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Inflation targeting and macroeconomic performance since the Great Recession

By Thomas Barnebeck Andersen[a], Nikolaj Malchow-Møller[b], and Jens Nordvig[c]

[a]Department of Business and Economics, University of Southern Denmark, Campusvej 55, 5230 Odense M, Denmark; e-mail: barnebeck@sam.sdu.dk
[b]Department of Business and Economics, University of Southern Denmark; e-mail: nmm@sam.sdu.dk
[c]Fixed Income Research Americas, Nomura Securities; e-mail: jnordvig@me.com

Abstract

Has inflation targeting (IT) conferred benefits in terms of economic growth on countries that followed this particular monetary policy strategy during the crisis period 2007–13? We answer this question in the affirmative. Countries with an IT monetary regime weathered the crisis much better than did countries with other monetary regimes, particularly countries with fixed exchange rates.

JEL classifications: E42, E58, O43

1. Introduction

Does the choice of exchange rate and monetary regime matter for economic growth? In his paper on exchange rate regimes in the modern era, Rose argues that 'views appear to be strongly held and sincere, yet they seem to have neither discernible causes nor visible consequences' (2011, p. 621). Indeed, according to Rose, 'the stakes could not be lower' (2011, p. 621).

Nevertheless, a fairly new monetary regime—a floating/flexible exchange rate with an inflation target (IT)—has gained an increasing number of adherents, at least since the Asian crisis of 1997–98.[1] Bernanke and Mishkin (1997) and Bernanke *et al*. (2001), for example, argue that the potential benefits to be obtained from the adoption of an IT regime are substantial. Some of the purported gains are lower and less variable inflation and interest rates, more stable growth, and an enhanced ability to respond to shocks without losing credibility. Others have added that IT countries may be better adapted to dealing with an economic

1 We follow Rose (2011, 2014) and distinguish between three categories of monetary regimes: (i) hard fix; (ii) floating/flexible exchange rates with inflation targeting; and (iii) other regimes, including floats with other targets than inflation. We return to this issue below.

crisis. In particular, a credible IT regime may allow for greater monetary easing without jeopardizing the inflation outlook; in a time when deflationary risks are looming large, the credibility of an IT regime can play an important role in avoiding a liquidity trap (Krugman, 1999).

A central element of an IT regime is the flexibility of the exchange rate. This may prove important in a crisis. For instance, consider the immediate response to the crisis in Sweden: the central bank significantly lowered policy rates, which led to currency depreciation, improved Swedish competitiveness, and an increase in exports (OECD, 2011).[2] This echoes important research on the Great Depression, where it has been shown that currency depreciation conferred important macroeconomic benefits (not necessarily beggar-thy-neighbour effects) on initiating countries (see Eichengreen and Sachs, 1985; Bernanke, 1995).

Such a (unilateral) response to a crisis would be impossible under an inflexible exchange rate, including hard and soft pegs. Here, a country would have to follow the monetary policy of the country to which its currency is pegged or, in the case of a currency union, rely on a concerted effort. This leads to a related problem with monetary policy under inflexible exchange rates, namely, 'when one size does not fit all' (Nechio, 2011). For example, simple Taylor rule recommendations for the Eurozone as a whole have been broadly consistent with ECB policy, but the more pertinent question concerns the appropriateness of the Eurozone rate for the individual Eurozone economies and the countries that have a fixed exchange rate vis-à-vis the euro.

Denmark, a country with a fixed exchange rate vis-à-vis the euro, is a case in point. By the fall of 2005, the first signs of 'over-heating' were beginning to show in Denmark (OECD, 2005). Yet monetary conditions appropriate for the Eurozone as a whole were providing stimulus to the Danish economy. By the spring of 2006, when the economy was clearly over-heated, monetary policy was still adding fuel to the economy (OECD, 2006). Hence, the OECD recommended that fiscal policy should be tightened, and it re-iterated the urgency of increasing labour supply, by strengthening work incentives and making it easier for foreigners to enter sectors like construction. The government did not comply. At this juncture, the obvious policy would have been an interest rate increase—as clearly recommended by a simple Taylor rule (OECD, 2008)—but such a policy was ruled out by design. The upshot of all this, it has been argued, was that Denmark suffered a deep and prolonged economic crisis (Sørensen, 2013).

The present article investigates whether flexible exchange rates with an inflation target conferred benefits in terms of economic growth during the crisis years 2007–13 on countries that followed this particular monetary strategy relative to countries that adhered to other strategies, in particular a fixed exchange rate regime. Our analysis proceeds in two steps. First, we consider the 34 OECD countries, where all countries (except 2) operated under either an IT regime or a fixed exchange rate regime in the period considered. Second, to enhance the robustness of our results, we also look beyond the OECD. The advantage of doing so is obviously that we can enlarge the sample by more countries. The disadvantages, which should not be overlooked, are first that data quality is lower, and second that we cannot control for the same type of variables as when considering only the OECD countries. The second disadvantage is minimized by the fact that we have a good instrumental

2 The SEK currency move also reflected tensions in global inter-bank markets, which affected Swedish banks with large dollar liabilities and thereby depressed the SEK by forcing USD buying and SEK selling (see, e.g., Nomura Securities, 2009).

variable (for the monetary regime) at hand. Furthermore, looking beyond the OECD allows us to include other alternatives to IT, such as soft pegs and floats with other targets than inflation in the analysis.

Our results show that countries with an IT monetary regime weathered the financial crisis much better than did countries with alternative regimes—particularly countries with a fixed exchange rate. This holds in the full OECD sample; it holds when we exclude the five so-called peripheral Eurozone countries (Greece, Italy, Ireland, Portugal, and Spain); and it holds when we exclude all Eurozone countries. IT also out-performs the fixed exchange rate regime in the extended sample with 196 countries—also when instrumenting the choice of monetary regime. It holds when we include alternatives to a fixed exchange rate regime in the comparison group (but the difference is driven by a difference between the IT group and the fixed exchange rate group). It is, in other words, a robust empirical finding.

