system and to the world economy.

¹⁶ Note that the rise in house prices coincides with the extra expansionary monetary policy period indicated above.

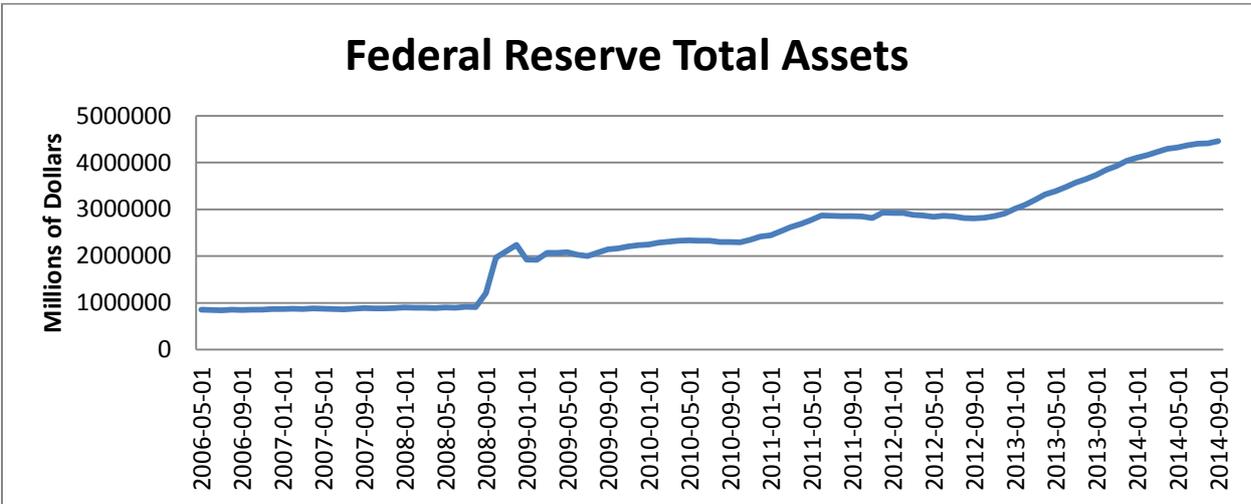
In sum, loose monetary policy, easy credit policies, and financial innovation generated financial instability; and new (and unregulated) financial instruments helped the crisis to spread to global scale.

5. Unconventional Monetary Policy during the Crisis

Following the crisis in the financial sector, the US economy started sliding into a deep recession. The Fed’s first reaction was cutting the policy interest rates up to the zero lower bound. But in order to prevent a recession like the one in 1930s the Fed still had to provide stimulus to the economy. Hence, unconventional monetary policies came into effect. Extra ordinary forward guidance and quantitative easing (QE) turned out to be the two major policies that the Fed, as well as some other central banks, utilized to defeat the recession. Forward guidance is defined as explicit and stronger policy communication with the public. In this regard, during the crisis central bankers promised to keep interest rates at low levels for extended period of time in order to influence people’s expectations of future interest rates and economic activities.

QE is large scale (mostly long-term) asset purchase program with newly printed money. The Fed’s asset purchases mostly composed of mortgage backed securities and Treasury bills. As QE increases the demand for assets, long term interest rates decrease and in return, economic recovery is supported through monetary policy. The following figure exhibits the dramatic increase in the Fed’s total assets following the financial crisis. Prior to crisis, Fed’s total assets were less than USD 1 trillion; by 2014 total value of assets exceeded USD 4 trillion.

Figure 5. Total Assets of the Federal Reserve System (2006-2014)



Source: Data from Federal Reserve Bank of St. Louis

There had been 3 rounds of QE in the US, each with different targets in economic recovery. QE1 mainly targeted the banking sector. The banking sector turned out to be highly fragile in the aftermath of the crisis. Moreover, the banking sector was impeding economic recovery as banks were not willing to provide credit to the economic agents. Starting from November 2008, for 17 months the Fed purchased USD 1.7 trillion worth of securities, which USD 1.25 trillion of it was mortgage backed securities. In return, the Fed cleared banks' balance sheets from their toxic subprime securities and helped the banking sector to recover.

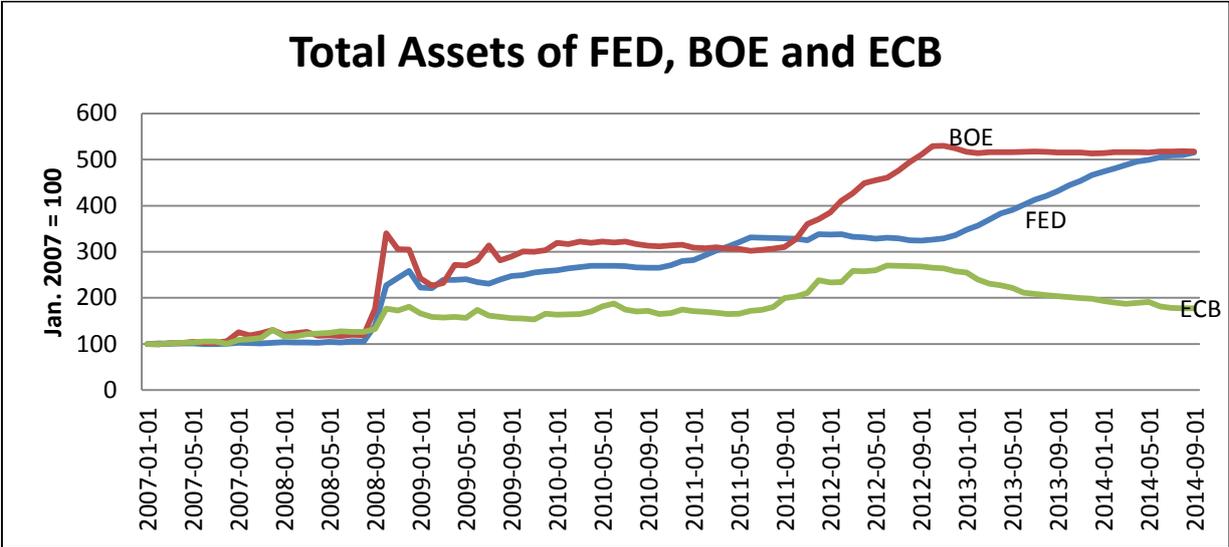
QE2 started in November 2010 and for 7 months the Fed purchased USD 85 billion worth of Treasury bills each month to support economic activity. In September 2011 the Fed revised QE2 through a program called "operation twist". According to this program the Fed used its proceedings from matured short-term Treasury bills to buy long term Treasury bills. The program also included matured short term mortgage backed securities to buy longer term mortgage backed securities. The main purpose of this program was to support the housing market.

Finally, the Fed announced QE3 in September 2012. With QE3 the Fed promised to purchase USD 85 billion of assets each month, which also included operation twist. In addition to asset purchases, the Fed announced that it would keep Fed fund rates at zero level until 2015 and would continue to buy bonds until the job market improves "substantially". This promise clarifies the target of QE3: to boost economic activity. These announcements were also part of the forward guidance; intending to influence long-term interest rates by informing the public about the future course of monetary policy.

The Fed was not the only central bank that used quantitative easing; but together with the Bank of England (BOE), it was the boldest one in this respect. European Central Bank (ECB) also made some form of asset purchases in order to surmount the financial crisis. However, as presented in Figure 6, compared to the Fed and the BOE, the ECB was rather slow or hesitant to expand its balance sheet. Europe's recovery from recession was also slow compared to the US and the UK. Specifically, while the US' and the UK's growth rates in the second quarter of 2014 were 5.9 and 6.2, respectively; Eurozone economy could grow only 0.7% in the same period. Likewise, while the unemployment rate in the US and the UK is around 6%; it is

11.5% in the Euro area. Some scholars witness the strong and faster recovery of the US and the UK from the crisis as the success of bolder monetary policies (in particular the QE).¹⁷

Figure 6. Total Assets of the Federal Reserve, Bank of England and European Central Bank.



Source: Data from Federal Reserve Bank of St. Louis

5.1 Exit from Unconventional Monetary Policies

Gertler and Karadi (2011) develop a DSGE model in order to analyze unconventional monetary policy in the manner that the Fed had followed during the financial crisis. The authors show that central bank intermediation is effective especially when the zero lower bound starts to bind. Nevertheless, taking the “politicization of credit allocation” into account, the authors argue that unconventional monetary policies should be reserved for crisis times only. Similarly, Bean et al. (2010) argue that if applied in normal times, policies such as the QE would distort the market structure. Accordingly, the authors suggest that, CBs should return to short term policy interest rate management as their aggregate demand management tool.

The Fed also specified an exit plan from the QE as the economy started to recover from the recession. In December 2012 the FED announced that it would continue with its USD 85 billion worth of monthly asset purchases until either the core inflation rises above 2.5% or

¹⁷ In addition to monetary policies, the US Treasury also applied some expansionary fiscal policies in order to stimulate demand; but they were limited in scope and in effect.

unemployment falls below 6.5%.¹⁸ Such clear targets improved public communication of monetary policy. And in December 2013, the Fed announced that it would reduce its asset purchases by USD 10 billion monthly. The Fed kept on reducing its asset purchases gradually and finally in October 2014 the Fed announced that it has ended its asset purchases program.

Hence, despite the fact that unconventional monetary policies during the crisis helped to mitigate the effects of the crisis, the research suggest that these policies are not well-suited for normal time policy making. Indeed, the Fed's exit from the asset purchasing program and its announcement that it would start increasing its policy interest rates after unemployment level falls to 6.5% or annual inflation rate rises to 2.5% implies the Fed's desire to end crisis time policies and let the main economic indicators again to determine the structure of monetary policy.

6. Summary and Conclusion

In this paper we have argued that development in monetary theory and policy making practices led to an era of (spanning from early 1980s to early 2000s) low and stable inflation and steady output growth levels; i.e., the great moderation. We have also argued that deviation from the fundamentals of good monetary policies and following expansionary policies for an extended period of time brought an end to the great moderation era and contributed to the emergence of the 2007-8 global financial crisis.

For monetary policy analysis we have employed the Taylor rule due to its efficiency as a feedback rule and its practicality in policy analysis. Using a simple OLS regression we first showed that the Taylor rule represents the Fed's interest rate setting behavior quite well. Nevertheless, utilizing CUSUM and Chow forecast tests we detected gradual structural break in the Fed's policies in the run-up of the financial crisis. That is, the tests confirm that starting from the early 2000s the Fed followed lower policy interest rates than indicated by the Taylor rule.

The period of lax monetary policy and excessive liquidity, accompanied with easy credit policies and financial innovations led to housing bubble, whose burst marked beginning of the financial crisis. After the burst of the housing bubble, it was realized that the financial system was weaker than it was imagined due to deregulations during the past few decades.

¹⁸ Later on, the Fed announced that even after these thresholds are reached they would not be considered as automatic triggers.

Regarding the Fed's reaction to the global financial crisis we have argued that the Fed first responded to the crisis by decreasing its policy interest rates. As the zero lower bound started to bite, the economy was still sliding into deeper recession due to weak financial system. In return, the Fed started to carry out unconventional monetary policies, such as forward guidance and quantitative easing. Other major central banks, such as the BOE, BOJ, and ECB also followed similar unconventional monetary policies. It is usually agreed upon that these policies were effective in preventing a complete financial collapse and helped the global economy to recover from the crisis.

Despite their usefulness during the crisis times, studies show that unconventional policies should be reserved only for extraordinary times. We observe that the Fed is also adjusting its policies in this direction. In May 2013 the Fed declared that it would decrease its monthly asset purchases as the economic conditions improve. As a next step, the Fed announced, it would start increasing its policy interest rates from around its zero level as unemployment and inflation rates reach to certain levels. Indeed, quitting the QE and letting inflation and unemployment levels determine its policy interest rates means turning back to its normal time policies.

Getting back on the pre-crisis policy practices should be no surprise as both the basics of good monetary policy making and consequences of deviation from these policies have been apprehended. As the great moderation era taught the basics of good monetary policy making; the global financial crisis has taught the dangers of deviation from those policies.

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Appendix I

Analysis with Monthly Data

As mentioned in the body of this chapter, we utilized quarterly data in our analysis in order to conform with the literature, specifically to the original Taylor rule. Nevertheless, since monthly data analysis is also used in the literature we present results from monthly data analysis. The results indicate that monthly and quarterly data produce similar results; equation A.1 below closely conforms to Equation 4 in the body of this text.

$$(A.1) \text{ Fed Rates}_t = 3.61 + 0.59(\text{outputgap}_t) + 1.2(\text{inf}_t - 2)$$

(0.14) (0.09) (0.10)

where $R^2 = 0.45$

The corresponding Taylor rule (with the above coefficients) is presented in Graph A.1. The Taylor rule again corresponds to the Fed rates.

Graph A.1 Comparison of Taylor rule and the Fed rates, monthly data (1987-2007)

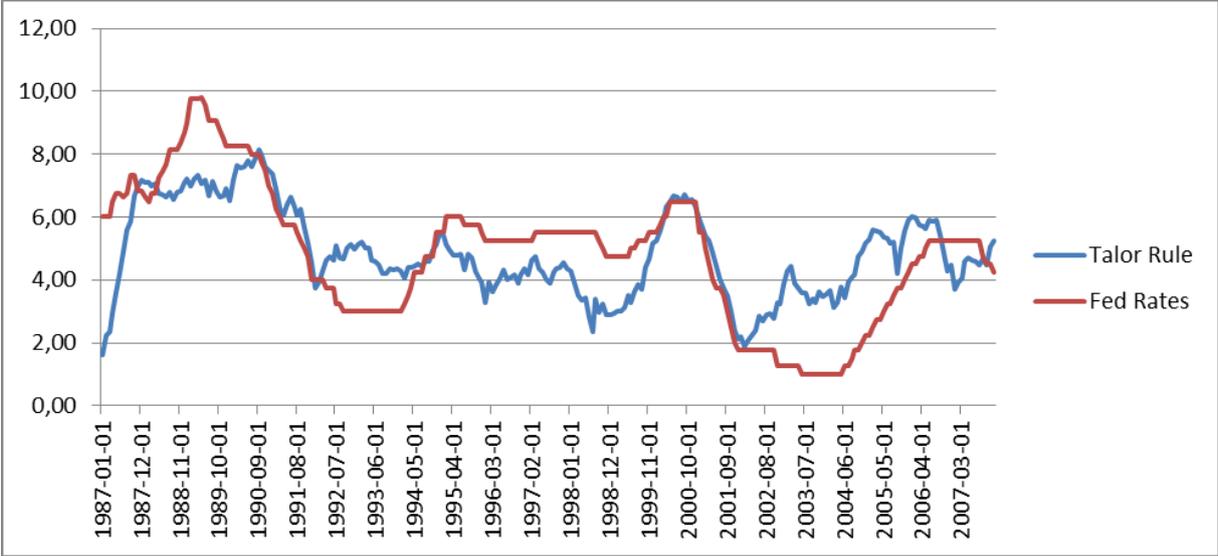


Table A.1. OLS Taylor rule analysis with monthly data

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	3.610896	0.142119	25.40761	0.0000
C(2)	0.591885	0.094005	6.296319	0.0000
C(3)	1.200321	0.101366	11.84144	0.0000
R-squared	0.450316	Mean dependent var		4.855714
Adjusted R-squared	0.445901	S.D. dependent var		2.117719
S.E. of regression	1.576384	Akaike info criterion		3.759977
Sum squared resid	618.7616	Schwarz criterion		3.801994
Log likelihood	-470.7572	Hannan-Quinn criter.		3.776884
F-statistic	101.9939	Durbin-Watson stat		0.050226
Prob(F-statistic)	0.000000			

Appendix II

Interest Rate Smoothing

Despite the appealing intuition and ease of use of the Taylor rule, empirical studies show that the Fed (and other central banks) exhibits inertial interest rate changes than implied by the Taylor rule. That is, the Fed appears to be avoiding frequent and aggressive interest rate changes; instead, it tends to move interest rates to its new level only gradually. In order to account for this gradualism, very often an explicit interest rate smoothing term, “ ρ ”, is added to the original Taylor rule; and it takes the following form:

$$(A.2) \quad i_t = (1 - \rho)\hat{i}_t + \rho i_{t-1} + \epsilon_t,$$

$$(A.3) \quad \hat{i}_t = r + \pi_t + g_\pi \bar{\pi}_t + g_y \bar{y}_t,$$

where, ρ determines the level of inertia in the monetary policy.¹⁹ In the literature, the smoothing term is found to be quite high. For instance, in Sack (1998) and Clarida, Gali and Gertler (2000) ρ ranges between 0.65 and 0.8 for the U.S data. This is such a huge amount which implies that only about 20 to 30 percent of the desired rate is achieved in a given period. Since Taylor rule analysis with an interest rate smoothing term is commonly used in the literature, we also carry out our analysis with an interest rate smoothing term using GMM methodology.²⁰ The corresponding Taylor rule reads:

$$(A.4) \quad Fed\ Rates_t = 3.95 + 0.87(Fed\ Rates_{t-1}) + 0.62(output\ gap_t) + 1.25(inf_t - 2)$$

As in other analysis, when a smoothing term is added, even though the Fed policy interest rates are explained better, only a small fraction of desired rate is achieved in each period.

¹⁹ In non-inertial rules, as in the original Taylor rule, ρ is zero.

²⁰ GMM method is explained in detail in Chapter 2.

