QUANTITATIVE ASSESSMENT OF INFLATION PRESSURE DURING A TRANSITION TO INFLATION TARGETING: THE TURKISH EXPERIENCE, 1996 - 2005

By

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To my parents,

Murat & Lem'a

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CHAPTER I

INTRODUCTION

This study is a quantitative assessment of a transition to inflation targeting in detail with a focus on the role of expectations in the adjustment process. To this objective, I construct and estimate inflation pressure indices to evaluate the performance of monetary policy and its relationship with the underlying inflationary environment. I innovate measures of expectations under different degrees of credibility to provide insight into the way in which the monetary authority's credibility evolves during a transition period. My case study is Turkish economy during 1996-2005, a period of multiple inflation reduction programs including a transitory semi-formal inflation targeting program. The fact that Turkey was not part of the great moderation allow me to consider with greater confidence that the expectational changes under investigation are a consequence of the monetary authority's inflation reduction programs[1].

I choose to study the Turkish economy during a transition for several reasons.

[1]Many researchers studied the substantial decline in macroeconomic volatility, often referred to "Great Moderation", in major industrialized economies. Kim and Nelson (1999) and McConnell and Perez-Quiros (2000) were among the first to note the reduction in the volatility of output. Warnock and Warnock's (2000) analysis on goods-producing sectors documented the drop in the volatility of employment. Blanchard and Simon (2001) reported the decline in the variability of inflation proving that the drop in variability was not exclusive to the growth in employment and real output since the mid-1980s in the U.S. Stock and Watson (2002) characterized the large drop in the cyclical volatility of economic activity, which they named as the great moderation, using a large number of U.S. economic time series. Kim, Nelson, and Piger's (2003) concluded that reduction of volatility of output was a multi-sectorial phenomenon during the great moderation.

Although the great moderation is well documented there is not a consensus among researchers in regards to underlying reasons of the great moderation. Various studies offered different explanations such as substantial structural changes, improved macroeconomic policies, or the substantial decline in size and the frequency of the the shocks hitting the economy, often referred to good luck hypothesis. Kahn, McConnell, and Perez-Quiros (2002), Campbell and Hercowitz (2005), and Galí and Gambetti (2009) were among the studies recognizing the significance of structural changes whereas Clarida, Galí, and Gertler (2000), Lubik and Schorfheide (2004), and Boivin and Giannoni (2006) advocated for the improved performance in macroeconomic policies. Finally, studies in line with the good luck hypothesis include Ahmed, Levin, and Wilson (2002), Sims and Zha (2006), Arias, Hansen, and Ohanian (2006), and Benati and Surico (2009).

Turkey is a developing economy which was not part of the great moderation as many other industrialized economies underwent beginning early 1990s. Instead, throughout 1990s and early 2000s, the Turkish economy experienced high and volatile inflation, three major crisis, and short-lived disinflation programs. The period of 2002-2005, on the other hand, is described by major structural reforms and significant drops in the inflation rate. The fact that Turkey was not part of the great moderation allow me to study the impact of the monetary authority's inflation reduction programs on inflation expectations in isolation.

The period of 1996-2005 in Turkey is a long transition period. In the first half the transition, non targeting disinflation programs were performed while semi-formal inflation targeting was in place during 2002-2005 which eventually led to full-fledged inflation targeting beginning 2006. Although the first half of the transition was rather volatile, the transitory semi-formal inflation targeting period was characterized by step by step structural reforms, systematic and transparent conduct of monetary policy. During 2002-2005, the monetary authority in Turkey initiated deliberate efforts to communicate with the private sector in regards to the objectives of the monetary authority and how it intend to reduce inflation. Surveying professional forecasters and making the forecast data available online to public was as an intentional decision for more transparent and effective communication. Turkey arises as a natural candidate to study the transition in detail due to such organized, clear-cut transition to inflation targeting.

The role of expectations is significant in contemporary macroeconomics. It is well known that inflationary expectations contribute to observed inflation substantially. Therefore, the long-term success of an inflation reduction program depends on the effectiveness of monetary policy in influencing the underlying economic conditions to reduce inflationary expectations. Expectations not only influence various macroeconomic variables they also respond to them as suggested by the Lucas critique. Having said that, the expectations are not directly observable and the underlying process through which they are formed is unknown. Therefore expectations must be imputed using a model for the underlying expectation formation process. I consider rational expectations hypothesis and private expectations formed consistent with the adaptive learning process.

I propose an analytical small open economy model capable of characterizing the Turkish economy during the period of 1996-2005. I assume the macroeconomic indicators of the U.S. economy represent the rest of the world. The analytical model includes four structural equations governing the domestic markets. Following the contemporary approach, I use a hybrid type new Keynesian Phillips curve and IS schedule. I innovate a hybrid type uncovered interest parity condition with a focus on in sample representation of the foreign exchange rate movements and with less consideration on forecasting. The model is closed using a forward looking Taylor type monetary policy reaction function consistent with structural breaks throughout the period of 1996-2005. In order to complete the open economy model, I use first order autoregressive process to represent the behavior of exogenous foreign (the U.S. economy in this case) variables such as inflation and short-term interest rates.

The period of 1996-2005 in Turkey is characterized by structural changes and reforms in the economic arena. In addition to several significant fiscal and financial reforms including the grant of independence to the Turkish central bank, the Central Bank of Republic of Turkey (CBRT) implemented three distinct inflation reduction programs during 1996-2005. Therefore, the structural equations in the model may be subject to structural breaks. I use Bai and Perron's (1998, 2003) multiple structural break analysis to estimate structural break dates as suggested by anecdotal evidence. I provide empirical evidence that the Phillips curve, IS schedule, and the uncovered interest parity condition were stable with no structural breaks during 1996-2005. On the other hand, the monetary policy reaction function was subject to structural breaks.

To estimate the analytical model, I apply empirical estimation methods of Generalized Method of Moments (GMM) and Ordinary Least Squares (OLS) to monthly data. The presence of endogenous forward looking expectations in the model requires the use of certain empirical applications. I first estimate the model using GMM consistent with the assumption of rational expectations. I then make use of the available forecast data and apply Smith's (2009) pooling forecast methodology to conduct sensitivity analysis under rational expectations. I use the computational methodology developed by Sims (2001) to obtain numerical rational expectations estimates corresponding the minimum state variables (MSV) solutions. I consider the MSV solutions as the underlying models of forecasting for private agents who are assumed to form expectations consistent with the adaptive learning hypothesis pioneered by Evans and Honkapohja (1995). I apply least squares learning algorithm to obtain private agents' forecast series which are used to find model estimates consistent with adaptive learning. I provide empirical evidence that model estimates under rational expectations and least squares adaptive learning are substantially close granting more confidence in the capability of the analytical model in representing the Turkish economy during 1996-2005 and the precision of the estimates.

I construct model consistent operational indices to characterize the inflationary environment, measure the changes in inflation expectations and evaluate the monetary policy effectiveness using counterfactual experiments. I borrow extensively from the two-step methodology proposed by Weymark (1995, 1998) and the methods used in Weymark and Shintani (2006) to set up counterfactual experiments and obtain inflation pressure indices. The inflation pressure indices are defined as the change in the inflation rate that would have been observed if the monetary authority had held its interest rate instrument constant for a period. I construct ex-ante inflation pressure to describe the inflationary environment that was faced by the monetary authority prior to the policy change to measure the changes in inflation expectations in response to exogenous shocks. Ex post inflation pressure is then obtained to measure the remaining inflation pressure after the implementation of the interest change policy using post-policy expectations. The monetary policy effectiveness is determined by the extent to which the monetary policy change was successful in reducing the inflation pressure conditional on the inflationary environment that existed prior to the implementation of the policy change. I obtain similar estimates for inflation pressure and monetary policy effectiveness under both rational expectation and adaptive learning. I show that the inflationary environment facing the Central bank of Republic of Turkey in period 2002-2005 was no favorable than that of 1996-2001 in regards to reducing inflation. However, I find that the CBRT was much more effective in reducing the inflation in 2002-2005 than it was during 1996-2001, especially when the economy was hit by positive inflationary shocks. Evidence also shows that the CBRT had a significantly passive stand in 1996-2001 in contrast to pre-emptive conduct of monetary policy during the period of semi-formal inflation targeting , 2002-2005.

Finally, I innovate an index of policy credibility to evaluate the credibility of the monetary authority's disinflation programs and announcements and study the way the monetary policy credibility evolved. I design new counterfactual experiments that would help constructing the credibility index. I measure the change in inflation expectations that would have been generated by the announcement of the inflation target if the announcement had been perceived as perfectly credible. Under full credibility, the change in expectations is computed by considering the monetary authority implemented the previous period's interest policy instead of the interest rate that is consistent with the announced inflation target. I refer to this measure as the expectations of inflation under full credibility and I use it as my benchmark measure. I then obtain a measure for expectations of inflation under true credibility a qualitatively similar measure to the ex post inflation pressure index. To obtain the measure for expectations of inflation under true credibility, I compare the expectational changes under the actual current interest policy versus the previous period. The degree to which the changes in expectations of inflation under true credibility get closer to that under full credibility is used to obtain monetary policy credibility index. I find that the underlying assumption of rational expectations or adaptive learning does not produce significantly different credibility estimates. My findings suggest that there was not a substantial change in the credibility of the CBRT during 1996-2005 and yet the CBRT succeeded to undershoot its inflation targets for four consecutive years during 2002-2005 suggesting that the CBRT acted as though the credibility was worse than it was during the semi-inflation targeting period.

CHAPTER II

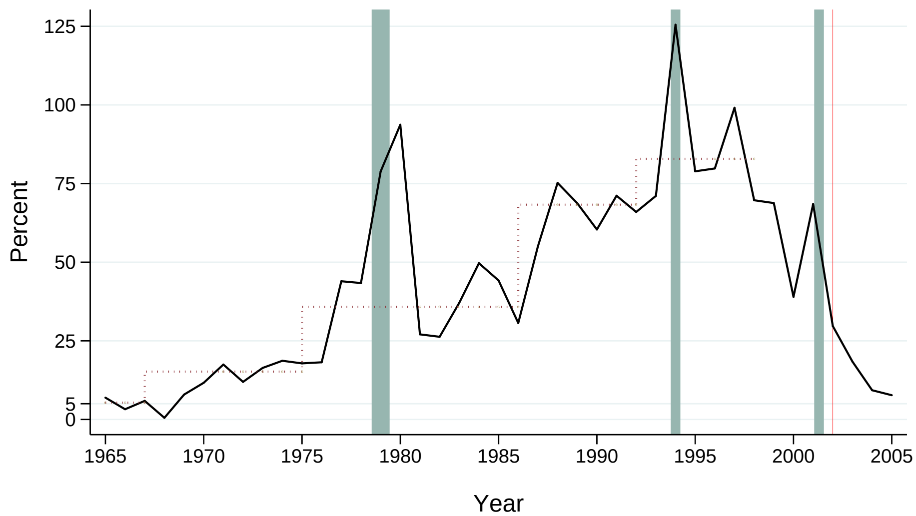
A BRIEF HISTORY OF THE TURKISH ECONOMY

Turkey has a long history of chronic inflation along with unsuccessful disinflation programs during the thirty years prior to the millennium[1]. The Consumer Price Index (CPI) based annual average inflation rate in Turkey increased in a stepwise fashion. Inflation was about 5% in late 1960s, 15% in early 1970s, 35% in late 1970s and early 1980s, 65-70% in late 1980s and early 1990s, and finally over 80% in late 1990s, coupled with burst of inflation rates preceding the debt-foreign exchange crisis of 1978-1980, the currency crisis of 1994, and the financial crisis of 2001 as presented in Figure II.1.

An early attempt to stabilize the economy, reduce the inflation, and to promote sustainable economic growth was launched on January 24, 1980. The government declared a reform package to deregulate the financial market, and to pursue an export based growth policy. Extremely generous export subsidies were provided along with managed floating exchange rates. Real exchange rate depreciation and exports subsidies gave a way to significant increases in the volume of export and growth in economic activity. The package also contained major structural steps toward a market-based, liberal, financial system where most of the government-levied restrictions on the financial sector were removed often referred to the deregulation of the financial sector. For instance, the foreign exchange market was liberalized which finally led to fully convertible Turkish Lira beginning 1990, certain restrictions on capital movements were removed, a short-term money market was established, and the Central Bank of the Republic of Turkey (CBRT) started to conduct open market

[1] Siklos (1995) defined the state of high and persistent inflation as "chronic" inflation.

operations. While the reforms were taking place, a military regime took control of the government via military coup détat in September, 1980. Celâsun and Rodrik (1989), Ertuğrul and Selçuk (2001), and Boratav and Yeldan (2006) provide a detailed account of the reforms, the resulting structural adjustments, and the changes in various macroeconomic indicators in the 1980s.



Inflation rates are measured by December-to-December percentage changes in the Consumer Price Index (CPI). The thick-shaded areas represent crisis which usually are preceded by or accompanied with burst of inflation. The thin vertical line at 2002 marks the beginning of semi-formal inflation targeting period which would last till December, 2005. Inflation was relatively low and steady during 1965-1975. It increased and became more volatile starting late 1970s. Following the currency crisis in 1994, inflation started to decline with still a fair amount of volatility. Aftermath of the crisis in February 2001, inflation continued to decline accompanied with relatively lower amount of volatility.
Source: TurkStat (Turkish Statistical Institute)

Figure II.1: Inflation Rate in Turkey, 1965-2005

Following the military takeover of September 1980, there was a subsequent drop in inflation accompanied by a short lived recession. The annual average inflation rate was reduced from about 90% in 1980 to an average of 33% in 1983-1985. However, the inflation rate started to climb up again starting 1986. Boratav and Yeldan (2006) reported that gross domestic product rose at an annual rate of 6.5%, and export revenues rose at an annual rate of 10.8% in the period of 1983-87. On the other hand, real wage income declined significantly. The decline in real wages was partly due to the restrictive wage policy that was used as part of an instrument to lower production costs in order to stimulate exports in line with export based growth policy. In addition, the presence of the military in the political arena and its aggressive actions against organized labor exacerbated the erosion in the real wage income. Boratav and Yeldan (2006) reported that the share of wage income in manufacturing value added declined from an average of 35.6% in 1977-80, to 20.6% in 1988 whereas the average mark up rates in private manufacturing increased from 31% to 38%.

Following the 1980's economic reform package, the process of capital account liberalization was completed in 1989. Significant tariff reductions were implemented and a number of other trade restrictions were removed. Celâsun (1998) reported large fiscal and external imbalances following the capital account liberalization during 1989-1990 where the real exchange rate appreciated more than 20% on average. The removal of restrictions on capital flows increased the interest rates as in other episodes of financial liberalization studied by Saraçoğlu (1996), and The World Bank (1997). A rise in the share of capital inflows and outflows strand the financial markets and the monetary authority in Turkey in early 1990s during which the Gulf War I would took place. The substantial capital outflows were not only responsible for causing foreign exchange reserves to decline precariously and leading to further deterioration of the trade balance; they also played a pivotal role in triggering financial instability.

Large and growing fiscal imbalances changed the governments' financing approach in early 1990s. Due to the legislative act limiting the CBRT's ability to finance the Treasury by 15%, the public sector borrowing became increasingly dependent on foreign savings where the private commercial banks would borrow from external sources and use those funds to obtain domestic debt instruments. This borrowing/lending scheme made the short term capital inflows the main source of public debt financing.

Ekinci (1996) reported that more than half of the 7.2 billion dollars of external debt accumulated in early 1990s was short term liabilities in which the foreign liabilities of the commercial banking sector constituted about 60%. Following the increased burden of domestic debt, the CBRT started printing money to pay off the government debt while Treasury auctions were put on hold in 1993. Paying off the government short term liabilities was later interpreted as "insolvent" Turkish government by Ozatay (1996). The bold shift towards CBRT financing the Treasury by printing money played an important role in the arrival of 1994 crisis which eventually led to three digits inflation rate.

The 1994 crisis was characterized by excessive short-term dept, capital outflows, shortage of foreign exchange, exchange rate depreciation and eventually a sharp devaluation of the Turkish Lira. The private commercial banks enjoyed high rates of return by holding domestic debt instruments and financing the public sector in expense of operating on extensive open positions in foreign exchange. Several private commercial bank and other sources of finance for the government rushed to the foreign exchange market to recover their open foreign exchange positions as suspicion developed about the government's ability to meet its short term liabilities[2]. As a result, the foreign exchange reserves of the CBRT drained out leading to devaluation of the Turkish Lira and hence the currency crisis of 1994 verifying the empirical finding by Rodrik and Velasco (1999) that the short-term debt to reserves ratio is a robust predictor of financial crises. Immediately after the crisis, although the government announced a series of resolutions, the April 5th Resolutions, to stabilize the economy and curb the inflation in line with the Stand-by-Agreement with the International Monetary Fund (IMF), it would soon be abandoned due to disagreements among the members of the

[2]Ozatay (1996) reported a significant drop in the open foreign exchange positions of the private commercial banks: a fall from USD 4.9 billion in December 1993 to USD 1.1 billion in June 1994 which highlights the extent of the rush into the foreign exchange market.

coalition government and the resulting political turmoil. In the following years up to 1998 there would be no other serious attempt to stabilize the economy and govern the inflation.

In June 26, 1998, the Turkish government declared a three-year Memorandum of Economic Policies to be performed under the supervision of IMF's Staff Monitored Program (SMP). The memorandum contained explicit inflation targets along with other targeted macroeconomic goals and noted the key reforms needed to be undertaken. It was stated that the government's three-year program is aimed to reduce the wholesale price inflation from over 90 percent at the end of 1997, to 50 percent by the end of 1998, 20 percent by the end of 1999, and single digits by the end of 2000[3]. It was noted that the autonomy of the central bank is respected, the Treasury should cease to borrow from the CBRT, and finally the CBRT, Treasury, and the Ministry of Finance should publish their respective quarterly program targets to achieve coordinated monetary policy. The disinflation program was slightly successful in curbing the inflation as inflation started move downwards. However, by the end on 1998, the inflation rate was still about 70% which was 20% points higher than the aimed inflation target. Similarly some of the fiscal imbalances were removed, yet the interest rates were still high and got worsened towards the end of 1998 when the Russian financial crisis (aka the "Ruble crisis") hit. In the following year, Turkey was struck by two consequent devastating earthquakes in August, and October 1999. The earthquakes were heavily felt in Izmit, an industrialized and densely populated urban area located in northwestern part of the country where oil refineries, several automotive plants, and the Turkish navy headquarters are located. The earthquakes left a devastating death toll besides severe economic consequences as reported in Selçuk and Yeldan (2001).

[3]On December 9, 1999, the CBRT announced a revised list of inflation targets where 20 percent by the end of 2000, 12 percent by the end of 2001, and 7 percent by the end of 2002 was aimed.

Having experienced two devastating earthquakes and marginal macroeconomic achievements, the Turkish government recognized the Memorandum of Economic Policies of 1999 as unsustainable. Instead, the Turkish government pushed the button for some structural reforms and adopted a new program, known as the Exchange Rate Based Stabilization (ERBS) program, in conjunction with the Stand-by-Agreement with IMF. The government enacted legislations aiming to reform the banking sector, and the social security system besides political reforms as discussed in Beris and Gürkan (2001). The central focus of the stabilization program was curbing the inflation and stabilizing the foreign exchange market. The program was announced to be implemented for one and a half year period beginning in January 2000. During the stabilization program, the CBRT announced a *tablita* plan where it committed to keep the percent change in the value of the Turkish Lira against the basket of foreign currencies, 1 USD plus 0.7 Euro, fixed as announced on a daily basis beforehand[4].

The exchange rate-based stabilization program could only be sustained for thirteen months. In February 2001, Turkey experienced its deepest financial crisis following the collapse of its soft exchange rate peg. The February 2001 crisis severely damaged the country's financial system and led to an unprecedented contraction in economic activity. The most direct indicators of the February crisis over the financial markets were the rapid rate of depreciation of the Turkish Lira (TL), and the sharp rise of the interest rates on the government's debt instruments. Yeldan (2002) reported that the USD/TL nominal parity increased by 96.5%, 116.5%, and 114.5% in the following three quarters of the crisis, and the real rates of interest on the government's debt instruments peaked at level of 117.5% by the end of the first quarter of 2001 casting doubts on government's ability to pay off its short-term domestic liabilities. Later in

[4]Tablita corresponds to a pre-announced crawling peg to some benchmark currency (usually USD) or a basket of currencies as defined in Reinhart and Rogoff (2004)

Table II.1: Foreign Exchange Rate Regimes, 1980-2005

Jan'80 - Apr'94	Crawling peg
Apr'94 - Dec'99	Managed float
Jan'00 - Feb'01	Tablita
Jul'01 - Present	Free float

July 2001, the CBRT announced it will keep the exchange rate within a band around a (fixed) exchange rate, and continue widening the band towards the end of 2002 in line with a gradual shift towards a more flexible exchange rate program. Table II.1 summarizes the evolution of foreign exchange rate regimes in Turkey since 1980.

The period immediately after the failure of exchange rate stabilization program and the financial crisis in 2001 is characterized by structural reforms and substantial changes in laws and regulations vis-á-vis the political and economic arena. The Turkish Parliament passed several laws including the law granting jure independence to the CBRT, a banking law, a law of complete reorganization, substantial downscaling and privatization of the state banks, an agricultural law (removal of the distortive price floors), a telecommunications law and privatization of Turk Telekom, a civil aviation law and the introduction of market determined fares, tobacco and sugar industry regulations law, a public procurement law, and public debt management law in about four months following the February crisis[5]. Contrary to the concerns expressed by Sachs (1997) and Kenen (2002) on the drawbacks of aiming opportunistic and far-reaching structural reforms in short periods of time, Derviş (2005) argued how the Turkish reformers "seized the moment" at a time of crisis and achieved several structural reforms that would be extremely difficult in normal times.

Following the April 2001 amendment to the Central Bank Law, the CBRT ac-

[5]Beris and Gürkan (2001) gave an extensive description of the enacted laws, regulations, and the amendments.

quired operational and jure independence from the political and fiscal authorities which is often referred as the primary prerequisite for inflation targeting[6]. In April 2001, shortly after the operational and jure independence granted to the CBRT, the CBRT declared its new monetary framework: a gradual transition to full-fledged inflation targeting, starting in January 2002. The monetary framework during 2002-2005 is often referred, with some ambiguity, to so-called "implicit inflation targeting" by Özatay (2005), Kara (2006), Başçı, Özel, and Sarıkaya (2008)[7]. During the period of 2002-2005, the CBRT employed two nominal anchors, an explicit "point target" of inflation and base money in line with the transition period towards a full-fledged inflation targeting which would become effective in January 2006. Due to the fact that an announcement of an official inflation target lies at the core of explicit inflation targeting, I call the period of 2002-2005 a semi-formal inflation targeting (instead of implicit targeting) period in line with Leiderman and Svensson (1995), and Dueker and Fischer (1996) where the CBRT announced a stepwise decreasing annual inflation targets, beside other monetary targets, as a path towards its long-run goal of single digit annual inflation rate by the end of 2005[8].

In April 2001, the CBRT explicitly stated and declared achieving and maintaining price stability as its primary objective[9]. During the transition period of 2002-2005, the CBRT started to officially announce its year-end CPI based inflation targets a

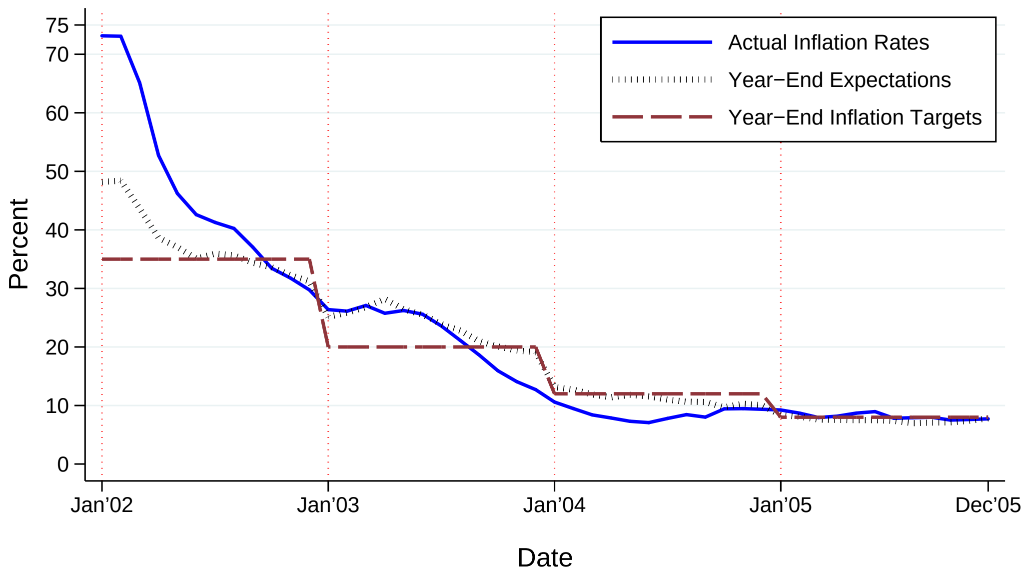
[6]The new law No. 4651 of April 25, 2001 amending Article IV of the Central Bank Law was quoted as "The primary objective of the Bank shall be to achieve and maintain price stability. The Bank shall determine on its own discretion the monetary policy that it shall implement and the monetary policy instruments that it is going to use in order to achieve and maintain price stability."

[7]Although official inflation targets were not announced as in explicit inflation targeting, Goodfriend (2003) argued that the FED had in fact committed to "implicit inflation targeting"'during the Greenspan era of 1987-2006, where FED assigned clear priority to low and stable inflation rates about 1 to 2 percent range.

[8]In its January 2, 2002 Press Release, the CBRT announced that it would switch to official full-fledged inflation targeting when necessary conditions emerge. Later, at the beginning of 2004, the CBRT declared that it intends to complete its transition by the end of 2005 and switch to full-fledged inflation targeting effective January 2006.

[9]The declared mission statement of the CBRT "The primary objective of the Bank shall be to achieve and maintain price stability has been published" has been published online since April 2001.

year in advance along with monetary base targets, often considered as complementary anchor. Ambitious year-end inflation targets of 35%, 20%, 12%, and 8% were officially announced for the years of 2002, 2003, 2004, and 2005 respectively. The CBRT continuously communicated with the general public regarding its targets and actions it will undertake to reach the announced targets via publishing inflation reports and press releases, and tried convincing the economic agents that even the most substantial measures would be carried out if needed.



Actual inflation rate measures the percentage change in prices over the past 12 months.
Source: Central Bank of Republic of Turkey (CBRT)

Figure II.2: Inflation Rates, Expectations and Targets, 2002-2005

During the transition period to inflation targeting, the CBRT achieved considerable success in terms of reaching its announced inflation targets and price stability where actual annual inflation rates of 29.7% in 2002, 18.4% in 2003, 9.3% in 2004, and 7.7% in 2005 were reported. Compared to its announced year-end inflation targets, the CBRT undershot for four consecutive years in transition to full-fledged inflation targeting as presented in Figure II.2. It's also shown that the gap between year-end inflation expectations and the inflation targets got smaller during the transition period. Başçı, Özel, and Sarıkaya (2008) interpreted undershooting as the CBRT's deliberate attempts to build credibility in line with Cukierman and Muscatelli's (2002) finding on the UK that monetary authorities focused heavily on keeping the inflation expectations low in comparison to managing the business cycles when credibility building was a concern. Carefully designed monetary policies coupled with deliberate and timely announcements, and consistent policy actions to shape individual's inflation expectations was crucial elements in Turkey's experience towards successfully reducing the inflation rates to a single digit level by the end of 2005[10].

[10]The significance of inflationary expectations was recognized by the CBRT in its January 2, 2002 Press Release stating "One of the main functions of monetary policy is to help shape the expectations."

CHAPTER III

LITERATURE REVIEW

Inflation targeting, a twenty year old monetary framework as of 2010, has been adopted by a number of industrial and emerging economies. As a result, a large literature has build upon this subject. Walsh (2009) provided a comprehensive survey of the studies on the effects of inflation targeting on macroeconomic performance and the provided evidence regarding the design of monetary policy. Inflation targeting was first introduced by New Zealand in 1990. Although there is some controversy over the issue of dating the adoption if inflation targeting, Mishkin and Schmidt-Hebbel (2007) identified the earliest adoption dates of inflation targeting as New Zealand in 1990, Canada and Chile in 1991, United Kingdom in 1992, and Australia 1994. Following the early targeters, inflation targeting spread to several other countries where it reached to 26 countries explicitly adopted inflation targeting as of 2009. Although this research has noticeable attributes, it draws upon several empirical and theoretical studies of inflation targeting and its macroeconomic impacts.

The existing literature that deals with inflation targeting, its relationship with expectations and its influence on key macroeconomic variables can at least be summarized in three main groups. The first group of studies deal with optimal design and performance of inflation targeting policies under diverse institutional, legal, and political environments along with the implications of alternative approaches to the conduct of monetary policy. Bernanke et al. (1999), Bernanke and Woodford (2005), and Mishkin (2006) summarized the debate on advantages and the drawbacks of inflation targeting policies for several economies. Truman (2003) focused on the implications of inflation targeting for the functioning of the international financial system and the performance of the world economy. Svensson and Woodford (2005) proposed a rational expectations based theoretical model of inflation-forecast targeting as a candidate for optimal monetary policy where they showed an inflation-forecast targeting procedure is consistent with optimal equilibrium and it could be a desirable approach for designing the decision making process in the conduct of a monetary policy.

Cecchetti and Kim (2005) focused on the design of an optimal targeting policy where the degree to which overshooting of the long-run target inflation rate should be followed by deliberate undershooting for a set of, mostly, industrialized economies. In a similar line of research, Jonas and Mishkin (2005) examined the experiences of transition economies Czech Republic, Poland, and Hungary with inflation targeting where they documented radical restructuring, democratization process, and the relationship between government and the central bank is likely to make inflation targeting more difficult to implement in such economies. They claimed, for the three transition economies, the substantial restructuring reforms played a significant role in making these economies often missed the announced inflation targets by large margins. Missing the announced targets by large margins, they argued, created a vicious cycle where it is crucial for the central bank avoid under or overshooting of its inflation targets in order not to jeopardize the fragile political support for the central bank and its authority in the conduct of monetary policy.

The second group of research examines the persistence properties of inflation and investigates whether the observed post World War II inflation persistence is structural and invariant to the shifts in monetary regimes. Although this line of research handles the concept of persistence in inflation from a general standpoint, it is especially connected to my research question in regards to inflation persistence and whether it has any systematic relationship with inflation targeting policies. The general finding of this second group of studies is that post inflation targeting periods are usually associated with lower inflation persistence for industrial economies.

Fuhrer and Moore's (1995) theoretical work on inflation persistence is a milestone in exploring the mechanism to make inflation persistence found in the data. Their research documented that the standard Phelps and Taylor overlapping wage contract model lacks enough inflation persistency observed in post World War II U.S. data. This finding led Fuhrer and Moore to argue that based on standard contract model, the predictions on monetary policy goals e.g. the output sacrifice ratio and the variance of inflation and output, may be unrealistically small or insignificant. Fuhrer and Moore's relative contracting model instead concluded that an aggressive disinflationary policy would yield a marked increase in lost output whereas a credible and extremely gradual disinflation program would significantly lower the output loss. A related recent study in similar line of modeling intrinsic inflation persistence is by Sheedy (2007). Although it's parallel with Fuhrer and Moore in terms of intrinsic inflation persistence, Sheedy (2007) proposed a model of price stickiness where firms are assumed to adjust older rather than newer prices to generate intrinsic inflation persistence which produced indispensable temporary reduction in economic activity.

Levin and Piger (2004) provided empirical evidence that the degree of inflation persistence is not an inherent characteristic or structural phenomenon in the sense of Lucas (1976) for a set of industrial economies. Their research applied Bayesian econometric methods to characterize the dynamic behavior of inflation and persistence for Australia, Canada, France, Germany, Italy, Japan, Netherlands, New Zealand, Sweden, Switzerland, the United Kingdom, and the United States. Many of the countries they considered went through substantial shifts in their monetary policy framework since 1990, particularly the widespread adoption of inflation targeting. Due to such shifts in the monetary regimes, Levin and Piger (2004) considered possible structural breaks at unknown dates in the inflation process for each country. They found strong evidence of structural breaks in inflation series and once they allowed for a break in intercepts, the inflation measures generally exhibited relatively low inflation persistence. Following a similar line of reasoning, Benati (2008) documented that inflation in the United Kingdom, Canada, Sweden, and New Zealand, under inflation targeting, followed a near white-noise process criticizing the notion of intrinsic inflation persistence and that inflation persistence is invariant to shifts in monetary regimes including the shifts towards inflation targeting.

O'Reilly and Whelan's (2004) empirical analysis focused on the stability of inflation over time for the Euro-area since 1970, particularly on the behavior of inflation persistence. The authors documented the facts in relation to structural changes over time in the processes of inflation persistence. They reported relatively little instability in the parameters of the Euro-area inflation process which led them to conclude that there hasn't really been significant structural changes in the process of inflation persistence contrasting the finding by Levin and Piger (2004), and Benati (2008).

The third and the last group of research offers critical evaluations of the macroeconomic impacts of inflation targeting for both developed and emerging economies as it has been implemented in practice thus far. In this respect, there exist numerous studies falling in this group which address the inflation targeting and its impact on the level and variability of inflation, output and inflation expectations. Though these studies can be summarized in different ways, I prefer to categorize them in three main classes where the first set of studies address empirical and theoretical aspects of inflation targeting and its macroeconomic impacts only for industrialized economies, the second set of studies are focused on emerging economies for the same subject matter, and finally the third set of studies dealing with both industrialized and emerging economies together. The evidence suggested by several of these studies is that a considerable heterogeneity exists regarding the inflation targeting experiences of both industrialized and emerging economies i.e. the impact of inflation targeting on various macroeconomic variables varies from country to country.

Ball and Sheridan (2003) investigated the impact of inflation targeting for a collection of industrialized targeting and non targeting economies. They examined not only the behavior of inflation but also output, and interest rates on various accounts such as average levels, variability and persistence in these variables . The authors found similar improvements in macroeconomic performance for both targeting and non targeting economies. In some cases, they found evidence that the inflation targeting economies performs better e.g. average inflation fell by a larger amount compared to non targeting economies. However, once they controlled for inflation targeting economies' worse macroeconomic performance than non targeting economies prior to the early 90s (the approximate date of adopting inflation targeting regime), the difference in macroeconomic performance disappeared which led them to conclude that the data simply reflects regression to the mean phenomenon.

The empirical study by Wu (2004) which uses a different set of industrialized targeting economies than Ball and Sheridan (2003) provided evidence that countries which have officially adopted inflation targeting experienced a decrease in their average inflation rates after the adoption of the new regime and this estimated effect persists even after controlling for the initial inflation rate. This is a finding negating the regression to the mean phenomenon. In a similar line of reasoning, Pétursson (2004) studied a collection of both industrialized and emerging inflation targeting economies where he provided evidence in favor of inflation targeting for bringing inflation and its persistency down which is also consistent with the earlier conclusions by Corbo et al. (2002), Neumann and von Hagen (2002). These findings supports the claim that the experiences of the emerging economies with inflation targeting differ in comparison to industrialized economies. That is why studying individual countries' targeting experiences is necessary, especially for the developing or the transition economies, to pinpoint the true underlying reasons characterizing the behavior of inflation and expectations.

The empirical studies discussed so far, in one way or another, uses standard econometric techniques where comparison of the economic performance of targeting to non targeting economies or economic performance prior to post inflation targeting periods is the essence. There are empirical studies incorporating more recent econometric techniques in addition to the standard empirical methods. Vega and Winkelried (2005) used a propensity scoring approach to study the effects of inflation targeting adoption for a sample of 109 countries of which 23 are inflation targeters. With this approach they found inflation targeting helped reduce the level and volatility of inflation in the countries that adopted it and persistence of inflation is rather weak in targeting economies. Lin and Ye (2007), on the other hand, used a comprehensive new data set to evaluate the treatment effect of inflation targeting for seven industrial countries adopted inflation targeting in the 1990s[1]. These authors provided statistically insignificant evidence for the treatment effects of inflation targeting on long-term nominal interest rates often used by policymakers as an indicator of inflation expectations. Empirical results in Willard (2006), and Dueker and Fischer (2006) are also in line with the studies suggesting little evidence that produces divergence in macroeconomic performance of inflation targeting and non targeting economies. Lin and Ye

[1]These countries are: Australia, Canada, Finland, New Zealand, Spain, Sweden, and the United Kingdom.

(2009), a more recent study utilizing propensity matching methods with a focus on developing economies only, found statistically significant impact of inflation targeting on inflation and inflation variability.

The matter that is most related to the objective of this study is the mechanism and the extent of the impact of inflation targeting on inflation expectations. In this respect there are several studies attempted to measure the direct impact of targeting on inflation expectations. Empirical studies by Johnson (2002, 2003) investigated the effect of inflation targeting on the behavior of inflation expectations for two different sets of industrialized economies. Johnson (2002) constructed a panel of eleven industrial inflation targeting and non targeting economies from 1984 to 2000[2]. He concentrated on the changes in three aspects of the behavior of expected inflation following the announcement of inflation targets: the level and variability of expected inflation and the average absolute size of inflation forecast errors. He found, after controlling for country and time specific fixed effects, the actual rate of inflation fell in both targeting and non-targeting economies, and the level of expected inflation in targeting countries significantly falls following the announcement of inflation targets. His work provided rather mixed evidence concerning the impact on inflation forecast errors which seem to suggest that inflation expectations respond differently in targeting and non targeting economies. Following this evidence, Johnson (2003) reduced the list of countries to only targeting industrialized economies, where the focus was switched to a longer series of prior and post targeting periods. By doing so, he provided evidence that announced inflation targets reduced the level of expected inflation for the targeting industrial economies under consideration with the exception of the United Kingdom. Therefore, one tend to think that even among the targeting indus-

[2]Johnson (2002) considered targeting economies: Australia, Canada, New Zealand, Sweden, and United Kingdom, and the non targeting economies: France, Germany, Italy, Netherlands, Japan, and the United States.

trialized economies there may be significant differences in how inflation expectations respond to the targeting policies implemented.

Empirical studies support the idea that inflation targeting anchor inflation expectations. Gürkaynak et al. (2006 and 2007) investigated the extent to which inflation targeting helps the central banks to anchor long-run inflation expectations. The authors compared the behavior of daily bond yield for some inflation targeting economies, the United Kingdom and Sweden (2006), and Canada and Chile (2007), to that of the United States, a non inflation targeting economy. They argued, if 10-year-ahead forward inflation compensation is relatively insensitive to incoming economic news, then that would suggest the financial market participants have fairly stable views regarding the distribution of long-term inflation outcomes, and hence the monetary policy framework has been reasonably successful in anchoring long-term inflation expectations. They showed that, in the United States, long-term inflation expectations react to news, suggesting that these expectations were not firmly anchored. In contrast, no such response was found for Sweden, United Kingdom, Canada and Chile which are inflation targeting economies. The authors interpreted this finding as an evidence for inflation expectations being anchored better under inflation targeting monetary framework.

A closely related study to the current research is by Ravenna (2007) where he studied whether it is the shift in the management of monetary policy or the reduction in the volatility of exogenous shocks a more prominent explanation for the Canada's period of low and stable inflation[3]. In his DSGE model, he obtained historical shock series, which were used to generate counterfactual experiments to examine whether

[3]The primary focus of Ravenna (2010) is the impact of inflation targeting in reducing inflation volatility in Canada, which dropped from 2.28 over the 1981-1990 decade to 0.51 over the following 1991-2000 decade, and to 0.48 over the 1991-2005 period as reported in Longworth (2002) and Murray (2006).

the inflation time series would have been significantly different under an alternative monetary policy than inflation targeting. Ravenna reported a significant decline in inflation volatility in Canada under inflation targeting with most of this decline attributed to the impact of the policy switch on expectations. Monetary policy shocks are estimated to have non-negligible variance, yet they contributed very little to inflation stabilization. His result supports the claim that changes in policy regime can dramatically affect the economy dynamics by altering private agents' decision making as discussed in Sargent (1999). Although Ravenna recognizes the importance of managing expectations, he suggested it's neither the adoption of inflation targeting regime nor the change in the conduct of policies of the central bank that could account for the historical improvement in inflation performance in Canada. Instead, it's the reduction in the size and the frequency of the shocks hitting the economy, often referred to as good luck hypothesis, and any other sensible monetary regime with a focus on managing the expectations would resulted in success.

Levin et al. (2004) evaluated the extent to which inflation targeting has a measurable influence on expectations formation and inflation dynamics. They compared time-series data since 1994 for five targeting industrialized economies (Australia, Canada, New Zealand, Sweden, and the United Kingdom) with that of seven non targeting countries (the United States, Japan, Denmark, France, Germany, Italy, and the Netherlands) where they found that inflation targeting has played a significant role in anchoring long-run inflation expectations. In relation to emerging economies, they provided graphical analysis for individual country's experiences[4]. In regards to the behavior of inflation expectations in emerging economies, they concluded that inflation targeting were not associated with an instantaneous fall in private-sector inflation forecasts and a marked reduction in the output costs of disinflation.

[4]The emerging economies they studied are Chile, Czech Republic, Israel, South Africa, South Korea, Thailand, Brazil, Colombia, Hungary, Mexico, and Poland.

CHAPTER IV

OVERVIEW OF METHODOLOGY

I adopt a methodology that borrows extensively from Weymark (1995, 1998), Weymark and Shintani (2006), and Siklos and Weymark (2009). I imagine the central bank aiming to reduce inflation in a gradual manner where monetary policy is conducted through announcements and interest rate changes. Each period the central bank faces a trade off between inflation and the interest rate in an environment subject to constant exogenous disturbances. Any exogenous disturbance to the economy has the potential to generate goods market disequilibria which alters the inflation rate. Conditional on the nature of the shock and the subsequent potential change in the inflation rate, the central bank decides whether or not to act the next time the policy rate is set. When a positive (inflation increasing) shock hits the economy, the central bank must counteract the potential inflationary pressure whereas a negative (inflation reducing) shock may be accommodated given that the potential reduction in the inflation rate is in accordance with the central bank's timeline for the disinflation program.

Implementing the outlined methodology above is not straightforward. First, the sequence of events are not fully observable. Second, there are multiple channels through which the policy effects inflation. The observed change in the inflation rate reflects not only the impact of the disturbance on the goods market but also the changes in the policy variables and other economic variables stimulated by the policy change. In order to be able to uncover the underlying shock and disentangle the impact of the policy change, I conduct counterfactual experiments.

I am primarily concerned with developing measures that would reflect the environment, i.e. the nature and the size of the shock, that the monetary authority is faced when undertaking policy initiative, and provide quantitative measures reflecting the degree to which policy change influenced the inflationary environment. I use ex ante inflation pressure to measure the magnitude of the initial disturbance to the economy. To this end, I conduct a policy experiment where I ask what would have happened to inflation rate if the central bank had kept its policy instrument constant and no other variables had responded to that particular disturbance. This counterfactual exercise gives a measure of the underlying inflationary environment in inflation units that the policy authority faced at a given point in time, and to which it responded by implementing the observed interest policy change.

Ex ante inflation pressure and its computation is perhaps most easily understood through an illustrative example. Consider a closed economy described by the following structural model:

$$\pi_t = \alpha_0 + \alpha_1 \pi_{t-1} + \alpha_2 E_t \pi_{t+1} + \alpha_3 y_{t-1} + \epsilon_t \tag{IV.1}$$

$$y_t = \beta_0 + \beta_1 y_{t-1} + \beta_2 E_t y_{t+1} - \beta_3 [i_{t-1} - E_{t-1} \pi_t] + \eta_t \tag{IV.2}$$

$$i_t = \rho i_{t-1} + (1-\rho)[\gamma_0 + \gamma_\pi E_t \pi_{t+2} + \gamma_y E_t y_{t+1} + \sigma_t] \tag{IV.3}$$

where π_t is the inflation rate at time t, y_t is the output gap in period t, and i_t is the period t nominal interest rate. $E_t \pi_{t+1}$ is a forward looking variable denoting the expectation that rational agents form about the future level of inflation in $t+1$ conditional on information observed through time period t. Similarly $E_t y_{t+1}$ is the rational, one period ahead expectation of the output gap. Equation (IV.3) is the monetary authority's interest rate rule where ρ indicates the degree of interest rate smoothing reflecting the monetary authority's tendency to smooth changes in the interest rate to reach its nominal target rate. γ_π and γ_y reflects the relative weights placed by the monetary authority on the expected future inflation and output gap. ϵ_t, η_t, and σ_t are zero mean, independent and identically distributed random disturbance terms.

The structural model used later in this study is different than what is outlined for illustrative purposes. I use a small open economy framework as opposed to closed economy. The estimated forward and backward looking lag structure of the empirical model is more complex than that of the illustrative example. However, the illustrative example is rich enough to allow addressing all of the technical and methodological issues that arise in computing inflation pressure in the empirical application in later chapters.

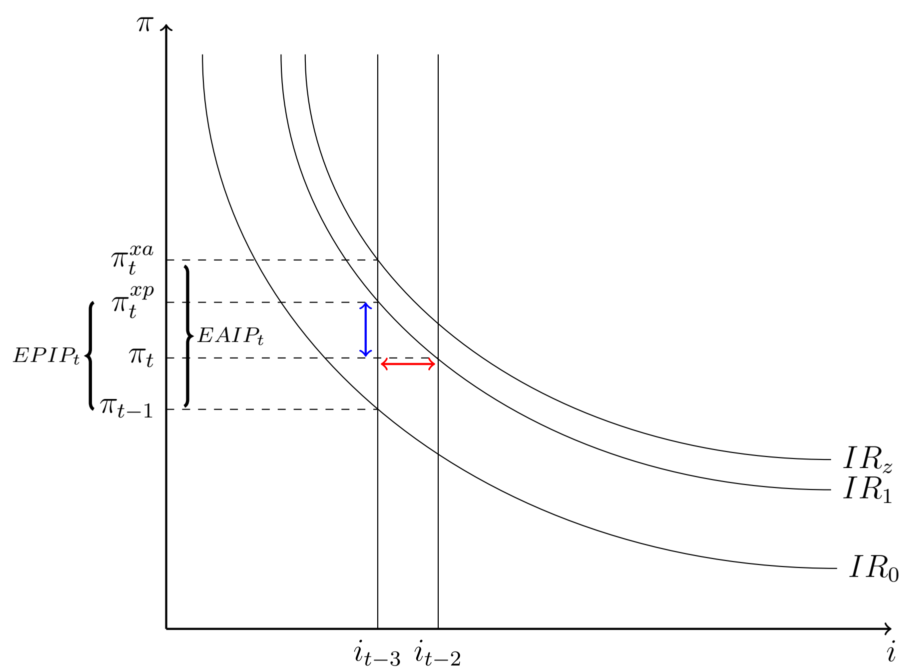
According to equation (IV.2), the output gap responds to the monetary authority's interest policy change one period after the policy is implemented. Similarly, the inflation rate, in equation (IV.1), responds to output gap with one period delay. To find the direct impact of the interest rate policy changes on inflation, I lag (IV.2) one period and substitute it into (IV.1) to get:

$$\begin{aligned}\pi_t &= \alpha_0 + \alpha_1 \pi_{t-1} + \alpha_2 E_t \pi_{t+1} + \epsilon_t \\ &\quad + \alpha_3 \left\{ \beta_0 + \beta_1 y_{t-2} + \beta_2 E_{t-1} y_t - \beta_3 [i_{t-2} - E_{t-2} \pi_{t-1}] + \eta_{t-1} \right\} \qquad \text{(IV.4)}\end{aligned}$$

Equation (IV.4) shows that there is a two period control lag between the monetary authority's policy tool, i, and the inflation rate in this economy. The relationship between interest rate changes and the inflation rate described in (IV.4) is represented graphically in Figure IV.1. The trade off curves, IR_0, IR_1, and IR_z, depict the inverse relationship between inflation and the interest rate that exists at various points in time with different sets of state variables describing the environment. The low-est curve, IR_0, represents the trade-off that existed in period $t-3$. The difference in the position of IR_0 and highest curve, IR_z, represents the shift in the trade-off caused by changes in any of the predetermined explanatory variables on the right hand side of (IV.4) other than i_{t-2}. I assume for simplicity that there are no exogenous expectational shocks, though this framework can handle exogenous expectational disturbances as well.

