

Does Inflation Targeting Outperform Alternative Policies during Global Downturns*

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Abstract

This article examines the economic performance of inflation targeting countries during the 2007-2012 global downturn compared to those without this policy. Propensity score matching methods are used to compare the two policy regimes, where during a downturn the relatively more successful policy should result in higher inflation and output growth, lower unemployment rates, and a better fiscal position. The analysis is conducted separately for developed and emerging countries. The evidence suggests that during the downturn inflation targeting tends to insulate developed countries, but is much less conclusive for the emerging countries. These results are opposite to this literature applied to normal economic periods which find inconclusive benefits for developed countries, but beneficial effects for emerging countries. Most concerning for emerging countries is that inflation targeters experience lower GDP growth in the crisis period. The results indicate that developed and emerging countries need to evaluate their choice of monetary regime by taking into account the tradeoff between low and stable inflation during normal periods with their desire to maintain growth during crisis periods.

Keywords: Inflation, Inflation targeting, Financial crisis, Propensity score matching

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1 Introduction

The ability of monetary policy to respond effectively to financial crises and economic downturns and the optimal form that monetary policy frameworks should take has again become topical since the 2007- crisis episode (Mishkin, 2009, 2010; Bean et. al, 2010; Cukierman, 2013). Although the proposed range of monetary policy frameworks, targets and instruments vary considerably (Henderson and McKibbin, 1993; Frankel and Chin, 1995; Rudebusch and Svensson, 1999), the actual frameworks adopted globally can be separated into inflation targeting and non-inflation targeting. One major reason given for the adoption of an inflation target is its effect on anchoring inflation expectations in the long run. The anchoring effect leads to stability in inflation, inflation volatility and hence growth (Bernanke and Mishkin, 1997; Svensson, 1997 for examples). A further advantage of inflation targeting is the discipline imposed on fiscal policy (Abo-Zaid and Tuzeman, 2012). This paper contributes to the empirical literature on relative economic outcomes under the policy regimes of inflation targeting and non-inflation targeting to determine whether inflation targeters fared better than those not targeting inflation during the 2007-2012 financial crisis and subsequent downturn.¹

The claims of the benefits of inflation targeting are sometimes disputed in empirical studies (Samarina et al., 2014). In their controversial paper, Ball and Sheridan (2004) argue that an inflation targeting regime is irrelevant to the economic performance of 20 developed countries. Most work subsequent to Ball and Sheridan who either use or improve on their difference in differences econometric technique find either no effect or a small negative effect of inflation targeting for inflation outcomes (Neumann and von Hagen, 2002; Vega and Winkelried, 2005; Mishkin and Schmidt-Hebbel, 2007; Ball, 2010; de Mendonça and de Guimarães e Souza, 2012; Willard, 2012).²

The evidence is stronger for inflation targeting emerging markets. Much of the previous work on emerging countries finds that inflation targeting reduces inflation and inflation volatility compared to the non-inflation targeting counterparts. Supporting this finding is Gonçalves and Salles (2008) who employ the cross-section difference-in-differences method of Ball and Sheridan (2004). More recently, Lin and Ye (2009) evaluate similar questions using the propensity score matching method to show that

¹Louis and Balli (2013) address the question of whether low inflation targets were a cause of the recent crisis episode in the first place and find that it was lax mortgage rules and financial deregulation rather than too low inflation targets.

²See also Gonçalves and Carvalho (2009) for a similar analysis focusing on the sacrifice ratio, where they find that inflation targeting is a better policy in periods of disinflation.

inflation targeting has a significant effect on lowering the inflation rate as well as inflation volatility. They also argue that the inflation targeting effects are impacted by country characteristics such as the exchange rate policy and the fiscal position, as well as the preconditions for policy adoption.³ This paper complements and extends this literature by using the propensity score matching technique to examine these questions for the 2007-2012 period. The propensity score matching method is able to deal with the self-selection problem for policy adoption which in other methods can lead to biased results.⁴ Others touching on this topic over a similar timeframe include de Carvalho Filho (2011) using a balanced panel data approach and Fouejieu (2013) a difference in differences approach.

The metrics measuring policy success during the crisis period are chosen to be a little different to those used when economies are functioning normally. Most of the papers listed above which focus on inflation targeting in normal periods measure success by relatively lower inflation and lower inflation variability compared to non-inflation targeting countries. Here, successful policy outcomes in a relative sense are measured by higher inflation and GDP growth and lower unemployment rates as the direction of these metrics reflect stronger economic conditions for countries experiencing crisis or recession. Impacts on the fiscal and external position are also analyzed, including the general government revenue to GDP ratio, the current account balance and the debt to GDP ratio.

The baseline results show that inflation targeting works better than not targeting inflation for developed countries during downturns. The three metrics of inflation, GDP growth, and the unemployment rate show that developed countries with an inflation targeting policy are more insulated from the recessionary effects of the financial crisis compared to those who do not have the policy. On an annual basis, average inflation is just over 1% higher, GDP growth rates are a substantial 2.6% stronger and unemployment rates are 1.2% lower for the inflation targeting countries compared to the non-inflation targeting countries.

Here the results for the inflation targeting emerging countries could not be more

³See also Fraga et al. (2003) for Brazil and Ito and Hayashi (2004) for four Asian countries. See Brito and Bystedt (2010) and Taguchi and Kato (2011) for counter examples finding negative impacts of inflation targeting for emerging countries.