Table A.2. GMM Taylor rule analysis with a smoothing term

FEDRATES=C(2)*FEDRATES(-1)+(1-C(2))*(C(1)+C(3)*(CPI-2)+C(4)
 *OUTPUTGAP)
 Instrument specification: C OUTPUTGAP(-1 TO -4) CPI(-1 TO -4)
 FEDRATES(-1 TO -4)

	Coefficient	Std. Error	t-Statistic	Prob.
C(2)	0.872760	0.033895	25.74863	0.0000
C(1)	3.956096	0.481231	8.220793	0.0000
C(3)	0.626898	0.376548	1.664855	0.1001
C(4)	1.251487	0.276023	4.534000	0.0000
R-squared	0.950253	Mean dependent var		4.714063
Adjusted R-squared	0.948289	S.D. dependent var		2.144751
S.E. of regression	0.487717	Sum squared resid		18.07799
Durbin-Watson stat	0.731802	J-statistic		10.65388
Instrument rank	13	Prob(J-statistic)		0.300182

Rationales for Interest Rate Smoothing

In order to justify the inertia in interest rate changes, an additional term in CBs' loss function is needed. In return, the loss function (equation (2) in the text) is adjusted as follows:

$$(A. 5) \quad E[L_t] = Var[\bar{\pi}_t] + \phi Var[\bar{y}_t] + v Var[\Delta i_t], \text{ where } \Delta i_t = i_t - i_{t-1}$$

According to this loss function, the CB is concerned with interest rate volatility in addition to inflation variation around a target level and output variation around a potential (or natural) level. There are basically five rationales that attempt to explain CBs' concerns for interest rate volatility. First, Goodfriend (1987) argues that policy rates are changed gradually in order not to disturb the financial markets. The second rationale is regarding the reputation of CBs. Lowe and Ellis (1997) suggest that CBs do not make one time dramatic changes in interest rates because they believe that small changes in the same direction is perceived by the public as competence of monetary policy makers.

The third rationale is about expectations management of economic agents. Woodford (1999) argues that due to continuous changes in the same direction, inertial interest rate rules enable central bankers to affect the long term interest rates and hence the desired changes in demand and supply can be easily achieved. Nevertheless, Rudebusch (2006) argues that for gradualism to be explained by acting as a lever on expectations, economic agents have to be fully forward looking and CB must be fully credible. Uncertainty about fully forward looking economic agents and lack of commitment of CB to an interest rate path prevents this rationale to fully explain the inertial interest rate rule.

The fourth rationale for interest rate smoothing is about parameter uncertainty. According to this argument, policy makers are uncertain about the dynamic structure of the economy. In other words, there is uncertainty about the response of the economy to policy changes; this uncertainty leads central bankers to change interest rates with some caution. Sack (2000) analyzes parameter uncertainty within a VAR model. He argues that, the Fed is most certain about the response of the economy to the rule that it has already implemented. Hence, the Fed does not deviate much from the rule that it has previously implemented. The author shows that parameter uncertainty attenuates the optimal interest rate policy, but still an unexplained amount of interest rate smoothing remains.

And finally, Amato and Laubach (2004) study implications of habit formation in consumption for optimal monetary policy. The authors find that when habit formation is introduced, welfare depends on variances of inflation and output gap as well as variability in output itself. Hence, an interest rate rule that approximates optimal plan indicates “super inertial” interest rate, with a smoothing term that is larger than 1.

Despite the superior performance of Taylor rule with a smoothing term to match the actual Fed rates and despite the rationales in favor of interest rate smoothing, Rudebusch (2002, 2006) and Rudebusch and Wu (2008) use term structure data on interest rates and show that financial markets do not have any information about future interest rate movements. That is, an interest rate smoothing term in the Taylor rule implies that it is possible to predict future changes in financial markets. However, financial market data show that market participants are not able to predict future variation in short term interest rates. This tells us that gradual movement in Fed rates does not indicate deliberate interest rate smoothing. Hence, Rudebusch and Wu (2008) suggest that inertia may be explained by some other variables, beyond current output and inflation.

CHAPTER II

II-Monetary Policy Response to Exchange Rates: An Empirical Investigation

ABSTRACT

Even though exchange rate concerns are in the center of major global economic arrangements they are usually omitted out from theoretical aspects of monetary policy making. Accordingly, simple interest rate rules, such as the Taylor rule, do not comprise exchange rate arguments even in small open economy settings. This chapter investigates whether monetary policy makers in open economies take exchange rate into consideration while setting policy interest rates. We employ a Taylor type of rule and utilize Generalized Method of Moments in order to examine the role of exchange rate in monetary policies of the US, the UK, Canada, and Norway. The results indicate that while exchange rate is insignificant in interest rate determination of big and relatively closed economies, such as the US; both exchange rate variability and exchange rate levels are significant in monetary policy conduct of small open economies.

JEL Classification: E43; E52; E58; F31

Keywords: Exchange rate stability; Monetary policy; GMM method

1. Introduction

In Chapter I we have argued that Federal Reserve System's (Fed) interest rate setting practices are successfully represented by Taylor type of interest rate rules, which suggest that policy interest rates are adjusted in response to deviation of inflation from a target level and deviation of output from its natural level. A crucial aspect of Taylor type of rules and other monetary policy frameworks is that, they typically omit out exchange rate arguments. Indeed the US is a big and relatively closed economy and it is widely agreed upon that exchange rate has less significant role in monetary policy conduct of closed economies. Nevertheless, exchange rate arguments are neglected also in monetary policy analysis of small open economies, where exchange rate level and its stability is a major concern (Svensson, 2003).

On the applied side, however, exchange rate level and stability have been in the center of major global economic arrangements. For instance, in 1944 the Bretton Woods System (BWS) was established to rebuild financial and price stability and international economic integration that ceased to exist during the interwar years. A major component of the BWS was pegging participating countries' currencies to the U.S. dollar which entitled the U.S. dollar to take over the role of gold under the gold standard era.

After the collapse of the BWS in 1971, currencies of major industrial countries were set to flow freely against the U.S. dollar. This promptly raised European policy makers' concerns about exchange rate stability; though only in 1979 a regional monetary arrangement, The European Monetary System (EMS) could be established. A major objective of the EMS was to promote monetary and exchange rate stability by closer monetary policy cooperation among the member countries. Two principal components of this arrangement was defining the European Currency Unit (ECU) and introducing European Exchange Rate Mechanism (ERM). However, ERM also came to a halt due to some speculative attacks in 1992 and 1993.

Today most countries follow "managed floating" or "limited flexibility" exchange rate systems (rather than "free floating"), where central banks (CB) keep foreign currencies in their reserves and intervene to exchange markets occasionally. Moreover, Calvo and Reinhart (2002) show that even emerging market economies that claim to follow floating exchange rate regimes, in practice try to stabilize their exchange rates either by direct intervention in the exchange market or through policy interest rate adjustments.

As a specific example of national level of exchange rate management, China, for instance, has long been criticized for keeping its currency under-valued (weak yuan has been blamed to be a source of recessions in many countries). Despite continuous appreciation of yuan since 2005, especially the USA keeps on asking China to let yuan to be at its "true" or "freely floating" level.²¹ Likewise, Swiss National Bank (SNB) abandoned floating exchange rate regime by releasing a "communication" in September 2011. Due to global financial crisis and the subsequent debt crisis in the Euro zone, Switzerland turned out to be safe haven of the region. The corresponding capital flow to Switzerland elevated the value of franc. Considering the competitiveness of Swiss exporters, SNB eventually announced that it would

²¹ In February 2014, Central Bank of China decided to weaken yuan by allowing it to float around a benchmark, which is set each morning by the bank; and the bank decided to lower the benchmark gradually.

take any necessary measure to keep the euro/franc exchange rate below 1.20.²² Even more explicit declaration of exchange rate stability concerns came from a former Bank of England governor Eddie George. In a speech, George noted that while maintaining macroeconomic stability, the Bank is also concerned with exchange rate stability as it promotes a more balanced economic growth (George, 1999).

Hence, there appears to be a gap between theory and practice. While exchange rate stability concerns and its management seems to play a significant role in global, regional and sovereign monetary policy arrangements, the theory omits out exchange rate arguments even in small open economy set ups. In this chapter we investigate whether the observed aggregate exchange rate concerns in monetary policy arrangements could be identified in monetary policy conduct of a sample of small open economies. Accordingly, we test whether CBs of England, Canada and Norway take exchange rate into consideration while setting their policy interest rates. As a reference point we also investigate whether monetary policy makers in the US are also concerned about exchange rate level.

Owing to its accuracy in predicting policy interest rates, Taylor types of rules have become a popular tool for monetary policy analysis. We also employ Taylor rule in our analysis and we utilize Generalized Method of Moments (GMM) method in order to determine whether exchange rate concerns (in addition to output and inflation) entail changes in policy interest rates. The results suggest that, besides their concerns about main economic variables, the Bank of England (BOE), the Bank of Canada (BOC), and the Central Bank of Norway (Norges Bank, NB) are all concerned about exchange rate stability and they tend to keep their exchange rates competitive against other major currencies. For the US, on the other hand, while exchange rate concerns seem to be important in interest rate setting practices; exchange rate coefficient is not significant at 10 % significance level.

The paper is organized as follows: The following section reviews the current monetary policy frameworks that major CBs utilize. Section three presents the methodology and the data. Empirical results are presented in section four. The final section concludes.

²² In January 2015 SNB announced that it abandoned the 1.20 currency ceiling. One reason for abandoning the currency ceiling was the announcement of European Central Bank's quantitative easing (QE) plans. The SNB would not be able to manage gross flow of capital that would emanate from the QE.

2. Exchange Rate Arguments in Monetary Policy Frameworks

Despite its imperative role in small open economies, exchange rate arguments are seldom included in monetary policy frameworks or in simple interest rate rules. For instance, inflation targeting (IT) has become a popular monetary policy framework and has been conducted by a number of countries since it was first introduced by New Zealand in 1990.²³ Basics of the IT framework constitute setting an explicit inflation rate target by the central bank; advising the public that price stability is the primary goal of monetary policy; enhancing transparency of the central bank about its plans, objectives, and decision making of the monetary policy; and improving accountability of the central bank to the target inflation rate. In effect, IT does not specify a formula for central banks' operating practices and it imposes only a long term constraint on monetary policy objective.

Hence, IT framework allows for short term discretion for viable policy concerns, such as output, employment and external competitiveness. However, Mishkin (2001) argues that implication of IT requires flexible exchange rate regime and it is a drawback of IT especially for emerging market economies. Brenner and Sokoler (2010) also discuss that inflation targeting regime cannot coexist with any governmental intervention to foreign exchange markets; according to them, for inflation targeting policy to be sustainable, exchange rate has to be determined solely by market forces. In accordance with these arguments, within IT framework, exchange rate is typically considered only in reference to its effect on inflation.

As an exception, Svensson (2000) analyzes IT in an open-economy set-up and considers exchange rate stability as an integral part of the decision making process. The author analyzes effects of *strict IT* where inflation is the only objective of monetary policy; and *flexible IT* where monetary policy may have additional objectives, such as output stabilization. He finds that while strict IT effectively stabilizes inflation, it generates significant fluctuation in real exchange rates and other variables due to active use of instruments to achieve the target inflation rate. Flexible IT, on the other hand, generates less variability in macro variables and still stabilizes inflation at a longer horizon. Even though the author does not introduce an exchange rate variability argument into central bank loss function, he still suggests applying flexible IT as it produces less exchange rate variability in open economies.

²³ Martinez (2008) lists 22 industrial, emerging and transition market economies that have adopted inflation targeting after New Zealand.

Regarding the countries that are analyzed in this paper, Canada is one of the first countries that adopted IT (in 1992). Following the breakdown of the exchange rate peg in Europe, the UK also adopted IT in 1992 as a nominal anchor to maintain a disciplined monetary policy (Bernanke and Mishkin, 1997). NB also maintains inflation targeting policy. While the US used to follow implicit IT, in 2012 the Fed also introduced explicit IT. Hence, IT framework and relevance of exchange rate argument within this context is most relevant for our subject countries.

While conducting monetary policy, the main instrument that all major central banks use is policy interest rates; and Taylor type of interest rate rules are widely used to describe interest rate setting behavior of central banks. Taylor (1993) shows that the Fed's policy is characterized by adjusting policy interest rates in response to deviation of inflation from a target level and deviation of output from its natural level. The corresponding simple monetary policy rule reads:

$$(1) \quad i_t = r + \pi_t + g_\pi \bar{\pi}_t + g_y \bar{y}_t + \varepsilon_t,$$

where, i is the policy interest rate; r is the neutral real interest rate; π is the inflation rate; $\bar{\pi}$ is the deviation of inflation from its target level; \bar{y} is deviation of output from its natural level; and ε is stochastic error term.

The underlying loss function reads:

$$(2) \quad \min \frac{1}{2} \gamma (\pi - \pi^*)^2 + \frac{1}{2} (y - y_n)^2$$

where π^* is the target level of inflation and y_n is the natural level of output. That is, the central bank minimizes the deviation of output from its natural level and deviation of inflation from its target level.

As in IT framework, however, exchange rate concerns are mostly omitted from Taylor type of rules even in open economy settings: exchange rate does not enter the policy makers' loss function and policy interest rate does not react to exchange rates. While omission of exchange rate concerns in monetary policy rules is recognized in the literature, it is often explained by implicit effect of exchange rate movements on policy interest rates. For instance, Clarida, Gali and Gertler (2001) explain the omission of exchange rate in monetary policies with the isomorphism between closed and open economies. That is, the authors argue that the difference between closed and open economies arises from terms of trade considerations,

where exchange rate level affects flows of export and import. Nevertheless, the authors show that under certain conditions, the terms of trade gap is proportionate to the output gap and hence, an open economy CB's loss function may take the standard closed economy form: a quadratic loss function in the output gap and inflation that approximates household preferences.

In this line of argument, Taylor (2001) argues that an exchange rate appreciation would subsequently result in lower GDP due to expenditure switching effect and fall in inflation owing to lower import prices and lower domestic production. With rational expectations in effect, anticipated fall in GDP and inflation would lead market participants to expect reduction in policy interest rates, which in return result in lower long-term interest rates. Since indirect effects of exchange rate movements already alter long term interest rates, Taylor (2001) concludes that an explicit exchange rate argument in interest rate rule would be redundant or may even deteriorate monetary policy performance.

While such arguments account for the effect of exchange rate on the overall economy, they do not consider exchange rate as a separate variable in CB's loss function. Hence, these arguments may underestimate the cost of exchange rate fluctuations in small open economies (Taylor, 2002).

Indeed, there have been some attempts to include exchange rate into simple interest rate rules. For instance, pointing out the significance of exchange rate channel (in addition to interest rate channel) in open economies Ball (1998) appended (change in the real) exchange rate into open-economy interest rate rules. As the author recognizes, the interest rate rule that he suggests is in essence a monetary condition index (MCI). MCI was first developed by the BOC in early 1990s in an attempt to incorporate exchange rate directly in the conduct of monetary policy. The rationale for developing MCI is that, if variables other than the interest rate (such as exchange rates or equity prices) are also important in affecting output gap and/or inflation then they should also be used in monetary policy implementation. After conducting some extensive research that indicated the importance of exchange rates in determining output gap and inflation, the BOC started using MCI as its policy instrument. MCI was formulated as a weighted average of interest rate and exchange rate in a chosen period:

$$MCI_t = \omega(e_t - e_0) + (1 - \omega)(i_t - i_0)$$

where the weight, ω , depends on the elasticity of aggregate demand to real exchange rate (e) and interest rate (i).²⁴ Changes in MCI indicate degree of tightening or easing the monetary conditions with respect to chosen time period.

First, Bank of Canada and subsequently Reserve Bank of New Zealand used MCI as an operating target; some other small open economies such as Sweden, Finland, Iceland, and Norway used MCI rather as an indicator of monetary policy stance. Gerlach and Smets (2000) point out two difficulties in conducting MCI. First, exchange rates and interest rates may not affect aggregate demand equally fast. Second, exchange rate changes can be due to either demand shock or credibility shock and each type of shock may require a different response from monetary policy makers. Specifically, if appreciation is due to excess demand for domestic goods, the target level of the MCI would increase, and the CB may want to accommodate this change; on the other hand, if change in the exchange rate is due to shift in credibility of monetary and fiscal policy, then exchange rate change can be offset by adjusting the MCI. If policy makers cannot distinguish the source of change on a timely basis, they may not be able to take appropriate policy action and impair the monetary policy stance. Guender (2005) also argues that existence of exchange rate in the open economy Philips curve was complicating the construction and operation of MCI. According to the author, due to such problems MCI ceased to exist after a decade it remained in use.

Hence, despite the attempts to include exchange rate concerns into monetary policy practices, exchange rate arguments are largely omitted out in the present literature. Moreover, there are only a limited number of studies that analyze whether monetary policy makers are concerned about exchange rates while conducting monetary policies. For instance, Lubik and Schorfheide (2007) investigate whether central banks respond to exchange rate movements within a small scale structural general equilibrium model for a small economy where the subject countries of the study are Australia, Canada, New Zealand and the UK over 1983 to 2002. The authors find that while BOC and BOE respond to exchange rate movements, central banks of Australia and New Zealand do not.

Alstadheim, Bjorland and Maih (2013) criticize Lubik and Schorfheide (2007) on the basis that over the analysis period of their study, many countries went through multiple regime changes; and time-invariant reaction function and constant volatility assumption may bias the results of the study. Accordingly, utilizing Markov switching dynamic stochastic general

²⁴ In Canada exchange rate had a weight about one third of the interest rate.

equilibrium model that explicitly allows for parameter changes, the authors explore whether inflation targeting central banks' weight on exchange rate stabilization remain constant throughout the period independent of the known regime changes and the volatility of shocks. The authors find that, central banks of Sweden and the UK switched from responding to exchange rate and output in the 1980s to inflation and output after they started implementing inflation targeting in early 1990s. While Canada also declined its response to exchange rate in 1997/98, the decline was relative to an increase in responding to inflation and output.²⁵ For Norway, the results indicate that the central bank responds to exchange rate both before and after it started implementing inflation targeting.

In the next section utilizing a GMM model we also investigate whether exchange rates play a role in the conduct of policy interest rate setting in our subject countries.

3. Methodology and Data

Baseline Policy Reaction Function and the GMM

We have argued above that Taylor type interest rate rules, such as equation (1), appropriately represent interest rate setting practices of monetary policy makers, particularly in closed economies. In order to investigate whether exchange rates play a decisive role in interest rate decision processes in small open economies we incorporate the real effective exchange rate (REER) into the Taylor rule as an explanatory variable. The REER is weighted average of a country's real exchange rate relative to its major trading partners, where the weights are determined with respect to trade shares of each partner. We have chosen the REER in our analysis because economists and policy makers are mostly interested in the REER when measuring a currency's overall alignment (Catao, 2007).

