The housing price boom of the late '90s: did inflation targeting matter?*

Sébastien Frappa and Jean-Stéphane Mésonnier†
Banque de France

2 June 2009 - Preliminary version

Abstract

The unprecedented boom in housing markets of most developed economies over the last decade has spurred criticism that the (successful) inflation targeting strategies followed by many central banks could have contributed, for various reasons, to the build-up of financial imbalances. This paper aims at providing a formal empirical test of such claims, using a standard program evaluation methodology in order to disentangle the impact of the choice of the monetary policy strategy from the consequences of other plausible determinants of housing price dynamics. We consider 17 industrial economies over the period 1980-2006, among which nine countries have targeted inflation at some dates. We find robust evidence of a significant positive effect of inflation targeting on housing price growth as well as on the housing price to rent ratio.

JEL classification: E4; E52; E58.

Keywords: Inflation targeting; Housing market; Treatment effect; OECD countries.

---

*We thank Rémy Lecat, Henri Fraisse, Hubert Kempf, Stefan Krause, Benoît Mojon, Alain Monfort, Henri Pagès and Xavier Ragot for useful discussions and comments. The opinions expressed here are the authors' own and do not necessarily reflect the views of the Banque de France.

†Corresponding author. Banque de France, Monetary Policy Research Division, 41-1422 POMONE, 75049 Paris cedex 01, France. Email: jean-stephane.mesonnier@banque-france.fr

1 Introduction

The credible anti-inflationist monetary policies conducted in major developed economies since the mid 1980s have been identified as one plausible factor behind the Great moderation episode over the last two decades. However, as the dotcom boom and bust of the early 2000s and the subprime mortgage crisis that began in 2007 amply proved it, financial crises associated with boom and bust episodes in asset prices are not merely a relic of the twentieth century. This unpleasant diagnosis has recently prompted a debate about the role of monetary policies that have a narrow focus on inflation stabilization in the build-up of imbalances that eventually led to such episodes of financial turmoil. Indeed, some central bank watchers have regularly contended over the recent years that monetary policy strategies that aim primarily at stabilizing inflation over a 2-3 years horizon would actively contribute to damaging financial stability at longer horizons, as they notably tend to neglect monetary and financial developments because these are irrelevant for future inflation in the short to medium term.[1] As for instance Leijonhufvud (2007) provocatively put it: "suppose you conduct a very expansionary monetary policy, and for a reason or another you do not experience inflation? Then what do you get? The answer is, on the one hand, inflation on asset prices and on the other, a general deterioration of credit standards. (...) Inflation targeting might mislead you into pursuing a policy that is actively damaging to financial stability".

While the consensus is broad in the economic profession that a policy focused at maintaining price stability is a necessary condition for maintaining also financial stability, opinions are much more contrasted as to whether it is a sufficient one.[2] Two lines of reasoning highlight how a restrictive view of the inflation targeting agenda could lead to a destabilizing outcome on the financial side.

First, an inflation targeting central bank may neglect important information about

[1] See notably a series of contributions by Claudio Borio, William White and their coauthors at the BIS (Borio et al., 2003, Borio and White, 2003, White, 2006). Bean (2003) claims on the contrary that inflation targets may be enough provided the central bank is sufficiently forward-looking.

[2] See for instance Bordo and Wheelock (1998) and Bordo et al. (2003) regarding the detrimental effect of episodes of monetary instability on financial stability from an historical perspective.

the build-up of financial imbalances which do not materialize rapidly into consumer price pressure. Many reasons may account for this disconnection between financial and price developments. The impact of globalization may be one. Indeed, falling import prices from emerging market economies that pursued policies of exchange rate pegs to major currencies have contributed to dampening inflation pressures and flattening the Phillips curve. Structural changes that have affected the functioning of labour and financial markets over the last two decades may be another cause. As labour markets get more flexible, second-round effects of inflationary supply shocks into wages remain contained. As financial markets are widely deregulated and witness a bout of innovative products like securitization (this is part of what Borio et al., 2003, call the "new environment hypothesis"), households and firms have an easier access to credit and their demand for debt is all the more stronger than the benign inflationary outlook warrants that interest rates are kept at a low level.

Second, the mere success of inflation targeting strategies could have contributed to hampering a proper risk assessment by inflation fighting central banks, what Borio et al. (2003) labelled the "paradox of credibility". Since the anti-inflationary commitment of the central bank becomes more credible, and long-run inflation expectations get more firmly anchored around the central bank's objective, the macroeconomic consequences of "cheap money" -including credit booms that sustain a rise in some asset prices- may take more time to show up into higher inflation. As a conclusion, policy rates may fail to rise sufficiently promptly to help restrain the build-up of financial imbalances (Borio and White, 2003).[3]

The housing price boom of the last decade in many developed economies was probably one of the most striking developments of the recent period and certainly the symptom of accumulated financial imbalances. In line with the "paradox of credibility" hypothesis, we may suspect that expectations of low and stable inflation over the medium term have been an ingredient of the rise of housing prices in countries where the central bank is committed to a credible inflation targeting strategy. Let us for example suppose that a positive shock

[3] A more formal presentation of a similar argument has been put forward by Amato and Shin (2005). In their model, where private agents have diverse private information about the true state of the economy, the public signal provided by the central bank has a disproportionate effect on agents' decisions, is likely to crowd out their private information and then tends to lower the information value of prices.

hits households'income or their capacity to borrow (due e.g. to financial innovation). As households are confident that the central bank will not need to raise short term interest rates in a foreseeable future because they think that inflation is on check, they will tend to believe that observed and projected growth rates in housing prices are sustainable. Since their expectations of low future interest rate should increase mechanically their assessment of the present value of houses considered as assets, they will be more willing to buy housing property at high current prices (compared to historical records). Finally, they will be less reluctant to finance their home acquisition through mortgage contracts with adjustable rates, which are generally cheaper than fixed rate mortgages. Other things being equal, this last effect would contribute to making access to mortgage credit easier under a credible inflation targeting monetary policy regime.[4]

We aim in this paper to bring this hypothesis to the data and evaluate whether inflation targeting actually mattered as regards housing price inflation in developed OECD economies. Over the last decade, an abundant empirical literature has tried to quantify the macroeconomic performance of countries that adopted inflation targeting.[5] Most studies focus on inflation performance, in absolute or in relative terms, while some also examine whether adopting an inflation targeting strategy could be made responsible for a more volatile output. However, to our knowledge, there is no comparative empirical work about the consequences of inflation targeting policies for financial stability. We thus aim at filling this gap, using a program evaluation methodology that has been recently transposed to macroeconomic issues (see notably Persson, 2001 and Lin and Ye, 2007) in order to circumvent some self-selection bias that is likely to plague previous studies on the consequences of adopting inflation targeting. Our study encompasses 17 industrial economies over the period 1980-2006, among which nine countries have targeted inflation at some dates.

Our results show that the average effect of inflation targeting on house price inflation is positive and statistically significant. These results are robust to various specifications

[4] On the optimal choice between fixed and adjustable rate mortgages by indebted households, see Campbell and Coco (2003).

[5] See for instance Ball and Sheridan (2004), Lin and Ye (2007), Vega and Winkelried (2005) and the studies collected in Bernanke and Woodford (2004).

and options of the evaluation procedure. On average, the adoption of inflation targeting has led to an increase in the level of house price inflation by some 2.1 percentage points in targeting countries. Note that the estimated effect is even larger when the control sample is restricted to the most recent sub-period (from 1990 to 2006).

In the rest of the paper, section 2 provide a summary view of the recent housing price boom in developed OECD economies. Section 3 presents our econometric methodology. Section 4 presents the dataset and discusses several empirical issues. Section 5 comments on the results and section 6 concludes.

2 The housing price boom of the last decade

Since 1970, nominal housing price growth has fluctuated widely in developed economies, with four expansionary phases -in the early and late 1970s, in the mid to late 1980s and from the late 1990s to the mid-2000s- and three slowing phases -in the mid 1970s, the early 1980s and the early 1990s.[6]. Note that, while housing price busts are normally characterized by a significant drop in real house prices, nominal house price deflation is rare and was associated in the past with episodes of severe economic downturns, such as the recessions in the early 1990s in Finland, Norway and Sweden[7].