⁴See Heckman et al. (1998) and Dehejia and Wahba (2002) for a detailed discussion. Generally, if the targeting choice is systematically correlated with a set of observable variables that also affect the economic outcomes, then there is a "selection of observables" problem, which makes methods such as traditional linear regression unreliable methods of estimation.

different to the results for the developed countries. The influence of inflation targeting on inflation rates during the crisis period is very small and mostly insignificant, while only 50% of the matching methods show a positive effect on GDP growth. The unemployment rates are higher for the inflation targeting countries, and current account balances are worse.

There is some consistency in the results across the two country types though and that is in the potential role of fiscal discipline. Both developed and emerging inflation targeting countries had better fiscal outcomes. Both developed and emerging countries who inflation target have a smaller tax burden and a lower debt to GDP ratio than their non-inflation targeting peers. For developed countries, the effectiveness of inflation targeting during downturns is an important result, and in contrast to the many papers who find that inflation targeting does not make much difference to outcomes in normally functioning markets. That inflation targeting makes a difference in a crisis period is argument for the adoption of such a policy by developed markets. For both types of economy there are trade-offs in the policy choices that are only revealed during recession periods, and which should be accounted for in policy choices.

This article is structured as follows: Section 2 presents the data, Section 3 presents the propensity score matching method used to examine the relative performance of inflation targeting. Section 4 presents the empirical results of the propensity score matching method for the developed and emerging countries. Section 5 presents a sensitivity analysis by removing countries who did not fall into recession during the sample period. Section 6 uses entropy balancing as an alternative technique to propensity score matching, while Section 7 concludes.

2 Data

To examine the differences between a panel of inflation targeters (the treatment group) and non-inflation targeters (the control group) during a crisis period, k economic variables of annual frequency are considered over the sample 2007 to 2012. These are k =the inflation rate, the GDP growth rate, the unemployment rate, the general government revenue to GDP ratio, the current account balance and the debt to GDP ratio. Inflation is measured as the annual (year-on-year) growth rate of the consumer price index, output is the annual GDP growth rate, the general government revenue and debt ratios to GDP are expressed in percentage terms and the current account balance

is in US dollars. The data is obtained from the IMF International Financial Statistics (IFS) database.

As previous work finds that inflation targeting has little impact on outcomes for developed countries but has more substantial effects for emerging countries, the sample is split along these lines to examine the stability of this result in times of financial crisis and widespread downturns. The sample consists of 31 advanced countries and 60 emerging countries. Tables 1 and 2 provide the list of inflation targeting countries (treatment group) and the non-inflation targeting countries (control group) for the advanced and emerging economies respectively, along with the year that each country adopted their inflation targeting policy, and their choice of exchange rate regime using the classification of Ilzetzki, Reinhart and Rogoff (2010). Of the developed countries, there are 10 inflation targeters and 21 countries in the control group.⁵ For the emerging countries, there are 18 inflation targeters and 42 countries in the control group. The starting year for each inflation targeting country is obtained from the IMF who in turn use their own staff calculations, Roger (2010) and Hammond (2011) as the basis of their dating.⁶ The concern of Rose (2007) that the date of the beginning of an inflation targeting regime is not always precisely clear is noted.

To ensure that the control group can reasonably be compared with the treatment group for each of the developed and emerging countries, the criteria applied to the selection of the control group countries is that their GDP per capita must be greater than or equal to the lowest GDP per capita of the inflation targeting treatment group. Second, the population of the control group must be greater than or equal to the lowest population in the treatment group (Rose, 2007; Lin and Ye, 2009; Samarina et al., 2014).

Table 3 presents the preliminary statistics on the k outcome variables considered for the inflation targeters and non-targeters separated by level of development. For the developed countries, the inflation targeting countries have better outcomes for all of the variables. Inflation and GDP growth are relatively higher and the unemployment rate, the tax burden, the current account deficit and the debt to GDP ratio are lower. The (large) maximum inflation value of the developed inflation targeting countries of 12.7% belongs to Iceland in 2008 which explains some of the higher mean value of inflation for the inflation targeting developed countries compared to the non-inflation

⁵The Lin and Ye (2009) sample is extended by the five additional countries which implemented inflation targeting after 2005.

⁶See <http://www.imf.org/external/pubs/ft/fandd/basics/target.htm>

targeting countries.

In contrast, the statistics for the emerging countries show that it is the non-inflation targeting countries that have higher inflation and GDP growth rates, along with lower unemployment rates, better current account balances and slightly lower debt to GDP ratios. The tax burden (Government revenue to GDP ratio) is slightly higher for the non-inflation targeters. For all statistics apart from the unemployment rate, volatility is higher for all outcome variables for the emerging inflation targeting countries.

3 Propensity Score Matching

To formally evaluate the effect of inflation targeting during a crisis period for developed and emerging markets, propensity score matching methods are used following the initial work of Rosenbaum and Rubin (1983) and Heckman, Ichimura, and Todd (1998). For more on the econometrics of the method see Becker and Ichino, (2002). For applications to inflation targeting see Vega and Winkelried (2005); de Mendonça and de Guimarães e Souza, (2012); Lin and Ye (2007,2009) and Samarina et al. (2014).

Consider

$$ATT = E [Y_{i1}^k | D_i = 1] - E [Y_{i0}^k | D_i = 1], \quad (1)$$

which presents the simplest version of the average treatment effect on the treated (*ATT*) concept. Y_i^k is the outcome for observation i and variable k and D_i is a dummy variable capturing whether or not treatment (inflation targeting) has occurred. Here,

$$D_i = \begin{cases} 1 & \text{inflation targeter} \\ 0 & \text{non-inflation targeter} \end{cases} .$$

The term $Y_{i1}^k | D_i = 1$ is the economic outcome of variable k given that i is an inflation targeter, and $Y_{i0}^k | D_i = 1$ is the counterfactual. That is, the second term measures what the economic outcome of variable k would be for country i if country i was not an inflation targeter.