When the exchange rate is incorporated into equation (1), the policy reaction function in open economies takes the following form:

$$(3) \quad i_t = r + \pi_t + g_\pi \bar{\pi}_t + g_y \bar{y}_t + g_e e_t + v_t$$

where, e_t is the REER and the rest of the variables are defined as in equation (1).

²⁵ Note that, the indicated change in BOC's policy conduct corresponds to the withdrawal of MCI by the bank.

We have utilized Generalized Method of Moments (GMM) in our analysis.²⁶ GMM is a very general class of estimators such that OLS is a special version of GMM. The idea of GMM is to choose parameter estimates such that the theoretical relation is satisfied as closely as possible; the method also accounts for possible serial correlation and heteroskedasticity.²⁷ The parameters of the GMM estimation should satisfy the following orthogonality condition between function of parameters and the set of instrumental variables:

$$E_t(f(\theta)'Z) = 0$$

where θ is the set of parameters to be estimated and Z is the vector of variables within the CB's information set when interest rate decision is made. The GMM estimators are produced such that the correlation between the instruments and the f function are as close to zero as possible, as defined by the criterion function:

$J(\theta) = [f(\theta)'Z]'A[f(\theta)'Z]$, where A is a weighting matrix that accounts for possible serial correlation in v_t .

Data

The subject countries of this study are the UK, Canada and Norway. Even though the US is rather a closed economy, due to its leading role in the world economy and the role of the US dollar (USD) as a vehicle currency in international transactions we also present the analysis for the US. The UK is an important actor in the world economy; policies of the BOE are closely followed in international markets and are of interest both for academicians and financial markets. Canada is a small open economy that is closely tied to the US. It would be instructive to see if this close tie between the US and Canada could be demonstrated in our analysis. Norway is another small open economy closely tied to Europe. Comparing the results for Canada and Norway would also be instructive.

While quarterly data is also commonly used in the literature, we use monthly data in the Taylor rule analysis. Indeed monetary policy committees in our subject countries meet more often than a quarter: Fed target rates are determined in Federal Open Market Committee meetings that are scheduled in every six weeks (twice a quarter) and additional meetings may be held if economic conditions persist. Likewise, BOE's Monetary Policy Committee meets

²⁶ The GMM framework is developed by Hansen (1982). See also Clarida, Gali and Gertler (1998) for application of GMM in Taylor rule analysis.

²⁷ For further discussion on this issue see Binder et al. (2005).

in the first week of every month; BOC announces its key policy interest rate at eight fixed dates every year, and finally NB's executive board normally meets six times a year in order to set its key interest rate. Therefore, monthly analysis turns out to be more appropriate than the quarterly analysis.

For our analysis we use the following data set: policy interest rates of the CBs, inflation rates, REER, and industrial production index (IPI). We use IPI data and HP filter in order to derive outputgap data. The data for our subject countries is extracted from the Federal Reserve System, the Fed of St. Louis, U.S Bureau of Labor Statistics, the OECD, Bank of International Settlements, Bank of England, the UK Office for National Statistics, Bank of Canada, Statistics Norway and Bank of Norway databases.

4. Results

The US Analysis

Success of the Taylor rule in representing the Fed's policy interest rate adjustment is widely recognized; it would also be illuminative to see how the Taylor rule with an exchange rate argument for the US would perform. Hence, as a point of reference, we first present the US analysis.

Our US data starts from January-1987 and ends in December-2007. The beginning of the US data is chosen simply to conform with the literature; in particular to the original study of Taylor (1993). As in our other subject countries, rise of the sub-prime mortgage crisis marks the end of our data.

We have incorporated the REER into the standard Taylor rule, as shown in equation (3) and we have utilized the following instrumental variables: the constant, the first six lags of outputgap, average cpi over the past six months and the REER. For the GMM analysis we use heteroskedasticity and autocorrelation consistent (HAC) covariance matrix estimation and we choose Barlett weights to ensure positive definiteness of the estimated variance-covariance matrix. The following results are obtained by implementing GMM in E-Views.

Table 1. GMM Estimation for the US data

	Coefficient	Std. Error	t-Statistic	Prob.
C	3.239166	2.192190	1.477594	0.1408
Outputgap	0.719640	0.108823	6.612942	0.0000
Inflation	1.197563	0.195005	6.141203	0.0000
REER	-0.022606	0.019598	-1.153479	0.2499
R-squared	0.528362	Mean dependent var		4.819675
Adjusted R-squared	0.522516	S.D. dependent var		2.130000
S.E. of regression	1.471835	Sum squared resid		524.2444
Durbin-Watson stat	0.073296	J-statistic		9.280121
Instrument rank	19	Prob(J-statistic)		0.862421

In GMM estimation, the validity of the instruments and overall specification of the model is often tested by the Hansen's J-test for overidentifying restrictions.²⁸ The p-value of the J-statistics (0.86, given on the right bottom end of the table) does not reject the null hypothesis that instruments are valid or the model is correctly specified. Hence we conclude that our instrument set is robust and monetary policy rule specification does not omit important variables that enter the central bank rule.

Coefficients for outputgap and inflation have expected signs and are both statistically significant as in standard Taylor rule. Coefficient for the REER also has expected sign; an increase in the REER indicates appreciation of exchange rate and if the central bank prefers to reverse the movement in exchange rates it is expected to cut policy interest rates (or, vice-versa). However, the REER coefficient is not significant at 10% significance level; this may be due to the size and level of openness of the US economy. That is, the US is considered to be a large and relatively a closed economy and the Fed may not be worrying too much for the value of the USD. Moreover, the role of the US dollar as a reserve currency and the fact that it is widely traded in foreign exchange markets may limit the Fed's desire and ability to prevent fluctuations in the value of dollar.

In sum, our analysis for the US suggests that a closed economy Taylor rule specification represent the Fed's monetary policy conduct quite successfully. As predicted, exchange rate movements do not indicate a significant response in the Fed's policy interest rates.

²⁸ If the model is correctly specified GMM should be consistent and hence over-identifying restrictions should be close to zero.

Analyzing the UK’s monetary policy conduct is illuminating for our purposes due to its open economy structure and its significant role in the world financial markets. Because we intend to carry out our analysis over a period where there is no major change in monetary policy conduct, our analysis for the UK starts from January 1993 and ends in December 2007. The UK’s withdrawal from the ERM and implementing inflation targeting commencing from end 1992 indicates the beginning of our analysis. Rise of global financial crisis dictates the end date of our analysis as the Taylor rule is suggested for systematic response to the explanatory variables in normal times.

GMM results for the UK data are presented in Table 2.

Table 2. GMM Estimation for the UK

	Coefficient	Std. Error	t-Statistic	Prob.
C	10.10200	1.122827	8.996930	0.0000
Outputgap	0.120434	0.114140	1.055141	0.2929
Inflation	-0.140176	0.212362	-0.660082	0.5101
REER	-0.047926	0.010060	-4.764185	0.0000
R-squared	0.168704	Mean dependent var	5.361034	
Adjusted R-squared	0.154034	S.D. dependent var	1.021393	
S.E. of regression	0.939440	Sum squared resid	150.0332	
Durbin-Watson stat	0.048350	J-statistic	18.43982	
Instrument rank	25	Prob(J-statistic)	0.621026	

While the p-value of the J-statistics (0.62) indicates an accurate specification of the model; the coefficient of determination (R-squared) points out that the regression line approximates the real data weakly. This may be due to the fact that the BOE considers a wider set of variables while deciding its policy interest rates. Specifically, BOE quarterly inflation reports states that in policy counselling the bank considers the growth rate of the UK as well as the growth rate in the rest of the world, asset prices, the value of the USD against the Euro, exports and imports, past and expected changes in the Fed’s official interest rates, and the REER.

Moreover, Taylor and Davradakis (2006) find that linear Taylor rule model is rejected against a nonlinear Taylor rule for the UK data. Specifically, the authors show that the Taylor rule describes interest rate changes of the BOE only when inflation rate is more than about half percent above the stated target level; otherwise, interest rate follows a random walk unrelated to expected inflation but with a small link to outputgap. Cukierman and Muscatelli (2008)

also find that before the inflation targeting period the BOE was applying Taylor rule mainly to avoid recessions; after the Bank started implementing inflation targeting, positive inflation shocks started to bring about more vigorous changes in the interest rates than negative inflation shocks.

Hence the poor performance of the above Taylor rule, in terms of the low R-squared value and insignificant coefficient values for output and inflation may be explained by wider set of variables that the BOE take into consideration as well as the nonlinearities in its monetary policy conduct. Nevertheless, significance of the REER and its expected (negative) sign indicates that the BOE take exchange rate changes into consideration while setting its policy interest rates and it tends to mitigate exchange rate fluctuations.

Canada Analysis

Canada is a small open economy and its economy is highly integrated with that of the United States. In addition to the effect of the REER, it would be enlightening to see if the close economic relation between the US and Canada could be detected in monetary policy conduct of the BOC. To this end, we add the Fed's policy interest rates as an additional explanatory variable to the policy specification of the BOC.

Starting from 1996, the BOC started using overnight interest rates as its key policy interest rate (during 1980-1996 the BOC was following a floating rate). Hence, our analysis for Canada starts from 1996 and ends in December 2007. Implementing the GMM estimation method we get the following results.

Table 3. GMM Estimation for Canada

	Coefficient	Std. Error	t-Statistic	Prob.
C	3.323820	0.773251	4.298501	0.0000
Outputgap	0.046883	0.044061	1.064059	0.2892
Inflation	0.309907	0.111203	2.786852	0.0061
REER	-0.031567	0.008023	-3.934444	0.0001
Fed Rates	0.632051	0.050316	12.56158	0.0000
R-squared	0.738803	Mean dependent var		3.829710
Adjusted R-squared	0.730947	S.D. dependent var		1.172598
S.E. of regression	0.608230	Sum squared resid		49.20254
Durbin-Watson stat	0.109300	J-statistic		10.56329
Instrument rank	25	Prob(J-statistic)		0.956771

The p-value for the J-statistics indicates a correct model specification of the BOC's interest rate setting policies. Regarding the coefficients, while REER and the Fed Rates are both significant and have the expected signs, outputgap is not significant and the inflation coefficient is smaller than one (i.e., it doesn't meet the Taylor principle for maintaining a stable inflation). Insignificance of outputgap and the weak response to inflation coefficient might stem from the presence of the coefficients for REER and the Fed Rates.

The coefficients indicate that, the BOC decreases its policy interest rate in response to an increase in the REER (or an appreciation). Moreover, the Fed Rates coefficient indicates that the BOC tends to synchronize its interest rate adjustments with that of the Fed's. When the Fed changes its policy interest rate, the BOC also tends to change its interest rate. Therefore, in addition to the fluctuation in the exchange rate, the BOC is also concerned about the levels of its exchange rate. Keeping the interest rates in conformity would prevent divergence in the two countries' exchange rate due to interest rate differentials.

Norway Analysis

Like Canada, Norway is another small open economy and it is highly integrated with the European market (Norway is a member of the European Economic Area, EEA). In order to analyze the influence of European Central Bank (ECB) on NB's monetary policy conduct, we incorporate the ECB's policy interest rates as an additional explanatory variable to the policy specification of the NB. Accordingly, our analysis starts from January 1999, a few months after the ECB was established and when euro was introduced.

Table 4. GMM Estimation for Norway

	Coefficient	Std. Error	t-Statistic	Prob.
C	3.825163	3.333906	1.147352	0.2541
Outputgap	0.069384	0.044347	1.564556	0.1210
Inflation	0.606309	0.135644	4.469863	0.0000
REER	-0.035912	0.032378	-1.109145	0.2701
ECB Rates	1.440026	0.144715	9.950738	0.0000
R-squared	0.640998	Mean dependent var		4.435644
Adjusted R-squared	0.626039	S.D. dependent var		2.039502
S.E. of regression	1.247203	Sum squared resid		149.3294
Durbin-Watson stat	0.086818	J-statistic		15.05276
Instrument rank	33	Prob(J-statistic)		0.977873

The p-value of the J-statistic again implies a correct model specification for NB's conduct of monetary policy. As in Canada, outputgap and inflation have expected signs but coefficient for outputgap is statistically insignificant and inflation coefficient does not meet the Taylor principle as it is smaller than 1. The REER and ECB rates also have the expected signs. Even though REER is not statistically significant the ECB Rates are statistically and economically significant, with a coefficient of 1.44.

Hence, the results for Norway also indicate concerns for the level and the volatility of the exchange rates while setting policy interest rates.

5. Conclusion

In this chapter we have argued that despite the fact that exchange rate concerns are central to both national and international monetary policy arrangements, they are often omitted out from theoretical and empirical monetary policy arguments even in open economy set-ups. Hence, we investigated whether monetary policy makers in small open economies do indeed take exchange rates into consideration while setting policy interest rates. To this end, we added the REER as an additional explanatory variable into our simple monetary policy rule and analyzed monetary policies of the US, the UK, Canada and Norway.

For the US, a large and relatively closed economy, we didn't find REER to be significant. For the UK, we found that exchange rate concern is quite significant. For Canada and Norway, due to their close integration with the US and Europe, respectively, we also incorporated policy interest rates of the Fed and ECB as an explanatory variable. We found that for Canada both the REER and the Fed rates are quite significant. For Norway, the results indicate that even though monetary authorities are concerned about the REER, the coefficient is not statistically significant; though, ECB rates are both statistically and economically significant. Hence, we conclude that exchange rate concerns, both in terms of alignment and level explicitly enter the decision making processes of small open economies.

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CHAPTER III

III-Why Monetary Policy Makers Should be Concerned about Exchange Rate Stability: An Alternative Explanation

ABSTRACT

Despite monetary policy makers' tendency to mitigate exchange rate fluctuations, the present literature does not propose a convincing argument about cost of exchange rate variability. Studies find that costs on pertinent variables to exchange rate fluctuation, such as level of international trade, investment and household welfare are rather moderate. In order to provide a practicable argument regarding the cost of exchange rate variability we develop a two sector (with producers and retailers) open economy model, where retailers set their prices on a staggered basis. In face of exchange rate fluctuations, retailers need to adjust composition of their sales for profit maximization. Retailers' sales adjustment and corresponding requisite for producers to work with extra capacity or inventory incurs cost both on retailers and producers. Monetary policy makers are able to mitigate exchange rate variability and let the economy work at flexible price level of output. On this account, we suggest that an exchange rate concern should be inserted into central banks' loss function together with inflation and output level.

JEL Classification: E12; E58; F41

Keywords: Exchange rate stability; New Keynesian open economy model; Monetary policy

1. Introduction

In the previous chapter we showed that central banks (CB), in particular the ones in small open economies tend to mitigate exchange rate fluctuations and that they are concerned about exchange rate levels. However, a convincing argument in favor of exchange rate stability is missing in the present literature. While conventional wisdom assumes that exchange rate stability stimulates international trade, provides a more favorable environment for investment, and maximizes household welfare; studies imply that exchange rate stability has, at best, some minor positive effects on the economy. This chapter aims at developing a model that accounts

for exchange rate stability concerns based on the empirical findings of Baum and Caglayan (2008, 2010) that exchange rate variability generates significant trade volatility.

Baum and Caglayan (2008, 2010) find that while the relationship between exchange rate volatility and volume of bilateral trade is weak, the relationship between exchange rate volatility and variability of bilateral trade flow (i.e., trade volatility) is significant and important in magnitude. Specifically, the authors show that a one standard deviation increase in exchange rate volatility increases trade volatility by a median estimated value of 8.16 percent. Relying on these findings, we argue that trade flow variability as a result of exchange rate fluctuations might generate significant cost on producers and retailers.

In order to present how such a cost would arise, we develop a two sector open economy model. Producers sell their products both in the domestic and foreign market; and retailers act as an intermediary sector between producers and households. We assume price rigidity at the retailer level; retailers set their prices in advance according to their expectations of producer prices and exchange rate levels. As exchange rate fluctuates, retailers need to adjust composition of their sales between domestic and imported goods in order to maximize their profit. The adjustment incurs costs both on retailers and producers. While active management of composition of sales and exchange rate risk incur costs on retailers, the requisite to adjust production or to work with extra capacity to meet the fluctuation in demand incur costs on producers. These costs generate a basis for policy makers to mitigate exchange rate fluctuations. And our monetary policy analysis indicate that active monetary policy management can stabilize exchange rate variability and let the economy operate at its natural level of output.

The chapter is organized as follows. The following section reviews the literature on cost of exchange rate volatility. Section 3 presents the model and role of central banks in this setting. The last section concludes.

2. Literature Review: Cost of Exchange Rate Volatility

An initial reflection on effects of exchange rate volatility points out to depressed international trade, lower investment and growth, and reduced household welfare. However, empirical analyses show that exchange rate volatility does not generate significant costs on the real economy. For instance, surveying the literature on effects of exchange rate volatility on trade, Cote (1994) finds that both theoretical and empirical studies produce mixed results; while

some studies suggest positive or no effect of exchange rate volatility on trade level, some of them suggest small negative effect. According to the author, mixed results are due to specific assumptions and different analysis periods used in studies. In a more recent survey, Clark et al. (2004) arrive to a similar conclusion with that of Cote (1994). The latter study also runs an empirical test that employs gravity model;²⁹ however, the authors again find no robust negative impact of exchange rate volatility on trade, and when such an impact is present it turns out to be weak in magnitude.

