Spring 5-5-2018

A New Keynesian Approach to Estimating Welfare Losses Under Strict and Flexible-Targeting Regimes

Shawn Weber
CUNY Hunter College

A New Keynesian Approach to Estimating Welfare Losses Under Strict and Flexible-Targeting Regimes

by

Shawn Weber

Submitted in partial fulfillment
of the requirements for the degree of
Master of Arts in Economics
Hunter College, City University of New York

2018

Thesis sponsor:

May 5, 2018
Date

Magnus Wiberg
First Reader

May 5, 2018
Date

Sangeeta Pratap
Second Reader

Acknowledgements

I would like to express my sincere gratitude to Professor Magnus Wiberg for providing me with his expertise, guidance, and time throughout the course of my research. His insights and knowledge were instrumental to its completion. I would also like to thank professor Pratap for offering to be my second reader on such short notice. In addition, I would like to thank all of the Hunter College Economics Faculty for being so accessible to students and being truly invested in the students educational outcomes.

Abstract

How do different inflation-targeting regimes affect the monetary loss-function of a central bank aiming at stabilizing inflation around an inflation target and stabilizing the real economy? Under a basic New-Keynesian framework, this paper examines the effect of inflation-targeting regimes on the monetary-loss function of a central bank. My analysis shows that both strict and flexible-inflation targeting regimes lower monetary-welfare losses after the adoption of the regime. However, strict-inflation targeters are able to lower monetary-welfare losses by only focusing on inflation and nothing else. This provides evidence for the Divine Coincidence, where a central bank can only focus on inflation and will subsequently have a closed output gap.

Contents

1 Introduction

How do different inflation-targeting regimes affect the monetary loss function for a central bank aiming at stabilizing inflation around an inflation target and stabilizing the real economy represented by the output gap?[1] Inflation targeting is a monetary-policy strategy that was first introduced by New Zealand in 1989. Many central banks have adopted inflation targeting as a pragmatic response to the failures of money-supply targeting. Monetary targeting was met with limited success because the demand for money became unstable, typically because of innovations in the financial markets. Inflation targeting is characterized by the public announcement of official quantitative targets, or ranges, for example, the inflation rate over a certain time horizon, and an unambiguous knowledge that low and stable inflation is the primary long-term goal of monetary policy. Under inflation targeting, there is a high degree of transparency and accountability among central banks. For example, central banks lead efforts to communicate with the public about their plans and objectives for monetary policy, which leads to strengthening the central bank's credibility and increasing their accountability for obtaining those objectives, setting a strong nominal anchor for the economy.

There are two types of inflation targeting that central banks engage in. The first is strict-inflation targeting, which means that the central bank is mainly concerned about keeping inflation as close to the given inflation target as possible, and nothing else.[2] The second is flexible-inflation targeting, which means that central banks set their policy rate to stabilize inflation around a target—generally, this target lies between inflation bands—and also to stabilize the real economy, for instance, "stabilizing a measure of resource utilization such as the output gap; that is, the gap between actual and potential output" (Svenson 2010). The inflation band allows the central bank to exploit the potential short-run tradeoff between inflation and output; that is, if a policymaker can expand aggregate demand, they can lower unemployment, but only at the cost of higher inflation and if a policy maker contracts aggregate demand, they can lower inflation, but only at the cost of higher unemployment. The inflation band allows for the possibility to exploit this trade-off while at the same time fulfill the inflation target. The divide in the inflation-targeting regimes among central banks comes from the following critiques starting with strict inflation targeting, the critiques are as follows.

Critique of strict-inflation targeting regimes:

- Strict-inflation targeting countries put too little emphasis on the real economy, such as unemployment and production.
- Strict targeting cannot stimulate demand sufficiently when the interest rate is close to its lower bound, which has been a problem in recent years.[3]

[1] Output gap is defined as actual output at time t minus the potential output, where potential output is a long-run average.

[2] Svenson (2010) argues that in practice,"inflation targeting is never strict but always flexible, in the sense that all inflation-targeting central banks put some weight on stabilizing the real economy". I will explore this notion in the analysis portion of the paper.

[3] Even in countries with flexible targeting, inflation has been very low due to the drop in demand.

Critique of flexible-inflation targeting regimes:

- Under flexible-inflation targeting, subjective judgements regarding the appropriate trade-off between inflation and the real economy can lead to a less well-balanced monetary policy.
- Where the price-stability objective is expressed in the inflation target; there is no stability objective expressed in a corresponding stability target, normally the natural output, but it is hard to measure such a variable.
- Finally, both strict and flexible inflation targeters take too little account of financial risks and imbalances—some argue this contributed unnecessarily to passive and restrictive monetary policy during and after the 2008 financial crisis.

Despite the critiques of strict and flexible inflation targeting, there are obvious benefits to the regimes. Strict-inflation targeting has proved effective in anchoring economic agents inflation expectations. It creates a nominal anchor where the economic agents expect monetary policy to bring inflation back on target if it deviates. For example, if inflation deviates from target, the economic agents expect the central bank to adjust monetary policy to bring inflation back on target. Under this type of policy, economic agents do not expect the central bank to compensate periods when inflation is above the target with periods of below-target inflation and vice-versa. Under flexible-inflation targeting, in the short run an expansionary monetary policy contributes to higher growth and lower unemployment—i.e. taking into account unemployment and production may contribute to a more stable output.