Most developed economies have experienced rapidly rising house prices since the mid-1990s.[8] Taken by its magnitude, length and geographical coverage, the latest boom has been quite exceptional. In the 17 OECD countries of our sample[9], the rate of growth of nominal housing prices has reached a yearly average of almost 7.5% (5.5% in real terms)

[6] See for instance Lecat and Mésonnier (2005).

[7] For a description of past housing booms and busts and the size of associated recessions in developped OECD economies, see for instance Claessens, Kose and Terrones (2008).

[8] An exception is Germany whose nominal house prices have been gradually declining since they reached a modest peak in 1994. Japan is another obvious exception, the country being stuck over the whole 1990s in the slump consecutive to the housing price and stock market bust of the beginning of that decade. The Japanese case being quite special, we excluded Japan from our database. Note that since Japan did not target inflation over the period under review, excluding Japan tends to minimize the probability of rejecting the null of no-impact of IT on house price growth.

[9] Countries are listed in section 4 below

between 1996 and 2006, to be compared with only 5.4% over the 1980-1995 period (0.5% in real terms). In addition, the recent boom lasted for almost ten years in most countries, which is roughly twice as long as the duration of past episodes.

An abundant literature has investigated the reasons why this housing boom was so pronounced and in particular decoupled that much from normal business cycle fluctuations. Demographic trends such as changes in the composition of households, the impact of financial deregulation affecting mortgage markets via a credit boom (Cardarelli et al., 2008), the loosening of credit standards (Dell'Ariccia et al., 2008) and the declining trend in real interest rates (Girouard et al., 2006) have been proposed as possible factors explaining this phenomenon. To our knowledge however, no empirical study so far tests the impact of the monetary policy regime and in particular of inflation targeting strategies.

We assess the buoyancy of the housing market according to both the annual rate of growth of housing prices in real terms (denoted RHOPG) and a price to rent ratio, which is akin to a price-earning ratio in stock markets (denoted HOPCPIH) and generally stands for an appropriate measure of housing valuation when housing is primarily viewed as an asset in the households' portfolio (instead of a source of housing services).[10] However, reliable and long enough time series on rents are not available for a number of countries and we had to proxy rents with the housing component of consumer price indices. Due to substantial differences in the definition of this component across countries, regarding in particular how owner-occupied housing services are valued, results related to our measure of the price to rent ratio deserves some additional caution. For this reason, we prefer to focus on real house price growth as our baseline. Although real housing price growth is arguably a very rough measure of possible imbalances in housing markets, we see no reason to suspect that inflation targeting as such could induce any substantive shift in the equilibrium or long run real housing price growth. Therefore, detecting any extra-growth in housing price inflation should be enough to signal a contribution of inflation targeting per se on the build-up of a positive housing price gap.

[10] Note that we also considered nominal housing price growth as a dependent variable, adding lagged inflation to the conditioning variables listed below in section 4. Results ar qualitatively unchanged. We nevertheless preferred to focus on real growth (1) for comparability with other studies and (2) to limit the risk of having conditioning variables that are endogenous to the adoption of formal inflation targeting.

Figure 2 shows real and nominal house price growth developments as well as the price to rent ratio for each country of the panel. The shaded area indicates whenever the central bank follows an explicit inflation targeting strategy (see section 4 for details). Most economies experienced a sharp rise in residential property prices in the second half of the 1980s, that often followed on a deregulation of the housing finance sector. In the 1990s, house prices slowed down or fell, following the US recession in 1990-1991 and the episode of high interest rates in Europe after the ERM crisis in 1992-93. Finally, housing price inflation accelerated in the second half of the 90s for most countries, apparently irrespective of their monetary policy strategy. However, what this graphical evidence cannot tell is whether this surge in housing price inflation was stronger in targeting countries, other things else being equal. This is what our empirical exercise aims to clarify.

3 Methodology

Let us first consider equation (1) where we regress housing price inflation Y_{it} on a dummy variable D_{it} standing for the adoption of inflation targeting and on relevant control variables X_{it} using a panel of countries i over T periods:

$$Y_{it} = \gamma D_{it} + \beta X_{it} + \varepsilon_{it} \tag{1}$$

Estimating equation (1) using some standard regression technique, may yield biased estimates of the policy regime coefficient γ if countries that choose to follow inflation targeting strategies are systematically different in terms of X_{it} from countries that do not. For instance, it may well be the case that countries with more liberalized and more developped financial markets, and notably more deregulated mortgage markets are also countries that would opt for an inflation targeting strategy. Indeed, a high degree of financial develoment is often seen as one pre-requisite for successful inflation targeting. In that case, we then face a problem of self-selectivity on the observables. Note that this problem cannot be solved by simply instrumenting the IT variable. The point at stake here is the possibility of non-linearities in the relationship between the control variables in X_{it} and the dependent variable Y_{it}.

Following recent work (Persson, 2001, Vega and Winkelried, 2005, Lin and Ye, 2007),

we solve this problem by applying to our macroeconomic dataset a microeconometric technique borrowed from the program evaluation literature. The intuition is to consider the adoption of IT as a natural experiment and to mimic the conditions of a randomized experiment where adopting officially an IT strategy is equivalent to receiving randomly a "treatment". Our objective is thus to assess the average effect of the "treatment" on the treated (ATT) in terms of some dependant variable Y_{it} (here real house price growth). Formally, we have:

$$ATT = E\left[Y_{it}^{1}|D_{it}=1\right] - E\left[Y_{it}^{0}|D_{it}=1\right] \tag{2}$$

where $Y_{it}^{1}|D=1$ denotes the value of the dependant variable in period t for a country that adopted IT ($D=1$) and $Y_{it}^{0}|D=1$ is the value of the outcome that would had obtain the same IT country if it had not adopted IT at the same date. Of course, the latter is unobservable, so we cannot measure the ATT directly. If IT adoption were a purely random decision, one could nevertheless obtain an accurate estimate of the ATT by comparing the mean of the dependant variable over all targeters (the treatment group) and its mean over all non-targeters (the control group). However, it is very likely that IT countries did not adopt IT randomly but instead waited for some preconditions to be met. In turn, some of these preconditions can be expressed in terms of macroeconomic variables that may also play a role in determining the dependant variable (house prices). Assuming that these variables are not altered in turn by the treatment, a solution is then to condition the outcome on these explaining variables. Hence, we have :

$$ATT = E\left[Y_{it}^{1}|D_{it}=1,X_{i}\right] - E\left[Y_{it}^{0}|D_{it}=1,X_{i}\right] \tag{3}$$

If, conditionally on X_i, the dependant variable is independent of the strategy variable[11], $E\left[Y_{it}^{0}|D=1,X_{i}\right]$ is then equivalent to $E\left[Y_{it}^{0}|D=0,X_{i}\right]$, which is observable.

The intuition of the matching procedure is thus to find for each observation taken from an IT country a counterfactual equivalent observation that is taken from a non-targeter country. Conditioning on the X_i allows us to attribute the difference in the value of Y_{it} between both observations to the impact of the "treatment" alone. In practice, when the

[11] This assumption is called CIA (conditionnal independance assumption) in evaluation literature.

dimension of X_i is superior to one, matching treated units with control units that share the same values of X_i becomes rapidly a tricky task (aka. the "curse of dimensionality"). A solution initially developed by Rosenbaum and Rubin (1983) consists in summarizing the information in X_i into a single one-dimensional index, called the propensity score $p(X_i)$ and matching treated and control observations on the basis of a comparison of their respective score. The propensity score is the probability of getting the treatment conditional on X_i:

$$p(X_i) = P(D_{it} = 1|X_i) = E\left[D_{it}|X_i\right] \tag{4}$$

It can here be estimated in a straightforward way using a simple logit or probit regression. Importantly, one has then to check that we compare things that do indeed compare, i.e. that the control units used for the matching procedure share the same support as the treated units. In our application, we only keep control units $Y_{it}^0|D_{it} = 0$ such that their propensity score $p(X_{it})$ is superior or equal to the minimum of the distribution of the scores of the treated units, $min\left\{p(X)|D_{it} = 1\right\}$, and discard the remaining observations. Finally, estimating equation 2 amounts to computing:

$$E\left[Y_{it}^1|D_{ii} = 1, p(X_{it})\right] - E\left[Y_{it}^0|D_{it} = 0, p(X_{it})\right] \tag{5}$$

A variety of propensity score matching methodologies with replacement can be used to estimate the ATT. All matching estimators associate one or more control units to each treated units. They differ however both in the way the neighborhood for each treated observation is defined and with respect to the weights assigned to the non-treated neighbours. Although all estimators should converge asymptotically, the choice of given method may matter in finite samples. Generally speaking, the choice of a specific method involves a trade-off between bias and variance of the estimator: intuitively, extending the number of control units considered as relevant neighbours of a given treated unit increases the risk of bad matches, hence the bias, but contributes to reducing the variance, since more information is included in the counterfactual observation.