Some caveats are in order concerning the extent to which our findings lend themselves to generalizations. Looking at a short and extraordinary period of six years is risky if one wants to draw general conclusions about the merits of a certain monetary regime. Yet it makes sense to single out the time period 2007–13 exactly because it is extraordinary. The world has experienced the worst crisis since the Great Depression; activist monetary policy is operating in uncharted territory; and there is even talk about an enduring negative natural rate of interest. In this light, the 2007–13 period may be one of the best tests of the relative performance of different monetary regimes. Indeed, since a widespread view before the crisis held that different monetary regimes performed equally well, the fact that IT outperformed the hard fix during the crisis should certainly count for something.

Our article is related to a number of earlier empirical studies exploring the economic consequences of IT. Analysing the period 1960–2002, Ball and Sheridan (2004) show that adopting IT appears to have been irrelevant for a group of 20 developed economies. Analysing a group of emerging economies, Gonçalves and Salles (2008) show that IT did appear to matter for these economies. Rose (2014) explores the growth consequences of monetary regimes during 2007–12, and he does not find a positive effect of IT on growth. As we will show, the reason for this 'non-finding' is that Rose does not employ a conditional growth regression. Instead, he compares time-demeaned growth rates across regimes. Our article is also related to de Carvalho Filho (2010). Combining developed and emerging economies, he explores the implications of inflation targeting for various economic indicators with data through 2009. He finds, among other things, that IT countries had higher GDP growth.[3]

The rest of the article is structured as follows. Sections 2 and 3 contain our empirical analyses of the OECD sample and the extended sample, respectively. Section 4 concludes.

2. Empirical analysis: OECD sample

In this section we examine whether OECD countries with flexible exchange rates and IT have out-performed countries with alternative monetary regimes—in particular countries with fixed exchange rates—in the period 2007–13. As a first step, we look at simple

3 Our article is also related to structural work in the new Keynesian tradition, for example, Ireland (2007) and Zanetti (2014), which investigates the impact of inflation dynamics in the context of general equilibrium models.

Table 1. Summary statistics by IT classification, OECD sample, 2007–13

	$IT = 1$			$IT = 0$		
	Mean	SD	Obs.	Mean	SD	Obs.
g	0.016	0.028	96	−0.005	0.035	108
GAP	−0.005	0.021	96	−0.016	0.037	102
gPY	0.030	0.008	96	0.020	0.011	103
$DEBT$	0.577	0.235	78	0.864	0.459	108
PR	1.277	0.260	50	1.113	0.232	83

Notes: The table reports summary statistics by IT classification. Real GDP growth, g, is calculated as $\log(Y_{it}/Y_{it-1})$, where Y_{it} is real GDP in country i in year t. GAP is the output gap. The (average annual decennial) growth rate of potential GDP, gPY, is calculated as $gPY_{it} = \log(PY_{it}/PY_{it-10})/10$, where PY is potential output. $DEBT$ is gross public debt as a share of GDP. PR is the price-to-rent ratio.

differences in terms of average growth between IT and non-IT countries. As a second step, we add control variables in a panel growth-regression framework.

2.1 Data and descriptive statistics

Sixteen of the 34 OECD member countries adopted IT with flexible exchange rates by 2007.[4] These 16 countries are Australia, Canada, Chile, Czech Republic, Hungary, Iceland, Israel, Korea (Rep.), Mexico, New Zealand, Norway, Poland, Sweden, Switzerland, Turkey, and the UK. Moreover, these countries maintained their IT regime throughout the period 2007–13. Equally many countries (Austria, Belgium, Denmark, Estonia, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, the Netherlands, Portugal, Slovakia, Slovenia, and Spain) chose fixed exchange rates in the form of a conventional peg (Denmark) or a common currency (the rest), whilst just two countries (Japan and the USA) chose flexible exchange rates without IT.[5] This leaves us with 18 non-IT countries in total in the OECD. It should be noted that two countries, Slovakia and Estonia, changed their monetary regime during our observation window. Specifically, Slovakia joined the Eurozone in 2009, and Estonia did so in 2011. We coded them as fixed exchange rate regimes, but, as we show, results are robust to excluding these two countries. Table 1 reports summary statistics for the variables used in this section.

As a first step in investigating whether IT countries have grown faster than non-IT countries, we start by observing that average annual real GDP growth between 2007 and 2013 was 1.59% in the group of IT countries and −0.46% in the group of non-IT countries (see Table 1). To illustrate this difference more clearly, Fig. 1 plots average annual real GDP growth between 2007 and 2013 against a dummy variable equal to 1 if the country is pursuing IT and 0 otherwise. The six best-performing IT countries in terms of economic

4 Regime classification data are from the underlying data set used in Rose (2014). The data are available at the http://faculty.haas.berkeley.edu/arose/RecRes.htm (accessed 1 December 2014). Whilst Rose codes Switzerland as an IT regime, the IMF does not do so consistently over the 2007–13 period. Excluding Switzerland from our sample does not change any of the conclusions reported herein.

5 As such, we essentially compare IT with a fixed exchange rate regime in the following. Note that the USA introduced elements of inflation targeting in 2012, and Japan did so in 2013. For completeness, coding the USA and Japan as IT regimes does not affect any of our results.