Previous empirical evidence shows a direct relationship between inflation targeting and certain measures of economic performance indicating some support for the view that inflation targeting improves overall macroeconomic performance. This support is derived from the following results:[4]

- Inflation targeting helps countries achieve lower inflation in the long run, have a more muted inflation response to oil-price and exchange-rate shocks, strengthen monetary policy independence, improve monetary policy efficiency and obtain inflation outcomes closer to target levels.
- Inflation volatility, inflation levels, and interest rates have declined once countries adopted either targeting regime.
- Inflation targeting leads to movements in the nominal exchange rate that are more responsive to real shocks than nominal shocks—indicating inflation targeting may help the nominal exchange rate act as a shock absorber for the real economy.

[4]For evidence supporting these claims, see Mishkin and Schmidt-Hebbel (2007), Bernanke et all (1999), Gonzalez, Cohen, and Powell (2003).

Given the above discussion, it seems reasonable to assume that these relationships might differ depending on what targeting regime a country adopts. The purpose of this paper is to empirically examine which inflation-targeting regime gives rise to the lowest monetary welfare losses, since its inception in 1989.
The loss function[5] is of great importance to a central bank because central banks view themselves as facing tradeoffs between inflation and output stabilization in the short run, summarized by the Phillips Curve; therefore, central banks seek to minimize their loss function. This is accomplished by pursuing a policy that allows for a partial accommodation of inflationary pressures in the short run, to avoid excessive instability in output and employment, while remaining committed to a medium-term inflation target (Gali, 2015).

My research question is motivated by the somewhat conflicting results in the literature regarding the effect of the monetary policy mandate on the variability of the monetary loss function, as well as the fact that major central banks around the world operate under different inflation-targeting regimes (Gali, 2015). For example, the European Central Bank operates under a hierarchal mandate that requires stable prices as a condition of pursuing other goals (i.e. strict inflation targeting). The Federal Reserve operates under a dual mandate that requires co-equal objectives of price stability and maximum sustainable employment (i.e. flexible inflation targeting). Other central banks target inflation bands (for example the Reserve Bank of Australia), which allows for a degree of short-run inflation variability; therefore, granting the central bank more room to exploit the short-run tradeoff between the real economy and inflation. This regime can be interpreted as a form of flexible inflation targeting, since the purpose is to allow inflation to vary within the band, which gives the central bank more room to exploit the short-run tradeoff between output and inflation.

Section 2 of the paper describes the basic New Keynesian model and the underlying theory that motivated my research question. Section 3 describes the data and presents descriptive statistics. Section 4 includes the econometric methodology and results, and section 5 offers concluding remarks.

2 New Keynesian Theory

Among mainstream academic economists and policymakers, the leading alternative to the real business cycle theory is the New Keynesian model. Whereas the basic real business cycle model features monetary neutrality[6] , perfect competition, and emphasizes that there is no role for stabilization policy by governments, the New Keynesian model builds in a friction that generates monetary non-neutrality and gives rise to a welfare justification for activist economic policies. The basic New Keynesian Model with Calvo price setting[7] simplifies to a system of two equations and a monetary policy rule setting the nominal interest rate

[5]See section 1 for a formal definition of the loss-function

[6]Monetary neutrality is when changes in the money supply do not influence real variables.

[7]Calvo pricing incorporates "sticky prices" (see Calvo, 1983), this is when a fraction of firms are stuck with their current prices with a constant probability (i.e. prices are fixed in the short run).

(see for example Gali, 2015). The two equations and the monetary policy rule are as follows:[8]

New Keynesian Phillips Curve:

$$\pi_t = \beta \mathbb{E}_t[\pi_{t+1}] + \lambda \tilde{mc}_t, \text{where} \lambda = \frac{(1-\theta)(1-\beta\theta)}{\theta} \text{ and} \tag{1}$$

$$\tilde{mc}_t = \text{mc}_t - \text{mc} = \frac{\sigma(1-\alpha) + \psi + \alpha}{(1-\alpha)}(y_t - y_t^n)$$

Where $\mathbb{E}_t[\pi_{t+1}]$ is expected inflation in time t+1, θ is the fraction of firms stuck with their current prices, α is the output elasticity of labor, ψ is the elasticity of labor supply, β is a discount factor between 0 and 1, σ is the households$'$ relative risk aversion, y_t^n is potential output, $(y_t - y_t^n)$ is the output gap, and mc_t is the marginal cost which is the labor needed to produce an additional unit of output times the cost of each unit of that labor. In steady state mc_t is constant over time. The economic intuition is as follows, according to (1) inflation will tend to rise when the real marginal cost rises compared to the real marginal cost in steady state, since firms want to pass on higher costs to consumers in the form of higher prices. It also follows that a positive (negative) output gap puts upward (downward) pressure on current inflation, since economic expansions (recessions) increases (decrease) aggregate demand and increases (decreases) firms pricing power.

