Credit conditions and tenure choice: A cross-country examination

David Cronin[c] and Kieran McQuinn*[a,b]

Abstract: An understanding of the house price to rent ratio and its determinants is important in assessing housing market developments and tenure choice therein. While the ratio is most usually explained by the user cost of capital, the influence of credit conditions on it has been added to econometric assessments in recent years. Using a new cross-country panel, we estimate the impact of variations in credit conditions on the house price to rent ratio between 1994 and 2015 on both a panel and country-by-country basis. This period was one of substantial cross-country house price movements as developments in standard explanatory variables, such as income levels, interest rates and demographics, were accompanied by major changes in credit markets. In line with other recent studies, our results establish the relevance of credit conditions to the house price to rent ratio at both panel and country levels. Moreover, the evidence points to credit conditions dominating the user cost of capital over the sample period, emphasising the need to include credit analysis when evaluating housing market developments.

*Corresponding Author: kieran.mcquinn@esri.ie

a   The Economic and Social Research Institute, Dublin
b   Department of Economics, Trinity College, Dublin
c   Central Bank of Ireland

1.   Introduction

One of the main indicators used to assess the stability of housing markets is the house price to rent ratio. Typically this ratio assumes that in the absence of frictions and credit restrictions, arbitrage between owner-occupied and rental housing ensures that the house price to rent ratio is a function of the real user cost of capital. However, mainly in light of the liberalisation of financial markets over recent years, a number of applications (Kim (2007), Duca, Muellbauer and Murphy (2011) and Cronin and McQuinn (2016)) have identified credit conditions as a wedge in the user cost / price-rent relationship and have augmented the standard relationship accordingly.

This development has a number of important implications. Under the standard relationship, changes in the equilibrium relationship between house prices and rents can only occur due to changes in interest rates, agents' expectations concerning house prices, and items such as the natural depreciation rate and relevant taxation rates. Under the augmented relationship, however, credit conditions can also cause movements in the house price to rent ratio. This reflects the impact changing credit conditions can have on tenure choice in a particular property market: all other things being equal, changes in the provision of credit affect households' preferences between renting and owner-occupying a property. The incorporation of credit conditions into the determination of the house price to rent ratio also reflects the period 1994 to 2015, which is that studied here, being one of substantial changes in credit provision across many OECD countries. For a variety of reasons, financial institutions across different countries were able to increase their lending to the real economy, although there was considerable variation, with some countries' financial sectors experiencing more rapid growth vis-á-vis GDP than others.[1]

In this paper, we conduct a detailed assessment of the determinants of the house price to rent ratio for 15 OECD countries using a newly constructed quarterly dataset over the period 1994 to 2015. Initially, we examine the impact of the user cost of capital and credit conditions on the ratio in a panel data context with the results indicating a long-run relationship arising between the three variables across countries over the period. However, given the heterogeneity observed in the rates of loan extension across

---

[1]See McCarthy and McQuinn (2017), for example, for a detailed examination of changes in the Irish financial sector - a sector which saw one of most significant increases in the period up to 2007.

different credit markets, we also examine the relationship on a country-by-country basis.

The econometric estimations have some salient features. First, credit conditions have a significant impact on the house price to rent ratio over the entire period. For most of the fifteen countries, the impact of credit conditions initially increased substantially during the earlier part of the house price boom that arose between 1995 and 2007, contained within the sample, before declining somewhat thereafter. For the period when house prices were increasing (pre-2007), it is evident from the results that credit availability dominates the user cost of capital in terms of the magnitude and significance of its impact. Secondly, parameter stability tests reveal that the adoption of the euro in 1999 and the international financial crash of 2007/08 are particularly influential in the relationship between the price to rent ratio, the user cost of capital, and credit availability for a number of countries. These results, arising at the aggregate level, mimic the results from the use of microeconomic data (Chiuri and Jappelli (2003), Bičáková and Sierminska (2007), Trucchi (2016) and Acolin, Bricker, Calem and Wachter (2016) for example), which demonstrate the importance of credit conditions in affecting tenure choice decisions.

The rest of the paper is structured as follows. In section 2, we first present the standard model of the house price to rent ratio and how it is augmented to include credit conditions. The data used are also outlined. The following section then presents the cross-country analysis with panel unit root tests and cointegration procedures being applied to the panel data. Section 4 reports the results of econometric estimations conducted at the individual country level. The implications of the results, including for macroprudential policy, are considered in the concluding section.