There are two difficulties in estimating the *ATT* using equation (1). First, this second term $Y_{i0}^k | D_i = 1$ in practice is not observed since it is not possible to observe the economic outcomes in an inflation targeting country that has not actually adopted inflation targeting. The assumption needed for the matching method to be realized is the conditional independence assumption, or unconfoundedness (Dehejia and Wahba,

2002).⁷ This is

$$(Y_0, Y_1 \perp D | X), \quad (2)$$

where X are a set of covariates which are not affected by being treated so that the outcomes are independent of the treatment (inflation targeting or not) so that

$$E[Y_{i0} | D_i = 1, X_i] = E[Y_{i0} | D_i = 0, X_i] = E[Y_{i0} | X_i]. \quad (3)$$

Equation (1) is then reexpressed as

$$ATT = E[Y_{i1} | D_i = 1, X_i] - E[Y_{i0} | D_i = 0, X_i]. \quad (4)$$

The second problem that arises in estimating the ATT occurs when the number of covariates in X increases resulting in a dimensionality problem. Rosenbaum and Rubin (1983) propose a method to match the treated group with the control group using their propensity scores in this circumstance (see Lin and Ye, 2007, 2009; and de Mendonça and de Guimarães e Souza, 2012; in the context of inflation targeting). These probabilities (or propensity scores) $p(D_i | X_i)$ are commonly estimated using probit or logit models. Here, equation (4) is rewritten as

$$ATT = E[Y_{i1} | D_i = 1, p(X_i)] - E[Y_{i0} | D_i = 0, p(X_i)]. \quad (5)$$

This is the propensity score matching estimator.

There are a variety of methods to match the treated (inflation targeting) countries with the comparator control group (non-inflation targeting) countries which mainly arise because $p(X_i)$ is continuous. The methods used in this paper are: nearest neighbor matching; radius matching; kernel matching; and stratification matching. The matching methods are summarized in Heckman et al. (1998) and Becker and Ichino (2002).

4 Empirical Results

This section examines the average treatment effect of inflation targeting on inflation, GDP growth, the unemployment rate, the government revenue to GDP ratio, the

⁷Even though the propensity score matching is a widely used methodology to examine the treatment effect of the inflation targeting regime, it is not possible to test whether or not conditional independence holds in practice (see Samarina et al. 2014 for a detailed discussion). See Section 6 on entropy balancing for an alternative method which does not have the potential conditional independence violations that is a risk in the propensity score matching method.

current account balance and the debt to GDP ratio. Section 4.1 presents the empirical estimation of the propensity scores, and Section 4.2 presents the results of the matching processes for the developed and emerging economies.

4.1 Estimation of the Propensity Scores

The propensity scores used in equation (4) are estimated using variables chosen to reflect the characteristics of an economy accounted for in the decision of whether to be an inflation targeter or to adopt some other type of policy, such as exchange rate targeting. Examples of previous literature on the factors for the adoption of inflation targeting include Svensson (2002), Mishkin (2004), Lin and Ye (2007) and de Mendonça and de Guimarães e Souza, (2012). The goal of estimating the propensity score is not to find the best statistical model to explain the probability of policy adoption as the conditional independence assumption implies that it is legitimate to exclude variables that systematically affect the probability that a country adopts inflation targeting but do not affect the economic outcomes in the probit regressions (Persson, 2001).

For the baseline model, $X_i = \{\alpha_0, \pi_{i,t-1}, Mon_{i,t}, Exc_{i,t}, Open_{i,t}\}$ where α_0 is a constant term, $\pi_{i,t-1}$ represents the lag of inflation, $Mon_{i,t}$ is broad money growth, $Exc_{i,t}$ is a dummy variable for the exchange rate regime, and $Open_{i,t}$ is openness to trade. The dummy variable for the exchange rate regime is

$$Exc_{i,t} = \begin{cases} 1 & \text{non-floating} \\ 0 & \text{floating} \end{cases} .$$

The coarse annual regime classification of Ilzetzki, Reinhart and Rogoff (2010) is the basis of the dummy classification in $Exc_{i,t}$ where any regime which is not purely floating as is shown in Tables 1 and 2 takes a value of 1.⁸ Openness to trade is expressed as the ratio of imports plus exports to GDP.

All variables are expected to be negatively correlated with the probability that a country will adopt inflation targeting. The $\pi_{i,t-1}$ represent initial conditions as found to be important in Ball and Sheridan (2004); $Mon_{i,t}$ captures pressure on inflation from money supply factors and is expected to be particularly important for the emerging economies; and $Exc_{i,t}$ and $Open_{i,t}$ captures factors increasing the likelihood of the adoption of alternative policy regimes. See Yamada (2013) for analysis of inflation targeting for emerging countries under alternative exchange rate regimes, as well as

⁸The propensity scores were also estimated by using the finer classification of exchange rate regimes. The results were qualitatively the same as those by using the coarser classification.

discussion in Lin and Ye (2009) and de Mendonça and de Guimarães e Souza (2012). Unlike these other papers, variables capturing GDP are not included in the logit equation specification as the effects of inflation targeting on GDP growth outcomes during crises are analyzed through the propensity score matching in Section 4.2.