Dynamic IS Curve:

$$\tilde{y}_t = \mathbb{E}_t[\tilde{y}_{t+1}] - \frac{1}{\sigma}(i_t - \mathbb{E}_t[\pi_{t+1}] - r_t^n), \text{where } r_t^n = \rho + \sigma \mathbb{E}_t[\Delta \tilde{y}_{t+1}^n] \tag{2}$$

where $\tilde{y}_t \equiv y_t - y_t^n$ is the output gap in period t, $\mathbb{E}_t[y_{t+1}]$ is expected output in time t + 1, σ is the households relative risk aversion, i_t is the nominal interest rate set by the central bank, $\mathbb{E}_t[\pi_{t+1}]$ is expected inflation in time t +1, $\rho > 0$ is the households$'$ discount rate, Δ is the first difference operator, and r_t^n is the natural rate of interest. The natural rate of interest can be defined as the equilibrium real rate of return when prices are fully flexible. From equation (2), it follows that the output gap is proportional to the real interest rate gap. One way of determining whether monetary policy is expansionary or contractionary is to compare the actual real interest—where the real interest rate is $(i_t - \mathbb{E}_t[\pi_{t+1}])$ in equation (2)—with the natural rate of interest r_t^n. If the actual real interest rate is below the natural interest rate, monetary policy is expansionary; if the actual real interest rate is above the natural interest rate, monetary policy is contractionary.

Monetary Policy Rule:

$$i_t = \rho + \phi_\pi \pi_t + \phi_y \tilde{y}_t, \tag{3}$$

where ϕ_π, ϕ_y are non-negative coefficients determined by the policy preferences of the central bank. The coefficients describe the strength of the response to changes in inflation and the output gap. As in equation (2), ρ has the same definition.

[8]For complete derivations, see Gali 2015

Monetary Loss Function:

$$\mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t (\tilde{\pi}_t^2 + \vartheta \, x_t^2), \tag{4}$$

where $\tilde{\pi}_t \equiv \pi_t - \pi t^*$ is inflation at time period t and π_t^* is equal to the inflation target at time period t, $x_t \equiv \ y_t - y_t^n$, where y_t is GDP at time period t and y_t^n denotes the potential level of output at time period t, and ϑ is the coefficient for the weight of output gap fluctuations relative to inflation, and is given by $\vartheta = \kappa/\epsilon$, where κ is the coefficient on the output gap, $\frac{(1-\theta)(1-\beta\theta)}{\theta} * \frac{\sigma(1-\alpha)+\psi+\alpha}{(1-\alpha)}$, and the variables have the same interpretation as in (1), and ϵ is the elasticity of substitution between goods.

Optimal monetary policy under the New-Keynesian Model is to stabilize firms′ marginal costs over time at a level consistent with their desired markup. Stabilizing marginal costs over time eliminates mark-up fluctuations over time, which keeps aggregate prices stable in steady state by the New Keynesian Phillips Curve. By (1), it also indicates that price stability leads to a closed output gap. The output gap plays a central role in monetary policy-making. For many central banks, including the U.S. Federal Reserve, maintaining maximum sustainable employment is a policy goal. Maximum sustainable employment corresponds to a maximum sustainable output or an output gap of zero. Nearly all central banks seek to keep inflation under control, and the output gap is a key determinant of inflation pressure. A central question for monetary decision makers is if there exist a trade-off between output stabilization and inflation. Indeed, the notion of flexible inflation targeting highlights such a short-run trade-off between stabilizing inflation and stabilizing output and employment.

By equation (1), price stability over time leads to a closed output gap. This is known as the Divine Coincidence (Blanchard and Gali, 2005), which means that a central bank doesn't need to know what the natural or efficient level of output is, since the latter can be attained automatically as a byproduct of a successful price stabilization policy (i.e. keeping inflation constant). Hence, according to the notion of Divine Coincidence, there is no trade-off between the stabilization of inflation and the stabilization of the output gap.

Some have argued that the Divine Coincidence does not necessarily hold in a non-linear form of the standard New-Keynesian model. Specifically, the property would only hold if the monetary authority is set to keep the inflation rate at exactly 0 % (see Alves, 2014). However, attempts at evaluating the welfare performance of the so called Taylor rule have shown that "the smallest welfare losses are attained when the monetary authority responds to changes in inflation only. Furthermore, those losses (as well as the underlying fluctuations in the output gap and inflation) become smaller as the strength of that response increases" (Gali, 2015). Which raises the question: why do central banks differ in their approach to inflation targeting? It would appear that the flexible-inflation targeting central banks do not adhere to the notion of Divine Coincidence while other central banks seem to put more emphasis on price stability in accordance with the prediction of the Divine Coincidence.

3 Data

The data used in this study cover 36 countries for the period from 1989 to 2016.[9] The main macroeconomic variables such as, GDP (measured in current US dollars, scaled by 1 billion), inflation (consumer prices annual %), trade openness (Imports plus exports/GDP), unemployment (annual %), domestic credit provided to financial sector (percent of GDP), and public debt (percent of GDP) were collected from the World Bank and the International Monetary Fund (IMF) using their World Development Indicators and World Economic Outlook databases, respectively.[10] Measures of central-bank independence were collected from Ana Carolina Garriga's personal website.[11] Central-bank independence is measured as a number between 0 and 1 with unity signifying a completely independent bank. Another variable of interest is the extent of political stability within a country. This was captured by the Polity5 dataset. The polity score captures the regime authority spectrum on a point scale ranging from -10 to 10, where the higher the number indicates a higher degree of political stability.