The distance between IR_0 and IR_z is a measure of the inflationary environment that the monetary authority faced at the beginning of time $t-2$ and to which it yet to respond. This distance can be measured horizontally (in interest rate units) or vertically (in inflation units). I choose to measure the distance between the trade off curves vertically because I focus on the inflation outcomes as it is the primary indicator of monetary policy effectiveness.

Figure IV.1: Graphical Representation of EAIP & EPIP



It is possible to measure the vertical distance between IR_0 and IR_z at different points along the horizontal axis, however, to derive more operational measures, it is advisable to use as many directly observable variables as possible. I therefore use the past period's interest rate, i_{t-3}, as benchmark. The impact of the disturbance that is represented by the shift in the trade off from IR_0 to IR_z is therefore given by the vertical distance from π_{t-1} to π_t^{xa} in Figure IV.1 at i_{t-3}. The vertical distance between IR_0 and IR_z, measured at i_{t-3} provides a quantitative characterization of the inflationary environment that the policy authority faced at the beginning of period $t-2$, and to which it responded when it implemented its interest rate policy in period $t-2$. The size of the vertical distance between IR_0 and IR_z is the ex ante inflation pressure at time t, $EAIP_t$, determining the inflation rate that would have been realized if the interest rate had been held constant and this policy decision had been correctly anticipated by the economic agents. Using the notation in Figure IV.1, the formal definition of Ex Ante Inflation Pressure index (EAIP) for period t is given by:

$$EAIP_t = \pi_t^{xa} - \pi_{t-1} \tag{IV.5}$$

where π_t^{xa} denotes the inflation rate that would have been observed in period t if the monetary authority had held its policy instrument constant for a period i.e. $i_{t-2} = i_{t-3}$.

I have defined a measure to characterize the underlying inflationary environment that was faced by the monetary authority. Now, I conduct a measurement experiment where I ask to find the magnitude of the inflation pressure left subsequent to the interest policy change. The size of the inflation pressure that remains after the implementation of monetary policy is called the ex post inflation pressure.

The observed change in inflation in response to the policy change is a combination of two forces. When agents form expectations rationally, their expectations about the future path of endogenous variables are affected by changes in policy variables as suggested by Lucas critique. In Figure IV.1, the impact of the period i_{t-2} interest rate policy on expectations is shown as an inward shift of (i.e., improvement in) in the trade off curve from IR_z to IR_1. Changes in the interest rate has also a direct impact on inflation through its influence on observed output gap. The direct impact of interest change on inflation is shown as a movement along the IR_1 trade off curve when interest rate changes from i_{t-3} to i_{t-2} on the horizontal axis. The ex post inflation pressure at time t is graphically measured by the distance between IR_1 and IR_0 which can be computed by measuring the vertical distance between π_t^{xp} and π_{t-1} at i_{t-3}. However, once the policy change is initiated, the distance between IR_z to IR_1 is not observable as it incorporates changes in the expectations which are not observable.

Once the policy rate is changed into i_{t-2}, the policy rate itself and the resulting inflation rate, π_t, are observable. The observed information can be used to back out the position of the IR_1 trade off curve. In Figure IV.1, ceteris paribus, I show the conversion factor between the horizontal distance from i_{t-3} to i_{t-2} and change in inflation rate attributed to that policy change in inflation units (vertically) to back out the location of IR_1 trade off curve at i_{t-3} and compute the ex post inflation pressure. Verbally, ex post inflation pressure is defined more precisely as the change in the inflation rate that would have occurred under the monetary policy actually implemented in a given period, if the policy authority had unexpectedly maintained its policy instrument at the same level as in the previous period.

Using the notation in Figure IV.1, the formal definition of Ex Post Inflation Pressure index (EPIP) for period t is given by:

$$EPIP_t = \pi_t^{xp} - \pi_{t-1} \tag{IV.6}$$

where π_t^{xp} denotes the inflation rate that would have been observed in period t if the monetary authority had unexpectedly held $i_{t-2} = i_{t-3}$.

Up to this point, I went through a graphical exposition of ex ante and ex post inflation pressure measures. Now, I show the analytical procedure required to perform the counter factual experiments needed to obtain measures of ex post and ex ante inflation pressure. Equation (IV.4) indicates that there is a two period control lag between the monetary authority's policy tool, i, and the inflation rate in this economy. Thus, the conduct of counterfactual experiments and obtaining measures of ex ante and ex post inflation pressure requires all variables that appear in (IV.4) expressed in terms of i_{t-2} and earlier. Initially I carry forward the expectation terms as they appear in (IV.4), but eventually in order to obtain ex ante inflation pressure, all variables including the expectation terms must be expressed in terms of i_{t-2} and earlier.

The first step in deriving the counterfactual experiments for inflation pressure is to recognize the relationships between variables in (IV.4), and how these variables depend on i_{t-2}. According to (IV.4), π_{t-1} depends on $E_{t-1}\pi_t$. $E_{t-1}\pi_t$ is a function of y_{t-1} which depends on i_{t-2}. Lagging (IV.1) and making appropriate substitutions in (IV.4) yields

$$\begin{aligned}\pi_t \quad &= \quad A_0 + \alpha_1^2\pi_{t-2} + A_1 y_{t-2} - \alpha_3\beta_2 i_{t-2} + \alpha_2 E_t\pi_{t+1} + \alpha_1\alpha_2 E_{t-1}\pi_t + \alpha_3\beta_3 E_{t-2}\pi_{t-1} \\ &\qquad + \alpha_3\beta_2 E_{t-1}y_t + \epsilon_t + \alpha_1\epsilon_{t-1} + \alpha_3\eta_{t-1} \qquad \text{(IV.7)}\end{aligned}$$

where $A_0 = \alpha_0(1+\alpha_1) + \alpha_3\beta_0$, and $A_1 = \alpha_3(\alpha_1 + \beta_1)$.

In order to obtain the ex post inflation pressure Δi_{t-2} has to be expressed in inflation equivalent units at i_{t-3}. Equation (IV.7) provides conversion factor as $-\alpha_3\beta_2$. That is to say, ceteris paribus, if the monetary authority had unexpectedly held $i_{t-2} = i_{t-3}$, the counterfactual inflation rate that would prevail would be π_t^{xp} which can be described as

$$\begin{aligned} \pi_t^{xp} &= A_0 + \alpha_1^2\pi_{t-2} + A_1 y_{t-2} - \alpha_3\beta_2 i_{t-3} + \alpha_2 E_t\pi_{t+1} + \alpha_1\alpha_2 E_{t-1}\pi_t + \alpha_3\beta_3 E_{t-2}\pi_{t-1} \\ &\quad + \alpha_3\beta_2 E_{t-1} y_t + \epsilon_t + \alpha_1\epsilon_{t-1} + \alpha_3\eta_{t-1} \end{aligned} \tag{IV.8}$$

Notice that the expectations are not adjusted to reflect the counterfactual change in i_{t-2}. This is because I am not asking the question "What would the inflation pressure has been under a different policy?" I merely try to ascertain what the overall underlying inflation pressure is when measured in commensurate inflation units. Thus, analytically, the ex post inflation pressure is give by

$$EPIP_t = \pi_t^{xp} - \pi_{t-1} \tag{IV.9}$$

Measuring π_t^{xp} as given in (IV.9) would pose significant practical problems. However, a much simpler operational measure can be obtained using observed data. Comparing (IV.7) and (IV.8) reveals that π_t^{xp} can be expressed as

$$\pi_t^{xp} = \pi_t + \alpha_3\beta_2\Delta i_{t-2} \tag{IV.10}$$

Thus, the ex post inflation pressure can be measured as[1]

$$EPIP_t = \Delta\pi_t + \alpha_3\beta_2\Delta i_{t-2} \tag{IV.11}$$

The ex post inflation pressure intends to provide a quantitative measure for the

[1]Note that the ex post inflation pressure is dated at period t taking into account the two period control lag between the policy authority's interest rate instrument, i and the inflation rate.

remaining inflation pressure subsequent to the implementation of the interest rate policy. In order to assess the degree to which the policy succeeded in moderating the inflation pressure that was present prior to the implementation of policy, the overall response of the variables, including the expectation terms, must be known. Policy changes have an impact on expectations as suggested by Lucas critique. I back out the impact of the observed policy change Δi_{t-2} on the expectational terms and in order to compute the ex ante inflation pressure. To this end, some assumptions have to be made in regards to private sector's expectation formation process. For the sake of illustration, here I consider rational expectations only. However, in later chapters, I consider both rational expectations and adaptive learning algorithm to obtain inflation pressure measures for comparison.

I consider rational private agents forming expectations where they use both contemporaneous and lagged observations of the endogenous variables, π, y, and i whereas they observe only the lagged disturbances, ϵ, η, and σ. For appropriate coefficient values, the model described by (IV.1)-(IV.3) has a unique minimal state variable (MSV) solution. In order to obtain expressions for the expectations appear in (IV.7) as functions of i_{t-2} and earlier, I conjecture that the MSV solutions for the endogenous variables, π_t, y_t, and i_t, are in the following form.

$$\pi_t = g_0 + g_1\pi_{t-1} + g_2 y_{t-1} + g_3 i_{t-1} + g_4\epsilon_t + g_5\eta_t + g_6\sigma_t \qquad \text{(IV.12)}$$

$$y_t = h_0 + h_1\pi_{t-1} + h_2 y_{t-1} + h_3 i_{t-1} + h_4\epsilon_t + h_5\eta_t + h_6\sigma_t \qquad \text{(IV.13)}$$

$$i_t = k_0 + k_1\pi_{t-1} + k_2 y_{t-1} + k_3 i_{t-1} + k_4\epsilon_t + k_5\eta_t + k_6\sigma_t \qquad \text{(IV.14)}$$

where g_i, h_j, and k_l for $i, j, l = 0, 1, 2, \ldots 6$ are constants.

Equation (IV.7) contains four expectational terms that needs to be expressed in terms of i_{t-2} and earlier. These expectations are $E_t\pi_{t+1}$, $E_{t-1}\pi_t$, $E_{t-2}\pi_{t-1}$, and $E_{t-1}y_t$. In Appendix (A.1), I explicitly show the steps that need to be undertaken to derive the expectational terms as functions of i_{t-2} and earlier as in (A.5)-(A.8). Substituting (A.5)-(A.8) into (IV.7) gives the following expression for π_t

$$\begin{aligned}\pi_t &= \Gamma_0 + \Gamma_1\pi_{t-2} - \alpha_3\beta_2 i_{t-2} + \Gamma_3 i_{t-2} + \epsilon_t + (\alpha_1 + \alpha_2 Q_4)\epsilon_{t-1} \\ &\quad + (\alpha_3 + \alpha_2 Q_5)\eta_{t-1} + \alpha_2 Q_6 \sigma_{t-1} \qquad \text{(IV.15)}\end{aligned}$$

where

$$\begin{aligned}\Gamma_0 &= A_0 + \alpha_2 Q_0 + \alpha_1\alpha_2 G_0 + \alpha_3\beta_3 g_0 + \alpha_3\beta_1 H_0 \\ \Gamma_1 &= \alpha_1^2 + \alpha_2 Q_1 + \alpha_1\alpha_2 G_1 + \alpha_3\beta_3 g_1 + \alpha_3\beta_1 H_1 \\ \Gamma_2 &= A_1 + \alpha_2 Q_2 + \alpha_1\alpha_2 G_2 + \alpha_3\beta_3 g_2 + \alpha_3\beta_1 H_2 \\ \Gamma_3 &= \alpha_2 Q_3 + \alpha_1\alpha_2 G_3 + \alpha_3\beta_3 g_3 + \alpha_3\beta_1 H_3\end{aligned}$$

Notice that there are two i_{t-2} variables appearing in (IV.15). The former term measures the direct impact of interest rate changes on inflation through changes in observed variables whereas the latter comes from the expectational terms measuring the impact of the monetary policy implemented at time $t-2$ on the period t inflation through expectations channel. Setting $i_{t-2} = i_{t-3}$ in (IV.15) to compute π_t^{xa} in Figure IV.1 gives

$$\begin{aligned}\pi_t^{xa} &= \Gamma_0 + \Gamma_1\pi_{t-2} - \alpha_3\beta_2 i_{t-3} + \Gamma_3 i_{t-3} + \epsilon_t + (\alpha_1 + \alpha_2 Q_4)\epsilon_{t-1} \\ &\quad + (\alpha_3 + \alpha_2 Q_5)\eta_{t-1} + \alpha_2 Q_6 \sigma_{t-1} \qquad \text{(IV.16)}\end{aligned}$$

Ex ante inflation pressure is defined as $EAIP_t = \pi_t^{xa} - \pi_{t-1}$. The operational EAIP index can be obtained by using (IV.15) and (IV.16) such that

$$EAIP_t = \Delta\pi_t + \alpha_3\beta_2\Delta i_{t-2} - \Gamma_3\Delta i_{t-2} \tag{IV.17}$$

Although the illustrative example was used to motivate the definitions for ex ante and ex post inflation pressure, the definitions themselves are model independent. This means that the methodology described here is completely general and flexible can be applied to any other model one might prefer.

Monetary policy effectiveness depends not only on the impact of the policy change on observed inflation but also on the underlying inflationary environment. When a policy initiative successfully moderates the impact of a disturbance on observed inflation, the remaining observed inflation only partially reflects the inflationary environment after the implementation of the policy. This is because part of the inflationary pressure that still exists is absorbed by the interest rate change. Depending on the degree to which the initiated policy change influenced private agent's expectations, smaller or larger interest rate changes might be required to achieve a similar inflation outcome subsequent to a given shock. Thus, evaluating the overall monetary policy effectiveness requires measuring the amount of inflation pressure that was dissipated by the change in the interest rate in addition to the observed change in the inflation rate. In Figure IV.1, the vertical distance between π_t^{xp} and π_{t-1} is the ex post inflation pressure showing the magnitude of inflation pressure that still exist after the implementation of the policy change. The vertical distance between π_t^{xa} and π_{t-1} is the ex ante inflation pressure that existed before the policy initiative was undertaken. Comparison of these two measures tells us how much of the existing inflation pressure was relieved due to the implementation of the policy change i.e. the monetary policy effectiveness.

In a situation in which one is concerned with assessing the effectiveness of a stabilization policy, moderation of ex ante inflation pressure is always desirable as studied by Weymark and Shintani (2006) where they primarily focus on evaluating the effectiveness of the stabilization policy of the U.S[2]. The U.S. economy has enjoyed low levels of inflation especially since the early 1990s and hence the monetary authority's focus was on to stabilize prices through moderating the positive or negative disturbances hitting the economy. Under such circumstances, it is reasonable to assess the monetary authority's effectiveness based on the degree to which the prices were stabilized. However, measuring policy effectiveness of a central bank with a primary goal of reducing the inflation to moderate levels requires a slightly different approach where distinguishing between the nature of the shocks hitting the economy and to which should the central bank respond in the sake of moderation is important.

A central bank aiming to reduce inflation may accommodates some shocks to some extent if these shocks are inflation reducing. I study Turkish economy during a period where the central bank's goal was to reduce inflation in a gradual manner. Thus, I measure the monetary authority's effectiveness by comparing how much of the inflation pressure was relieved due to the policy initiative and its accordance with the goal of lowering the inflation level. The monetary authority facing a though economic environment with significantly high inflationary pressure implements a successful interest rate policy which reduces the observed inflation and alleviates part of the inflationary pressure existed before. That would mean a highly effective monetary policy has been implemented. On the other hand, an inflation reducing shock hitting the economy may cause a significant drop in the observed inflation rate where the respond of the monetary authority to this shock is not the deriving force behind the

[2] Weymark and Shintani (2006) defined effective price stabilization (EPS) index as $EPS_t = 1 - \frac{\Delta\pi_t}{EAIP_t}$. The EPS index was intended to measure the extent to which the policy authority was successful in moderating any disturbances hitting the economy.

observed decline in the inflation rate. The monetary policy action aiming to moderate the impact of the disturbance may even exacerbate the inflation if the policy change was unnecessarily strong enough reversing the impact of the inflation reducing exogenous shock. Therefore, evaluating monetary policy effectiveness in reference to the inflationary environment under which the policy was implemented is crucial.

The ex ante inflation pressure index describes the inflationary environment that was faced by the monetary authority prior to the policy change. An estimated positive EAIP value represents a positive (inflation increasing) shock to the economy whereas a negative EAIP value shows a negative (inflation reducing) shock. If the economy is subject to a positive shock (PS), the monetary policy effectiveness (MPE) index is given by

$$MPE_{t-2}^{PS} = 1 - \frac{EPIP_t}{EAIP_t} \quad if\ EAIP_t > 0 \tag{IV.18}$$

If the economy is subject to a negative shock (NS), the monetary policy effectiveness (MPE) index is measured as

$$MPE_{t-2}^{NS} = \frac{EPIP_t}{EAIP_t} \quad if\ EAIP_t < 0 \tag{IV.19}$$

Notice that the monetary policy effectiveness indices are dated at $t-2$ recognizing the fact that there is a two period control lag between the implementation of the policy and its impact on inflation. So, MPE_{t-2} essentially tells how successful the monetary policy implemented in time $t-2$ was in reducing the inflation pressure in period t. Careful reader will also notice that the proposed monetary policy effectiveness indices compare ex ante and ex post inflation pressure measures which differ only through an interest rate component as can be seen by comparing (IV.11) and (IV.17). Unlike the ex post inflation pressure measure, ex ante inflation pressure measure contains an interest rate component (the second interest rate term) reflecting the impact of interest policy change on inflation through expectations channel. Therefore, the monetary policy indices essentially measure the magnitude of the response of the expectations to the implemented policy change and their subsequent influence on observed inflation.

Under both definitions of policy effectiveness, an index value of 1 indicates that policy was effective in removing all inflation pressure that existed prior to the implementation of the policy change. An index value of 0, on the other hand, implies completely ineffective policy. Index values between 0 and 1 indicate partial effectiveness in reducing the inflation pressure.

When ex ante inflation pressure is positive, MPE index value greater than 1 indicates that monetary policy has more than counteracted the positive shock and achieved to alleviate all inflation pressure and reduce observed inflation. Negative MPE index values show highly ineffective policy where the action of the monetary policy reinforced the impact of the shock increasing the inflation in the economy.

Negative values of ex ante inflation pressure describes a favorable inflationary environment for a monetary authority wishing to reduce inflation. When ex ante inflation pressure is negative, MPE index value greater than 1 indicates highly effective policy where the monetary authority took advantage and reinforced the inflation reducing shock and successfully reduced the inflation. A negative MPE index value, on the other hand, is a sign of highly ineffective policy where the monetary policy action exacerbate the inflation reversing the impact of the inflation reducing exogenous shock.

The methodological procedures explained above consider situations in which the predominant shock to the status quo is some exogenous disturbance that does not originate with the policy authority itself. In this case, the policy authority would respond to exogenous shocks hitting the economy. However, when the monetary authority implements a regime, such as inflation targeting, where announcements are made on a systematic basis, the sequence of events is different which makes disentangling the impact of the exogenous shock more difficult. In this environment, the policy initiative is two dimensional; making announcements and conduct of interest rate policy. The sequence of the events is such that the monetary authority's announcement and the exogenous shock disturb the economy, then the interest rate policy is undertaken. No matter the timing between the announcements made and the shocks hitting the economy, the environment faced by the monetary authority at the beginning of the implementation of the interest rate policy is described by the inflationary pressure generated by the exogenous shocks and the announcements made by the monetary authority. Under such circumstances, the ex ante and ex post inflation pressure indices become indistinguishable.

When the monetary authority make announcements directed towards changing the underlying inflationary environment, there no longer exists a pure exogenous change to the environment which can be used to assess the impact of the overall policy initiative. The interest rate policy changes are made in an environment described by inflationary expectations due to some exogenous shock and the announcements made. Therefore, the monetary policy effectiveness measure discussed above reflects the effectiveness of the interest rate policy changes only. Quantifying the impact of the announcements to be able to assess the effectiveness of the monetary policy overall requires a new benchmark. I consider the change in inflation expectations that would have been generated by the policy (announcements and interest rate changes) that was implemented if that policy had been perceived as perfectly credible as the new benchmark.

There are two reasons for choosing this benchmark. First, it may allow us to gain some insight into the ongoing controversy that centers around the unresolved question of whether the observed reduction in inflation after inflation targeting is the result of targeting or whether the inflationary environment improved on its own at the time of the inflation targeting was implemented so that virtually any sensible regime would have been just as successful. Second, we may be able to quantify the evolution of credibility under inflation targeting or other monetary regimes associated with making periodical inflation target announcements.

The main problem that arises with the new benchmark is that it is not in any sense exogenous. Rather, it is one possible endogenous response to the policy initiative itself and will only be observed when the policy is, in fact, perfectly credible. As in the case of ex ante inflation pressure, conduct of counterfactual experiments is required to obtain a measure of the benchmark. Unlike the ex ante inflation pressure which captures the size of an exogenous shock, the new benchmark can be obtained by imputing, from the observed data and the structure of the economy, the magnitude of the expectational change that would have occurred under full credibility. I call the measure for this new benchmark expectations of inflation under full credibility (XIFC) which clearly requires somewhat more complex counterfactual experiment than that needed to obtain ex ante inflation pressure. I then obtain a measure for expectations of inflation under true credibility (XITC) which essentially is identical to the ex post inflation pressure index to construct an index of monetary policy credibility.

I use the illustrative model above described by (IV.1)-(IV.3) to derive analytical constructs for the measures of inflation expectations under full credibility (XIFC), inflation expectations under true credibility (XITC), and monetary policy credibility index (MPCI). It is apparent from (IV.4) that there is a two period control lag between the monetary authority's policy tool, i, and the inflation rate. Consider that the monetary authority publicly announces π_t^T in advance as its inflation target for period t prior to the implementation of its interest rate policy. Given the publicly known announcement, the best the policy authority can do with the information available in period $t-2$ is to set i_{t-2} at the level that will ensure $E_{t-2}\pi_t = \pi_t^T$.

Taking expectation of both sides in (IV.4) conditional on the information available in period $t-2$ results in:

$$\begin{aligned} E_{t-2}\pi_t &= \alpha_0 + \alpha_1 E_{t-2}\pi_{t-1} + \alpha_2 E_{t-2}[E_t\pi_{t+1}] \\ &\quad + \alpha_3\left\{\beta_0 + \beta_1 y_{t-2} + \beta_2 E_{t-2}[E_{t-1}y_t] - \beta_3[i_{t-2} - E_{t-2}\pi_{t-1}]\right\} \end{aligned} \tag{IV.20}$$

where it has been assumed that y_{t-2} is contemporaneously observable by the monetary authority. The policy instrument, i_{t-2}, must, of course, be known to the policy authority. The notation $E_{t-2}[E_t\pi_{t+1}]$ reflects the expectation that the policy authority forms in period $t-2$ about the expectations that the private sector will hold in period $t+1$. The interpretation of $E_{t-2}[E_{t-1}y_t]$ is analogous. Under the assumption that the policy authority announces its inflation targets one period ahead, and that these inflation targets are fully credible, $E_{t-2}[E_t\pi_{t+1}] = \pi_{t+1}^T$. Given that the policy authority is committed to inflation targeting program, it must also be the case that $E_{t-2}[\pi_{t-1}] = \pi_{t-1}^T$ and $E_{t-2}\pi_t = \pi_t^T$. The monetary authority's expectation about $E_{t-1}y_t$ depends on how much information it has about the way in which the private agents formulate their expectations of output gap. I consider that the monetary authority knows whether the private agents are fully rational or form expectations according to the process of adaptive learning and that the monetary authority use this information in forming its own expectations in period $t-2$. For the purposes of the present illustration, I assume rational private agents and that the minimum state variable solutions for π_t, y_t, and i_t are given by (VII.8)-(VII.10).

In order to conduct counterfactual experiments as in obtaining ex ante inflation pressure, $E_{t-2}[E_{t-1}y_t]$ must be expressed in terms of i_{t-2} and earlier. Appendix A.1 shows the analytical steps needed to obtain $E_{t-2}[E_{t-1}y_t]$ as a function of i_{t-2} and earlier as described by (A.9) . Substituting (A.9), $E_{t-2}\pi_t = \pi_t^T$, $E_{t-2}[\pi_{t-1}] = \pi_{t-1}^T$, and $E_{t-2}[E_t\pi_{t+1}] = \pi_{t+1}^T$ into (IV.20) and solving for i_{t-2} yields the interest rate setting for period $t-2$ under full credibility:

$$i_{t-2}^T = \frac{1}{\Lambda_3}\left\{\pi_t^T - \Lambda_0 - \Lambda_1\pi_{t-2} - \Lambda_2 y_{t-2} - \Lambda_4\pi_{t-1}^T - \Lambda_5\pi_{t+1}^T\right\} \qquad \text{(IV.21)}$$

where Λ_i for $i = 0, 1, 2 \ldots, 5$ are constants as defined in Appendix A.1.

Under fully credible targeting regime, $E_t\pi_{t+1} = \pi_{t+1}^T$, $E_{t-1}\pi_t = \pi_t^T$, and $E_{t-2}\pi_{t-1} = \pi_{t-1}^T$ must hold turning (IV.7) into

$$\begin{aligned}\pi_t^{FC} \quad = \quad & A_0 + \alpha_1^2\pi_{t-2} + A_1 y_{t-2} - \alpha_3\beta_2 i_{t-2} + \alpha_2\pi_{t+1}^T + \alpha_1\alpha_2\pi_t^T + \alpha_3\beta_3\pi_{t-1}^T \\ & + \alpha_3\beta_2 E_{t-1}y_t + \epsilon_t + \alpha_1\epsilon_{t-1} + \alpha_3\eta_{t-1} \qquad \text{(IV.22)}\end{aligned}$$

where π_t^{FC} stands for fully credible inflation rate at time t. In order to solve for inflation rate that would have been achieved under a fully credible inflation targeting regime, $E_{t-1}y_t$ must be expressed in terms of i_{t-2} and earlier as shown in Appendix A.1 in (A.7). Substituting (A.7) into (IV.22) yields

$$\begin{aligned}\pi_t^{FC} \quad = \quad & \Gamma_0' + \Gamma_1'\pi_{t-2} + \Gamma_2' y_{t-2} - \alpha_3\beta_2 i_{t-2}^T + \alpha_3\beta_2 H_3 i_{t-2}^T + \alpha_2\pi_{t+1}^T + \alpha_1\alpha_2\pi_t^T \\ & + \alpha_3\beta_3\pi_{t-1}^T + \epsilon_t + \alpha_1\epsilon_{t-1} + \alpha_3\eta_{t-1} \qquad \text{(IV.23)}\end{aligned}$$

where $\Gamma_0^{'} = A_0 + \alpha_3\beta_2 H_0$, $\Gamma_1^{'} = \alpha_1^2 + \alpha_3\beta_2 H_1$, and $\Gamma_2^{'} = A_1 + \alpha_3\beta_2 H_2$.

In order to determine the expectational change that would have occurred under a fully targeting system, the part of π_t^{FC} that is attributable to expectations and the implementation of the impact of the interest rate policy must be distinguished. To this end, I conduct a counterfactual policy experiment in which I ask what the inflation rate would have been if private agents had considered the announced targets to be fully credible, but the monetary authority had then held the interest rate at its previous level, i_{t-2}, rather than implementing i_{t-2}^T. This counterfactual policy experiment results in counterfactual fully credible inflation rate give by:

$$\hat{\pi}_t^{FC} = \pi_t^{FC} - \alpha_3\beta_2(H_3 - 1)\Delta i_{t-2}^T \qquad \text{(IV.24)}$$

where $\hat{\pi}_t^{FC}$ is the counterfactual fully credible inflation rate at time t and $\Delta i_{t-2}^T = i_{t-2}^T - i_{t-3}$. When π_t^T is publicly known, then the inflation rate that is attributable to expectations under full credibility is given by

$$\hat{\pi}_t^{FC} = \pi_t^T + \alpha_3\beta_2(1 - H_3)\Delta i_{t-2}^T \qquad \text{(IV.25)}$$

Thus, the benchmark measure for expectations of inflation under full credibility (XIFC) is obtained as

$$XIFC_t = [\pi_t^T - \pi_{t-1}] + \alpha_3\beta_2(1 - H_3)\Delta i_{t-2}^T \qquad \text{(IV.26)}$$

Under true degree of credibility, the inflation rate is given by (using (IV.22))

$$\begin{aligned} \pi_t^{TC} \quad = \quad & A_0 + \alpha_1^2\pi_{t-2} + A_1 y_{t-2} - \alpha_3\beta_2 i_{t-2} + \alpha_2\pi_{t+1}^T + \alpha_1\alpha_2\pi_t^T + \alpha_3\beta_3\pi_{t-1}^T \\ & + \alpha_3\beta_2 E_{t-1} y_t + \epsilon_t + \alpha_1\epsilon_{t-1} + \alpha_3\eta_{t-1} \qquad \text{(IV.27)} \end{aligned}$$

The impact of expectations under true credibility is obtained by setting $i_{t-2} = i_{t-3}$ in (IV.27) with expectations held constant under actual policy. Thus, the expectations of inflation under true credibility (XITC) is given by

$$XITC_t = [\pi_t - \pi_{t-1}] + \alpha_3 \beta_2 \Delta i_{t-2} \tag{IV.28}$$

Given the measures for the expectations of inflation under full credibility and true credibility, the monetary policy credibility index (MPCI) is then obtained by

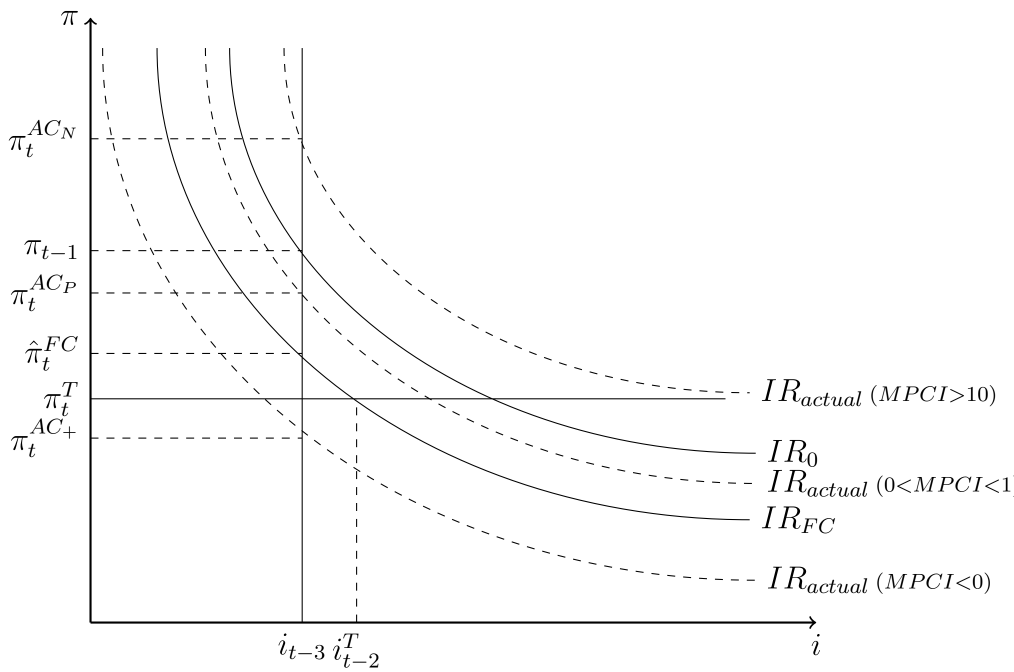
$$MPCI_t = \frac{XITC_t}{XIFC_t} \tag{IV.29}$$

Measures of expectations of inflation under full credibility and true credibility, and the associated estimated index values are perhaps understood the best using an illustrative diagram. Figure IV.2 depicts changes in the expectations due to fully and partially credible, and non credible announcements. Change in expectations under full credibility is given by the vertical distance between $\hat{\pi}_t^{FC} - \pi_{t-1} < 0$. The vertical distance between $\pi_t^{AC_P} - \pi_{t-1} < 0$ shows the change in expectations under true partial credibility. In general, if the announced inflation targets are not credible and private agents don't believe in the inflation reduction program, then the change in expectations is given by the vertical distance between $\pi_t^{AC_N} - \pi_{t-1} > 0$.

Monetary policy credibility index value of 1 indicates perfectly credible policy whereas an index value of 0 reflects complete lack of credibility. Intermediate degrees of credibility lie between 0 and 1. While index values grater than 1 indicates super credibility, negative index values refer to negative credibility.

Negative credibility may occur due to political or economic conditions. Credibility index can take negative values if private agents don't believe the monetary authority can continue reducing the inflation at the current rate because π_t^T has been undershot

Figure IV.2: Graphical Representation of XIFC & XITC



too many times. If the credibility index is negative due to successive undershooting, this does not necessarily reflect the lack of credibility of the whole inflation reduction program, but rather a temporary disbelieve in the current announcement.

The monetary policy credibility index takes values greater than 1 (super credibility) when people believe the policy authority's true inflation target lies below the announced target due to observing successive undershooting. In this case, the announced target itself may be not credible, but the monetary authority's inflation reduction program is credible indeed.

CHAPTER V

ANALYTICAL MODEL

I consider a small open economy version of the monetary model in Clarida, Galì and Gertler (2000), Fuhrer (2002), and Rudebusch (2002). My goal is to lay out an appropriate representation of the underlying structural model and assess monetary policy effectiveness in Turkey in 1996-2005. I use hybrid type IS and Phillips curves, forward looking interest rate rule, and a hybrid type uncovered interest parity condition. The model considered here has a much more complex lag structure than the illustrative model employed in Chapter IV. However, thanks to the model independent inflation pressure indices, the same methodology is appropriately applied. Numerous estimations has been undertaken to arrive at the specified equations with the described backward and forward looking lag structure. The structural model considered here was selected based on the goodness of fit and the reliability of the in sample estimates to be able to demonstrate the underlying model for the Turkish economy.

The period under investigation is characterized by structural reforms and changes in political and economic arena as discussed in Chapter II. Thus, I use anecdotal evidence and Bai and Perron's (1998, 2003) multiple structural break analysis to locate possible structural break dates in the structural model. Empirical results show no significant evidence for structural breaks in the Phillips curve, IS schedule, and the uncovered interest parity condition. However, the monetary policy reaction function is subject to several breaks which I discuss in detail below in Section V.3. The fact that no structural breaks have been found in the structural equations reflects the stability of the underlying structural model.

V.1 The IS curve

I consider an open economy version of the forward looking expectational IS curve specification as the benchmark. The IS curve can be described as

$$y_t = \beta_0 + \beta_1 y_{t-1} + \beta_2 y_{t-2} + \beta_3 E_t y_{t+1} + \beta_4 [i_{t-2} - E_{t-2}\pi_{t-1}] - \beta_5 \Delta q_{t-1} + \eta_t \quad \text{(V.1)}$$

where y_t is the output gap, i_t is the nominal interest rate, π_t is the domestic inflation rate, q_t is the real depreciation of the domestic exchange rate, and E_t is the expectation operator conditional on information observed through time period t. Output gap is measured as the deviation from its long-run trend. This form of IS curve is also known as hybrid IS curve specification as in Fuhrer and Rudebusch (2004), and Goodhart and Hofmann (2005). The IS curve specification includes both backward and forward looking elements to capture the extent of endogenous persistence in output and inflation. The current specification differs from the traditional IS curve formulation mainly because current output gap depends on expected future output gap as well as real interest rate, $i_{t-2} - E_{t-2}\pi_{t-1}$. Theoretically, β_4 is expected to be negative, so that a rise in the real interest rate reduces the current output gap due to intertemporal substitution of consumption. Output gap persistence is expected to be, a priori, positive, so that $\beta_1 > 0$, $\beta_2 > 0$, and $\beta_3 > 0$ as suggested by the consumption smoothing hypothesis. The last coefficient, β_5, reflects the responsiveness output gap to real exchange rate variations in contrast to the canonical open economy framework in Clarida, Galí, and Gertler (2002) where the responsiveness output gap to real exchange rate variations is assumed to be zero. As the real exchange rate changes, domestic output is affected by a magnitude depending on the size of import and export elasticities of demand i.e there is no strong prior for the sign of the last coefficient.

By definition, the real exchange rate depreciation reflects both nominal exchange rate depreciation, Δe_t, and the difference between domestic and foreign inflation rates[1].

$$\Delta q_{t-1} = \Delta e_{t-1} - (\pi_{t-1} - \pi^*_{t-1}) \tag{V.2}$$

V.2 The Phillips curve

I use a version of the hybrid econometric specification for the Phillips curve following Clarida, Galí, and Gertler (1999, 2000, 2002). The Phillips curve is described as

$$\pi_t = \alpha_0 + \alpha_1 \pi_{t-1} + \alpha_2 E_t \pi_{t+2} + \alpha_3 y_{t-4} - \alpha_4 \Delta q_{t-1} + \epsilon_t \, ; \quad \alpha_1, \alpha_2, \alpha_3 > 0 \tag{V.3}$$

with all variables as previously defined. The hybrid specification allows inflation depend on a convex combination of lagged inflation as well as expected future inflation to permit measuring the degree of inertia in inflation. In theory, inflation has inertia implying $\alpha_1 > 0$. Expected inflation pressures the current inflation upward which implies $\alpha_2 > 0$. Similarly, an anticipated rise in the output gap is considered to be inflationary, so that $\alpha_3 > 0$. I use alternative output gap measures, instead of marginal cost, as the relevant indicator of real economic activity. In doing so, I rely on the claim that marginal cost has a close relationship with correctly measured output gap suggested by Woodford (2001), Galí (2002), and Nelson and Kalin (2003). Using output gap measure also facilitates comparison with the related studies. The last coefficient, α_4, reflects the responsiveness of inflation to real exchange rate variations, and there is not a strong prior for it's sign. The use of hybrid Phillips curve specification is usually praised by empirical studies as it provides a better first-order approximation to the inflation process. It is also important to note that, under a hybrid specification Phillips curve, disinflation is a costly process leading to reductions in output.

[1] The real exchange rate is defined as $q_t = \frac{e_t P^*_t}{P_t}$ where P_t and P^*_t are the domestic and foreign price levels respectively. Log differencing the both sides of the equation gives $\Delta q_t = \Delta e_t - (\pi_t - \pi^*_t)$.

V.3 Monetary policy reaction function

I consider a version of forward looking interest rate rule following Clarida, Galí, and Gertler (1998, 1999, 2000). The interest rate rule is described as

$$i_t^T = i^* + \gamma_\pi [E_t \pi_{t+k} - \pi^T] + \gamma_y y_{t-q} + \gamma_y^{'} E_t y_{t+s} \tag{V.4}$$

where i_t^T is the target nominal interest rate in period t, i^* is the benchmark real interest rate i.e. the long run equilibrium real interest rate, π^T is the inflation target rate, π_{t+k} is the inflation rate from period t to $t+k$, y_{t-q} is the lagged output gap between periods t and $t-q$, and y_{t+s} is the output gap from period t to $t+s$. Output gap is defined as the level of deviation from its long run trend i.e. the level of deviation from its potential.

As in Clarida, Galí, and Gertler (1998, 2000), I allow for gradual adjustment of the nominal interest rate to the target as described by

$$i_t = (1-\rho) i_t^T + \rho i_{t-1} + \zeta_t \tag{V.5}$$

where the parameter ρ indicates the degree of (positive) interest rate smoothing, i_t is the actual nominal interest rate, and ζ_t is an i.i.d error term . Partial adjustment mechanism given in (V.5) reflects the central bank's tendency to smooth changes in the interest rate by eliminating the gap between its current nominal target rate and the previous periods actual rate. Substituting the interest rate rule, (V.4), into the partial adjustment equation, (V.5), yields the monetary policy reaction function described as

$$i_t = \rho i_{t-1} + (1-\rho) \left[\gamma_0 + \gamma_\pi E_t \pi_{t+k} + \gamma_y y_{t-q} + \gamma_y^{'} E_t y_{t+s} + \sigma_t \right] \tag{V.6}$$

$$\gamma_{\pi}, \gamma_{y}^{'}, \gamma_{y} > 0, \quad k, q, s > 0$$

where ρ indicates the degree of (positive) interest rate smoothing, γ_{π}, $\gamma_{y}^{'}$, and γ_{y} measure the relative weights placed by the central bank on the expected future inflation, expected future and past output gap, i is the nominal interest rate, and σ_t is the error term. The Taylor principle implies that $\gamma_{\pi} > 0$, so that a rise in expected in inflation results in a proportionately larger response in the domestic policy instrument, i_t. Theoretical considerations suggest that $\gamma_{y}^{'}, \gamma_{y} > 0$ i.e. an increase in output gap, an excess demand, pulls inflation up which prompts the monetary authority to raise the interest rates to stabilize the prices. The values for k, q, and s are determined based on the goodness of fit of the estimates obtained as a result of numerous estimations with different lag length and combinations of forward and backward looking components.

The period under investigation is characterized by structural changes concerning both fiscal and monetary authorities as summarized in Chapter II. Besides, the monetary authority adopted distinct monetary stabilization programs e.g. the major shift towards inflation targeting occurred during 1996-2005. The existence of structural changes and hence the implied changes in the conduct of monetary policy signals for potential structural breaks in the monetary policy reaction function. These structural breaks need to be handled carefully in order to be able to characterize the central bank's policy reactions properly. I take a step-by-step approach to deal with the possible structural breaks in the monetary policy rule.

The monetary policy reaction function with m structural breaks (m + 1 regime) can be re-written as

$$i_t = \rho^j i_{t-1} + (1 - \rho^j) \left[\gamma_0^j + \gamma_\pi^j E_t \pi_{t+k} + \gamma_y^j y_{t-q} + \gamma'^j_y E_t y_{t+s} + \sigma_t \right] \tag{V.7}$$

where $j = 1, ..., m+1$. In this formulation, $j = 1$ would mean there is a single regime (no structural breaks), or $j = 2$ would mean that there were two distinct regimes (one structural break) associated with significantly different estimates for the coefficients in the monetary policy reaction function. Moreover, under distinct monetary regimes, the forward and backward looking lag structure in the monetary policy reaction function may differ.

First, I use anecdotal evidence to find structural break dates in the monetary policy reaction function. I consider February 2001 as a potential break date. There are several reasons behind this consideration. Turkey experienced a deep financial crisis in February 2001 following the collapse of its soft exchange rate peg in line with the exchange rate based stabilization program launched in January 2000. In the following few months after the crisis, several structural reforms took place along with several amendments to major legislations governing the fiscal and financial sector including the amendment to the central bank law recognizing the the central bank as an independent entity capable of designing and conducting monetary policies independent from the fiscal authorities. In line with the undertaken structural reforms granting the central bank's independence, the CBRT announced it will implement, which I call, semi-formal inflation targeting beginning January 2002 in April 2001. Given that several structural and operational steps concerning the monetary policy were taking place right after February 2001, and these steps ended up at the clearly distinct monetary framework, it's reasonable to consider February 2001 as a structural break point.

The existence of a structural break date in February 2001 in the monetary policy reaction function produces two regimes i.e. two segments of data: the data associated with, generally speaking, exchange rate based stabilization programs, and the data observed during the period of semi-formal inflation targeting. There maybe additional structural breaks within each segment of data before and after February 2001 supported by some anecdotal evidence. During the period of Jan'1996 - Feb'2001, the CBRT went through two different exchange rate based price stabilization programs. Mar'01 - Dec'05, on the other hand, is a transition period to full-fledged inflation targeting during which several legislative reforms, and adjustments took place. It is reasonable to think that implementation of the reforms in practice required time which means, for instance, that the operational conduct of monetary policy substantially differed during the earlier and later stages of the transition period. That's to say, there may be substantial differences between the estimates describing the monetary policy reaction function in the earlier and later phases of the transition period.

I described the possibility of additional break dates occurring at unknown dates within the monetary policy reaction functions before and after February 2001. To test this conjecture and provide statistical evidence, I use the methodology developed by Bai and Perron (1998, 2003) to estimate break dates. Bai and Perron's methodology can be described in two parts where they provide a least squares based algorithm for estimating the unknown break dates, and conducting inference based on a series of significance tests, and suggestions for how to interpret the various tests based on asymptotic critical values. I refer the reader to Appendix (A.2) for more details on the Bai and Perron's methodology. Below, I apply Bai and Perron's methodology to the monetary policy reaction function described in (V.7) for each segment of the data before and after February 2001 to locate structural break dates (if any).

First, I investigate potential structural break dates in Mar'01 - Dec'05. For that purpose, I apply the Gauss routine provided by Bai and Perron (1998, 2003) to the interest rate rule in (V.7). I assume $k = 3$, $q = 6$, and $\gamma_y^{'} = 0$ since the period of Mar'01 - Dec'05 is best characterized by such forward and backward lag structure[2]. Following Bai and Perron, I consider homoskedastic and not serially correlated disturbance terms as the lag of the dependent variable is included in the regression. I allow up to two breaks and use a trimming $\epsilon = 0.25$ which secures at least 14 observations in each subsample given that breaks are found. The empirical results are presented in Table V.1.

Table V.1: Estimated structural break dates in Mar'01 - Dec'05

	Specifications		
$z_t = 1$	$q = 4$	$p = 0$	
$m = 2$	$\epsilon = 0.25$	$h = 14$	
	Tests †		
$supF_T(1)$	$supF_T(2)$	$UDMax$	$WDMax$
36.51^*	26.23^*	36.51^*	36.51^*
$supF(2\|1)$			
17.74^*			
	Number of breaks selected ‡		
Sequential	1		
LWZ$'$	1		
BIC$''$	2		
	Estimated break dates §		
T_1	T_2		
April'02	Oct'03		
(Mar'02 - Jun'02)	(Jun'03 - Feb'04)		

Notes: †The residuals are pre-whitened using a VAR(1). ‡I use the sequential test $supF_T(k+1|k)$ at the significance level of 5%. §In parentheses are the 95% confidence intervals for T_i $(i = 1, 2)$ using corrected standard errors (robust to serial correlation). * Significance at the 5% level. $''$ LWZ is the Modified Schwarz Criterion proposed by Liu, Wu, and Zidek (1997). $'$ Bayesian Information Criterion.

Bai and Perron (1998, 2003) suggest choosing the number of breaks first by check-

[2]The Gauss code to implement Bai and Perron's (1998, 2003) methodology is available online at Perron's home page, `http://people.bu.edu/perron/code.html`

ing $supF(m|0)$ and confirm that there is at least one break, and if so, then the largest k can be found where the $supF(k+1|k)$ value is no longer significant based on the critical values. Following this procedure, I first consider $supF_T(m|0)$ tests to determine all possible and statistically significant candidates for the structural break dates in the data. Empirical findings show that $supF_T(1|0)$ and $supF_T(2|0)$ tests are significant at the 5% significance level. This suggests at least one break is present in the monetary policy reaction function.