Negative effects of exchange rate volatility on investment, growth and welfare are also found to be small in magnitude. Studies about effect of exchange rate volatility on investment and growth essentially concentrate on firm level analysis. In corporate finance, whenever net present value of a project is positive, the investment is implemented. Dixit and Pindyck (1994) show that when irreversibility of investment is also taken into account “holding (or, delaying) investment” also enters to firms’ decision strategy. Accordingly, the authors argue that when irreversibility is present together with uncertainty, firms require a higher net present value to implement investment; and this reduces investment and growth levels. Darby et al. (1999) extend this model to include exchange rate volatility as a source of uncertainty. Nevertheless, in this analysis, investment level depends on how frequently investors observe their reserve prices (the minimum net present value they require to implement the investment) and exchange rate stability does not necessarily stimulate investment. Given sufficient conditions, higher exchange rate volatility may even stimulate investment as it increases the probability of observing reserve prices of investors.³⁰

Goldberg (1993) also suggests that theory about the effect of exchange rate level and its variability has competing predictions on investment decisions. The author notes, while depreciation may increase foreign demand for domestic goods and may stimulate investment, it also has real-income reducing effect, which may well contract domestic demand more than the increase in foreign demand for domestic goods. Goldberg (1993) also comments on the effect of exchange rate volatility on foreign direct investment. She argues that even if exchange rate volatility may be undesirable on aggregate, this uncertainty may induce foreign direct investment for producers that want to diversify risk. Due to inconclusive theoretical predictions, the author runs some empirical analysis; however, the empirical results also turn out to be conflicting. While depreciations and exchange rate volatility stimulated investment

²⁹ In gravity models trade between two countries depends on their incomes and distance between them.

³⁰ Obviously, there are cases where exchange rate volatility depresses investment.

in 1970s, it depressed investment in 1980s. The author also adds that detrimental effects of exchange rate volatility remain quantitatively small.³¹

Regarding the welfare costs of exchange rate volatility, the literature suggests that trade level and household welfare are either not correlated, or when they are correlated, the welfare cost of exchange rate volatility is small. In this regard, Bacchetta and van Wincoop (2000) develop a general equilibrium model, but they find no one to one correlation between exchange rate stability and welfare. The authors compare trade under fixed and flexible exchange rate regimes separately and they show that depending on the assumptions about household preferences regarding consumption and leisure, trade level can be higher in either of the exchange rate regimes. Moreover, while trade can be higher in one regime, welfare can be higher in the other one. It is due to different determinants of trade and welfare: while household welfare is determined by variance of their consumption and leisure; trade level is determined by certainty equivalent of firms' revenues and costs in the home market relative to foreign market. Bergin, Tchakarov and Shin (2005) make a quantitative analysis of effect of exchange rate variability on welfare. In a baseline model, the authors find welfare effects to be small; welfare costs are significant only when habit persistence in consumption and asymmetric asset markets are considered. For this conclusion to hold, however, exchange rate variability must lead to lower output, which is not supported by the data and theory as mentioned above.

Comparing fixed and flexible exchange rate regimes, Devereux and Engel (2003) argue that incomplete exchange rate pass through eliminates the expenditure switching effect of flexible exchange rates in face of country-specific productivity or demand shocks. In return, benefit of exchange rate flexibility disappears and optimal monetary policy turns out to be fixed exchange rate regime. Sutherland (2005) extends this model to analyze the link between exchange rate volatility, incomplete pass-through and welfare. He finds that welfare may be increasing or decreasing in nominal exchange rate volatility in a "complicated relationship"; optimal monetary policy may entail either stabilizing or destabilizing the exchange rate. Hence, while result of Devereux and Engel (2003) can be considered in support of exchange rate stabilization, Sutherland (2005) finds contradictory results when welfare effects are incorporated into the analysis.

³¹ Besides these competing factors, it is empirically difficult to single out the effect of exchange rate uncertainty on investment and growth in the long run due to changes in other variables such as costs and tastes or some fiscal factors.

One would argue that small costs of exchange rate fluctuations may be due to availability of hedging instruments, which may foreclose the cost of exchange rate fluctuations. However, Wei (1999) argues that hedging is not costless and its cost often increases together with exchange rate volatility. Moreover, the author argues that hedging instruments are often available for short term horizons that they cannot insure exporters, importers or investors against exchange rate fluctuations. Hence, in the present literature, cost of exchange rate volatility or policy makers' inclination to reduce exchange rate variability remains unexplained.

Nevertheless, more recent research by Baum and Caglayan (2008, 2010) indicate that exchange rate variability generates some significant volatility on trade volume (not level). On the back of this finding, we argue that demand and production volatility, driven by exchange rate fluctuations might generate significant costs on the real sector. In order to demonstrate how such a cost would arise, the following section presents a two sector open economy model with producers and retailers.

3. A Two-Sector Open Economy Model

While long run benefits of exchange rate stability would be shared by greater parts of the society, the immediate burden of exchange rate volatility would fall on exporters and importers. However, single sector models where producers sell directly to domestic and foreign households are not practicable to elucidate the cost of trade volatility on the real sector. Hence, we insert a retail sector into a standard New Keynesian open economy model where exchange rate volatility generates trade flow volatility. To maximize profit, retailers need to adjust composition of their sales as exchange rate fluctuates; in return, producers need to work with extra capacity or inventory to meet fluctuating demand from the retailers. While exchange rate variability driven demand and production volatility is argued to generate costs on the real sector, it generates a basis for policy makers to mitigate exchange rate fluctuations.

Exporters and importers are introduced in different studies where exchange rate is also a concern. For instance, Viaene and de Vries (1992) investigate the relationship between the volume of trade and exchange rate volatility in a well-developed forward markets. The authors analyze behavior of exporters and importers separately and they conclude that the two parties take opposite hedge positions on the forward market as they are on the opposite sides of the market. Monacelli (2005) employs exporters and importers in order to introduce imperfect exchange rate pass-through; where he also studies the impact of incomplete pass-

through on the optimal conduct of monetary policy. The main finding of Monacelli (2005) is that isomorphism of closed and open economies (as suggested by Clarida, Gali, Gertler (2001) and Taylor (2001)) disappear when incomplete exchange rate pass-through is recognized. Corsetti and Dedola (2005) also introduce incomplete exchange rate pass-through by optimal international price discrimination in a two country model with exporters and importers. The authors introduce endogenous pricing to market into this general equilibrium open-economy model, and thereby account for deviations from the law of one price. However, neither of these studies analyze whether if exchange rate variability incurs cost on exporters and importers separately and asymmetrically. Hence, they do not explore if monetary policy makers should maintain exchange rate stability due to concern on the real sector.

This paper attempts to contribute to the literature by developing such an analysis in a two sector open economy model. In our model, exchange rate variability is not required to depress the trade level; volatility of trade volume is sufficient to generate extra cost on exporters and importers. Since empirical findings of Baum and Caglayan (2008, 2010) supports such effect of exchange rate volatility, our model provides an alternative explanation to the cost of exchange rate volatility.

3.1 The Model

The model that we develop is essentially a standard New Keynesian model, such as the one presented in Gali (2008, Chp. 3). The open economy set up is analogous to that of Corsetti and Pesenti (2005) and Gali and Monacelli (2005); and the two sector characteristics are akin to that of Monacelli (2005). The model consists of government, firms and optimally behaving households. Firms maximize profits; optimally behaving households maximize their expected present value of utility; and government is represented by central bank (CB), who is in charge of the monetary policy.

Households

Infinitely lived households in both countries have identical preferences; they derive utility from consuming composite consumption good and derive disutility from labor supply to the firms in exchange for wage incomes. Households maximize the lifetime expected present value of utility:

$$E_0 \sum_{t=0}^{\infty} \beta^t U(C_t, N_t)$$

where C_t is a consumption index and N_t denotes hours of work; $\beta < 1$ is the discount rate.

Composite consumption index is composed of domestically produced goods and imported goods; it is defined by

$$C_t \equiv [(1 - \alpha)^{1/\eta} (C_{H,t})^{(\eta-1)/\eta} + \alpha^{1/\eta} (C_{F,t})^{(\eta-1)/\eta}]^{\eta/(\eta-1)}$$

Domestic consumption goods index and imported consumption goods index are given by constant elasticity of substitution (CES) function

$$C_{H,t}(i) = \left(\int_0^1 C_t(h, i)^{(\varepsilon-1)/\varepsilon} dh \right)^{\varepsilon/(\varepsilon-1)}$$

$$C_{F,t}(i) = \left(\int_0^1 C_t(f, i)^{(\varepsilon-1)/\varepsilon} df \right)^{\varepsilon/(\varepsilon-1)}$$

α : is the share of imported goods in total consumption and it may be thought of as a measure of openness.

$\eta > 0$: is the elasticity of substitution between domestic and foreign goods.

h and f : denote the good variety produced in home and foreign country, respectively (and each variety of good is produced by a monopolistic competitive firm).

$i \in [0,1]$: denotes the household index.

$\varepsilon > 1$: is the elasticity of substitution between the goods within domestic and foreign produced goods.

$C_t(h, i)$ and $C_t(f, i)$ are, respectively, consumption of home brand h and foreign brand f by home household i at time t . Consumption indices in the foreign country, $C_{H,t}^*(i^*)$ and $C_{F,t}^*(i^*)$ are analogously defined.

First stage optimization problem of households

Households would always want to minimize their expenditure to buy one unit of the composite consumption good. Hence, household i minimizes $\int_0^1 P_{H,t}(i) C_{H,t}(i) di$ subject to domestic good index; the same minimization is carried out also for the imported goods. The optimal allocation leads to the following utility based price of a consumption bundle of domestically produced and imported goods:³²

$$P_{H,t} = \left(\int_0^1 P_t(h)^{1-\varepsilon} dh \right)^{1/(1-\varepsilon)} \quad P_{F,t} = \left(\int_0^1 P_t(f)^{1-\varepsilon} df \right)^{1/(1-\varepsilon)} \quad (1)$$

We also obtain the following demand function for each category of goods from the expenditure minimization problem:

$$C_t(h, i) = \left(\frac{P_t(h)}{P_{H,t}} \right)^{-\varepsilon} C_{H,t}(i) \quad C_t(f, i) = \left(\frac{P_t(f)}{P_{F,t}} \right)^{-\varepsilon} C_{F,t}(i) \quad (2)$$

The demand function for the home good h says that, household i 's demand for home good h depends on the relative price (with price elasticity ε) and the size of household's total consumption of home goods. Demand for the foreign good is analogously defined.

The optimal allocation of expenditures between domestic and imported goods gives the demand functions for aggregate Home and Foreign goods:

$$C_{H,t} = (1 - \alpha) \left(\frac{P_t(h)}{P_t} \right)^{-\eta} C_t \quad C_{F,t} = \alpha \left(\frac{P_t(f)}{P_t} \right)^{-\eta} C_t$$

Where the corresponding consumer price index (CPI) reads:

$$P_t = \left[(1 - \alpha) P_{H,t}^{1-\eta} + \alpha P_{F,t}^{1-\eta} \right]^{1/(1-\eta)}$$

Second Stage Optimization of Households

Taking prices and wages as given, domestic households maximize U_t subject to the budget constraint. Households receive wage income and earn dividends from portfolio of firms' shares. The period budget constraint is given by,

$$P_t C_t + E_t \{ Q_{t,t+1} D_{t+1} \} \leq D_t + W_t N_t + T_t$$

Where total consumption of households is given by $P_t C_t = P_{H,t} C_{H,t} + P_{F,t} C_{F,t}$.

³² Derivations are addressed in the Appendix.

D_{t+1} is the nominal payoff in period $t + 1$ of the portfolio held at the end of period t .

Q_{t+1} is the stochastic discount factor for one period ahead nominal payoffs relevant to the domestic household.

W_t is the nominal wage. And T_t is the lump sum taxes or transfers; all expressed in terms of domestic currency.

Following the literature, we specify the period utility function as:

$$U(C, N) \equiv \frac{C^{1-\sigma}}{1-\sigma} - \frac{N^{1+\varphi}}{1+\varphi}$$

As shown in the Appendix, the optimality condition for household leads to standard intratemporal optimality condition, which determines the quantity of labor supply as a function of real wage, given the marginal utility of consumption:

$$C_t^\sigma N_t^\varphi = \frac{W_t}{P_t} \tag{3}$$

which can be represented in log form as: $w_t - p_t = \sigma c_t + \varphi n_t$

And the Euler condition for the optimal intertemporal consumption allocation in log form reads:

$$c_t = E_t\{c_{t+1}\} - \frac{1}{\sigma}(r_t - E_t\{\pi_{t+1}\} - \rho) \tag{4}$$

where $\pi_t = p_t - p_{t-1}$ is the CPI inflation; $\rho = -\log\beta$ is the time discount rate; $r_t = -\log Q_t$ is the short term nominal interest rate, which is assumed to be the monetary policy instrument.

Aggregate Supply

Monopolistically competitive firms produce different varieties of consumption goods; each good is an imperfect substitute to all other varieties. As an intermediary sector between producers and households we append retailers. Retailers buy both from local producers and import goods from foreign producers. Retailers could be thought as department stores where both domestic and imported goods are provided to final consumers. Below, we first introduce the production process and then analyze the price setting mechanism both for producers and retailers.

There is a continuum of monopolistic competitive firms and each firm produces a differentiated good. In accordance with their production, firms are also indexed by the variety of goods that they produce. All the firms use identical production function. The production function for home firm $h \in [0,1]$ reads:

$$Y_t(h) = A_t N_t(h)$$

where A_t represents the level of technology, common to all firms and evolve exogenously over time. Each firm typically minimizes its cost $W_t N_t$ subject to the production function:

$$\min W_t N_t + \delta_t (Y_t - A_t N_t)$$

The first order condition gives the marginal cost:

$$MC_t = \delta_t = \frac{W_t}{A_t} \tag{5}$$

and the real marginal cost in log form reads: $mc_t = (w_t - p_{H,t}) - a_t$

Market clearing requires, supply of good variety h to be equal to demand by home consumer i and foreign consumer i^* :

$$Y_t(h) = \int_0^1 C_t(h, i) di + \int_0^1 C_t^*(h, i^*) di^* \tag{6}$$

Price Setting

In the New Keynesian set up, prices are assumed to be rigid. For simplicity, we assume that price rigidity is only at the retailer level; producer prices are assumed to be adjusted flexibly.³³ Because producers sell both to the domestic and foreign retailers they need to set two different prices. Nevertheless, we assume that there is no deliberate price discrimination in the foreign market. Home producer h 's price in the domestic market is $P_t(h)$ and in the Foreign market it is $P_t^*(h)$.

There are three possible settings for export invoice currency. Producers can set their invoice in home currency (producer currency pricing or PCP), in the currency of the buyer (local currency pricing or LCP); and in case of multi-country analysis, in a strong currency that is widely used in international transactions, such as the USD (vehicle currency pricing or VCP). PCP indicates complete exchange rate pass-through (ERPT), however in the literature ERPT

³³ Applying price rigidity also at the producer level would complicate the analysis without adding extra insight.

is found to be partial. For instance, Campa and Goldberg (2005) find that the unweighted average of ERPT elasticities across 25 OECD countries to be approximately 46% over one quarter, and 64% over the long term. In terms of determination of export invoice currency Friberg (1998) shows under some general conditions and under exchange rate uncertainty, LCP yields higher expected profits. Aubin (2012) analyzes trade and payment transactions data and concludes that the use of the US dollar and the euro in global trade is much higher than the US's and Europe's share in global trade volumes. The study indicates VCP is highly practiced in international trade.

These studies imply that, for a small open economy, it is more likely that exporters set their invoice currency according to LCP or VCP; and that is what we assume in this paper. Both pricing practices have identical implications in terms of optimal price determination. Under no deliberate price discrimination in the foreign market, the export price of the domestic producer reads: $P_t(h) = S_t P_t^*(h)$; where S_t is the nominal exchange rate.³⁴

Accordingly, the profit function to be maximized with respect to these two prices is:

$$\max \Pi_t(h) = P_t(h) \int_0^1 C_t(h, i) di + S_t P_t^*(h) \int_0^1 C_t(h, i^*) di^* - W_t N_t(h)$$

From the production function, $N_t(h)$ can be written as: $Y_t(h)/A_t$. Utilizing also equation (6), $\Pi_t(h)$ reads:

$$\begin{aligned} \Pi_t(h) = & P_t(h) \int_0^1 C_t(h, i) di + S_t P_t^*(h) \int_0^1 C_t(h, i^*) di^* \\ & - \frac{W_t}{A_t} \left(\int_0^1 C_t(h, i) di + \int_0^1 C_t^*(h, i^*) di^* \right) \end{aligned}$$

Recall that firms must take the downward sloping demand function given in (2) into account while setting their prices. Let's first rearrange the above equation in order to take its first order derivative with respect to $P_t(h)$:

$$\begin{aligned} P_t^{1-\varepsilon}(h) \cdot P_{H,t}^\varepsilon \cdot \int_0^1 C_{H,t}(i) di + S_t P_t^*(h) \int_0^1 C_t(h, i^*) di^* \\ - \frac{W_t}{A_t} \left(P_t^{-\varepsilon}(h) \cdot P_{H,t}^\varepsilon \cdot \int_0^1 C_{H,t}(i) di + \int_0^1 C_t^*(h, i^*) di^* \right) \end{aligned}$$

³⁴ An increase in S_t indicates depreciation of domestic currency.

And the maximization result reads:

$$(1 - \varepsilon) \cdot P_t^{-\varepsilon}(h) = \left(\frac{W_t}{A_t}\right) (-\varepsilon) \cdot P_t^{-\varepsilon-1}(h)$$

Rearranging this equation gives the optimal price setting:

$$\Rightarrow P_t(h) = \frac{\varepsilon}{\varepsilon-1} MC_t \quad (7)$$

Since we assume no deliberate price discrimination in the export market, the optimal price for the export market is given by:

$$P_t(h) = S_t P_t^*(h) = \frac{\varepsilon}{\varepsilon-1} MC_t \quad (8)$$

As ε is the constant elasticity of substitution, $\varepsilon/(\varepsilon - 1)$ is the constant markup reflecting the monopoly power of the firm. Hence, the optimal price under flexible prices is a markup over marginal cost. As the elasticity of substitution, ε , approaches to infinity, individual goods become closer substitutes and individual firms have less market power.