Finally, I collected my main covariate of interest—type of inflation-targeting regime and inflation target—from a variety of sources, which include: central-bank websites, monetary-policy reports, and journal articles.[12] I classified the regimes as flexible based on the following criteria. If a country explicitly stated they were a strict or flexible-inflation targeter, I categorized them as such. If a country was not explicit in its choice of regime, I looked at their inflation target history and if they allowed inflation to vary within a band, they were classified as flexible-inflation targeters, otherwise they were classified as strict-inflation targeters. The type of inflation-targeting regime is captured by two binary variables. Strict-inflation targeters are categorized as equal to 0 if the country has not yet adopted strict-inflation targeting and equal to 1 after they adopt strict-inflation targeting. Flexible-inflation targeters are equal to 0 if the country has not yet adopted flexible-inflation targeting, and equal to 1 after the country adopts flexible-inflation targeting. The inflation target for a country is a point target. If the country is a flexible inflation targeter and has a band around the inflation target, I used the center of the band for the target. See graph 1 for the inflation targets of the countries in the sample as well as the cross-country time variation of inflation.

[Table 1 Summary Statistics]

[Graph 1 Inflation and Inflation Targets by Country]

[9] For a list of countries see graph 1

[10] Some observations of inflation, GDP, domestic-credit, and public-debt were collected from the countries respective central bank website.

[11] Garriga, Ana Carolina. 2016. Central Bank Independence in the World: A New Dataset. International Interactions 42 (5):849-868

[12] See appendix for data sources.

4 Econometric Methodology

In order to analyze the effects of inflation targeting regimes on monetary welfare losses, my empirical strategy is to use a fixed effects model of the following form:

$$\text{lossfunction}_{ct} = \alpha_1 + \alpha_2 S_{ct} + \alpha_3 F_{ct} + \alpha_4 Z_{1ct} + \delta_c + \delta_t + \epsilon_{1ct}, \tag{5}$$

where lossfunction_{ct} denotes the loss function in country c at time t. The loss function is defined as the squared deviation in inflation from target in country c at time t divided by 100 plus the squared deviation of the log of the output gap in country c at time t, $(\pi_{ct} - \pi^*_{ct})^2 + (y_{ct} - y^n_{ct})^2$, where y_{ct} and y^n_{ct} are log transformed. This allows for the interpretation of the loss function to be in basis points. S_{ct} is a dummy variable equal to one if a country is a strict-inflation targeter in country c at time t, I expect α_2 to be negative. F_{ct} is a dummy variable equal to one if a country is a flexible-inflation targeter in country c at time t, I expect α_3 to be negative. Z_{1ct} represents a vector of control variables, α_1 is an intercept, δ_c is a country fixed effect, δ_t is a time-specific fixed effect, and ϵ_{1ct} is an error term capturing omitted factors, where $\mathbb{E}(\epsilon_{1ct}) = 0$ for all c and t. All regressions are adjusted for intragroup correlation by clustering the standard errors on a country level.[13]

Nine variables are included in the vector Z_{1ct}, they are as follows: international-oil price, domestic credit provided to the financial sector (% of GDP), central-bank independence, public debt (% of GDP), political stability, and trade openness. In my analysis I will be applying coequal weight to both the output gap and the deviation from target and will therefore not be estimating ϑ.[14] As for obtaining y^n_t, in practice y^n_t is hard to observe, but in theory this is arguably a long-run average of GDP. In my analysis, I calculated y^n_t by applying a Hodrick-Prescott time-series filter to filter out business cycle fluctuations in GDP.

4.1 Results

All the regression results in table 2 impose no restrictions on the direction of the sign of the output gap and the sign of the deviation of inflation from its target. To determine the effect of a demand and supply shock on the monetary loss function, I need to separate the case with a positive output gap and an inflation above target from the case with a negative output gap and an inflation below target. In the first case, the coefficients on domestic credit and public debt are expected to be positive, since positive demand shocks, i.e. an expansionary fiscal policy and easier credit conditions, increase welfare losses when the output gap is positive and inflation is above target.The coefficient on the oil price is expected to be positive, since a negative supply shock, i.e. a higher oil price, increases welfare losses when the output gap

[13]This relaxes the usual requirement that the observations are independent, that is, observations are independent across countries, but not necessarily within countries. The choice to use clustered standard errors is as follows: while fixed effects removes unobserved heterogeneity between different groups in the model, it does not account for observations that are not independent and identically distributed (i.i.d). Since I have multiple observations of countries across time there may still be some unexplained variation in the dependent variable that is correlated across time. For example, if there was an economic downturn in the previous period there is a high probability that an economic downturn will continue in the next period.

[14]Data is not sufficient to estimate the coefficient on weight.

is positive and inflation is above target. The reason is that a negative supply shock decreases the natural level of output and increases inflation, which increases the output gap and the deviation of inflation from target at a time when the output gap is positive and inflation is above target. In the second case, I expect the coefficients on domestic credit and public debt to be negative, since expanding credit at a time when output is below the natural level can indicate an economic expansion is underway. The oil price is still expected to have a positive coefficient because a negative supply shock at a time when output is below the natural level will push the economy further from its natural level, thus increasing monetary-welfare losses.[15] These results would be expected to hold irrespective of the targeting regime applied.