Next, $supF(2|1)$ test takes the value of 17.74 which is significant at the 5% level suggesting two break dates in the monetary policy reaction function. The estimated break dates are April'02, and Oct'03. Note that the estimated break date Oct'03 coincides with the date of the announcement made by the CBRT in Jan'04 that it will switch to full-fledged inflation targeting beginning Jan'06. While the sequential procedure (using a 5% significance level) finds two breaks, the BIC, and the modified Schwarz criterion of Liu, Wu, and Zidek (1997) find a single break. It is documented that the information criteria are usually biased downward and that the sequential procedure tests perform better suggesting in favor of two break dates. Having said that, the empirical estimation of the monetary reaction function using the estimated two break dates may be problematic due to the poor performance of estimation with small sample size. Hence, I decide to operate using the estimated break date at Oct'03 only in line with the conjecture that monetary authority obtained more expertize in the conduct of semi-formal inflation targeting and that its policy initiatives became even more influential. This decision results in two segments of data during Mar'01 - Dec'05; Mar'01 - Sep'03 and Oct'03 - Dec'05. The first segment contains thirty one, and the second segment has twenty seven observations securing enough sample size to overcome the poorer empirical performance that would have occurred with smaller samples.

Second, I turn my focus on locating potential structural break dates in Jan'96 - Oct'00[3]. As before, I apply the Gauss routine to (V.7) where $k = 3$, $q = 5$, and $\gamma_y^{'} = 0$ is assumed since the entire period of Jan'96 - Oct'00 is best characterized by such forward and backward lag structure. I consider homoskedastic and not serially correlated disturbance terms as the lag of the dependent variable is included in the regression. I allow up to three breaks and use a trimming $\epsilon = 0.20$ which secures at least 11 observations in each subsample given that breaks are found. The empirical results are presented in Table V.2.

Table V.2: Estimated structural break dates in Jan'96 - Oct'00

		Specifications		
$z_t = 1$	$q = 4$	$p = 0$		
$m = 3$	$\epsilon = 0.20$	$h = 11$		
		Tests †		
$supF_T(1)$	$supF_T(2)$	$supF_T(3)$	$UDMax$	$WDMax$
18.31*	16.68*	15.55*	18.31*	22.61*
$supF(2\|1)$	$supF(3\|2)$			
16.88*	22.99*			
		Number of breaks selected ‡		
Sequential	3			
LWZ$^{'}$	1			
BIC$^{''}$	1			
		Estimated break dates §		
T_1	T_2	T_3		
Nov'96	Nov'98	Oct'99		
(Oct'96 - April'97)	(Sep'98 - Dec'98)	(Jul'99 - Feb'00)		

Notes: †The residuals are pre-whitened using a VAR(1). ‡I use the sequential test $supF_T(k+1|k)$ at the significance level of 5%. §In parentheses are the 95% confidence intervals for T_i $(i = 1, 2)$ using corrected standard errors (robust to serial correlation). * Significance at the 5% level. $''$ LWZ is the Modified Schwarz Criterion proposed by Liu, Wu, and Zidek (1997). $'$ Bayesian Information Criterion.

Empirical findings in Table V.2 show that $supF_T(1|0)$, $supF_T(2|0)$, and $supF_T(3|0)$

[3]Note that four outlier data points are dropped off the sample. These data points belong to the period of Nov'00 - Feb'01 which is associated with severe financial crisis of February 2001. Given that there is a small number of observations at hand, outlier data points are dropped to have a better representation of the entire period of Jan'96 - Oct'00.

tests are significant at the 5% significance level. This finding suggests that at least one break date exist in the monetary policy reaction function during the period of Jan'96 - Oct'00. It also shown that $supF(2|1)$ and $supF(3|2)$ tests take the values of 16.88 and 22.99 respectively. These test values are significant at the 5% level suggesting three break dates in the monetary policy reaction function. The estimated break dates during Jan'96 - Oct'00 are given by Nov'96, Nov'98, and Oct'99. It is important to note that the estimated break dates of Nov'98, and Oct'99 coincides with the declaration of the Memorandum of Economic Policies in Jun'98 and the beginning of Exchange Rate Based Stabilization (EBRS) program in Jan'00. While the sequential procedure (using a 5% significance level) finds three breaks, the BIC, and the modified Schwarz criterion of Liu, Wu, and Zidek (1997) find a single break. As I discussed before, small sample size is a serious problem when it comes to empirical estimation. Hence, I decide to operate using the estimated break date at Nov'98 only which has a rather narrower confidence interval, besides it's supported by the anecdotal evidence. This decision results in two segments of data during Jan'96 - Oct'00; Jan'96 - Nov'98 and Dec'98 - Oct'00. The first segment contains thirty five, and the second segment has twenty three observations providing enough sample size to overcome the poor empirical performance that would have occurred with smaller samples.

V.4 Uncovered Interest Parity condition

Turkey is considered to be small open economy. To close the small economy model, I innovate a hybrid style uncovered interest parity (UIP) condition to represent the exchange rate movements. Uncovered interest parity is usually rejected in empirical data (aka the forward premium puzzle), but is, nevertheless, widely used as a benchmark for the purpose of explaining international interest rate differentials[4]. I consider

[4]There is a vast literature on the forward premium puzzle including Frankel (1979), Hansen and Hodrick (1980), Fama (1984), and Froot and Thaler (1990). Engel (1996) provided an extensive survey of the early studies on the forward premium anomaly. More recent contributions to the

the following uncovered interest parity condition

$$e_t = \phi_1 e_{t-1} + \phi_2 E_t e_{t+1} + \phi_3 (i_{t-1} - i^*_{t-1}) + \nu_t \tag{V.8}$$

where e_t is the nominal exchange rate (USD per Turkish Lira, TL), i^*_{t-1} is the short-term foreign (U.S.) nominal interest rate that is comparable to the domestic nominal interest rate, i_{t-1}, and ν_t is random disturbance term. The hybrid style uncovered interest parity incorporates both backward and forward looking components, and an interest rate differential term which is not conventional. The traditional UIP condition incorporates forward looking exchange rate and interest rate differential with no reference to the lagged exchange rate term. Recent empirical studies attempted to explain exchange rate movements using random walk process. Having recognized the existing controversy in modeling exchange rate movements and forecasting, I applied both of the approaches commonly used in the literature. It turns out using a mixture of the two approaches gives the best in sample representation of the exchange rate movements in Turkey during 1996-2005 which is the primary concern in this study.

problem are made by Meredith and Ma (2002), Engel and West (2006), Burnside, Eichenbaum, Kleshchelski, and Rebelo (2008), Backus, Gavazzoni, Telmer, and Zin (2010) among several others surveyed by Engel (2011).

CHAPTER VI

DATA & PRELIMINARY EMPIRICS

This study uses monthly frequency data covering the period of 1996m1-2005m12. Table VI.1 gives an overview of the data, definitions, and the sources. The domestic inflation rate, π, is defined as the monthly percentage changes in the Consumer Price Index for all items (CPI General) obtained from the Central Bank of the Republic of Turkey. The corresponding foreign inflation rate, π^*, representing the price level in the "rest of the world" is the U.S. monthly inflation rate measured by percentage changes in the Consumer Price Index for All Urban Consumers for the U.S.

Table VI.1: Data Description

Data Sources:	
TURKSTAT	: Turkish Statistical Institute
CBRT	: Central Bank of Republic of Turkey
OECD	: Organization for Economic Co-Operation and Development
FRED	: Federal Reserve Economic Data
Turkish Variables	
π_t	: Inflation rate, monthly % changes in the CPI, Overall
i_t	: Interest rate, interbank overnight rate (monthly average) (%)
y_t	: Output gap, Industrial Production Index (1997=100)
e_t	: Nominal exchange rate, USD/TL (monthly average)
U.S. Variables	
π_t^*	: Inflation rate, monthly % changes in the CPI for all urban consumers (1982-84=100)
i_t^*	: Interest rate, Federal Funds Rate (monthly average) (%)

I consider overnight interbank interest rate to measure the domestic short-term interest rate, i, the policy instrument of the CBRT's monetary policy. Following the line of reasoning and the empirical evidence provided by Bernanke and Blinder (1992) on the use of federal funds rate as the Federal Reserve's monetary policy stance, Kalkan, Kipici, and Peker (1997), and Berument and Malatyalı (2000) provided empirical evidence that overnight interbank interest rates in Turkey can be used as an appropriate measure of the CBRT's monetary policy stance. I obtain monthly measure of the domestic short-term interest rate, i, by taking the weighted average of the daily interbank overnight interest rates. The corresponding foreign short-term interest rate, i^*, is the U.S. Federal Funds Rate (FEDFUNDS) measured as the monthly average of the daily rates.

I use monthly series of Industrial Production (IP) Index published by the Turkish Statistical Institute to obtain a measure for the output gap. Figure VI.1 gives a sketch of the IP index over the period of Jan'96 - Dec'05 in Turkey. The IP index measures output in manufacturing, mining, and electric and gas utilities industries in Turkey. Ideally one would like to have monthly GDP or GNP figures to measure output gap. However these indicators are not available on a monthly basis. The highest frequency for the GDP and the GNP data is on quarterly basis in Turkey. Due to unavailable monthly GDP or GNP figures and the fact that changes in industrial production closely follows the changes in GDP and GNP figures, I rely on IP index figures to derive measures of output gap. Having said that, I consider different output gap measures using linear and non-linear de-trending techniques.

Following the usual practice, I first apply Hodrick-Prescott (HP) filter to the monthly IP index data with smoothing parameter, $\lambda = 14,400$. I then experiment HP filtering using a smoothing parameter of $\lambda = 129,600$.[1]. Next, I apply quadratic and cubic de-trending techniques to measure output gap. Finally, I employ Dufour, Khalaf and Kichian's (2006) iterative de-trending procedure to obtain a measure for

[1]Common wisdom has been to use $\lambda = 1600$ when applying the HP filter to quarterly economic data. For other frequencies, Ravn and Uhlig (2002) have shown that quite different values should be used: 6.25 for annual data and 129,600 for monthly data.

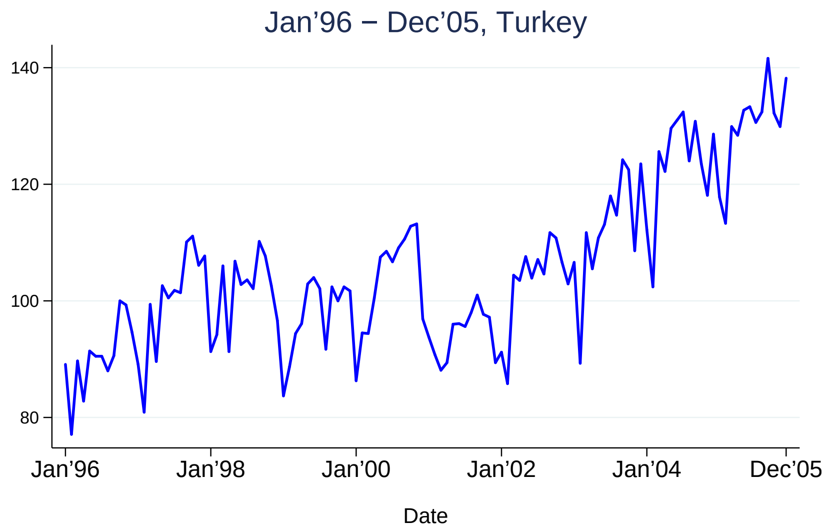


Figure VI.1: Industrial Production Index, 1997=100

the output gap. Dufour, Khalaf and Kichian's (2006) de-trending procedure is way of de-trending of the variable of interest iteratively rather than de-trending observations using the full sample of observations all at once. To implement the iterative de-trending procedure, first HP filter is applied to a sub sample of the observations to find the value of the gap (the cycle) at time t using the data ending in time t only. Then the sample is extended by one more observation and the HP de-trending re-applied which yields a value for the gap at time $t+1$. This process is repeated until the end of the sample is reached. In this procedure, the resulting gap measure obtained for time t does not use information beyond that period when the de-trending is implemented, and therefore can be used as a valid instrument if needed. For comparison, I display the model estimates using different output gap measures.

This research also utilizes forecast data on expectations derived from the Survey of Expectations conducted by the CBRT since August 2001. The survey of expectations were conducted to find out the expectations of experts, decision makers from the financial and real sectors, and professionals, pertaining to consumer price (CPI) inflation, interest rates, exchange rate, current account balance and GNP growth rate.

I display the questionnaire form used for the conduct of the Survey of Expectations by the CBRT in Figure VI.2 for documentation purposes. The surveys were conducted twice a month, in the first and third weeks of every month. The available forecast data is used to re-estimate the model and conduct sensitivity analysis regarding the estimates obtained by certain econometric techniques.

Table VI.2: Augmented Dickey-Fuller's Unit Root Tests

	Alternative Hypothesis	
	Intercept term & no time trend	Intercept term & time trend
Turkish Variables		
π_t	-1.523	-3.874
i_t	-2.917	-4.166
e_t	-1.145	-0.848
U.S. Variables		
π_t^*	-4.840	-4.931
i_t^*	-1.795	-2.005

Notes: Data is for Jan'1996-Dec'2005. Monthly frequency. Four lags are used. MacKinnon's 1%, 5% and 10% critical values for rejection of the null hypothesis of a unit root are -3.505, -2.889, and -2.579 respectively for the model with constant term and no time trend. When a linear time trend is included in addition to an intercept term, the critical values are -4.035, -3.448, and -3.148, respectively.

The econometric estimation procedures used in this study, and the presence of time series data requires the variables to be stationary. In this regard, I first provide graphical representations of the data in Figure VI.3. Next, following the standard practice, I apply Augmented Dickey-Fuller (ADF) stationarity tests to detect unit roots. The ADF test results are reported in Table VI.2. The test results shows that the domestic inflation rate series, π_t, is trend stationary, the nominal exchange rate, e_t, and the U.S. short-term interest rate, i_t^*, series are difference stationary. On the other hand, the null hypothesis of a unit root in the domestic short-term interest rate, i_t, and the U.S. inflation rate, π_t^*, is rejected at 5% and 1% significance levels, respectively.

CENTRAL BANK OF THE REPUBLIC OF TURKEY

STATISTICS DEPARTMENT

REAL SECTOR DATA DIVISION

SURVEY OF EXPECTATIONS

All individual response information will be kept confidential. Please fill in the appropriate boxes. Provide only numbers (e.g. 1 or 1.7), NOT ranges (e.g. 3 – 4).
Please leave the boxes of the questions empty, in case you don't want to answer.

	Monthly Inflation			***Annual Inflation***		
	Current Month	*Next Month*	*2nd Month Ahead*	*End of the year (January-December)*	*End of the next 12 months*	*End of the next 24 months*
What is your expectation of the CPI? %						

	3-Month Ahead	*12-Month Ahead*
What do you expect for the secondary market annually compounded interest rate of the zero coupon government bond with maturity of about six months? %		

	12-Month Ahead
What do you expect for the secondary market annually compounded interest rate of fixed rate TRY denominated government bond with maturity of about five years? %	

	Current Month
What is your expectation of the ISE repo and reverse repo overnight interest rate? %	

	Current Month	*3-Month Ahead*	*6-Month Ahead*	*12-Month Ahead*	*24-Month Ahead*
What is your expectation of one-week CBRT repo auction interest rate? %					

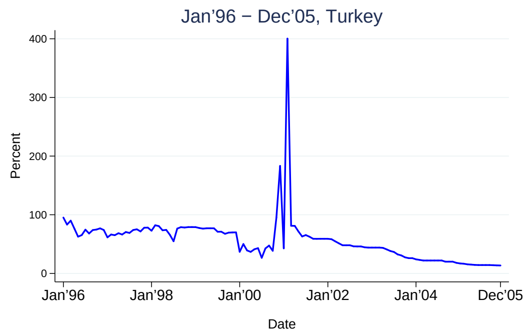
	Current Month	*End of the year*	*End of the next 12 months*
What is your expectation of the US Dollar rate in the interbank foreign exchange market? *(Turkish Lira-TRY) (Please indicate in four decimal)*			

	Current Year (Jan. - Dec.)	*Next Year (Jan. - Dec.)*
What is your expectation of the annual current account balance? ((+)Surplus, (-)Deficit) ($ Million)		

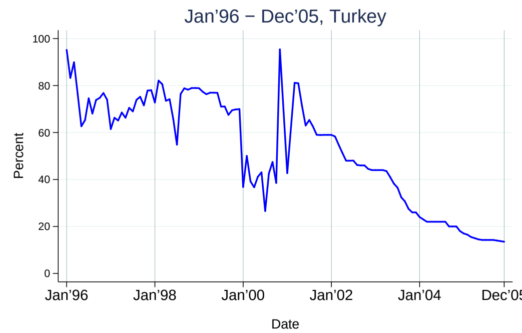
	Current Year (Jan. - Dec.)	*Next Year (Jan. - Dec.)*
What is your expectation of the GNP Growth Rate? ((+) Increase, (-) Decrease) %		

Please send an e-mail to **beklenti.anketi@tcmb.gov.tr** in case there is a change in your e-mail address.
Thank you for participating in our survey.

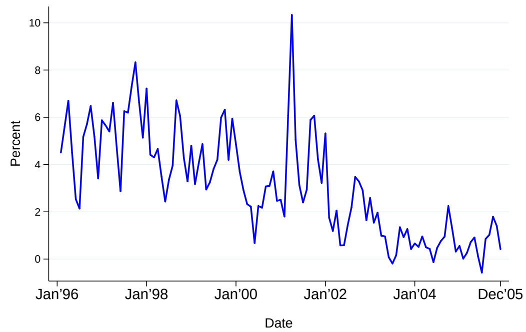
Figure VI.2: Questionnaire form - Survey of Expectations, CBRT



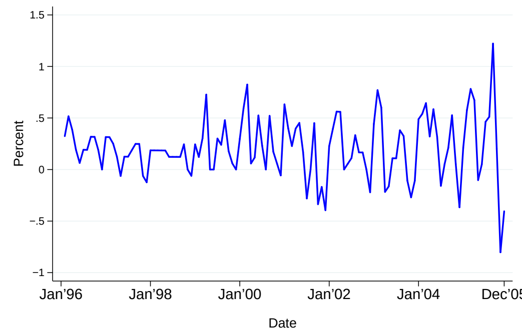
(a) Interbank overnight interest rate, %



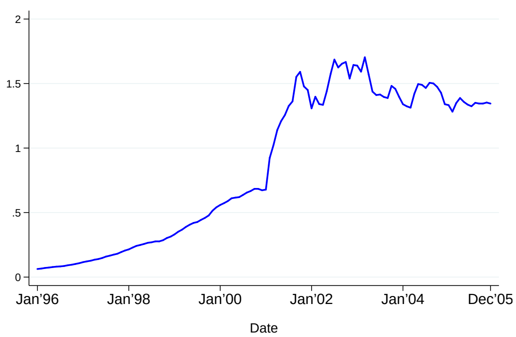
(b) Interbank overnight interest rate[1], %



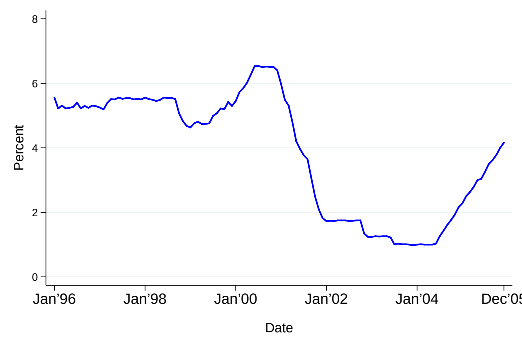
(c) Monthly inflation rates, Turkey, %



(d) Monthly inflation rates, U.S. %



(e) Nominal exchange rate, USD/TL



(f) Federal Funds Rate, U.S. %

[1] This diagram is drawn excluding two data points: 183.2 % in Dec'00 and 400.27 % in Feb'01.

Figure VI.3: Raw Data in Graphics

CHAPTER VII

EMPIRICAL IMPLEMENTATION AND COMPUTATION

In this chapter, I present estimates from three alternative approaches, numerical solutions to the model, and the corresponding values of the operational indices. The model consists of three forward looking expectational variables which reflect the expectations formed by private agents about the future inflation rate, the future output gap, and the future nominal exchange rate. True expectations are not observable and the actual underlying process by which they are formed is unknown. Therefore estimating the model requires either adoption of some assumptions in regards to the expectation formation process or using survey forecast data if data for the related expectational variables were available. I implement both. I first assume rational expectations hypothesis and rely on standard single-equation generalized method of moments (GMM) estimation of the model described by (V.1)-(V.3), (V.7), and (V.8). Next, I utilize the available survey forecast data published by the CBRT and undertake ordinary least squares (OLS) to re-estimate the model under rational expectations to check for the sensitivity of the results. I conclude by finding numerical solutions to the analytical model under rational expectations.

Rational expectations hypothesis, an equilibrium concept, may not provide enough room to understand the dynamics of an economic model in a transition period. To address this issue, I assume adaptive learning approach to impute expectations, and OLS estimate the analytical model. Under adaptive learning, individuals are assumed to be bounded rational where they lack some information about the underlying economic system i.e they don't know the the true size of the coefficients of the underlying model. Instead, the economic agents constantly update their beliefs through adopting new information as it becomes available. A key aspect of the adaptive learning approach is that it accounts for the fact that macroeconomic variables depend on the economic agent's forecast estimates and in turn those estimates are constantly updated in response to the changes in the macroeconomic variables.

VII.1 Empirical Implementation under Rational Expectations

I obtain my benchmark estimates relying on standard single-equation GMM estimation of the model described by (V.1)-(V.3), (V.7), and (V.8). Next, I employ the available survey forecast data published by the CBRT and estimate the model using OLS as in Smith (2009) to check for the sensitivity of the model estimates.

VII.1.1 Generalized Method of Moments Estimation

I use single-equation GMM to estimate the forward looking IS and the Phillips curves, the monetary policy reaction function, and the uncovered interest parity condition described by (V.1), (V.3), (V.7), and (V.8), respectively. All estimation are for the periods of Jan'96-Dec'05.

I use an instruments set of a constant, fifteen lags of inflation rates and overnight interest rates, eighteen lags of output gap, and twelve lags of M2 growth rates to estimate the IS curve with GMM. The GMM estimates for the IS curve are displayed in Table VII.1. Columns 1, 2, and 3 show the estimates for the IS curve described in (V.1) using alternative output gap measures. Column 1 measures output gap as deviations from the HP trend using smoothing parameter of 14,400, column 2 measures output gap as deviations from the HP trend using smoothing parameter of 129,600, and column 3 measures output gap as deviations from the Khalaf-Kichian's iterative

HP trend using smoothing parameter of 14,400. The signs of all of the estimates are consistent with theory and with the results obtained in other empirical studies. I find that both expected future and lagged output gap are positive and significant. The output gap responds negatively to increases in the real interest rate. The coefficient on the lagged real exchange rate depreciation is negative and significant in columns 1 and 2 whereas in column 3 it has a negative sign but not significant at conventional levels. Hansen's J statistics in columns 1, 2, and 3 are small enough not to reject the joint null hypothesis that the instruments are valid i.e. the instruments are uncorrelated with the error term, and that the excluded instruments are correctly excluded from the estimated equation.

Table VII.1: GMM Estimates of the IS curve

Equation	Variable	(1)	(2)	(3)
y_t	constant	0.1190**	0.1209**	0.0837
		(0.056)	(0.056)	(0.054)
	y_{t-1}	0.2512***	0.2852***	0.2475***
		(0.053)	(0.049)	(0.055)
	y_{t-2}	0.1660***	0.1678***	0.1812***
		(0.032)	(0.029)	(0.035)
	$E_t y_{t+1}$	0.3701***	0.3736***	0.3994***
		(0.037)	(0.037)	(0.037)
	$i_{t-2} - E_{t-2}\pi_{t-1}$	-0.0041***	-0.0041***	-0.0033***
		(0.001)	(0.001)	(0.001)
	Δq_{t-1}	-0.0274**	-0.0281**	-0.0146
		(0.014)	(0.014)	(0.014)
	R-squared	0.33	0.42	0.38
	$\chi^2(56)$ [p-value]	63.56 [0.22]	61.75 [0.27]	63.96 [0.21]
	rk Wald $F^\dagger$	49.61**	29.26**	41.34**

Notes: The estimation is for the periods of 1996m1-2005m12. *** p < 0.01, ** p < 0.05, * p < 0.1 Robust standard errors are in the parentheses underneath the coefficients. The GMM instruments set includes a constant, 15 lags of inflation rates, 18 lags of output gap, 15 lags of overnight interest rates, and 12 lags of M2 growth rates. $\chi^2(56)$ stands for the J-statistic and (the number of over identifying restrictions). Estimation (1), (2), and (3) differ based on how the output gap is measured. (1) measures output gap as deviations from the HP trend using smoothing parameter of 14,400, (2) measures output gap as deviations from the HP trend using smoothing parameter of 129,600, and (3) measures output gap as deviations from the Khalaf-Kichian's iterative HP trend using smoothing parameter of 14,400.

† Kleibergen-Paap rk Wald F statistic. ** 5% maximal IV relative bias, * 10% maximal IV relative bias using the Stock and Yogo's (2005) weak instruments test critical values.

I use GMM to estimate the Phillips curve using an instruments set that is composed of a constant, six lags of monthly inflation rates, output gap, and overnight interest rates. The GMM estimates for the Phillips curve are reported in Table VII.2. Estimates in column 1, 2, and 3 are obtained using alternative output gap measures as explained for the IS schedule. Using different output gap measures does not seem to affect the results substantially and the signs of all of the estimates are consistent with theory. I find significantly positive coefficients on expected future inflation and lagged inflation, and the lagged output gap. The impact of the lagged real exchange rate depreciation is found to be negative and significant. The joint null hypothesis of valid instruments, and the excluded instruments are correctly excluded from the estimated equation can not be rejected using the Hansen's J statistics in all estimations.

Table VII.2: GMM Estimates of the Phillips curve

Equation	Variable	(1)	(2)	(3)
π_t	constant	-0.0302	-0.0229	-0.0123
		(0.088)	(0.090)	(0.085)
	π_{t-1}	0.4513***	0.4681***	0.4542***
		(0.085)	(0.085)	(0.080)
	$E_t\pi_{t+2}$	0.2898***	0.3041***	0.2333**
		(0.093)	(0.095)	(0.091)
	y_{t-4}	0.2025***	0.1798***	0.1851***
		(0.064)	(0.062)	(0.053)
	Δq_{t-1}	-0.0629***	-0.0639***	-0.0691***
		(0.016)	(0.017)	(0.016)
	R-squared	0.29	0.28	0.28
	$\chi^2(15)$ [p-value]	11.97 [0.68]	12.73 [0.62]	12.73 [0.62]
	rk Wald $F^{\dagger}$	16.32*	15.89*	17.51*

Notes: The estimation is for the periods of 1996m1-2005m12. *** p < 0.01, ** p < 0.05, * p < 0.1 Robust standard errors are in the parentheses underneath the coefficients. The GMM instruments set includes a constant, 6 lags of monthly inflation rates, output gap, and overnight interest rates. $\chi^2(15)$ stands for the J-statistic and (the number of over identifying restrictions). Estimation (1), (2), and (3) differ based on how the output gap is measured. (1) measures output gap as deviations from the HP trend using smoothing parameter of 14,400, (2) measures output gap as deviations from the HP trend using smoothing parameter of 129,600, and (3) measures output gap as deviations from the Khalaf-Kichian's iterative HP trend using smoothing parameter of 14,400. † Kleibergen-Paap rk Wald F statistic. ** 5% maximal IV relative bias, * 10% maximal IV relative bias using the Stock and Yogo's (2005) weak instruments test critical values.

Next, I estimate the UIP condition representing the nominal exchange rate movements in Turkey. Exchange rate series may have non-normal data generating process which would raise suspicion on the reliability of the UIP estimates obtained by using GMM. The first differences in the exchange rates are known to have non-normal distribution as documented by Westerfield (1977) and McFarland, Pettit, and Sung (1982). Boothe and Glassman (1987) showed high frequency data, e.g. daily or weekly, usually exhibits non-normal or fat-tail distributions due to the presence of extreme observations. To abstain from exchange rate series subject to fat-tail distributions, I use a less frequent exchange rate data. In addition, I use monthly averages of exchange rates where the averaging process is considered to substantially reduce the probability of extreme observations appear in the series as in Frankel (1979). Therefore, I consider GMM estimation controlled for heteroskedastic and autocorrelated errors an appropriate technique to obtain reliable UIP estimates.

Estimation of the uncovered interest parity condition was conducted using and instruments set that contain a constant, nine lags of exchange rates, three lags of (domestic) inflation rates, six lags of (domestic) overnight interest rates, and three lags of (foreign) interest rates. Table VII.3 shows the GMM estimates for the UIP condition. Estimation (1) and (2) differ based on the choice of lag structure of the interest rate differential. Estimation (1) uses one period lagged interest rate differential whereas estimation (2) considers contemporaneous interest rate differentials. Empirical evidence shows that the coefficients on both expected future and one period lagged nominal exchange rate are positive and significant. Estimation (1) suggests a negative but significant impact of the one period lagged interest rate differentials on the variability of the nominal exchange rate. On the other hand, estimation (2) finds positive and significant coefficient on the contemporaneous interest rate differentials. Hansen's J statistics are small enough not to reject the validity of instruments. I rely

Table VII.3: GMM Estimates of the UIP condition

Equation	Variable	(1)	(2)
e_t	constant	...	...
	e_{t-1}	0.4018***	0.3859***
		(0.053)	(0.048)
	$E_t e_{t+1}$	0.4733***	0.6310***
		(0.086)	(0.084)
	$i_{t-1} - i^*_{t-1}$	-0.0418**	...
		(0.016)	
	$i_t - i^*_t$	...	0.0721***
			(0.014)
	R-squared	0.37	0.39
	$\chi^2(19)$ [p-value]	14.58 [0.74]	16.33 [0.63]
	rk Wald $F^\dagger$	3.54	2.91

Notes: The estimation is for the periods of 1996m1-2005m12. *** p < 0.01, ** p < 0.05, * p < 0.1 Heteroskedasticity and auto-correlation (HAC) robust standard errors (based on Bartlett kernel function with bandwidth K=2) are in the parentheses underneath the coefficients. The GMM instruments set includes a constant, 9 lags of exchange rates, 3 lags of (domestic) inflation rates, 6 lags of (domestic) overnight interest rates, and 3 lags (foreign) interest rates .$\chi^2(19)$ stands for the J-statistic and (the number of over identifying restrictions).
† Kleibergen-Paap rk Wald F statistic. ** 5% maximal IV relative bias, * 10% maximal IV relative bias using the Stock and Yogo's (2005) weak instruments test critical values.

on UIP estimates obtained in (1) in my analysis later in this study.

The monetary policy reaction function is subject to structural breaks as discussed in detail in Chapter V. The estimated break dates are Nov'98, Feb'01, and Sep'03 following Bai and Perron (1998, 2003) and the available anecdotal evidence. I report the GMM estimates of the monetary policy reaction functions for each sub period in Table VII.4. The GMM instruments set used consists of a constant, six lags of monthly inflation rates, output gap, and overnight interest rates in all periods, except the period of Mar'01-Sep'03 where a constant, three lags of monthly inflation rates, output gap, and overnight interest rates are used. The estimates are in line with the theory and those of Berument and Taşçı (2004), Yazgan and Yılmazkuday (2007), and Aklan and Nargeleçekenler (2008). There is evidence of substantial interest rate smoothing during the period of Mar'01-Dec'05 vis-á-vis the transition period toward

Table VII.4: GMM Estimates of the Monetary Reaction Function

Equation	Variable	Jan'96 - Nov'98	Dec'98 - Oct'00	Mar'01 - Sep'03	Oct'03 - Dec'05
i_t	constant	-3.1188*	7.7013	...	...
		(1.6185)	(1.5940)		
	i_{t-1}	0.6188***	0.3689***	0.8672***	0.9347***
		(0.112)	(0.072)	(0.1350)	(0.013)
	$E_t\pi_{t+2}$	4.5288***	...	7.9209**	...
		(1.1804)		(2.7536)	
	$E_t\pi_{t+3}$	...	9.0144***	...	8.1975***
			(0.9459)		(0.6556)
	y_{t-5}	5.3237***	5.2955***	...	...
		(1.2644)	(0.1614)		
	y_{t-6}	...	...	4.2048***	...
				(1.0316)	
	$E_t y_{t+1}$	...	...	...	5.6217***
					(0.5031)
	R-squared	0.32	0.60	0.41	0.92
	$\chi^2(15)$ [p-value]	12.19 [0.66]	15.03 [0.44]	...	12.96 [0.60]
	$\chi^2(7)$ [p-value]	...	...	6.01 [0.53]	...
	rk Wald $F^\dagger$	7.65	1.85	1.58	5.20

Notes: *** p < 0.01, ** p < 0.05, * p < 0.1 Robust standard errors are in the parentheses underneath the coefficients. The GMM instruments set includes a constant, 6 lags of monthly inflation rates, output gap, and overnight interest rates for all periods, except the period of Mar'01-Sep'03 which uses a constant, 3 lags of monthly inflation rates, output gap, and overnight interest rates. $\chi^2(15)$ and $\chi^2(7)$ stands for the J-statistic and (the number of over identifying restrictions) for the corresponding periods.
† Kleibergen-Paap rk Wald F statistic. ** 5% maximal IV relative bias, * 10% maximal IV relative bias using the Stock and Yogo's (2005) weak instruments test critical values.

full-fledged inflation targeting. The coefficients on the expected future inflation rates are positive and significant. The lagged output gap variables have a positive and significant coefficients in periods of Jan'96-Nov'98, Dec'98-Oct'00, and Mar'01-Sep'03. The Sep'03-Dec'05 period is best characterized by having expected future output gap instead of lagged output gap in the model where positive and significant coefficient on the expected output gap is estimated. The Hansen's J statistics are 12.19, 15.03, 6.01, and 12.96, respectively, for the periods of Jan'96-Nov'98, Dec'98-Oct'00, Mar'01-Sep'03, and Oct'03-Dec'05 respectively. The J statistics are small enough to fail to reject the joint null hypothesis of valid instruments and correct specification.

VII.1.2 Ordinary Least Squares Estimation

GMM based inference has been heavily criticized since its estimators are inconsistent when weak instruments (sometimes referred to underidentification in non-linear GMM) problem is present. Weak instruments problem arise when instruments are only weakly correlated with the included endogenous variables. If instruments are weak, then the sampling distributions of GMM and IV estimators are in general non-normal and therefore the standard GMM and IV point estimates, hypothesis testing, and the confidence intervals can be misleading.

Table VII.1, VII.2, VII.3, and VII.4 report the Kleibergen-Paap rk Wald F statistics which can be used to test for weak instruments. The Kleibergen-Paap rk Wald F statistics for the estimations of the IS and Phillips curves are higher than the Stock and Yogo's (2005) weak instruments test critical values rejecting the null hypothesis of weak instruments. On the other hand, the null hypothesis of weak instruments for the UIP condition and the monetary policy reaction functions can not be rejected. In order to improve my estimation results, and conduct sensitivity analysis, I make use of the forecast survey data to re-estimate the model using standard OLS estimation following the pooling forecasts methodology proposed by Smith (2009).

Linear rational expectations models with endogenous expectations variables can be estimated in different ways using forecast survey data. Roberts (1995) pioneered the use of the forecast surveys in estimating the new Keynesian Phillips curve. Rudebusch (2002) replaced endogenous inflation expectations by the Michigan survey of inflation expectations to OLS estimate a version of the Phillips curve. Orphanides and Williams (2002, 2005), Adam and Padula (2003), and Brissimis and Magginas (2008) use inflation forecasts of the Survey of Professional Forecasters (SPF) or the Federal Reserves Greenbook as proxies for expectations to estimate the Phillips curve.

Smith (2009) shows how using the actual future values of the endogenous expectations variables in addition to the forecast survey data improves the statistical efficiency of estimating a hybrid new Keynesian Phillips curve for the U.S. I follow the reasoning provided by Smith to re-estimate the model in a more efficient way.

The structural model in this study consists of three forward looking expectational variables; the expectations about the future inflation rate, the future output gap, and the future nominal exchange rate. Unfortunately, the CBRT's forecast surveys did not contain questions in relation to output gap until the beginning of full-fledged inflation targeting in Jan'06. Therefore I will not be able to re-estimate the equations containing expected future output gap terms, namely the IS curve and the monetary policy reaction function for the sub period of Oct'03-Dec'05. The CBRT's forecast surveys collected expectations data on nominal exchange rate by the end of the month, CPI inflation rate for the current month and the second month ahead which can be used for the estimations.

Smith's pooling forecasts methodology requires two pre-condition to be met. First, the instrumented actual values should have no incremental predictive ability for the endogenous regressors beyond that provided by the forecast value, and second, the forecast survey value should be an unbiased predictor of the corresponding endogenous variable. I first estimate the following regressions using OLS to test for relevance of supplementary instruments used in the GMM estimation of the UIP condition.

$$e_{t+1} = \phi_1 e_{t-1} + \phi_2 E_t^s e_t + \phi_3 (i_{t-1} - i_{t-1}^*) + \phi' z_t^{uip} + \nu_t \qquad \text{(VII.1)}$$

In equation (VII.1), $E_t^s e_t$ is the forecast series for the nominal exchange rate by the end of the month and z_t^{uip} is the vector instrumented actual values used in the GMM estimation of the UIP condition. I then test the hypothesis $H_0 : \phi^{'} = 0$. The standard F-statistic, $[F(20, 27) = 3.42]$, is large enough to reject the null hypothesis. That's to say the first pre-condition fails to hold where the supplementary instruments do have predictive ability for the endogenous regressors beyond that provided by the forecast value.

Next, I check whether $E_t^s e_t$ is an unbiased estimator of e_{t+1}. To check for unbiasedness, I run the following OLS regression and test for the joint hypothesis $H_0 : \phi_0 = 0, \phi_s = 1$

$$e_{t+1} = \phi_0 + \phi_s E_t^s e_t + \nu_t^s \tag{VII.2}$$

where ν_t^s is an i.i.d. error term. I obtain an F statistics $[F(2, 49) = 20.94]$, and a p-value of 0.00 rejecting the null hypothesis of unbiasedness. Since neither the first nor second pre-condition of Smith's pooling forecasts methodology is met, forecast series on nominal exchange rate by the end of the month can not be used to improve the efficiency of the GMM estimation. Therefore, I skip using his methodology to re-estimate the UIP condition.

Next, I look at whether the forecast value of the CPI inflation rate for the second month ahead can be appropriate used to OLS estimate the Phillips curve. I first estimate the following regressions using OLS to test for relevance of supplementary instruments used in the GMM estimation of the Phillips curve.

$$\pi_t = \alpha_0 + \alpha_1 \pi_{t-1} + \alpha_2 E_t^s \pi_{t+2} + \alpha_3 y_{t-4} - \alpha_4 \Delta q_{t-1} + \alpha^{'} z_t^{pc} + \epsilon_t \tag{VII.3}$$

In equation (VII.3), $E_t^s \pi_{t+2}$ is forecast series of the CPI inflation rate for the second month ahead and $z_t^{pc} = (\pi_{t-2}, y_{t-5}, i_{t-1})$ is the vector of the major instrumented actual values used in the GMM estimation of the Phillips curve. I then test the null hypothesis of $H_0 : \alpha^{'} = 0$. The standard F-statistic is $[F(3, 43) = 0.27]$ with a p-value of 0.84 suggesting the null hypothesis can not be rejected.

Next, I check whether $E_t^s \pi_{t+2}$ is an unbiased estimator of π_{t+2}. To check for unbiasedness, I run the following OLS regression and test for the joint hypothesis $H_0 : \alpha_0 = 0, \alpha_s = 1$

$$\pi_{t+2} = \alpha_0 + \alpha_s E_t^s \pi_{t+2} + \epsilon_t^s \tag{VII.4}$$

where ϵ_t^s is an i.i.d. error term. I obtain an F statistics $[F(2, 49) = 0.76]$, and a p-value of 0.47 failing to reject the null hypothesis of unbiasedness. Since both the first and second pre-condition of Smith's pooling forecasts methodology are met, the forecast value of the CPI inflation rate for the second month ahead can be used to re-estimate the Phillips curve. Estimating the Phillips curve described by (V.3) using OLS gives the following relationship

$$\hat{\pi}_t = 0.0660 + 0.3730^{**} \pi_{t-1} + 0.7848^{*} E_t \pi_{t+2} + 0.0532 y_{t-4} + 0.0375 \Delta q_{t-1} \tag{VII.5}$$

with R-squared value of 0.44. The fit of the Phillips curve is improved by some extent measured by the rise in the R-squared value from 0.29 to 0.44 comparing the GMM results in column 1 of Table VII.2 and the OLS estimation results. In general, the OLS estimates are in line with the GMM estimates obtained before. Both lagged and expected future inflation rates have positive and significant coefficients. However, the output gap has a positive but insignificant coefficient at the conventional significance levels. It's also important to note that the size of the coefficient on the expected future inflation rate is about three times bigger when Phillips curve is estimated using OLS.

Finally, I turn to estimating the monetary policy reaction function in Mar'01-

Sep'03 using the forecast data available for Aug'01 and onwards. The monetary reaction function for the period Oct'03-Dec'05 is not re-estimated since forecast data on expected future output gap is not available. As in the previous analysis, I look at whether the forecast value of the CPI inflation rate for the second month ahead can be appropriate used to OLS estimate the monetary reaction function in Mar'01-Sep'03. For this purpose, I estimate the following regression using OLS to test for relevance of supplementary instruments used in the GMM estimation of the monetary reaction function.

$$i_t = \rho i_{t-1} + (1-\rho)\left[\gamma_\pi E_t^s \pi_{t+2} + \gamma_y y_{t-6} + \gamma^{'} z_t^{tr} + \sigma_t\right] \tag{VII.6}$$

In equation (VII.6), $E_t^s \pi_{t+2}$ is forecast value of the CPI inflation rate for the second month ahead and $z_t^{tr} = (\pi_{t-1}, \pi_{t-2}, \pi_{t-3}, y_{t-1}, y_{t-2}, y_{t-3}, i_{t-2}, i_{t-3})$ is the vector of the instrumented actual values used in the GMM estimation of the monetary reaction function. I then test the hypothesis $H_0 : \gamma^{'} = 0$. The standard F-statistic is $[F(8,41) = 1.06]$ with a p-value of 0.40 suggesting the null hypothesis can not be rejected.

It was shown that $E_t^s \pi_{t+2}$ is an unbiased estimator of π_{t+2}. Hence, both of the pre-conditions of the Smith's pooling forecasts methodology are met which allow me to estimate the following monetary reaction function using OLS for the period of Mar'01-Sep'03. OLS estimation predicts the following relationship

$$\hat{i}_t = 0.7582^{***} i_{t-1} + 4.2113^{**} E_t^s \pi_{t+2} + 1.6348^{**} y_{t-6} \tag{VII.7}$$

with R-squared value of 0.81. Comparing the R-squared values, an increase from 0.41 to 0.81, reveals a large increase in the fit of the model when OLS is employed. The coefficients are similar to that of the GMM results. The interest rate smoothing parameter, and the coefficient of the output gap, and the coefficient on the expected future inflation rate are lower when OLS is used. However, they all have the same sign and are significant as in the GMM results.

VII.2 Numerical Rational Expectations Solutions

Calculating the operational indices requires the use of the estimates of the coefficients in the model as well as the rational expectations solutions for the endogenous variables π_t, y_t, i_t, and e_t. The presence of several expectations variables make the analytical model too complex to obtain analytically derived closed form solutions. Therefore, I adopt Sim's (2002) numerical methodology and use his Matlab code, the "gensys" program, to obtain numerical rational expectation solutions[1]. Appendix A.3. provides detailed explanation on how the rational expectations solutions were obtained for each sub period once the structural break dates in the monetary policy reaction function considered. Table VIII.1-VIII.4 display estimated rational expectations solutions also known as the minimum state variables (MSV) solutions.

VII.3 Empirical Implementation under Adaptive Learning

Rational expectations is a very strong assumption because it assumes economic agents to know the correct form of the underlying structural model and the parameters describing the model. Besides, rational expectations is an equilibrium concept which may not be the appropriate way to characterize the way expectations are formed in periods of transition. To reach a more realistic view and for comparison, I now adopt adaptive learning approach which allows me to re-estimate the model using OLS. Later, I compute operational indices under both rational expectations and adaptive learning assumptions and discuss the implications of these assumptions on the operational indices.

[1] The "gensys" program is available online at `http://sims.princeton.edu/yftp/gensys/`

The adaptive learning theory pioneered by Evans & Honkapohja (1995) considers rational expectations solutions as a natural benchmark which is eventually learned by the economic agents through constant updating as new information become available. Agents are assumed to act like econometricians in formulating their expectations and constantly engage in a process of learning about the structure of the economy and the parameters describing it. I borrow an illustrative example by Evans & Honkapohja (2009) to provide further insight on the formal implementation of adaptive learning. There are two key building blocks to adaptive learning; a forecasting model describing the agents' beliefs and the method agents obtain estimates for the parameters in the forecasting model. Suppose agents are assumed to use the following perceived law of motion to formulate their expectations

$$p_t = a + b^{'} w_{t-1} + \eta_t$$

where the true values of a and b are not known. Assume further that agents use Least Squares (LS) technique to find estimates of the parameters in the perceived law of motion. Agents estimate a and b by recursive least squares using past data $\{p_i, w_i\}_{i=0}^{t-1}$, and they formulate their expectations as

$$\tilde{E}_{t-1} p_t = a_{t-1} + b_{t-1}^{'} w_{t-1}$$

where a_{t-1} and b_{t-1} are the estimated parameters obtained using available data up to the date $t-1$.

I apply the adaptive learning algorithm described above to derive series of private agent's expectations that appear in the IS and Phillips curves, and the UIP condition. These expectational variables are $E_t \pi_{t+2}$, $E_t y_{t+1}$, $E_{t-2} \pi_{t-1}$, and $E_t e_{t+1}$. I assume that the central bank has rational expectations therefore I don't estimate adaptively learned expectations series for the expectation terms appearing in the monetary reaction function. I then use the generated expectations series to obtain estimates for the IS and Phillips curves, and the UIP condition using OLS. Following the standard approach, I consider the form of the MSV solution displayed in Table VIII.1-VIII.4 as the underlying forecasting model describing the private agents' beliefs. The forecasting models of π_t, y_t, and e_t are given by

$$\begin{aligned}\pi_t &= g_0 + g_1\pi_{t-1} + g_2 y_{t-1} + g_3 i_{t-1} + g_4 e_{t-1} + g_5\pi^*_{t-1} + g_6 i^*_{t-1} + g_7\pi_{t-2} + g_8 y_{t-2} \\ &\quad + g_9 y_{t-3} + g_{10} y_{t-4} + g_{11} y_{t-5} + g_{12} y_{t-6} + g_{13} i_{t-2} + g_{14} i_{t-3} + g_{15} e_{t-3} + g_{16}\pi^*_{t-2} \\ &\quad - g_{17}\epsilon_t - g_{18}\eta_t - g_{19}\sigma_t - g_{20}\nu_t - g_{21}\epsilon^*_t - g_{22}\sigma^*_t \end{aligned} \tag{VII.8}$$

$$\begin{aligned}y_t &= h_0 + h_1\pi_{t-1} + h_2 y_{t-1} + h_3 i_{t-1} + h_4 e_{t-1} + h_5\pi^*_{t-1} + h_6 i^*_{t-1} + h_7\pi_{t-2} + h_8 y_{t-2} \\ &\quad + h_9 y_{t-3} + h_{10} y_{t-4} + h_{11} y_{t-5} + h_{12} y_{t-6} + h_{13} i_{t-2} + h_{14} i_{t-3} + h_{15} e_{t-3} + h_{16}\pi^*_{t-2} \\ &\quad - h_{17}\epsilon_t - h_{18}\eta_t - h_{19}\sigma_t - h_{20}\nu_t - h_{21}\epsilon^*_t - h_{22}\sigma^*_t \end{aligned} \tag{VII.9}$$

$$\begin{aligned}e_t &= s_0 + s_1\pi_{t-1} + s_2 y_{t-1} + s_3 i_{t-1} + s_4 e_{t-1} + s_5\pi^*_{t-1} + s_6 i^*_{t-1} + s_7\pi_{t-2} + s_8 y_{t-2} \\ &\quad + s_9 y_{t-3} + s_{10} y_{t-4} + s_{11} y_{t-5} + s_{12} y_{t-6} + s_{13} i_{t-2} + s_{14} i_{t-3} + s_{15} e_{t-3} + s_{16}\pi^*_{t-2} \\ &\quad - s_{17}\epsilon_t - s_{18}\eta_t - s_{19}\sigma_t - s_{20}\nu_t - s_{21}\epsilon^*_t - s_{22}\sigma^*_t \end{aligned} \tag{VII.10}$$

I use recursive least squares, which weights more recent data more heavily, to estimate (VII.8)-(VII.10) with an initial window size of twenty observations. This procedure generates expectations series, $\tilde{E}_t\pi_{t+2}$, $\tilde{E}_t y_{t+1}$, $\tilde{E}_{t-2}\pi_{t-1}$, and $\tilde{E}_t e_{t+1}$, consistent with the underlying forecasting model and least squares learning algorithm. I then use ordinary least squares to re-estimate the IS and Phillips curves, and the UIP condition using the private agent's estimated forecast series. The OLS estimation results are displayed in Table VII.5. Column 1, 2 and 3 report OLS estimates for the IS schedule, Phillips curve, and the uncovered interest parity condition. The signs of the OLS estimates are consistent with theory and in general with the results obtained using GMM estimation.