2. Econometric approach and data

2.1. Econometric model

The standard approach to the determination of the house price to rent approach assumes that, in the absence of credit restrictions, arbitrage between owner-occupied and rental housing ensures that the house price to rent ratio depends on the real user cost of capital, i.e.

$$hp_t/rent_t = (r_t + \sigma_t + t_t - \triangle hp_t^e/hp_t). \tag{1}$$

where hp is house prices, $rent$ is actual rental rates, t relates to any property taxes to which the homeowner is liable, r is the real interest rate, σ is the natural rate of depreciation of the house and hp^e is *expected* house prices. We label the right hand side of (1) as $RUSER_t$, the real user cost of capital:

$$hp_t/rent_t = RUSER_t. \tag{2}$$

Variants of this framework applied to housing markets can be found in Blackey and Follain (1995), Himmelberg et al (2005), Murphy (2005), Campbell, Davis, Gallin and Martin (2006), Gallin (2008), Diaz and Luengo-Prado (2012) and Browne, Conefrey and Kennedy (2013).

The presence of mortgage market imperfections such as credit rationing, however, lead Kim (2007) to identify a wedge in the user cost / price-rent arbitrage relationship. Kim (2007) demonstrates that the equilibrium price to rent ratio can be affected by binding, credit constraints as well as the real user cost of capital. Thus, to reflect such frictions, (2), is augmented in the following manner:

$$(hp_t/rent_t) = f[RUSER_t, CRED_t]. \tag{3}$$

Cronin and McQuinn (2016) estimate (3) with Irish data and find that restrictions on credit availability have a significant long-run impact on the ratio of house prices to rents in the Irish market. Furthermore, the magnitude of the coefficients in the Cronin and McQuinn (2016) application are broadly in line with the comparable results in Duca, Muellbauer and Murphy (2011) in a US context.

In this paper we estimate equation (3) initially for a cross-country sample of 15 OECD countries over the period 1994Q4 to 2015Q1 before doing so also at an individual country level.

2.2. Data

Quarterly data for 15 OECD countries are used in the paper. The dataset is new in that it combines cross-country data on housing and mortgage markets from a number of different sources. The countries are Germany (DE), France (FR), Italy (IT), the United States (US), the United Kingdom (UK), Canada (CA), Spain (ES), Australia (AU), the Netherlands (NE), Sweden (SW), Denmark (DK), Norway (NO), Finland (FI), New Zealand (NZ) and Ireland (IE), while the time period is 1994:Q4 to 2015:Q1. Three main sources of data are used: house price and rent data are taken from the OECD Analytical House Price database; household credit is from the Bank of International Settlements (BIS); quarterly GDP, interest rates and GDP deflator data are taken from the IMF's International Financial Statistics (IFS) database. The house price and house price to rent data are then both expressed as an index equalling 100 in 2010, while the credit data are expressed as a percentage of GDP.

Most country level mortgage markets are characterised, in the aggregate, by a preference for either variable or fixed rate mortgages. A survey paper, ECB (2003), based on questionnaires conducted by national central banks (NCBs), provides some information on the nature of mortgage contracts in individual EU countries. The interest rate adjustment in each country is characterised as being either fixed (F) or variable (V). For an interest rate to be classified as fixed, it must be fixed for more than five years, or until final maturity, whereas in the case of the variable rate, it is either negotiable after one year, is tied to market rates, or is adjustable at the discretion of the lender.[2] Based on these observations, each country in our sample is classified into a variable or fixed rate category where the variable (fixed) rate mortgage rates are proxied by country specific short-term money market rates (long-term Government bond rates). Annual population data is taken from either a country's national statistical agency or EuroStat's NewCronos. These series are then interpolated and along with the GDP data are combined to arrive at a quarterly GDP per capita series for each country. The data are summarised in Table 1.

To capture the country-specific fluctuations for some of the main variables between 1994 and 2015, we plot in Figures 1 to 3 the coefficient of variation for each country for the price to rent ratio, nominal house prices and household credit to GDP. The coeffi-

---

[2]See Table 5.1 of ECB (2003) for more details.

cient of variation is a standardized measure of dispersion of a probability distribution or frequency distribution and is defined as the ratio of the standard deviation to the mean. For the period, the Irish market exhibits the largest degree of volatility for both the price to rent and the household credit to GDP ratios. This is unsurprising as previous research has highlighted the significance and scale of the Irish housing and credit bubble in the context of other OECD countries (Kennedy and McQuinn (2011)).