[Table 2]

From the first model in table 2, only using the dummy variables for targeting regime in the regression, it shows that both types of targeting regimes have negative coefficients. Both of the coefficients on the inflation-targeting regimes are significant, they indicate that on average a strict-targeting regime lowers welfare losses by 1.38 basis points from its pre period and a flexible-targeting regime lowers welfare losses by 3.18 basis points from its pre period. After adding in a supply shock, the oil price, in model 2 the coefficient is significant and has a negative coefficient, indicating a negative supply shock will decrease welfare losses. However, this result is somewhat misleading because there are no restrictions placed on the direction of the output gap or the deviation from inflation. For strict-targeting countries, welfare losses are now reduced by 1.2 basis points, slightly less than in model 1, but still significant. The coefficient on flexible-inflation targeters remains significant and now reduces welfare losses by 3.02 basis points on average. After adding in financial-demand shocks such as domestic credit lent by the financial sector and public debt in model 3 (both represented as a percent of GDP) only domestic credit is statistically significant and a 10% increase in domestic credit lent by the financial sector increases welfare losses by .00589 basis points on average.

In model 4 I account for trade openness, which I would expect to have a negative coefficient. Countries that are more open tend have more synchronized business cycles with the rest of the world. It is reasonable to assume that the business cycle of the world economy, which is a weighted average of the business cycle of several countries, to fluctuate less than the business cycle of a single country. Therefore, fluctuations in the real economy, as well as in inflation, should be lower in more open economies, leading to lower monetary-welfare losses as openness increases. However, in this model although the coefficient is negative it is statistically insignificant. In model 5 and 6 I add central bank independence and political stability to the model. I would expect both the coefficients on central bank independence and political stability to have negative coefficients. A more independent bank would be less likely to succumb to political pressures and more likely to pursue an optimal policy that stabilizes the real economy and inflation around the target, which translates into lower monetary policy losses. Moreover, politically stable countries are more likely to implement economic policies that stabilizes the real economy and inflation leading to lower monetary-welfare losses. Af-

[15]There are not sufficient observations in the data to test this hypothesis.

ter taking these variables into account neither of the coefficients are statistically significant. When the political stability variable is divided into separate categories the coefficient on countries that are an open anocracy[16] is significant and indicate that having an autocratic regime increase welfare losses by nearly 3.5 basis points compared to having a full democracy.

Table 3 shows the regression imposing the restriction that the output gap is positive while inflation is above the target. I account for this by restricting the sample to only observations that meet that criteria. Now, both strict and flexible-inflation targeting dummies are still significant and the coefficient on strict-inflation targeters is larger than the unrestricted estimations, while the coefficient on flexible-inflation targeters is smaller than the unrestricted estimations. Strict-targeting central banks decrease monetary-welfare losses by 1.5 basis points compared to their post period and flexible-targeting central banks decrease their welfare losses by 2.04 basis points compared to their post period.

The oil price is insignificant throughout all of the models in table 3 and has a negative coefficient, which was not the predicted sign. A reason for this may be because when actual output is above the natural level a negative oil supply shock will shift the short-run aggregate supply curve upward, which will push output towards its natural level—decreasing monetary-welfare losses. Public debt seems to have no effect on monetary-welfare losses, while domestic credit lent by the financial sector does. A 10% increase in domestic credit increases monetary-welfare losses by .00819 basis points. Trade openness and central bank independence are also insignificant throughout the models, while certain types of political regimes have an increasing effect on monetary-welfare losses. Compared to a full democracy, a democratic regime will increase monetary-welfare losses by 1.54 basis points and an open anocracy increases monetary-welfare losses by 4.5 basis points. The other types of political regimes are insignificant I believe this is due to the small number of countries in the sample that are classified as that type of political regime. Countries that are closed and open anocracies only make up 5% of the data.

[Table 3]

4.2 Robust Estimations

For my analysis in tables 2 and 3, I applied coequal weight to both the deviation in inflation and the output gap. However, as previously noted in section 1, in practice inflation targeting is always flexible and never strict, in the sense that all central banks place some weight on the real economy. Therefore, I will be applying a ϑ of 1/3 to strict-inflation targeting countries$'$ loss function and a ϑ of 1/2 to flexible-inflation targeting countries$'$ loss function. The loss function is defined the same way as in (5), except for the inclusion of ϑ on the log transformed output gap, which represents central-bank emphasis on the real economy.[17]

[16] An anocracy is defined as a regime that mixes democratic and autocratic features.

[17] The weights of central bank emphasis on the real economy are not representative of any one central bank. The weights were chosen to show that strict-targeting central banks place less emphasis on the real economy than flexible-inflation targeters.

After accounting for central-bank emphasis on the real economy, model 6 in table 4 exhibits consistent results compared to table 3. Now, a strict-inflation targeting country reduces welfare losses by 1.7 basis points from its pre period, and flexible-inflation targeting countries reduce welfare losses by 2.15 basis points from its pre period. Both regimes reduce welfare losses by a greater amount after applying central-bank emphasis to the real economy. This makes intuitive sense because the central banks are now applying a smaller weight on the real economy than in table 3. Therefore, the central banks will not be penalized as much for deviations in the output gap. The effect of domestic credit has the same interpretation as in table 3, a 10% increase in domestic credit increase welfare losses by .0077 basis points. This is because the economy is already in a state of expansion due to high demand and an increase in domestic credit will further push actual output from its potential output, increasing the output gap and thus contributing to larger monetary-welfare losses.