Besides, handling with small samples, as is typically the case when microeconometric

methods are applied to a macroeconomic context, raises specific concerns.[12] First, gaps are more likely to appear in the common support of controls and treated, so that treatment effects may be retrieved for a limited number of treated units only, resulting in a bias. Second, small samples increase the variance of estimated effects, making identification of significant effects more difficult. According to a recent study Frölich (2004), kernel matching estimators, which compare treated units to a weighted mean of all control units on the common support, prove to be quite robust to small sample problems. Therefore, we implement kernel matching in our baseline estimation.[13] Each treated unit is then matched to all control units weighted in proportion to the distance between the treated unit and the control unit. Formally, the kernel matching estimator of the ATT reads:

$$\widehat{ATT} = \frac{1}{n_1} \sum_{i \in I_1} \left(Y_{1i} - \frac{\sum_{j \in I_0} Y_{0i} G\left(\frac{P_j - P_i}{\alpha_n}\right)}{\sum_{j \in I_0} G\left(\frac{P_j - P_i}{\alpha_n}\right)} \right) \tag{6}$$

where I_1 denotes the set of treated, I_0 the set of controls, n_1 the number of treated units on the common support and p_j is the estimated propensity scores of unit i. G(.) is the kernel function and α_n the bandwidth parameter. In a standard way, we chose an Epanechnikov kernel defined as $G(u) = \left(1 - \mid u \mid^2\right)$ and a bandwidth parameter of 0.06. The variance of this estimator is not known analytically, hence we bootstrapped it.

4 Empirical issues

4.1 Data and definition of variables

Our data set includes 17 industrial countries, namely Australia, Belgium, Canada, Denmark, Finland, France, Germany, Ireland, Italy, the Netherlands, New Zealand, Norway, Spain, Sweden, Switzerland, the United Kingdom and the United States. The database covers the period from 1980 to 2006 with annual frequency. Nine countries—Australia, Canada, Finland, New Zealand, Norway, Spain, Sweden, Switzerland and the United Kingdom—adopted inflation targeting during our sample period. Note that two targeting

[12] On issues associated with small samples, see Heckman, Ichimura, and Todd (1997).

[13] All matching procedures have been implemented using the Stata routine PSMATCH2 developped by Leuven and Sianesi (2003).

countries, Finland and Spain, joined the Euro in 1999, thus switching from IT to non-IT in our sample. This notwithstanding, the within variability of the IT variable remains obviously very low, which makes usual panel regression methods less relevant, as stated in section 3 above.

Whatever the targeting country, the date of IT adoption is not always clear-cut and depends on how inflation targeting is defined. Several choices occur in the empirical literature. While some authors consider the first year when the turn to an IT-like strategy was mentioned or announced by monetary authorities, others adopt a stricter view and date IT adoption to the year when an explicit or fully fledged IT scheme was implemented, including the publication of a quantified inflation objective by the central bank.[14] For robustness, we considered both definitions in the following, that we labelled IT1 for soft inflation targeting and IT2 for the adoption of a fully fledged targeting scheme. Table 1 shows the adoption dates according to both definitions. Depending on the definition, adoption dates differ for four countries in our sample: Canada (by three years), New Zealand (one year), Spain (one year) and Sweden (two years). In others cases both definitions converge.

Commenting on Ball and Sheridan (2004), Gertler (2004) argues that a host of countries that these authors classified as non-targeters did actually run monetary policies that proved to be close in practice to formal inflation targeting. He concludes that classifying countries according to what they say (their official strategy), not what they do, is probably misleading when assessing the relative performance of countries in terms of inflation stabilization. In particular, this issue could be raised regarding the classification of two major non-targeting central banks, the US Federal Reserve of the Greenspan-Bernanke era as well as the ECB, which have been both frequently described as implicit targeters by commentators.[15] In particular, the ECB, which commits itself explicitely to pursuing a quantified inflation objective, is arguably close to the inflation targeting paradigm. In our baseline experiment, we preferred not to introduce any arbitrariness in our classification

[14] For details about dates of IT adoption, see Vega and Winkelried (2005) and references therein.

[15] Goodfriend (2005) argues e.g. that the recent successes of US monetary policy "...can be attributed in large part to inflation-targeting policy procedures that the Fed has adopted gradually and implicitly over the last two decades".

scheme and stuck to official statements about the prevailing monetary policy strategies in both economies. However, as a variant, we also considered the case of an alternative unbalanced country database where the euro area appears as such and is classified as an inflation targeter since its inception in 1999, whileEMU member economies are dropped from the database from 1999 on.

4.2 Propensity scores estimation

We estimate the propensity scores using a pooled probit where the dependent variable is the targeting dummy (i.e. either IT1 for soft targeting or IT2 for fully fledged targeting) and the RHS variables are the factors deemed to influence the choice of an inflation targeting strategy and the dynamics of house prices. Remember that the purpose of the probit regression is to reduce the dimensionality of the matching problem, not to provide any plausible model of IT adoption. We must select all regressors that we would expect to have an impact on the ultimate variable of interest, here RHOPG, and could impinge on the IT status, thus implying a bias if we had computed the ATT without correction. Meanwhile, for the CIA to be valid, all conditioning variables should be chosen so that they are not influenced by the adoption of the IT regime.

Having this in mind, we finally selected seven conditioning variables for our baseline specification with reference to standard empirical models of housing price dynamics. These conditioning variables are : the lagged short and long interest rates in real terms (RIRS_1 and RIRL_1), the lagged net household disposable income in real terms (NDIG_1), a fixed exchange rate regime dummy (FER), a dummy variable indicating the degree of sophistication of the national mortgage market (MS) and the lagged ratio of the private credit to GDP (CREGDP_1) as a proxy for national financial development[16].

We took special care in correcting for cross-country heterogeneity in mortgage struc-

[16] Data sources and construction are detailed in Appendix A. In some variants of the baseline specification, we replaced the ratio of credit to GDP with the rate of net houshold savings to their disposable income (SAR), as a proxy of the capacity of housholds to borrow. We also choose a broader indicator of financial development such as liquid liabilities to GDP ratio as in Beck, Demirguc-Kunt, Levine (1999). Finally, we tested the inclusion of a banking crisis dummy (BKCR). None of these changes did affect qualitatively our results. The results are available upon request to the authors.

tures. Indeed, a few recent studies suggest that those structures matter for housing price dynamics.[17] They can also have a bearing on the probability to adopt or not an inflation targeting scheme. Indeed, one may argue that monetary authorities are more likely to implement IT when they gauge that the domestic banking and financial systems are developed enough for monetary transmission to work through quickly and efficiently[18]. In practice, controlling for differences in mortgage structures between countries is not an easy task because most available data on the mortgage market characteristics of OECD countries are qualitative, or given as constant for the last two decades (which means that they may actually refer to different periods of time), thus ignoring possible trend changes in market regulations or practices (as the extension of securitization or the decrease in credit standards over the last decade). To bypass these data limitations, we can use some proxies for financial development, such as the private credit-to-GDP ratio[19]. Another possibility is to construct a composite index summarizing institutional aspects of the mortgage markets such as the IMF (2008) recently did it. A quick look at mortgage market characteristics as shown in table 2 suggest that IT countries are predominantly countries where for instance variable rate mortgages prevail, mortgage equity withdrawal is at least legally possible and often used and loan-to-value ratios of mortgages are relatively high. However, it is fair to note that some non-targeters do also share the same strutural characteristics.