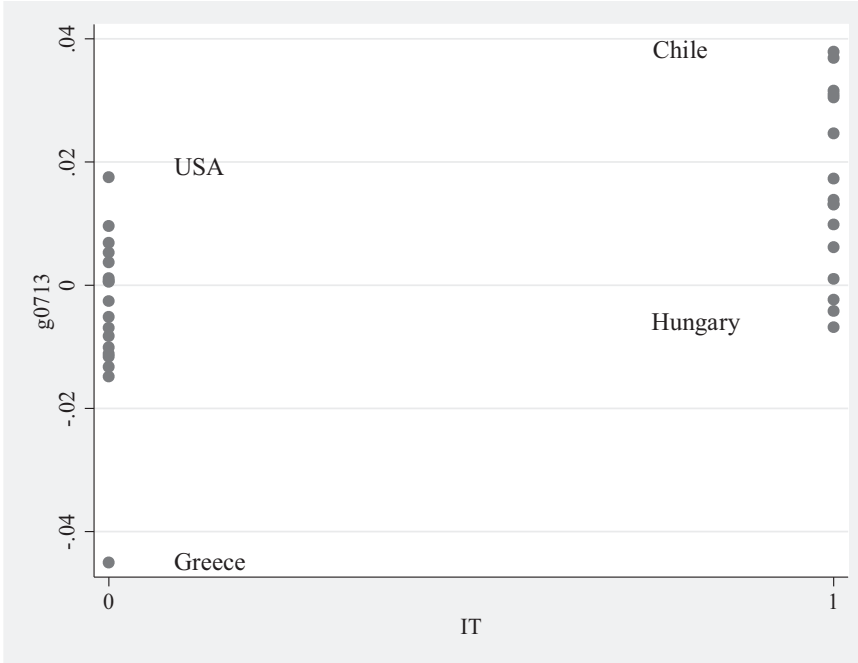

Fig. 1. Average annual real GDP Growth, 2007–13, in countries without ($IT = 0$) and with ($IT = 1$) inflation targeting

Notes: For data sources, see Table 1. All countries ordered from lowest to highest growth rates are ($IT = 1$ in italic): Greece, Italy, Ireland, Portugal, Slovenia, Spain, Finland, Denmark, *Hungary*, Estonia, *Iceland*, the Netherlands, *UK*, Japan, Luxembourg, *Czech Republic*, France, Belgium, Austria, *Norway*, Germany, the USA, *Sweden*, *Switzerland*, *Canada*, *New Zealand*, *Mexico*, Slovakia, *Australia*, *Poland*, *Korea*, *Turkey*, *Israel*, and *Chile*.

growth (Chile, Israel, Turkey, Korea, Poland, and Australia) all grew faster than the best-performing non-IT country (Slovakia). Moreover, in between Slovakia and the second-best non-IT country (the USA) are five IT countries (Mexico, New Zealand, Canada, Switzerland, and Sweden). At the same time, non-IT countries are clustered at the bottom of the (unconditional) growth distribution. The five worst performers (Greece, Italy, Ireland, Portugal, and Slovenia) are all non-IT countries. Indeed, four of them are members of the notorious group of so-called peripheral Eurozone countries. Consequently, simply eyeballing the (conditional) growth distributions immediately indicates a systematic difference in growth performance between IT and non-IT OECD countries.

To test whether the means are different in the two sub-groups, we regress annual growth on the IT dummy variable during the period 2007–13. Results from this exercise, which are reported in column (1) of Table 2, confirm that the difference of more than 2 percentage points in average growth rates between IT and non-IT countries is statistically significant. Removing the USA and Japan from the group of non-IT countries only increases this difference, as their average annual real GDP growth during the said period were, respectively, 0.96% and 0.05%. In column (2) of Table 2 we exclude the five peripheral Eurozone countries: Greece, Italy, Ireland, Portugal, and Spain. Yet omitting them changes very little. IT countries have still out-performed non-IT countries by some (statistically significant)

Table 2. IT and real GDP growth in the OECD, OLS estimation

Dep. var.	(1) *g*	(2) *g*	(3) *g*	(4) *g*	(5) *g*	(6) *g*
IT	0.0207***	0.0150***	0.0151***	0.0223***	0.0158***	0.0137**
	(0.0049)	(0.0042)	(0.0052)	(0.0054)	(0.0051)	(0.0058)
Constant	−0.0046	0.0014	−0.0010	−0.0060	−0.0005	−0.0026
	(0.0034)	(0.0022)	(0.0038)	(0.0039)	(0.0025)	(0.0046)
Obs.	204	174	114	170	145	95
Countries	34	29	19	34	29	19
Sample	2007–13	2007–13	2007–13	2008–13	2008–13	2008–13
R-squared	0.096	0.052	0.039	0.099	0.053	0.028
Excluded	None	Peripheral	Eurozone	None	Peripheral	Eurozone

Notes: The table reports OLS regressions of the type $g_{it} = a_0 + a_1 \cdot IT_i + u_{it}$. Peripheral countries are Greece, Italy, Ireland, Portugal, and Spain. Clustered (at the country level) standard errors are reported in parentheses. ***, **, and * denote significance at 1%, 5%, and 10% levels, respectively.

margin: 1.50 percentage points to be precise. In column (3) we exclude the 15 OECD countries that are Eurozone members—leaving us with Denmark, Japan, and the USA as the only remaining non-IT countries—and again the basic conclusion remains.[6] In the remaining columns we change the period to 2008–13, again with no implications for the result.

As noted, Slovakia and Estonia changed their monetary regime during our observation window. These two countries do not drive our results, as they were excluded from the sample with the group of all Eurozone countries; that is, they are excluded in columns (3) and (6) of Table 2.

In sum, viewing the empirical evidence in a simple and straightforward manner and from different angles—visually, case-wise, and statistically—leads to the same conclusion: IT countries have weathered the financial crisis much better than did non-IT countries in the OECD.[7]

2.2 Growth regressions

The evidence brought to bear so far cannot tell us whether IT countries did better because they entered the crisis in better shape (or had other advantages)—thus being better positioned to deal with it in terms of fiscal stimulus, say—or alternatively because the increased flexibility that comes with an independent monetary policy somehow enabled IT countries to better navigate the crisis. Consequently, this dictates that we control for the overall 'health' of the macroeconomy when the global financial crisis started to reverberate in 2007.