[Table 4]

5 Conclusion

It appears that both inflation-targeting regimes are effective in reducing monetary-welfare losses. Both strict and flexible-targeting regimes have lower monetary-welfare losses after the adoption of the regime, which provides evidence for the Divine Coincidence under strict-targeting regimes, since arguably a country with no monetary policy regime has relatively less well-anchored inflation expectations and relatively higher variability in prices over time; furthermore, responses to inflation only, such as under strict targeting, can approximate arbitrarily well the optimal policy. This is an extremely interesting result. Based on the notion of a central bank trying to minimize monetary-policy losses, it asserts that a central bank can only focus on inflation and perform as well as a flexible-targeting central bank that places emphasis on and responds to fluctuations in the real economy as well as inflation.

6 Data Appendix

[1] Bank of Brazil. (2017). Retrieved from: http://www.bcb.gov.br/Pec/metas/TabelaMetaseResultados.pdf

[2] Bank of Canada. (2017). Retrieved from: http://www.bankofcanada.ca/core-functions/monetary-policy/

[3] Bank of France. (2017). Retrieved from: https://www.banque-france.fr

[4] Bank of Ghana. (2017). Retrieved from: https://www.bog.gov.gh/statistics/publication/annual-report

[5] Bank of Hungary. (2017). Retrieved from: http://www.mnb.hu/en/monetary-policy/monetary-policy-framework/inflation-targeting

[6] Bank of Iceland. (2017). Retrieved from: https://www.cb.is/monetary-policy/inflation-target/

[7] Bank of Ireland. (2017). Retrieved from: https://www.centralbank.ie/monetary-policy/policy-setting

[8] Bank of Israel. (2017). Retrieved from: http://www.boi.org.il/en/MonetaryPolicy/MonetaryPolicyReports/Pages/Default.aspx

[9] Bank of Romania. (2017). Retrieved from: http://www.bnro.ro/Inflation-Targets-3241.aspx

[10] Bank of Thailand. (2017). Retrieved from: https://www.bot.or.th/English/MonetaryPolicy/MonetPolicyKnowledge/Pages/Target.aspx

[11] Bank of Turkey. (2017). Retrieved from: http://www.tcmb.gov.tr/wps/wcm/connect/tcmb+en/tcmb+en/main+menu/monetary+policy/price+stability/inflation+targets

[12] CESifo Group Munich. (2017). Retrieved from: https://www.cesifo-group.de/ifoHome/facts/DICE/Banking-and-Financial-Markets/Banking/Monetary-Policy/Infation-targeting-framework/fileBinary/Infation-targeting-framework.pdf

[13] Czech National Bank. (2017). Retrieved from: http://www.cnb.cz

[14] Estonia Central Bank. (1993-2017). Retrieved from: https://www.eestipank.ee/en/publications/series/annual-report

[15] European Central Bank. (2018). Retrieved from: https://www.ecb.europa.eu

[16] Federal Reserve. (2017). Retrieved from: https://www.federalreserve.gov

[17] Federal Reserve. (2017). Retrieved from: https://fred.stlouisfed.org/series/POILBREUSDM

[18] Haldane, A. (2000). Ghostbusting: The UK Experience of Inflation Targeting. Bank of England.

[19] Hammond, G. (2012). State of the Art Inflation Targeting. London: Bank of England.

[20] Hristov, K., Zaimov, M. (2003). Shadowing the Euro: Bulgarias Monetary Policy Five Years On. Bank for International Settlements.

[21] International Monetary Fund. (2017). Retrieved from: https://www.imf.org/en/Data

[22] Garriga, A. C. (2016). Central Bank Independence in the World: A New Dataset. International Interactions, 849-868.

[23] Marshall, M. (2017). Retrieved from: http://systemicpeace.org/polity/polity4.htm

[24] Martinez, G. O. (2008). Inflation Targeting. Bank of Canada.

[25] Pikkarainen, P., Suvanto, A. (1997). Monetary Policy in Finland: experiences since 1992. Bank for International Settlements.

[26] Reserve Bank of New Zealand. (2017). Retrieved from: https://www.rbnz.govt.nz/monetary-policy

[27] Treasurer. (2017). Retrieved from: https://www.rba.gov

[28] World Bank. (2017). Retrieved from: https://data.worldbank.org/

7 Bibliography

References

[1] Alves, S. (2014). Is the Divine Coincidence Just a Coincidence? The Implications of Trend Inflation. *Journal Of Monetary Economics*. 329.

[2] Ameer, J., Freeman, R. (1995). Inflation Targeting in the 1990's: The experiences of New Zealand, Canada, and the United Kingdom. *Journal of Economics and Business*, 47(2), 165-192.

[3] Apel, M., Claussen, C. (2012). *Monetary policy, interest rates and risk-taking*, Sveriges Riksbank. Economic Review, 2012:2.

[4] Bernanke, B., Mishkin, F. (1999). Inflation Targeting: Lessons from the International Experience. Princeton, N.J.: Princeton University Press.

[5] Calvo, G. (1983). Staggered Prices in a Utility-Maximizing Framework. *Journal of Monetary Economics*, 383-398.

[6] Carare, A., Stone, M. R. (2006). Inflation Targeting Regimes. *European Economic Review*, 50(5), 1297-1315.