The results of the estimation of the propensity scores of the baseline model of equation 4 are reported in Table 4. Most of the coefficient estimates from the model for both the developed and emerging countries group have signs in accordance with expectations. The main exception is for the lag-inflation term for the developed countries which is positive here in contrast to negative coefficients in Ball and Sheridan (2004); Lin and Ye (2007,2009); de Mendonça and de Guimarães e Souza (2012); and three of the four cases in Samarina et al. (2014). The lag-inflation term for the emerging countries is negative and consistent with these other studies. Broad money growth is positive but insignificant for all country types. The exchange rate regime choice is significant for the emerging countries but not for the developed countries. The openness variable is significant for both types of countries suggesting that countries who follow a more controlled exchange rate regime or have more trade activities abroad are less likely to implement an inflation targeting policy.

4.2 Inflation Targeting and Growth During Crises

The propensity score matching shown in Table 5 compares the economic outcomes of countries with an inflation targeting policy compared to those who do not have the policy during the crisis period to determine which policy settings lead to better outcomes. In comparison to other work evaluating inflation targeting which sees lower inflation as an indicator of the inflation targeting policy success, success during recessionary periods is consistent with relatively higher inflation and growth. The premise is that during a crisis period economic strength is observed through GDP growth, some inflation and low unemployment rates. Conversely, crisis affected countries are likely to have lower inflation as asset and consumer prices fall and higher unemployment rates, both consequences of low or falling GDP growth.

To ensure that the treated units and control units are comparable, the estimated propensity scores are sorted and the control units with estimated propensity scores which are less than the lowest score of the treated units are discarded. The results for the range of matching methods considered for the baseline model are illustrated in Table 5. This table shows the *ATT* statistics for inflation, GDP growth, the unemployment

rate, the general government revenue to GDP ratio, the current account balance and the debt to GDP ratio for the developed and emerging countries respectively calculated using the baseline logit model estimated in the previous sub-section. The first column reports the nearest neighbor matching results. The next three columns contain the radius matching results with radien of $r = 0.01, 0.02, \text{ and } 0.03$. The final two columns contain the results of the kernel and stratification matching.

4.2.1 Developed Countries

The propensity score matching for the three metrics of inflation, GDP growth, and the unemployment rate shows that developed countries with an inflation targeting policy are more insulated from the recessionary effects of the global financial crisis compared to those who do not have the policy. Table 5 shows that in the baseline model, the average treatment effect of inflation targeting on the inflation rates of the inflation targeting countries (the ATT) estimated by the four matching methods are on average 1.245% higher for the developed economies. The range of the inflation gap of the inflation targeting countries over the non-inflation targeting countries estimated using the matching methods is 0.799% to 2.016%. All of the methods find that the inflation rate gaps are significant.

Table 5 also shows that the treatment effects of the inflation targeting policy for developed countries for the GDP growth rates are relatively strong and significant. The inflation targeting policy contributes on average 2.622% to the GDP growth rates above the non-inflation targeters. The majority of the matching methods indicate that this additional increment to the growth rates for the inflation targeting countries is significant. In turn, the estimated treatment effects on the unemployment rates are found to be significant for all matching methods and are negatively related to the adoption of inflation targeting. Unemployment rates are 1.207% lower on average for the countries using inflation targeting compared to the non-inflation targeting policy countries. All matching methods find significant results for the effect of inflation targeting on the unemployment rate.

In addition to examining the variables of inflation, GDP growth and the unemployment rate, the propensity score matching method is also applied to the government revenue to GDP ratio, the size of the current account and the debt to GDP ratio. For the developed countries, all except for one of the matching methods (nearest neighbor) show that inflation targeting countries have a smaller tax burden than

their non-targeting counterparts by on average 4.352%. This smaller tax revenue as a proportion of the size of the economy is indicative of inflation targeting imposing a relatively high level of fiscal discipline. The better fiscal discipline also reveals itself in lower debt to GDP ratios, with those following the inflation targeting policy having debt to GDP ratios 27.2% lower than those choosing other forms of monetary policy. The fiscal discipline of inflation targeters may well be the reason that inflation targeters perform comparatively better during the recession period, with this effect only showing up as a positive in the data when recession occurs. This is consistent with the innocuous effects that inflation targeting versus non-inflation targeting appears to have for developed countries during periods of growth.

4.2.2 Emerging Countries

The effects of the inflation targeting policy during financial crises for emerging countries are almost diametrically opposed to those for the developed markets. The influence of inflation targeting on inflation rates during the crisis period is very little with only two matching methods showing that there are significant differences in inflation outcomes for the emerging countries, and this is at the 10% level of significance. This signs of the matching statistics for inflation are negative, indicating that inflation is lower under inflation targeting during the financial crisis period. This result is consistent with other studies who examine non-recessionary periods for emerging markets such as Mishkin and Schmidt-Hebbel (2007), Vega and Winkelried (2005), Lin and Ye (2009) and Mendonça and de Guimarães e Souza (2012). Turning to the effects of inflation targeting for GDP growth, the results are also mixed. Only 50% of the matching methods show that the effect of inflation targeting is significant for GDP growth. This is different to studies that focus on pre-financial crisis periods and who find that inflation targeting has significant positive effects on GDP growth in emerging countries (Abo-Zaid and Tuzeman, 2012).

A much stronger result holds in the case for the unemployment rate, where all matching methods show that during the crisis inflation targeting is significant, however, the sign of the coefficient is the opposite to that for the developed markets. The unemployment rates are higher for the inflation targeting countries, by on average 2.40%. Not only do the inflation targeting countries report higher unemployment rates in the crisis period than those who do not target inflation, but the current account balance is also worse. In fact, all of the matching methods find that the effect of

inflation targeting for current account balances is statistically significant at the 1% level. Current account balances are on average $-\$24.37$ billion dollars worse for the countries with an inflation target. The bright spot for the emerging inflation targeting countries is that the government revenue to GDP ratio is statistically significantly lower by on average -5.471% , and the choice of an inflation targeting policy does not have significance adverse consequences for the debt to GDP ratio.