Finally, since all firms have identical production technology and all face the same demand curves, with constant and equal demand elasticity; all prices are symmetric across the firms:

$$P_t(h) = P_{H,t}$$

In the household optimization problem we found in equation (3) that the real wage is equal to the marginal rate of substitution between consumption and leisure. Inserting equation (3) to the optimal price setting of producers, we get the “natural” level of employment: That is, (3) plugged into (7), we get the potential output:

$$C_t^\sigma = \frac{\varepsilon-1}{\varepsilon} N_t^{-\varphi} A_t \quad (9)$$

And from the equation above we derive potential level of employment:

$$\bar{l} = \left(\frac{\varepsilon-1}{\varepsilon}\right)^{1/\sigma} N_t^{-\varphi/\sigma} \quad (10)$$

The equation indicates that under flexible prices, employment is at some constant level, which is referred to as “potential or natural level of employment”. As given in the equation, the potential level of employment depends negatively on the market power of firms and disutility of labor effort.

Retailers' Price Setting and Demand Determination

As mentioned above, we assume that retailers set their prices on a staggered fashion. In the New Keynesian models, staggered price setting is due to Calvo (1983). In the Calvo model, each firm has a constant probability (say, θ) to adjust its prices in each period and price adjustment opportunities occur randomly. Goodfriend (2004) provides the following rationale for price stickiness: it is costly to a firm to determine the price that maximizes its profit at each point in time. The cost is due to obtaining information on demand and cost conditions and getting this information assessed by the top management. Therefore, a firm considers whether to change its product price only when demand and cost conditions are expected to move the actual markup significantly and persistently away from the profit maximizing markup level.

As retailers make purchases from both the domestic and foreign producers, producer prices and exchange rates (for imported goods) make up the marginal cost of retailers. And because retailers' prices remain fixed over the period determined by the probability θ , they need to set their prices according to their expectations of marginal costs (and their markups) as shown in the optimal price formula.

Once retailers set their prices at the beginning of each term, they should be ready to meet the demand at the given prices until they get the chance to change their prices. However, if for example, producer prices or exchange rates increase such that retailers' ex post markups fall below one (i.e., $MC_t^{Ret.} > P_t^{Ret.}$) retailers will not be willing to accommodate the demand. This is called the '**participation constraint**'. Hence, in setting both the domestic and imported goods prices, retailers solve an optimal dynamic markup problem, such that retail prices remain as close as possible to their desired (optimal) prices over the period that their prices remain fixed. Like producers, retailers also need to take into account the downward sloping demand of households while setting their prices.

Accordingly retailers solve the following maximization problem in order to maximize the retail price of the domestic goods, $P_t^{Ret.}(h)$:

$$E_t \left\{ \sum_{k=0}^{\infty} \beta^k Q_{t,t+k} \theta_H^k (P_t^{Ret.}(h) - P_{t+k}(h)) C_{t+k}(h, i) \right\}$$

such that, $C_{t+k}(h, i) = \left(\frac{P_t^{Ret.}(h)}{P_{H,t+k}} \right)^{-\varepsilon} C_{H,t+k}(i)$

where $\beta^k Q_{t,t+k}$ is the discount factor and θ_H^k is the probability that the price set at time t still holds k periods ahead. Domestic good h 's price, $P_t(h)$, is the marginal cost for the retailer.

The first order condition of the problem yields:

$$P_t^{Ret.}(h) = \left(\frac{\varepsilon}{\varepsilon-1} \right) \frac{E_t \{ \sum_{k=0}^{\infty} \beta^k Q_{t,t+k} \theta_H^k (P_{t+k}(h) C_{t+k}(h,i)) \}}{E_t \{ \sum_{k=0}^{\infty} \beta^k Q_{t,t+k} \theta_H^k C_{H,t+k}(i) \}} \quad (11)$$

Likewise, for imported good i retailers set $P_t^{Ret.}(f)$ in order to maximize:

$$E_t \left\{ \sum_{k=0}^{\infty} \beta^k Q_{t,t+k} \theta_F^k \left(P_{F,t}^{Ret.}(i) - S_{t+k} P_{t+k}(f) \right) C_{t+k}(f,i) \right\}$$

$$\text{such that, } C_{t+k}(f,i) = \left(\frac{P_t^{Ret.}(f)}{P_{F,t+k}} \right)^{-\varepsilon} C_{F,t+k}(i)$$

where $S_t P_t(f)$ is the marginal cost of the imported good f for the retailer.

And the first order condition yields:

$$P_{F,t}^{Ret.}(f) = \left(\frac{\varepsilon}{\varepsilon-1} \right) \frac{E_t \{ \sum_{k=0}^{\infty} \beta^k Q_{t,t+k} \theta_F^k (S_{t+k} P_{t+k}(f) C_{t+k}(f,i)) \}}{E_t \{ \sum_{k=0}^{\infty} \beta^k Q_{t,t+k} \theta_F^k C_{F,t+k}(i) \}} \quad (12)$$

The first order conditions show that, as in producer prices, the optimal price for retailers is a markup over marginal cost. But because retailers' prices are fixed they generate an expectation for their marginal cost which is composed of producer prices and (in case of imported goods) exchange rates.

Typically, once retailers set their prices, they stand ready to meet demand at the ongoing prices as long as their prices remain above their marginal cost. If, however, producer prices increase or exchange rates depreciate such that marginal cost of retailers exceeds their (preset) prices, then participation constraint would be violated and retailers would prefer to not to provide the good to consumers. Moreover, even if the participation constraint is not violated, if retailers have capacity constraint, their rate of profit from sale of domestic and imported goods may vary depending on the producer prices and exchange rate movements. And depending on their profit margins, retailers may change the composition of the goods that they provide.

To be more concrete, let us assume that the economy we consider is Turkey and retailers' import invoice currency is US dollar. Assume that the exchange rate, S_t , is 2 (that is, one US dollar is exchanged for 2 Turkish liras). And assume that both the domestic and foreign

producers' prices remain the same over the given period; such that, $P_{H,t}(i)$ is 10 TL and $P_{F,t}(i)$ is \$5.

If the exchange rate depreciates, let's say to 2.2 USD/TL; retailers' marginal cost for the imported good increases from 10TL to 11TL. Because retailers' prices are rigid, they have to absorb the rise in marginal cost and keep on providing the good to their consumers as long as the rise does not violate the participation constraint.³⁵ However, even if the participation constraint is not violated, the exchange rate movement alters the profit margins from imported goods. The new profit rates, in return, would determine the composition of sales of the retailers. That is, if the rate of profit from domestically produced good sales exceeds the rate of profit from imported good sales, retailers may prefer to provide less of imported goods and more of domestically produced goods in order to maximize their overall profits. Adjustment in the composition of sales may become more essential when firms are capacity constrained in the short run.

Retailers' adjustment of composition of sales indicates volatility in the volume of trade at the aggregate level. Accordingly, the model that we suggest provides an explanation for exchange rate volatility driven fluctuation in the volume of trade as empirically demonstrated by Baum and Caglayan (2008, 2010). Fluctuation in trade volume incurs costs both to retailers and to producers. While retailers need to adjust composition of sales would incur costs on them; adjustment in output (or working with extra capacity or inventory) would incur costs on producers. Hence, in order to eliminate these costs, monetary policy makers' would target flexible price level of output. We now turn to optimal monetary policy setting.

3.2 Monetary Policy

We have shown above that under flexible prices the economy operates at its natural level of output (or the potential level of employment). However, under staggered prices, retailers' set their prices according to their expectations for producer prices and expected exchange rate levels. Provided that retailers' expectations coincide with the actual values, potential level of employment would still be maintained. However, productivity shocks and exchange rate fluctuations would impede the economy to operate at its natural level. Let us now see what role central banks would assume in maintaining the potential level of employment.

³⁵ If market power of firms are small (i.e., if the markups are low) even small changes in exchange rates may violate the participation constraint.

Monetary Policy Instrument

Monetary policy instrument is represented by a rule for setting the nominal interest rate, r_t . Since retailers set their prices in a forward-looking manner it is analytically convenient to introduce a forward looking measure of monetary stance, μ_t , such that:³⁶

$$\frac{1}{\mu_t} = \beta(1 + r_t)E_t\left(\frac{1}{\mu_{t+1}}\right) \quad (13)$$

which implies that monetary easing at time t (μ_t temporarily above trend) reflects either a temporary interest rate cut at time t , or expectation of temporary interest rate cuts sometime in the future.

Comparing the Euler equation given in the Appendix: $P_t^{-1}C_t^{-\sigma} = \beta R_t E_t\{P_{t+1}^{-1}C_{t+1}^{-\sigma}\}$ with the monetary stance, we obtain

$$\mu_t = P_t C_t^\sigma \quad (14)$$

And using the optimality condition for the labor supply (3) as well, we obtain

$$\mu_t = \frac{W_t}{N_t^\phi} \quad (15)$$

The two equations above indicate that a monetary expansion raises nominal spending and real wages. This is a basic effect of monetary policy with preset prices and competitive wages. Aggregate demand moves with the money supply, to accommodate the higher demand firms hire more workers, and this increases the wage rate.

Role of Monetary Policy

The analysis above shows that, it is possible to maintain flexible price level of output with active monetary policy management. In the New Keynesian framework optimal monetary policy is defined as the policy that maximizes the expected utility of the representative household in the presence of uncertainty and one-period nominal rigidities. In closed economies, the optimal monetary policy turns out to be the one that replicates flexible prices; this also ensures that the economy operates at its natural level of employment.³⁷ That is, at the optimum, CBs respond to productivity shocks and stabilize firms' markups at the flexible price levels. In open economy set ups, there are adjustments in optimal monetary policies, for

³⁶ As in Corsetti and Pesenti (2005)

³⁷ See for instance, Goodfriend (2004)

instance due to terms of trade concerns;³⁸ yet, on average, inflation stabilization turns out to be a good approximation of optimal monetary policy also in open economies.

Let's now turn to analyze the effects of productivity shocks and exchange rate fluctuations. A positive productivity shock would decrease marginal costs at the producer level (due to equation 5). Because prices are assumed to be flexible at the producer level, the increase in productivity would be transferred into lower prices. Accordingly, the equilibrium level of employment would still be maintained as higher productivity would be accompanied by lower prices (and, in return, by higher demand). However, because prices are rigid at the retailer level, lower producer prices would not be transferred to consumers. Hence the chain that would bring the supply and demand conditions into equilibrium and sustain the economy at the potential level of employment is distracted by price rigidity at the retailer level.

Nevertheless, the CB may still facilitate the economy to operate at its natural level by increasing the money supply. That is, as exogenous monetary shocks are non-neutral in this setting, consumption would rise due to loose monetary policy stance, as shown by equation (14). In return, higher output (due to higher productivity) would be accompanied by higher demand and the natural level of output would still be maintained.

A similar mechanism would work for changes in exchange rate. Exchange rate appreciation, for instance, translates into lower costs of imported goods for the retailer. However, because prices are rigid at the retailer level, consumers would not benefit from lower costs, but retailers' profit margin from imported goods would increase. Accordingly, profit maximizing retailers would adjust composition of their sales in favor of imported goods. This would translate into lower demand for domestic producers. Nevertheless, monetary expansion would bring back the domestic currency to its previous level and domestic producers' loss would be prevented.

Given exchange rate volatility driven trade volume flow and the corresponding costs on both retailers and producers call for active monetary policy management in terms of exchange rate stabilization. Exchange rate stabilization may both be in terms of preventing large fluctuations by direct intervention in the foreign exchange market or by considering the policy effects on exchange rate movements. In the following sub-section we investigate how a central bank's loss function would be adjusted when exchange rate concerns are appended into central bank loss function.

³⁸ See for instance, Benigno and Benigno (2006).

Central Bank Loss Function

In the literature the CB is typically assumed to minimize a loss function that is composed of deviation of inflation around a target level and deviation of output around the natural level, such as the following:

$$\min \gamma(\pi - \pi^*)^2 + \kappa(y - y_n)^2$$

It is often assumed that in such loss functions an explicit term for exchange rate movements is not necessary as changes in inflation would account for exchange rate movements. However, the argument that we have developed in this paper indicates that, besides its effects on inflation, exchange rate movements have further effects on the real economy.

Even if it is not always explicitly stated, as argued above, central banks should be concerned about the effects of exchange rate fluctuations on the real sector, as they are the ones who are directly affected by the fluctuations. As former Bank of England governor Eddie George noted in a speech “while maintaining macroeconomic stability, the Bank is also concerned with exchange rate stability as it promotes a more balanced economic growth” (George, 1999).

Moreover, as we have shown above, exchange rate fluctuations distract flexible price level of employment. Since maintaining flexible price level of output turns out to be optimal monetary setting in both closed and open economies, exchange rate stabilization in order to maintain flexible price level of employment is another argument in this respect.

Accordingly, we believe that a loss function which consists also an exchange rate argument would better capture central banks’ concerns. An explicit term for exchange rate fluctuation inserted into the loss function of the CB would read:

$$\min \gamma(\pi - \pi^*)^2 + \kappa(y - y_n)^2 + \vartheta(S_t - S_{t-1})^2$$

The loss function with exchange rate volatility concern also provides an alternative explanation for inertial interest rate changes of central banks, which argues that CBs’ tend to avoid frequent and aggressive interest rate changes; instead, it tends to move its interest rates to its new level only gradually.³⁹

³⁹ This issue is discussed in more detail in an Appendix to Chapter I.

4. Conclusion

In this chapter we have argued that despite the policy makers' observed tendency to mitigate exchange rate variability, the present literature does not provide a convincing argument about the cost of exchange rate volatility. Specifically, cost of exchange rate variability on level of international trade, investment and household welfare appears to be either neutral or negligible in magnitude.

Accordingly, we suggest an alternative explanation about the cost of exchange rate volatility based on the empirical findings of Baum and Caglayan (2008, 2010) that exchange rate volatility generates significant variability in trade flow. In order to explain exchange rate volatility driven trade flow variability, we developed a two sector open economy model with staggered price setting at the retailer level. According to the model, in order to maintain profit maximization, retailers need to adjust composition of their sales between domestic and imported goods as exchange rate fluctuates. Producers, in return, need to adjust their production or need to work with extra capacity or inventory. Adjustments of output and sales generate costs both on retailers and producers.

We also show that monetary policy makers can maintain flexible price level of output and thereby eliminate the need for production and sales adjustment in face of exchange rate variability. Hence, a central banker that is concerned about the real sector and price level stability should mitigate exchange rate variability; and exchange rate variability concern should be inserted into central bank loss function together with inflation and output variability.

It should be noted that there are additional factors that might intensify policy makers' response to exchange rate movement. For instance, our model could also account for a production scheme where producers use both domestic and imported raw materials in production. In such a case, cost of production would also vary with exchange rate movements; and in order to minimize cost, producers would need to adjust composition of their intermediate inputs as well.⁴⁰ While such adjustments would generate additional trade flows, and further conform to the findings of Baum and Caglayan (2008, 2010), for tractability concerns we did not include intermediate input arguments into our analysis.

⁴⁰ Nevertheless, because producers are also exporters, their export - import coverage ratio (in terms of foreign exchange income and expenditures) would also need to be considered.

Habit persistence in consumption might be another factor. As mentioned above, Bergin, Tchakarov and Shin (2005) investigate the cost of exchange rate volatility on household welfare and find that cost on household welfare is significant only if there is habit persistence in consumption of households. We noted that, for welfare cost with habit persistence to be significant in that setting, exchange rate fluctuations need to result in lower output; but the literature does not support this requirement. In our setting, on the other hand, volatility in goods available for consumption would generate cost on consumers with habit formation in utility function. Since habit formation implies that the marginal utility of current consumption depends upon both past and expected future consumption, it indicates concerns for changes in consumption. For instance, in a closed economy set up Amato and Laubach (2004) develops a general equilibrium model with sticky prices and habit formation in consumption. The authors find that interest rate rule that approximates optimal monetary plan imposes mitigating output variability in addition to inflation and output gap variability. Analogously, trade flows, in our set up, would induce costs on consumers with habit formation in consumption; and habit formation would enhance exchange rate stability concerns.

Nevertheless, some restrictions might apply on monetary policy makers' response to exchange rate movements. Determining the source of exchange rate fluctuation might be such a concern for the policy maker. Specifically, if an exchange rate appreciation is realized due to rise in demand to domestic goods, policy maker may want to accommodate this change. On the other hand, if the appreciation is due to capital outflow, policy maker would respond to the movement in exchange rate.