6 We experimented with a dummy called *FLEX* (not reported), which equals 1 if the country is either the USA or Japan. Regressing *g* on IT when the sample is restricted to all countries with flexible exchange rates—that is, the sample with IT = 1 and *FLEX* = 1—produces a statistically significant IT coefficient equal to 0.011. IT countries thus out-performed FLEX countries in terms of real GDP growth during 2007–13.

7 In fact, this holds both for the Great Recession (2007–9) period and its aftermath (2009–13). Specifically, regressing *g*0709 on IT yields a statistically significant (*p*-value 0.006) coefficient of 0.022, and regressing *g*0913 on IT yields a statistically significant (*p*-value 0.004) coefficient of 0.020. Using instead the split 2007–10 and 2010–13 yields similar results.

We therefore estimate the following growth regression:

$$g_{it} = a_0 + a_1 IT_i + a_2 GAP_{it-1} + a_3 gPY_{it-1} + a_4 DEBT_{it-1} + a_5 PR_{it-1} + \sum_{s=2}^{T} \gamma_s d_{s,it} + u_{it} \quad (1)$$

In the equation, g_{it} is real GDP growth for country i in year t. IT_i is our inflation targeting dummy. GAP_{it-1} is the output gap in country i in year $t-1$. gPY_{it-1} is the average annual growth rate of potential GDP over the previous decade. $DEBT_{it-1}$ is gross public debt as a share of GDP. The price-to-rent ratio, PR_{it-1}, is a widely used indicator of housing market conditions, which captures the cost of owning a house versus renting it. A large value of the price-to-rent ratio is an indication of over-valuation, and vice versa for a small value (André, 2010).[8] Finally, $d_{s,it}$ is a time dummy equal to 1 if $t = s$ and to 0 otherwise. We have lagged all the explanatory variables one year in an effort to reduce simultaneity concerns.

Some motivation for the specification in eq. (1) runs as follows: a large output gap indicates that productive capacity is unable to keep up with growing aggregate demand; that is, growth is occurring at an unsustainable rate. Such economic 'over-heating' is generally followed by lower than average economic growth because of the need for a 'correction'. At the same time, the output gap captures regression-towards-the-mean effects. *A priori*, we therefore expect $a_2 < 0$.

The growth rate of potential output captures whether the economy's 'speed limit' has increased in the period leading up to the crisis. If IT countries have implemented more favourable economic reforms than non-IT countries, say, then the growth rate of potential output will pick up this effect. Including this variable should therefore greatly reduce the scope for omitted variable bias. *A priori*, we expect $a_3 > 0$.

The amount of public debt (as a share of nominal GDP) will, amongst other things, determine the course of the fiscal response to the crisis. Large debt means higher taxes and/or lower public spending; it also determines the degree of front-loading of the eventual fiscal consolidation measures. Depending on macroeconomic history, different countries can tolerate different levels of debt to GDP, so this variable will probably have a heterogeneous effect. For this reason the point estimate may be difficult to interpret, although we expect it to be negative ($a_4 < 0$).

Finally, the amount of house price over-valuation is expected to have a negative impact on subsequent growth ($a_5 < 0$) by amplifying the negative effects of the crisis. This could happen in various ways. Consumption demand, for example, is likely to be negatively affected by a (large) crisis-induced drop in house prices through both a wealth effect and a collateral effect. Furthermore, although residential investment is a small component of GDP, it is rather volatile and may have a large impact on economic growth. On top, residential construction is labour-intensive, thus influencing employment in important ways.

8 Housing data are from the online annex tables—analysis and forecasts—to the Economic Outlook, http://www.oecd.org/eco/outlook/economicoutlookannextables.htm (accessed 27 March 2014). Regime classification data are from the underlying data set used in Rose (2014). The remaining variables are from the 2014 OECD Economic Outlook (OECD, 2014).

Table 3. IT and real GDP growth in the OECD, 2007-13, panel growth regressions

Dep. var.	(1) *g*	(2) *g*	(3) *g*	(4) *g*
IT	0.0226***	0.0145**	0.0120**	0.0108*
	(0.0051)	(0.0058)	(0.0055)	(0.0053)
GAP	−0.2575**	−0.2055***	−0.1955***	−0.2038***
	(0.1109)	(0.0723)	(0.0683)	(0.0721)
gPY		0.7341**	0.4721	0.2002
		(0.3367)	(0.3561)	(0.3364)
DEBT			−0.0075	−0.0132
			(0.0107)	(0.0102)
PR				−0.0014
				(0.0092)
Time fixed effects	Yes	Yes	Yes	Yes
Obs.	198	190	173	150
Countries	33	33	30	26
Sample	2007–13	2007–13	2007–13	2007–13
R-squared	0.535	0.561	0.522	0.534

Notes: The table reports OLS panel growth regressions of the type $g_{it} = a_0 + a_1 IT_i + a_2 GAP_{it-1} + a_3 gPY_{it-1} + a_4 DEBT_{it-1} + a_5 PR_{it-1} + \sum_{s=2}^{T} \gamma_s d_{s,it} + u_{it}$. The constant term is suppressed in all columns of the table. Clustered (at the country level) standard errors reported in parentheses. ***, **, and * denote significance at 1%, 5%, and 1% levels, respectively.

In sum, the growth of potential output captures differences in the more fundamental growth factors across countries, whilst the three other variables are included to capture differences in macroeconomic imbalances.