5 Robustness to Recession

The hypothesis considered in this paper is that during a crisis period inflation targeting countries achieve better economic outcomes than those who do not have an inflation targeting policy. The hypothesis is that during a crisis period, inflation rates and GDP growth rates will be higher for the inflation targeting countries, and that unemployment rates will be lower relative to those who do not target inflation. As illustrated above, the results for the developed countries support this hypothesis, but for the emerging countries the signs of the *ATT* statistics are generally the opposite.

In normal periods, the result of lower inflation rates for the emerging markets under inflation targeting is illustrated in many papers (Mishkin and Schmidt-Hebbel, 2007, Vega and Winkelried, 2005, Lin and Ye, 2009, and Mendonça and de Guimarães e Souza, 2012). This result may be because the crisis was a developed country phenomena and that emerging markets generally did not fall into recession, meaning that the hypothesis of inflation targeting being consistent with lower inflation is in fact the appropriate hypothesis for these countries in the global crisis period.

To investigate whether or not the results for the emerging markets come about because most emerging markets were operating in an expansionary economic environment, the logit model is re-run containing only those countries that experienced recession during the sample period.⁹ The countries in recession during the sample period are shown in Tables 1 and 2. The model is also rerun for the developed countries only in recession.

Table 6 presents the results of the propensity score matching for both the developed and emerging countries when countries who do not fall into recession are excluded from the analysis. The evidence regarding the effectiveness of inflation targeting in these circumstances is a little less strong for the developed countries than when only the

⁹The analysis cannot make any statement on whether or not inflation targeting countries are less likely to fall into recession in first place.

recession countries are included. The statistical significance of higher inflation rates is evident in 50% of the matching methods, with inflation being around 1% higher than for the non-inflation targeting countries. This compares to all matching methods being significant in the benchmark model. The GDP growth variable is higher for the inflation targeting countries during the crisis period, although the significance has fallen with only two of the matching methods significant in the matching process. In terms of fiscal discipline there are no longer significant differences in the debt to GDP ratio, but the size of the tax burden relative to GDP is still substantially smaller under the inflation targeting regime. The major differences in results are that the unemployment rate is no different across the two types of policy regimes and that the current account balance is worse and significant in more cases.

The second panel of Table 6 presents the results of excluding the non-recession countries from the propensity score matching for the emerging countries. The results of the baseline model in Table 5 effectively still hold. Inflation outcomes for inflation targeting emerging countries are lower (and significant in 50% of the matching cases), and in conjunction with a statistically significant lower GDP growth and higher unemployment, inflation targeting does not appear to work for emerging countries in recession. In terms of fiscal discipline, the result holds that government revenue as a percentage of GDP is significantly lower, but there are no differences in the debt to GDP ratio.

6 Entropy Balancing

As described in Section 3, the two conditions needed for propensity score matching to successfully work are balancing and unconfoundedness. One of the main criticisms of the propensity score matching method is that in practice it can be difficult to ensure that the distributions of the covariates X_i of the control and treatment groups are balanced (see for example Rosenbaum and Rubin, 1983,1985; Dehejia and Wahba, 2002 for tests to check for balance). This property is important as the aim is to ensure the conditional independence of the treatment (here an inflation targeting policy) from the covariates as described in Section 3.¹⁰

To examine the robustness of our results to the matching methods used, an alternative method of achieving balance between the control and treatment groups based on

¹⁰Unconfoundedness cannot be tested.

the entropy balancing method for binary treatments of Hainmueller (2011) and Hainmueller and Xu (2013) is used. The advantage of this method is that it endogenously determines a weighting amongst the covariates of the treatment and the control groups. The method matches the moments of the covariate data for the control group with the moments of the covariate data of the treatment group. It avoids the need to manually search for balance amongst the two groups which is usually an iterative process, subject to trade-offs which are arbitrarily decided upon.

The entropy balancing method also avoids the need to use logit or probit models to estimate the propensity scores required for the matching process. Rather, it is the sample moments of the treatment and control groups that are directly balanced. This occurs by estimating the counterfactual mean

$$E \left[\widehat{Y_{i0}^k} \mid D_i = 1 \right] = \frac{\sum_{\{i|D=0\}} Y_i^k \omega_i^k}{\sum_{\{i|D=0\}} \omega_i^k}, \quad (6)$$

with the weights ω_i^k chosen for the control group variables by minimizing

$$\min_{\omega_i^k} H(\omega^k) = \sum_{\{i|D=0\}} \omega_i^k \log(\omega_i^k / q_i^k), \quad (7)$$

which is an entropy distance function of the form of Kullback (1959) and where $q_i^k = 1/n_0$. n_0 is the number of observations in the number of units in the control group.

The entropy distance function is minimized subject to three constraints which ensure balance. These are

$$\sum_{\{i|D=0\}} \omega_i^k c_{ri}^k(X_i^k) = m_r^k, \quad r \in 1, \dots, R, \quad (8)$$

$$\sum_{\{i|D=0\}} \omega_i^k = 1, \quad (9)$$

$$\omega_i \geq 0 \quad \forall i \text{ such that } D = 0, \quad (10)$$

where the balance constraints $c_{ri}^k(X_i^k) = m_r^k$ are imposed through a reweighting of the r moments of X_i^k of the control group. In this application $r = 1$.