Table VII.5: OLS Estimates of IS, PC, and UIP

	(1) y_t	(2) π_t	(3) e_t
constant	-0.0366	-0.0182	-0.0033
	(0.1298)	(0.1022)	(0.0092)
y_{t-1}	0.1705		
	(0.1172)		
y_{t-2}	0.1893^{**}		
	(0.0880)		
$\tilde{E}_t y_{t+1}$	0.3841^{***}		
	(0.0959)		
$i_{t-2} - \tilde{E}_{t-2}\pi_{t-1}$	-0.0045^{**}		
	(0.0017)		
π_{t-1}		0.4606^{***}	
		(0.1190)	
$\tilde{E}_t \pi_{t+2}$		0.4383^{***}	
		(0.0982)	
y_{t-4}		0.1079^{*}	
		(0.0630)	
Δq_{t-1}	-0.0217	-0.0361	
	(0.0306)	(0.0241)	
e_{t-1}			0.3885^{***}
			(0.1187)
$\tilde{E}_t e_{t+1}$			0.4097^{*}
			(0.2142)
$i_{t-1} - i^*_{t-1}$			-0.0518^{*}
			(0.0285)
R-squared	0.33	0.49	0.26
N	101	101	101

Notes: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$ OLS estimation is used. Robust standard errors are in the parentheses underneath the coefficients.

VII.4 Expectational Stability

Expectational stability also known as E-stability deals with the stability of a rational expectations equilibrium under adaptive learning. To motivate the concept of E-stability consider a rational expectations equilibrium, $\bar{\phi}$, for an economic model where $\bar{\phi}$ contain the estimated rational expectations, or the minimum state variables solution, of the model. Under adaptive learning the private agents are assumed not to know $\bar{\phi}$, but try to estimate it using data from the economy. Constant updating the data and estimation of the model leads to estimates ϕ_t at time t. The concern is whether $\phi_t \to \bar{\phi}$ as $t \to \infty$. In Appendix A.5, I show that the estimated minimum state variables solutions for the periods of Jan'96-Nov'98, Dec'98-Oct'00, Mar'01-Sep'03, and Oct'03-Dec'05 are E-stable under least squares learning.

VII.5 Comparison of RE and Adaptive Learning Estimates

The estimates for the IS schedule are substantially close under rational expectations and adaptive learning. Under rational expectations, the coefficients on the expected future output gap and the real interest rate are 0.3701 and -0.0041 respectively vis-à-vis 0.3841 and -0.0045 under adaptive learning. Under both expectations formation, expected future output gap and the real interest rate have significant impact on the current output gap. I obtain similar estimates for the second lag of output gap under rational expectations and learning though the coefficient on the first lag of output gap under learning is not significant and lower than the estimate obtained assuming rational expectations.

Comparison of the estimates for the Phillips curve indicates that rational expectations estimates of the inflation terms are lower than that of adaptive learning. The difference between the estimates is much larger for the expected future inflation term.

According to GMM estimation, one period lagged and the expected two period ahead inflation rates have coefficients of 0.4513 and 0.2898, respectively. The corresponding estimates under adaptive learning are 0.4606 and 0.4383. The estimates of the lagged and expected inflation rates are significant at 1% significance level under both expectations formation. Under adaptive learning, although the sign is in line with the theory, the coefficient on the lagged output gap is substantially lower than that of rational expectations. I obtain estimates of 0.2025 under rational expectation versus 0.1079 under learning where the former is significant at 1% and the latter is significant at 10% significance level. The impact of the real exchange rate depreciation on inflation is negative under both expectation formation processes. However, real exchange rate depreciation seem to have a larger and significant impact on inflation only when estimation is through GMM.

The point estimates are the closest when I estimate the uncovered interest parity condition using rational expectations and adaptive learning approaches. The estimates of the one period lagged and one period forward looking exchange rate are 0.4018 and 0.4733 under rationality assumption. Under learning, the estimates turn into 0.3885 and 0.4097, respectively. Although the estimates obtained under learning are lower than that of rational expectations, they all are significant at conventional significance levels. The lagged domestic-foreign interest rate differential has a negative impact on current nominal exchange rate under both expectation formation processes. I obtain -0.0418 under rational expectations and -0.0518 under learning for the coefficient on the interest rate differential where the former is significant at 5% and the latter is significant at 10% significance level.

Comparison of the estimates obtained under different expectation formation processes is considered a sensitivity analysis. The estimation results indicate that estimates for the uncovered interest parity condition, the IS schedule, and the Phillips curve are substantially close though different assumptions governing the underlying process of expectations formation are used. I interpret this finding as an evidence supporting the reliability of the estimates for the structural model. On the other hand, it is important to note that the way the learning methodology is conducted may inherently have a tendency towards producing similar estimates as in rational expectations approach. Given the lag structure of the forecasting models of adaptive learning given by (VII.8)-(VII.10), estimating the forecast series requires mainly the use of lagged values of inflation rate, output gap, and interest rate. These lagged terms constitute a major part of the instruments sets used in the GMM estimations which are used in the first stage regressions determining the relevance of the instruments. The use of similar set of lagged terms, and analogous methods of least squares learning and the first stage regressions seem to play a role in obtaining close estimates for the structural model under the alternative assumptions of rational expectations and adaptive learning.

VII.6 Formulae for Operational Indices

VII.6.1 Formulae for Ex Ante and Ex Post Inflation Pressure

In order to find the impact of the interest rate policy changes on inflation through the output gap, I lag (V.1) four periods and substitute it into (V.3) to get:

$$\begin{aligned} \pi_t &= \alpha_0 + \alpha_1 \pi_{t-1} + \alpha_2 E_t \pi_{t+2} - \alpha_4 \Delta q_{t-1} + \epsilon_t \\ &\quad + \alpha_3 \left\{ \beta_0 + \beta_1 y_{t-5} + \beta_2 y_{t-6} + \beta_3 E_{t-4} y_{t-3} + \beta_4 [i_{t-6} - E_{t-6}\pi_{t-5}] - \beta_5 \Delta q_{t-5} + \eta_{t-4} \right\} \end{aligned} \tag{VII.11}$$

According to (VII.11) there is a six period control lag between the implementation of the interest rate policy and its impact on the inflation. Following the methodology explained in Chapter IV, the conduct of the counterfactual experiments require keeping the interest rate constant for a period. I consider a quarter to be the benchmark period to be able to observe the full impact of the counterfactual experiment as in Weymark and Shintani (2006). Hence, using monthly data, where a quarter is equivalent to three months, requires setting $i_{t-4} = i_{t-5} = i_{t-6} = i_{t-7}$ to undertake the counterfactual experiments described in Chapter IV and obtain measures of ex ante and ex post inflation pressure. Therefore, all variables that appear in (VII.11) must be expressed in terms of i_{t-4} and earlier. Initially I carry forward the expectation terms as they appear in (VII.11), but eventually I express the expectation terms as functions of i_{t-4} and earlier in order to obtain ex ante inflation pressure measure.

Using (VII.11), an operational formulae for ex post inflation pressure can be obtained. Although the derivation is straightforward, it is tedious. Appendix A.6 shows the details of the derivation. The resulting ex post inflation pressure formulae is given by

$$EPIP_t = \Delta\pi_t - Z_6\Delta^3 i_{t-4} - Z_7\Delta^2 i_{t-5} - Z_8\Delta i_{t-6} \tag{VII.12}$$

where

$$\begin{aligned}
Z_6 &= \alpha_4\phi_3(\rho^2 + \phi_1^2) - \alpha_4\phi_3(1 - (\alpha_1 - \alpha_4))(\rho + \phi_1 + (\alpha_1 - \alpha_4)) \\
Z_7 &= \phi_1^3\alpha_4\phi_3 - \alpha_4\phi_3(1 - (\alpha_1 - \alpha_4))(\phi_1^2 + \phi_1(\alpha_1 - \alpha_4) + (\alpha_1 - \alpha_4)^2) \\
Z_8 &= \phi_1^4\alpha_4\phi_3 + \alpha_3(\beta_5\phi_3 + \beta_4)
\end{aligned}$$

Notice that the formulae for the ex post inflation pressure is obtained considering the post-policy expectations constant. Since expectations terms are kept constant, there is no room for different processes of expectations formation leading to different outcomes i.e. the formulae for the ex post inflation pressure is identical under rational expectations and adaptive learning and given by (VII.12).

Solving for ex ante inflation pressure requires the expectations terms that appear in (A.25)-(A.28) in Appendix A.6 represented as functions of i_{t-4} and earlier. I use the form of the MSV solutions reported in Table (VIII.1)-(VIII.1) to successfully express all of the expectations in terms of i_{t-4} and earlier. Appendix A.6 shows the details of the derivation.

Under rational expectations, ex ante inflation pressure formulae is given by

$$EAIP_t^i = \Delta\pi_t - (Z_6 + Z_6^{xa,i})\Delta^3 i_{t-4} - (Z_7 + Z_7^{xa,i})\Delta^2 i_{t-5} - (Z_8 + Z_8^{xa,i})\Delta i_{t-6} \quad \text{(VII.13)}$$

for each period where $i = I, II, III$, and IV. Appendix A.6 shows that $Z_6^{xa,i}$, $Z_7^{xa,i}$, and $Z_8^{xa,i}$ are constants obtained from complex combinations of the MSV solution values reported in Table VIII.1-VIII.4. Comparison of (VII.12) and (VII.13) reveals that $Z_6^{xa,i}$, $Z_7^{xa,i}$, and $Z_8^{xa,i}$ reflect the impact of the interest change policy on inflation through changes in the expectations.

Deriving the formulae for the ex ante inflation pressure index under adaptive learning requires several ordinary least squares estimations to obtain private agents' forecast series of expectations and the corresponding counterfactual series. In Appendix A.6, I report a detailed derivation of the formulae for ex ante inflation pressure. The ex ante inflation pressure index under adaptive learning is given by

$$\begin{aligned} EAIP_t^i &= \Delta\pi_t - (Z_6 + Z_6^{re,i})\Delta^3 i_{t-4} - (Z_7 + Z_7^{re,i})\Delta^2 i_{t-5} - (Z_8 + Z_8^{re,i})\Delta i_{t-6} \\ &\quad - \sum_{j=20}^{j=31} \Lambda_j[\tilde{E} - \tilde{E}^{cf}] \end{aligned} \quad \text{(VII.14)}$$

for periods of $i = I, II, III$, and IV. The term $\tilde{E}$ stands for various expectational terms with different lag length as described in Appendix A.6 and the term $\tilde{E}^{cf}$ is the corresponding counterfactual forecast series. According to Appendix A.6, $Z_6^{re,i}$, $Z_7^{re,i}$, and $Z_8^{re,i}$ are constants obtained from complex combinations of the MSV solution values reported in Table VIII.1-VIII.4. Finally, Λ_j correspond to the coefficients denoted by Z, Z', Z^a, or Z^b which are functions of the model estimates. Notice that, there two distinct expectations channels through which the interest rate changes affect the inflation rate. The coefficients, $Z_6^{re,i}$, $Z_7^{re,i}$, and $Z_8^{re,i}$, measures the impact of interest rate changes on the inflation through rational expectations terms while Λ_j measures the impact through the private agents' adaptive expectations.

VII.6.2 Formulae for XIFC & XITC Indices

According to (VII.11) there is a six period control lag between the implementation of the interest rate policy and its impact on the inflation. In order to be able to conduct the counterfactual experiments introduced in Chapter IV, all variables which appear in(VII.11) must be expressed in terms of i_{t-6} and earlier as shown in Appendix A.7. Initially I carry forward the expectation terms as they appear in (VII.11) to solve for the index of expectations of inflation under true credibility. I, then express the expectation terms as functions of i_{t-6} and earlier as well to obtain index formula for expectations of inflation under full credibility.

The impact on expectations under true credibility is obtained by setting $i_{t-6} = i_{t-7}$ in (A.55)-(A.57) with expectations held constant under actual policy. Thus, a measure of expectations of inflation under true credibility (XITC) is computed by

$$XITC_t = \Delta\pi_t - W_8 \Delta i_{t-6} \tag{VII.15}$$

where W_8 is a constant made of estimates of the structural model as defined in

Appendix A.7. Notice that the formula for XITC index is identical under rational expectations and adaptive learning as the post-policy expectations are kept constant when undertaking the counterfactual experiment to derive XITC. However, the estimated index values of XITC will vary due to different estimates for the coefficient that appear in W_8 under rational expectations and adaptive learning.

In Appendix A.7, I solve for the interest rate, i^T_{t-6}, that ensures inflation target, π^T_t. I then conduct counterfactual experiments to obtain the expectations of inflation under full credibility (XIFC) index. Under rational expectations, the XIFC index is given by

$$XIFC^j_t = (\pi^T_t - \pi_t) - \theta_j[i^T_{t-6} - i_{t-7}] \tag{VII.16}$$

for the periods of $j = II, III, IV$. The coefficients θ_j are functions of W_8. The indices of expectations of inflation under full credibility for each period and the coefficients, θ_j, are explicitly defined in Appendix A.7 in (A.65)-(A.67).

In Appendix A.7, I show the index of expectations of inflation under full credibility under adaptive learning can be computed as

$$\begin{aligned} XIFC^j_t &= (\pi^T_t - \pi_t) - W_8[i^T_{t-6} - i_{t-7}] - \Omega_j[i^T_{t-6} - i_{t-7}] \\ &\quad - \sum_{i=27}^{i=32} W_i[\tilde{E}^T - \tilde{E}^{CF}] \end{aligned} \tag{VII.17}$$

for the periods of $j = II, III, IV$. Private agents' estimated forecast series using i^T_{t-6} and i_{t-7} are representd by $\tilde{E}^T$ and $\tilde{E}^{CF}$, respectively. The coefficients W_i and Ω_j are defined in Appendix A.7. Each forecast model of learning has a distinct lag structure as explicitly shown in Appendix A.7 in (A.71)-(A.73). The term, $\Omega_j[i^T_{t-6} - i_{t-7}]$

indicates the impact of the interest change policy on inflation via output changes through rational expectations channel. In periods II and III, $\Omega_j = 0$ holds whereas $\Omega_{IV} \neq 0$ due to the expectations of future output gap term appearing in the monetary authority's reaction function in period IV.

VII.7 Estimated Indices under RE and Adaptive Learning

VII.7.1 Monetary Policy Effectiveness Index

Over the period of 1996-2005, the CBRT implemented three major disinflation programs; the 1998-2000 IMF-sponsored program, the exchange rate based stabilization program during 2000-Feb'01, and finally the semi-formal inflation targeting since the beginning of 2002. The former two disinflation and stabilization programs were abandoned since very marginal improvement was realized in terms of the decline in inflation rate and achieving stable prices. However, the CBRT's semi-formal inflation targeting launched in 2002 was extremely successful in terms of getting the inflation under control and reducing it to moderate levels. A simple comparison of the inflation rate of 75% at the beginning of 2002 and about 8% by the end of 2005 is broad enough to appreciate the success achieved in the pursuit of reducing inflation. Having experienced significant inflation reductions under semi-formal inflation targeting, the CBRT turned into implementing full-fledged targeting beginning January 2006. The estimated ex ante and ex post inflation pressure measures and the monetary policy effectiveness index reported in Table VIII.5-VIII.8 are intended to help us understand the true driving force behind unsuccessful attempts prior to inflation targeting as well as successfully reducing the inflation rate in transition to full-fledged inflation targeting.

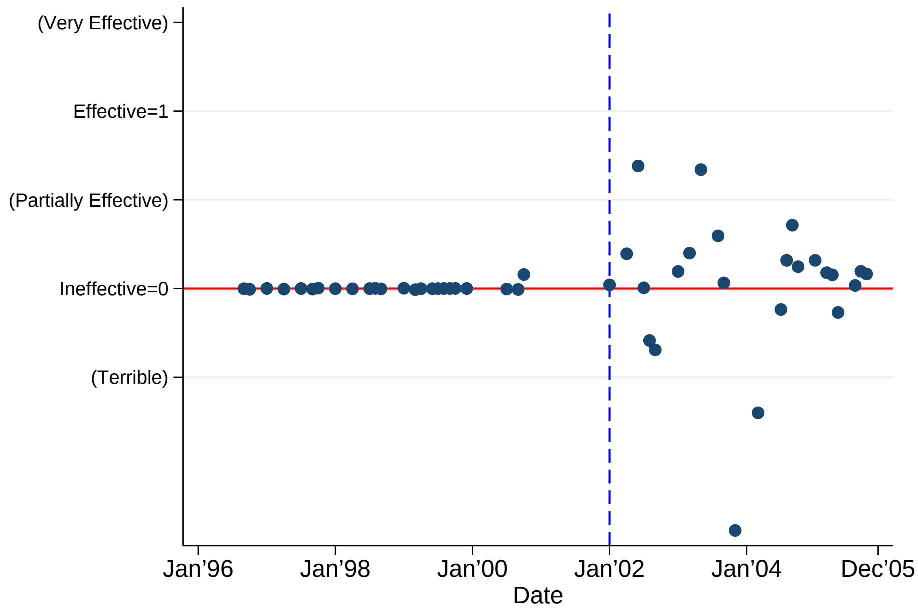
Did the economic conditions contribute significantly to the CBRT's disinflation and stabilization efforts? Answering this question requires having an appropriate measure of the inflationary environment in hand. The ex ante inflation pressure index values describe the inflationary environment that was faced by the CBRT. According to Table VIII.5 and VIII.6, there were 52 months of negative ex ante inflation pressure during Jan'96-Dec'05 under rational expectations. Half of these negative ex ante inflation pressure values were in Jan'96-Oct'00 and the other half was in the inflation targeting transition period, Mar'01-Dec'05. Similarly, there were 32 and 36 positive ex ante inflation pressure values during Jan'96-Oct'00 and Mar'01-Dec'05, respectively. Although the number of the negative ex ante inflation pressure measures are equal for the periods Jan'96-Oct'00 and Mar'01-Dec'05, the number of positive ex ante inflation pressure values in Mar'01-Dec'05 were higher than that of Jan'96-Oct'00.

I used t-tests to evaluate whether the average size of the exogenous shocks were significantly different during the Mar'01-Dec'05 period as compared that of Jan'96-Oct'00. The estimated t-test statistic, -2.40, is large enough to reject the null hypothesis at the 5% significance level that the positive exogenous shocks, as measured by positive ex ante inflation pressure index values, during the semi-formal inflation targeting period are significantly smaller in size than the positive shocks in Jan'96-Oct'00. Moreover, the t-test statistic, 1.42, is large enough to reject the null hypothesis at 10% significance level that the negative exogenous shocks, as measured by negative ex ante inflation pressure index values, during the semi-formal inflation targeting period are significantly larger in size than the negative shocks in Jan'96-Oct'00. The frequency analysis and the t-tests provide evidence that the pre-policy inflationary environment, measured in terms of ex ante inflation pressure, over the period Mar'01-Dec'05 was at least as disadvantageous as it was in the Jan'96-Oct'00 period in terms of the size and the frequency of the shocks hitting the economy.

Conditional on the nature of inflationary environment as measured by the ex ante inflation pressure, I obtain monetary policy effectiveness index values which are reported in Table VIII.5-VIII.8. As discussed in Chapter IV, monetary policy effectiveness index is defined as $MPE_{t-6} = 1 - \frac{EPIP_t}{EAIP_t}$ if there is an inflation increasing shock ($EAIP_t > 0$), and $MPE_{t-6} = \frac{EPIP_t}{EAIP_t}$ if there is an inflation reducing shock ($EAIP_t < 0$) to the economy. Figures VII.1 and VII.2 display the monetary policy effectiveness index values under rational expectations for positive and negative values of ex ante inflation pressure.

According to Figure VII.1, CBRT had completely ineffective monetary policy initiatives prior to 2002 when the economy was subject to inflation increasing shocks. The transition period to full-fledged inflation targeting, on the other hand, was a period where the CBRT had, in general, partially effective policy changes. Prior to Jan'2004, the date in which the CBRT officially announced that it will switch to full-fledged inflation targeting beginning January 2006, there are four negative monetary policy effectiveness index values in contrast to two negative values afterwards. This suggests improvement in the implementation of the monetary policy over time during the semi-formal targeting years.

Figure VII.2 shows that, when inflation reducing shocks hit the economy, the CBRT had completely effective monetary policy changes prior to 2002, and effective or partially effective policy changes during 2002-2005. There are seven data points indicating partial monetary policy effectiveness as opposed to thirteen data points reporting completely or very effective policy changes during 2002-2005. The data points indicating partially effective policy show that the inflation would have fallen more about thirty five percent of the time if the CBRT had not implemented any interest rate changes. On the other hand, the data points higher than 1 indicate that the CBRT was able to reinforce the impact of the inflation reducing shock roughly

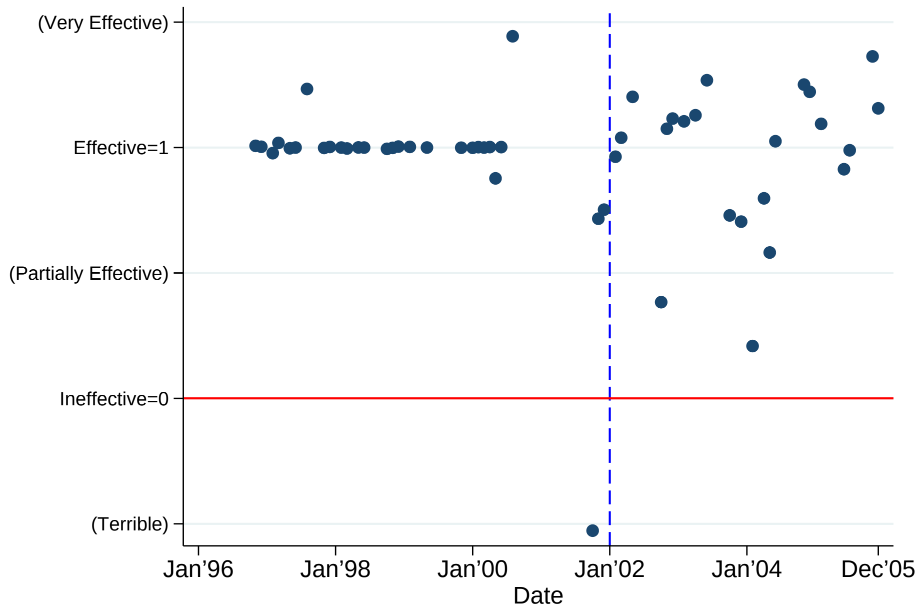


This diagram is drawn excluding the outlier data point of -10.1 in Jan'04.

Figure VII.1: Monetary Policy Effectiveness | $EAIP > 0$, RE

sixty five percent of the time. Comparison of Figure VII.1 and VII.2 reveals that the CBRT had been more successful in reducing inflation when the inflationary environment was advantageous.

I used t-test analysis to evaluate the remaining post-policy inflationary pressure, as measured by the ex post inflationary pressure values, during the non targeting period of 1996-2001 and semi-formal inflation targeting period of 2002-2005. The t-test statistic, 0.52, is small enough not to reject the null hypothesis that the remaining post-policy inflationary pressure is smaller during the period of semi-formal inflation targeting period than in the non targeting period. Overall, Figures VII.1 and VII.2 provide evidence that the CBRT pursued pre-emptive monetary policies during the period 2002-2005 rather than the accommodative policies of the earlier 1996-2001 period. Notice that using the ranges given above, the monetary policy effectiveness index characterizes accommodative policies under negative shocks as effective policy



This diagram is drawn excluding the outlier data point of 67.5 in Jul'03.

Figure VII.2: Monetary Policy Effectiveness | $EAIP < 0$, RE

decisions because, at the very least, the central bank did not counteract inflation reducing shocks that were in line with its stated objective (i.e., reducing inflation). However, because the central bank fully accommodated both negative and positive shocks, the intent behind the central bank's actions and therefore also the effectiveness of its monetary policy become suspect.

The monetary policy effectiveness as measured by the MPE index values under adaptive learning does not show a significant difference in policy effectiveness comparing the period prior to and during the implementation of the semi-formal inflation targeting. Figures VII.3 and VII.3 show the estimated policy effectiveness measures conditional on the inflationary environment as described by the ex ante inflation pressure.

The estimated policy effectiveness index values suggest that the monetary policy changes of the CBRT in 1996-2001 were as effective as that of 2002-2005 no matter

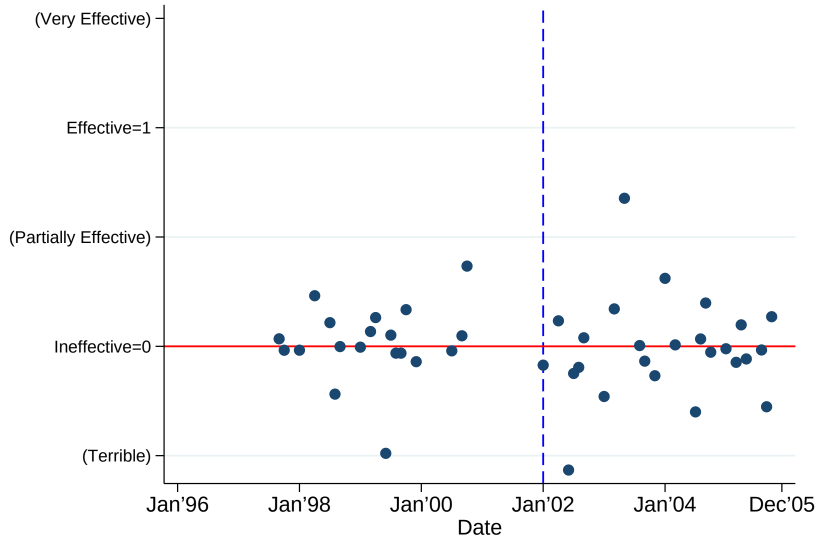


Figure VII.3: Monetary Policy Effectiveness | $EAIP > 0$, A. Learning

the underlying inflationary pressure.

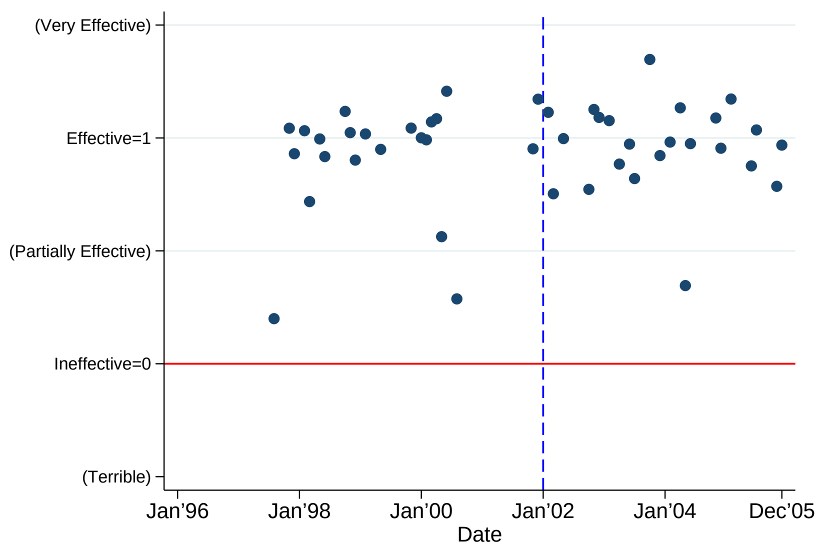


Figure VII.4: Monetary Policy Effectiveness | $EAIP < 0$, A. Learning

When private agents are assumed to form expectations based on adaptive learning, the CBRT's policy changes don't seem to be effective in reducing the inflation if the economy is subject to positive shocks. However, as the estimates in Figure VII.4

indicates, the CBRT was very effective in reducing inflation pressure when the economy was hit by inflation reducing negative shocks. The observed inflation rates in periods of 1996-2001 and 2002-2005 are distinct suggesting different degrees of policy effectiveness of the CBRT. From this angle, the predictions under adaptive learning seem problematic. Due to the structural breaks present in the monetary reaction function, the sub periods under investigation are short. As a result, the least squares learning algorithm seem to put similar weight on recent observations and older ones. That is to say, estimated private agents's forecast series reflect convex combination of the past high and recent lower inflation rates and other associated variables. Thus, under learning with small sample sizes, the monetary policy effectiveness predictions for each period are dragged closer[2].

VII.7.2 Monetary Policy Credibility Index

Since the declaration of the Memorandum of Economic Policies (MEP) in 1998, the Central Bank of Republic of Turkey began to announce target inflation rates to align private sector's expectations. The timing of the announcements during 1998-2001 was not systematic whereas in 2002-2005 announcement were made consistently at the beginning of each year. An announced objective in the MEP was to reduce the wholesale price inflation to 50 percent by the end of 1998, 20 percent by the end of 1999, and to single digits by the end of 2000. In December 1999, the CBRT announced a revised list of inflation targets where 20 percent by the end of 2000, 12 percent by the end of 2001, and 7 percent by the end of 2002 was aimed. Following the Feb'01 financial crisis, the CBRT adopted a semi-formal inflation targeting program in which the CBRT began to announce explicit end of year inflation targets at the beginning of each year starting in Jan'02. During 2002-2005, inflation targets of 35%, 20%, 12%,

[2] It is important to note that this does not necessarily mean that the conduct of adaptive learning approach is not helpful to study transition periods. In fact, assuming expectations formed through adaptive learning during transition periods seem more plausible as long as the length of the transition period is long enough to allow adaptive learning algorithm work in the appropriate way.

and 8% were officially announced by the CBRT for the end of 2002, 2003, 2004, and 2005, respectively.

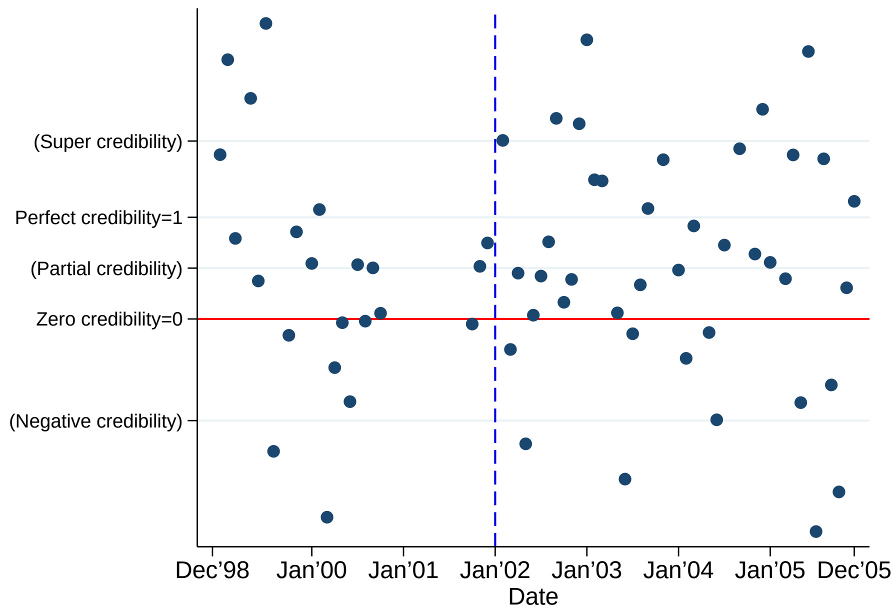
The actual inflation rates were 69 percent by the end of 1998, 68 percent by the end of 1999, 39 percent by the end of 2000, and 68 percent by the end of 2001. The observed end of year inflation rates prior to 2002 were significantly larger than the announced targets. The observed inflation rates by the end of the year 2002, 2003, 2004, and 2005 were about 29%, 18%, 9%, 7%, respectively. During the period 2002-2005, the transition period towards full-fledged inflation targeting, the CBRT undershot the announced inflation targets for four consecutive years.

Considering the periods in which explicit inflation targets were announced, I study the credibility of the monetary authority's announcements and in general the evolution of the Central Bank of Republic of Turkey's credibility. To this end, I follow the methodology explained in Chapter IV to compute the monetary policy credibility index of the CBRT prior to 2002, and during the transition period of 2002-2005. I consider rational private agents besides private expectations formed using the process of adaptive learning to obtain reliable credibility estimates. The credibility index formulae under different expectations formation are shown in VII.6.2[3]. Table VIII.9 and VIII.10 report the estimated monetary policy credibility index values under rational expectations and adaptive learning during 1998-2005.

The scatter diagram Figure VII.5 displays the estimated monetary policy credibility index values in 1998-2005 under the assumption that private agents are rational. The diagram suggests no significant change in the credibility comparing the period of

[3]Note that the index formulae in VII.6.2 requires the use of target rates at each point in time t. Since I use monthly data and all other variables are on a monthly basis, I convert the CBRT's announced end of year targets into implicit monthly targets by dividing the annual target to twelve.

semi-formal targeting to the previous non targeting period in 1998-2001. The average estimated credibility during 2002-2005 is 0.52 in comparison to 0.48 in 1998-2001[4]. The diagram also shows that there are times of super as well as negative credibility before and after 2002.



Monetary Policy Credibility Index values under Rational Expectations. This scatter diagram is drawn excluding the following twelve outlier data points: −3.79 in Dec'98, 7.48 in Apr'99, −3.20 in Sep'99, −18.85 in Dec'99, 12.61 in Dec'01, 8.10 in Apr'03, 7.15 in Oct'03, 4.80 in Dec'03, −21.84 in Apr'04, 12.47 in Aug'04, −9.75 in Oct'04, and −13.18 in Feb'05.

Figure VII.5: MPCI, Rational Expectations

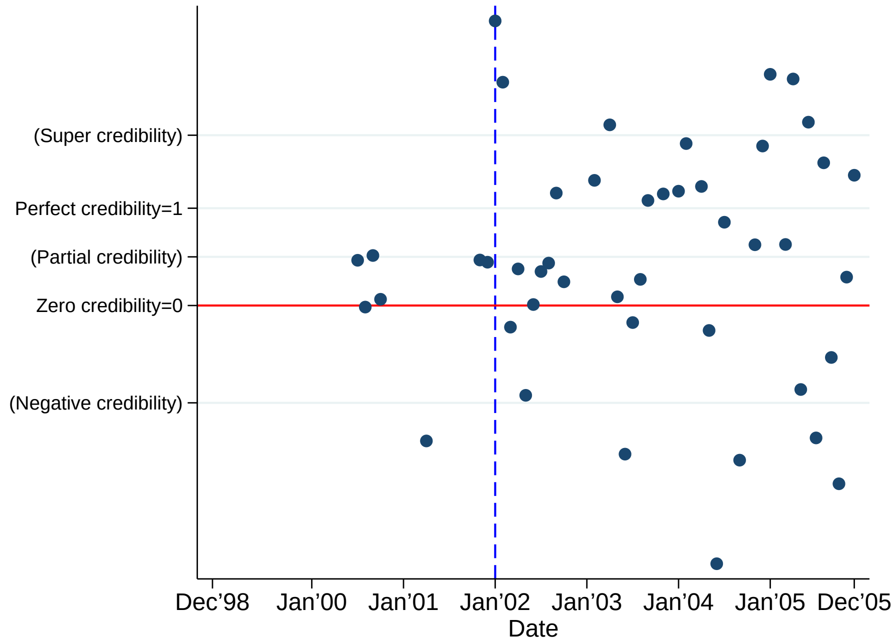
There are two major predictions of the credibility index for the period that starts with the disinflation program of the Memorandum of Economic Policies in 1998. The estimated credibility index values are very high at the very beginning of the program and rapidly decreasing as the time approaches to the year-ends for which some specific inflation targets were announced. The high credibility estimates at the beginning of the disinflation program in early 1998 seem to reflect the private agents' complete disbelief in the disinflation program itself. The private agents seem to have believed, from the beginning, that the Central Bank of Republic of Turkey would not take

[4]The (arithmetic) average credibility is computed excluding the outlier index values reported underneath the Figure VII.5.

appropriate action to reduce inflation to the level consistent with the program and the announced inflation targets. The fact that these expectations of policy failure were fulfilled is what is being captured by high credibility index values at the beginning of 1998. The estimated credibility index values for the period of 1998-2001 are rapidly decreasing, which indicates that the private agents lost their belief in the credibility of the announced targets themselves at each point in time due to the excessive overshooting of inflation targets for three successive years during 1998-2001.

During 2001-2005 overall, there don't seem to be a clear upward or downward pattern in the estimated credibility index values. However, credibility index values become larger towards the end of the year within the years of 2002, 2003, 2004, and 2005. Comparing the credibility index values among the the end of years of 2002, 2003, 2004, and 2005 suggest that credibility went down from super credibility about the end of 2002 to perfectly credible level by the end of 2005 picking up the extent of undershooting and that it got smaller towards 2005.

There are significantly large negative estimates for the credibility reported underneath of the Figure VII.5. The credibility estimate of -18.85 in Sep'99 seem to reflect the complete loss of confidence in the disinflation program due to significant overshooting as found by comparing the announced target rate of 20% and the observed actual rate of 68% by the end of 1999. Following this loss of credibility, the CBRT abandoned the its disinflation program embedded in the Memorandum of Economic Policies in 1998. Besides, I estimate negative credibility index values of -21.84 and -9.75 in Dec'03 and Oct'04, respectively. These negative estimates seem to reflect loss of credibility in the announcements themselves rather then the disinflation program due to undershooting occurred in the previous years.



Monetary Policy Credibility Index values under Adaptive Learning. This scatter diagram is drawn excluding the following twelve outlier data points: 3.61 in Mar'03, −4.86 in Sep'01, 5.09 in Nov'02, −17.08 in Dec'02, 12.43 in Jan'03, −12.41 in Mar'03, 36.59 in Oct'03, 9.47 in Dec'03, 4.63 in Mar'04, 3.11 in Aug'04, −4.61 in Oct'04, and 5.95 in Feb'05.

Figure VII.6: MPCI, Adaptive Learning

Estimated monetary policy credibility index values under adaptive learning are displayed in the scatter diagram VII.6[5]. The diagram suggests no significant change in the credibility overall, during 2002-2005. The arithmetic average of the estimated credibility index is 0.50 during 2002-2005 and 0.43 in 1998-2005[6]. These credibility estimates are extremely close to that of under the assumption of rational expectations. Negative or positive outlier credibility estimates reported underneath the Figure VII.6 are also aligned with the timing of the outliers predicted when agents are rational. However, there seem to be lower variability in the estimated index values under adaptive learning. The credibility estimates are dragged closer due to recursive

[5]I use an initial window size of twenty observations when OLS estimating the private agents' forecast series utilizing i^T_{t-6} and the announced target rates consistent withe the process of adaptive learning. The estimated credibility index values displayed in VII.6 represents credibility between time t and twenty months earlier. There are no announced inflation targets prior to 1998. Besides, there is data loss during the computation of i^T_{t-6}. Therefore, there are no credibility estimates for the periods prior to Jul'07.

[6]The average credibility is computed excluding the outlier index values reported underneath the Figure VII.6.

estimations undertaken consistent with adaptive learning.

The scatter diagrams of Turkish monetary policy credibility index under rational expectations and adaptive learning are substantially variable across the periods 1998-2005. Nevertheless, the Central Bank of Republic of Turkey was able to come in below its announced inflation targets for four consecutive years during 2002-2005. This indicates that the CBRT was very watchful with regard to perceived credibility and also very conservative in that no matter how bad (or good) the credibility was, the CBRT always acted as though credibility was worse than it was and came in under the announced inflation targets. A truly heroic effort.

CHAPTER VIII

CONCLUSION

The impact of inflation targeting on inflation and expectations is still an open question. Studies focusing on industrialized economies usually reject the hypothesis that inflation targeting matter in reducing inflationary expectations whereas studies on non industrialized economies find a considerable heterogeneity across countries.

This dissertation provides quantitative assessment of a transition to inflation targeting in detail with a focus on the role of expectations in the adjustment process. Counterfactual experiments are conducted to produce measures of inflation pressure to characterize the behavior of inflation expectations during the transition. I analyze the Turkish economy during 1996-2005, a long period of transition. By focusing on a developing country which was not part of the great moderation, I provide detailed evidence for the impact of targeting on inflation expectations in isolation.

I provide statistical evidence accompanied with anecdotal information that the monetary reaction function of the CBRT was subject to structural breaks during the transition to full-fledged inflation targeting. However, the structural model underlying the Turkish economy is shown to be stable during the transition. In order to represent expectations better, I consider empirical application of adaptive learning besides the standard rational expectations approach. I show that neither the model estimates nor the computed inflation pressure indices seem to differ significantly under rational expectations or adaptive learning approach confirming the reliability of the model estimates.

I construct ex ante inflation pressure index on a monthly basis to describe the inflationary environment that was faced by the Central Bank of Republic of Turkey. Ex post inflation pressure index, on the other hand, shows the magnitude of the renaming inflation pressure. Monetary policy effectiveness index is then estimated to assess the effectiveness of the monetary policy conditional on the inflationary environment. I show that, although the inflationary environment during 2002-2005, the semi-formal targeting period, was at least as disadvantageous as it had been during the non inflation targeting period of 1996-2001, the Central Bank of Republic of Turkey was able to reduce inflation from excessive levels to about 8% by the end of 2005. This indicates highly effective monetary policy during the transition to full-fledged targeting.

Some might argue that significant disinflation in a short period of time may be a very costly process. However, in the case of Turkey, the central bank's success in reducing inflation significantly during the semi-formal inflation targeting period (2002-2005), was accompanied by improvements in the real side of the economy as well. It is apparent, using Brazil, Russian, India, and China (BRIC) economies as a basis of comparison, that the Turkish economy had a high growth rate during 2002-2005. Turkey had an average annual GNP (Gross National Product) growth rate of 7.8% whereas the BRIC economies experienced an annual average GDP growth rate about 6.2% during the 2000-2005 period. High growth performance of the Turkish Economy was also maintained in 2006. During 2006, the Turkish economy started implementing full-fledged inflation targeting monetary framework while the economy grew at an annual GNP growth rate of 6%.

It is usually believed that monetary authorities build credibility under inflation targeting regimes. To evaluate this hypothesis and assess the credibility of the Central Bank of Republic of Turkey, I introduced a new measure of monetary policy credibility to the literature. Surprisingly, I found that although the credibility in the disinflation programs of the CBRT and the inflation target announcements was high and rapidly decreasing during 1998-2001, it did not follow a dominant upward or downward pattern overall during the period of 1996-2005.

Successive overshooting of the inflation targets during 1998-2001 and continuous undershooting in the period of 2002-2005 provide strong evidence in favor of the hypothesis that the monetary policy of the Turkish central bank was much more effective in controlling the inflation during the semi-formal inflation targeting than it had been during the period of non targeting monetary frameworks. High credibility estimates at the beginning of non targeting disinflation programs during 1998-2001 seem to indicate the degree of the disbelief of the economic agents in the Turkish central bank's disinflation programs and announced targets during that time and that the poor performance of the monetary policy was fully anticipated. In order to obtain more directly interpretable credibility index values during non targeting periods of pre-2002 periods, moderate artificial inflation targets may be used as benchmarks to evaluate monetary policy credibility. The fact that announcements are not explicitly modeled in the structural model also suggests that new avenues can be explored by incorporating inflation target announcements more explicitly into the structural model recognizing the announcements as important elements in the expectational formation process of the private agents.