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Appendix

First stage optimization of households i.e., derivation of price indexes

$$\min \int_0^1 P_t(h) C_t(h, i) dh$$

subject to

$$C_{H,t}(i) = \left(\int_0^1 C_t(h, i)^{(\varepsilon-1)/\varepsilon} dh \right)^{\varepsilon/(\varepsilon-1)}$$

The corresponding Lagrangian reads:

$$\mathcal{L}_t(i) = \min \int_0^1 P_t(h) C_t(h, i) dh + \lambda_t \left[C_{H,t}(i) - \left(\int_0^1 C_t(h, i)^{\varepsilon-1/\varepsilon} dh \right)^{\varepsilon/\varepsilon-1} \right]$$

The first order condition for good h is:

$$\frac{\partial \mathcal{L}_t(i)}{\partial C_t(h, i)} = P_t(h) - \lambda_t \frac{\varepsilon}{\varepsilon-1} \left(\int_0^1 C_t(h, i)^{\varepsilon-1/\varepsilon} dh \right)^{\frac{\varepsilon}{\varepsilon-1}-1} \left(\frac{\varepsilon-1}{\varepsilon} \right) C_t(h, i)^{-1/\varepsilon} = 0$$

This can be rearranged as:

$$C_t(h, i) = \left(\frac{P_t(h)}{\lambda_t} \right)^{-\varepsilon} C_{H,t}(i) \quad (\text{A1.1})$$

Now, raise both sides of the equation to the $(\varepsilon-1)/\varepsilon$ power and take the integral over i brands:

$$\int_0^1 C_t(h, i)^{(\varepsilon-1)/\varepsilon} dh = \lambda_t^{\varepsilon-1} \left(\int_0^1 P_t(h)^{1-\varepsilon} dh \right) C_{H,t}^{\varepsilon-1/\varepsilon}$$

Solving for λ_t , we find that the λ_t is price index for domestically produced goods:

$$\lambda_t = \left[\int_0^1 P_t(h)^{1-\varepsilon} dh \right]^{1/1-\varepsilon} \equiv P_{H,t}$$

Inserting the above equation into A1.1 above, gives us the demand equation:

$$C_t(h, i) = \left(\frac{P_t(h)}{P_{H,t}} \right)^{-\varepsilon} C_{H,t}(i)$$

Second Stage Household Optimization Problem

$$\mathcal{L}_t(j) = \max U_t(i) + E_t \sum_{t=0}^{\infty} \beta^t \{ \chi_t(i) [P_t C_t + E_t \{ Q_{t,t+1} D_{t+1} \} - D_t - W_t N_t - T_t] \}$$

First order condition with respect to C_t : $\chi_t = -\frac{C_t^{-\sigma}}{P_t}$

First order condition with respect to N_t : $\chi_t = \frac{N_t^\varphi}{W_t}$

Rearranging these two equations gives intratemporal optimality condition: $C_t^\sigma N_t^\varphi = \frac{W_t}{P_t}$

First order condition with respect to D_{t+1} : $\chi_t E_t \{ Q_{t,t+1} \} = \beta \chi_{t+1}$

Inserting $\chi_t = -\frac{C_t^{-\sigma}}{P_t}$ into the above equation gives the intertemporal consumption allocation:

$$Q_t = \beta E_t \left\{ \left(\frac{C_{t+1}}{C_t} \right)^{-\sigma} \left(\frac{P_t}{P_{t+1}} \right) \right\}$$

Where $Q_t = E_t \{ Q_{t,t+1} \}$ denotes the price of a one-period discount bond paying off one unit of domestic currency in $t + 1$.⁴¹ Indicating $R_t = \frac{1}{E_t \{ Q_{t,t+1} \}}$ as the nominal interest rate, the Euler equation reads:

$$P_t^{-1} C_t^{-\sigma} = \beta R_t E_t \{ P_{t+1}^{-1} C_{t+1}^{-\sigma} \}$$

Rearranging this equation and writing in log linearized form gives the usual optimal intertemporal consumption allocation:

$$c_t = E_t \{ c_{t+1} \} - \frac{1}{\sigma} (r_t - E_t \{ \pi_{t+1} \} - \rho)$$

where $\pi_t = p_t - p_{t-1}$ is the CPI inflation; $\rho = -\log \beta$ is the time discount rate.

⁴¹ For elaboration on this part, see Galí (2008), page 154-155.

CHAPTER IV

IV-Macroeconomic Performance Index: A New Approach to Calculation of Economic Wellbeing⁴²

ABSTRACT

Since the rise of the global financial crisis there has been revival of interest in performance indexes that measures the overall stance of the economy and the wellbeing of households. Such indexes typically consist of inflation rates, growth rates, employment rates and long term interest rates. We extend the index by appending exchange rate and weighting each variable by the inverse of its variance in order to prevent the more volatile variable to dominate the index. We call this macroeconomic performance index (MPI) and argue that such an index better explains the economic stance especially in emerging economies. We have generated the index for three emerging economies; namely Turkey, Brazil and Poland for the period 2001-2014. Our analysis of the index for the subject countries indicates a nonlinear structure and hence we analyze the behavior of the index using threshold autoregression (TAR) model. It is observed that MPI captures the economic situation, developments and responses to shocks quite successfully in each country. To further see the relevance of the MPI we run TAR cointegration analysis with consumer confidence indexes for each subject country with Enders Siklos (2001) TAR co-integration test. The results indicate long term relationship between the MPI and consumer confidence indexes in all three countries.

JEL Classification: C52; E37; E66

Keywords: Economic wellbeing; Emerging economies; Threshold autoregression model

1. Introduction and the Literature Review

In 1970s inflation and unemployment elevated to record highs in the US. Specifically, consumer price index (CPI) inflation hit to 11.1% in 1974; and unemployment rate hit to 8.6% in 1975. As the burden of unemployment and inflation rates were inducing more hardship on households, economist Arthur Okun suggested the sum of these two variables as a measure of

⁴² This chapter is a joint work with Prof. Nazım Ekren and Assoc. Prof. Elçin Aykaç Alp.

misery on households, which is known as Okun's Misery Index (OMI). While the index reflects a measure of overall stance of the economy; for households, it indicates whether their job prospects improve and how their purchasing power evolves.

In 1999 Robert Barro incorporated gross domestic product (GDP) growth rate and long-term interest rates to the OMI in order to assess the performance of US presidents throughout their presidency terms. Barro (1999) calls this Barro Misery Index (BMI) and he argues that this is a better measure than the original misery index.

In a related study, Di Tella et al. (2001) analyze the weight of inflation and unemployment in social welfare functions. Specifically, by utilizing life satisfaction survey data and running an OLS regression analysis, authors test how the European and US citizens' level of wellbeing vary with inflation and unemployment. The results suggest that unemployment has a larger weight in a welfare function that is composed of unemployment and inflation. More explicitly, the authors state that "people would tradeoff a 1-percentage-point increase in unemployment rate for a 1.7 percentage-point increase in inflation rate".

In a similar manner, Welsch (2007) analyzes the determinants of life satisfaction for European citizens. When only inflation and unemployment rates are considered, the results suggest that (like that of Di Tella et al., 2001) people care more about unemployment than they do for inflation. However, when other variables in the BMI are included into the regression, it turns out that households care about growth and employment on the one hand, and "stability" on the other hand, where stability is measured either by inflation rate or long term interest rate.⁴³ In other words, Welsch (2007) finds that, people care about stability just as much as they care for growth and unemployment levels.

Since the economic outlook started to deteriorate by the rise of the global financial crisis in 2008, there has been revival of interest in misery indexes. For instance, an article by Bruce Yandle in the US News in March 6, 2012 suggests that Misery Index should again be taken into consideration more seriously in order to assess the impact of crisis on households' wellbeing. The author argues that, even if economic variables indicate that economic crisis is coming to an end and the situation seems to be improving, politicians should care more about improving everyday lives of households.

⁴³ When long term interest rates are included into the regression, the inflation rate becomes insignificant.

By the same token, Hanke (2014) argues that wellbeing of citizens should be watched more closely in hard times such as the global financial crisis. Accordingly, the author applies a version of BMI to US data and compares the periods where rather liberal policies were followed with the periods where the state assumed a larger role in the economy.⁴⁴ Hanke (2014) further suggests that such indexes can easily be used for global comparisons, and accordingly he constructs a misery ranking for 89 countries.

A macroeconomic performance index that measures the overall stance of the economy and wellbeing of citizens and that allows for inter-temporal and inter-country comparisons would be valuable for economic policy analysis particularly in emerging economies. Nevertheless, we believe that in addition to inflation, unemployment, growth rates, and long term interest rates, exchange rates should also be an integral part of such indexes.

Exchange rate level and its stability are important at both macroeconomic and microeconomic level both in tranquil and crisis times. Today most countries follow “managed floating” or “limited flexibility” exchange rate systems (rather than “free floating”), where central banks keep foreign currencies in their reserves and intervene to exchange markets occasionally. Indeed, Calvo and Reinhart (2002) show that even the countries that report to the IMF that they let their currencies float, actually intervene into exchange rate market and prevent large currency swings. The authors argue that exchange rates are allowed to fluctuate freely only in brief periods, such as following currency crisis or chaotic episodes of high inflation.

As a specific example of national level of exchange rate management, China, for instance, has long been criticized for keeping its currency under-valued; and weak yuan has been blamed to be a source of recessions in many countries. Despite continuous appreciation of yuan since 2005, especially the USA urges China to let yuan to be at its “true” or “freely floating” level.⁴⁵

Hence, due to the importance of exchange rates in international economic relations and on household welfare particularly in emerging economies, we append the exchange rate as a fifth term into our performance index and suggest a more comprehensive index which we call macroeconomic performance index (MPI). Besides incorporating the exchange rate to the performance index, we weigh each variable by inverse of variance of the variables in order to

⁴⁴ The results suggest that overall stance of the economy is superior during the periods where liberal policies are followed.

⁴⁵ In February 2014, Central Bank of China decided to weaken yuan by letting it float around a benchmark, which is set each morning by the bank and the benchmark is decided to be lowered gradually.

prevent the component with large volatility to dominate the index. We suggest that such an index would better capture the wellbeing of households especially in emerging countries.

In the remaining, we first present and calculate the MPI for three emerging countries: Turkey, Brazil and Poland. Our analysis indicates a nonlinear structure, and hence we investigate the behavior of the MPI with threshold autoregressive (TAR) model. Threshold values and regime switching structure is presented. We detect presence of unit root by utilizing Caner and Hansen (2001) unit root test, which indicates that shocks have persistent effects in all three countries. To further see the relevance of the MPI, we examine the relationship of the MPI with consumer confidence indicators for each country with TAR cointegration method. The final section provides an overall evaluation and concludes.

2. The Macroeconomic Performance Index

The MPI that we have formulated is composed of inflation, growth rates, employment rates, long term interest rates and exchange rates. In weighting the variables we follow the “precision weighting scheme” (or “variance-weighted scheme”) approach that has emerged as the most commonly used weighting scheme in exchange market pressure (EMP) indexes.⁴⁶ In order to prevent the component with relatively large volatility to dominate the movement of the index, this approach weighs each variable by the ratio of the inverse of their variance over the sample period.

The variables of the MPI are defined as follows: Inflation rate, growth rate, employment rate, and long term interest rate are all given in percentage values; hence in the MPI these variables are defined as their first differences from the same period of the previous year. In order to make exchange rate comparable with other variables, we define the exchange rate as its percent change from the previous period. While annual inflation rate or growth rate or even the change in interest rate has a common usage in the literature, exchange rate changes over shorter periods have a more significant impact. Hence, for exchange rate, we utilize the difference from the “previous period” rather than the “same period of the previous year”.

The variables and the weights attached to them are defined as follows:

Inflation rate: $\Delta\pi = \omega_{\pi}(\pi_t - \pi_{t-1})$.

⁴⁶ EMP indexes are mostly used in early warning systems (EWS) that are developed to anticipate financial crisis. See, for instance, Bussiere and Fratzscher (2006).

Growth rate: $\Delta y = \omega_y (y_t - y_{t-1})$

Employment rate: $\Delta emp = \omega_{emp} (emp_t - emp_{t-1})$

Long-term interest rates: $\Delta i = \omega_i (i_t - i_{t-1})$

Exchange rates: $ex_t = \frac{exb_t - exb_{t-1}}{exb_{t-1}}$ and $\Delta ex = \omega_{ex} (ex_t - ex_{t-1})$, where exb stands for nominal exchange rate.

The Macroeconomic Performance Index reads:

$$MPI = \omega_y (y_t - y_{t-1}) + \omega_{emp} (emp_t - emp_{t-1}) - [\omega_\pi (\pi_t - \pi_{t-1}) + \omega_i (i_t - i_{t-1}) + \omega_{ex} (ex_t - ex_{t-1})]$$

Or, in a simple form, the MPI can be represented as:

$$MPI = \Delta y + \Delta emp - (\Delta \pi + \Delta i + \Delta ex)$$

Positive effect of the growth rate and the employment rate, and the negative effect of the inflation rate and the interest rate on the overall stance of the economy and the households, and hence on the MPI are quite straightforward. The negative contribution of exchange rate depreciation to the index though deserves some explanation.

An initial assessment would imply that especially developing countries would prefer low valued national currencies in order to gain easy access to export markets. However, keeping national currencies undervalued for extended periods to gain international competitiveness often results in producing undifferentiated goods, which eventually leads such countries to lag behind in economic development. Therefore, we assume that currencies are normally set at their true values (not artificially under or over-valued) and their international competitiveness and trade is realized at their ongoing exchange rate levels. That is, if the subject country has strong macroeconomic fundamentals and if its economy is performing well, then the country is expected to realize foreign direct investment and capital inflows. This typically leads to appreciation of the country's currency. In a reverse scenario, currency depreciation would be realized. Hence, we reckon exchange rate appreciation as a signal of economic strength of the subject country; we assign a negative value for exchange rate depreciation both in order to take into account the strength of the country's export market and the strength of its macroeconomic fundamentals.

Appreciation of Swiss Franc during the 2008 global financial crisis is a striking example in this respect. During the crisis, Switzerland once again emerged as a safe haven for the unnerved investors that fled from the Eurozone; and Swiss Franc appreciated due to capital flight to the country. Exchange rate appreciation was a vivid sign of market confidence to Swiss economy even in the mid of the global financial crisis. Nevertheless, over-appreciation of the Swiss franc had two major negative effects on the economy; it put Swiss exporters at a disadvantaged position and increased the risk of deflation. The Swiss National Bank responded to appreciation by abandoning the floating exchange rate regime in September 2011 by announcing that it would take any necessary measure to keep the euro/franc exchange rate above 1.20.⁴⁷

In addition, foreign exchange, especially US Dollar (USD) denominated debts (of both public and private sector) is often prevalent in emerging economies. Hence, unexpected exchange rate depreciation escalates the debt burden in emerging economies and may even lead to sovereign default or bankruptcies of companies. Recent revaluation of USD against the emerging market currencies again brought up this problem and rating agencies warned emerging countries regarding this point.

3. Implementing MPI to three Emerging Economies

In order to assess the relevance of the MPI, we have applied the index to Turkish, Brazilian, and Polish data sets and investigate how the index captures economic developments in these three countries. For our analysis, we use quarterly data from the year 2001 to 2014. For Turkey, long term interest data is extracted from Oxford Economics; inflation, employment and growth rates are extracted from Turkish Statistical Institute; exchange rate data is extracted from Central Bank of the Republic of Turkey (CBRT) data base. Exchange rate data for Turkey is equally weighted basket of USD and Euro. The basket exchange rate is regularly reported by the CBT and it is followed by the financial markets.

For Brazil and Poland, data is extracted from the Federal Reserve Bank of St. Louis. Only the exchange rate data for Poland is extracted from National Bank of Poland; and again a basket of USD and Euro against Polish Zloty is used due to Poland's close economic relations with Europe and the US. Exchange rate data for Brazil is the rate of Real against the USD.

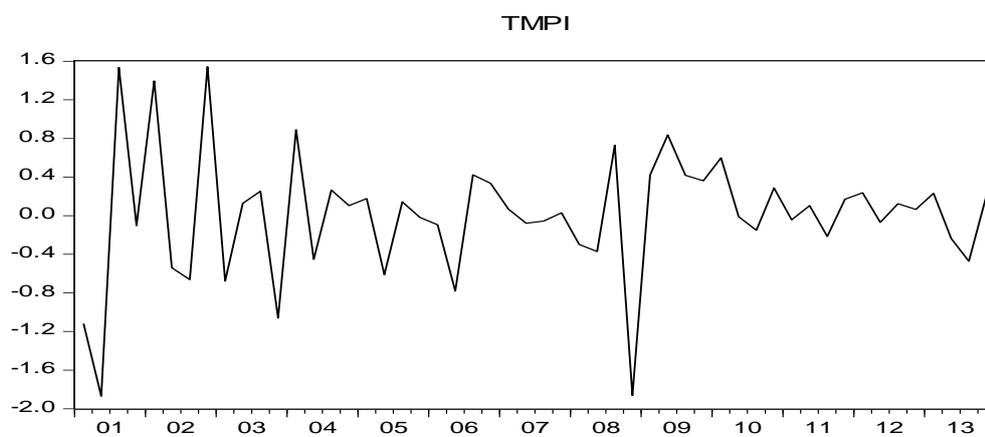
⁴⁷ The Bank had lifted the minimum exchange rate level in January 2015, after the European Central Bank started considering a bolder quantitative easing program.

Consumer confidence index (CCI) data that we utilize for TAR co-integration analysis is extracted from OECD data set.

Turkey Analysis with the MPI

Application of the MPI to Turkish data (TMPI) is presented in Graph 1. According to the MPI, Turkish economy during the given period exhibits two characteristics. First, there are two shocks to the economy, one in 2001 and the other in late 2008. And second, after some sharp fluctuation following the first shock, the economy follows a smoother path.

Graph 1: MPI for Turkey (TMPI)



These two characteristics indeed capture the economic developments in the Turkish economy during the given time period. Specifically, in the 1990s Turkish economy was marked with large budget deficit, high inflation, and repeated economic/financial crisis. In order to break the vicious circle of high public budget deficit and high interest rates, Turkey launched an exchange rate based stabilization program and signed a stand-by agreement with the IMF in December 1999. Tight fiscal policy and preannounced crawling exchange rate level in order to anchor inflation expectations were the basics of the stand-by program. CBRT was required to not to print money against domestic assets and let the macroeconomic equilibrium to be determined by interest rate changes through international capital flows (Öniş, 2003).

The stand-by program was first well received by the markets and created optimism for stabilization of the Turkish economy. However, the government was slow in making the necessary structural reforms, such as privatization of state owned enterprises. From the third quarter of 2000, markets realized that the coalition government at the time was not fully committed to the stand-by agreement. The international markets were more risk averse to such situations in the emerging markets after the 1997 Asian and 1998 Russian crisis.

Additionally, high inflation rates and high trade deficits led to deterioration of confidence in the stabilization program (Akyüz and Boratav, 2003).

As the confidence eroded, international creditors closed their credit lines with rather more vulnerable Turkish banks; foreign investors started leaving Turkish lira and domestic banks started buying USD in order to close their end year open positions. A medium sized private bank, Demirbank had a particularly risky position; it was financing its substantial government securities portfolio with short term borrowings from the money market. Demirbank could not meet its requirements and got into a liquidity problem in November 2000. The CBT first did not provide liquidity to the bank due to its obligation in the stabilization program. Demirbank started to fire sale government bonds in order to meet its requirements. Interest rates on government bonds rose from 35% to 50% within a few days and overnight rates reached to three digit levels (Akyüz and Boratav, 2003). Consequently, Demirbank was taken over by governmental bodies on December.