That said, we constructed a dummy variable summarizing what we thought to be relevant features of the domestic mortgage markets.[20] More specifically, we focused on those institutional features which appear to matter for monetary policy transmission according to the results in Calza et al. (2009) and Gerlach and Assenmacher-Wesche (2008): the presence or absence of mortgage equity withdrawal, the typical loan-to-value ratio, the extent of securitization, the share of owner-occupied homes, and, last but not least, the dominant type of interest rate adjustment (fixed rate vs adjustable rate morgages).[21] On

[17] See Tstatsaronis and Zhu (2004), Gerlach and Assenmacher-Wesche (2008) and Calza et al. (2008).

[18] Mishkin (2004) argues that a sound and well-developed financial system is a necessary condition for the success of an inflation targeting regime.

[19] This measure is widely used in the empirical literature. See Beck, Demirguc-Kunt and Levine (1999).

[20] See the data appendix for more details.

[21] Note that the IMF (2008) index does not cover this latter feature, but focuses instead on the possibility

this basis, we classify each country as having either a "highly developed" (the dummy variable MS equals 1) or a "less developed" (the dummy variable MS equals 0) mortgage market.Table 2 gives a view of institutional features of mortgage markets in our sample of countries, as well as the value of our dummy variable. The institutional features of national mortgage markets among OECD countries remain quite heterogenous. Broadly speaking, IT countries (Australia, UK, Sweden and Norway) provide the easiest access to home ownership. In contrast, in non IT countries (France, Italy, Germany, Belgium) the access to housing finance is somewhat constrained. Nevertheless, some exceptions remain such as the US and the Netherlands (both "highly developed" mortgage markets but non IT countries).

Let us turn now to the expected signs of the estimated coefficients in the probit regressions. On the basis of previous studies, we would expect real interest rates and the fixed exchange rate regime to be negatively correlated with the probability of running an inflation targeting strategy. On the contrary, we would expect a positive coefficient for the CREGDP variable and the mortgage structure dummy, since a developed financial system warranting an efficient transmission of monetary policy is often seen as one of the prerequisites for IT adoption.[22]. We would also expect a positive sign for the net disposable income growth.

Table 3 provides summary statistics for housing price growth in real terms and the set of conditioning variables chosen. The comparison of the means of the relevant variables across non-inflation targeting (first two columns for two different periods) and inflation targeting countries reveals that inflation targeters exhibit on average higher real house price inflation, as well as a larger banking credit to GDP ratio and a somewhat stronger net disposable income growth. However, they display lower short and long term real interest rates. These preliminary statistics hint that a simple comparison of housing price inflation in IT vs non-IT countries is potentially affected by non-random selection of the "treated", which should bias the result. This again provides support to the program evaluation methodology we adopted here.

---

to reimburse pre-emptively without penality.

[22] See for instance Mishkin (2007, p. 411) for a list of prerequisites.

Finally, table 4 shows the results of the pooled probit estimations[23] in four cases corresponding to the two different timings of IT adoption and two different time periods for the control group of observations (i.e. 1980-2006 vs 1990-2006). For robustness, we also present in table 4 a model specification based on an alternative measure of financial development (the net households' savings to income ratio, SAR). Constant terms were included in the regressions but are not reported for clarity. The real short term interest rate (RIRS_1), the ratio of private credit to GDP (CREGDP_1), the fixed exchange rate dummy (FER) and mortgage structure dummy (MS) all show up to be significant and with the expected sign. The quality of the fit is reasonably good with a pseudo-R^2 between 0.31 and 0.44 depending on the model. Figure 7 displays the densities of the propensity score for IT and non-IT countries as derived for each of the estimated four models of table 4. Although the model has not been designed as a proper model of IT adoption, it is noteworthy that it does a relatively good job in discriminating the two types of countries. Indeed, we can see a marked difference in the densities of propensity score between targeters and non targeters in the upper right hand panel. It can also be seen that changes in the definition of IT adoption dates affects the densities to a lesser extent than changes in the control group. However, whatever the size of the control group or the timing of IT adoption, the densities relative to targeters and non-targeters still have a large common support[24], which warrants that we can implement a matching strategy based on a comparison of the propensity scores.

5 Results of matching

Table 5 reports the main results of the matching procedure. The upper panel shows the results when the control group covers the entire 1980-2006 period, contrasting two timings of IT adoption, while the lower panel shows the results when the control group is restricted to the 1990s and 2000s.

The first column of table 5 refers to our baseline specification. Targeting inflation

[23] As a robustness test, we estimated a panel probit with random effects to control for unobservable heterogeneity across countries. The magnitude and sign of all the coefficients has not changed.

[24] Defined as the intersection of the densities.

appears to be associated with a significant average extra-growth of real housing prices, whatever the dates of IT adoption and the size of the control group. The size of the effect is larger and indeed quite large when the control group is restricted to data posterior to 1990, but the point estimator of the ATT is then more likely to be affected by small sample bias and a lack of common support.

We checked the robustness of this positive effect of IT strategies on housing prices along several dimensions. As a first check, we implemented various alternative matching procedures to estimate the ATT.[25] As is commonly the case, we find that our results are quite robust to the choice of the matching procedure, although the effect tends to be less significant when matched controls are taken from a narrowing neihgbourhood around a given treated unit (e.g. within a caliper of 1%). Indeed, whenever a caliper is set with a value below 2%, up to a third of treated units can be automatically dropped because of the vanishing common support. Nevertheless, it is questionable whether applying such a strict caliper limit in the case of a relatively small database of macroeconomic outcomes is warranted, although it is common in the microeconometric literature.

Table 5 also displays the estimated ATT when some outlier observations are first discarded from the sample, when alternative conditioning variables are considered in the propensity score estimation or when the ATT is computed for alternative dependent variables. In column 2, we discarded observations within the first percentile of the real housing price growth variable, so as to temper the possible favourable impact of severe housing price busts which occured in non targeting countries in the 1980s and early 1990s.[26] Column 3 shows the estimated ATT when the level of financial development is measured by the ratio of net savings of households to their net disposable income instead of the ratio of private credit to GDP. The estimated effect is somehow dampened when using control units from the whole sample period, but remains elevated and significant whenever control

[25] We tested one and three enearest-neighbours matching with replacement, with and without a caliper, radius (or caliper) matching, using caliper from 1% to 5%, as well as local linear matching. The results remained qualitatively unchanged. Detailed results are not reproduced here for brevity but are available upon request to the authors.

[26] The deleted observations, with negative growth rates between 18.6% and 24.4% in real terms, refer to Finland in 1991 and 1992, Sweden in 1992, and Denmark and the Netherlands in 1981.

units are taken from the most recent subperiod.[27] Column 4 tests the impact of targeting inflation on nominal housing price growth (HOPG) instead of real growth.[28] Finally, the last column shows estimates of the ATT for the housing price to rent ratio (HOPCPIH). Targeting inflation also appears to be systematically associated with a higher price to rent ratio. The effect is positive and significant when strict targeting is considered and controls are taken in the whole period of observation, but is larger and very significant if the control sample is restricted to the post-1990 period.

Finally, table 6 presents the results of the same ATT estimations when the euro area is added to the database as a genuine inflation targeter from 1999 to 2006, instead of individual EMU member countries. Again, the conclusions reached from the baseline experiment are qualitatively unchanged. Overall, we thus find a robust evidence of a positive and significant effect of running an IT strategy on housing price inflation and the house price to rent ratio. Ceteris paribus, inflation targeting is associated with an increase in real housing price growth by some 2.2 percentage points, averaging our findings across all model variants, while the price to rent ratio is increased by some 10 percentage points.

Technically, the self-selection bias which motivates the matching procedure is controlled for if the covariates X's are sufficiently balanced by the matching process, i.e. they appear to have the same distribution for matched treated and non-treated. Overall, we fiund that matching on the estimated propensity score balances the X's in the matched samples quite well. The standard balancing test proposed by Rosenbaum and Rubin (1983) is a two-sample t-test if the null that there are no significant differences left in the means of conditioning variables across both groups. The null was never rejected at 10% for any covariate, whatever the sample and model variant. Table **??** provides standard quality-matching indicators. Consistently with the results of the t-tests for individual covariates, the median covariate bias between the treated and control groups, which ranged between 4.2% and 13.25% before matching, is reduced to below 1% by the matching procedure.[29]

[27] Note also that the savings to income ratio is not available for all countries over the whole 1980-2006 period.