Table VIII.1: Rational Expectations Solution, Jan'96-Nov'98

		π_t		y_t		i_t		e_t
	g_0	-0.0089	h_0	0.2620	k_0	-2.9916	s_0	0.4493
π_{t-1}	g_1	0.4067	h_1	-0.0378	k_1	0.1085	s_1	-0.0064
y_{t-1}	g_2	0.0255	h_2	0.3707	k_2	0.1522	s_2	-0.0702
i_{t-1}	g_3	-0.0010	h_3	-0.0040	k_3	0.6129	s_3	-0.0918
e_{t-1}	g_4	0.0562	h_4	0.0233	k_4	-0.0402	s_4	0.5442
π^*_{t-1}	g_5	0.0725	h_5	0.0357	k_5	0.0571	s_5	-0.0067
i^*_{t-1}	g_6	0.0008	h_6	0.0013	k_6	0.0050	s_6	0.0936
π_{t-2}	g_7	...	h_7	0.0019	k_7	0.0003	s_7	-0.0001
y_{t-2}	g_8	0.0700	h_8	0.1886	k_8	0.4170	s_8	-0.0699
y_{t-3}	g_9	0.0233	h_9	-0.0033	k_9	0.1390	s_9	-0.0577
y_{t-4}	g_{10}	0.2096	h_{10}	-0.0057	k_{10}	0.0423	s_{10}	-0.0780
y_{t-5}	g_{11}	-0.0036	h_{11}	-0.0035	k_{11}	2.0082	s_{11}	-0.1175
y_{t-6}	g_{12}	...	h_{12}	0.0000	k_{12}	0.0000	s_{12}	0.0000
i_{t-2}	g_{13}	-0.0001	h_{13}	-0.0047	k_{13}	-0.0007	s_{13}	0.0003
i_{t-3}	g_{14}	-0.0668	h_{14}	-0.0305	k_{14}	-0.0232	s_{14}	0.0030
e_{t-3}	g_{15}	...	h_{15}	-0.0003	k_{15}	0.0000	s_{15}	0.0000
π^*_{t-2}	g_{16}	...	h_{16}	0.0003	k_{16}	0.0001	s_{16}	0.0000
ϵ_t	g_{17}	1.0489	h_{17}	-0.0177	k_{17}	0.2915	s_{17}	-0.0205
η_t	g_{18}	0.0301	h_{18}	1.1576	k_{18}	0.1793	s_{18}	-0.0624
σ_t	g_{19}	-0.0007	h_{19}	-0.0009	k_{19}	0.3772	s_{19}	-0.0220
ν_t	g_{20}	-0.0048	h_{20}	0.0136	k_{20}	-0.0287	s_{20}	1.3480
ϵ^*_t	g_{21}	0.0168	h_{21}	0.0148	k_{21}	0.1002	s_{21}	-0.0109
σ^*_t	g_{22}	0.0017	h_{22}	0.0011	k_{22}	0.0098	s_{22}	0.0590

Note: This table should be read as equations in the form of: $\pi_t = g_0 + g_1\pi_{t-1} + g_2 y_{t-1} + g_3 i_{t-1} + g_4 e_{t-1} + g_5\pi^*_{t-1} + g_6 i^*_{t-1} + g_7\pi_{t-2} + g_8 y_{t-2} + g_9 y_{t-3} + g_{10} y_{t-4} + g_{11} y_{t-5} + g_{12} y_{t-6} + g_{13} i_{t-2} + g_{14} i_{t-3} + g_{15} e_{t-3} + g_{16}\pi^*_{t-2} - g_{17}\epsilon_t - g_{18}\eta_t - g_{19}\sigma_t - g_{20}\nu_t - g_{21}\epsilon^*_t - g_{22}\sigma^*_t$

Table VIII.2: Rational Expectations Solution, Dec'98-Oct'00

	π_t		y_t		i_t		e_t	
	g_0	-0.0764	h_0	0.2118	k_0	6.9606	s_0	-0.9686
π_{t-1}	g_1	0.4069	h_1	-0.0377	k_1	0.1310	s_1	-0.0029
y_{t-1}	g_2	0.0222	h_2	0.3668	k_2	1.5372	s_2	-0.1705
i_{t-1}	g_3	-0.0004	h_3	-0.0033	k_3	0.3721	s_3	-0.0731
e_{t-1}	g_4	0.0563	h_4	0.0234	k_4	-0.1146	s_4	0.5489
π^*_{t-1}	g_5	0.0723	h_5	0.0355	k_5	0.1051	s_5	-0.0115
i^*_{t-1}	g_6	0.0009	h_6	0.0013	k_6	-0.0005	s_6	0.0944
π_{t-2}	g_7	...	h_7	0.0019	k_7	0.0009	s_7	-0.0002
y_{t-2}	g_8	0.0692	h_8	0.1877	k_8	0.5635	s_8	-0.0917
y_{t-3}	g_9	0.0229	h_9	-0.0037	k_9	0.1477	s_9	-0.0700
y_{t-4}	g_{10}	0.2093	h_{10}	-0.0065	k_{10}	0.0035	s_{10}	-0.0992
y_{t-5}	g_{11}	-0.0042	h_{11}	-0.0052	k_{11}	3.3351	s_{11}	-0.1553
y_{t-6}	g_{12}	...	h_{12}	0.0000	k_{12}	0.0000	s_{12}	0.0000
i_{t-2}	g_{13}	-0.0001	h_{13}	-0.0047	k_{13}	-0.0022	s_{13}	0.0006
i_{t-3}	g_{14}	-0.0667	h_{14}	-0.0304	k_{14}	-0.0379	s_{14}	0.0052
e_{t-3}	g_{15}	...	h_{15}	-0.0003	k_{15}	-0.0001	s_{15}	0.0000
π^*_{t-2}	g_{16}	...	h_{16}	0.0003	k_{16}	0.0002	s_{16}	0.0000
ϵ_t	g_{17}	1.0492	h_{17}	-0.0176	k_{17}	0.3712	s_{17}	-0.0174
η_t	g_{18}	0.0266	h_{18}	1.1544	k_{18}	0.5277	s_{18}	-0.1506
σ_t	g_{19}	-0.0008	h_{19}	-0.0012	k_{19}	0.6297	s_{19}	-0.0293
ν_t	g_{20}	-0.0045	h_{20}	0.0139	k_{20}	-0.1698	s_{20}	1.3574
ϵ^*_t	g_{21}	0.0166	h_{21}	0.0145	k_{21}	0.1984	s_{21}	-0.0182
σ^*_t	g_{22}	0.0017	h_{22}	0.0011	k_{22}	0.0105	s_{22}	0.0598

Note: This table should be read as equations in the form of: $\pi_t = g_0 + g_1\pi_{t-1} + g_2 y_{t-1} + g_3 i_{t-1} + g_4 e_{t-1} + g_5\pi^*_{t-1} + g_6 i^*_{t-1} + g_7\pi_{t-2} + g_8 y_{t-2} + g_9 y_{t-3} + g_{10} y_{t-4} + g_{11} y_{t-5} + g_{12} y_{t-6} + g_{13} i_{t-2} + g_{14} i_{t-3} + g_{15} e_{t-3} + g_{16}\pi^*_{t-2} - g_{17}\epsilon_t - g_{18}\eta_t - g_{19}\sigma_t - g_{20}\nu_t - g_{21}\epsilon^*_t - g_{22}\sigma^*_t$

Table VIII.3: Rational Expectations Solution, Mar'01-Sep'03

		π_t		y_t		i_t		e_t
	g_0	-0.0315	h_0	0.2456	k_0	-0.0048	s_0	-0.0183
π_{t-1}	g_1	0.4065	h_1	-0.0377	k_1	0.0660	s_1	-0.0057
y_{t-1}	g_2	0.0272	h_2	0.3716	k_2	0.0989	s_2	-0.0428
i_{t-1}	g_3	-0.0024	h_3	-0.0051	k_3	0.8585	s_3	-0.1237
e_{t-1}	g_4	0.0562	h_4	0.0232	k_4	-0.0245	s_4	0.5434
π^*_{t-1}	g_5	0.0725	h_5	0.0358	k_5	0.0350	s_5	-0.0051
i^*_{t-1}	g_6	0.0008	h_6	0.0013	k_6	0.0031	s_6	0.0936
π_{t-2}	g_7	...	h_7	0.0019	k_7	0.0002	s_7	-0.0001
y_{t-2}	g_8	0.0715	h_8	0.1896	k_8	0.2596	s_8	-0.0388
y_{t-3}	g_9	0.0251	h_9	-0.0020	k_9	0.0911	s_9	-0.0204
y_{t-4}	g_{10}	0.2113	h_{10}	-0.0036	k_{10}	0.0322	s_{10}	-0.0206
y_{t-5}	g_{11}	-0.0013	h_{11}	0.0001	k_{11}	-0.0045	s_{11}	-0.0273
y_{t-6}	g_{12}	-0.0016	h_{12}	-0.0016	k_{12}	0.5526	s_{12}	-0.0435
i_{t-2}	g_{13}	-0.0001	h_{13}	-0.0047	k_{13}	-0.0005	s_{13}	0.0002
i_{t-3}	g_{14}	-0.0668	h_{14}	-0.0305	k_{14}	-0.0143	s_{14}	0.0022
e_{t-3}	g_{15}	...	h_{15}	-0.0003	k_{15}	0.0000	s_{15}	0.0000
π^*_{t-2}	g_{16}	...	h_{16}	0.0003	k_{16}	0.0000	s_{16}	0.0000
ϵ_t	g_{17}	1.0489	h_{17}	-0.0175	k_{17}	0.1774	s_{17}	-0.0173
η_t	g_{18}	0.0315	h_{18}	1.1583	k_{18}	0.1145	s_{18}	-0.0407
σ_t	g_{19}	-0.0004	h_{19}	-0.0004	k_{19}	0.1314	s_{19}	-0.0103
ν_t	g_{20}	-0.0048	h_{20}	0.0136	k_{20}	-0.0175	s_{20}	1.3473
ϵ^*_t	g_{21}	0.0169	h_{21}	0.0149	k_{21}	0.0613	s_{21}	-0.0086
σ^*_t	g_{22}	0.0017	h_{22}	0.0011	k_{22}	0.0060	s_{22}	0.0592

Note: This table should be read as equations in the form of: $\pi_t = g_0 + g_1\pi_{t-1} + g_2 y_{t-1} + g_3 i_{t-1} + g_4 e_{t-1} + g_5\pi^*_{t-1} + g_6 i^*_{t-1} + g_7\pi_{t-2} + g_8 y_{t-2} + g_9 y_{t-3} + g_{10} y_{t-4} + g_{11} y_{t-5} + g_{12} y_{t-6} + g_{13} i_{t-2} + g_{14} i_{t-3} + g_{15} e_{t-3} + g_{16}\pi^*_{t-2} - g_{17}\epsilon_t - g_{18}\eta_t - g_{19}\sigma_t - g_{20}\nu_t - g_{21}\epsilon^*_t - g_{22}\sigma^*_t$

Table VIII.4: Rational Expectations Solution, Oct'03-Dec'05

		π_t		y_t		i_t		e_t
	g_0	-0.0332	h_0	0.2445	k_0	0.1328	s_0	-0.0506
π_{t-1}	g_1	0.4068	h_1	-0.0375	k_1	0.0019	s_1	0.0010
y_{t-1}	g_2	0.0278	h_2	0.3715	k_2	0.2730	s_2	-0.0421
i_{t-1}	g_3	-0.0030	h_3	-0.0055	k_3	0.9251	s_3	-0.1361
e_{t-1}	g_4	0.0561	h_4	0.0232	k_4	-0.0152	s_4	0.5421
π^*_{t-1}	g_5	0.0726	h_5	0.0358	k_5	0.0188	s_5	-0.0032
i^*_{t-1}	g_6	0.0008	h_6	0.0013	k_6	0.0011	s_6	0.0937
π_{t-2}	g_7	...	h_7	0.0019	k_7	0.0004	s_7	-0.0001
y_{t-2}	g_8	0.0729	h_8	-0.0015	k_8	0.0177	s_8	-0.0016
y_{t-3}	g_9	0.0262	h_9	-0.0014	k_9	0.0176	s_9	-0.0016
y_{t-4}	g_{10}	0.2125	h_{10}	-0.0029	k_{10}	0.0041	s_{10}	-0.0002
y_{t-5}	g_{11}	...	h_{11}	0.0010	k_{11}	0.0002	s_{11}	0.0000
y_{t-6}	g_{12}	...	h_{12}	...	k_{12}	...	s_{12}	...
i_{t-2}	g_{13}	-0.0001	h_{13}	-0.0047	k_{13}	-0.0009	s_{13}	0.0002
i_{t-3}	g_{14}	-0.0669	h_{14}	-0.0306	k_{14}	-0.0072	s_{14}	0.0014
e_{t-3}	g_{15}	...	h_{15}	-0.0003	k_{15}	-0.0001	s_{15}	0.0000
π^*_{t-2}	g_{16}	...	h_{16}	0.0003	k_{16}	0.0001	s_{16}	0.0000
ϵ_t	g_{17}	1.0495	h_{17}	-0.0169	k_{17}	0.0180	s_{17}	-0.0004
η_t	g_{18}	0.0316	h_{18}	1.1579	k_{18}	0.2165	s_{18}	-0.0498
σ_t	g_{19}	-0.0002	h_{19}	-0.0002	k_{19}	0.0648	s_{19}	-0.0056
ν_t	g_{20}	-0.0049	h_{20}	0.0135	k_{20}	-0.0030	s_{20}	1.3450
ϵ^*_t	g_{21}	0.0170	h_{21}	0.0150	k_{21}	0.0341	s_{21}	-0.0054
σ^*_t	g_{22}	0.0017	h_{22}	0.0011	k_{22}	0.0020	s_{22}	0.0595

Note: This table should be read as equations in the form of: $\pi_t = g_0 + g_1\pi_{t-1} + g_2 y_{t-1} + g_3 i_{t-1} + g_4 e_{t-1} + g_5\pi^*_{t-1} + g_6 i^*_{t-1} + g_7\pi_{t-2} + g_8 y_{t-2} + g_9 y_{t-3} + g_{10} y_{t-4} + g_{11} y_{t-5} + g_{12} y_{t-6} + g_{13} i_{t-2} + g_{14} i_{t-3} + g_{15} e_{t-3} + g_{16}\pi^*_{t-2} - g_{17}\epsilon_t - g_{18}\eta_t - g_{19}\sigma_t - g_{20}\nu_t - g_{21}\epsilon^*_t - g_{22}\sigma^*_t$

Table VIII.5: EPIP, EAIP, and MPE under Rational Expectations

Jan'1996 - Dec'2001

	EPIP	EAIP	MPE		EPIP	EAIP	MPE
1996:1	...	...	...	1999:1	1.50	1.50	0.00
1996:2	...	...	...	1999:2	-1.53	-1.52	1.00
1996:3	...	...	...	1999:3	0.89	0.89	-0.01
1996:4	...	...	...	1999:4	0.82	0.82	0.00
1996:5	...	...	...	1999:5	-1.81	-1.81	1.00
1996:6	...	...	...	1999:6	0.34	0.34	0.00
1996:7	...	...	...	1999:7	0.59	0.59	0.00
1996:8	...	...	...	1999:8	0.41	0.41	0.00
1996:9	0.51	0.51	0.00	1999:9	1.73	1.73	0.00
1996:10	0.72	0.71	0.00	1999:10	0.36	0.36	0.00
1996:11	-1.24	-1.23	1.01	1999:11	-1.98	-1.98	1.00
1996:12	-1.70	-1.69	1.00	1999:12	1.70	1.70	0.00
1997:1	2.35	2.36	0.00	2000:1	-0.99	-0.99	1.00
1997:2	-0.20	-0.21	0.98	2000:2	-1.06	-1.06	1.00
1997:3	-0.25	-0.24	1.02	2000:3	-0.72	-0.72	1.00
1997:4	1.16	1.15	0.00	2000:4	-0.54	-0.54	1.00
1997:5	-1.82	-1.82	1.00	2000:5	-0.06	-0.07	0.88
1997:6	-1.74	-1.74	1.00	2000:6	-1.48	-1.48	1.00
1997:7	3.25	3.25	0.00	2000:7	1.58	1.58	0.00
1997:8	-0.04	-0.04	1.23	2000:8	-0.04	-0.02	1.44
1997:9	1.06	1.06	0.00	2000:9	0.92	0.91	-0.01
1997:10	0.96	0.97	0.00	2000:10	0.06	0.06	0.08
1997:11	-1.56	-1.56	1.00	2000:11	...	...	...
1997:12	-1.38	-1.38	1.00	2000:12	...	...	...
1998:1	1.99	1.99	0.00	2001:1	...	...	...
1998:2	-2.62	-2.62	1.00	2001:2	...	...	...
1998:3	-0.07	-0.07	1.00	2001:3	...	...	...
1998:4	0.38	0.38	0.00	2001:4	...	...	...
1998:5	-1.08	-1.08	1.00	2001:5	...	...	...
1998:6	-1.00	-1.00	1.00	2001:6	...	...	...
1998:7	0.94	0.94	0.00	2001:7	...	...	...
1998:8	0.62	0.62	0.00	2001:8	...	...	...
1998:9	2.67	2.66	0.00	2001:9	...	...	...
1998:10	-0.59	-0.59	0.99	2001:10	0.25	-0.47	-0.53
1998:11	-1.63	-1.63	1.00	2001:11	-1.68	-2.35	0.72
1998:12	-0.93	-0.93	1.00	2001:12	-0.90	-1.19	0.75

Notes: EPIP is the ex ante inflation pressure. EAIP is the ex ante inflation pressure. MPE is the monetary policy effectiveness.

Table VIII.6: EPIP, EAIP, and MPE under Rational Expectations

Jan'2002 - Dec'2005

	EPIP	EAIP	MPE		EPIP	EAIP	MPE
2002:1	2.09	2.13	0.02	2005:1	0.26	0.31	0.16
2002:2	-3.37	-3.49	0.96	2005:2	-0.51	-0.47	1.09
2002:3	-0.48	-0.46	1.04	2005:3	0.26	0.29	0.09
2002:4	0.93	1.16	0.20	2005:4	0.47	0.51	0.08
2002:5	-1.38	-1.15	1.20	2005:5	0.22	0.19	-0.13
2002:6	0.09	0.28	0.69	2005:6	-0.79	-0.87	0.91
2002:7	0.93	0.93	0.00	2005:7	-0.66	-0.67	0.99
2002:8	0.81	0.63	-0.29	2005:8	1.44	1.46	0.02
2002:9	1.34	1.00	-0.35	2005:9	0.18	0.20	0.10
2002:10	-0.10	-0.26	0.38	2005:10	0.77	0.84	0.08
2002:11	-0.28	-0.26	1.07	2005:11	-0.37	-0.27	1.36
2002:12	-1.16	-1.04	1.12	2005:12	-0.96	-0.83	1.16
2003:1	1.01	1.11	0.10				
2003:2	-0.95	-0.86	1.10				
2003:3	0.49	0.62	0.20				
2003:4	-0.89	-0.78	1.13				
2003:5	0.04	0.13	0.67				
2003:6	-0.80	-0.63	1.27				
2003:7	-0.20	0.00	67.57				
2003:8	0.41	0.59	0.30				
2003:9	1.24	1.28	0.03				
2003:10	-0.36	-0.49	0.73				
2003:11	0.40	0.17	-1.36				
2003:12	-0.78	-1.11	0.70				
2004:1	0.29	0.03	-10.1				
2004:2	-0.10	-0.48	0.21				
2004:3	0.49	0.29	-0.70				
2004:4	-0.42	-0.52	0.80				
2004:5	-0.03	-0.05	0.58				
2004:6	-0.52	-0.51	1.03				
2004:7	0.64	0.57	-0.12				
2004:8	0.31	0.37	0.16				
2004:9	0.21	0.33	0.36				
2004:10	1.30	1.48	0.12				
2004:11	-0.89	-0.71	1.25				
2004:12	-0.96	-0.79	1.22				

Notes: EPIP is the ex ante inflation pressure. EAIP is the ex ante inflation pressure. MPE is the monetary policy effectiveness.

Table VIII.7: EPIP, EAIP, and MPE under Adaptive Learning

Jan'1996 - Dec'2001

	EPIP	EAIP	MPE		EPIP	EAIP	MPE
1996:1	...	...	...	1999:1	1.50	1.49	0.00
1996:2	...	...	...	1999:2	-1.52	-1.50	1.02
1996:3	...	...	...	1999:3	0.89	0.96	0.07
1996:4	...	...	...	1999:4	0.82	0.94	0.13
1996:5	...	...	...	1999:5	-1.81	-1.91	0.95
1996:6	...	...	...	1999:6	0.34	0.23	-0.49
1996:7	...	...	...	1999:7	0.59	0.62	0.05
1996:8	...	...	...	1999:8	0.41	0.40	-0.03
1996:9	...	...	...	1999:9	1.73	1.68	-0.03
1996:10	...	...	...	1999:10	0.36	0.44	0.17
1996:11	...	...	...	1999:11	-1.98	-1.89	1.04
1996:12	...	...	...	1999:12	1.70	1.59	-0.07
1997:1	...	...	...	2000:1	-0.99	-0.99	1.00
1997:2	...	...	...	2000:2	-1.06	-1.07	0.99
1997:3	...	...	...	2000:3	-0.72	-0.67	1.07
1997:4	...	...	...	2000:4	-0.54	-0.50	1.09
1997:5	...	...	...	2000:5	-0.07	-0.12	0.56
1997:6	...	...	...	2000:6	-1.48	-1.23	1.21
1997:7	...	...	...	2000:7	1.58	1.55	-0.02
1997:8	-0.04	-0.22	0.20	2000:8	-0.03	-0.12	0.29
1997:9	1.06	1.10	0.03	2000:9	0.91	0.96	0.05
1997:10	0.96	0.95	-0.02	2000:10	0.06	0.09	0.37
1997:11	-1.56	-1.49	1.04	2000:11	...	...	...
1997:12	-1.38	-1.48	0.93	2000:12	...	...	...
1998:1	1.99	1.96	-0.02	2001:1	...	...	...
1998:2	-2.62	-2.53	1.03	2001:2	...	...	...
1998:3	-0.07	-0.10	0.72	2001:3	...	...	...
1998:4	0.38	0.50	0.23	2001:4	...	...	...
1998:5	-1.08	-1.08	1.00	2001:5	...	...	...
1998:6	-1.00	-1.09	0.92	2001:6	...	...	...
1998:7	0.94	1.05	0.11	2001:7	...	...	...
1998:8	0.62	0.51	-0.22	2001:8	...	...	...
1998:9	2.67	2.66	0.00	2001:9	...	...	...
1998:10	-0.59	-0.52	1.12	2001:10	0.23	0.02	0.89
1998:11	-1.63	-1.59	1.02	2001:11	-1.70	-1.79	0.95
1998:12	-0.93	-1.03	0.90	2001:12	-0.90	-0.77	1.17

Notes: EPIP is the ex ante inflation pressure. EAIP is the ex ante inflation pressure. MPE is the monetary policy effectiveness.

Table VIII.8: EPIP, EAIP, and MPE under Adaptive Learning

Jan'2002 - Dec'2005

	EPIP	EAIP	MPE		EPIP	EAIP	MPE
2002:1	2.09	1.92	-0.09	2005:1	0.26	0.26	-0.01
2002:2	-3.37	-3.03	1.11	2005:2	-0.51	-0.44	1.17
2002:3	-0.48	-0.63	0.75	2005:3	0.26	0.24	-0.07
2002:4	0.94	1.06	0.12	2005:4	0.47	0.52	0.10
2002:5	-1.37	-1.38	1.00	2005:5	0.22	0.21	-0.06
2002:6	0.09	0.06	-0.57	2005:6	-0.79	-0.91	0.88
2002:7	0.93	0.83	-0.12	2005:7	-0.66	-0.64	1.04
2002:8	0.81	0.74	-0.10	2005:8	1.44	1.42	-0.02
2002:9	1.34	1.39	0.04	2005:9	0.18	0.14	-0.28
2002:10	-0.11	-0.14	0.77	2005:10	0.77	0.89	0.14
2002:11	-0.28	-0.25	1.13	2005:11	-0.37	-0.47	0.79
2002:12	-1.16	-1.06	1.09	2005:12	-0.96	-0.99	0.97
2003:1	1.01	0.82	-0.23				
2003:2	-0.95	-0.88	1.08				
2003:3	0.50	0.60	0.17				
2003:4	-0.88	-1.00	0.88				
2003:5	0.04	0.14	0.68				
2003:6	-0.80	-0.82	0.97				
2003:7	-0.20	-0.24	0.82				
2003:8	0.42	0.42	0.00				
2003:9	1.24	1.17	-0.07				
2003:10	-0.36	-0.27	1.35				
2003:11	0.39	0.35	-0.13				
2003:12	-0.79	-0.85	0.92				
2004:1	0.29	0.41	0.31				
2004:2	-0.10	-0.10	0.98				
2004:3	0.48	0.49	0.01				
2004:4	-0.42	-0.37	1.13				
2004:5	-0.03	-0.08	0.35				
2004:6	-0.52	-0.54	0.97				
2004:7	0.64	0.49	-0.30				
2004:8	0.31	0.33	0.03				
2004:9	0.21	0.27	0.20				
2004:10	1.30	1.27	-0.03				
2004:11	-0.89	-0.82	1.09				
2004:12	-0.96	-1.01	0.95				

Notes: EPIP is the ex ante inflation pressure. EAIP is the ex ante inflation pressure. MPE is the monetary policy effectiveness.

Table VIII.9: XIFC, XITC, and MPCI under Rational Expectations

	XIFC	XITC	MPCI		XIFC	XITC	MPCI
1998:12	0.25	-0.93	-3.79	2002:12	-0.60	-1.16	1.92
1999:1	0.93	1.50	1.62	2003:1	0.37	1.01	2.75
1999:2	-0.60	-1.53	2.55	2003:2	-0.69	-0.95	1.37
1999:3	1.13	0.89	0.79	2003:3	0.36	0.49	1.36
1999:4	0.11	0.82	7.49	2003:4	-0.11	-0.89	8.10
1999:5	-0.84	-1.81	2.17	2003:5	0.72	0.04	0.06
1999:6	0.92	0.34	0.37	2003:6	0.51	-0.80	-1.58
1999:7	0.20	0.59	2.91	2003:7	1.40	-0.20	-0.15
1999:8	-0.32	0.41	-1.30	2003:8	1.23	0.41	0.34
1999:9	-0.54	1.73	-3.21	2003:9	1.14	1.24	1.09
1999:10	-2.25	0.36	-0.16	2003:10	-0.05	-0.36	7.15
1999:11	-2.31	-1.98	0.86	2003:11	0.25	0.40	1.57
1999:12	-0.09	1.70	-18.86	2003:12	-0.16	-0.78	4.81
2000:1	-1.82	-0.99	0.55	2004:1	0.60	0.29	0.48
2000:2	-0.99	-1.06	1.08	2004:2	0.26	-0.10	-0.39
2000:3	0.37	-0.72	-1.95	2004:3	0.53	0.49	0.92
2000:4	1.13	-0.54	-0.48	2004:4	0.02	-0.42	-21.85
2000:5	1.75	-0.06	-0.04	2004:5	0.23	-0.03	-0.13
2000:6	1.82	-1.48	-0.81	2004:6	0.53	-0.52	-0.99
2000:7	2.96	1.58	0.53	2004:7	0.88	0.64	0.73
2000:8	1.66	-0.04	-0.02	2004:8	0.03	0.31	12.47
2000:9	1.82	0.92	0.50	2004:9	0.13	0.21	1.67
2000:10	1.03	0.06	0.06	2004:10	-0.13	1.30	-9.76
				2004:11	-1.40	-0.89	0.64
2001:10	-4.94	0.25	-0.05	2004:12	-0.47	-0.96	2.06
2001:11	-3.25	-1.68	0.52	2005:1	0.46	0.26	0.56
2001:12	-1.20	-0.90	0.75	2005:2	0.04	-0.51	-13.18
2002:1	0.17	2.09	12.61	2005:3	0.66	0.26	0.40
2002:2	-1.92	-3.37	1.76	2005:4	0.29	0.47	1.61
2002:3	1.59	-0.48	-0.30	2005:5	-0.27	0.22	-0.82
2002:4	2.06	0.93	0.45	2005:6	-0.30	-0.79	2.63
2002:5	1.12	-1.38	-1.23	2005:7	0.32	-0.66	-2.09
2002:6	2.30	0.09	0.04	2005:8	0.91	1.44	1.58
2002:7	2.21	0.93	0.42	2005:9	-0.28	0.18	-0.65
2002:8	1.07	0.81	0.76	2005:10	-0.45	0.77	-1.70
2002:9	0.68	1.34	1.97	2005:11	-1.20	-0.37	0.31
2002:10	-0.61	-0.10	0.16	2005:12	-0.83	-0.96	1.16
2002:11	-0.73	-0.28	0.39				

Notes: Estimates for Dec'1998 - Dec'2005. XIFC measures the change in expectations of inflation under full credibility. XITC measures the change in expectations of inflation under true credibility. MPCI is the monetary policy credibility index.

Table VIII.10: XIFC, XITC, and MPCI under Adaptive Learning

	XIFC	XITC	MPCI		XIFC	XITC	MPCI
1998:12	...	-0.99	...	2002:10	2.01	-0.15	-0.08
1999:1	...	1.55	...	2002:11	1.96	-0.43	-0.22
1999:2	...	-1.65	...	2002:12	1.92	-1.25	-0.65
1999:3	...	0.86	...	2003:1	2.10	0.94	0.45
1999:4	...	0.82	...	2003:2	1.17	-1.01	-0.86
1999:5	...	-1.94	...	2003:3	1.69	0.43	0.25
1999:6	...	0.31	...	2003:4	1.21	-1.02	-0.84
1999:7	...	0.57	...	2003:5	1.96	-0.03	-0.01
1999:8	...	0.39	...	2003:6	2.09	-0.86	-0.41
1999:9	...	1.77	...	2003:7	3.37	-0.30	-0.09
1999:10	...	0.33	...	2003:8	3.36	0.33	0.10
1999:11	...	-2.11	...	2003:9	3.00	1.22	0.41
1999:12	...	1.74	...	2003:10	1.64	-0.43	-0.27
2000:1	...	-1.10	...	2003:11	1.92	0.35	0.18
2000:2	...	-1.14	...	2003:12	1.10	-0.85	-0.77
2000:3	...	-0.79	...	2004:1	1.30	0.23	0.18
2000:4	...	-0.59	...	2004:2	1.43	-0.16	-0.11
2000:5	...	-0.11	...	2004:3	1.59	0.45	0.28
2000:6	...	-1.54	...	2004:4	0.95	-0.45	-0.48
2000:7	4.86	1.49	0.31	2004:5	1.48	-0.07	-0.05
2000:8	3.11	-0.07	-0.02	2004:6	1.08	-0.53	-0.49
2000:9	3.21	0.88	0.27	2004:7	1.53	0.61	0.40
2000:10	2.33	0.02	0.01	2004:8	1.53	0.25	0.16
				2004:9	1.09	0.22	0.20
2001:3	2.53	4.25	1.68	2004:10	0.84	1.28	1.52
2001:4	-1.62	4.28	-2.65	2004:11	-0.26	-0.95	3.64
				2004:12	0.77	-0.97	-1.26
2001:9	1.26	2.87	2.28	2005:1	1.19	0.22	0.19
2001:10	-1.72	0.20	-0.11	2005:2	0.72	-0.51	-0.71
2001:11	-1.78	-1.88	1.05	2005:3	1.14	0.21	0.19
2001:12	0.29	-0.99	-3.44	2005:4	1.00	0.44	0.44
2002:1	2.91	2.10	0.72	2005:5	0.47	0.22	0.47
2002:2	0.46	-3.63	-7.89	2005:6	0.33	-0.81	-2.46
2002:3	4.41	-0.55	-0.12	2005:7	1.09	-0.66	-0.60
2002:4	4.33	0.85	0.20	2005:8	1.51	1.41	0.94
2002:5	3.30	-1.37	-0.41	2005:9	0.38	0.16	0.42
2002:6	4.55	-0.06	-0.01	2005:10	0.05	0.77	15.95
2002:7	4.45	0.88	0.20	2005:11	-0.67	-0.37	0.55
2002:8	3.50	0.75	0.21	2005:12	-0.11	-0.99	9.14
2002:9	2.98	1.28	0.43				

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APPENDIX

A.1 Technical Appendix to IV

In order to derive ex ante inflation formulae, the expectation terms, $E_t\pi_{t+1}$, $E_{t-1}\pi_t$, $E_{t-2}\pi_{t-1}$, and $E_{t-1}y_t$ that appear in (IV.7) must be expressed in terms of i_{t-2} and earlier. I use the MSV solutions, (VII.8)-(VII.10), and make enough successive backward substitutions until all variables are written in terms of variables dated at $t-2$ and earlier. I begin by expressing $E_t\pi_{t+1}$ in terms i_{t-2} and earlier. From (VII.8), $E_t\pi_{t+1}$ can be shown as

$$E_t\pi_{t+1} = g_0 + g_1\pi_t + g_2y_t + g_3i_t \tag{A.1}$$

where $E_t\epsilon_{t+1} = E_t\eta_{t+1} = E_t\sigma_{t+1} = 0$.

Substituting the MSV solutions, (VII.8)-(VII.10), into (A.1) produces:

$$\begin{aligned} E_t\pi_{t+1} \quad = \quad & g_0 + g_1[g_0 + g_1\pi_{t-1} + g_2y_{t-1} + g_3i_{t-1} + g_4\epsilon_t + g_5\eta_t + g_6\sigma_t] \\ & + g_2[h_0 + h_1\pi_{t-1} + h_2y_{t-1} + h_3i_{t-1} + h_4\epsilon_t + h_5\eta_t + h_6\sigma_t] \\ & + g_3[k_0 + k_1\pi_{t-1} + k_2y_{t-1} + k_3i_{t-1} + k_4\epsilon_t + k_5\eta_t + k_6\sigma_t] \end{aligned} \tag{A.2}$$

Collecting the common terms yields

$$E_t\pi_{t+1} = G_0 + G_1\pi_{t-1} + G_2y_{t-1} + G_3i_{t-1} \tag{A.3}$$

where

$$\begin{aligned}
G_0 &= g_0 + g_1 g_0 + g_2 h_0 + g_3 k_0 \\
G_1 &= g_1^2 + g_2 h_1 + g_3 k_1 \\
G_2 &= g_1 g_2 + g_2 h_2 + g_3 k_2 \\
G_3 &= g_1 g_3 + g_2 h_3 + g_3 k_3
\end{aligned}$$

Lagging the MSV solutions one period and inserting them into (A.3) gives:

$$\begin{aligned}
E_t\pi_{t+1} &= G_0 + G_1[g_0 + g_1\pi_{t-2} + g_2 y_{t-2} + g_3 i_{t-2} + g_4\epsilon_{t-1} + g_5\eta_{t-1} + g_6\sigma_{t-1}] \\
&\quad + G_2[h_0 + h_1\pi_{t-2} + h_2 y_{t-2} + h_3 i_{t-2} + h_4\epsilon_{t-1} + h_5\eta_{t-1} + h_6\sigma_{t-1}] \\
&\quad + G_3[k_0 + k_1\pi_{t-2} + k_2 y_{t-2} + k_3 i_{t-2} + k_4\epsilon_{t-1} + k_5\eta_{t-1} + k_6\sigma_{t-1}]
\end{aligned}$$

Collecting the common terms yields

$$E_t\pi_{t+1} = Q_0 + Q_1\pi_{t-2} + Q_2 y_{t-2} + Q_3 i_{t-2} + Q_4\epsilon_{t-1} + Q_5\eta_{t-1} + Q_6\sigma_{t-1} \tag{A.5}$$

where

$$\begin{aligned}
Q_0 &= G_0 + G_1 g_0 + G_2 h_0 + G_3 k_0 \\
Q_1 &= G_1 g_1 + G_2 h_1 + G_3 k_1 \\
Q_2 &= G_1 g_2 + G_2 h_2 + G_3 k_2 \\
Q_3 &= G_1 g_3 + G_2 h_3 + G_3 k_3 \\
Q_4 &= G_1 g_4 + G_2 h_4 + G_3 k_4 \\
Q_5 &= G_1 g_5 + G_2 h_5 + G_3 k_5 \\
Q_6 &= G_1 g_6 + G_2 h_6 + G_3 k_6
\end{aligned}$$

Similarly, I obtain

$$
\begin{aligned}
E_{t-1}\pi_t &= G_0 + G_1\pi_{t-1} + G_2 y_{t-1} + G_3 i_{t-1} && \text{(A.6)}\\
E_{t-2}\pi_{t-1} &= g_0 + g_1\pi_{t-2} + g_2 y_{t-2} + g_3 i_{t-2} && \text{(A.7)}\\
E_{t-1}y_t &= H_0 + H_1\pi_{t-2} + H_2 y_{t-2} + H_3 i_{t-2} && \text{(A.8)}\\
E_{t-2}[E_{t-1}y_t] &= H_0 + H_1\pi_{t-2} + H_2 y_{t-2} + H_3 i_{t-2} && \text{(A.9)}
\end{aligned}
$$

where

$$
\begin{aligned}
H_0 &= h_0 + h_1 g_0 + h_2 h_0 + h_3 k_0\\
H_1 &= h_1 g_1 + h_2 h_1 + h_3 k_1\\
H_2 &= h_1 g_2 + h_2 h_2 + h_3 k_2\\
H_3 &= h_1 g_3 + h_2 h_3 + h_3 k_3
\end{aligned}
$$

Substituting (A.9), $E_{t-2}\pi_t = \pi_t^T$, $E_{t-2}[\pi_{t-1}] = \pi_{t-1}^T$, and $E_{t-2}[E_t\pi_{t+1}] = \pi_{t+1}^T$ into (IV.20) yields

$$
\pi_t^T = \Lambda_0 + \Lambda_1\pi_{t-2} + \Lambda_2 y_{t-2} + \Lambda_3 i_{t-2}^T + \Lambda_4\pi_{t-1}^T + \Lambda_5\pi_{t+1}^T \tag{A.10}
$$

where

$$
\begin{aligned}
\Lambda_0 &= \alpha_0 + \alpha_3(\beta_0 + \beta_2 H_0)\\
\Lambda_1 &= \alpha_3\beta_2 H_2\\
\Lambda_2 &= \alpha_3(\beta_1 + \beta_2 H_1)\\
\Lambda_3 &= \alpha_3(\beta_2 H_3 - \beta_3)\\
\Lambda_4 &= \alpha_1 + \alpha_3\beta_3\\
\Lambda_5 &= \alpha_2
\end{aligned}
$$

Rearranging the terms in (A.10) and solving for i_{t-2}^{T} gives

$$i_{t-2}^{T} = \frac{1}{\Lambda_3}\left\{\pi_t^T - \Lambda_0 - \Lambda_1\pi_{t-2} - \Lambda_2 y_{t-2} - \Lambda_4\pi_{t-1}^T - \Lambda_5\pi_{t+1}^T\right\} \tag{A.11}$$

A.2 Multiple Structural Change Analysis

This section is built upon Bai and Perron (1998, 2003) and borrows extensively from Brady's (2008) eloquent summary on how to set up the problem and conduct the methodology to estimate multiple break dates at unknown dates. Bai and Perron (1998, 2003) use the following multiple linear regression model with m structural breaks (m+1 regime):

$$y_t = x_t^{'}\beta + z_t^{'}\delta_j + u_t \qquad t = T_{j-1}+1, \ldots T_j \tag{A.12}$$

for $j = 1, \ldots, m+1$. In this model, y_t is the observed dependent variable at time t, $x_t\,(px1)$, and $z_t\,(qx1)$ are vectors of regressors, β and δ_j are the corresponding vectors of coefficients, and u_t is the disturbance at time t. Equation (A.12) posits a partial structural change model since the parameter vector β is not subject to shifts and is estimated using the entire sample. If $p = 0$, equation (A.12) turns into complete structural change model in which all of the coefficients are allowed to change across m-partitions $(T_1, \ldots, T_m)$. A complete structural change model, which I use in this research, with m breaks can be written as

$$y_t = z_t^{'}\delta_j + u_t \qquad t = T_{j-1}+1, \ldots T_j \tag{A.13}$$

Given the complete structural change model, the associated least squares estimates for δ_j for a given m-partition $(T_1, \ldots, T_m)$ are obtained by minimizing the sum of squared residuals

$$\sum_{i=1}^{m+1} \sum_{t=T_{i-1}+1}^{T_i} [y_t - z_t^{'}\delta_i]^2$$

Once $\hat{\delta}_j$ are estimated for a given m-partition $(T_1, \ldots, T_m)$, Bai and Perron (1998, 2003) suggests two techniques to locate structural break dates.

In the first, global, approach, m, the number of breaks, is obtained as the one that minimizes the resulting sum of square residuals, $S_T(T_1, \ldots, T_m)$, obtained by substituting the estimators, $\hat{\delta}_j$, into the objective function. That is to say, the estimates for break point locations are determined by $(\hat{T}_1, \ldots, \hat{T}_m) = argmin_{T_1,\ldots,T_m} S_T(T_1, \ldots, T_m)$, where the minimization is taken over all partitions. Thus, in the first approach, the break-point estimators are global minimizers of the objective function.

In the second approach, break dates are determined sequentially, starting with the single break date that minimizes the sum of square residuals. Then the whole sample is broken at the estimated break date into two partitions to test for other structural breaks within each of the resulting partitions. The second break date is the one that minimizes the sum of square residuals within each partition and has the lower sum of square residuals across the two partitions. Next, the whole sample is split at the second break date into two new partitions to continue searching for other structural breaks in a similar fashion in the second round. The process of searching for structural break dates is repeated sequentially to find all break dates regardless of whether the determined break dates are statistically significant or not[1].

[1]Bai and Perron's (1998, 2003) sequential approach is different than the Altissimo and Corradi's (2003) sequential methodology where the focus is switched on the statistical significance of the break dates. Altissimo and Corradi first find the single break that minimizes the sum of square residuals. If this break is found to be statistically significant, then they move to find the second break, given the existence and location of the first break that minimize the sum of squared residuals, and so forth.

In practice, Bai and Perron provide a much more detailed explanation using matrix algebra and then explain the method for optimizing over each partition. Hence, I refer the reader to Bai and Perron (1998, 2003) for more details.

The $supF(m|0)$ and $supF(m+1|m)$ tests for choosing break dates

Bai and Perron (1998, 2003) recommend choosing the break dates by testing the null hypothesis of $m = 0$ breaks versus the alternative of $m = k$ breaks. In practice, this is done by evaluating $supF(m|0)$ and $supF(k+1|k)$ tests. Based on the application of these tests, one can then choose the number of breaks, and hence, the final model. $SupF(m|0)$ is a generalized version of the $supF$ test detailed in Andrews (1993) for testing multiple structural breaks. The $supF$ test is motivated by the fact that in a hypothesis test of structural change, the break point, T_j, appears as a parameter under the alternative hypothesis but not the null. Therefore, the usual Wald, LM, or LR-statistics fail to have the standard asymptotic properties[2]. In practice, $supF(m|0)$ is constructed for every possible m-partition and compared to the asymptotic critical values provided by Bai and Perron (1998).

In addition, the $supF(k+1|k)$ test provides a refined version of the $supF$ test for detecting the presence of $k+1$ breaks conditional on existing k breaks. The $supF(k+1|k)$ test is a sequential method for choosing the number of breaks following the initial $supF$ test signaling statistical evidence for the existence of at least one break. In practice, one can choose the number of breaks first by checking $supF(m|0)$ and confirm that there is at least one break. If so, then the largest k can be found where the $supF(k+1|k)$ value is no longer significant based on the asymptotic critical values provided by Bai and Perron (1998). For example, if $supF(2|1)$ is significant,

[2]Refer to Andrews (1993), Andrews, Lee, and Ploberger (1996) for a detailed discussion on this issue.

this suggests that there are two breaks, given one break has been found. If the next test, if $supF(3|2)$ is insignificant, then one can conclude that there are, in fact, only two breaks given the two breaks confirmed by $supF$ test.

A.3 The Model

The model consists of four structural equations, Phillips and IS curves, an Uncovered Interest Parity (UIP) condition, and monetary policy reaction function. Phillips and IS curve equations, and the UIP condition are identical across periods throughout the period of 1996m1-2005m12, whereas the monetary reaction functions differ across periods of 1996m1-1998m11, 1998m12-2000m10, 2001m3-2003m9, and 2003m10-2005m12, due to the structural breaks found in the data.

The Phillips curve is given by

$$\pi_t = \alpha_0 + \alpha_1 \pi_{t-1} + \alpha_2 E_t \pi_{t+2} + \alpha_3 y_{t-4} - \alpha_4 [\pi_{t-1} - \pi^*_{t-1} - (e_{t-1} - e_{t-2})] + \epsilon_t \tag{A.14}$$

The IS curve is given by

$$\begin{aligned} y_t &= \beta_0 + \beta_1 y_{t-1} + \beta_2 y_{t-2} + \beta_3 E_t y_{t+1} + \beta_4 [i_{t-2} - E_{t-2}\pi_{t-1}] \\ &\quad - \beta_5 [\pi_{t-1} - \pi^*_{t-1} - (e_{t-1} - e_{t-2})] + \eta_t \end{aligned} \tag{A.15}$$

The monetary policy reaction function for each period is given by

Period I, 1996m1-1998m11 :

$$i_t = \rho i_{t-1} + (1-\rho)\left[\gamma_0 + \gamma_\pi E_t \pi_{t+2} + \gamma_y y_{t-5} + \sigma_t\right] \tag{A.16}$$

Period II, 1998m12-2000m10 :

$$i_t = \rho i_{t-1} + (1-\rho)\left[\gamma_0 + \gamma_\pi E_t \pi_{t+3} + \gamma_y y_{t-5} + \sigma_t\right] \tag{A.17}$$

Period III, 2001m3-2003m9 :

$$i_t = \rho i_{t-1} + (1-\rho)\left[\gamma_\pi E_t \pi_{t+2} + \gamma_y y_{t-6} + \sigma_t\right] \tag{A.18}$$

Period IV, 2003m10-2005m12 :

$$i_t = \rho i_{t-1} + (1-\rho)\left[\gamma_\pi E_t \pi_{t+3} + \gamma_y E_t y_{t+1} + \sigma_t\right] \tag{A.19}$$

The Uncovered Interest Parity (UIP) condition is given by

$$e_t = \phi_1 e_{t-1} + \phi_2 E_t e_{t+1} + \phi_3 (i_{t-1} - i^*_{t-1}) + \nu_t \tag{A.20}$$

The inflation and interest rates for the US are assumed to follow an AR(1) process

$$\pi^*_t = \alpha^*_0 + \alpha^*_1 \pi^*_{t-1} + \epsilon^*_t \tag{A.21}$$

$$i^*_t = \gamma^*_0 + \rho^* i^*_{t-1} + \sigma^*_t \tag{A.22}$$

A.4 Technical Appendix to VII.2

A.4.1 Rational Expectations Computational Algorithm

I used the computational program developed by Sims (2001) to find rational expectations solution. Sims' rational expectations solution algorithm requires the model expressed in the following state-space form:

$$\mathbf{\Gamma_0 X_t = \Gamma_1 X_{t-1} + C + \Psi z_t + \Pi} \omega_\mathbf{t} \tag{A.23}$$

$t = 1, 2, 3, \dots T$, where C is a vector of constants, z_t is an exogenously evolving, possibly serially correlated, random disturbance, and ω_t contains expectational errors, satisfying $E_t\omega_{t+1} = 0 \;\forall\; t$.