In order to convince the markets that the stabilization program was still on track, in December the IMF provided USD 10 billion worth of new financial package and the Turkish government made further commitments in terms of tax rate rises, privatization and financial sector restructuring. However, the support to the program was not enough to strengthen the structure of the Turkish economy. As external funds remained short term, maturity of government bonds was also shortened and interest rates reached 70% in mid-February (Akyüz and Boratav, 2003). A political crisis on the top of the state in February 2001 marked the end of the stabilization program; currency peg was abolished and in the same day Turkish lira was depreciated by about 1/3 against the USD.

2001 crisis is considered to be the deepest financial crisis in the history of Republic of Turkey. As the crisis was deepened, the economic team was changed and the government signed a new agreement with the IMF in May 2001. The IMF opened a new credit line worth of USD 8 billion. Main pillars of the new program were inflation targeting, floating exchange rate regime, fiscal discipline and restructuring of the financial sector. The newly elected government in 2002 kept on implementing this well-balanced stabilization program and Turkey enjoyed a stable political and economic period during the upcoming years.

The second shock depicted in Graph 1 is the effects of the global financial crisis on the Turkish economy. As mentioned above, following the 2001 crisis Turkey strengthened its

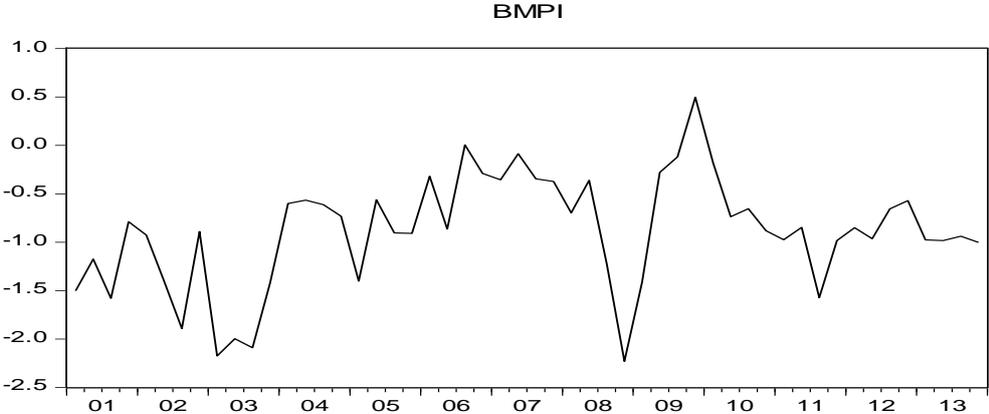
fiscal structure and financial sector. Thus, effects of the global crisis on the Turkish economy were rather limited and Turkey could recover from the crisis relatively quickly.

Hence, the TMPI successfully captures the 2001 crisis, the short fluctuation period in the aftermath of the stabilization program and the relative stability in the Turkish economy from 2004 onwards. The index also captures the effects of the global financial crisis to the Turkish economy in 2008 and the subsequent fast recovery from the crisis.

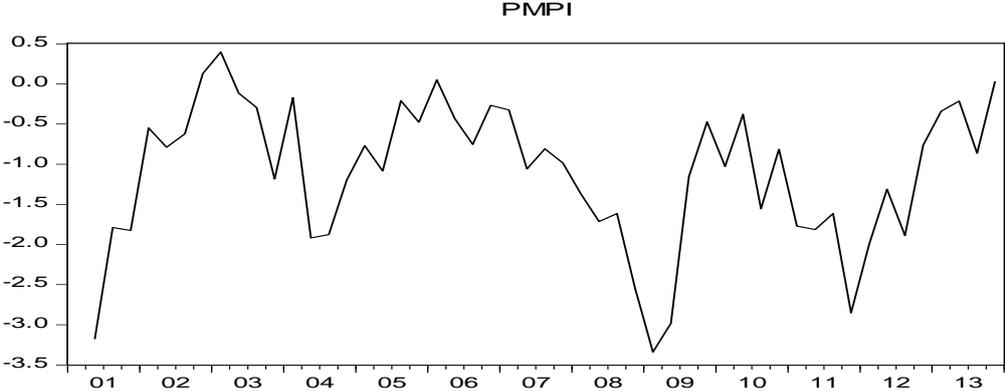
Further Analysis with MPI: Brazil and Poland

In order to assess how the MPI captures economic developments in different economies we further apply the indexation to Brazil and Poland. These countries have similar economic structures to Turkey in terms of per capita income and integration with the world economy. Like Turkey, Brazil also suffered from a high inflation period through 1980s and 1990s and undertook a stabilization program in 2004 named “Plano Real”. As a consequence of the stabilization program, a more balanced budget was achieved and inflation rate decreased to reasonable levels.

Graph 2a: MPI for Brazil (BMPI)



Graph 2b: MPI for Poland (PMPI)



Poland's transition from centrally planned to market economy started in 1989. The country suffered from hyperinflation at annual rates around 500 percent in 1990; and inflation rate could be reduced to single digits only in 2000. Second wave of reforms in health, education, labor markets and institutions started in 1999. In April 2000 Poland started to let market forces to determine the value of zloty. And in 2004 Poland became a full member of the European Union (Lehmann, 2012).

The MPI for Brazil and Poland is presented in Graph 2a and Graph 2b. The most apparent reflection of the MPI for Brazil and Poland is identifying the global financial crisis in 2008. The fact that Polish economy is highly integrated with that of Europe is also indicated by the extended recovery period of Poland from the crisis in tandem with Europe; the double-dip recession of Europe is also captured by the index in this manner. Ascension in the economic performance of Poland after its full membership to EU is also depicted in Graph 2b.

MPI for Brazil identifies the improvement in country's economic performance thanks to the stabilization program commenced in 2004. Brazil's competitive power is argued to deteriorate due to increased production costs over the years; weak recovery of Brazil from the 2008 crisis due to Brazil's deteriorated competitive power is also marked with the MPI.⁴⁸ In short, the MPI successfully captures the economic developments also in Brazil and Poland over the given time period.

4. Econometric Analysis

Having analyzed the relevance of the MPI for three different emerging countries, we next turn to analyze the behavior of the MPI over time. Business cycle and financial data have long been studied with non-linear data analysis. In time series analysis, threshold models, which are designed to capture discrete changes in the series that generate the data, have been widely applied due to their ability to replicate key characteristics of observed data. Both threshold autoregressive (TAR) and smooth transition autoregressive (STAR) models are used in country analysis for this purpose. Though, TAR models appear to be more successful in explaining country dynamics that are more fragile against economic crises and where structural changes have more turbulent effects. Since structural changes or effects of economic crisis transpire promptly in emerging economies rather than in a smooth manner, TAR model is more commonly utilized in emerging country analysis.

⁴⁸ See the article on Brazil in *The Economist*, August 18th, 2012 issue.

In order to see whether TAR model is appropriate for our analysis we first run Caner and Hansen (2001) test. As Caner and Hansen (2001) bootstrap threshold test allows us to carry out analysis with TAR model, we next run the TAR model and investigate how the MPI behaves in the three countries that we study. Next, we investigate the relationship between MPI and consumer confidence indicators of each country. Caner and Hansen (2001) tests indicate also that the series we have are first degree stationary; hence, we investigate the relationship with a non-linear cointegration method. For this analysis we utilize Enders and Siklos (2001) method. The results indicate that for all three countries, there is cointegration between the MPI and the CCI. Below, we first discuss the econometric methods that we utilize in our analysis and then present the results.

4.1 TAR Models

Among nonlinear model specifications, TAR model have gained great popularity since it was first introduced by Tong (1978, 1983), and Tong and Lim (1980). TAR models are relatively easy to estimate and it is quite successful in explaining nonlinear sequential dependent structures when the number of regimes is small. Hence, we utilize TAR model in order to analyze the behavior of the MPI. For our purposes TAR model allows us to determine a threshold value for the index from which we would investigate changes between the two regimes.

Two regime TAR model, such as the one that MPI suggests has the following structure:

$$y_t = (\phi_{1,0} + \phi_{1,1}y_{t-1} + \dots + \phi_{1,p}y_{t-p})I(q_{t-1} \leq \gamma) + (\phi_{2,0} + \phi_{2,1}y_{t-1} + \dots + \phi_{2,p}y_{t-p})I(q_{t-1} > \gamma) + e_t \quad (1)$$

In equation (1), $I(\cdot)$ is an indicator function and $q_{t-1} = q(y_{t-1}, \dots, y_{t-p})$ is the functional form of the data. $p \geq 1$ gives the AR degree and γ is the threshold value. When $q_{t-1} \leq \gamma$, the slope parameter is $\phi_{1,j}$; and when $q_{t-1} > \gamma$, the slope parameter is $\phi_{2,j}$. The error term e_t is the Martingale difference sequence of the past values of y_t . While the e_t is expected to have conditional heteroscedasticity, it is assumed to follow $e_t \sim iid(0, \sigma^2)$.

Let $x_t = (1 \ y_{t-1} \dots \ y_{t-p})'$ and $x_t(\gamma) = (x_t'1(q_{t-1} \leq \gamma) \ x_t'1(q_{t-1} > \gamma))'$

Then equation (1) could be written as in the following form:

$$y_t = x_t' \phi_1 I(q_{t-1} \leq \gamma) + x_t' \phi_2 I(q_{t-1} > \gamma) + e_t \quad (2)$$

If we further assume, $\theta = (\phi_1' \phi_2')'$, then

$$y_t = x_t(\gamma)' \theta + e_t \quad (3)$$

Equation (3) is a linear regression equation, even if it is not linear in parameters and the best estimation method for equation (3) is Ordinary Least Squares (OLS). The error terms is assumed to follow $e_t \sim iid(0, \sigma^2)$. As long as this assumption is realized, OLS estimates give the same results with Maximum Likelihood (ML) estimation. When the regression equation is nonlinear and it is not continuous, the OLS results would be obtained by conditional heteroscedasticity OLS. For a given γ value, the OLS estimate of θ is:

$$\theta(\gamma) = \left(\sum_{t=1}^n x_t(\gamma) x_t(\gamma)' \right)^{-1} \left(\sum_{t=1}^n x_t(\gamma) y_t \right)$$

The error terms are $\hat{e}_t(\gamma) = y_t - x_t(\gamma)' \theta(\gamma)$ and variance of the error terms are given by,

$$\hat{\sigma}_n^2(\gamma) = \frac{1}{n} \sum_{t=1}^n \hat{e}_t(\gamma)^2 \quad (4)$$

The OLS estimate of the threshold value γ minimizes equation (4).

If $\Gamma = [\underline{\gamma}, \bar{\gamma}]$, then equation form can be represented as follows:

$$\hat{\gamma} = \arg \min \hat{\sigma}_n^2(\gamma) \quad (5)$$

Depending on the different values that parameter γ takes, the variance of the error terms in equation (5) $\hat{\sigma}_n^2(\gamma)$ can take n different values: $\hat{\sigma}_n^2(q_{t-1})$, $t=1, 2, \dots, n$.

In order to get the OLS estimate of equation (5) the following algorithm is followed:

For all $q_{t-1} \in \Gamma$, $\gamma = q_{t-1}$ equation (3) would be estimated with the OLS. For each regression, variance of the error term $\hat{\sigma}_n^2(\gamma)$ would be calculated and the minimum value of all would be selected. The variance would be written as follows:

$$\hat{\gamma} = \arg \min \hat{\sigma}_n^2(q_{t-1}) \quad (6)$$

As result of the OLS estimate θ would be found as $\theta = \theta(\gamma)$. Similarly, the OLS errors $\hat{e}_t = y_t - x_t(\gamma)' \theta$ and sample variances $\hat{\sigma}_n^2 = \hat{\sigma}_n^2(\hat{\gamma})$

4.2. Caner and Hansen (2001) Unit Root Test

In order to see whether we can determine the behavior of the MPI with a TAR model (i.e., whether if there is a threshold effect) and whether if there is a unit root we run Caner and Hansen (2001) unit root test.

Caner and Hansen (2001) developed an asymptotic theory for a two-regime TAR model with possible unit root. Simulation results show that when the process is in nonlinear form, the unit root test suggested by the authors indeed is more powerful than the ADF (Augmented Dickey-Fuller) test. The authors analyze a two-regime TAR(k) model with autoregressive unit root. For the threshold effect they utilize Wald test and for the unit root process Wald tests and t-test are employed. The method that we have employed in this study for Caner and Hansen (2001) tests is as follows:

The TAR model is in the following form:

$$\Delta y_t = \theta_1' x_{t-1} I\{z_{t-1} < \gamma\} + \theta_2' x_{t-1} I\{z_{t-1} \geq \gamma\} + e_t \quad (7)$$

where $x_{t-1} = (y_{t-1} \ r_t' \ \Delta y_{t-1} \dots \Delta y_{t-k})'$. $t=1,2,\dots,T$ and $I\{\cdot\}$ is the indicator function. e_t is assumed to be an i.i.d error. For some $m \geq 1$, $Z_t = y_t - y_{t-m}$. r_t is a vector of deterministic components including an intercept and possibly a linear time trend. Z_{t-1} is a predetermined variable that is strictly stationary and ergodic with a continuous distribution function. The threshold value γ is unknown and it is within $\gamma \in \Gamma = [\gamma_1, \gamma_2]$. Within this interval for γ_1 and γ_2 , $P(Z_t \leq \gamma_1) = \pi_1 > 0$, $P(Z_t \leq \gamma_2) = \pi_2 < 1$ could be written.

In the analysis, the components θ_1 and θ_2 are discussed separately and the vectors are partitioned as,

$$\theta_1 = \begin{pmatrix} \rho_1 \\ \beta_1 \\ \alpha_1 \end{pmatrix}, \theta_2 = \begin{pmatrix} \rho_2 \\ \beta_2 \\ \alpha_2 \end{pmatrix}$$

Where (ρ_1, ρ_2) are the slope coefficients on y_{t-1} ; (β_1, β_2) are the slopes on the deterministic components, and (α_1, α_2) are the slope coefficients on $(\Delta y_{t-1}, \dots, \Delta y_{t-k})$ (Caner and Hansen, 2001).

$\rho_1 = \rho_2 = 0$ holds for the slope coefficients when the following restrictions apply for parameters μ_1 and μ_2 : $\beta_1' r_t = \mu_1$ and $\beta_2' r_t = \mu_2$ and $|a_1' \iota| < 1$ and $|a_2' \iota| < 1$ where ι is a k -dimensional vector composed of 1's.

The OLS estimate of the TAR model for each $\gamma \in \Gamma$ is as follows:

$$\Delta y_t = \hat{\theta}_1(\gamma)' x_{t-1} I_{\{z_{t-1} < \gamma\}} + \hat{\theta}_2(\gamma)' x_{t-1} I_{\{z_{t-1} \geq \gamma\}} + \hat{e}_t(\gamma) \quad (9)$$

And the estimated model could be written as:

$$\Delta y_t = \hat{\theta}_1' x_{t-1} I_{\{z_{t-1} < \hat{\gamma}\}} + \hat{\theta}_2' x_{t-1} I_{\{z_{t-1} \geq \hat{\gamma}\}} + \hat{e}_t \quad (10)$$

For constant γ , the OLS estimate of σ^2 is:

$$\hat{\sigma}^2(\gamma) = T^{-1} \sum_1^T \hat{e}_t(\gamma)^2 \quad (11)$$

The OLS estimate of the threshold value γ is obtained by minimizing $\sigma^2(\gamma)$.

The threshold effect is tested by the joint hypothesis:

$$H_0 : \theta_1 = \theta_2 \quad (12)$$

The hypothesis is tested by using Wald statistics using equation (10).

And the existence of the unit root is tested by

$$H_0 : \rho_1 = \rho_2 = 0 \quad (13)$$

When the hypothesis in (13) holds, equation (7) indicates existence of unit root in y_{t-1} .

If standard Wald statistics for the hypothesis in equation (13) is represented by R_T , Wald statistics for γ is $R_T = R_T(\hat{\gamma})$. R_T statistics is standard Dickey-Fuller statistics generalized for

two parameters. From estimation of equation (7), threshold effect and presence of unit root is tested by Wald tests W_T and R_T and with the parameter restrictions.

When equation (7) and parameter restrictions are valid, ρ_1 and ρ_2 parameters test the stationarity of y_t . In this case the following hypothesis is tested:

$$H_0 : \rho_1 = \rho_2 = 0 \quad (14)$$

If H_0 is not rejected, then the model given in (7) could be written as stationary TAR model with Δy_t being a stationary variable.

In this case, y_t follows an I(1) unit root process. If the series is stationary and ergodic, in the special case of $\rho = 1$, if $\rho_1 < 0$, $\rho_2 < 0$ and $(1 + \rho_1)(1 + \rho_2) < 1$ then the model is stationary (Caner and Hansen, 2001).

The alternative hypothesis of the one in equation (14) is set as $H_1 : \rho_1 < 0$ and $\rho_2 < 0$. But a third case is also present. In case of partial unit root, the valid hypothesis is in the following form:

$$H_2 : \begin{cases} \rho_1 < 0 & \text{and } \rho_2 = 0, \\ & \text{or} \\ \rho_1 = 0 & \text{and } \rho_2 < 0. \end{cases} \quad (15)$$

If H_2 holds, then the process y_t will behave like a unit root process in one regime, but will behave like a stationary process in the other. Under H_2 , the process is nonstationary, but it is not a classic unit root process.