[7] Powell, A. (2003). A New Test for the Success of Infaltion Targeting. 231.

[8] Gali, J. (2015). *Monetary Policy, Inflation, and the Business Cycle: An introduction to the new Keynesian framework*. (Second ed.).

[9] Morande, F. (2001). A Decade of Inflation Targeting in Chile: Developments, Lessons, and Challenges. 02.

[10] Pikkarainen, P., Suvanto, A. (1997). Monetary Policy in Finland: experiences since 1992. Bank for International Settlements.

[11] Schmidt-Hebbel, K., Werner, A. (2002). Inflation Targeting in Brazil, Chile, and Mexico: Performance, Credibility, and the Exchange Rate. *Economía*, 2(2), 31-89.

[12] Svensson, L. E. O., Inflation Targeting(December 2010).NBER Working Paper No. w16654.

8 Tables

Table 1: Summary Statistics

Variable	Mean	Std. Dev.	Min.	Max.	N
Loss Function	0.402	6.415	0	164.205	1008
Country	25.639	15.015	2	50	1008
Year	2002.5	8.082	1989	2016	1008
Inflation(annual %)	11.52	62.14	-4.48	1281.4	1008
Strict Targeter	0.485	0.5	0	1	1008
Flexible Targeter	0.224	0.417	0	1	1008
Trade Openness	82.386	49.402	0	410.172	1008
Oil price	46.604	33.11	12.719	111.96	1008
CB Independence	0.603	0.245	0	0.899	1008
Political Stability	8.579	3.485	-7	10	1008
Full Democracy	0.663	0.473	0	1	1008
Democracy	0.258	0.438	0	1	1008
Open Anocracy	0.024	0.153	0	1	1008
Closed Anocracy	0.025	0.156	0	1	1008
Autocracy	0.031	0.173	0	1	1008
Public Debt(% of gdp)	57.085	38.031	0.318	264.443	1008
Domestic Credit(% of GDP)	109.614	60.799	0.23	316.613	1008

Table 2: Fixed Effects (no restrictions)

	(1) Model 1	(2) Model 2	(3) Model 3	(4) Model 4	(5) Model 5	(6) Model 6
Strict Targeting	-0.0138**	-0.0120*	-0.0131**	-0.0131**	-0.0110*	-0.0103*
	(0.00472)	(0.00460)	(0.00470)	(0.00470)	(0.00426)	(0.00403)
Flexible Targeting	-0.0318*	-0.0302*	-0.0293*	-0.0293*	-0.0268*	-0.0284*
	(0.0119)	(0.0114)	(0.0115)	(0.0114)	(0.0111)	(0.0123)
Oil Price		-0.0000403**	-0.0000782***	-0.0000782***	-0.0000690***	-0.0000682***
		(0.0000123)	(0.0000200)	(0.0000200)	(0.0000175)	(0.0000181)
Domestic Credit			0.0000589**	0.0000588**	0.0000514**	0.0000525**
			(0.0000214)	(0.0000213)	(0.0000187)	(0.0000175)
Public Debt			-0.00000743	-0.00000736	-0.00000586	1.39e-08
			(0.0000124)	(0.0000125)	(0.0000110)	(0.0000129)
Trade Openness				-0.00000229	-0.00000511	0.00000142
				(0.0000178)	(0.0000190)	(0.0000212)
CB Independence					-0.00406	-0.00552
					(0.00683)	(0.00701)
Political Stability					-0.00142	
					(0.000841)	
Democracy						0.0135
						(0.00863)
Open Anocracy						0.0359*
						(0.0145)
Closed Anocracy						0.0115
						(0.0110)
Autocracy						0.0431
						(0.0269)
Constant	0.0233***	0.0240***	0.0199***	0.0201***	0.0338***	0.0158**
	(0.00363)	(0.00376)	(0.00336)	(0.00340)	(0.00713)	(0.00505)
N	973	973	973	973	973	973
R-Square(within)	0.174	0.178	0.191	0.191	0.206	0.236

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 3: Fixed Effects (with restrictions)

	(1) Model 1	(2) Model 2	(3) Model 3	(4) Model 4	(5) Model 5	(6) Model 6
Strict Targeting	-0.0162**	-0.0170**	-0.0188**	-0.0187**	-0.0173**	-0.0155**
	(0.00566)	(0.00590)	(0.00601)	(0.00592)	(0.00601)	(0.00549)
Flexible Targeting	-0.0241*	-0.0248**	-0.0222*	-0.0221*	-0.0205**	-0.0204*
	(0.00932)	(0.00892)	(0.00847)	(0.00840)	(0.00744)	(0.00762)
Oil Price		0.0000141	-0.0000413	-0.0000418	-0.0000330	-0.0000291
		(0.0000254)	(0.0000331)	(0.0000316)	(0.0000309)	(0.0000325)
Domestic Credit			0.0000854*	0.0000855*	0.0000781*	0.0000819**
			(0.0000336)	(0.0000335)	(0.0000308)	(0.0000290)
Public Debt			-0.0000775	-0.0000775	-0.0000791	-0.0000628
			(0.0000541)	(0.0000541)	(0.0000564)	(0.0000384)
Trade Openness				0.00000410	0.00000548	0.0000201
				(0.0000489)	(0.0000503)	(0.0000524)
CB Independence					-0.00195	-0.00702
					(0.0114)	(0.0113)
Political Stability					-0.00118	
					(0.00160)	
Democracy						0.0154**
						(0.00537)
Open Anocracy						0.0449*
						(0.0170)
Closed Anocracy						-0.00240
						(0.0125)
Autocracy						0.0446
						(0.0511)
Constant	0.0226***	0.0223***	0.0207***	0.0203**	0.0309*	0.0137
	(0.00287)	(0.00302)	(0.00534)	(0.00566)	(0.0119)	(0.00801)
N	334	334	334	334	334	334
R-Square(within)	0.140	0.140	0.170	0.170	0.179	0.247