Table 3 reports the results of estimating eq. (1) for the period 2007–13. *GAP* is available for 33 OECD countries (see Table 1); we lose additional observations as we add *gPY*, *DEBT*, and *PR*. Column (1) therefore starts with regressing GDP growth on *IT* and *GAP* (time fixed effects are included in all estimations). This simple regression explains more than 53% of the variation in growth. Moreover, the estimated coefficient on *GAP* has the expected sign and is statistically significant. With *IT*, *GAP*, and *gPY* as controls, more than 56% of the variation in economic growth during the 2007–13 period is explained (see column (2)). However, as sample sizes differ, values of *R*-squared cannot be compared across columns. The *IT* coefficient estimate, a_1, is reduced when we control for potential output growth, but it stays significant at the 5% level. Adding, respectively, *DEBT* in column (3) and *DEBT* and *PR* in column (4) change nothing qualitatively. Whilst the point estimate of *IT* changes somewhat across columns, which is not too surprising given the changes in sample size, it stays statistically significant.[9]

Table 4 repeats the estimations of Table 3, but using growth over the period 2008–13 as the dependent variable. This has only trivial implications for our results.

Now the obvious question is: how large is the effect of having an IT regime? As *IT* is a 0/1 dummy, multiplying the parameter estimate of a_1 by 100 gives us the growth effect in percentage points of switching from $IT = 0$ to $IT = 1$. A conservative approach based on

9 If we add the *FLEX* dummy (equal to 1 if country is the USA or Japan) to the specifications in Table 3, it comes out significant in all columns save for column (1), where its *p*-value is 0.158.

Table 4. IT and real GDP growth in the OECD, 2008–13, panel growth regressions

Dep. var.	(1) *g*	(2) *g*	(3) *g*	(4) *g*
IT	0.0253***	0.0164***	0.0136**	0.0131**
	(0.0057)	(0.0055)	(0.0053)	(0.0054)
GAP	−0.2579**	−0.1876**	−0.1734**	−0.2020**
	(0.1228)	(0.0893)	(0.0820)	(0.0845)
gPY		0.7308**	0.4543	0.1725
		(0.3163)	(0.3143)	(0.3105)
DEBT			−0.0075	−0.0118
			(0.0121)	(0.0117)
PR				0.0035
Time fixed effects	Yes	Yes	Yes	Yes
Obs.	165	160	145	126
Countries	33	33	30	26
Sample	2008–13	2008–13	2008–13	2008–13
R-squared	0.556	0.577	0.536	0.557

Notes: The table reports OLS panel growth regressions of the type $g_{it} = a_0 + a_1 IT_i + a_2 GAP_{it-1} + a_3 gPY_{it-1} + a_4 DEBT_{it-1} + a_5 PR_{it-1} + \sum_{s=2}^{T} \gamma_s d_{s,it} + u_{it}$. The constant term is suppressed in all columns of the table. Clustered (at the country level) standard errors reported in parentheses. ***, **, and * denote significance at 1%, 5%, and 1% levels, respectively.

Table 3 would use a parameter estimate of 0.01. With this estimate, we find that a shift in 2007 from not pursuing inflation targeting ($IT = 0$) to adopting it ($IT = 1$) would have increased average annual real GDP growth by 1 percentage point.

Consequently, the robust message that emerges from investigating the empirical evidence in different ways is that OECD countries with inflation targeting have weathered the crisis much better than OECD countries pursuing a different monetary policy strategy: predominantly countries with a fixed exchange rate regime.

3. Empirical analysis: extended sample

In this section we extend the sample with non-OECD countries. The benefit from this exercise is obviously that we increase the generality of our results, whereas the downside is that data quality deteriorates non-trivially. GDP data for some of the world's poorest countries are of extremely poor quality (see, e.g., Jerven, 2013). Furthermore, we cannot pursue the same 'selection on observables' control strategy, as *GAP*, *gPY*, *DEBT*, and *PR* are not readily available for many countries. Instead, we opt for an IV approach using an external instrument.

3.1 Data and descriptive statistics

With respect to the classification of the monetary regime for the non-OECD countries, we once again follow Rose (2014), which in turn is based on the IMF's *de facto* classification as reported in its Annual Report on Exchange Arrangements and Exchange Restrictions (AREAER). Rose operates with three categories of monetary regimes: 'hard fix', 'floating with an inflation target', and 'the rest'. Hard fix means a fixed exchange rate regime in the form of either (i) no separate legal tender, (ii) a currency board arrangement, or (iii) a conventional peg. The second group are the IT countries with a floating exchange rate and an

Table 5. Summary statistics by IT classification, extended samples

	$IT = 1$			$IT = 0$		
	Mean	SD	Obs.	Mean	SD	Obs.
Sample 1						
g	0.019	0.034	189	0.008	0.078	407
$\log(y_{t-1})$	9.148	1.276	189	8.132	1.455	407
$\log(pop)$	16.915	1.402	189	14.330	1.912	407
Sample 2						
g	0.019	0.034	189	0.006	0.071	512
$\log(y_{t-1})$	9.148	1.276	189	8.551	1.585	512
$\log(pop)$	16.195	1.402	189	16.663	1.958	512
Sample 3						
g	0.019	0.034	189	0.019	0.059	1,130
$\log(y_{t-1})$	9.148	1.276	189	8.028	1.590	1,130
$\log(pop)$	16.195	1.402	189	15.262	2.150	1,130

Notes: Annual real GDP *per capita* growth is defined as $g_{it} = \log(y_{it}/y_{it-1})$, where $\log(y_{it-1})$ is the (log of) one-period lagged real GDP *per capita*; IT_i is the durable inflation-targeting dummy; and $\log(pop)$ is the (log of) population size. Data on real GDP *per capita* and population size are from World Development Indicators 2014; data source for IT regime classification is provided in note 4. Sample 1 includes the group of 27 durable inflation-targeting countries and the group of 60 durable hard-fix countries. Sample 2 adds the Eurozone countries to sample 1. Sample 3 includes all countries for which we have data.

independent central bank targeting inflation, whilst the residual group contains a variety of monetary regimes, including soft fixes and floaters with targets other than inflation.