The credit variable used in the estimation of (3) is credit supplied to the households and non-profit institutions serving households (NPISHs) sectors. To capture the impact of supply-side changes on credit conditions, the actual series is first adjusted to allow for changes in relevant demand-side variables.

The actual household credit variable is modelled as a function of demand side factors such as changes in the log of unemployment (dlU), interest rates (r), population levels (POP) and household income levels (Y). The credit variable is filtered ($flcred$) to allow for long-run changes. The following specification, also estimated for the Irish market in Kelly and McQuinn (2014), is used:

$$lCRED_t = \alpha_0 + \alpha_1 lCRED_{t-1} +$$

$$\alpha_2 flCRED_t + \alpha_3 dlU_t + \alpha_4 Y_t + \alpha_5 POP_t + \alpha_6 r_t + \epsilon_t. \tag{4}$$

In estimating (4) for each country, we adopt the Hendry (1993) general-to-specific approach and only leave in the variables which are significant. The fitted series is similar to the indicator of credit conditions estimated by Fernandez-Corugedo and Muellbauer (2006) for the UK market and the mortgage market conditions index estimated for the Irish market by McCarthy and McQuinn (2017). The resulting *adjusted* CRED ($ACRED_t$) is calculated in the same manner as in Duca, Muellbauer and Murphy (2011). This is estimated on a single-equation basis for each country in our sample.

To estimate an expression for the real user cost ($RUSER_t$), we compile an expected house price appreciation term. Following Duca, Muellbauer and Murphy (2011), we use a four period moving average of this term here.[3]

---

[3]Kelly and McQuinn (2014) examine alternative possible price expectations mechanisms such as a naïve expectations approach and following Himmelberg, Mayer, and Sinai (2005) and Duca, Muellbauer, and Murphy (2011) lagged house price appreciation over the prior four years. However, the overall results were not sensitive to the alternative specifications.

3.   Panel Unit Root Tests and Cointegration Results

In Table 2 we present the results of a number of panel data unit root tests for the three variables of interest: the house price to rent ratio ($hp_t/rent_t$), the real user cost of capital ($RUSER_t$) and the adjusted credit variable ($ACRED_t$). In particular we apply the Im, Pesaran, and Shin (2003), Breitung (2000) and Hadri (2000) tests. The Im Pesaran and Shin (2003) test computes separate ADF test statistics on each individual country series and combines those by the simple averaging of the t-statistics across all 15 countries. The Im Pesaran and Shin (2003) test statistic used is a normalized and rescaled version of this called $Z_{\tilde{t}-bar}$ which has an asymptotic N(0, 1) distribution. The Hadri (2000) test is unlike the other two in that the null hypothesis is stationarity. Based on the statistics reported in Table 2, we cannot reject the null of a unit root (Im Pesaran and Shin (2003) and Breitung (2000)) and can reject the null of stationarity (Hadri(2000)) for all three variables.

Given these results, we next estimate a panel model version of equation (3). We test for cointegration within a panel-data context using the Pedroni (1999) single equation framework. These tests are all single-equation methods based on estimating the static cointegrating regression of the following form:

$$y_{it} = \alpha_i + \delta_u t + \beta_i x_{it} + \epsilon_{it} \quad i = 1, 2.., N; \quad t = 1, 2.., T \tag{5}$$

where x is a vector of regressors and β consists of its associated parameters. The tests are constructed by using the residuals $\hat{\epsilon}_{it}$ from the above cointegrating regression.

The cointegration tests proposed by Pedroni are sufficiently flexible so as to enable the investigation of heterogeneous panels, in which heterogeneous slope coefficients, fixed effects and individual specific deterministic trends are permitted. Pedroni proposes a number of panel cointegration statistics. Some of these statistics, called *panel* cointegration statistics, are based on within-country based statistics, while the other statistics, called *group mean* panel cointegration tests, are between-country panel statistics.

The standardized statistics tend in distribution to the normal density under the null hypothesis of no cointegration. Pedroni (1999) tabulates the required moments for the standardization by simulation, for different specifications of deterministics included

in the models. The cointegration test results are presented in Table 3. Inspection of the critical values indicates that the null hypothesis of no cointegration between the variables can be rejected across the different tests.