[28] The set of conditioning variables for the computation of the propensity score is then augmented with CPI inflation (CPIG), while real interest rates are replaced with the corresponding nominal interest rates.

[29] Following Rosenbaum and Rubin (1985), for a given covariate X, the standardized difference before

As expected, the pseudo-R^2 of the probit decreases sharply after matching, which suggests that there is no systematic difference left in the distribution of covariates between both groups. In addition, the joint significance of the regressors is always rejected after matching, while it is always accepted before matching. Hence, we can conclude that our kernel matching procedure proved able to wipe out most of the initial selection bias.

6 Conclusion

In this study we implemented standard program evaluation techniques to assess whether the choice of an inflation targeting (IT) strategy by the central bank had any significant impact on housing price dynamics in 17 developed OECD economies. This exercise was thought as an empirical test of recurrent but generally unformal critics that are adressed to the inflation targeting paradigm from the perspective of its consequences for financial stability.

Our central findings support the idea that the adoption of IT, either in its soft or fully fledged version, had a significant impact on the growth rate of house prices as well as on the house rpice to rent ratio. These results appear to be quite robust, but it is fair to say that they may suffer from several data limitations, in particular regarding the quality and comparability of house price data across countries. In addition, given that, for most countries, data on credit for house purchase is not available on a sufficiently long period, testing simultaneously for an impact of IT on mortgage credit growth remained out of reach. This would have usefully completed the picture, since the latest housing price boom was clearly sustained by a concomitant credit boom.

Overall, the evidence presented provides an impetus for further research, both theoretical and empirical, on the relatively neglected issue of the consequences of inflation targeting strategies for financial stability.

---

matching is the difference in the sample means in the full treateed and non-treated groups as a percentage of the square root mean of the sample variances in both groups. After matching, the respective means are computed over the treated and the non-treated units that fall on the common support.

References

[1] Amato, J. D., Shin, H. S., 2006. Imperfect common knowledge and the information value of prices. Economic theory, 27, 213-241.

[2] Arthur, S, 2005. Obtaining Real Estate Data: Criteria, Difficulties and Limitations. BIS Papers No. 21, 63–69

[3] Assenmacher-Wesche, K, Gerlach,S, 2008. Ensuring Financial Stability: Financial Structure and the Impact of Monetary Policy on Asset Prices. CEPR Discussion Papers 6773.

[4] Ball, L., Sheridan, N., 2004. Does inflation targeting matter? Matter?", The Inflation-Targeting Debate, eds. Ben S. Bernanke and Michael Woodford, Chicago: University of Chicago Press for the National Bureau of Economic Research, 2005, 249-276

[5] Bean, C, 2003. Asset prices, financial imbalances and monetary policy: are inflation targets enough?. BIS Working Papers No. 140, September.

[6] Beck, T, Demirguc-Kunt, A., Levine, R, 1999. A new database on financial development and structure. World Bank Policy Research Working Paper 2146, 1999

[7] Bernanke, B, Woodford, M,.The Inflation-Targeting Debate. NBER Book Series Studies in Business Cycles. December 2004

[8] BIS, 2006, 76th Annual Report, www.bis.org/publ/arpdf/ar2006e.pdf (Basel: Bank for International Settlements).

[9] Bordo M, Dueker, M, Wheelock, D 2003. Aggregate price shocks and financial stability: The UK 1796-1999 in "Explorations in economic history" Vol. 40, n° 2, April, 143-169.

[10] Bordo, M, Wheelock, D, 1998. Price stability and financial stability: The historical record. Federal Reserve Bank of St.Louis Review, Sep/Oct., 41-62.

[11] Borio, C, English, B, Filardo, A, 2003. A tale of two perspectives: Old or new challenges for monetary policy. BIS Working Papers No. 127, February.

[12] Borio, C, Lowe, P, 2002. Asset prices, financial and monetary stability: exploring the nexus. BIS Working Papers, no 114, July.

[13] Borio, C, White, W, 2003. Whither Monetary and Financial Stability? The Implications of Evolving Policy Regimes. BIS Working Paper No. 147

[14] Calza, A., Monacelli, T. Stracca, L., 2009. Housing finance and monetary policy. Unpublished manuscript.

[15] Campbell, J, Cocco, J, 2003. Household Risk Management And Optimal Mortgage Choice. The Quarterly Journal of Economics, MIT Press, vol. 118(4), pages 1449-1494, November, 1449-1494

[16] Caprio, G., Klingebiel, D, 2003. Episodes of Systemic and Borderline Financial Crises mimeo, World Bank.

[17] Cardarelli, Monacelli, Rebucci, Sala, 2008. Housing Finance, Housing Shocks, and the Business Cycle: VAR Evidence from OECD Countries, unpublished manuscript.

[18] Claessens, S, Kose, A, Terrones, M, 2008. What Happens During Recessions, Crunches and Busts? IMF Working Paper No 274, December.

[19] Dell'Aricia, G., Igan, D., Laeven, L., 2008. Credit booms and lending standards: evidence from the subprime mortgage market. CEPR Discussion paper No. 6683, London: CEPR.

[20] Detken, C, Smets, F, 2004. Asset price booms and monetary policy. Working Paper Series 364, European Central Bank.

[21] Dehejia, R. H., Wahba S., 2002. Propensity Score Matching Methods for Nonexperimental Causal Studies. The Review of Economics and Statistics, 84(1), 151-161.

[22] Frölich, M., 2004. Finite Sample Properties of Propensity-Score Matching and Weighting Estimators. Review of Economics and Statistics, 86, 77-90.

[23] Gertler, M, 2004. "Comments on Ball and Sheridan," in Inflation Targeting, Ben Bernanke and Michael Woodford, editors, NBER, 276-281.

[24] Girouard, N. et al. (2006), "Recent House Price Developments: The Role of Fundamentals", OECD Economics Department Working Papers, No. 475.

[25] Heckman, J., Ichimura, H., Todd, E., 1998. Matching as an econometric evaluation estimator. Review of Economic Studies 65, 261–294.

[26] IMF (2008). The changing housing cycle and the implications for monetary policy. World Economic Outlook, April.

[27] Lecat R, Mesonnier, JS, 2005. What role do financial factors play in house price dynamics? Banque de France. Bulletin Digest No. 134 – February 2005, 29-47

[28] Leijonhufvud, A., 2007. Monetary and Financial Stability. CEPR Policy Insight No. 14, October.

[29] Leuven, E., Sianesi B., 2003. PSMATCH2: stata module to perform full mahalanobis and propensity score matching, common support graphing, and covariate imbalance testing. Software: http://ideas.repec.org/c/boc/bocode/s432001.html. This version 3.0.0.

[30] Lin, S., Ye, H., 2007. Does inflation targeting really make a difference? Evaluating the treatment effect of inflation targeting in seven industrial countries. Journal of Monetary Economics 54, 2521–2533.

[31] Mishkin, F, 2004. Can inflation targeting work in emerging market countries?, NBER Working Paper Series 10646, National Bureau of Economic Research.

[32] Mishkin, F,Schmidt-Hebbel, K. 2007. One Decade of Inflation Targeting in the World: What Do We Know and What Do We Need to Know? Monetary Policy Strategy. Cambridge: The MIT Press, 405-444.

[33] Persson, T., 2001. Currency union and trade: how large is the treatment effect? Economic Policy 33, 433–448.

[34] Rose, A., 2007. Are International Financial Crises a Barbarous Relic? Inflation Targeting as a Monetary Vaccine. CEPR Policy Insight No. 1, January.

[35] Rosenbaum, P., Rubin, D, 1983. The Central Role of the Propensity Score in Observational Studies for Causal Effects. Biometrika, 70, 41-50.

[36] Rosenbaum, P., Rubin, D, 1985. Constructing a control group using multivariate matched sampling methods that incorporate the propensity score. The American Statistician, 39(1), 33-38.