Rose refines his sample further, as do we, by requiring that the regime must be maintained continuously throughout the period; that is, it must be durable.[10] There are 60 such durable hard-fix regime countries when Eurozone countries are excluded.[11] When the Eurozone is included, the size of this group is 75 countries.[12] With respect to IT countries, there are 27 durable inflation targeters in the group of all inflation-targeting countries.[13]

We work with three different samples in this section. Sample 1 includes the group of 27 durable inflation-targeting countries and the group of 60 durable hard-fix countries; that is,

10 Rose requires durability over the period 2006–12, whilst we have opted for 2007–12. This choice makes no difference for the results. In fact, only Ghana changes status from 2006 to 2007. Interestingly, the central bank in Ghana actually claims to have pursued IT unofficially since 2005.

11 These 60 countries with a durable hard fix are Antigua and Barbuda, Aruba, Bahamas, Bahrain, Barbados, Belize, Benin, Bhutan, Bosnia and Herzegovina, Brunei, Bulgaria, Burkina Faso, Cameroon, Cape Verde, Central African Republic, Chad, Comoros, Congo (Rep.), Côte d'Ivoire, Denmark, Djibouti, Dominica, Ecuador, El Salvador, Equatorial Guinea, Eritrea, Fiji, Gabon, Grenada, Guinea-Bissau, Hong Kong, Jordan, Kiribati, Latvia, Lesotho, Libya, Lithuania, Mali, Marshall Islands, Micronesia, Montenegro, Morocco, Namibia, Nepal, Niger, Oman, Palau, Panama, Qatar, Samoa, San Marino, Saudi Arabia, Senegal, St. Kitts and Nevis, St. Lucia, St. Vincent and the Grenadines, Swaziland, Timor-Leste, Togo, and United Arab Emirates.

12 The Eurozone countries are Austria, Belgium, Cyprus, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Malta, the Netherlands, Portugal, Slovenia, and Spain.

13 The 27 inflation targeters are Armenia, Australia, Brazil, Canada, Chile, Colombia, Czech Republic, Ghana, Guatemala, Hungary, Iceland, Indonesia, Israel, Korea (Rep.), Mexico, New Zealand, Norway, Peru, the Philippines, Poland, Romania, South Africa, Sweden, Switzerland (not consistently coded as IT regime in AREAER 2007–13), Thailand, Turkey, and the UK.

there are 87 countries in sample 1. Sample 2 adds the Eurozone countries to sample 1, so there are 102 countries in sample 2. The two samples allow us to compare in a 'clean' way the relative performance of the two groups with well-defined monetary regimes. That is, samples 1 and 2 compare inflation targeting to a fixed exchange rate regime (the latter group being the omitted category). For completeness, however, we also report on what happens in the full sample (sample 3) when all countries for which data exist are included in the empirical analysis. Sample 3 includes 196 countries.

In sum, we measure the performance of the group of 27 IT countries against three different comparison groups. Descriptive statistics as well as data sources for the variables used in the subsequent analyses are reported in Table 5.

3.2 Growth regressions

For estimation purposes, we use the standard conditional growth-regression framework. This framework has often been used to gauge the impact of monetary regimes on economic growth (see Tavlas *et al.*, 2008, for an extensive list of literature references). More specifically, consider the following conditional growth regression:

$$g_{it} = a_0 + a_1 \cdot \log\,(y_{it-1}) + a_2 \cdot IT_i + \sum_{s=2}^{T} \gamma_s \cdot d_{s,it} + \sum_{j=2}^{J} \gamma_j \cdot d_{j,i} + u_{it} \qquad (2)$$

In eq. (2), $g_{it} = \log(y_{it}/y_{it-1})$, $\log\,(y_{it-1})$ is the (log of) one-period lagged real GDP *per capita*, IT_i is the durable inflation-targeting dummy (the omitted category is hard-fix regimes in samples 1 and 2 and all non-IT regimes in sample 3), $d_{s,it}$ is a time dummy equal to 1 if $t = s$ and equal to 0 otherwise, and $d_{j,i}$ is a regional dummy equal to 1 if country i is located in region j and equal to 0 otherwise (regional groupings are taken from World Development Indicators).[14]

Table 6 reports the results from the estimation of eq. (2) using random effects estimation on a panel covering the years 2007–13. The IT point estimate is positive and significant in all columns. We may thus conclude that the correlation between IT and economic growth is not limited to the OECD sample.[15] Put differently, when comparing all the durable IT regimes with all the durable hard-fix regimes, the former group has significantly out-performed the latter during the 2007–13 period.

When we finally compare IT regimes with all non-IT regimes, the IT regimes also perform better (see columns (3) and (6)). The difference is smaller, but it remains statistically significant.[16]

14 The regions are East Asia and Pacific, Europe and Central Asia, Latin America and Caribbean, Middle East and North Africa; North America, South Asia; and sub-Saharan Africa.

15 If we estimate the specification in columns (1)–(3) of Table 6 on the OECD country sample, we obtain a statistically significant value of the IT coefficient of 0.0119 (clustered *t*-stat is 3.04); if we also include regional fixed effects as well—that is, if we estimate the specification in columns (4)—(6) of Table 6 on the OECD sample—we obtain a statistically significant value of the IT coefficient of 0.0087 (clustered *t*-stat is 2.35). Put differently, the standard conditional growth-regression framework—that is, eq. (2)—also delivers a statistically significant impact of IT on economic growth on the OECD sample.

16 If we construct a dummy, which equals 1 if the country is neither an IT country nor a hard fixer, this dummy turns out statistically significant (coefficient 0.018, *t*-stat 4.72) alongside IT (coefficient 0.015, *t*-stat 4.02). Thus we cannot conclude that IT countries grew faster than the 'sloppy middle', as Rose (2014) denotes this undefined residual category.