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 4: Fixed Effects (Robustness Check)

	(1) Model 1	(2) Model 2	(3) Model 3	(4) Model 4	(5) Model 5	(6) Model 6
Strict Targeting	-0.0191**	-0.0191**	-0.0209**	-0.0209**	-0.0188**	-0.0170**
	(0.00581)	(0.00591)	(0.00610)	(0.00604)	(0.00619)	(0.00569)
Flexible Targeting	-0.0264*	-0.0264**	-0.0237*	-0.0237*	-0.0216**	-0.0215**
	(0.00986)	(0.00937)	(0.00888)	(0.00880)	(0.00764)	(0.00786)
Oil Price		0.000000680	-0.0000529	-0.0000529	-0.0000415	-0.0000374
		(0.0000225)	(0.0000316)	(0.0000305)	(0.0000278)	(0.0000290)
Domestic Credit			0.0000828*	0.0000828*	0.0000738*	0.0000777**
			(0.0000331)	(0.0000328)	(0.0000295)	(0.0000275)
Public Debt			-0.0000915	-0.0000915	-0.0000933	-0.0000771
			(0.0000581)	(0.0000581)	(0.0000607)	(0.0000414)
Trade Openness				-0.000000390	0.000000876	0.0000155
				(0.0000478)	(0.0000491)	(0.0000509)
CB Independence					-0.00357	-0.00865
					(0.0116)	(0.0114)
Political Stability					-0.00135	
					(0.00162)	
Democracy						0.0164*
						(0.00642)
Open Anocracy						0.0470*
						(0.0178)
Closed Anocracy						-0.000107
						(0.0124)
Autocracy						0.0481
						(0.0512)
Constant	0.0228***	0.0227***	0.0220***	0.0221***	0.0348**	0.0157
	(0.00299)	(0.00316)	(0.00560)	(0.00575)	(0.0122)	(0.00822)
N	334	334	334	334	334	334
R-Square(within)	0.180	0.180	0.212	0.212	0.224	0.292

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

9 Figures

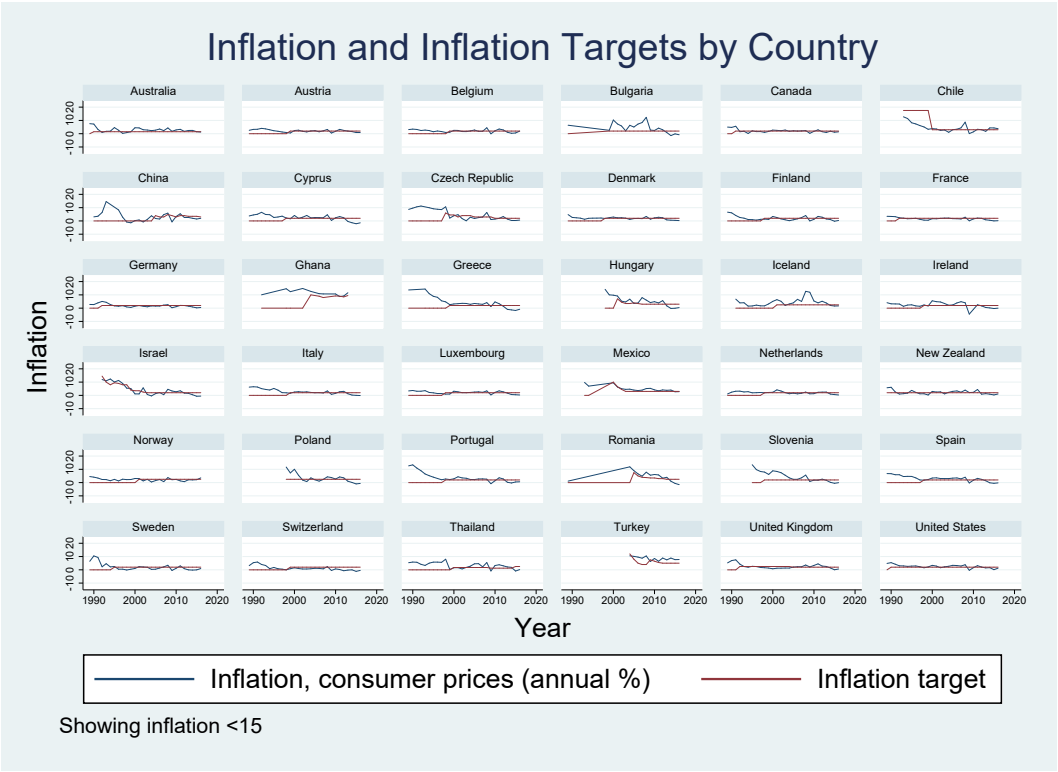

Figure 1: Graph 1