[37] Sianesi, B, 2004. An Evaluation of the Active Labour Market Programmes in Sweden. The Review of Economics and Statistics, 86(1), 133-155.

[38] Tsatsaronis, K, Zhu, H, 2004. What drives housing prices dynamics: Cross country evidence. Bank of International Settlements, Quarterly Review, mars

[39] Vega, M., Winkelried, D., 2005. Inflation Targeting and Inflation Behavior: A Successful Story?. International Journal of Central Banking, vol. 1(3), December, 153-175

[40] White, W, 2006. Procyclicality in the financial system: do we need a new macrofinancial stabilisation framework? BIS Working Papers No 193, January.

[41] White, W, 2006. Is price stability enough? Working Papers No 205, April.

Appendix A: data

We use yearly data for 17 OECD countries covering a period that ranges from 1980 until 2006. Data are seasonally adjusted except for interest rates. The set of data series comprises:

- We used data on residential property prices provided by the Bank for International Settlements (BIS). The BIS collects the data from national sources. We used yearly nominal house price series. Series are indices at the end of the year[30].

- Real net household disposable income is from the OECD Economic Outlook database. Data were expressed in billions of national currency units. Growth is defined as year-on-year changes (NDIG).

- The short-term interest rate (IRS) is a 3-month money market rate taken from the OECD Economic Outlook database. The long-term interest rate (IRL) is the yield on long-term government bond on the secondary market with residual maturity of about 10-years. The interest rates used are yearly averages of daily figures taken from the OECD Economic Outlook database. Real rates are computed as ex-post real interest rates using annualized inflation rates (RIRS and RIRL).

- Data for credit to the private sector (CRE) is taken from the IMF IFS database (codes 32d which include gross credit from the financial system to individuals, enterprises and non financial public entities). Series are outstanding amounts at the end of the year. Many of the IMF credit series displayed large level shifts owing to changes in definitions or re-classifications. So, when series showed significant structural breaks as indicated by a TRAMO application, breaks have been corrected one by one. The level of the series was then adjusted by backdating the series starting from the sample end and based on the adjusted series. We detected level shifts and therefore we adjusted series for Belgium, Canada, Denmark, Ireland, New Zealand and Sweden. Then, we calculated, as in Borio and Lowe (2002), the ratio of nominal credit to nominal GDP (CREGDP).

[30] More details on the house-price series are available in Arthur (2005).

- We constructed a banking crisis dummy variable (BKCR) that takes the value 1 during the crisis. To identify banking crisis episodes, we rely on the updated database of Caprio and Klingebiel (2003) maintained by the World Bank .

- The FER variable is a dummy variable. We use the exchange rate classification proposed by Reinhart and Rogoff (2004). We consider the first two categories of the Reinhart and Rogoff's classification as fixed regimes (the dummy variable equals 1) and for the other categories, the dummy variable equals 0.

- The IMF mortgage market index summarizes 5 institutional characteritics of the mortgage market (see Table 1 in IMF, 2008): mortgage equity withdrawal, the existence of early repayment fees, the loan-to-value ratio, the development of the covered bonds market and the mortgage-backed securities market. Regarding our own index, we considered the following variables: the presence of mortgage equity withdrawal, the loan-to-value ratio, securitization, the share of owner-occupied homes, the type of interest rate adjustment (fixed or variable). Sources are available in IMF (2008), in Calza et al. (2009) and in Assenmacher-Wesche and Gerlach (2008). For securitization, values of 0, 0.5, and 1 are assigned to each country depending on whether this feature is nonexistent, limited, or widespread, respectively. For loan-to-value ratio and share of owner-occupied homes, each country is assigned a value between 0 and 1, equal to the ratio to the maximum value across all countries. Then, our index is computed as a simple average of these four features. It ranges from 0 to 1 with higher values indicating easier access to household mortgage finance. The group of 17 countries is split in two groups where each country is classified as having either a "high developed" (the dummy variable MS equals 1) or a "low developed" (the dummy variable MS equals 0) mortgage market (see table 2)

Table 1: Inflation targeters and dates of IT adoption

Countries	Starting year of IT strategy	
	soft (IT 1)	explicit (IT 2)
Australia	1994	1994
Canada	1991	1994
Finland	1993	1993
New Zealand	1990	1991
Norway	2001	2001
Spain	1994	1995
Sweden	1993	1995
Switzerland	2000	2000
United Kingdom	1992	1992

Source: Vega and Winkelried (2005).

Table 2: Structural features of national mortgage markets

	Mortgage equity withdrawal	Loan-to-value ratio (in %)	Interest rate adjustment	Securitisation	Share of owner occupied homes (%)	IMF index	Dummy MS1
Australia	yes	80	V	yes	70	0.69	1
Belgium	no	83	F	no	72	0.34	0
Canada	yes	75	F	yes	66	0.57	1
Denmark	yes	80	F	no	59	0.82	0
Finland	yes	75	V	no	64	0.49	1
France	no	75	F	no	56	0.23	0
Germany	no	70	F	no	42	0.28	0
Ireland	limited	70	V	yes	78	0.39	1
Italy	no	50	F	no	80	0.26	0
Netherlands	yes	90	V	yes	53	0.71	1
New Zealand	yes	-	F	-	-	-	0
Norway	yes	70	V	no	77	0.59	1
Spain	limited	70	V	yes	85	0.4	1
Sweden	yes	80	F	no	61	0.66	0
Switzerland	no	-	V	no	36	-	0
UK	yes	75	V	yes	70	0.58	1
US	yes	80	F	yes	69	0.98	1

F = fixed and V = variable.

Sources: IMF (2008); Calza, Monacelli and Stracca (2008); Gerlach and Assenmacher-Wesche (2008).

Table 3: Descriptive statistics

	IT1=0, 1980-2006			IT1=1, 1980-2006		
Variables	Obs	Mean	Std.Dev.	Obs	Mean	Std.Dev.
RHOPG	343	2.13	7.71	99	3.99	5.87
RIRS	343	4.15	3.18	99	3.25	1.83
RIRL	343	4.56	2.66	99	4.24	1.75
NDIG	323	2.27	2.40	99	2.68	2.41
CREGDP	343	0.70	0.43	99	1.01	0.35
MS1	343	0.51	0.50	99	0.62	0.49
SAR	343	11.50	9.74	99	5.85	5.21
BKCR	343	0.10	0.30	99	0.05	0.22

Table 4: Probit regressions

Variables/regression	IT1	IT2	IT1 (1990-2006)	IT2 (1990-2006)	IT2 with SAR	IT2 EMU
RIRS(-1)	-0.14	-0.24	-0.13	-0.24	-0.26	-0.25
	(0.06)**	(0.06)***	(0.07)*	(0.07)***	(0.06)***	(0.06)***
RIRL(-1)	0.30	0.39	0.51	0.58	0.33	0.35
	(0.07)**	(0.07)***	(0.11)***	(0.12)***	(0.07)***	(0.07)***
NDIG(-1)	-0.01	0.03	-0.02	0.04	-0.01	0.02
	(0.04)	(0.04)	(0.05)	(0.05)**	(0.04)	(0.04)
FER	-1.98	-2.18	-2.34	-2.47	-1.91	-1.89
	(0.25)***	(0.25)***	(0.24)***	(0.25)***	(0.22)***	(0.28)***
MS1	0.38	0.35	0.43	0.35	0.01	0.43
	(0.18)**	(0.20)*	(0.19)**	(0.21)	(0.18)	(0.23)*
CREGDP(-1)	1.71	1.65	1.34	1.22	-	1.83
	(0.23)***	(0.25)***	(0.32)***	(0.35)***	-	(0.29)***
SAR(-1)	-	-	-	-	-0.05	-
	-	-	-	-	(0.01)***	-
BKCR(-1)	-0.40	-0.75	-1.28	-1.56	-0.94	-0.66
	(0.33)**	(0.33)**	(0.45)***	(0.43)***	(0.29)***	(0.33)**
Obs.	425	425	289	289	425	367
Countries	17	17	17	17	17	18
Pseudo-R^2	0.39	0.42	0.46	0.48	0.37	0.40

Robust standard errors are shown in parentheses.

Table 5: Estimates of the ATT of inflation targeting: alternative specifications and dependent variables (Kernel matching method).