Table 6. IT and real GDP *per capita* growth, extended samples, 2007–13, random effects panel estimation of conditional growth regressions

Dep. var.	(1) g	(2) g	(3) g	(4) g	(5) g	(6) g
IT	0.0190***	0.0173***	0.0080**	0.0168***	0.0158***	0.0064*
	(0.0046)	(0.0035)	(0.0033)	(0.0043)	(0.0036)	(0.0035)
$\log(y_{t-1})$	−0.0078***	−0.0071***	−0.0074***	−0.0100***	−0.0098***	−0.0092***
	(0.0021)	(0.0016)	(0.0013)	(0.0024)	(0.0021)	(0.0016)
Time fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Regional fixed effects	No	No	No	Yes	Yes	Yes
R-squared	0.103	0.125	0.123	0.114	0.136	0.143
Obs.	596	701	1,319	596	701	1,319
Countries	87	102	196	87	102	196
Sample	1	2	3	1	2	3

Notes: The table estimates a panel version of a conditional growth regression of the following type: $g_{it} = a_0 + a_1 \cdot \log(y_{it-1}) + a_2 \cdot IT_i + \sum_{s=2}^{T} \gamma_s \cdot d_{s,it} + \sum_{j=2}^{J} \gamma_j \cdot d_{j,i} + u_{it}$. The constant term is suppressed in the table. All standard errors are clustered at the country level. ***, **, and * denote significance at 1%, 5%, and 10% levels, respectively.

3.3 IV regression

To take the potential endogeneity of the monetary regime into account, we now turn to IV estimation using (the log of) total population as an instrument for IT. The rationale is that smaller economies are more likely to adopt a fixed exchange rate, whereas larger economies are more likely to adopt an IT regime (see, e.g., Rose, 2014). Moreover, scale effects are not a feature of economic growth at the country level (see, e.g., Romer, 2006), for which reason the exclusion restriction should be valid. In other words, population size should have no direct effect on economic growth or an effect through other channels, but only an indirect effect running through the monetary regime. With exact identification, this presumption cannot be tested.

Table 7 re-estimates the columns of Table 6 using IV. The first thing to notice is that the instrument is very strong; a conclusion that follows immediately on noting that the *F*-statistic from the first stage ranges from 21 to 127. The second thing to note is that the *IT* coefficient estimate is significant in all columns. Third, *IT* point estimates in Table 7 are slightly larger than the values reported in Table 6. However, the difference is not statistically significant when samples 1 and 2 are used. When sample 3 is used, the point estimates in Table 7 are significantly higher than the values reported in Table 6. In any case, IV confirms the result that IT countries out-performed non-IT countries during 2007–13.[17]

17 There is an interesting alternative to a 2SLS estimation, which allows us to gauge the consequences of endogeneity by exploiting directly the fact that the (potential) endogenous regressor, *IT*, is a binary variable. In particular, the so-called treatment effects model also assumes that the conditional mean is linear, but it adds more structure, first by changing the first-stage model to be a latent variable model and second by assuming that the error terms of the regression equation and the selection equation are bivariate normal. If the normality assumption is untenable, this identification strategy is obviously fragile; if it is tenable, the treatment effects model will provide increased precision of the estimation. Use of this model (not reported) confirms the results reported in Table 7.

Table 7. IT and real GDP *per capita* growth, extended sample, 2007–13, 2SLS (IV) panel estimation of conditional growth regressions

Dep. var.	(1) g	(2) g	(3) g	(4) g	(5) g	(6) g
IT	0.0240***	0.0262***	0.0348**	0.0254***	0.0263***	0.0301**
	(0.0054)	(0.0064)	(0.0149)	(0.0053)	(0.0059)	(0.0129)
$\log(y_{t-1})$	−0.0083***	−0.0076***	−0.0086***	−0.0105***	−0.0099***	−0.0100***
	(0.0017)	(0.0015)	(0.0015)	(0.0023)	(0.0022)	(0.0018)
Time fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Regional fixed effects	No	No	No	Yes	Yes	Yes
F first stage	88.12	37.79	21.72	127.32	57.38	23.41
Obs.	596	701	1,319	596	701	1,319
Countries	87	102	196	87	102	196
Sample	1	2	3	1	2	3

Notes: The table estimates a panel version of a conditional growth regression of the following type: $g_{it} = a_0 + a_1 \cdot \log(y_{it-1}) + a_2 \cdot IT_i + \sum_{s=2}^{T} \gamma_s \cdot d_{s,it} + \sum_{j=2}^{J} \gamma_j \cdot d_{j,i} + u_{it}$. The constant term is suppressed in the table. *IT* is instrumented with (the log of) population size. All standard errors are clustered at the country level. ***, **, and * denote significance at 1%, 5%, and 10% levels, respectively. *F* first stage refers to the *F*-test of the null hypothesis that the instrument is irrelevant in the first-stage equation.

Table 8. IT and real GDP *per capita* growth, extended samples, 2007–13, random effects panel estimation of unconditional growth regressions

Dep. var.	(1) g	(2) g	(3) g	(4) g	(5) g	(6) g
IT	0.0108**	0.0131***	−0.0002	0.0131***	0.0151***	0.0013
	(0.0046)	(0.0043)	(0.0038)	(0.0050)	(0.0043)	(0.0040)
Time fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Regional fixed effects	No	No	No	Yes	Yes	Yes
R-squared	0.076	0.097	0.084	0.089	0.112	0.107
Obs.	596	701	1,319	596	701	1,319
Countries	87	102	196	87	102	196
Sample	1	2	3	1	2	3

Notes: The table estimates a panel version of an unconditional growth regression of the following type: $g_{it} = a_0 + a_2 \cdot IT_i + \sum_{s=2}^{T} \gamma_s \cdot d_{s,it} + \sum_{j=2}^{J} \gamma_j \cdot d_{j,i} + u_{it}$. The constant term is suppressed in the table. All standard errors are clustered at the country level. ***, **, and * denote significance at 1%, 5%, and 10% levels, respectively.