To determine the impact of inflation targeting on economic outcomes following the entropy balancing procedure, the following equation is estimated

$$\widetilde{Y}^k = \alpha^k + \beta^k D + u_t,$$

where \widetilde{Y}^k is the economic outcome data k which combines the re-weighted data for the control group with the original data of the inflation targeting group. The coefficient

α^k is a constant and β^k is the coefficient capturing the treatment effect of inflation targeting.

Table 7 contains the entropy balancing estimates of the treatment effect of inflation targeting. The results are heartening in that the results are fairly consistent with those of the propensity score matching methods indicating that the models estimated in Sections 4 and 5 do not appear to violate the assumptions of conditional independence. For the developed countries the magnitudes and signs of the inflation targeting effects are similar. Inflation targeting has a positive impact on inflation during the crisis being 2.076% higher, GDP growth is also 3.457% higher and unemployment is -2.409% lower. These are all statistically significant coefficients. In terms of the fiscal variables, the narrative is consistent with the propensity score matching results with a lower fiscal burden in terms of the size of the tax burden as a proportion of GDP as well as lower debt to GDP ratios.

For the emerging countries the entropy balancing produces a similar story to that told earlier. During the crisis period the inflation targeting countries perform weaker by some metrics and are stronger in others. Inflation is 0.907% lower though not significantly so, GDP growth is -1.285% lower and unemployment is 1.522% higher. Again on the other hand, on the fiscal side inflation targeting countries appear to be better off with a smaller tax burden and a lower debt to GDP ratio.

7 Conclusion

Previous work shows that inflation targeting policy adoption appears to work well in emerging countries with favorable effects on inflation and inflation volatility. At the same time, the evidence is less conclusive for developed economies (Lin and Ye, 2007; 2009). All of these prior papers focus on periods of time in which the global economy functions normally. This paper explores similar issues to these previous works by evaluating the average treatment effect of inflation targeting for 31 developed countries and 61 emerging countries but by employing data for the 2007-2012 financial crisis and downturn period to examine whether or not inflation targeting performs better in worst case events. In contrast to the previous studies for normal economic periods, the propensity matching score method for the developed countries shows that the effects of inflation targeting on inflation, GDP growth, and the unemployment rate are favorable in periods of widespread downturn. Furthermore, there is evidence that

inflation targeting imposes fiscal discipline, with government revenue as a proportion of GDP and the debt to GDP ratio being lower for the inflation targeting developed markets.

In contrast to previous studies, inflation targeting is not as successful for emerging countries when the period of global economic downturn is considered. Although inflation is lower for inflation targeters, there does not seem to be a significant effect on GDP growth rates for emerging countries as is the case for the developed markets. In fact, unemployment rates in the crisis period are higher for inflation targeters than for those who do not target inflation. However, the bright spot for the emerging inflation targeting countries is in fiscal discipline whereby the government revenue to GDP ratio is significantly lower by on average -5.471% , and the choice of an inflation targeting policy does not have significance adverse consequences for the debt to GDP ratio.

These results suggest that both developed and emerging countries need to carefully consider whether or not inflation targeting is an appropriate policy regime choice. Assuming that the same policy type is adopted in both regimes of recession and expansion, both types of countries are subject to trade-offs, albeit different trade-offs, across the two regimes which need to be taken into account when devising optimal economic policy. Inflation targeting developed countries are not substantially better off during expansion periods, but benefit greatly during recession. Inflation targeting emerging countries are better off during expansion periods, but are worse off during recession.

A policy implication for developed countries is that the announcement of a specific inflation target during a recession period may improve economic outcomes, and this is potentially a feasible policy option for both types of policy adopters. On the other hand, it is probably not as easy for emerging countries to abandon their inflation targeting policy during recession. The loss of credibility and the anchoring effects that are features of the inflation targeting policy are probably too valuable to risk when there is adverse economic change as countries are developing. Instead, emerging inflation targeters may need to institute alternative stimulatory policies perhaps through the fiscal side. The emerging inflation targeters are on average in a better fiscal position than those don't target inflation (as are the developed countries), implying that fiscal policy is a feasible stimulus policy option, and a reason to remain inflation targeters during both regime types.

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Table 1: List of Inflation targeters (treatment) and non-inflation targeters (control) for the developed economies, the inflation targeting start date and exchange rate regime.

Inflation targeters			Non-inflation targeters	
Country	Start year	Exchange rate	Country	Exchange rate
Australia	1993	4	Austria	1
Canada	1991	3	Belgium	1
Czech Republic	1997	3	Cyprus	1
Iceland*	2001	3	Denmark*	1
Israel	1997	3	Finland	1
Korea, Republic of	2001	3	France	1
New Zealand*	1990	3	Germany	1
Norway	2001	3	Greece*	1
Sweden*	1993	3	Hong Kong SAR	1
United Kingdom*	1992	3	Ireland*	1
			Italy*	1
			Japan*	4
			Luxembourg*	1
			Malta	2,1
			Netherlands	1
			Portugal*	1
			Singapore	3
			Slovenia	1
			Spain*	1
			Switzerland	3
			United States*	3

Sources: IMF website (2013) (<http://www.imf.org/external/pubs/ft/fandd/basics/target.htm>); and Ilzetzki, Reinhart and Rogoff (2010).

The exchange rate classification codes correspond to:

1 - no separate legal tender, currency board or defacto peg; 2 - crawling peg; 3 - crawling band; 4 - managed floating; 5 - freely falling; 6 - dual market.

*These countries entered into a recession during the sample period.

Table 2: List of Inflation targeters (treatment) and non-inflation targeters (control) for the emerging economies, the inflation targeting start date and exchange rate regime.