In our model, the monetary reaction function differs across periods, which results in four different state-space configurations.

i Period I: Jan'96 - Nov'98

The vectors, $\mathbf{X_t^I}, \mathbf{X_{t-1}^I}, \mathbf{C^I}, \mathbf{z_t^I}$, and $\omega_\mathbf{t}^\mathbf{I}$, consistent with the state-space form in (A.10) are expressed as following

$$\mathbf{X_t^I} = \begin{bmatrix} \pi_t \\ y_t \\ i_t \\ e_t \\ \pi_t^* \\ i_t^* \\ y_{t-1} \\ y_{t-2} \\ y_{t-3} \\ y_{t-4} \\ i_{t-1} \\ e_{t-1} \\ E_{t-1}\pi_t \\ E_t\pi_{t+1} \\ E_t\pi_{t+2} \\ E_t y_{t+1} \\ E_t e_{t+1} \end{bmatrix} \mathbf{X_{t-1}^I} = \begin{bmatrix} \pi_{t-1} \\ y_{t-1} \\ i_{t-1} \\ e_{t-1} \\ \pi_{t-1}^* \\ i_{t-1}^* \\ y_{t-2} \\ y_{t-3} \\ y_{t-4} \\ y_{t-5} \\ i_{t-2} \\ e_{t-2} \\ E_{t-2}\pi_{t-1} \\ E_{t-1}\pi_t \\ E_{t-1}\pi_{t+1} \\ E_{t-1} y_t \\ E_{t-1} e_t \end{bmatrix} \mathbf{C^I} = \begin{bmatrix} \alpha_0 \\ \beta_0 \\ (1-\rho)\gamma_0 \\ 0 \\ \alpha_0^* \\ \gamma_0^* \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \end{bmatrix} \mathbf{z_t^I} = \begin{bmatrix} \epsilon_t \\ \eta_t \\ \sigma_t \\ \nu_t \\ \epsilon_t^* \\ \sigma_t^* \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \end{bmatrix} \omega_\mathbf{t}^\mathbf{I} = \begin{bmatrix} 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ \theta_{1,t} \\ \theta_{2,t} \\ \theta_{3,t} \\ \theta_{4,t} \end{bmatrix}$$

The auxiliary equations associated with the vectors, $\mathbf{X_t^I}, \mathbf{X_{t-1}^I}, \mathbf{C^I}, \mathbf{z_t^I}$, and $\omega_\mathbf{t}^\mathbf{I}$, and which must be added to the system are written as

$$
\begin{array}{lcllcl}
y_{t-1} & = & y_{t-1}, & & & \\
y_{t-2} & = & y_{t-2}, & & & \\
y_{t-3} & = & y_{t-3}, & & & \\
y_{t-4} & = & y_{t-4}, & E_t\pi_{t+1} & = & E_{t-1}\pi_{t+1} + \theta_{1,t} \\
i_{t-1} & = & i_{t-1}, & \pi_t & = & E_{t-1}\pi_t + \theta_{2,t} \\
e_{t-1} & = & e_{t-1}, & y_t & = & E_{t-1}y_t + \theta_{3,t} \\
E_{t-1}\pi_t & = & E_{t-1}\pi_t, & e_t & = & E_{t-1}e_t + \theta_{4,t}
\end{array}
$$

The matrices completing the state-space form configuration for the first period are given by

$$
\mathbf{\Gamma_0^I} = \begin{bmatrix}
1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & -\alpha_2 & 0 & 0 \\
0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & -\beta_3 & 0 \\
0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & -(1-\rho)\gamma_\pi & 0 & 0 \\
0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & -\phi_2 \\
0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 \\
1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0
\end{bmatrix}
$$

$$
\mathbf{\Gamma_1^I} = \begin{bmatrix}
\alpha_I' & 0 & 0 & \alpha_4 & \alpha_4 & 0 & 0 & 0 & \alpha_3 & 0 & 0 & -\alpha_4 & 0 & 0 & 0 & 0 & 0 \\
-\beta_5 & \beta_1 & 0 & \beta_5 & \beta_5 & 0 & \beta_2 & 0 & 0 & 0 & \beta_4 & -\beta_5 & -\beta_4 & 0 & 0 & 0 & 0 \\
0 & 0 & \rho & 0 & 0 & 0 & 0 & 0 & 0 & \gamma_y^I & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & \phi_3 & \phi_1 & 0 & -\phi_3 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & \alpha_1^* & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & \rho^* & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1
\end{bmatrix}
$$

where $\alpha_I' = \alpha_1 - \alpha_4$, and $\gamma_y^I = (1-\rho)\gamma_y$.

$$
\mathbf{\Psi^I} = \begin{bmatrix}
1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & (1-\rho) & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0
\end{bmatrix}
$$

$$
\mathbf{\Pi^{I}} = \begin{bmatrix}
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1
\end{bmatrix}
$$

ii Period II: Dec'98 - Oct'00

The vectors, $\mathbf{X_t^{II}}, \mathbf{X_{t-1}^{II}}, \mathbf{C^{II}}, \mathbf{z_t^{II}}$, and $\omega_{\mathbf{t}}^{\mathbf{II}}$, consistent with the state-space form in (A.10) are expressed as following

$$\mathbf{X_t^{II}} = \begin{bmatrix} \pi_t \\ y_t \\ i_t \\ e_t \\ \pi_t^* \\ i_t^* \\ y_{t-1} \\ y_{t-2} \\ y_{t-3} \\ y_{t-4} \\ i_{t-1} \\ e_{t-1} \\ E_{t-1}\pi_t \\ E_t\pi_{t+1} \\ E_t\pi_{t+2} \\ E_t\pi_{t+3} \\ E_t y_{t+1} \\ E_t e_{t+1} \end{bmatrix} \mathbf{X_{t-1}^{II}} = \begin{bmatrix} \pi_{t-1} \\ y_{t-1} \\ i_{t-1} \\ e_{t-1} \\ \pi_{t-1}^* \\ i_{t-1}^* \\ y_{t-2} \\ y_{t-3} \\ y_{t-4} \\ y_{t-5} \\ i_{t-2} \\ e_{t-2} \\ E_{t-2}\pi_{t-1} \\ E_{t-1}\pi_t \\ E_{t-1}\pi_{t+1} \\ E_{t-1}\pi_{t+2} \\ E_{t-1}y_t \\ E_{t-1}e_t \end{bmatrix} \mathbf{C^{II}} = \begin{bmatrix} \alpha_0 \\ \beta_0 \\ (1-\rho)\gamma_0 \\ 0 \\ \alpha_0^* \\ \gamma_0^* \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \end{bmatrix} \mathbf{z_t^{II}} = \begin{bmatrix} \epsilon_t \\ \eta_t \\ \sigma_t \\ \nu_t \\ \epsilon_t^* \\ \sigma_t^* \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \end{bmatrix} \omega_{\mathbf{t}}^{\mathbf{II}} = \begin{bmatrix} 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ \theta_{1,t} \\ \theta_{2,t} \\ \theta_{3,t} \\ \theta_{4,t} \\ \theta_{5,t} \end{bmatrix}$$

The auxiliary equations associated with the vectors, $\mathbf{X_t^{II}}, \mathbf{X_{t-1}^{II}}, \mathbf{C^{II}}, \mathbf{z_t^{II}}$, and $\omega_{\mathbf{t}}^{\mathbf{II}}$, and which must be added to the system are written as

$$
\begin{aligned}
y_{t-1} &= y_{t-1}, & & \\
y_{t-2} &= y_{t-2}, & & \\
y_{t-3} &= y_{t-3}, & E_t\pi_{t+1} &= E_{t-1}\pi_{t+1} + \theta_{1,t} \\
y_{t-4} &= y_{t-4}, & E_t\pi_{t+2} &= E_{t-1}\pi_{t+2} + \theta_{2,t} \\
i_{t-1} &= i_{t-1}, & \pi_t &= E_{t-1}\pi_t + \theta_{3,t} \\
e_{t-1} &= e_{t-1}, & y_t &= E_{t-1}y_t + \theta_{4,t} \\
E_{t-1}\pi_t &= E_{t-1}\pi_t & e_t &= E_{t-1}e_t + \theta_{5,t}
\end{aligned}
$$

The matrices completing the state-space form configuration for the second period are given by

$$
\mathbf{\Gamma_0^{II}} = \begin{bmatrix}
1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & -\alpha_2 & 0 & 0 & 0 \\
0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & -\beta_3 & 0 \\
0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & -(1-\rho)\gamma_\pi & 0 & 0 \\
0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & -\phi_2 \\
0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 \\
1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0
\end{bmatrix}
$$

$$
\mathbf{\Gamma_1^{II}} = \begin{bmatrix}
\alpha'_{II} & 0 & 0 & \alpha_4 & \alpha_4 & 0 & 0 & 0 & \alpha_3 & 0 & 0 & -\alpha_4 & 0 & 0 & 0 & 0 & 0 & 0 \\
-\beta_5 & \beta_1 & 0 & \beta_5 & \beta_5 & 0 & \beta_2 & 0 & 0 & 0 & \beta_4 & -\beta_5 & -\beta_4 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & \rho & 0 & 0 & 0 & 0 & 0 & 0 & \gamma_y^{II} & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & \phi_3 & \phi_1 & 0 & -\phi_3 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & \alpha_1^* & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & \rho^* & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1
\end{bmatrix}
$$

where $\alpha'_{II} = \alpha_1 - \alpha_4$, and $\gamma_y^{II} = (1-\rho)\gamma_y$.

$$
\mathbf{\Psi^{II}} = \begin{bmatrix}
1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & (1-\rho) & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0
\end{bmatrix}
$$

$$
\mathbf{\Pi^{II}} = \begin{bmatrix}
0&0&0&0&0&0&0&0&0&0&0&0&0&0&0&0&0&0\\
0&0&0&0&0&0&0&0&0&0&0&0&0&0&0&0&0&0\\
0&0&0&0&0&0&0&0&0&0&0&0&0&0&0&0&0&0\\
0&0&0&0&0&0&0&0&0&0&0&0&0&0&0&0&0&0\\
0&0&0&0&0&0&0&0&0&0&0&0&0&0&0&0&0&0\\
0&0&0&0&0&0&0&0&0&0&0&0&0&0&0&0&0&0\\
0&0&0&0&0&0&0&0&0&0&0&0&0&0&0&0&0&0\\
0&0&0&0&0&0&0&0&0&0&0&0&0&0&0&0&0&0\\
0&0&0&0&0&0&0&0&0&0&0&0&0&0&0&0&0&0\\
0&0&0&0&0&0&0&0&0&0&0&0&0&0&0&0&0&0\\
0&0&0&0&0&0&0&0&0&0&0&0&0&0&0&0&0&0\\
0&0&0&0&0&0&0&0&0&0&0&0&0&0&0&0&0&0\\
0&0&0&0&0&0&0&0&0&0&0&0&0&0&0&0&0&0\\
0&0&0&0&0&0&0&0&0&0&0&0&0&1&0&0&0&0\\
0&0&0&0&0&0&0&0&0&0&0&0&0&0&1&0&0&0\\
0&0&0&0&0&0&0&0&0&0&0&0&0&0&0&1&0&0\\
0&0&0&0&0&0&0&0&0&0&0&0&0&0&0&0&1&0\\
0&0&0&0&0&0&0&0&0&0&0&0&0&0&0&0&0&1
\end{bmatrix}
$$

iii Period III: Mar'01 - Sep'03

The vectors, $\mathbf{X_t^{III}}, \mathbf{X_{t-1}^{III}}, \mathbf{C^{III}}, \mathbf{z_t^{III}}$, and $\omega_\mathbf{t}^\mathbf{III}$, consistent with the state-space form in (A.10) are expressed as following

$$\mathbf{X_t^{III}} = \begin{bmatrix} \pi_t \\ y_t \\ i_t \\ e_t \\ \pi_t^* \\ i_t^* \\ y_{t-1} \\ y_{t-2} \\ y_{t-3} \\ y_{t-4} \\ y_{t-5} \\ i_{t-1} \\ e_{t-1} \\ E_{t-1}\pi_t \\ E_t\pi_{t+1} \\ E_t\pi_{t+2} \\ E_t y_{t+1} \\ E_t e_{t+1} \end{bmatrix} \quad \mathbf{X_{t-1}^{III}} = \begin{bmatrix} \pi_{t-1} \\ y_{t-1} \\ i_{t-1} \\ e_{t-1} \\ \pi_{t-1}^* \\ i_{t-1}^* \\ y_{t-2} \\ y_{t-3} \\ y_{t-4} \\ y_{t-5} \\ y_{t-6} \\ i_{t-2} \\ e_{t-2} \\ E_{t-2}\pi_{t-1} \\ E_{t-1}\pi_t \\ E_{t-1}\pi_{t+1} \\ E_{t-1}y_t \\ E_{t-1}e_t \end{bmatrix} \quad \mathbf{C^{III}} = \begin{bmatrix} \alpha_0 \\ \beta_0 \\ 0 \\ 0 \\ \alpha_0^* \\ \gamma_0^* \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \end{bmatrix} \quad \mathbf{z_t^{III}} = \begin{bmatrix} \epsilon_t \\ \eta_t \\ \sigma_t \\ \nu_t \\ \epsilon_t^* \\ \sigma_t^* \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \end{bmatrix} \quad \omega_\mathbf{t}^\mathbf{III} = \begin{bmatrix} 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ \theta_{1,t} \\ \theta_{2,t} \\ \theta_{3,t} \\ \theta_{4,t} \end{bmatrix}$$

The auxiliary equations associated with the vectors, $\mathbf{X_t^{III}}, \mathbf{X_{t-1}^{III}}, \mathbf{C^{III}}, \mathbf{z_t^{III}}$, and $\omega_\mathbf{t}^\mathbf{III}$, and which must be added to the system are written as

$$
\begin{aligned}
y_{t-1} &= y_{t-1} & & \\
y_{t-2} &= y_{t-2} & & \\
y_{t-3} &= y_{t-3} & & \\
y_{t-4} &= y_{t-4} & & \\
y_{t-5} &= y_{t-5} & E_t\pi_{t+1} &= E_{t-1}\pi_{t+1} + \theta_{1,t} \\
i_{t-1} &= i_{t-1} & \pi_t &= E_{t-1}\pi_t + \theta_{2,t} \\
e_{t-1} &= e_{t-1} & y_t &= E_{t-1}y_t + \theta_{3,t} \\
E_{t-1}\pi_t &= E_{t-1}\pi_t & e_t &= E_{t-1}e_t + \theta_{4,t}
\end{aligned}
$$

The matrices completing the state-space form configuration for the second period are given by

$$
\mathbf{\Gamma_0^{III}} = \begin{bmatrix}
1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & -\alpha_2 & 0 & 0 \\
0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & -\beta_3 & 0 \\
0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & -(1-\rho)\gamma_\pi & 0 & 0 \\
0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & -\phi_2 \\
0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 \\
1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0
\end{bmatrix}
$$

$$
\mathbf{\Gamma_1^{III}} = \begin{bmatrix}
\alpha'_{III} & 0 & 0 & \alpha_4 & \alpha_4 & 0 & 0 & 0 & \alpha_3 & 0 & 0 & 0 & -\alpha_4 & 0 & 0 & 0 & 0 & 0 \\
-\beta_5 & \beta_1 & 0 & \beta_5 & \beta_5 & 0 & \beta_2 & 0 & 0 & 0 & 0 & \beta_4 & -\beta_5 & -\beta_4 & 0 & 0 & 0 & 0 \\
0 & 0 & \rho & 0 & 0 & 0 & 0 & 0 & 0 & 0 & \gamma_y^{III} & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & \phi_3 & \phi_1 & 0 & -\phi_3 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & \alpha_1^* & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & \rho^* & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1
\end{bmatrix}
$$

where $\alpha'_{III} = \alpha_1 - \alpha_4$, and $\gamma_y^{III} = (1-\rho)\gamma_y$.

$$
\mathbf{\Psi^{III}} = \begin{bmatrix}
1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & (1-\rho) & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0
\end{bmatrix}
$$

$$\mathbf{\Pi^{III}} = \begin{bmatrix} 0&0&0&0&0&0&0&0&0&0&0&0&0&0&0&0&0&0 \\ 0&0&0&0&0&0&0&0&0&0&0&0&0&0&0&0&0&0 \\ 0&0&0&0&0&0&0&0&0&0&0&0&0&0&0&0&0&0 \\ 0&0&0&0&0&0&0&0&0&0&0&0&0&0&0&0&0&0 \\ 0&0&0&0&0&0&0&0&0&0&0&0&0&0&0&0&0&0 \\ 0&0&0&0&0&0&0&0&0&0&0&0&0&0&0&0&0&0 \\ 0&0&0&0&0&0&0&0&0&0&0&0&0&0&0&0&0&0 \\ 0&0&0&0&0&0&0&0&0&0&0&0&0&0&0&0&0&0 \\ 0&0&0&0&0&0&0&0&0&0&0&0&0&0&0&0&0&0 \\ 0&0&0&0&0&0&0&0&0&0&0&0&0&0&0&0&0&0 \\ 0&0&0&0&0&0&0&0&0&0&0&0&0&0&0&0&0&0 \\ 0&0&0&0&0&0&0&0&0&0&0&0&0&0&0&0&0&0 \\ 0&0&0&0&0&0&0&0&0&0&0&0&0&0&0&0&0&0 \\ 0&0&0&0&0&0&0&0&0&0&0&0&0&0&0&0&0&0 \\ 0&0&0&0&0&0&0&0&0&0&0&0&0&0&1&0&0&0 \\ 0&0&0&0&0&0&0&0&0&0&0&0&0&0&0&1&0&0 \\ 0&0&0&0&0&0&0&0&0&0&0&0&0&0&0&0&1&0 \\ 0&0&0&0&0&0&0&0&0&0&0&0&0&0&0&0&0&1 \end{bmatrix}$$

iv Period IV: Oct'03 - Dec'05

The vectors, $\mathbf{X_t^{IV}}, \mathbf{X_{t-1}^{IV}}, \mathbf{C^{IV}}, \mathbf{z_t^{IV}}$, and $\omega_\mathbf{t}^\mathbf{IV}$, consistent with the state-space form in (A.10) are expressed as following

$$\mathbf{X_t^{IV}} = \begin{bmatrix} \pi_t \\ y_t \\ i_t \\ e_t \\ \pi_t^* \\ i_t^* \\ y_{t-1} \\ y_{t-2} \\ y_{t-3} \\ i_{t-1} \\ e_{t-1} \\ E_{t-1}\pi_t \\ E_t\pi_{t+1} \\ E_t\pi_{t+2} \\ E_t\pi_{t+3} \\ E_t y_{t+1} \\ E_t e_{t+1} \end{bmatrix} \mathbf{X_{t-1}^{IV}} = \begin{bmatrix} \pi_{t-1} \\ y_{t-1} \\ i_{t-1} \\ e_{t-1} \\ \pi_{t-1}^* \\ i_{t-1}^* \\ y_{t-2} \\ y_{t-3} \\ y_{t-4} \\ i_{t-2} \\ e_{t-2} \\ E_{t-2}\pi_{t-1} \\ E_{t-1}\pi_t \\ E_{t-1}\pi_{t+1} \\ E_{t-1}\pi_{t+2} \\ E_{t-1} y_t \\ E_{t-1} e_t \end{bmatrix} \mathbf{C^{IV}} = \begin{bmatrix} \alpha_0 \\ \beta_0 \\ 0 \\ 0 \\ \alpha_0^* \\ \gamma_0^* \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \end{bmatrix} \mathbf{z_t^{IV}} = \begin{bmatrix} \epsilon_t \\ \eta_t \\ \sigma_t \\ \nu_t \\ \epsilon_t^* \\ \sigma_t^* \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \end{bmatrix} \omega_\mathbf{t}^\mathbf{IV} = \begin{bmatrix} 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ \theta_{1,t} \\ \theta_{2,t} \\ \theta_{3,t} \\ \theta_{4,t} \\ \theta_{5,t} \end{bmatrix}$$

The auxiliary equations associated with the vectors, $\mathbf{X_t^{IV}}, \mathbf{X_{t-1}^{IV}}, \mathbf{C^{IV}}, \mathbf{z_t^{IV}}$, and $\omega_\mathbf{t}^\mathbf{IV}$, and which must be added to the system are written as

$$
\begin{array}{lcllcl}
y_{t-1} & = & y_{t-1}, & & & \\
y_{t-2} & = & y_{t-2}, & E_t\pi_{t+1} & = & E_{t-1}\pi_{t+1} + \theta_{1,t} \\
y_{t-3} & = & y_{t-3}, & E_t\pi_{t+2} & = & E_{t-1}\pi_{t+2} + \theta_{2,t} \\
i_{t-1} & = & i_{t-1}, & \pi_t & = & E_{t-1}\pi_t + \theta_{3,t} \\
e_{t-1} & = & e_{t-1}, & y_t & = & E_{t-1}y_t + \theta_{4,t} \\
E_{t-1}\pi_t & = & E_{t-1}\pi_t, & e_t & = & E_{t-1}e_t + \theta_{5,t}
\end{array}
$$

The matrices completing the state-space form configuration for the second period are given by

$$
\mathbf{\Gamma_0^{IV}} = \begin{bmatrix}
1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & -\alpha_2 & 0 & 0 & 0 \\
0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & -\beta_3 & 0 \\
0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & -\gamma_\pi^{IV} & -\gamma_y^{IV} & 0 \\
0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & -\phi_2 \\
0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 \\
1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0
\end{bmatrix}
$$

where $\gamma_\pi^{IV} = (1-\rho)\gamma_\pi$, and $\gamma_y^{IV} = (1-\rho)\gamma_y$.

$$
\mathbf{\Gamma_1^{IV}} = \begin{bmatrix}
\alpha_1-\alpha_4 & 0 & 0 & \alpha_4 & \alpha_4 & 0 & 0 & 0 & \alpha_3 & 0 & -\alpha_4 & 0 & 0 & 0 & 0 & 0 & 0 \\
-\beta_5 & \beta_1 & 0 & \beta_5 & \beta_5 & 0 & \beta_2 & 0 & 0 & \beta_4 & -\beta_5 & -\beta_4 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & \rho & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & \phi_3 & \phi_1 & 0 & -\phi_3 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & \alpha_1^* & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & \rho^* & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1
\end{bmatrix}
$$

$$
\mathbf{\Psi^{IV}} = \begin{bmatrix}
1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & (1-\rho) & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0
\end{bmatrix}
$$

$$
\mathbf{\Pi^{IV}} = \begin{bmatrix}
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1
\end{bmatrix}
$$

A.4.2 Estimated Rational Expectations Solutions

The estimated rational expectations (RE) solutions are reported in Table VIII.1, VIII.2, VIII.3, and VIII.4. These estimates are obtained using the computational algorithm outlined in Appendix A.4.1, and the estimates obtained by the Generalized Method of Moments (GMM) estimation of the structural model displayed in Table VII.1, VII.2, VII.3, and VII.4.

A.5 E-Stability

The estimated RE solutions can be written in the following form

$$
\mathbf{X_t} = \mathbf{C} + \mathbf{\Lambda_1 X_{t-1}} + \mathbf{\Lambda_2} \mu_\mathbf{t} \tag{A.24}
$$

where

$$
\mathbf{X_t} = \begin{bmatrix} \pi_t \\ y_t \\ i_t \\ e_t \\ \pi_t^* \\ i_t^* \\ \pi_{t-1} \\ y_{t-1} \\ y_{t-2} \\ y_{t-3} \\ y_{t-4} \\ y_{t-5} \\ i_{t-1} \\ i_{t-2} \\ e_{t-1} \\ e_{t-2} \\ \pi_{t-1}^* \end{bmatrix}
\mathbf{X_{t-1}} = \begin{bmatrix} \pi_{t-1} \\ y_{t-1} \\ i_{t-1} \\ e_{t-1} \\ \pi_{t-1}^* \\ i_{t-1}^* \\ \pi_{t-2} \\ y_{t-2} \\ y_{t-3} \\ y_{t-4} \\ y_{t-5} \\ y_{t-6} \\ i_{t-2} \\ i_{t-3} \\ e_{t-2} \\ e_{t-3} \\ \pi_{t-2}^* \end{bmatrix}
\mathbf{C} = \begin{bmatrix} g_0 \\ h_0 \\ k_0 \\ s_0 \\ \alpha_0^* \\ \gamma_0^* \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \end{bmatrix}
\mu_{\mathbf{t}} = \begin{bmatrix} \epsilon_t \\ \eta_t \\ \sigma_t \\ \nu_t \\ \epsilon_t^* \\ \sigma_t^* \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \end{bmatrix}
$$

$$
\mathbf{\Lambda_1} = \begin{bmatrix}
g_1 & g_2 & g_3 & g_4 & g_5 & g_6 & g_7 & g_8 & g_9 & g_{10} & g_{11} & g_{12} & g_{13} & g_{14} & 0 & g_{15} & g_{16} \\
h_1 & h_2 & h_3 & h_4 & h_5 & h_6 & h_7 & h_8 & h_9 & h_{10} & h_{11} & h_{12} & h_{13} & h_{14} & 0 & h_{15} & h_{16} \\
k_1 & k_2 & k_3 & k_4 & k_5 & k_6 & k_7 & k_8 & k_9 & k_{10} & k_{11} & k_{12} & k_{13} & k_{14} & 0 & k_{15} & k_{16} \\
s_1 & s_2 & s_3 & s_4 & s_5 & s_6 & s_7 & s_8 & s_9 & s_{10} & s_{11} & s_{12} & s_{13} & s_{14} & 0 & s_{15} & s_{16} \\
0 & 0 & 0 & 0 & \alpha_1^* & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & \rho^* & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 \\
0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0
\end{bmatrix}
$$

$$
\mathbf{\Lambda_2} = \begin{bmatrix}
-g_{17} & -g_{18} & -g_{19} & -g_{20} & -g_{21} & -g_{22} & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
-h_{17} & -h_{18} & -h_{19} & -h_{20} & -h_{21} & -h_{22} & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
-k_{17} & -k_{18} & -k_{19} & -k_{20} & -k_{21} & -k_{22} & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
-s_{17} & -s_{18} & -s_{19} & -s_{20} & -s_{21} & -s_{22} & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0
\end{bmatrix}
$$

A rational expectation equilibrium (REE) solution is E-stable if the eigenvalues of Λ_1 never leave the unit circle. Note that the vector $\mathbf{x}$ is an eigenvector of the matrix Λ_1 with eigenvalue λ if $\mathbf{\Lambda_1 x} = \lambda \mathbf{x}$ holds. Hence, the eigenvalues of Λ_1 are the solutions λ to the equation $det(\Lambda_1 - \lambda I) = 0$.

In Period I, Jan'96-Nov'98, the solution for $det(\Lambda_1 - \lambda I) = 0$ give eigenvalues of $c_1 = .3383, c_2 = .6309, c_3 = 0, c_4 = .8609, c_5 = .8609, c_6 = -.5877, c_7 = -.5877, c_8 = -.1923, c_9 = -.1923, c_{10} = .3832, c_{11} = .3832, c_{12} = .5316, c_{13} = .4656, c_{14} = -.0048, c_{15} = .0048, c_{16} = .0087, c_{17} = 0$ where $|c_i| < 1 \; \forall \; i = 1, 2, \ldots 17$. Thus, the REE solution for the period of Jan'96-Nov'98 is E-stable.

In Period II, Dec'98-Oct'00, the solution for $det(\Lambda_1 - \lambda I) = 0$ give eigenvalues of $c_1 = .3383, c_2 = .6309, c_3 = 0, c_4 = .8430, c_5 = .8430, c_6 = -.6439, c_7 = -.6439, c_8 = -.2366, c_9 = -.2366, c_{10} = .3814, c_{11} = .3814, c_{12} = .5338, c_{13} = .4642, c_{14} = -.0077, c_{15} = .0110, c_{16} = .0054, c_{17} = 0$ where $|c_i| < 1 \; \forall \; i = 1, 2, \ldots 17$.

Thus, the REE solution for the period of Dec'98-Oct'00 is E-stable.

In Period III, Mar'01-Sep'03, the solution for $det(\Lambda_1 - \lambda I) = 0$ give eigenvalues of $c_1 = .3383, c_2 = .6309, c_3 = 0, c_4 = .8692, c_5 = .8692, c_6 = -.5762, c_7 = -.4138, c_8 = -.4138, c_9 = -.0289, c_{10} = -.0289, c_{11} = .4470, c_{12} = .4470, c_{13} = .5303, c_{14} = .4703, c_{15} = -.0045, c_{16} = .0066, c_{17} = .0066$ where $|c_i| < 1 \; \forall \; i = 1, 2, \ldots 17$. Thus, the REE solution for the period of Mar'01-Sep'03 is E-stable.

In Period IV, Oct'03-Dec'05, the solution for $det(\Lambda_1 - \lambda I) = 0$ give eigenvalues of $c_1 = .3383, c_2 = .6309, c_3 = 0, c_4 = .8613, c_5 = .5382, c_6 = .5244, c_7 = .5244, c_8 = .0045, c_9 = .0045, c_{10} = -.2197, c_{11} = -.0296, c_{12} = -.0193, c_{13} = -.0193, c_{14} = .0194, c_{15} = .0194, c_{16} = .0072, c_{17} = 0$ where $|c_i| < 1 \; \forall \; i = 1, 2, \ldots 17$. Thus, the REE solution for the period of Oct'03-Dec'05 is E-stable.

A.6 Technical Appendix to VII.6.1

Following the methodology described in Chapter IV, I express (VII.11) as function of i_{t-4} and earlier. The derivation is straightforward but tedious. After numerous reverse substitutions of the type described in Appendix A.1, I obtain the following formulae to solve for ex post inflation for the periods of (I) Jan'96-Nov'98, (II) Dec'98-Oct'00, (III) Mar'01-Sep'03, and (IV) Oct'03-Dec'05. Notice that different interest rate rules for each of these sub periods yield different formulations for the inflation rate, π_t.

$$
\begin{aligned}
\pi_t^I \;=\;& Z_0 + Z_1\pi_{t-5} + \sum_{j=5}^{j=8} Z_{j-3}y_{t-j} + \sum_{j=4}^{j=6} Z_{j+2}i_{t-j} + Z_9 e_{t-6} + \sum_{j=1}^{j=5} Z_{j+9}\pi^*_{t-j} \\
&+ \sum_{j=2}^{j=6} Z_{j+13}i^*_{t-j} + \sum_{j=0}^{j=4} Z_{j+20}E_{t-j}\pi_{t+2-j} + Z_{25}E_{t-6}\pi_{t-5} + Z_{26}E_{t-4}y_{t-3} \\
&+ \sum_{j=1}^{j=5} Z_{j+26}E_{t-j}e_{t+1-j} + \sum_{j=0}^{j=4} Z_{j+32}\epsilon_{t-j} + Z_{37}\eta_{t-4} + \sum_{j=2}^{j=3} Z_{j+36}\sigma_{t-j} \\
&+ \sum_{j=1}^{j=5} Z_{j+39}\nu_{t-j} \qquad \text{(A.25)}
\end{aligned}
$$

$$
\begin{aligned}
\pi_t^{II} \;=\;& Z_0 + Z_1\pi_{t-5} + \sum_{j=5}^{j=8} Z_{j-3}y_{t-j} + \sum_{j=4}^{j=6} Z_{j+2}i_{t-j} + Z_9 e_{t-6} + \sum_{j=1}^{j=5} Z_{j+9}\pi^*_{t-j} \\
&+ \sum_{j=2}^{j=6} Z_{j+13}i^*_{t-j} + \sum_{j=0}^{j=1} Z_{j+20}E_{t-j}\pi_{t+2-j} + Z^a_{22}E_{t-2}\pi_t + Z^b_{22}E_{t-2}\pi_{t+1} \\
&Z^a_{23}E_{t-3}\pi_{t-1} + Z^b_{23}E_{t-3}\pi_t + Z_{24}E_{t-4}\pi_{t-2} + Z_{25}E_{t-6}\pi_{t-5} + Z_{26}E_{t-4}y_{t-3} \\
&+ \sum_{j=1}^{j=5} Z_{j+26}E_{t-j}e_{t+1-j} + \sum_{j=0}^{j=4} Z_{j+32}\epsilon_{t-j} + Z_{37}\eta_{t-4} + \sum_{j=2}^{j=3} Z_{j+36}\sigma_{t-j} \\
&+ \sum_{j=1}^{j=5} Z_{j+39}\nu_{t-j} \qquad \text{(A.26)}
\end{aligned}
$$

$$
\begin{aligned}
\pi_t^{III} \;=\;& Z_0^{'} + Z_1\pi_{t-5} + \sum_{j=5}^{j=6} Z_{j-3}y_{t-j} + Z_4^{'}y_{t-7} + Z^a_5 y_{t-8} + Z^b_5 y_{t-9} + \sum_{j=4}^{j=6} Z_{j+2}i_{t-j} \\
&+ Z_9 e_{t-6} + \sum_{j=1}^{j=5} Z_{j+9}\pi^*_{t-j} + \sum_{j=2}^{j=6} Z_{j+13}i^*_{t-j} + \sum_{j=0}^{j=4} Z_{j+20}E_{t-j}\pi_{t+2-j} + Z_{25}E_{t-6}\pi_{t-5} \\
&+ Z_{26}E_{t-4}y_{t-3} + \sum_{j=1}^{j=5} Z_{j+26}E_{t-j}e_{t+1-j} + \sum_{j=0}^{j=4} Z_{j+32}\epsilon_{t-j} + Z_{37}\eta_{t-4} \\
&+ \sum_{j=2}^{j=3} Z_{j+36}\sigma_{t-j} + \sum_{j=1}^{j=5} Z_{j+39}\nu_{t-j} \qquad \text{(A.27)}
\end{aligned}
$$

$$
\begin{aligned}
\pi_t^{IV} \;=\;& Z_0^{'} + Z_1\pi_{t-5} + \sum_{j=5}^{j=6} Z_{j-3}y_{t-j} + Z_4^{''}y_{t-7} + Z_5^{''}y_{t-8} + \sum_{j=4}^{j=6} Z_{j+2}i_{t-j} + Z_9 e_{t-6} \\
&+ \sum_{j=1}^{j=5} Z_{j+9}\pi^*_{t-j} + \sum_{j=2}^{j=6} Z_{j+13}i^*_{t-j} + \sum_{j=0}^{j=1} Z_{j+20}E_{t-j}\pi_{t+2-j} + Z_{22}^{a}E_{t-2}\pi_t \\
&+ Z_{22}^{b}E_{t-2}\pi_{t+1} + Z_{23}^{a}E_{t-3}\pi_{t-1} + Z_{23}^{b}E_{t-3}\pi_t + Z_{24}E_{t-4}\pi_{t-2} + Z_{25}E_{t-6}\pi_{t-5} \\
&+ Z_{26}^{a}E_{t-4}y_{t-3} + Z_{26}^{b}E_{t-3}y_{t-2} + Z_{26}^{c}E_{t-2}y_{t-1} + \sum_{j=1}^{j=5} Z_{j+26}E_{t-j}e_{t+1-j} \\
&+ \sum_{j=0}^{j=4} Z_{j+32}\epsilon_{t-j} + Z_{37}\eta_{t-4} + \sum_{j=2}^{j=3} Z_{j+36}\sigma_{t-j} + \sum_{j=1}^{j=5} Z_{j+39}\nu_{t-j} \qquad \text{(A.28)}
\end{aligned}
$$

where

$$
\begin{aligned}
Z_0 &= \alpha_3\beta_5 + \alpha_0\left[1 + (\alpha_1-\alpha_4) + (\alpha_1-\alpha_4)^2 + (\alpha_1-\alpha_4)^3 + (\alpha_1-\alpha_4)^4\right] \\
&\quad - \alpha_4\phi_3(1-\rho)\gamma_0 + \gamma_0(1-\rho)\left[\alpha_4\phi_3\rho - \alpha_4\phi_3(1-(\alpha_1-\alpha_4))\right] \\
Z_0^{'} &= Z_0 \, where \, \gamma_0 = 0 \\
Z_1 &= (\alpha_1-\alpha_4)^5 - \alpha_3\beta_5 \\
Z_2 &= \alpha_3[\beta_1 + (\alpha_1-\alpha_4)] \\
Z_3 &= \alpha_3[\beta_2 + (\alpha_1-\alpha_4)^2] \\
Z_4 &= \alpha_3(\alpha_1-\alpha_4)^3 + \alpha_4\phi_3(1-\rho)\gamma_y \\
Z_4^{'} &= \alpha_3(\alpha_1-\alpha_4)^3 \\
Z_4^{''} &= \alpha_3(\alpha_1-\alpha_4)^3 \\
Z_5 &= \alpha_3(\alpha_1-\alpha_4)^4 + [\alpha_4\phi_3\rho - \alpha_4\phi_3(1-(\alpha_1-\alpha_4))](1-\rho)\gamma_y \\
Z_5^{''} &= \alpha_3(\alpha_1-\alpha_4)^4 \\
Z_5^{a} &= \alpha_3(\alpha_1-\alpha_4)^4 + \alpha_4\phi_3(1-\rho)\gamma_y \\
Z_5^{b} &= [\alpha_4\phi_3\rho - \alpha_4\phi_3(1-(\alpha_1-\alpha_4))](1-\rho)\gamma_y \\
Z_6 &= \alpha_4\phi_3(\rho^2 + \phi_1^2) - \alpha_4\phi_3(1-(\alpha_1-\alpha_4))(\rho + \phi_1 + (\alpha_1-\alpha_4)) \\
Z_7 &= \phi_1^3\alpha_4\phi_3 - \alpha_4\phi_3(1-(\alpha_1-\alpha_4))(\phi_1^2 + \phi_1(\alpha_1-\alpha_4) + (\alpha_1-\alpha_4)^2) \\
Z_8 &= \phi_1^4\alpha_4\phi_3 + \alpha_3(\beta_5\phi_3 + \beta_4) \\
&\quad - \alpha_4\phi_3(1-(\alpha_1-\alpha_4))(\phi_1^3 + \phi_1^2(\alpha_1-\alpha_4) + \phi_1(\alpha_1-\alpha_4)^2 + (\alpha_1-\alpha_4)^3) \\
Z_9 &= \alpha_4[\phi_1^5 - (\alpha_1-\alpha_4)^4] + \alpha_3\beta_5(\phi_1 - 1) \\
&\quad - \alpha_4[1-(\alpha_1-\alpha_4)][\phi_1^4 + \phi_1^3(\alpha_1-\alpha_4) + \phi_1^2(\alpha_1-\alpha_4)^2 + \phi_1(\alpha_1-\alpha_4)^3]
\end{aligned}
$$

$$
\begin{aligned}
Z_{10} &= \alpha_4 \\
Z_{11} &= \alpha_4(\alpha_1 - \alpha_4) \\
Z_{12} &= \alpha_4(\alpha_1 - \alpha_4)^2 \\
Z_{13} &= \alpha_4(\alpha_1 - \alpha_4)^3 \\
Z_{14} &= \alpha_4(\alpha_1 - \alpha_4)^4 + \alpha_3\beta_5 \\
Z_{15} &= -\alpha_4\phi_3 \\
Z_{16} &= \alpha_4\phi_3(1 - (\alpha_1 - \alpha_4)) \\
Z_{17} &= -\phi_1^2\alpha_4\phi_3 + \alpha_4\phi_3(1 - (\alpha_1 - \alpha_4))[\phi_1 + (\alpha_1 - \alpha_4)] \\
Z_{18} &= -\phi_1^3\alpha_4\phi_3 + \alpha_4\phi_3(1 - (\alpha_1 - \alpha_4))[\phi_1^2 + \phi_1(\alpha_1 - \alpha_4) + (\alpha_1 - \alpha_4)^2] \\
Z_{19} &= -\phi_3(\phi_1^4\alpha_4 + \alpha_3\beta_5) \\
&\quad + \alpha_4\phi_3(1 - (\alpha_1 - \alpha_4))[\phi_1^3 + \phi_1^2(\alpha_1 - \alpha_4) + \phi_1(\alpha_1 - \alpha_4)^2 + (\alpha_1 - \alpha_4)^3] \\
Z_{20} &= \alpha_2 \\
Z_{21} &= \alpha_2(\alpha_1 - \alpha_4) \\
Z_{22} &= \alpha_2(\alpha_1 - \alpha_4)^2 + \alpha_4\phi_3(1 - \rho)\gamma_\pi \\
Z_{22}^a &= \alpha_2(\alpha_1 - \alpha_4)^2 \\
Z_{22}^b &= \alpha_4\phi_3(1 - \rho)\gamma_\pi \\
Z_{23} &= \alpha_2(\alpha_1 - \alpha_4)^3 + [\alpha_4\phi_3\rho - \alpha_4\phi_3(1 - (\alpha_1 - \alpha_4))](1 - \rho)\gamma_\pi \\
Z_{23}^a &= \alpha_2(\alpha_1 - \alpha_4)^3 \\
Z_{23}^b &= [\alpha_4\phi_3\rho - \alpha_4\phi_3(1 - (\alpha_1 - \alpha_4))](1 - \rho)\gamma_\pi \\
Z_{24} &= \alpha_2(\alpha_1 - \alpha_4)^4 \\
Z_{25} &= -\alpha_3\beta_4 \\
Z_{26} &= \alpha_3\beta_3 \\
Z_{26}^a &= \alpha_3\beta_3 \\
Z_{26}^b &= \alpha_4\phi_3(1 - \rho)\gamma_y \\
Z_{26}^c &= [\alpha_4\phi_3\rho - \alpha_4\phi_3(1 - (\alpha_1 - \alpha_4))](1 - \rho)\gamma_y \\
Z_{27} &= \alpha_4\phi_2 \\
Z_{28} &= -\alpha_4\phi_2(1 - (\alpha_1 - \alpha_4)) \\
Z_{29} &= \phi_1^2\alpha_4\phi_2 - \alpha_4\phi_2(1 - (\alpha_1 - \alpha_4))[\phi_1 + (\alpha_1 - \alpha_4)] \\
Z_{30} &= \phi_1^3\alpha_4\phi_2 - \alpha_4\phi_2(1 - (\alpha_1 - \alpha_4))[\phi_1^2 + \phi_1(\alpha_1 - \alpha_4) + (\alpha_1 - \alpha_4)^2] \\
Z_{31} &= -\phi_2(\phi_1^4\alpha_4 + \alpha_3\beta_5) \\
&\quad - \alpha_4\phi_2(1 - (\alpha_1 - \alpha_4))[\phi_1^3 + \phi_1^2(\alpha_1 - \alpha_4) + \phi_1(\alpha_1 - \alpha_4)^2 + (\alpha_1 - \alpha_4)^3]
\end{aligned}
$$

$$
\begin{aligned}
Z_{32} &= 1 \\
Z_{33} &= (\alpha_1 - \alpha_4) \\
Z_{34} &= (\alpha_1 - \alpha_4)^2 \\
Z_{35} &= (\alpha_1 - \alpha_4)^3 \\
Z_{36} &= (\alpha_1 - \alpha_4)^4 \\
Z_{37} &= \alpha_3 \\
Z_{38} &= \alpha_4\phi_3(1-\rho) \\
Z_{39} &= [\alpha_4\phi_3\rho - \alpha_4\phi_3(1-(\alpha_1-\alpha_4))](1-\rho) \\
Z_{40} &= \alpha_4 \\
Z_{41} &= -\alpha_4(1-(\alpha_1-\alpha_4)) \\
Z_{42} &= \phi_1^2\alpha_4 - \alpha_4(1-(\alpha_1-\alpha_4))(\phi_1+(\alpha_1-\alpha_4)) \\
Z_{43} &= \phi_1^3\alpha_4 - \alpha_4[1-(\alpha_1-\alpha_4)][\phi_1^2+\phi_1(\alpha_1-\alpha_4)+(\alpha_1-\alpha_4)^2] \\
Z_{44} &= \phi_1^4\alpha_4 + \alpha_3\beta_5 - \alpha_4[1-(\alpha_1-\alpha_4)][\phi_1^3+\phi_1^2(\alpha_1-\alpha_4)+\phi_1(\alpha_1-\alpha_4)^2+(\alpha_1-\alpha_4)^3]
\end{aligned}
$$

Setting $i_{t-4} = i_{t-5} = i_{t-6} = i_{t-7}$ in (A.25)-(A.28) gives the ex post counterfactual inflation rate for each period as

$$
\begin{aligned}
\pi_t^{xp} &= \pi_t - Z_6(i_{t-4} - i_{t-7}) - Z_7(i_{t-5} - i_{t-7}) - Z_8(i_{t-6} - i_{t-7}) \\
&= \pi_t - Z_6\Delta^3 i_{t-4} - Z_7\Delta^2 i_{t-5} - Z_8\Delta i_{t-6} \qquad \text{(A.29)}
\end{aligned}
$$

Using (A.29) and the definition of EPIP result in the following formulae for ex post inflation pressure as

$$
\begin{aligned}
EPIP_t &= \pi_t^{xp} - \pi_{t-1} \\
&= \Delta\pi_t - Z_6\Delta^3 i_{t-4} - Z_7\Delta^2 i_{t-5} - Z_8\Delta i_{t-6} \qquad \text{(A.30)}
\end{aligned}
$$

Solving for ex ante inflation pressure requires the expectations terms that appear in (A.25)-(A.28) represented as functions of i_{t-4} and earlier. I use the MSV solutions (VII.8)-(VII.10) and (A.34) to express all of the expectations in terms of i_{t-4} and earlier. The MSV solutions are given by:

$$\begin{aligned}\pi_t &= g_0 + g_1\pi_{t-1} + g_2 y_{t-1} + g_3 i_{t-1} + g_4 e_{t-1} + g_5\pi^*_{t-1} + g_6 i^*_{t-1} + g_7\pi_{t-2} + g_8 y_{t-2} \\ &\quad + g_9 y_{t-3} + g_{10} y_{t-4} + g_{11} y_{t-5} + g_{12} y_{t-6} + g_{13} i_{t-2} + g_{14} i_{t-3} + g_{15} e_{t-3} + g_{16}\pi^*_{t-2} \\ &\quad - g_{17}\epsilon_t - g_{18}\eta_t - g_{19}\sigma_t - g_{20}\nu_t - g_{21}\epsilon^*_t - g_{22}\sigma^*_t \end{aligned} \tag{A.31}$$

$$\begin{aligned}y_t &= h_0 + h_1\pi_{t-1} + h_2 y_{t-1} + h_3 i_{t-1} + h_4 e_{t-1} + h_5\pi^*_{t-1} + h_6 i^*_{t-1} + h_7\pi_{t-2} + h_8 y_{t-2} \\ &\quad + h_9 y_{t-3} + h_{10} y_{t-4} + h_{11} y_{t-5} + h_{12} y_{t-6} + h_{13} i_{t-2} + h_{14} i_{t-3} + h_{15} e_{t-3} + h_{16}\pi^*_{t-2} \\ &\quad - h_{17}\epsilon_t - h_{18}\eta_t - h_{19}\sigma_t - h_{20}\nu_t - h_{21}\epsilon^*_t - h_{22}\sigma^*_t \end{aligned} \tag{A.32}$$

$$\begin{aligned}e_t &= s_0 + s_1\pi_{t-1} + s_2 y_{t-1} + s_3 i_{t-1} + s_4 e_{t-1} + s_5\pi^*_{t-1} + s_6 i^*_{t-1} + s_7\pi_{t-2} + s_8 y_{t-2} \\ &\quad + s_9 y_{t-3} + s_{10} y_{t-4} + s_{11} y_{t-5} + s_{12} y_{t-6} + s_{13} i_{t-2} + s_{14} i_{t-3} + s_{15} e_{t-3} + s_{16}\pi^*_{t-2} \\ &\quad - s_{17}\epsilon_t - s_{18}\eta_t - s_{19}\sigma_t - s_{20}\nu_t - s_{21}\epsilon^*_t - s_{22}\sigma^*_t \end{aligned} \tag{A.33}$$

$$\begin{aligned}i_t &= k_0 + k_1\pi_{t-1} + k_2 y_{t-1} + k_3 i_{t-1} + k_4 e_{t-1} + k_5\pi^*_{t-1} + k_6 i^*_{t-1} + k_7\pi_{t-2} + k_8 y_{t-2} \\ &\quad + k_9 y_{t-3} + k_{10} y_{t-4} + k_{11} y_{t-5} + k_{12} y_{t-6} + k_{13} i_{t-2} + k_{14} i_{t-3} + k_{15} e_{t-3} + k_{16}\pi^*_{t-2} \\ &\quad - k_{17}\epsilon_t - k_{18}\eta_t - k_{19}\sigma_t - k_{20}\nu_t - k_{21}\epsilon^*_t - k_{22}\sigma^*_t \end{aligned} \tag{A.34}$$

Expressing the expectations in terms of i_{t-4} and earlier is straightforward but extremely tedious. Using (A.31)-(A.34) and after numerous reverse substitutions of the type described in Appendix A.1, I obtain each of the expectations term in (A.25)-(A.28) expressed in terms of i_{t-4} and earlier.