		Dependent variable / Model specification				
		RHOPG baseline	RHOPG no out.	RHOPG SAR	HOPG	HOPCPIH
		(1)	(2)	(3)	(4)	(5)
Controls over whole sample period (1980-2006)						
IT1	ATT	2.78	2.73	0.63	3.28	0.09
	SD	(1.20)	(1.18)	(0.92)	(1.51)	(0.04)
	Treated /Control units	99/326	99/323	98/322	99/326	99/315
IT2	ATT	2.64	2.58	1.28	2.32	0.08
	SD	(0.99)	(0.96)	(0.95)	(1.07)	(0.04)
	Treated /Control units	92/333	92/330	91/329	92/333	92/322
Controls over 1990-2006						
IT1	ATT	5.97	5.64	2.91	5.65	0.12
	SD	(1.62)	(1.34)	(1.18)	(1.62)	(0.04)
	Treated /Control units	99/190	99/187	98/190	99/190	99/190
IT2	ATT	4.35	4.12	2.86	4.18	0.12
	SD	(1.21)	(1.16)	(1.15)	(1.29)	(0.04)
	Treated /Control units	92/197	92/194	91/197	92/197	92/197
Bootstrapped standard errors for ATT are reported in parenthesis (1000 reps)						

Table 6: Estimates of the ATT of inflation targeting (variant with EMU as an inflation targeter): alternative specifications and dependent variables (Kernel matching method).

		Dependent variable / Model specification				
		RHOPG baseline	RHOPG no out.	RHOPG SAR	HOPG	HOPCPIH
		(1)	(2)	(3)	(4)	(5)
Controls over whole sample period (1980-2006)						
IT1	ATT	3.07	2.81	0.86	2.84	0.08
	SD	(1.32)	(1.26)	(0.93)	(1.41)	(0.04)
	Treated /Control units	105/262	105/260	104/258	105/262	105/251
IT2	ATT	2.72	2.60	1.32	2.18	0.10
	SD	(1.16)	(1.10)	(0.92)	(1.09)	(0.04)
	Treated /Control units	98/269	98/267	97/265	98/269	98/258
Controls over 1990-2006						
IT1	ATT	4.40	4.42	2.72	5.06	0.14
	SD	(1.52)	(1.24)	(1.10)	(1.47)	(0.04)
	Treated /Control units	105/126	105/124	104/126	105/126	105/126
IT2	ATT	3.79	3.94	2.62	3.93	0.12
	SD	(1.10)	(1.10)	(1.08)	(1.16)	(0.03)
	Treated /Control units	98/133	98/131	97/133	98/133	98/133
Bootstrapped standard errors for ATT are reported in parenthesis (1000 reps)						

Table 7: Indicators of covariate balancing, before and after matching (strict targeting IT2, controls over 1980-2006, kernel matching method)

		ATT	Probit ps.-R^2 before	Probit ps.-R^2 after	Pr $>\chi^2$ after	Median bias before	Median bias after
				Whole sample			
RHOPG	IT1	2.78	0.39	0.03	19.64	13.25	0.32
	IT2	2.64	0.42	0.01	23.27	8.79	0.93
HOPCPIH	IT1	0.09	0.40	0.02	17.76	10.21	0.59
	IT2	0.09	0.43	0.02	25.44	6.37	0.78
				Post-1990 sample			
RHOPG	IT1	5.97	0.46	0.01	26.66	6.91	0.98
	IT2	4.35	0.48	0.03	23.90	8.35	0.44
HOPCPIH	IT1	0.13	0.46	0.01	26.66	6.91	0.98
	IT2	0.12	0.48	0.03	23.90	8.35	0.44
Variant: EMU as IT country							
				Whole sample			
RHOPG	IT1	3.07	0.37	0.04	33.14	9.94	0.11
	IT2	2.72	0.40	0.01	39.03	4.20	0.98
HOPCPIH	IT1	0.08	0.38	0.03	32.55	5.85	0.42
	IT2	0.10	0.41	0.00	39.07	4.03	0.99
				Post-1990 sample			
RHOPG	IT1	4.40	0.37	0.01	27.85	5.94	0.94
	IT2	3.78	0.40	0.02	41.14	5.33	0.63
HOPCPIH	IT1	0.14	0.37	0.01	27.85	5.94	0.94
	IT2	0.12	0.40	0.02	41.14	5.33	0.63

Figure 1: House prices and house price to rent ratio. Real house price growth (yoy in %, left axis, solid line), nominal house price growth growth (yoy in %, left axis, dashes), house price to rent ratio (right axis, dotted line). Shaded area indicates inflation targeting regime.

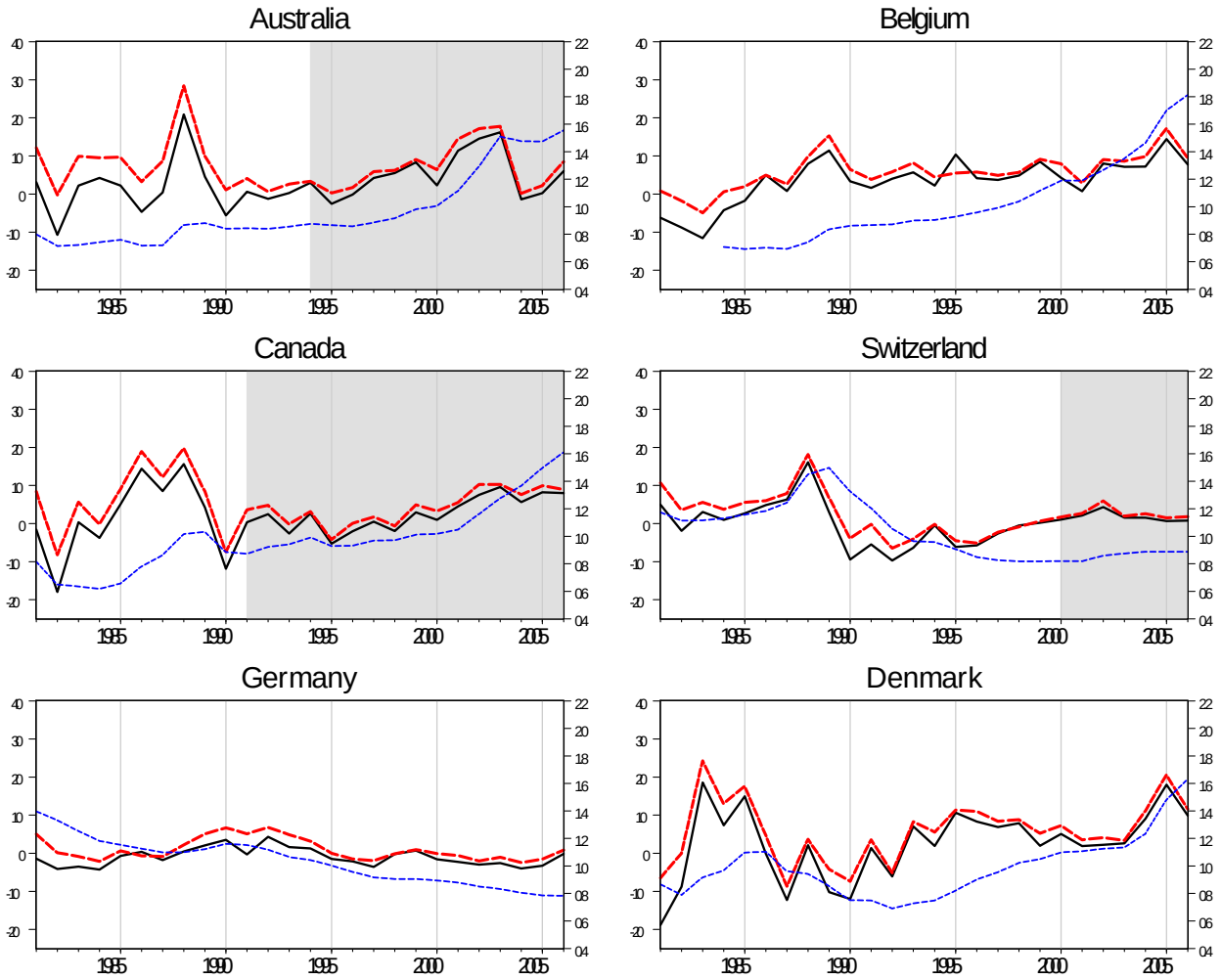

Figure 2:

Figure 3: House prices and house price to rent ratio (cont'd).