Inflation targeters			Non-inflation targeters			
Country	Start year	Exchange rate	Country	Exchange rate	Country	Exchange rate
Albania	2009	3	Algeria	2	Kuwait*	1
Armenia	2006	3	Angola	1,2	Lebanon	1
Brazil	1999	3	Argentina	2	Libya	6
Chile	1999	3	Azerbaijan	1	Malaysia	1,3
Colombia	1999	3	Belarus	1,3	Moldova	2
Ghana	2007	2	Bolivia	2,1	Morocco	1
Guatemala	2005	2	Bosnia and Herzegovina	1	Nicaragua	2
Hungary	2001	3	Bulgaria	1	Panama	1
Indonesia	2005	3	China	3,1	Papua New Guinea	2
Mexico	2001	3	Costa Rica	1	Paraguay	3,1
Peru	2002	2	Croatia*	2	Russia*	2,3
Philippines	2002	2,3	Dominican Republic	3,2	Saudi Arabia	1
Poland	1998	3	Ecuador	1	South Sudan	2
Romania*	2005	3	Egypt	2	Sri Lanka	2
Serbia	2006	3	El Salvador	1	Sudan*	2
South Africa	2000	4	Georgia	2	Tunisia	2
Thailand	2000	3	Honduras	1	Turkmenistan	6
Turkey	2006	4,3	Iraq	2	Ukraine	1
			Islamic Republic of Iran	1	United Arab Emirates	1
			Jordan	1	Uruguay	3
			Kazakhstan	2	Venezuela*	1

Sources: IMF website (2013) (<http://www.imf.org/external/pubs/ft/bannd/basics/target.htm>); and Ilzetzki, Reinhart and Rogoff (2010).

The exchange rate classification codes correspond to:

1 - no separate legal tender, currency board or defacto peg; 2 - crawling peg; 3 - crawling band; 4 - managed floating; 5 - freely falling; 6 - dual market.

*These countries entered into a recession during the sample period.

Table 3: Descriptive statistics of outcome variables 2007 to 2012

Variable	Inflation targeting countries					Non-inflation targeting countries				
	Obs	Mean	Std. Dev.	Min	Max	Obs	Mean	Std. Dev.	Min	Max
Developed countries										
Inflation	60	3.0	2.2	-0.5	12.7	126	2.2	1.5	-1.7	6.6
GDP growth	60	1.7	2.9	-6.6	6.9	126	0.7	3.5	-8.5	14.8
Unemployment (%)	60	5.8	2.1	1.0	9.4	126	7.3	4.2	2.0	25.0
Govt. revenue to GDP (%)	60	39.9	9.2	22.7	58.4	126	40.5	9.1	17.7	55.7
Current account	60	-2.2	36.3	-93.9	72.4	126	-8.3	136.4	-713.4	248.0
Debt to GDP (%)	60	50.2	24.3	9.7	102.3	126	76.7	39.1	6.7	238.0
Emerging countries										
Inflation	106	5.6	3.1	-0.9	19.3	249	8.1	8.0	-2.7	59.2
GDP growth	106	3.6	4.1	-14.2	15.0	248	4.7	8.8	-62.1	104.5
Unemployment (%)	106	10.5	6.2	0.7	28.7	206	8.6	5.0	0.6	29.0
Govt. revenue to GDP (%)	106	27.1	9.5	11.1	53.8	248	32.2	12.4	10.0	72.3
Current account	106	-8.6	15.6	-75.1	21.9	248	15.0	48.9	-14.8	420.6
Debt to GDP (%)	106	39.2	16.9	3.9	81.8	248	35.9	28.0	0.0	168.4

Table 4: Logit model propensity score estimates

	Developed countries		Emerging countries	
	Baseline	Exclude	Baseline	Exclude
		Non-recession countries		Non-recession countries
Inflation-lag	0.397***	0.460**	-0.103***	-0.091**
Money-growth	2.840	2.020	-2.940	-2.510
	0.003	0.004	-0.018	-0.019
Currency regime	0.170	0.130	-1.280	-1.340
	-0.019	-1.653**	-1.110***	-1.111***
Openness	-0.040	-2.160	-3.190	-3.050
	0.010**	-0.023***	-0.020***	-0.020***
Constant	-1.960	-2.750	-3.190	-3.120
	-1.190*	1.504	2.413***	2.359***
	-1.810	1.480	4.040	3.870
No. of obs	118	66	227	207
pseudo R ²	0.123	0.281	0.140	0.139

Note: t-statistics are reported below the coefficients. *, **, and *** indicate significance at the 10%, 5%, and 1% level respectively

Table 5: Estimates of the average treatment effect of inflation targeting on economic variables in the baseline model.