In order to be able conduct the counterfactual experiment described in Chapter IV, the counterfactual inflation rates, π_t^{xa}, for each period must be obtained. Under rational expectations, substituting the expectations that were expressed in terms of i_{t-4} and earlier into (A.25)-(A.28) and setting $i_{t-4} = i_{t-5} = i_{t-6} = i_{t-7}$ yields the following counterfactual inflation rates for period I-IV.

$$\pi_t^{xa,I} = \pi_t - (Z_6 + Z_6^{xa,I})\Delta^3 i_{t-4} - (Z_7 + Z_7^{xa,I})\Delta^2 i_{t-5} - (Z_8 + Z_8^{xa,I})\Delta i_{t-6} \tag{A.35}$$

$$\pi_t^{xa,II} = \pi_t - (Z_6 + Z_6^{xa,II})\Delta^3 i_{t-4} - (Z_7 + Z_7^{xa,II})\Delta^2 i_{t-5} - (Z_8 + Z_8^{xa,II})\Delta i_{t-6} \quad (A.36)$$

$$\pi_t^{xa,III} = \pi_t - (Z_6 + Z_6^{xa,III})\Delta^3 i_{t-4} - (Z_7 + Z_7^{xa,III})\Delta^2 i_{t-5} - (Z_8 + Z_8^{xa,III})\Delta i_{t-6} \quad (A.37)$$

$$\pi_t^{xa,IV} = \pi_t - (Z_6 + Z_6^{xa,IV})\Delta^3 i_{t-4} - (Z_7 + Z_7^{xa,IV})\Delta^2 i_{t-5} - (Z_8 + Z_8^{xa,IV})\Delta i_{t-6} \quad (A.38)$$

Using (A.35)-(A.38) and the definition of EAIP result in the following formulae for ex ante inflation pressure for each period

$$\begin{aligned} EAIP_t^I &= \pi_t^{xa,I} - \pi_{t-1} \qquad (A.39) \\ &= \Delta\pi_t - (Z_6 + Z_6^{xa,I})\Delta^3 i_{t-4} - (Z_7 + Z_7^{xa,I})\Delta^2 i_{t-5} - (Z_8 + Z_8^{xa,I})\Delta i_{t-6} \end{aligned}$$

$$\begin{aligned} EAIP_t^{II} &= \pi_t^{xa,II} - \pi_{t-1} \qquad (A.40) \\ &= \Delta\pi_t - (Z_6 + Z_6^{xa,II})\Delta^3 i_{t-4} - (Z_7 + Z_7^{xa,II})\Delta^2 i_{t-5} - (Z_8 + Z_8^{xa,II})\Delta i_{t-6} \end{aligned}$$

$$\begin{aligned} EAIP_t^{III} &= \pi_t^{xa,III} - \pi_{t-1} \qquad (A.41) \\ &= \Delta\pi_t - (Z_6 + Z_6^{xa,III})\Delta^3 i_{t-4} - (Z_7 + Z_7^{xa,III})\Delta^2 i_{t-5} - (Z_8 + Z_8^{xa,III})\Delta i_{t-6} \end{aligned}$$

$$\begin{aligned} EAIP_t^{IV} &= \pi_t^{xa,IV} - \pi_{t-1} \qquad (A.42) \\ &= \Delta\pi_t - (Z_6 + Z_6^{xa,IV})\Delta^3 i_{t-4} - (Z_7 + Z_7^{xa,IV})\Delta^2 i_{t-5} - (Z_8 + Z_8^{xa,IV})\Delta i_{t-6} \end{aligned}$$

where

$$
\begin{aligned}
Z_6^{xa,I} &= Z_{20}Q_9^{''} + Z_{21}M_9^{'} + Z_{22}D_9^{'} + Z_{23}A_9^{'} + Z_{24}B_9^{'} + Z_{26}r_9^{'} + Z_{27}\lambda_9^{''} + Z_{28}n_9^{'} \\
&\quad + Z_{29}p_9^{'} + Z_{30}L_9^{'} \\
Z_7^{xa,I} &= Z_{20}Q_{10}^{''} + Z_{21}M_{10}^{'} + Z_{22}D_{10}^{'} + Z_{23}A_{10}^{'} + Z_{24}B_{10}^{'} + Z_{26}r_{10}^{'} + Z_{27}\lambda_{10}^{''} + Z_{28}n_{10}^{'} \\
&\quad + Z_{29}p_{10}^{'} + Z_{30}L_{10}^{'} + Z_{31}N_9^{'} \\
Z_8^{xa,I} &= Z_{20}Q_{11}^{''} + Z_{21}M_{11}^{'} + Z_{22}D_{11}^{'} + Z_{23}A_{11}^{'} + Z_{24}B_{11}^{'} + Z_{25}g_3 + Z_{26}r_{11}^{'} + Z_{27}\lambda_{11}^{''} \\
&\quad + Z_{28}n_{11}^{'} + Z_{29}p_{11}^{'} + Z_{30}L_{11}^{'} + Z_{31}N_{10}^{'} \\
Z_6^{xa,II} &= Z_{20}Q_9^{''} + Z_{21}M_9^{'} + Z_{22}^aD_9^{'} + Z_{22}^bc_9 + Z_{23}^aA_9^{'} + Z_{23}^bY_9^{'} + Z_{24}B_9^{'} + Z_{26}r_9^{'} + Z_{27}\lambda_9^{''} \\
&\quad + Z_{28}n_9^{'} + Z_{29}p_9^{'} + Z_{30}L_9^{'} \\
Z_7^{xa,II} &= Z_{20}Q_{10}^{''} + Z_{21}M_{10}^{'} + Z_{22}^aD_{10}^{'} + Z_{22}^bc_{10} + Z_{23}^aA_{10}^{'} + Z_{23}^bY_{10}^{'} + Z_{24}B_{10}^{'} + Z_{26}r_{10}^{'} \\
&\quad + Z_{27}\lambda_{10}^{''} + Z_{28}n_{10}^{'} + Z_{29}p_{10}^{'} + Z_{30}L_{10}^{'} + Z_{31}N_9 \\
Z_8^{xa,II} &= Z_{20}Q_{11}^{''} + Z_{21}M_{11}^{'} + Z_{22}^aD_{11}^{'} + Z_{22}^bc_{11} + Z_{23}^aA_{11}^{'} + Z_{23}^bY_{11}^{'} + Z_{24}B_{11}^{'} + Z_{25}g_3 \\
&\quad + Z_{26}r_{11}^{'} + Z_{27}\lambda_{111}^{''} + Z_{28}n_{11}^{'} + Z_{29}p_{11}^{'} + Z_{30}L_{11}^{'} + Z_{31}N_{10} \\
Z_6^{xa,III} &= Z_{20}Q_9^{''} + Z_{21}M_9^{'} + Z_{22}D_9^{'} + Z_{23}A_9^{'} + Z_{24}B_9^{'} + Z_{26}r_9^{'} + Z_{27}\lambda_9^{''} + Z_{28}n_9^{'} \\
&\quad + Z_{29}p_9^{'} + Z_{30}L_9^{'} \\
Z_7^{xa,III} &= Z_{20}Q_{10}^{''} + Z_{21}M_{10}^{'} + Z_{22}D_{10}^{'} + Z_{23}A_{10}^{'} + Z_{24}B_{10}^{'} + Z_{26}r_{10}^{'} + Z_{27}\lambda_{10}^{''} + Z_{28}n_{10}^{'} \\
&\quad + Z_{29}p_{10}^{'} + Z_{30}L_{10}^{'} + Z_{31}N_9^{'} \\
Z_8^{xa,III} &= Z_{20}Q_{11}^{''} + Z_{21}M_{11}^{'} + Z_{22}D_{11}^{'} + Z_{23}A_{11}^{'} + Z_{24}B_{11}^{'} + Z_{25}g_3 + Z_{26}r_{11}^{'} + Z_{27}\lambda_{11}^{''} \\
&\quad + Z_{28}n_{11}^{'} + Z_{29}p_{11}^{'} + Z_{30}L_{11}^{'} + Z_{31}N_{10}^{'} \\
Z_6^{xa,IV} &= Z_{20}Q_9^{''} + Z_{21}M_9^{'} + Z_{22}^aD_9^{'} + Z_{22}^bc_9 + Z_{23}^aA_9^{'} + Z_{23}^bY_9^{'} + Z_{24}B_9^{'} + Z_{26}^ar_9^{'} + Z_{26}^bf_9^{'} \\
&\quad + Z_{26}^ce_9^{'} + Z_{27}\lambda_9^{''} + Z_{28}n_9^{'} + Z_{29}p_9^{'} + Z_{30}L_9^{'} \\
Z_7^{xa,IV} &= Z_{20}Q_{10}^{''} + Z_{21}M_{10}^{'} + Z_{22}^aD_{10}^{'} + Z_{22}^bc_{10} + Z_{23}^aA_{10}^{'} + Z_{23}^bY_{10}^{'} + Z_{24}B_{10}^{'} + Z_{26}^ar_{10}^{'} \\
&\quad + Z_{26}^bf_{10}^{'} + Z_{26}^ce_{10}^{'} + Z_{27}\lambda_{10}^{''} + Z_{28}n_{10}^{'} + Z_{29}p_{10}^{'} + Z_{30}L_{10}^{'} + Z_{31}N_9 \\
Z_8^{xa,IV} &= Z_{20}Q_{11}^{''} + Z_{21}M_{11}^{'} + Z_{22}^aD_{11}^{'} + Z_{22}^bc_{11} + Z_{23}^aA_{11}^{'} + Z_{23}^bY_{11}^{'} + Z_{24}B_{11}^{'} + Z_{25}g_3 \\
&\quad + Z_{26}^ar_{11}^{'} + Z_{26}^bf_{11}^{'} + Z_{26}^ce_{11}^{'} + Z_{27}\lambda_{11}^{''} + Z_{28}n_{11}^{'} + Z_{29}p_{11}^{'} + Z_{30}L_{11}^{'} + Z_{31}N_{10}
\end{aligned}
$$

The coefficients, $Q_i^{''}$, $M_i^{'}$, $D_i^{'}$, $A_i^{'}$, $B_i^{'}$, $r_i^{'}$, $\lambda_i^{''}$, $n_i^{'}$, $p_i^{'}$, $L_i^{'}$, $N_j^{'}$, $c_i^{'}$, $Y_i^{'}$, $f_i^{'}$, and $e_i^{'}$, for $i = 9, 10, 11$ and $j = 9, 10$ are complex combinations of the MSV solution values displayed in Table VIII.1-VIII.4.

Under adaptive learning, I use least squares algorithm to estimate forecast series corresponding the private agents's expectations. However, the monetary authority is assumed to have rational expectations. In (A.25)-(A.28), all expectation terms are pooled together. I first re-write (A.25)-(A.28) distinguishing between the private agents' and the monetary authority's expectations denoted by $\tilde{E}$ and E respectively.

$$\begin{aligned}
\pi_t^I \quad = \quad & Z_0 + Z_1\pi_{t-5} + \sum_{j=5}^{j=8} Z_{j-3}y_{t-j} + \sum_{j=4}^{j=6} Z_{j+2}i_{t-j} + Z_9e_{t-6} + \sum_{j=1}^{j=5} Z_{j+9}\pi^*_{t-j} + \sum_{j=2}^{j=6} Z_{j+13}i^*_{t-j} \\
& + \sum_{j=0}^{j=1} Z_{j+20}\tilde{E}_{t-j}\pi_{t+2-j} + Z_{22}^{'}\tilde{E}_{t-2}\pi_t + Z_{22}^{''}E_{t-2}\pi_t + Z_{23}^{'}\tilde{E}_{t-3}\pi_{t-1} + Z_{23}^{''}E_{t-3}\pi_{t-1} \\
& + Z_{24}\tilde{E}_{t-4}\pi_{t-2} + Z_{25}\tilde{E}_{t-6}\pi_{t-5} + Z_{26}\tilde{E}_{t-4}y_{t-3} + \sum_{j=1}^{j=5} Z_{j+26}\tilde{E}_{t-j}e_{t+1-j} \\
& + \sum_{j=0}^{j=4} Z_{j+32}\epsilon_{t-j} + Z_{37}\eta_{t-4} + \sum_{j=2}^{j=3} Z_{j+36}\sigma_{t-j} + \sum_{j=1}^{j=5} Z_{j+39}\nu_{t-j} \qquad \text{(A.43)}
\end{aligned}$$

$$\begin{aligned}
\pi_t^{II} \quad = \quad & Z_0 + Z_1\pi_{t-5} + \sum_{j=5}^{j=8} Z_{j-3}y_{t-j} + \sum_{j=4}^{j=6} Z_{j+2}i_{t-j} + Z_9e_{t-6} + \sum_{j=1}^{j=5} Z_{j+9}\pi^*_{t-j} \\
& + \sum_{j=2}^{j=6} Z_{j+13}i^*_{t-j} + \sum_{j=0}^{j=1} Z_{j+20}\tilde{E}_{t-j}\pi_{t+2-j} + Z_{22}^{a}\tilde{E}_{t-2}\pi_t + Z_{22}^{b}E_{t-2}\pi_{t+1} \\
& Z_{23}^{a}\tilde{E}_{t-3}\pi_{t-1} + Z_{23}^{b}E_{t-3}\pi_t + Z_{24}\tilde{E}_{t-4}\pi_{t-2} + Z_{25}\tilde{E}_{t-6}\pi_{t-5} + Z_{26}\tilde{E}_{t-4}y_{t-3} \\
& + \sum_{j=1}^{j=5} Z_{j+26}\tilde{E}_{t-j}e_{t+1-j} + \sum_{j=0}^{j=4} Z_{j+32}\epsilon_{t-j} + Z_{37}\eta_{t-4} + \sum_{j=2}^{j=3} Z_{j+36}\sigma_{t-j} \\
& + \sum_{j=1}^{j=5} Z_{j+39}\nu_{t-j} \qquad \text{(A.44)}
\end{aligned}$$

$$\begin{aligned}
\pi_t^{III} \quad = \quad & Z_0^{'} + Z_1\pi_{t-5} + \sum_{j=5}^{j=6} Z_{j-3}y_{t-j} + Z_4^{'}y_{t-7} + Z_5^{a}y_{t-8} + Z_5^{b}y_{t-9} + \sum_{j=4}^{j=6} Z_{j+2}i_{t-j} + Z_9e_{t-6} \\
& + \sum_{j=1}^{j=5} Z_{j+9}\pi^{*}_{t-j} + \sum_{j=2}^{j=6} Z_{j+13}i^{*}_{t-j} + \sum_{j=0}^{j=1} Z_{j+20}\tilde{E}_{t-j}\pi_{t+2-j} + Z_{22}^{'}\tilde{E}_{t-2}\pi_t + Z_{22}^{''}E_{t-2}\pi_t \\
& + Z_{23}^{'}\tilde{E}_{t-3}\pi_{t-1} + Z_{23}^{''}E_{t-3}\pi_{t-1} + Z_{24}\tilde{E}_{t-4}\pi_{t-2} + Z_{25}\tilde{E}_{t-6}\pi_{t-5} + Z_{26}\tilde{E}_{t-4}y_{t-3} \\
& + \sum_{j=1}^{j=5} Z_{j+26}\tilde{E}_{t-j}e_{t+1-j} + \sum_{j=0}^{j=4} Z_{j+32}\epsilon_{t-j} + Z_{37}\eta_{t-4} + \sum_{j=2}^{j=3} Z_{j+36}\sigma_{t-j} \\
& + \sum_{j=1}^{j=5} Z_{j+39}\nu_{t-j} \qquad \text{(A.45)}
\end{aligned}$$

$$\begin{aligned}
\pi_t^{IV} \quad = \quad & Z_0^{'} + Z_1\pi_{t-5} + \sum_{j=5}^{j=6} Z_{j-3}y_{t-j} + Z_4^{''}y_{t-7} + Z_5^{''}y_{t-8} + \sum_{j=4}^{j=6} Z_{j+2}i_{t-j} + Z_9e_{t-6} \\
& + \sum_{j=1}^{j=5} Z_{j+9}\pi^{*}_{t-j} + \sum_{j=2}^{j=6} Z_{j+13}i^{*}_{t-j} + \sum_{j=0}^{j=1} Z_{j+20}\tilde{E}_{t-j}\pi_{t+2-j} + Z_{22}^{a}\tilde{E}_{t-2}\pi_t \\
& + Z_{22}^{b}E_{t-2}\pi_{t+1} + Z_{23}^{a}\tilde{E}_{t-3}\pi_{t-1} + Z_{23}^{b}E_{t-3}\pi_t + Z_{24}\tilde{E}_{t-4}\pi_{t-2} + Z_{25}\tilde{E}_{t-6}\pi_{t-5} \\
& + Z_{26}^{a}\tilde{E}_{t-4}y_{t-3} + Z_{26}^{b}E_{t-3}y_{t-2} + Z_{26}^{c}E_{t-2}y_{t-1} + \sum_{j=1}^{j=5} Z_{j+26}\tilde{E}_{t-j}e_{t+1-j} \\
& + \sum_{j=0}^{j=4} Z_{j+32}\epsilon_{t-j} + Z_{37}\eta_{t-4} + \sum_{j=2}^{j=3} Z_{j+36}\sigma_{t-j} + \sum_{j=1}^{j=5} Z_{j+39}\nu_{t-j} \qquad \text{(A.46)}
\end{aligned}$$

where the coefficients, Z, are as defined before.

Deriving the formulae for the ex ante inflation pressure index under adaptive learning requires several ordinary least squares estimations to obtain private agents' forecast series of future expectations and the corresponding counterfactual series. After expressing all expectation terms in (A.43)-(A.46) as functions of i_{t-4} and earlier, I OLS estimate each of the private expectations term, denoted by $\tilde{E}$, to obtain forecast series. I then set $i_{t-4} = i_{t-5} = i_{t-6} = i_{t-7}$ and re-estimate the private expectations to find the corresponding counterfactual series, denoted as $\tilde{E}^{cf}$. When $i_{t-4} = i_{t-5} = i_{t-6} = i_{t-7}$ is set, the counterfactual inflation rates under learning for period I-IV are given by

$$\begin{aligned}
\pi_t^{cf,I} \quad = \quad & \pi_t - (Z_6 + Z_6^{re,I})\Delta^3 i_{t-4} - (Z_7 + Z_7^{re,I})\Delta^2 i_{t-5} - (Z_8 + Z_8^{re,I})\Delta i_{t-6} \\
& - Z_{20}[\tilde{E}_t\pi_{t+2} - \tilde{E}_t^{cf}\pi_{t+2}] - Z_{21}[\tilde{E}_{t-1}\pi_{t+1} - \tilde{E}_{t-1}^{cf}\pi_{t+1}] \\
& - Z_{22}^{'}[\tilde{E}_{t-2}\pi_t - \tilde{E}_{t-2}^{cf}\pi_t] - Z_{23}^{'}[\tilde{E}_{t-3}\pi_{t-1} - \tilde{E}_{t-3}^{cf}\pi_{t-1}] \\
& - Z_{24}[\tilde{E}_{t-4}\pi_{t-2} - \tilde{E}_{t-4}^{cf}\pi_{t-2}] - Z_{25}[\tilde{E}_{t-6}\pi_{t-5} - \tilde{E}_{t-6}^{cf}\pi_{t-5}] \\
& - Z_{26}[\tilde{E}_{t-4}y_{t-3} - \tilde{E}_{t-4}^{cf}y_{t-3}] - Z_{27}[\tilde{E}_{t-1}e_t - \tilde{E}_{t-1}^{cf}e_t] \\
& - Z_{28}[\tilde{E}_{t-2}e_{t-1} - \tilde{E}_{t-2}^{cf}e_{t-1}] - Z_{29}[\tilde{E}_{t-3}e_{t-2} - \tilde{E}_{t-3}^{cf}e_{t-2}] \\
& - Z_{30}[\tilde{E}_{t-4}e_{t-3} - \tilde{E}_{t-4}^{cf}e_{t-3}] - Z_{31}[\tilde{E}_{t-5}e_{t-4} - \tilde{E}_{t-5}^{cf}e_{t-4}] \qquad \text{(A.47)}
\end{aligned}$$

$$\begin{aligned}
\pi_t^{cf,II} \quad = \quad & \pi_t - (Z_6 + Z_6^{re,II})\Delta^3 i_{t-4} - (Z_7 + Z_7^{re,II})\Delta^2 i_{t-5} - (Z_8 + Z_8^{re,II})\Delta i_{t-6} \\
& - Z_{20}[\tilde{E}_t\pi_{t+2} - \tilde{E}_t^{cf}\pi_{t+2}] - Z_{21}[\tilde{E}_{t-1}\pi_{t+1} - \tilde{E}_{t-1}^{cf}\pi_{t+1}] \\
& - Z_{22}^{'}[\tilde{E}_{t-2}\pi_t - \tilde{E}_{t-2}^{cf}\pi_t] - Z_{23}^{'}[\tilde{E}_{t-3}\pi_{t-1} - \tilde{E}_{t-3}^{cf}\pi_{t-1}] \\
& - Z_{24}[\tilde{E}_{t-4}\pi_{t-2} - \tilde{E}_{t-4}^{cf}\pi_{t-2}] - Z_{25}[\tilde{E}_{t-6}\pi_{t-5} - \tilde{E}_{t-6}^{cf}\pi_{t-5}] \\
& - Z_{26}[\tilde{E}_{t-4}y_{t-3} - \tilde{E}_{t-4}^{cf}y_{t-3}] - Z_{27}[\tilde{E}_{t-1}e_t - \tilde{E}_{t-1}^{cf}e_t] \\
& - Z_{28}[\tilde{E}_{t-2}e_{t-1} - \tilde{E}_{t-2}^{cf}e_{t-1}] - Z_{29}[\tilde{E}_{t-3}e_{t-2} - \tilde{E}_{t-3}^{cf}e_{t-2}] \\
& - Z_{30}[\tilde{E}_{t-4}e_{t-3} - \tilde{E}_{t-4}^{cf}e_{t-3}] - Z_{31}[\tilde{E}_{t-5}e_{t-4} - \tilde{E}_{t-5}^{cf}e_{t-4}] \qquad \text{(A.48)}
\end{aligned}$$

$$\begin{aligned}
\pi_t^{cf,III} \quad = \quad & \pi_t - (Z_6 + Z_6^{re,III})\Delta^3 i_{t-4} - (Z_7 + Z_7^{re,III})\Delta^2 i_{t-5} - (Z_8 + Z_8^{re,III})\Delta i_{t-6} \\
& - Z_{20}[\tilde{E}_t\pi_{t+2} - \tilde{E}_t^{cf}\pi_{t+2}] - Z_{21}[\tilde{E}_{t-1}\pi_{t+1} - \tilde{E}_{t-1}^{cf}\pi_{t+1}] \\
& - Z_{22}^{'}[\tilde{E}_{t-2}\pi_t - \tilde{E}_{t-2}^{cf}\pi_t] - Z_{23}^{'}[\tilde{E}_{t-3}\pi_{t-1} - \tilde{E}_{t-3}^{cf}\pi_{t-1}] \\
& - Z_{24}[\tilde{E}_{t-4}\pi_{t-2} - \tilde{E}_{t-4}^{cf}\pi_{t-2}] - Z_{25}[\tilde{E}_{t-6}\pi_{t-5} - \tilde{E}_{t-6}^{cf}\pi_{t-5}] \\
& - Z_{26}[\tilde{E}_{t-4}y_{t-3} - \tilde{E}_{t-4}^{cf}y_{t-3}] - Z_{27}[\tilde{E}_{t-1}e_t - \tilde{E}_{t-1}^{cf}e_t] \\
& - Z_{28}[\tilde{E}_{t-2}e_{t-1} - \tilde{E}_{t-2}^{cf}e_{t-1}] - Z_{29}[\tilde{E}_{t-3}e_{t-2} - \tilde{E}_{t-3}^{cf}e_{t-2}] \\
& - Z_{30}[\tilde{E}_{t-4}e_{t-3} - \tilde{E}_{t-4}^{cf}e_{t-3}] - Z_{31}[\tilde{E}_{t-5}e_{t-4} - \tilde{E}_{t-5}^{cf}e_{t-4}] \qquad \text{(A.49)}
\end{aligned}$$

$$
\begin{aligned}
\pi_t^{cf,IV} \;=\;& \pi_t - (Z_6 + Z_6^{re,IV})\Delta^3 i_{t-4} - (Z_7 + Z_7^{re,IV})\Delta^2 i_{t-5} - (Z_8 + Z_8^{re,IV})\Delta i_{t-6} \\
& - Z_{20}[\tilde{E}_t\pi_{t+2} - \tilde{E}_t^{cf}\pi_{t+2}] - Z_{21}[\tilde{E}_{t-1}\pi_{t+1} - \tilde{E}_{t-1}^{cf}\pi_{t+1}] \\
& - Z_{22}^{'}[\tilde{E}_{t-2}\pi_t - \tilde{E}_{t-2}^{cf}\pi_t] - Z_{23}^{'}[\tilde{E}_{t-3}\pi_{t-1} - \tilde{E}_{t-3}^{cf}\pi_{t-1}] \\
& - Z_{24}[\tilde{E}_{t-4}\pi_{t-2} - \tilde{E}_{t-4}^{cf}\pi_{t-2}] - Z_{25}[\tilde{E}_{t-6}\pi_{t-5} - \tilde{E}_{t-6}^{cf}\pi_{t-5}] \\
& - Z_{26}[\tilde{E}_{t-4}y_{t-3} - \tilde{E}_{t-4}^{cf}y_{t-3}] - Z_{27}[\tilde{E}_{t-1}e_t - \tilde{E}_{t-1}^{cf}e_t] \\
& - Z_{28}[\tilde{E}_{t-2}e_{t-1} - \tilde{E}_{t-2}^{cf}e_{t-1}] - Z_{29}[\tilde{E}_{t-3}e_{t-2} - \tilde{E}_{t-3}^{cf}e_{t-2}] \\
& - Z_{30}[\tilde{E}_{t-4}e_{t-3} - \tilde{E}_{t-4}^{cf}e_{t-3}] - Z_{31}[\tilde{E}_{t-5}e_{t-4} - \tilde{E}_{t-5}^{cf}e_{t-4}] \qquad \text{(A.50)}
\end{aligned}
$$

Using (A.47)-(p8A) and the definition of EAIP yields the following ex ante formulae under adaptive learning for the periods I-IV.

$$
\begin{aligned}
EAIP_t^{I} \;=\;& \pi_t^{cf,I} - \pi_{t-1} \\
=\;& \Delta\pi_t - (Z_6 + Z_6^{re,I})\Delta^3 i_{t-4} - (Z_7 + Z_7^{re,I})\Delta^2 i_{t-5} - (Z_8 + Z_8^{re,I})\Delta i_{t-6} \\
& - Z_{20}[\tilde{E}_t\pi_{t+2} - \tilde{E}_t^{cf}\pi_{t+2}] - Z_{21}[\tilde{E}_{t-1}\pi_{t+1} - \tilde{E}_{t-1}^{cf}\pi_{t+1}] \\
& - Z_{22}^{'}[\tilde{E}_{t-2}\pi_t - \tilde{E}_{t-2}^{cf}\pi_t] - Z_{23}^{'}[\tilde{E}_{t-3}\pi_{t-1} - \tilde{E}_{t-3}^{cf}\pi_{t-1}] \\
& - Z_{24}[\tilde{E}_{t-4}\pi_{t-2} - \tilde{E}_{t-4}^{cf}\pi_{t-2}] - Z_{25}[\tilde{E}_{t-6}\pi_{t-5} - \tilde{E}_{t-6}^{cf}\pi_{t-5}] \\
& - Z_{26}[\tilde{E}_{t-4}y_{t-3} - \tilde{E}_{t-4}^{cf}y_{t-3}] - Z_{27}[\tilde{E}_{t-1}e_t - \tilde{E}_{t-1}^{cf}e_t] \\
& - Z_{28}[\tilde{E}_{t-2}e_{t-1} - \tilde{E}_{t-2}^{cf}e_{t-1}] - Z_{29}[\tilde{E}_{t-3}e_{t-2} - \tilde{E}_{t-3}^{cf}e_{t-2}] \\
& - Z_{30}[\tilde{E}_{t-4}e_{t-3} - \tilde{E}_{t-4}^{cf}e_{t-3}] - Z_{31}[\tilde{E}_{t-5}e_{t-4} - \tilde{E}_{t-5}^{cf}e_{t-4}] \qquad \text{(A.51)}
\end{aligned}
$$

$$
\begin{aligned}
EAIP_t^{II} \;=\;& \pi_t^{cf,II} - \pi_{t-1} \\
=\;& \Delta\pi_t - (Z_6 + Z_6^{re,II})\Delta^3 i_{t-4} - (Z_7 + Z_7^{re,II})\Delta^2 i_{t-5} - (Z_8 + Z_8^{re,II})\Delta i_{t-6} \\
& - Z_{20}[\tilde{E}_t\pi_{t+2} - \tilde{E}_t^{cf}\pi_{t+2}] - Z_{21}[\tilde{E}_{t-1}\pi_{t+1} - \tilde{E}_{t-1}^{cf}\pi_{t+1}] \\
& - Z_{22}^{'}[\tilde{E}_{t-2}\pi_t - \tilde{E}_{t-2}^{cf}\pi_t] - Z_{23}^{'}[\tilde{E}_{t-3}\pi_{t-1} - \tilde{E}_{t-3}^{cf}\pi_{t-1}] \\
& - Z_{24}[\tilde{E}_{t-4}\pi_{t-2} - \tilde{E}_{t-4}^{cf}\pi_{t-2}] - Z_{25}[\tilde{E}_{t-6}\pi_{t-5} - \tilde{E}_{t-6}^{cf}\pi_{t-5}] \\
& - Z_{26}[\tilde{E}_{t-4}y_{t-3} - \tilde{E}_{t-4}^{cf}y_{t-3}] - Z_{27}[\tilde{E}_{t-1}e_t - \tilde{E}_{t-1}^{cf}e_t] \\
& - Z_{28}[\tilde{E}_{t-2}e_{t-1} - \tilde{E}_{t-2}^{cf}e_{t-1}] - Z_{29}[\tilde{E}_{t-3}e_{t-2} - \tilde{E}_{t-3}^{cf}e_{t-2}] \\
& - Z_{30}[\tilde{E}_{t-4}e_{t-3} - \tilde{E}_{t-4}^{cf}e_{t-3}] - Z_{31}[\tilde{E}_{t-5}e_{t-4} - \tilde{E}_{t-5}^{cf}e_{t-4}] \qquad \text{(A.52)}
\end{aligned}
$$

$$\begin{aligned}
EAIP_t^{III} &= \pi_t^{cf,III} - \pi_{t-1} \\
&= \Delta\pi_t - (Z_6 + Z_6^{re,III})\Delta^3 i_{t-4} - (Z_7 + Z_7^{re,III})\Delta^2 i_{t-5} - (Z_8 + Z_8^{re,III})\Delta i_{t-6} \\
&\quad - Z_{20}[\tilde{E}_t\pi_{t+2} - \tilde{E}_t^{cf}\pi_{t+2}] - Z_{21}[\tilde{E}_{t-1}\pi_{t+1} - \tilde{E}_{t-1}^{cf}\pi_{t+1}] \\
&\quad - Z_{22}'[\tilde{E}_{t-2}\pi_t - \tilde{E}_{t-2}^{cf}\pi_t] - Z_{23}'[\tilde{E}_{t-3}\pi_{t-1} - \tilde{E}_{t-3}^{cf}\pi_{t-1}] \\
&\quad - Z_{24}[\tilde{E}_{t-4}\pi_{t-2} - \tilde{E}_{t-4}^{cf}\pi_{t-2}] - Z_{25}[\tilde{E}_{t-6}\pi_{t-5} - \tilde{E}_{t-6}^{cf}\pi_{t-5}] \\
&\quad - Z_{26}[\tilde{E}_{t-4}y_{t-3} - \tilde{E}_{t-4}^{cf}y_{t-3}] - Z_{27}[\tilde{E}_{t-1}e_t - \tilde{E}_{t-1}^{cf}e_t] \\
&\quad - Z_{28}[\tilde{E}_{t-2}e_{t-1} - \tilde{E}_{t-2}^{cf}e_{t-1}] - Z_{29}[\tilde{E}_{t-3}e_{t-2} - \tilde{E}_{t-3}^{cf}e_{t-2}] \\
&\quad - Z_{30}[\tilde{E}_{t-4}e_{t-3} - \tilde{E}_{t-4}^{cf}e_{t-3}] - Z_{31}[\tilde{E}_{t-5}e_{t-4} - \tilde{E}_{t-5}^{cf}e_{t-4}] \qquad \text{(A.53)}
\end{aligned}$$

$$\begin{aligned}
EAIP_t^{IV} &= \pi_t^{cf,IV} - \pi_{t-1} \\
&= \Delta\pi_t - (Z_6 + Z_6^{re,IV})\Delta^3 i_{t-4} - (Z_7 + Z_7^{re,IV})\Delta^2 i_{t-5} - (Z_8 + Z_8^{re,IV})\Delta i_{t-6} \\
&\quad - Z_{20}[\tilde{E}_t\pi_{t+2} - \tilde{E}_t^{cf}\pi_{t+2}] - Z_{21}[\tilde{E}_{t-1}\pi_{t+1} - \tilde{E}_{t-1}^{cf}\pi_{t+1}] \\
&\quad - Z_{22}'[\tilde{E}_{t-2}\pi_t - \tilde{E}_{t-2}^{cf}\pi_t] - Z_{23}'[\tilde{E}_{t-3}\pi_{t-1} - \tilde{E}_{t-3}^{cf}\pi_{t-1}] \\
&\quad - Z_{24}[\tilde{E}_{t-4}\pi_{t-2} - \tilde{E}_{t-4}^{cf}\pi_{t-2}] - Z_{25}[\tilde{E}_{t-6}\pi_{t-5} - \tilde{E}_{t-6}^{cf}\pi_{t-5}] \\
&\quad - Z_{26}[\tilde{E}_{t-4}y_{t-3} - \tilde{E}_{t-4}^{cf}y_{t-3}] - Z_{27}[\tilde{E}_{t-1}e_t - \tilde{E}_{t-1}^{cf}e_t] \\
&\quad - Z_{28}[\tilde{E}_{t-2}e_{t-1} - \tilde{E}_{t-2}^{cf}e_{t-1}] - Z_{29}[\tilde{E}_{t-3}e_{t-2} - \tilde{E}_{t-3}^{cf}e_{t-2}] \\
&\quad - Z_{30}[\tilde{E}_{t-4}e_{t-3} - \tilde{E}_{t-4}^{cf}e_{t-3}] - Z_{31}[\tilde{E}_{t-5}e_{t-4} - \tilde{E}_{t-5}^{cf}e_{t-4}] \qquad \text{(A.54)}
\end{aligned}$$

where

$Z_6^{re,I} = Z_{22}''D_9' + Z_{23}''A_9'$; $\quad Z_7^{re,I} = Z_{22}''D_{10}' + Z_{23}''A_{10}'$; $\quad Z_8^{re,I} = Z_{22}''D_{11}' + Z_{23}''A_{11}'$

$Z_6^{re,II} = Z_{22}^b c_9 + Z_{23}^b Y_9'$; $\quad Z_7^{re,II} = Z_{22}^b c_{10} + Z_{23}^b Y_{10}'$; $\quad Z_8^{re,II} = Z_{22}^b c_{11} + Z_{23}^b Y_{11}'$

$Z_6^{re,III} = Z_{22}''D_9' + Z_{23}''A_9'$; $\quad Z_7^{re,III} = Z_{22}''D_{10}' + Z_{23}''A_{10}'$; $\quad Z_8^{re,III} = Z_{22}''D_{11}' + Z_{23}''A_{11}'$

$Z_6^{re,IV} = Z_{22}^b c_9 + Z_{23}^b Y_9' + Z_{26}^b f_9' + Z_{26}^c e_9'$

$Z_7^{re,IV} = Z_{22}^b c_{10} + Z_{23}^b Y_{10}' + Z_{26}^b f_{10}' + Z_{26}^c e_{10}'$

$Z_8^{re,IV} = Z_{22}^b c_{11} + Z_{23}^b Y_{11}' + Z_{26}^b f_{11}' + Z_{26}^c e_{11}'$

A.7 Technical Appendix to VII.6.2

Following the methodology described in Chapter IV, I express (VII.11) as function of i_{t-6} and earlier. The derivation is extremely tedious. After numerous reverse substitutions of the type described in Appendix A.1, I obtain the following equations for the inflation rate the periods of (II) Dec'98-Oct'00, (III) Mar'01-Sep'03, and (IV) Oct'03-Dec'05. Since there were not announced inflation targets before 1998, I don't derive formulae for the period of Jan'96-Nov'98.

$$\begin{aligned}
\pi_t^{II} = {} & W_0 + W_1\pi_{t-5} + W_2 y_{t-5} + W_3 y_{t-6} + W_4 y_{t-7} + W_5 y_{t-8} + W_6 y_{t-9} + W_7 y_{t-10} \\
& + W_8 i_{t-6} + W_9 e_{t-6} + W_{10}\pi^*_{t-1} + W_{11}\pi^*_{t-2} + W_{12}\pi^*_{t-3} + W_{13}\pi^*_{t-4} + W_{14}\pi^*_{t-5} \\
& + W_{15} i^*_{t-1} + W_{16} i^*_{t-2} + W_{17} i^*_{t-3} + W_{18} i^*_{t-5} + W_{19} i^*_{t-6} + W_{20} E_t\pi_{t+2} \\
& + W_{21} E_{t-1}\pi_{t+1} + W^a_{22} E_{t-2}\pi_t + W^b_{22} E_{t-2}\pi_{t+1} + W^a_{23} E_{t-3}\pi_{t-1} + W^b_{23} E_{t-3}\pi_t \\
& + W^a_{24} E_{t-4}\pi_{t-2} + W^b_{24} E_{t-4}\pi_{t-1} + W_{25} E_{t-5}\pi_{t-2} + W_{26} E_{t-6}\pi_{t-5} + W_{27} E_{t-4} y_{t-3} \\
& + W_{28} E_{t-1} e_t + W_{29} E_{t-2} e_{t-1} + W_{30} E_{t-3} e_{t-3} + W_{31} E_{t-4} e_{t-3} + W_{32} E_{t-5} e_{t-4} \\
& + W_{33}\epsilon_t + W_{34}\epsilon_{t-1} + W_{35}\epsilon_{t-2} + W_{36}\epsilon_{t-3} + W_{37}\epsilon_{t-4} + W_{38}\eta_{t-4} + W_{39}\sigma_{t-2} \\
& + W_{40}\sigma_{t-3} + W_{41}\sigma_{t-4} + W_{42}\sigma_{t-5} + W_{43}\nu_{t-1} + W_{44}\nu_{t-2} + W_{45}\nu_{t-3} \\
& + W_{46}\nu_{t-4} + W_{47}\nu_{t-5}
\end{aligned} \tag{A.55}$$

$$\begin{aligned}
\pi_t^{III} = {} & W_0 + W_1\pi_{t-5} + W_2 y_{t-5} + W_3 y_{t-6} + W'_4 y_{t-7} + W'_5 y_{t-8} + W'_6 y_{t-9} + W'_7 y_{t-10} \\
& + W''_7 y_{t-11} + W_8 i_{t-6} + W_9 e_{t-6} + W_{10}\pi^*_{t-1} + W_{11}\pi^*_{t-2} + W_{12}\pi^*_{t-3} + W_{13}\pi^*_{t-4} \\
& + W_{14}\pi^*_{t-5} + W_{15} i^*_{t-1} + W_{16} i^*_{t-2} + W_{17} i^*_{t-3} + W_{18} i^*_{t-5} + W_{19} i^*_{t-6} + W_{20} E_t\pi_{t+2} \\
& + W_{21} E_{t-1}\pi_{t+1} + W_{22} E_{t-2}\pi_t + W_{23} E_{t-3}\pi_{t-1} + W_{24} E_{t-4}\pi_{t-2} + W_{25} E_{t-5}\pi_{t-2} \\
& + W_{26} E_{t-6}\pi_{t-5} + W_{27} E_{t-4} y_{t-3} + W_{28} E_{t-1} e_t + W_{29} E_{t-2} e_{t-1} + W_{30} E_{t-3} e_{t-3} \\
& + W_{31} E_{t-4} e_{t-3} + W_{32} E_{t-5} e_{t-4} + W_{33}\epsilon_t + W_{34}\epsilon_{t-1} + W_{35}\epsilon_{t-2} + W_{36}\epsilon_{t-3} \\
& + W_{37}\epsilon_{t-4} + W_{38}\eta_{t-4} + W_{39}\sigma_{t-2} + W_{40}\sigma_{t-3} + W_{41}\sigma_{t-4} + W_{42}\sigma_{t-5} \\
& + W_{43}\nu_{t-1} + W_{44}\nu_{t-2} + W_{45}\nu_{t-3} + W_{46}\nu_{t-4} + W_{47}\nu_{t-5}
\end{aligned} \tag{A.56}$$

$$
\begin{aligned}
\pi_t^{IV} &= W_0 + W_1\pi_{t-5} + W_2 y_{t-5} + W_3 y_{t-6} + W_4 y_{t-7} + W_5 y_{t-8} + W_6 y_{t-9} + W_7 y_{t-10} \\
&\quad + W_8 i_{t-6} + W_9 e_{t-6} + W_{10}\pi^*_{t-1} + W_{11}\pi^*_{t-2} + W_{12}\pi^*_{t-3} + W_{13}\pi^*_{t-4} + W_{14}\pi^*_{t-5} \\
&\quad + W_{15} i^*_{t-1} + W_{16} i^*_{t-2} + W_{17} i^*_{t-3} + W_{18} i^*_{t-5} + W_{19} i^*_{t-6} + W_{20} E_t\pi_{t+2} \\
&\quad + W_{21} E_{t-1}\pi_{t+1} + W^a_{22} E_{t-2}\pi_t + W^b_{22} E_{t-2}\pi_{t+1} + W^a_{23} E_{t-3}\pi_{t-1} + W^b_{23} E_{t-3}\pi_t \\
&\quad + W^a_{24} E_{t-4}\pi_{t-2} + W^b_{24} E_{t-4}\pi_{t-1} + W_{25} E_{t-5}\pi_{t-2} + W_{26} E_{t-6}\pi_{t-5} + W^a_{27} E_{t-5} y_{t-4} \\
&\quad + W^b_{27} E_{t-4} y_{t-3} + W^c_{27} E_{t-3} y_{t-2} + W^d_{27} E_{t-2} y_{t-1} + W_{28} E_{t-1} e_t + W_{29} E_{t-2} e_{t-1} \\
&\quad + W_{30} E_{t-3} e_{t-3} + W_{31} E_{t-4} e_{t-3} + W_{32} E_{t-5} e_{t-4} + W_{33}\epsilon_t + W_{34}\epsilon_{t-1} + W_{35}\epsilon_{t-2} \\
&\quad + W_{36}\epsilon_{t-3} + W_{37}\epsilon_{t-4} + W_{38}\eta_{t-4} + W_{39}\sigma_{t-2} + W_{40}\sigma_{t-3} + W_{41}\sigma_{t-4} + W_{42}\sigma_{t-5} \\
&\quad + W_{43}\nu_{t-1} + W_{44}\nu_{t-2} + W_{45}\nu_{t-3} + W_{46}\nu_{t-4} + W_{47}\nu_{t-5} \qquad \text{(A.57)}
\end{aligned}
$$

where

$$
\begin{aligned}
W_0' &= \alpha_3\beta_5 + \alpha_0\left[1 + (\alpha_1-\alpha_4) + (\alpha_1-\alpha_4)^2 + (\alpha_1-\alpha_4)^3 + (\alpha_1-\alpha_4)^4\right] \\
W_0 &= \alpha_3\beta_5 + \alpha_0\left[1 + (\alpha_1-\alpha_4) + (\alpha_1-\alpha_4)^2 + (\alpha_1-\alpha_4)^3 + (\alpha_1-\alpha_4)^4\right] \\
&\quad - \alpha_4\phi_3(1-\rho)\gamma_0 + \gamma_0(1-\rho)\left[\alpha_4\phi_3\rho - \alpha_4\phi_3(1-(\alpha_1-\alpha_4))\right] \\
&\quad + \gamma_0(1-\rho)\left[\alpha_4\phi_3(\rho^2+\phi_1^2) - \alpha_4\phi_3(1-(\alpha_1-\alpha_4))(\alpha_1-\alpha_4+\rho+\phi_1)\right] \\
&\quad + \gamma_0(1-\rho)[\alpha_4\phi_3(\rho^3+\rho\phi_1^2+\phi_1^3) \\
&\qquad\quad - \alpha_4\phi_3(1-(\alpha_1-\alpha_4))(\phi_1^2+(\alpha_1-\alpha_4)^2+\rho(\rho+\phi_1)+(\rho+\phi_1)(\alpha_1-\alpha_4))] \\
W_1 &= (\alpha_1-\alpha_4)^5 - \alpha_3\beta_5 \\
W_2 &= \alpha_3[\beta_1 + (\alpha_1-\alpha_4)] \\
W_3 &= \alpha_3[\beta_2 + (\alpha_1-\alpha_4)^2] \\
W_4 &= \alpha_3(\alpha_1-\alpha_4)^3 + \alpha_4\phi_3(1-\rho)\gamma_y \\
W_4' &= \alpha_3(\alpha_1-\alpha_4)^3 \\
W_5 &= \alpha_3(\alpha_1-\alpha_4)^4 + [\alpha_4\phi_3\rho - \alpha_4\phi_3(1-(\alpha_1-\alpha_4))](1-\rho)\gamma_y \\
W_5' &= \alpha_3(\alpha_1-\alpha_4)^4 + \alpha_4\phi_3(1-\rho)\gamma_y \\
W_6 &= [\alpha_4\phi_3(\rho^2+\phi_1^2) - \alpha_4\phi_3(1-(\alpha_1-\alpha_4))(\rho+\phi_1+(\alpha_1-\alpha_4))](1-\rho)\gamma_y \\
W_6' &= [\alpha_4\phi_3\rho - \alpha_4\phi_3(1-(\alpha_1-\alpha_4))](1-\rho)\gamma_y \\
W_7 &= [\alpha_4\phi_3(\rho^3+\rho\phi_1^2\phi_1^3) - \alpha_4\phi_3(1-(\alpha_1-\alpha_4)) \\
&\qquad (\phi_1^2+(\alpha_1-\alpha_4)^2+(\rho+\phi_1)(\rho+(\alpha_1-\alpha_4)))](1-\rho)\gamma_y \\
W_7' &= W_6 \\
W_7'' &= W_7 \\
W_8 &= \alpha_4\phi_3(\rho^4+\rho^2\phi_1^2+\rho\phi_1^3+\phi_1^4) + \alpha_3(\beta_5\phi_3+\beta_4) \\
&\quad - \alpha_4\phi_3(1-(\alpha_1-\alpha_4))[((\rho+\phi_1)+(\alpha_1-\alpha_4))(\phi_1^2+(\alpha_1-\alpha_4)^2) \\
&\qquad\qquad + (\rho+\phi_1)(\rho^2+\rho(\alpha_1-\alpha_4))]
\end{aligned}
$$

$$
\begin{aligned}
W_9 &= \alpha_4[\phi_1^5 - (\alpha_1 - \alpha_4)] + \alpha_3\beta_5(\phi_1 - 1) \\
&\quad - \alpha_4[1 - (\alpha_1 - \alpha_4)][\phi_1^4 + \phi_1^3(\alpha_1 - \alpha_4) + \phi_1^2(\alpha_1 - \alpha_4)^2 + \phi_1(\alpha_1 - \alpha_4)^3] \\
W_{10} &= \alpha_4 \\
W_{11} &= \alpha_4(\alpha_1 - \alpha_4) \\
W_{12} &= \alpha_4(\alpha_1 - \alpha_4)^2 \\
W_{13} &= \alpha_4(\alpha_1 - \alpha_4)^3 \\
W_{14} &= \alpha_4(\alpha_1 - \alpha_4)^4 + \alpha_3\beta_5 \\
W_{15} &= -\alpha_4\phi_3 \\
W_{16} &= \alpha_4\phi_3(1 - (\alpha_1 - \alpha_4)) \\
W_{17} &= -\phi_1^2\alpha_4\phi_3 + \alpha_4\phi_3(1 - (\alpha_1 - \alpha_4))[\phi_1 + (\alpha_1 - \alpha_4)] \\
W_{18} &= -\phi_1^3\alpha_4\phi_3 + \alpha_4\phi_3(1 - (\alpha_1 - \alpha_4))[\phi_1^2 + \phi_1(\alpha_1 - \alpha_4) + (\alpha_1 - \alpha_4)^2] \\
W_{19} &= -\phi_3(\phi_1^4\alpha_4 + \alpha_3\beta_5) \\
&\quad + \alpha_4\phi_3(1 - (\alpha_1 - \alpha_4))[\phi_1^3 + \phi_1^2(\alpha_1 - \alpha_4) + \phi_1(\alpha_1 - \alpha_4)^2 + (\alpha_1 - \alpha_4)^3] \\
W_{20} &= \alpha_2 \\
W_{21} &= \alpha_2(\alpha_1 - \alpha_4) \\
W_{22} &= \alpha_2(\alpha_1 - \alpha_4)^2 + \alpha_4\phi_3(1 - \rho)\gamma_\pi \\
W_{22}^a &= \alpha_2(\alpha_1 - \alpha_4)^2 \\
W_{22}^b &= \alpha_4\phi_3(1 - \rho)\gamma_\pi \\
W_{23} &= \alpha_2(\alpha_1 - \alpha_4)^3 + [\alpha_4\phi_3\rho - \alpha_4\phi_3(1 - (\alpha_1 - \alpha_4))](1 - \rho)\gamma_\pi \\
W_{23}^a &= \alpha_2(\alpha_1 - \alpha_4)^3 \\
W_{23}^b &= [\alpha_4\phi_3\rho - \alpha_4\phi_3(1 - (\alpha_1 - \alpha_4))](1 - \rho)\gamma_\pi \\
W_{24} &= \alpha_2(\alpha_1 - \alpha_4)^4 \\
&\quad + [\alpha_4\phi_3(\rho^2 + \phi_1^2) - \alpha_4\phi_3(1 - (\alpha_1 - \alpha_4))(\rho + \phi_1 + (\alpha_1 - \alpha_4))](1 - \rho)\gamma_\pi \\
W_{24}^a &= \alpha_2(\alpha_1 - \alpha_4)^4 \\
W_{24}^b &= [\alpha_4\phi_3(\rho^2 + \phi_1^2) - \alpha_4\phi_3(1 - (\alpha_1 - \alpha_4))(\rho + \phi_1 + (\alpha_1 - \alpha_4))](1 - \rho)\gamma_\pi \\
W_{25} &= [\alpha_4\phi_3(\rho^3 + \rho\phi_1^2 + \phi_1^3) \\
&\quad - \alpha_4\phi_3(1 - (\alpha_1 - \alpha_4))(\phi_1^2 + (\alpha_1 - \alpha_4)^2 + (\rho + \phi_1)(\rho + (\alpha_1 - \alpha_4)))](1 - \rho)\gamma_\pi \\
W_{26} &= -\alpha_3\beta_4 \\
W_{27} &= \alpha_3\beta_3 \\
W_{27}^a &= W_{25}\left(\frac{\gamma_y}{\gamma_\pi}\right) \\
W_{27}^b &= W_{27} + [\alpha_4\phi_3(\rho^2 + \phi_1^2) - \alpha_4\phi_3(1 - (\alpha_1 - \alpha_4))(\rho + \phi_1 + (\alpha_1 - \alpha_4))](1 - \rho)\gamma_\pi \\
W_{27}^c &= [\alpha_4\phi_3\rho - \alpha_4\phi_3(1 - (\alpha_1 - \alpha_4))](1 - \rho)\gamma_y
\end{aligned}
$$

$$
\begin{aligned}
W_{27}^{d} &= \alpha_4\phi_3(1-\rho)\gamma_y \\
W_{28} &= \alpha_4\phi_2 \\
W_{29} &= -\alpha_4\phi_2(1-(\alpha_1-\alpha_4)) \\
W_{30} &= \phi_1^2\alpha_4\phi_2-\alpha_4\phi_2(1-(\alpha_1-\alpha_4))[\phi_1+(\alpha_1-\alpha_4)] \\
W_{31} &= \phi_1^3\alpha_4\phi_2-\alpha_4\phi_2(1-(\alpha_1-\alpha_4))[\phi_1^2+\phi_1(\alpha_1-\alpha_4)+(\alpha_1-\alpha_4)^2] \\
W_{32} &= -\phi_2(\phi_1^4\alpha_4+\alpha_3\beta_5) \\
&\qquad\qquad -\alpha_4\phi_2(1-(\alpha_1-\alpha_4))[\phi_1^3+\phi_1^2(\alpha_1-\alpha_4)+\phi_1(\alpha_1-\alpha_4)^2+(\alpha_1-\alpha_4)^3] \\
W_{33} &= 1 \\
W_{34} &= (\alpha_1-\alpha_4) \\
W_{35} &= (\alpha_1-\alpha_4)^2 \\
W_{36} &= (\alpha_1-\alpha_4)^3 \\
W_{37} &= (\alpha_1-\alpha_4)^4 \\
W_{38} &= \alpha_3 \\
W_{39} &= \alpha_4\phi_3(1-\rho) \\
W_{40} &= [\alpha_4\phi_3\rho-\alpha_4\phi_3(1-(\alpha_1-\alpha_4))](1-\rho) \\
W_{41} &= [\alpha_4\phi_3(\rho^2+\phi_1^2)-\alpha_4\phi_3(1-(\alpha_1-\alpha_4))(\rho+\phi_1+(\alpha_1-\alpha_4))](1-\rho)\gamma_\pi \\
W_{42} &= [\alpha_4\phi_3(\rho^3+\rho\phi_1^2+\phi_1^3) \\
&\qquad -\alpha_4\phi_3(1-(\alpha_1-\alpha_4))(\phi_1^2+(\alpha_1-\alpha_4)^2+(\rho+\phi_1)(\rho+(\alpha_1-\alpha_4)))](1-\rho)\gamma_\pi \\
W_{43} &= \alpha_4 \\
W_{44} &= -\alpha_4[1-(\alpha_1-\alpha_4)] \\
W_{45} &= \phi_1^2\alpha_4-\alpha_4[1-(\alpha_1-\alpha_4)][\phi_1+(\alpha_1-\alpha_4)] \\
W_{46} &= \phi_1^3\alpha_4-\alpha_4[1-(\alpha_1-\alpha_4)][\phi_1^2+\phi_1(\alpha_1-\alpha_4)+(\alpha_1-\alpha_4)^2] \\
W_{47} &= \phi_1^4\alpha_4+\alpha_3\beta_5-\alpha_4[1-(\alpha_1-\alpha_4)][\phi_1^3+\phi_1^2(\alpha_1-\alpha_4)+\phi_1(\alpha_1-\alpha_4)^2+(\alpha_1-\alpha_4)^3]
\end{aligned}
$$