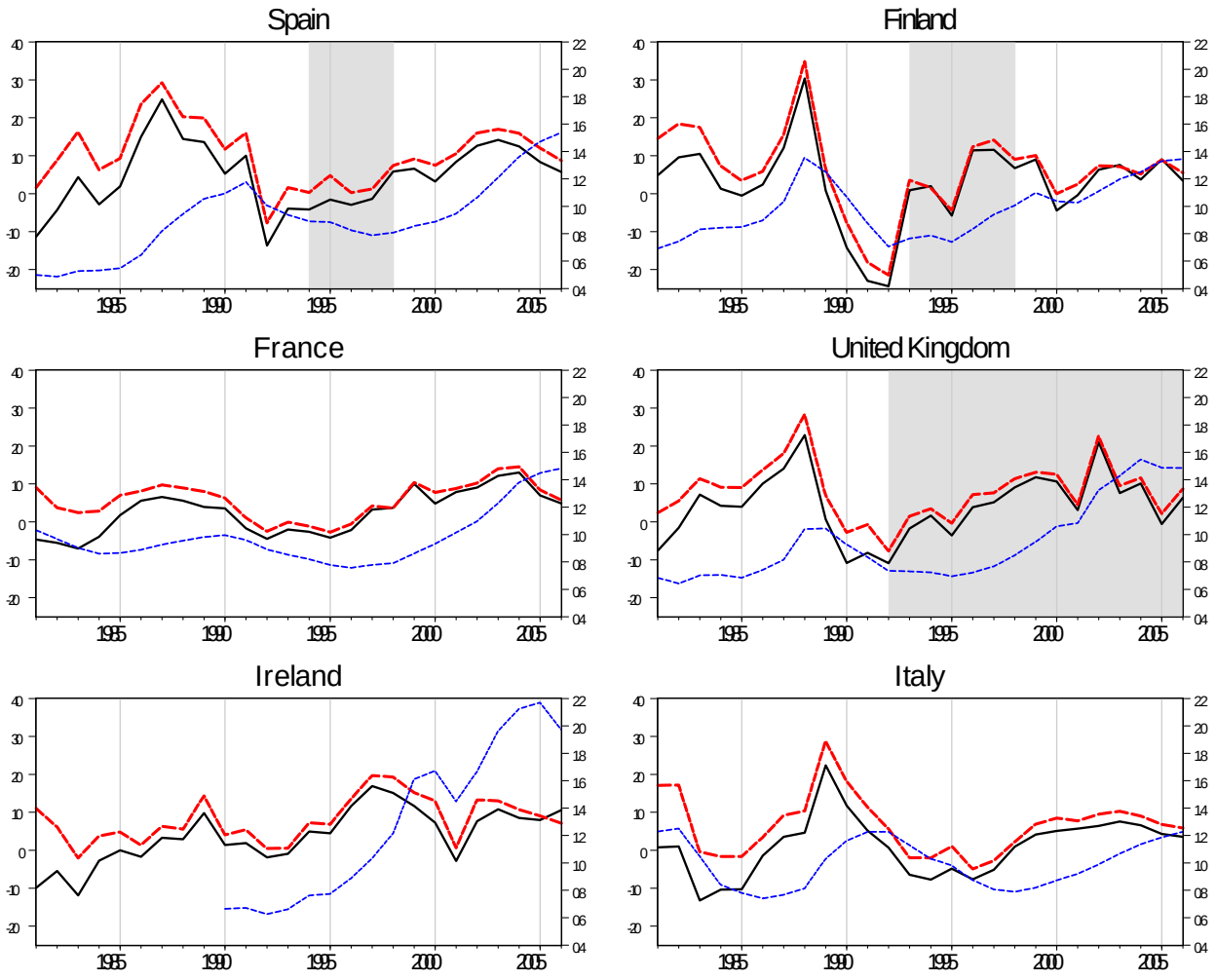

Figure 4:

Figure 5: House prices and house price to rent ratio (cont'd).

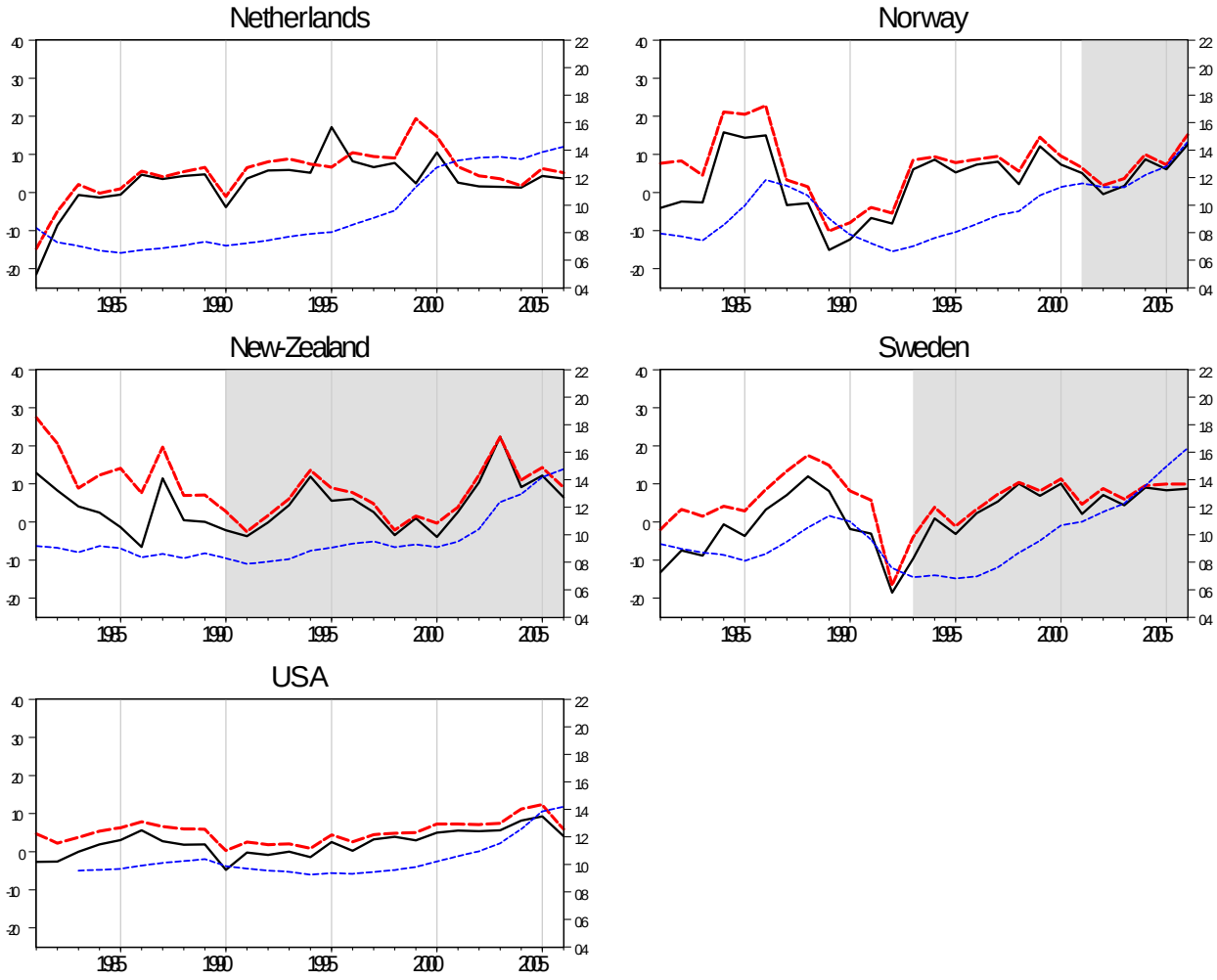

Figure 6:

Figure 7: Densities of estimated propensity scores. First row: controls over 1980-2006, second row: controls over 1990-2006. First column: IT1, second column: IT2.