Model	Matching methods					
	Nearest-neighbor matching	Radius matching			Kernel matching	Stratification matching
		r=0.01	r=0.02	r=0.03		
Developed countries						
Inflation	2.016***	0.871*	0.799*	1.229**	1.362***	1.191***
	2.901	1.724	1.950	2.412	2.742	2.678
GDP growth	2.817*	2.996	2.367*	2.322	2.680**	2.552***
	1.857	1.437	1.675	1.585	2.319	2.739
Unemployment (%)	-1.684**	-1.196*	-0.851*	-0.912*	-1.360**	-1.239**
	-2.253	-1.769	-1.674	-1.645	-2.070	-2.193
Govt. revenue to GDP (%)	-2.818	-4.709**	-4.916***	-4.636***	-4.130**	-4.906***
	-1.178	-2.042	-2.692	-2.686	-2.323	-2.775
Current account	116.437**	8.328	10.625	6.292	33.339	30.689
	2.188	0.218	0.420	0.292	1.154	1.096
Debt to GDP (%)	-22.099**	-28.315***	-29.362***	-27.878***	-28.656***	-26.884***
	-2.156	-3.035	-3.639	-3.723	-4.360	-4.126
Emerging countries						
Inflation	-0.603	-0.691	-1.070	-1.198*	-0.856*	-0.996*
	-0.677	-0.894	-1.471	-1.775	-1.375	-1.658
GDP growth	-2.249**	-1.052	-1.215	-1.226*	-1.344*	-1.019
	-2.378	-1.283	-1.561	-1.759	-1.782	-1.474
Unemployment (%)	2.447**	4.014***	2.376**	2.363**	1.685*	1.495*
	2.198	2.879	2.051	2.040	1.657	1.702
Govt. revenue to GDP (%)	-7.425***	-4.801**	-4.771***	-5.106***	-5.802***	-4.921***
	-2.757	-2.548	-2.969	-3.154	-3.094	-2.927
Current account	-28.899***	-24.306***	-24.057***	-23.788***	-22.355***	-22.840***
	-2.975	-3.048	-3.439	-3.642	-3.853	-4.320
Debt to GDP (%)	-0.327	-1.229	-1.638	6.021	-7.357	-7.484*
	-0.058	-0.292	-0.417	0.970	-1.609	-1.953

Note: Bootstrapped t-statistics are reported below the ATT coefficients. *, **, and *** indicate significance at the 10%, 5%, and 1% level respectively.

Table 6: Estimates of the average treatment effect of inflation targeting on economic variables when countries without recession are excluded.

Model	Matching methods					
	Nearest-neighbor matching	Radius matching			Kernel matching	Stratification matching
		r=0.01	r=0.02	r=0.03		
Developed countries						
Inflation	1.505***	1.184	0.884	0.896	1.087**	1.087**
	3.066	1.076	1.227	1.447	2.258	2.069
GDP growth	2.106	1.948	1.561	2.172	2.217*	2.500**
	1.458	0.923	0.989	1.620	1.884	2.000
Unemployment (%)	1.047	-0.660	0.380	0.506	0.563	0.557
	1.284	-0.550	0.338	0.545	0.679	0.757
Govt. Revenue to GDP (%)	-4.798*	-9.996**	-9.980***	-8.997***	-7.797***	-8.099***
	-1.702	-2.089	-2.840	-2.636	-2.908	-3.093
Current account	-54.871**	-50.732	-39.787	-42.142*	-42.313*	-45.326**
	-2.549	-1.261	-1.453	-1.651	-1.852	-2.027
Debt to GDP (%)	-4.697	-1.900	-1.180	1.058	0.848	-0.771
	-0.708	-0.156	-0.137	0.149	0.129	-0.128
Emerging countries						
Inflation	-1.472	-1.070	-1.641*	-1.459*	-1.171	-1.276*
	-1.636	-1.113	-1.920	-1.763	-1.639	-1.944
GDP growth	-2.088**	-2.086**	-1.696**	-1.617**	-2.223***	-1.901***
	-2.347	-2.167	-2.124	-2.073	-3.285	-2.887
Unemployment (%)	1.876*	3.437***	3.289***	3.283***	1.612	1.752*
	1.809	2.798	2.786	2.780	1.600	1.917
Govt. Revenue to GDP (%)	-3.724*	-4.575**	-4.140**	-4.344***	-2.720*	-3.247*
	-1.722	-2.193	-2.351	-2.839	-1.807	-1.929
Current account	-39.420**	-33.393**	-30.773***	-32.105***	-33.167***	-36.902***
	-2.286	-2.279	-2.786	-3.073	-2.618	-3.035
Debt to GDP (%)	-5.723	-0.106	-0.355	0.640	-3.536	-1.595
	-1.216	-0.029	-0.098	0.178	-0.959	-0.458

Note: Bootstrapped t-statistics are reported below the ATT coefficients. *, **, and *** indicate significance at the 10%, 5%, and 1% level respectively.

Table 8: Estimates of the average treatment effect of inflation targeting on economic variables using the entropy balancing estimates.

		Coefficient	Linearized Std. Error	t-statistic
Developed countries				
Inflation	α^k	2.076***	0.544	3.82
	β^k	1.314***	0.301	4.36
GDP growth	α^k	3.475***	0.977	3.56
	β^k	-1.810**	0.762	-2.37
Unemployment (%)	α^k	-2.409*	1.338	-1.80
	β^k	8.242***	1.289	6.39
Govt. revenue to GDP (%)	α^k	-3.684*	1.873	-1.97
	β^k	41.973***	1.287	32.61
Current account	α^k	14.063	13.369	1.05
	β^k	-18.928	12.497	-1.51
Debt to GDP (%)	α^k	-10.913**	5.172	-2.11
	β^k	55.709***	3.309	16.83
Emerging countries				
Inflation	α^k	-0.907	0.565	-1.60
	β^k	6.762	0.388	17.41
GDP growth	α^k	-1.285*	0.677	-1.90
	β^k	4.690	0.423	11.10
Unemployment (%)	α^k	1.522*	0.892	1.71
	β^k	8.993	0.474	18.96
Govt. revenue to GDP (%)	α^k	-5.202***	1.762	-2.95
	β^k	32.089	1.358	23.62
Current account	α^k	-25.607***	6.367	-4.02
	β^k	18.563	6.152	3.02
Debt to GDP (%)	α^k	-5.298	3.437	-1.54
	β^k	42.931	2.791	15.38

Note: *, **, and *** indicate significance at the 10%, 5%, and 1% level respectively.