3.4 The difference between our results and those of Rose (2014)

As noted in Section 1, Rose (2014) does not find a positive effect of IT on growth. The reason is that Rose employs an unconditional growth regression, whereas we employ conditional growth regressions. To substantiate this assertion, and explore the difference between our results and those of Rose (2014) in more detail, we report a batch of results from unconditional growth regressions in Table 8. The estimation samples in columns (1)–(6) of Table 8 correspond to the estimation samples in columns (1)–(6) of Table 6.

Table 9. IT and real GDP *per capita* growth, extended samples, 2007–13, random effects panel estimation of conditional growth regressions, large economies excluded

Dep. var.	(1) g	(2) g	(3) g	(4) g	(5) g	(6) g
IT	0.0193***	0.0178***	0.0075*	0.0171***	0.0163***	0.0050
	(0.0045)	(0.0035)	(0.0040)	(0.0042)	(0.0036)	(0.0041)
$\log(y_{t-1})$	−0.0077***	−0.0070***	−0.0067***	−0.0099***	−0.0097***	−0.0080***
	(0.0021)	(0.0016)	(0.0017)	(0.0024)	(0.0021)	(0.0019)
Time fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Regional fixed effects	No	No	No	Yes	Yes	Yes
R-squared	0.101	0.124	0.097	0.113	0.135	0.119
Obs.	589	694	1,186	589	694	1,186
Countries	86	101	177	86	101	177
Sample	1	2	3	1	2	3

Notes: The table estimates a panel version of a conditional growth regression of the following type: $g_{it} = a_0 + a_1 \cdot \log(y_{it-1}) + a_2 \cdot IT_i + \sum_{s=2}^{T} \gamma_s \cdot d_{s,it} + \sum_{j=2}^{J} \gamma_j \cdot d_{j,i} + u_{it}$. The constant term is suppressed in the table. All standard errors are clustered at the country level. ***, **, and * denote significance at 1%, 5%, and 10% levels, respectively.

Inspection of Table 8 reveals that the positive relationship between IT and growth is also found in the unconditional model when samples 1 and 2 are used (see columns (1)–(2) and (4)–(5)). However, when estimated on sample 3 the result disappears (see columns (3) and (6)). Consequently, in sample 3 we need to condition on lagged income to demonstrate a positive relationship between IT and growth during 2007–13. The natural question is then whether this conditioning is appropriate. We believe it is for at least three reasons. First, lagged income *per capita* is always significant, suggesting it should be included. Second, the neoclassical growth model actually predicts transitional dynamics, for which reason the lagged income term can be firmly grounded in growth theory (see Barro and Sala-i-Martin, 2004). Third, IT and (the log) of income *per capita* are positively correlated. In sample 3 the correlation is almost 0.25. This means that excluding lagged income may introduce an omitted variables problem. To see this, recall the specification in eq. (2). From the standard omitted variables formula (see Wooldridge, 2002, p. 62) we know that if Cov $(IT, \log(y_{t-1})) > 0$ and $a_1 < 0$ then the IT coefficient estimate, a_2, is biased downwards when $\log(y_{t-1})$ is excluded from eq. (2). Indeed, inspection of Table 8 reveals that this is exactly what happens in the unconditional model. Consequently, the inclusion of lagged income is easily justifiable.

As opposed to Rose (2014)—who excludes China, the Eurozone, Japan, the UK, and the USA—we retain large economies in the sample. Sample 1 includes the UK, sample 2 the UK and the Eurozone, and sample 3 includes them all. The question is whether excluding them has any consequences for our results. In Table 9 we investigate this issue. Columns (1) and (4) exclude the UK from sample 1. Columns (2) and (5) exclude the UK from sample 2.[18] Finally, in columns (3) and (6) we exclude China, the Eurozone, Japan, the UK, and the USA from sample 3 (i.e., we exclude 19 countries in all). Inspection of Table 9 shows that excluding the large economies is inconsequential for our results except for column (6),

18 Note that if we exclude the UK and EMU from sample 2, we just get the sample in column (1).

where IT is now insignificant. However, in column (6) we have included regional fixed effects, which Rose never does in his empirical analysis, and without these fixed effects (column (3)), IT is still significant in the sample with 177 countries. Furthermore, if we alternatively construct a dummy for the sloppy middle and include it alongside IT,[19] both this dummy (coefficient 0.022) and IT (coefficient 0.012) are statistically significant at the 1% level. Consequently, excluding large economies is not what is driving the difference between our results and those of Rose. The difference is driven by lagged income. Specifically, if we re-estimate column (3) of Table 9 in a specification without lagged income then IT turns insignificant (coefficient is−0.0014, *p*-value 0.725).

Therefore, the conclusion that IT countries weathered the crisis better than hard fixers stands no matter how we (within reason) cut the sample.

4. Concluding remarks

In this article we have shown that OECD countries with an IT monetary policy framework have systematically out-performed OECD countries with other regimes (predominantly fixed exchange rates) in terms of economic growth during the period 2007–13.

Moreover, as a robustness check, we have also compared IT regimes with fixed exchange rate regimes on extended samples of more than 100 countries using random effects and 2SLS regressions. All analyses confirmed the positive relationship between IT and economic growth since the Great Recession.

It would surely be imprudent to claim that one monetary policy regime always and everywhere dominates all other regimes. However, we trust that our empirical analysis demonstrates that the choice of monetary regime is not irrelevant, as, for example, Rose (2011, 2014) claims it is. Indeed, our results indicate that the choice of monetary regime can be very important for economic growth; especially in times when flexibility matters the most, which is arguably when a huge adverse shock hits as it did in 2007–8.

The basic insight of our article is particularly important at the current juncture, where there is little debate or consensus about the costs and benefits of the different monetary and exchange rate regimes. For example, this type of analysis, which suggests tangible growth benefits of an IT regime with a flexible exchange rate in a crisis situation compared to (at least) a fixed exchange rate regime, should be a part of the set of considerations for Eastern European countries considering joining the euro and other countries that are considering abandoning a flexible exchange rate regime.

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19 See also note 16.

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