The method used to test H_0 is Wald statistics. And unrestricted alternative is $\rho_1 \neq 0$ or $\rho_2 \neq 0$. The tests statistics is,

$$R_{2t} = t_1^2 + t_2^2 \quad (16)$$

where t_1 and t_2 are the t ratios for $\hat{\rho}_1$ and $\hat{\rho}_2$ obtained from the OLS equation given in equation (10). H_1 and H_2 here are one-sided. However, this two-sided Wald statistics may be less powerful than a one-sided version. The one-sided Wald statistics for $\rho_1 < 0$ and $\rho_2 < 0$ is calculated with:

$$R_{IT} = t_1^2 I_{\{\hat{\rho}_1 < 0\}} + t_2^2 I_{\{\hat{\rho}_2 < 0\}} \quad (17)$$

Caner and Hansen (2001) mentions that R_{IT} and R_{2T} tests are powerful against the H_1 and H_2 alternatives. If the test statistics is meaningful, then H_0 hypothesis i.e., that the series have a unit root is rejected. However, in order to determine which of H_1 or H_2 hypothesis is valid, t_1 and t_2 tests that allows to make unit root tests for two regimes separately becomes important. If only one of $-t_1$ and $-t_2$ statistics is statistically significant, then the partial unit root case would be consistent, which allows us to distinguish among the hypothesis H_0 , H_1 , and H_2 . The authors show that their test is more powerful than the ADF unit root tests.

4.3. TAR Cointegration

Threshold cointegration was first introduced by Balke and Fomby (1997), where the authors study asymmetric adjustments towards a long-run equilibrium. In this framework, the adjustment does not need to occur instantaneously, but only when the deviations exceed some critical value. Following this work a number of contributions were made to the TAR cointegration literature.⁴⁹ Enders and Siklos (2001) developed an explicit cointegration test with asymmetric error correction. Their threshold cointegration test is an augmented approach of Engle and Granger (1987).

Engle and Granger (1987) estimate the long run relation between X and Y, such as

$$y_t = \hat{\alpha} + \hat{\beta}x_t + e_t \quad (18)$$

where y_t and x_t are first order stationary, I(1) variables.

$\hat{\alpha}$ and $\hat{\beta}$ are estimated parameters from cointegrating equation and the e_t is the white – noise disturbance term. In second step of this approach the stationarity of the disturbance term is tested with the following equation,

$$\Delta e_t = \rho e_{t-1} + \varepsilon_t \quad (19)$$

⁴⁹ Some of the important studies in this context are Balke and Wohar (1998), Baum and Karasulu (1998), Enders and Falk (1998), Taylor (2001), Lo and Zivot (2001).

The null hypothesis on cointegration tests $\rho = 0$ and the alternative hypothesis is $-2 < \rho < 0$ that means the residuals of the main equation are stationary with mean zero. However, this cointegration framework is misspecified if the adjustment process is asymmetric.

Hence, Enders and Siklos (2001) proposed an alternative test of cointegration, defining the second step with TAR model which allows asymmetric adjustment on disturbance term from the first equation.

Thus the tested TAR model in this step is defined as,

$$\Delta e_t = I_t \rho_1 e_{t-1} + (1 - I_t) \rho_2 e_{t-1} + \varepsilon_t, \quad (20)$$

Where I_t is the heaviside indicator function such that,

$$I_t = \begin{cases} 1 & \text{if } e_{t-1} \geq \tau \\ 0 & \text{if } e_{t-1} < \tau \end{cases} \quad (21)$$

and τ is the value of the threshold and ε_t is a sequence of zero mean, constant variance i.i.d. random variables. Relying on the results in Petrucelli and Woodford (1984), the necessary and sufficient conditions for the stationarity of e_t is defined as, $\rho_1 < 0$, $\rho_2 < 0$ and $(1 + \rho_1)(1 + \rho_2) < 1$ for any value of τ (Enders and Siklos, 2001).

4.4 Econometric Results

We first report unit root analysis for MPI index variables and consumer confidence index (TCCI, BCCI, PCCI) variables that we investigate for long term equilibrium relation. Stationarity of the variables are tested by Caner and Hansen's (2001) TAR unit root analysis. In the second stage, we report the TAR model results for the MPI. In the final step, we report the relationship results between the MPI and CCI that we have investigated by using Enders and Siklos (2001) TAR co-integration results.

4.4.1. Non-Linearity and Unit Root Test Results

While some studies in the literature carry out only conventional unit root tests such as Augmented Dickey Fuller (ADF) or Phillips Perron (PP) prior to cointegration analysis; we believe that when the data is in TAR model, more appropriate unit root tests to this structure should be utilized. Accordingly, Even though conventional unit root tests give similar results, below we also present Caner and Hansen (2001) test results.

First, ‘bootstrap threshold test’ of Caner and Hansen (2001) tests results presented in Table 1 indicate that a two regime TAR model is appropriate to analyze the behavior of the MPI.

We have also analyzed the stationarity of the performance and confidence indexes for each country with Caner and Hansen (2001) test. Tests regarding the unit root are given in Table 1 and estimated TAR models are given in Table 2.

Caner and Hansen (2001) tests indicate nonlinearity and when the two regimes are analyzed separately t_1 and t_2 tests indicate presence of unit root. One exception to this result is that, when asymptotic probability values of TMPI is examined, while the first regime turns out to be stationary, the second regime has a unit root. Nevertheless, bootstrap probability values indicate presence of unit root both in the overall data and in each of the two regimes.

Table 1. Caner-Hansen (2001) Unit Root Test Results

TMPI m=2				
Threshold Estimate: 0.265798	Variable	Wald Statistic	Bootstrap n-val.	Asymptotic n-val.
Bootstrap Threshold Test	TMPI	37.25	0.04	0.02
Two Sided Wald Test (R₂)	TMPI	22.28	0.07	0.001
Two Sided Wald Test (R₁)	TMPI	22.28	0.07	0.001
Unit Root Test (t₁)	TMPI	3.41	0.07	0.03
Unit Root Test (t₂)	TMPI	3.25	0.16	0.051
BMPI m=1				
Threshold Estimate: -1.23	Variable	Wald Statistic	Bootstrap n-val.	Asymptotic n-val.
Bootstrap Threshold Test	BMPI	24.71	0.00	0.00
Two Sided Wald Test (R₂)	BMPI	1.80	0.90	0.96
Two Sided Wald Test (R₁)	BMPI	0.83	0.80	0.98
Unit Root Test (t₁)	BMPI	-0.99	0.90	0.87
Unit Root Test (t₂)	BMPI	0.91	0.70	0.89
PMPI m=2				
Threshold Estimate: -1.62	Variable	Wald Statistic	Bootstrap n-val.	Asymptotic n-val.
Bootstrap Threshold Test	PMPI	25.41	0.00	0.00
Two Sided Wald Test (R₂)	PMPI	6.67	0.70	0.42
Two Sided Wald Test (R₁)	PMPI	6.67	0.60	0.37
Unit Root Test (t₁)	PMPI	2.05	0.40	0.44
Unit Root Test (t₂)	PMPI	1.57	0.60	0.67
TCCI m=1				
Threshold Estimate: -8.59	Variable	Wald Statistic	Bootstrap n-val.	Asymptotic n-val.
Bootstrap Threshold Test	TCCI	38.05	0.00	0.00

Two Sided Wald Test (R₂)	TCCI	14.27	0.10	0.04
Two Sided Wald Test (R₁)	TCCI	5.70	0.90	0.48
Unit Root Test (t₁)	TCCI	2.93	0.99	0.11
Unit Root Test (t₂)	TCCI	2.38	0.50	0.29
BCCI m=5				
Threshold Estimate: 10.60	Variable	Wald Statistic	Bootstrap p-val.	Asymptotic p-val.
Bootstrap Threshold Test	BCCI	90.39	0.00	0.00
Two Sided Wald Test (R₂)	BCCI	9.52	0.30	0.18
Two Sided Wald Test (R₁)	BCCI	0.42	0.99	0.99
Unit Root Test (t₁)	BCCI	0.65	0.8	0.93
Unit Root Test (t₂)	BCCI	3.02	0.90	0.09
PCCI m=5				
Threshold Estimate: -5.8	Variable	Wald Statistic	Bootstrap p-val.	Asymptotic p-val.
Bootstrap Threshold Test	PCCI	30.5	0.00	0.00
Two Sided Wald Test (R₂)	PCCI	6.72	0.50	0.41
Two Sided Wald Test (R₁)	PCCI	6.72	0.4	0.37
Unit Root Test (t₁)	PCCI	1.34	0.3	0.76
Unit Root Test (t₂)	PCCI	2.22	0.50	0.36

Lag length, k is determined to be 4 according to AIC criteria for all the variables. Lag length parameter, m is determined according to Caner and Hansen (2001) tests; the values that minimize sum of squared residuals (SSR) is found to be 2 for Turkey and Poland; and 1 for Brazil for MPI indices. Bootstrap threshold test analyzes the threshold effect in the series we have. Statistical results and probabilities for lag length m is given in Table 2. The results indicate presence of threshold effects for all the indexes we have. Accordingly, against the linearity hypothesis, we accept the alternative hypothesis that indicates the presence threshold effect.

In the next stage we investigate R₁ and R₂ tests. While R₂ test indicates a two-sided Wald statistics, R₁ indicates a one-sided test. R₂ test, which tests the zero hypothesis that the series is stationary ($H_0 : \rho_1 = \rho_2 = 0$) against the alternative ($H_1 : \rho_1 \neq \rho_2 \neq 0$) is rejected at the 5% significance level. For the R₁ test results, the alternative hypothesis that indicates the presence of unit root $H_1 : \rho_1 < 0, \rho_2 < 0$ is accepted against the stationarity hypothesis, $H_0 : \rho_1 = \rho_2 = 0$. Also R₂ test results indicate that the variable has a unit root.

As mentioned in Caner and Hansen (2001) two sided Wald statistics is less powerful than the one sided version; accordingly the final decision is given based on the one sided and t₁ , t₂

tests. One-sided R_1 test indicates presence of unit root for all the variables. t_1 and t_2 tests analyze the presence of unit root in each of the two regimes. In one-sided t_1 tests, the hypothesis that indicates stationarity in each regime, $H_0 : \rho_1 = \rho_2 = 0$ is tested against the alternative that there is unit root only in the first regime, $H_1 : \rho_1 < 0, \rho_2 = 0$ and the results indicate presence of unit root in the first regime. And in one sided t_2 test when $H_0 : \rho_1 = \rho_2 = 0$ is tested against the presence of unit root in the second regime, $H_1 : \rho_1 = 0, \rho_2 < 0$ the presence of unit root is accepted.

4.4.2. Results of the TAR Model

The TAR model for the MPI for Turkey (TMPI) indicates that 71% of the observations are located in the first regime ($Z_{t-1} < 0.27$); and 29% of the observations are located in the second regime ($Z_{t-1} > 0.27$). In the analyzed time period, the first regime becomes active if the TMP index decreases, remains constant or rises by less than 0.27 points over the two quarter period; and if the index increases by more than 0.27 points over a two quarter period, the second regime becomes active.

For Brazil (BMPI) the TAR model indicates that 21% of the observations take place in the first regime ($Z_{t-1} < -1.23$); and 79% of the observations are in the second regime ($Z_{t-1} > -1.23$). If the index decreases by more than -1.23 points from the previous period, then the first regime becomes active; if the index decreases by less than -1.23 points from the previous period or if the index increases, then the second regime becomes active.

For Poland, the TAR model indicates that 26% of the observations take place in the first regime ($Z_{t-1} < -1.62$); and 74% of the observations are located in the second regime ($Z_{t-1} > -1.62$). In the analyzed time period, if the index decreases by more than -1.62 points over a two quarter period, then the first regime becomes active; and if the index decreases by less than -1.62 points or if the index moves upwards over a two quarter period, then the second regime becomes active.

Table 2. Test results of the TAR models for performance indexes.

TMPI				
$\hat{\gamma} = 0.27$	Regime 1: $Z_{t-1} < \hat{\gamma}$ (%71)		Regime 2: $Z_{t-1} > \hat{\gamma}$ (%29)	
Variable	Estimate	St Error	Estimate	St Error
Intercept	-0.172181	0.080497	0.199778	0.221768

TMPI (t-1)	-1.698078	0.497340	-1.917224	0.588143
DTMPI(t-1)	0.007125	0.393434	0.949163	0.495628
DTMPI (t-2)	-0.612551	0.340980	0.829636	0.309108
DTMPI (t-3)	-0.282742	0.221928	0.541476	0.256504
DTMPI (t-4)	-0.206453	0.138871	0.171628	0.139838
BMPI				
$\hat{\gamma} = -1.23$	Regime 1: $Z_{t-1} < \hat{\gamma}$ (%21)		Regime 2: $Z_{t-1} > \hat{\gamma}$ (%79)	
Variable	Estimate	St Error	Estimate	St Error
Intercept	0.906888	0.651572	-0.292818	0.180944
BMPI (t-1)	0.422882	0.428984	-0.215251	0.236326
DBMPI (t-1)	-0.360509	0.339138	-0.221464	0.169223
DBMPI (t-2)	-0.657814	0.371757	0.310106	0.146011
DBMPI (t-3)	-0.961340	0.396708	0.134897	0.148792
DBMPI (t-4)	-0.331319	0.323389	-0.195642	0.128824
PMPI				
$\hat{\gamma} = -1.62$	Regime 1: $Z_{t-1} < \hat{\gamma}$ (%26)		Regime 2: $Z_{t-1} > \hat{\gamma}$ (%74)	
Variable	Estimate	St Error	Estimate	St Error
Intercept	-2.091668	0.709017	-0.463551	0.203077
PMPI(t-1)	-0.827567	0.403190	-0.355285	0.226489
DPMPI (t-1)	1.094405	0.340019	-0.341164	0.233817
DPMPI (t-2)	-0.656415	0.437557	0.226333	0.156259
DPMPI (t-3)	-0.133192	0.398506	0.302987	0.155959
DPMPI (t-4)	-0.016874	0.301938	0.185687	0.135733

4.4.3 TAR Co-integration Results for MPI and Consumer Confidence Indexes

In the previous subsection we have identified the structure of the MPI with the TAR model. To further test the relevance of the MPI, we examine the relationship of the MPI with the consumer confidence indexes for each country. If the MPI and CCI are cointegrated in each country, this could be interpreted as a further indication that the MPI captures the key macroeconomic variables that affect household welfare.

As Caner and Hansen (2001) unit root test indicates first degree stationarity of the series we have, the relationship between the MPI and CCI for each country can be studied with

cointegration method with asymmetric adjustment. Hence we utilize Enders and Siklos (2001) methodology that analyses the long term equilibrium relations between the nonlinear variables.

Enders and Siklos (2001) F-joint test and t-max test results are reported in Table 3, and they indicate presence of cointegration for all three countries.

Table 3. Enders Siklos threshold values and test results for CCI and MPI variables

Model	TCCI-TMPI	BCCI-BMPI	PCCI-PMPI
Test			
τ	-10.34	12.30	-8.82
$H_0 : \rho_1 = \rho_2 = 0$	8.25(7.54)	10.34(7.13)	7.68(7.25)
t-Max	-1.678**	-3.309	-2.357*

*5% significance level

**10% significance level.

Enders and Siklos (2001) threshold adjustment results for Turkey Consumer Confidence Index (TCCI) and TMPI are as follows (where the standard errors are reported in parenthesis):

$$\Delta e_t = -0.795I_t e_{t-1} - 0.272(1 - I_t)e_{t-1} + 0.017\Delta e_{t-1} + \varepsilon_t$$

(0.20) (0.16) (0.13)

The model that we have utilized here informs us about the speed of adjustment. When there is a positive deviation from the long-term threshold value, the speed of adjustment is -0.795; and for negative deviations the speed of adjustment is -0.272. In other words, for positive deviations, convergence to the long run equilibrium is three times faster than negative deviations.

Enders and Siklos (2001) threshold adjustment results for Brazil, BCCI and BMPI are as follows:

$$\Delta e_t = -0.839I_t e_{t-1} - 0.465(1 - I_t)e_{t-1} + 0.48\Delta e_{t-1} - 0.019\Delta e_{t-2} + 0.25\Delta e_{t-3} + \varepsilon_t$$

(0.219) (0.140) (0.14) (0.139) (0.138)

Similar to Turkey, a positive deviation from the long-term equilibrium has adjustment speed of -0.839; while negative deviations adjust with a speed of -0.465. That is, negative deviations tend to persist, whereas positive deviations tend to revert back to the long term equilibrium faster.

For Poland, Enders and Siklos (2001) threshold adjustment tests results for PCCI and PMPI are as follows:

$$\Delta e_t = -0.145I_t e_{t-1} - 0.44(1 - I_t)e_{t-1} + 0.495\Delta e_{t-1} + 0.246\Delta e_{t-2} + \varepsilon_t$$

(0.06) (0.129) (0.127) (0.159)

For Poland, while positive deviations converge to the equilibrium with a speed of -0.145, negative deviations converge to the equilibrium with a speed of -0.44. Hence, different from Turkey and Brazil, results for Poland indicate faster convergence for negative deviations from long-term equilibrium.

5. Evaluation and Conclusion

Based on the idea that exchange rate effects are significant especially for emerging economies we have developed an index in order to evaluate economic performance of countries over given time periods. In this respect the MPI could be considered as an updated version of Okun's misery index (1970) and Barro's misery index (1999). The MPI consist of growth rates, employment, inflation, long term interest rates and exchange rates. In addition to considering the effects of exchange rates, our contribution to the literature is to incorporate weights to the variables based on their volatilities, as in exchange market pressure (EMP) indexes.

We have calculated the index for three emerging countries: Turkey, Brazil and Poland. The econometric analysis that we have carried out indicates that the structure is nonlinear and it could be represented by TAR model. We have presented the threshold values and regime switching structure for each country. The models show that while the first regime that takes part below the threshold value is the dominant one for Turkey the second regime is the dominant one for Brazil and Poland.

We have also showed that unit root effect is present for each country. This implies that any shock has a long lasting effect for each country. Finally, we show that index dependence on the previous terms is higher in Brazil and Poland compared to Turkey. This may imply the vibrant structure of the Turkish economy; and that while Turkey recovers from economic crisis relatively fast; it has hardship in maintaining a smoother economic structure.

Finally, we have investigated the long term relationship between consumer confidence index and macroeconomic performance index. Results indicate a long-term relationship for all three

countries. While for Turkey and Brazil positive deviations tend to converge faster to the equilibrium, for Poland negative deviations tend to converge faster to the equilibrium. Among the three countries, convergence to the equilibrium from a negative deviation is longest in Turkey.

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