Setting $i_{t-6} = i_{t-7}$ in (A.55)-(A.57) while holding the post-policy expectations constant produces counter factual inflation rate of $\pi_t^{cf} = \pi_t - W_8\Delta i_{t-6}$. Using the counterfactual inflation rate, the measure for expectations of inflation under true credibility is obtained as

$$
\begin{aligned}
XITC_t &= \pi_t^{cf} - \pi_{t-1} \\
&= \Delta\pi_t - W_8\Delta i_{t-6} \qquad \text{(A.58)}
\end{aligned}
$$

Taking expectation of both sides of (A.55)-(A.57) conditional on the information available in period $t-6$ results in:

$$
\begin{aligned}
E_{t-6}\pi_t^{II} \;=\;& W_0 + W_1 E_{t-6}\pi_{t-5} + W_2 E_{t-6}y_{t-5} + W_3 y_{t-6} + W_4 y_{t-7} + W_5 y_{t-8} + W_6 y_{t-9} \\
& + W_7 y_{t-10} + W_8 i_{t-6} + W_9 e_{t-6} + W_{10} E_{t-6}\pi^*_{t-1} + W_{11} E_{t-6}\pi^*_{t-2} \\
& + W_{12} E_{t-6}\pi^*_{t-3} + W_{13} E_{t-6}\pi^*_{t-4} + W_{14} E_{t-6}\pi^*_{t-5} + W_{15} E_{t-6} i^*_{t-1} + W_{16} E_{t-6} i^*_{t-2} \\
& + W_{17} E_{t-6} i^*_{t-3} + W_{18} E_{t-6} i^*_{t-5} + W_{19} i^*_{t-6} + W_{20} E_{t-6}[E_t \pi_{t+2}] \\
& + W_{21} E_{t-6}[E_{t-1}\pi_{t+1}] + W^a_{22} E_{t-6}[E_{t-2}\pi_t] + W^b_{22} E_{t-6}[E_{t-2}\pi_{t+1}] \\
& + W^a_{23} E_{t-6}[E_{t-3}\pi_{t-1}] + W^b_{23} E_{t-6}[E_{t-3}\pi_t] + W^a_{24} E_{t-6}[E_{t-4}\pi_{t-2}] \\
& + W^b_{24} E_{t-6}[E_{t-4}\pi_{t-1}] + W_{25} E_{t-6}[E_{t-5}\pi_{t-2}] + W_{26} E_{t-6}[E_{t-6}\pi_{t-5}] \\
& + W_{27} E_{t-6}[E_{t-4} y_{t-3}] + W_{28} E_{t-6}[E_{t-1} e_t] + W_{29} E_{t-6}[E_{t-2} e_{t-1}] \\
& + W_{30} E_{t-6}[E_{t-3} e_{t-3}] + W_{31} E_{t-6}[E_{t-4} e_{t-3}] + W_{32} E_{t-6}[E_{t-5} e_{t-4}]
\end{aligned} \tag{A.59}
$$

$$
\begin{aligned}
E_{t-6}\pi_t^{III} \;=\;& W_0 + W_1 E_{t-6}\pi_{t-5} + W_2 E_{t-6}y_{t-5} + W_3 y_{t-6} + W_4' y_{t-7} + W_5' y_{t-8} + W_6' y_{t-9} \\
& + W_7' y_{t-10} + W_7'' y_{t-11} + W_8 i_{t-6} + W_9 e_{t-6} + W_{10} E_{t-6}\pi^*_{t-1} + W_{11} E_{t-6}\pi^*_{t-2} \\
& + W_{12} E_{t-6}\pi^*_{t-3} + W_{13} E_{t-6}\pi^*_{t-4} + W_{14} E_{t-6}\pi^*_{t-5} + W_{15} E_{t-6} i^*_{t-1} + W_{16} E_{t-6} i^*_{t-2} \\
& + W_{17} E_{t-6} i^*_{t-3} + W_{18} E_{t-6} i^*_{t-5} + W_{19} E_{t-6} i^*_{t-6} + W_{20} E_t \pi_{t+2} \\
& + W_{21} E_{t-6}[E_{t-1}\pi_{t+1}] + W_{22} E_{t-6}[E_{t-2}\pi_t] + W_{23} E_{t-6}[E_{t-3}\pi_{t-1}] \\
& + W_{24} E_{t-6}[E_{t-4}\pi_{t-2}] + W_{25} E_{t-6}[E_{t-5}\pi_{t-2}] + W_{26} E_{t-6}[E_{t-6}\pi_{t-5}] \\
& + W_{27} E_{t-6}[E_{t-4} y_{t-3}] + W_{28} E_{t-6}[E_{t-1} e_t] + W_{29} E_{t-6}[E_{t-2} e_{t-1}] \\
& + W_{30} E_{t-6}[E_{t-3} e_{t-3}] + W_{31} E_{t-6}[E_{t-4} e_{t-3}] + W_{32} E_{t-6}[E_{t-5} e_{t-4}]
\end{aligned} \tag{A.60}
$$

$$
\begin{aligned}
E_{t-6}\pi_t^{IV} \;=\;& W_0 + W_1 E_{t-6}\pi_{t-5} + W_2 E_{t-6}y_{t-5} + W_3 y_{t-6} + W_4 y_{t-7} + W_5 y_{t-8} + W_6 y_{t-9} \\
& + W_7 y_{t-10} + W_8 i_{t-6} + W_9 e_{t-6} + W_{10} E_{t-6}\pi^*_{t-1} + W_{11} E_{t-6}\pi^*_{t-2} + W_{12} E_{t-6}\pi^*_{t-3} \\
& + W_{13} E_{t-6}\pi^*_{t-4} + W_{14} E_{t-6}\pi^*_{t-5} + W_{15} E_{t-6} i^*_{t-1} + W_{16} E_{t-6} i^*_{t-2} + W_{17} E_{t-6} i^*_{t-3} \\
& + W_{18} E_{t-6} i^*_{t-5} + W_{19} E_{t-6} i^*_{t-6} + W_{20} E_{t-6}[E_t \pi_{t+2}] + W_{21} E_{t-6}[E_{t-1}\pi_{t+1}] \\
& + W^a_{22} E_{t-6}[E_{t-2}\pi_t] + W^b_{22} E_{t-6}[E_{t-2}\pi_{t+1}] + W^a_{23} E_{t-6}[E_{t-3}\pi_{t-1}] \\
& + W^b_{23} E_{t-6}[E_{t-3}\pi_t] + W^a_{24} E_{t-6}[E_{t-4}\pi_{t-2}] + W^b_{24} E_{t-6}[E_{t-4}\pi_{t-1}] \\
& + W_{25} E_{t-6}[E_{t-5}\pi_{t-2}] + W_{26} E_{t-6}[E_{t-6}\pi_{t-5}] + W^a_{27} E_{t-6}[E_{t-5} y_{t-4}] \\
& + W^b_{27} E_{t-6}[E_{t-4} y_{t-3}] + W^c_{27} E_{t-6}[E_{t-3} y_{t-2}] + W^d_{27} E_{t-6}[E_{t-2} y_{t-1}] \\
& + W_{28} E_{t-6}[E_{t-1} e_t] + W_{29} E_{t-6}[E_{t-2} e_{t-1}] + W_{30} E_{t-6}[E_{t-3} e_{t-3}] \\
& + W_{31} E_{t-6}[E_{t-4} e_{t-3}] + W_{32} E_{t-6}[E_{t-5} e_{t-4}]
\end{aligned} \tag{A.61}
$$

where it has been assumed that the monetary authority observes all contemporaneous variables and

$$E_{t-6}\epsilon_t = E_{t-6}\epsilon_{t-1} = E_{t-6}\epsilon_{t-2} = E_{t-6}\epsilon_{t-3} = E_{t-6}\epsilon_{t-4} = 0$$
$$E_{t-6}\eta_{t-4} = 0$$
$$E_{t-6}\sigma_{t-2} = E_{t-6}\sigma_{t-3} = E_{t-6}\sigma_{t-4} = E_{t-6}\sigma_{t-5} = 0$$
$$E_{t-6}\nu_{t-1} = E_{t-6}\nu_{t-2} = E_{t-6}\nu_{t-3} = E_{t-6}\nu_{t-4} = E_{t-6}\nu_{t-5} = 0$$

Step 1: Under the assumption that the monetary authority announces its inflation targets one period in advance, and that these targets are fully credible, the following must hold: $E_{t-6}[E_t\pi_{t+2}] = \pi^T_{t+2}$, $E_{t-6}[E_{t-1}\pi_{t+1}] = \pi^T_{t+1}$, $E_{t-6}[E_{t-2}\pi_t] = \pi^T_t$, $E_{t-6}[E_{t-2}\pi_{t+1}] = \pi^T_{t+1}$, $E_{t-6}[E_{t-3}\pi_{t-1}] = \pi^T_{t-1}$, $E_{t-6}[E_{t-3}\pi_t] = \pi^T_t$, $E_{t-6}[E_{t-4}\pi_{t-2}] = \pi^T_{t-2}$, $E_{t-6}[E_{t-4}\pi_{t-1}] = \pi^T_{t-1}$, $E_{t-6}[E_{t-5}\pi_{t-2}] = \pi^T_{t-2}$, and $E_{t-6}[E_{t-6}\pi_{t-5}] = \pi^T_{t-5}$. It must also be the case that $E_{t-6}\pi_t = \pi^T_t$ and $E_{t-6}\pi_{t-5} = \pi^T_{t-5}$.

Step 2: After several reverse substitutions I express (A.21) and (A.22) in terms of i^*_{t-6} which then give

$$E_{t-6}\pi^*_{t-5} = \alpha^*_0 + \alpha^*_1\pi^*_{t-6}$$
$$E_{t-6}\pi^*_{t-4} = \alpha^*_0(1 + \alpha^*_1) + (\alpha^*_1)^2\pi^*_{t-6}$$
$$E_{t-6}\pi^*_{t-3} = \alpha^*_0(1 + \alpha^*_1 + (\alpha^*_1)^2) + (\alpha^*_1)^3\pi^*_{t-6}$$
$$E_{t-6}\pi^*_{t-2} = \alpha^*_0(1 + \alpha^*_1 + (\alpha^*_1)^2 + (\alpha^*_1)^3) + (\alpha^*_1)^4\pi^*_{t-6}$$
$$E_{t-6}\pi^*_{t-1} = \alpha^*_0(1 + \alpha^*_1 + (\alpha^*_1)^2 + (\alpha^*_1)^3 + (\alpha^*_1)^4) + (\alpha^*_1)^5\pi^*_{t-6}$$
$$E_{t-6}i^*_{t-5} = \gamma^*_0 + \rho^*_1\pi^*_{t-6}$$
$$E_{t-6}i^*_{t-4} = \gamma^*_0(1 + \rho^*_1) + (\rho^*_1)^2\pi^*_{t-6}$$
$$E_{t-6}i^*_{t-3} = \gamma^*_0(1 + \rho^*_1 + (\rho^*_1)^2) + (\rho^*_1)^3\pi^*_{t-6}$$
$$E_{t-6}i^*_{t-2} = \gamma^*_0(1 + \rho^*_1 + (\rho^*_1)^2 + (\rho^*_1)^3) + (\rho^*_1)^4\pi^*_{t-6}$$

$$E_{t-6}i^*_{t-1} = \gamma^*_0(1 + \rho^*_1 + (\rho^*_1)^2 + (\rho^*_1)^3 + (\rho^*_1)^4) + (\rho^*_1)^5\pi^*_{t-6}$$

Step 3: Using the MSV solutions (A.31)-(A.34), and after many reverse substitutions of the type described in Appendix A.1, the non inflationary expectation terms that appear in (A.55)-(A.57), $E_{t-6}y_{t-5}$, $E_{t-6}[E_{t-5}y_{t-4}]$, $E_{t-6}[E_{t-4}y_{t-3}]$, $E_{t-6}[E_{t-3}y_{t-2}]$, $E_{t-6}[E_{t-2}y_{t-1}]$ $E_{t-6}[E_{t-1}e_t]$, $E_{t-6}[E_{t-2}e_{t-1}]$, $E_{t-6}[E_{t-3}e_{t-2}]$, $E_{t-6}[E_{t-4}e_{t-3}]$, $E_{t-6}[E_{t-5}e_{t-4}]$, can be expressed in terms of i_{t-6} and earlier.

Substituting the outcomes of Step 1-3 into (A.55)-(A.57), and collecting the terms give

$$\begin{aligned}
\pi_t^{T,II} \;=\;& C + (w_2 + w_4h_1)\pi_{t-6} + (w_3 + w_4h_7)\pi_{t-7} + (w_5 + w_4h_2)y_{t-6} + (w_6 + w_4h_8)y_{t-7} \\
&+ (w_7 + w_4h_9)y_{t-8} + (w_8 + w_4h_{10})y_{t-9} + (w_9 + w_4h_{11})y_{t-10} + (w_{10} + w_4h_{12})y_{t-11} \\
&+ (w_{11} + w_4h_3)i^T_{t-6} + (w_{12} + w_4h_{13})i_{t-7} + (w_{13} + w_4h_{14})i_{t-8} + (w_{14} + w_4h_4)e_{t-6} \\
&+ w_{15}e_{t-7} + (w_{16} + w_4h_{15})e_{t-8} + W_{20}\pi^T_{t+2} + (W_{21} + W^b_{22})\pi^T_{t+1} + (W^a_{22} + W^b_{23})\pi^T_t \\
&+ (W^a_{23} + W^b_{24})\pi^T_{t-1} + (W^a_{24} + W_{25})\pi^T_{t-2} + (W_{26} + w_1)\pi^T_{t-5} \\
&+ [w_{17}(\alpha^*_1)^5 + w_{18}(\alpha^*_1)^4 + w_{19}(\alpha^*_1)^3 + w_{20}(\alpha^*_1)^2 + w_{21}\alpha^*_1 + w_{22}]\pi^*_{t-6} + w_{23}\pi^*_{t-7} \\
&+ [w_{24}(\rho^*)^5 + w_{25}(\rho^*)^4 + w_{26}(\rho^*)^3 + w_{27}(\rho^*)^2 + w_{28}\rho^*_1 + w_{29}]i^*_{t-6} \qquad \text{(A.62)}
\end{aligned}$$

$$\begin{aligned}
\pi_t^{T,III} \;=\;& C + (w_2 + w_4h_1)\pi_{t-6} + (w_3 + w_4h_7)\pi_{t-7} + (w_5 + w_4h_2)y_{t-6} + (w_6 + w_4h_8)y_{t-7} \\
&+ (w_7 + w_4h_9)y_{t-8} + (w_8 + w_4h_{10})y_{t-9} + (w_9 + w_4h_{11})y_{t-10} + (w_{10} + w_4h_{12})y_{t-11} \\
&+ (w_{11} + w_4h_3)i^T_{t-6} + (w_{12} + w_4h_{13})i_{t-7} + (w_{13} + w_4h_{14})i_{t-8} + (w_{14} + w_4h_4)e_{t-6} \\
&+ w_{15}e_{t-7} + (w_{16} + w_4h_{15})e_{t-8} + W_{20}\pi^T_{t+2} + W_{21}\pi^T_{t+1} + W_{22}\pi^T_t + W_{23}\pi^T_{t-1} \\
&+ W_{24}\pi^T_{t-2} + W_{25}\pi^T_{t-3} + (W_{26} + w_1)\pi^T_{t-5} \\
&+ [w_{17}(\alpha^*_1)^5 + w_{18}(\alpha^*_1)^4 + w_{19}(\alpha^*_1)^3 + w_{20}(\alpha^*_1)^2 + w_{21}\alpha^*_1 + w_{22}]\pi^*_{t-6} + w_{23}\pi^*_{t-7} \\
&+ [w_{24}(\rho^*)^5 + w_{25}(\rho^*)^4 + w_{26}(\rho^*)^3 + w_{27}(\rho^*)^2 + w_{28}\rho^*_1 + w_{29}]i^*_{t-6} \qquad \text{(A.63)}
\end{aligned}$$

$$
\begin{aligned}
\pi_t^{T,IV} \;=\;& C + (w_2' + w_4' h_1)\pi_{t-6} + (w_3' + w_4' h_7)\pi_{t-7} + (w_5' + w_4' h_2) y_{t-6} + (w_6' + w_4' h_8) y_{t-7} \\
& + (w_7' + w_4' h_9) y_{t-8} + (w_8' + w_4' h_{10}) y_{t-9} + (w_9' + w_4' h_{11}) y_{t-10} + (w_{10}' + w_4' h_{12}) y_{t-11} \\
& + (w_{11}' + w_4' h_3) i_{t-6}^T + (w_{12}' + w_4' h_{13}) i_{t-7} + (w_{13}' + w_4' h_{14}) i_{t-8} + (w_{14}' + w_4' h_4) e_{t-6} \\
& + w_{15}' e_{t-7} + (w_{16}' + w_4' h_{15}) e_{t-8} + W_{20}\pi_{t+2}^T + (W_{21} + W_{22}^b)\pi_{t+1}^T + (W_{22}^a + W_{23}^b)\pi_t^T \\
& + (W_{23}^a + W_{24}^b)\pi_{t-1}^T + (W_{24}^a + W_{25})\pi_{t-2}^T + (W_{26} + w_1')\pi_{t-5}^T \\
& + [w_{17}'(\alpha_1^*)^5 + w_{18}'(\alpha_1^*)^4 + w_{19}'(\alpha_1^*)^3 + w_{20}'(\alpha_1^*)^2 + w_{21}'\alpha_1^* + w_{22}']\pi_{t-6}^* + w_{23}'\pi_{t-7}^* \\
& + [w_{24}'(\rho^*)^5 + w_{25}'(\rho^*)^4 + w_{26}'(\rho^*)^3 + w_{27}'(\rho^*)^2 + w_{28}'\rho_1^* + w_{29}'] i_{t-6}^* \qquad \text{(A.64)}
\end{aligned}
$$

where

$$
\begin{aligned}
C \;=\;& w_0 + w_{17}\alpha_0^*(1 + \alpha_1^* + (\alpha_1^*)^2 + (\alpha_1^*)^3 + (\alpha_1^*)^4) + w_{18}\alpha_0^*(1 + \alpha_1^* + (\alpha_1^*)^2 + (\alpha_1^*)^3) \\
& + w_{19}\alpha_0^*(1 + \alpha_1^* + (\alpha_1^*)^2) + w_{20}\alpha_0^*(1 + \alpha_1^*) + w_{21}\alpha_0^* \\
& + w_{24}\gamma_0^*(1 + \rho^* + (\rho^*)^2 + (\rho^*)^3 + (\rho^*)^4) + w_{25}\gamma_0^*(1 + \rho^* + (\rho^*)^2 + (\rho^*)^3) \\
& + w_{26}\gamma_0^*(1 + \rho^* + (\rho^*)^2) + w_{27}\gamma_0^*(1 + \rho^*) + w_4 h_0 \\
w_0 \;=\;& W_0' + W_{27} r_0'' + W_{28}\lambda_0^b + W_{29} n_0^b + W_{30} p_0^b + W_{31} L_0^b + W_{32} N_0^b \\
w_1 \;=\;& W_1 \\
w_2 \;=\;& W_{27} r_1'' + W_{28}\lambda_1^b + W_{29} n_1^b + W_{30} p_1^b + W_{31} L_1^b + W_{32} N_1^b \\
w_3 \;=\;& W_{27} r_2'' + W_{28}\lambda_2^b + W_{29} n_2^b + W_{30} p_2^b + W_{31} L_2^b + W_{32} N_2^b \\
w_4 \;=\;& W_2 \\
w_5 \;=\;& W_3 + W_{27} r_3'' + W_{28}\lambda_3^b + W_{29} n_3^b + W_{30} p_3^b + W_{31} L_3^b + W_{32} N_3^b \\
w_6 \;=\;& W_4' + W_{27} r_4'' + W_{28}\lambda_4^b + W_{29} n_4^b + W_{30} p_4^b + W_{31} L_4^b + W_{32} N_4^b \\
w_7 \;=\;& W_5' + W_{27} r_5'' + W_{28}\lambda_5^b + W_{29} n_5^b + W_{30} p_5^b + W_{31} L_5^b + W_{32} N_5^b \\
w_8 \;=\;& W_6' + W_{27} r_6'' + W_{28}\lambda_6^b + W_{29} n_6^b + W_{30} p_6^b + W_{31} L_6^b + W_{32} N_6^b \\
w_9 \;=\;& W_7' + W_{27} r_7'' + W_{28}\lambda_7^b + W_{29} n_7^b + W_{30} p_7^b + W_{31} L_7^b + W_{32} N_7^b \\
w_{10} \;=\;& W_7'' + W_{27} r_8'' + W_{28}\lambda_8^b + W_{29} n_8^b + W_{30} p_8^b + W_{31} L_8^b + W_{32} N_8^b \\
w_{11} \;=\;& W_8 + W_{27} r_9'' + W_{28}\lambda_9^b + W_{29} n_9^b + W_{30} p_9^b + W_{31} L_9^b + W_{32} N_9^b \\
w_{12} \;=\;& W_{27} r_{10}'' + W_{28}\lambda_{10}^b + W_{29} n_{10}^b + W_{30} p_{10}^b + W_{31} L_{10}^b + W_{32} N_{10}^b \\
w_{13} \;=\;& W_{27} r_{11}'' + W_{28}\lambda_{11}^b + W_{29} n_{11}^b + W_{30} p_{11}^b + W_{31} L_{11}^b + W_{32} N_{11}^b \\
w_{14} \;=\;& W_9 + W_{27} r_{12}'' + W_{28}\lambda_{12}^b + W_{29} n_{12}^b + W_{30} p_{12}^b + W_{31} L_{12}^b + W_{32} N_{12}^b \\
w_{15} \;=\;& W_{27} r_{13}'' + W_{28}\lambda_{13}^b + W_{29} n_{13}^b + W_{30} p_{13}^b + W_{31} L_{13}^b + W_{32} N_{13}^b \\
w_{16} \;=\;& W_{27} r_{14}'' + W_{28}\lambda_{14}^b + W_{29} n_{14}^b + W_{30} p_{14}^b + W_{31} L_{14}^b + W_{32} N_{14}^b \\
w_{17} \;=\;& W_{10} + W_{28}\lambda_{15}^b \\
w_{18} \;=\;& W_{11} + W_{28}\lambda_{16}^b + W_{29} n_{15}^b \\
w_{19} \;=\;& W_{12} + W_{28}\lambda_{17}^b + W_{29} n_{16}^b + W_{30} p_{15}^b \\
w_{20} \;=\;& W_{13} + W_{27} r_{15}'' + W_{28}\lambda_{18}^b + W_{29} n_{17}^b + W_{30} p_{16}^b + W_{31} L_{15}^b
\end{aligned}
$$

$$
\begin{aligned}
w_{21} &= W_{14} + W_{27}r''_{16} + W_{28}\lambda^b_{19} + W_{29}n^b_{18} + W_{30}p^b_{17} + W_{31}L^b_{16} + W_{32}N^b_{15} \\
w_{22} &= W_{27}r''_{17} + W_{28}\lambda^b_{20} + W_{29}n^b_{19} + W_{30}p^b_{18} + W_{31}L^b_{17} + W_{32}N^b_{16} \\
w_{23} &= W_{27}r''_{18} + W_{28}\lambda^b_{21} + W_{29}n^b_{20} + W_{30}p^b_{19} + W_{31}L^b_{18} + W_{32}N^b_{17} \\
w_{24} &= W_{28}\lambda^b_{22} \\
w_{25} &= W_{15} + W_{28}\lambda^b_{23} + W_{29}n^b_{21} \\
w_{26} &= W_{16} + W_{28}\lambda^b_{24} + W_{29}n^b_{22} + W_{30}p^b_{20} \\
w_{27} &= W_{17} + W_{27}r''_{19} + W_{28}\lambda^b_{25} + W_{29}n^b_{23} + W_{30}p^b_{21} + W_{31}L^b_{19} \\
w_{28} &= W_{18} + W_{27}r''_{20} + W_{28}\lambda^b_{26} + W_{29}n^b_{24} + W_{30}p^b_{22} + W_{31}L^b_{20} + W_{32}N^b_{18} \\
w_{29} &= W_{19} + W_{27}r''_{21} + W_{28}\lambda^b_{27} + W_{29}n^b_{25} + W_{30}p^b_{23} + W_{31}L^b_{21} + W_{32}N^b_{19}
\end{aligned}
$$

and

$$
\begin{aligned}
w'_0 &= W'_0 + W^a_{27}h^b_0 + W^b_{27}r''_0 + W^c_{27}d^b_0 + W^d_{27}d^c_0 + W_{28}\lambda^b_0 + W_{29}n^b_0 + W_{30}p^b_0 + W_{31}L^b_0 \\
&\quad + W_{32}N^b_0 \\
w'_1 &= W_1 \\
w'_2 &= W^a_{27}h^b_1 + W^b_{27}r''_1 + W^c_{27}d^b_1 + W^d_{27}d^c_1 + W_{28}\lambda^b_1 + W_{29}n^b_1 + W_{30}p^b_1 + W_{31}L^b_1 + W_{32}N^b_1 \\
w'_3 &= W^a_{27}h^b_2 + W^b_{27}r''_2 + W^c_{27}d^b_2 + W^d_{27}d^c_2 + W_{28}\lambda^b_2 + W_{29}n^b_2 + W_{30}p^b_2 + W_{31}L^b_2 + W_{32}N^b_2 \\
w'_4 &= W_2 \\
w'_5 &= W_3 + W^a_{27}h^b_3 + W^b_{27}r''_3 + W^c_{27}d^b_3 + W^d_{27}d^c_3 + W_{28}\lambda^b_3 + W_{29}n^b_3 + W_{30}p^b_3 + W_{31}L^b_3 \\
&\quad + W_{32}N^b_3 \\
w'_6 &= W_4 + W^a_{27}h^b_4 + W^b_{27}r''_4 + W^c_{27}d^b_4 + W^d_{27}d^c_4 + W_{28}\lambda^b_4 + W_{29}n^b_4 + W_{30}p^b_4 + W_{31}L^b_4 \\
&\quad + W_{32}N^b_4 \\
w'_7 &= W_5 + W^a_{27}h^b_5 + W^b_{27}r''_5 + W^c_{27}d^b_5 + W^d_{27}d^c_5 + W_{28}\lambda^b_5 + W_{29}n^b_5 + W_{30}p^b_5 + W_{31}L^b_5 \\
&\quad + W_{32}N^b_5 \\
w'_8 &= W_6 + W^a_{27}h^b_6 + W^b_{27}r''_6 + W^c_{27}d^b_6 + W^d_{27}d^c_6 + W_{28}\lambda^b_6 + W_{29}n^b_6 + W_{30}p^b_6 + W_{31}L^b_6 \\
&\quad + W_{32}N^b_6 \\
w'_9 &= W_7 + W^a_{27}h^b_7 + W^b_{27}r''_7 + W^c_{27}d^b_7 + W^d_{27}d^c_7 + W_{28}\lambda^b_7 + W_{29}n^b_7 + W_{30}p^b_7 + W_{31}L^b_7 \\
&\quad + W_{32}N^b_7 \\
w'_{10} &= W^a_{27}h^b_8 + W^b_{27}r''_8 + W^c_{27}d^b_8 + W^d_{27}d^c_8 + W_{28}\lambda^b_8 + W_{29}n^b_8 + W_{30}p^b_8 + W_{31}L^b_8 + W_{32}N^b_8 \\
w'_{11} &= W_8 + W^a_{27}h^b_9 + W^b_{27}r''_9 + W^c_{27}d^b_9 + W^d_{27}d^c_9 + W_{28}\lambda^b_9 + W_{29}n^b_9 + W_{30}p^b_9 + W_{31}L^b_9 \\
&\quad + W_{32}N^b_9
\end{aligned}
$$

$$
\begin{aligned}
w'_{12} &= W^a_{27}h^b_{10} + W^b_{27}r''_{10} + W^c_{27}d^b_{10} + W^d_{27}d^c_{10} + W_{28}\lambda^b_{10} + W_{29}n^b_{10} + W_{30}p^b_{10} + W_{31}L^b_{10} \\
&\quad + W_{32}N^b_{10} \\
w'_{13} &= W^a_{27}h^b_{11} + W^b_{27}r''_{11} + W^c_{27}d^b_{11} + W^d_{27}d^c_{11} + W_{28}\lambda^b_{11} + W_{29}n^b_{11} + W_{30}p^b_{11} + W_{31}L^b_{11} \\
&\quad + W_{32}N^b_{11} \\
w'_{14} &= W_9 + W^a_{27}h^b_{12} + W^b_{27}r''_{12} + W^c_{27}d^b_{12} + W^d_{27}d^c_{12} + W_{28}\lambda^b_{12} + W_{29}n^b_{12} + W_{30}p^b_{12} + W_{31}L^b_{12} \\
&\quad + W_{32}N^b_{12} \\
w'_{15} &= W^a_{27}h^b_{13} + W^b_{27}r''_{13} + W^c_{27}d^b_{13} + W^d_{27}d^c_{13} + W_{28}\lambda^b_{13} + W_{29}n^b_{13} + W_{30}p^b_{13} + W_{31}L^b_{13} \\
&\quad + W_{32}N^b_{13} \\
w'_{16} &= W^a_{27}h^b_{14} + W^b_{27}r''_{14} + W^c_{27}d^b_{14} + W^d_{27}d^c_{14} + W_{28}\lambda^b_{14} + W_{29}n^b_{14} + W_{30}p^b_{14} + W_{31}L^b_{14} \\
&\quad + W_{32}N^b_{14} \\
w'_{17} &= W_{10} + W_{28}\lambda^b_{15} \\
w'_{18} &= W_{11} + W^d_{27}d^c_{15} + W_{28}\lambda^b_{16} + W_{29}n^b_{15} \\
w'_{19} &= W_{12} + W^c_{27}d^b_{15} + W^d_{27}d^c_{16} + W_{28}\lambda^b_{17} + W_{29}n^b_{16} + W_{30}p^b_{15} \\
w'_{20} &= W_{13} + W^b_{27}r''_{15} + W^c_{27}d^b_{16} + W^d_{27}d^c_{17} + W_{28}\lambda^b_{18} + W_{29}n^b_{17} + W_{30}p^b_{16} + W_{31}L^b_{15} \\
w'_{21} &= W_{14} + W^a h^b_{15} + W^b_{27}r''_{16} + W^c_{27}d^b_{17} + W^d_{27}d^c_{18} + W_{28}\lambda^b_{19} + W_{29}n^b_{18} + W_{30}p^b_{17} \\
&\quad + W_{31}L^b_{16} + W_{32}N^b_{15} \\
w'_{22} &= W^a h^b_{16} + W^b_{27}r''_{17} + W^c_{27}d^b_{18} + W^d_{27}d^c_{19} + W_{28}\lambda^b_{20} + W_{29}n^b_{19} + W_{30}p^b_{18} + W_{31}L^b_{17} + \\
&\quad + W_{32}N^b_{16} \\
w'_{23} &= W^a h^b_{17} + W^b_{27}r''_{18} + W^c_{27}d^b_{19} + W^d_{27}d^c_{20} + W_{28}\lambda^b_{21} + W_{29}n^b_{20} + W_{30}p^b_{19} + W_{31}L^b_{18} + \\
&\quad + W_{32}N^b_{17} \\
w'_{24} &= W_{28}\lambda^b_{22} \\
w'_{25} &= W_{15} + W^d_{27}d^c_{21} + W_{28}\lambda^b_{23} + W_{29}n^b_{21} \\
w'_{26} &= W_{16} + W^c_{27}d^b_{20} + W^d_{27}d^c_{22} + W_{28}\lambda^b_{24} + W_{29}n^b_{22} + W_{30}p^b_{20} \\
w'_{27} &= W_{17} + W^b_{27}r''_{19} + W^c_{27}d^b_{21} + W^d_{27}d^c_{23} + W_{28}\lambda^b_{25} + W_{29}n^b_{23} + W_{30}p^b_{21} + W_{31}L^b_{19} \\
w'_{28} &= W_{18} + W^a_{27}h^b_{18} + W^b_{27}r''_{20} + W^c_{27}d^b_{22} + W^d_{27}d^c_{24} + W_{28}\lambda^b_{26} + W_{29}n^b_{24} + W_{30}p^b_{22} \\
&\quad + W_{31}L^b_{20} + W_{32}N^b_{18} \\
w'_{29} &= W_{19} + W^a_{27}h^b_{19} + W^b_{27}r''_{21} + W^c_{27}d^b_{23} + W^d_{27}d^c_{25} + W_{28}\lambda^b_{27} + W_{29}n^b_{25} + W_{30}p^b_{23} \\
&\quad + W_{31}L^b_{21} + W_{32}N^b_{19}
\end{aligned}
$$

The W coefficients are defined above which I obtain using the empirical estimates of the structural model depending on the way private expectations are formed. Other coefficients, h^b_i, r''_i, d^b_i, d^c_i, λ^b_i, n^b_i, p^b_i, L^b_i, and N^b_i for $i = 0, 1, 2, \ldots 27$ are extremely complex combinations of the MSV solutions reported in Table VIII.1-VIII.4.

Rearranging the terms in (A.62)-(A.64) gives explicit formulae for i^T_{t-6} for each period. Setting $i^T_{t-6} = i_{t-7}$ in (A.62)-(A.64) gives counterfactual inflation rate of $\hat{\pi}_t$ where $\hat{\pi}_t = \pi^T_t - (w_{11} + w_4 h_3)[i^T_{t-6} - i_{t-7}]$ holds if π^T_t is publicly known. As a result, under rational expectations, the expectations of inflation under full credibility (XIFC) index is obtained by

$$\begin{aligned} XIFC^{II}_t &= \hat{\pi}_t - \pi_{t-1} \\ &= (\pi^T_t - \pi_t) - (w_{11} + w_4 h_3)[i^T_{t-6} - i_{t-7}] \end{aligned} \tag{A.65}$$

$$\begin{aligned} XIFC^{III}_t &= \hat{\pi}_t - \pi_{t-1} \\ &= (\pi^T_t - \pi_t) - (w_{11} + w_4 h_3)[i^T_{t-6} - i_{t-7}] \end{aligned} \tag{A.66}$$

$$\begin{aligned} XIFC^{IV}_t &= \hat{\pi}_t - \pi_{t-1} \\ &= (\pi^T_t - \pi_t) - (w'_{11} + w_4 h_3)[i^T_{t-6} - i_{t-7}] \end{aligned} \tag{A.67}$$

When agents are forming expectations based on the process of adaptive learning, setting $i^T_{t-6} = i_{t-7}$ in (A.55)-(A.57) results in the following each period's counterfactual inflation rates

$$\begin{aligned} \pi^{XFC,II}_t = \; & \pi^T_t - W_8(i^T_{t-6} - i_{t-7}) \\ & - W_{27}[\tilde{E}^T_{t-4} y_{t-3} - \tilde{E}^{CF}_{t-4} y_{t-3}] - W_{28}[\tilde{E}^T_{t-1} e_t - \tilde{E}^{CF}_{t-1} e_t] \\ & - W_{29}[\tilde{E}^T_{t-2} e_{t-1} - \tilde{E}^{CF}_{t-2} e_{t-1}] - W_{30}[\tilde{E}^T_{t-3} e_{t-2} - \tilde{E}^{CF}_{t-3} e_{t-2}] \\ & - W_{31}[\tilde{E}^T_{t-4} e_{t-3} - \tilde{E}^{CF}_{t-4} e_{t-3}] - W_{32}[\tilde{E}^T_{t-5} e_{t-4} - \tilde{E}^{CF}_{t-5} e_{t-4}] \end{aligned} \tag{A.68}$$

$$
\begin{aligned}
\pi_t^{XFC,III} &= \pi_t^T - W_8(i_{t-6}^T - i_{t-7}) \\
&\quad - W_{27}[\tilde{E}_{t-4}^T y_{t-3} - \tilde{E}_{t-4}^{CF} y_{t-3}] - W_{28}[\tilde{E}_{t-1}^T e_t - \tilde{E}_{t-1}^{CF} e_t] \\
&\quad - W_{29}[\tilde{E}_{t-2}^T e_{t-1} - \tilde{E}_{t-2}^{CF} e_{t-1}] - W_{30}[\tilde{E}_{t-3}^T e_{t-2} - \tilde{E}_{t-3}^{CF} e_{t-2}] \\
&\quad - W_{31}[\tilde{E}_{t-4}^T e_{t-3} - \tilde{E}_{t-4}^{CF} e_{t-3}] - W_{32}[\tilde{E}_{t-5}^T e_{t-4} - \tilde{E}_{t-5}^{CF} e_{t-4}] \quad (A.69)
\end{aligned}
$$

$$
\begin{aligned}
\pi_t^{XFC,IV} &= \pi_t^T - W_8(i_{t-6}^T - i_{t-7}) - [W_{27}^a + (W_{27}^b - W_{27}) + W_{27}^c + W_{27}^d]\Delta i_{t-6}^T \\
&\quad - W_{27}[\tilde{E}_{t-4}^T y_{t-3} - \tilde{E}_{t-4}^{CF} y_{t-3}] - W_{28}[\tilde{E}_{t-1}^T e_t - \tilde{E}_{t-1}^{CF} e_t] \\
&\quad - W_{29}[\tilde{E}_{t-2}^T e_{t-1} - \tilde{E}_{t-2}^{CF} e_{t-1}] - W_{30}[\tilde{E}_{t-3}^T e_{t-2} - \tilde{E}_{t-3}^{CF} e_{t-2}] \\
&\quad - W_{31}[\tilde{E}_{t-4}^T e_{t-3} - \tilde{E}_{t-4}^{CF} e_{t-3}] - W_{32}[\tilde{E}_{t-5}^T e_{t-4} - \tilde{E}_{t-5}^{CF} e_{t-4}] \quad (A.70)
\end{aligned}
$$

where $\tilde{E}_t^T$ represents private agents' estimated forecast series using i_{t-6}^T, and $\tilde{E}_t^{CF}$ is the forecast series predicted when $i_{t-6}^T = i_{t-7}$ is set. Using (A.68)-(A.70) and by definition, the expectations of inflation under full credibility (XIFC) index under adaptive learning is given by

$$
\begin{aligned}
XIFC_t^{II} &= \pi_t^{XFC,II} - \pi_{t-1} \\
&= (\pi_t^T - \pi_t) - W_8 \Delta i_{t-6}^T \\
&\quad - W_{27}[\tilde{E}_{t-4}^T y_{t-3} - \tilde{E}_{t-4}^{CF} y_{t-3}] - W_{28}[\tilde{E}_{t-1}^T e_t - \tilde{E}_{t-1}^{CF} e_t] \\
&\quad - W_{29}[\tilde{E}_{t-2}^T e_{t-1} - \tilde{E}_{t-2}^{CF} e_{t-1}] - W_{30}[\tilde{E}_{t-3}^T e_{t-2} - \tilde{E}_{t-3}^{CF} e_{t-2}] \\
&\quad - W_{31}[\tilde{E}_{t-4}^T e_{t-3} - \tilde{E}_{t-4}^{CF} e_{t-3}] - W_{32}[\tilde{E}_{t-5}^T e_{t-4} - \tilde{E}_{t-5}^{CF} e_{t-4}] \quad (A.71)
\end{aligned}
$$

$$
\begin{aligned}
XIFC_t^{III} &= \pi_t^{XFC,III} - \pi_{t-1} \\
&= (\pi_t^T - \pi_t) - W_8 \Delta i_{t-6}^T \\
&\quad - W_{27}[\tilde{E}_{t-4}^T y_{t-3} - \tilde{E}_{t-4}^{CF} y_{t-3}] - W_{28}[\tilde{E}_{t-1}^T e_t - \tilde{E}_{t-1}^{CF} e_t] \\
&\quad - W_{29}[\tilde{E}_{t-2}^T e_{t-1} - \tilde{E}_{t-2}^{CF} e_{t-1}] - W_{30}[\tilde{E}_{t-3}^T e_{t-2} - \tilde{E}_{t-3}^{CF} e_{t-2}] \\
&\quad - W_{31}[\tilde{E}_{t-4}^T e_{t-3} - \tilde{E}_{t-4}^{CF} e_{t-3}] - W_{32}[\tilde{E}_{t-5}^T e_{t-4} - \tilde{E}_{t-5}^{CF} e_{t-4}] \quad (A.72)
\end{aligned}
$$

$$
\begin{aligned}
XIFC_t^{IV} &= \pi_t^{XFC,IV} - \pi_{t-1} \\
&= (\pi_t^T - \pi_t) - W_8 \Delta i_{t-6}^T - [W_{27}^a + (W_{27}^b - W_{27}) + W_{27}^c + W_{27}^d] \Delta i_{t-6}^T \\
&\quad - W_{27}[\tilde{E}_{t-4}^T y_{t-3} - \tilde{E}_{t-4}^{CF} y_{t-3}] - W_{28}[\tilde{E}_{t-1}^T e_t - \tilde{E}_{t-1}^{CF} e_t] \\
&\quad - W_{29}[\tilde{E}_{t-2}^T e_{t-1} - \tilde{E}_{t-2}^{CF} e_{t-1}] - W_{30}[\tilde{E}_{t-3}^T e_{t-2} - \tilde{E}_{t-3}^{CF} e_{t-2}] \\
&\quad - W_{31}[\tilde{E}_{t-4}^T e_{t-3} - \tilde{E}_{t-4}^{CF} e_{t-3}] - W_{32}[\tilde{E}_{t-5}^T e_{t-4} - \tilde{E}_{t-5}^{CF} e_{t-4}] \qquad \text{(A.73)}
\end{aligned}
$$

Notice that in Period IV, unlike the other periods, there is a second component, $[W_{27}^a + (W_{27}^b - W_{27}) + W_{27}^c + W_{27}^d] \Delta i_{t-6}^T$, in the XIFC index. This term is due to expectations of future output gap term that appear in the monetary authority's reaction function in period IV. Since the monetary authority is always assumed to be rational, the term, $[W_{27}^a + (W_{27}^b - W_{27}) + W_{27}^c + W_{27}^d] \Delta i_{t-6}^T$, indicates the impact of the interest change policy on inflation via output changes through expectations channel.