Based on these tests, we next estimate long-run models of (3) using OLS, fixed effects, random effects and the panel fully modified (FM-OLS) estimator with dummy variables included for the individual countries. The FM-OLS estimator can be distinguished between three different forms of estimator depending on the way the data are pooled: estimators that pool information along the between-dimension (Pedroni (2004)); estimators that pool information along the within-dimension weighting all the variables by their long run covariances (Pedroni (2004) and Kao and Chiang (2000)); and within-estimators that do not scale the variables (Mark and Sul (2003) and Pedroni (2004)). The group mean FM-OLS estimator can be obtained as:

$$\hat{\psi}_{GFM} = \frac{\sum_{i=1}^{N} \hat{\psi}_{FM,i}}{N}$$

where $\psi_{FM,i}$ is the FM-OLS estimator applied to the ith member of the panel. An important advantage of this estimator is that the manner in which the data are pooled allows for greater flexibility in the presence of heterogenity of the cointegrating vector. Point estimates for the between-dimension estimator can be interpreted as the mean values for the cointegrating vectors.

The results for the different estimators are presented in Table 4. There is a clear difference between the OLS estimates and the panel data estimators, with the latter set of results suggesting a stronger influence of credit conditions. The F-test, which is for the null hypothesis that country specific dummies are insignificantly different from 0, indicates that panel estimators are more appropriate given the apparent cross-country heterogeneity in the sample. The results for the different panel data estimators, in terms of the scale of the coefficients, are very similar. As the credit variable and the house price to rent ratio are in log format, the panel estimates suggest that a one per cent increase in the supply of credit causes a one per cent increase in the house price to rent ratio for the period.[4]

---

[4]With satisfactory long run relationships being established in the data, we also estimate short-run dynamic regressions where the change in the house price-to-rent ratio is the left-hand side variable. The results suggest the presence of error-correction. The results are available, upon request, from the authors.

4.   Country-By-Country Results

The period 1994 to 2015 saw significant changes in the degree of credit extension across different OECD countries. A substantial literature has sought to characterise developments across banking sectors, mainly in the US and European Union. A non-exhaustive set of such studies includes Borio and Disyatat (2011), Bernanke et al. (2011), Shin (2012), Bruno and Shin (2012a), Bruno and Shin (2012b), Obsfeld (2012), and Gourinchas (2012), which each examine the origination and propagation of gross capital flows and credit boom conditions in certain advanced economies during this timeframe.

Notwithstanding the general increase in bank lending over this period, it is also evident that significant differences emerged between countries in the rate of credit expansion that each was undertaking. For example, as noted in European Systemic Risk Board (2014), a widening gap emerged between the European Union and the United States from the 1980s onwards in terms of the ratio of bank loans to GDP, as European global banks, in particular, availed of the expansion in derivatives and foreign lending. However, even within the EU, differences in the pace of credit expansion across markets arose: certain EU countries experienced only modest increases in credit to GDP (FI, DE, and FR) while other countries (IE, ES and PT) saw substantial increases in the same ratio. These differences within the EU have been attributed to capital flows from "core" euro area countries to the "periphery', with credit flowing into, for example, ES and IE funding housing and consumption booms in those countries in the period up to 2007.

Accordingly, notwithstanding the panel regression results in the previous section establishing the relevance of credit conditions to the determination of the house price-to-rent ratio, the heterogeneity of credit market developments over the 1994-2015 period suggest that it would be informative to estimate equation (3) on a country-by-country basis. In this section we examine the changing nature of the relationship between the house price-to-rent ratio, the user cost of capital and credit conditions for each country within the panel.

Following on Table 4, the relevant coefficients in that table were re-estimated on a country-by-country basis, by OLS for the entire 1994Q4 - 2015Q1 sample. The coefficients on RUSER and ACRED are shown in the two panels of Figure 4. There is some

divergence from the results in Table 4. In particular, only for FR, SW, NO and CA does the coefficient on RUSER have the hypothesised negative sign. For the remaining countries, the coefficient is either insignificant in value (US, IT, ES, NE, FI, IE, DK, AU, NZ) or has a positive value (UK, DE). The coefficients on the other regressor, ACRED, however, are in fourteen of the fifteen cases of the hypothesised positive sign and are usually highly significant. The exception is DE where a negative coefficient is reported.

The full-sample OLS estimates of Figure 4 are complemented by the leverage measures contained in Figure 5. Across the 82 quarterly observations for each country, the leverage measure distingushes data points on the basis of their influence in the estimation of the parameter values over the full sample. The higher the leverage value, the greater the influence of the data from that quarter. The leverage measure, thus, provides information on what could be important developments during the sample period. A number of different features stand out in Figure 5. One is that the quarters around 1999 were particularly influential for the some of the euro area member states (IT, ES, NE, FI). Those are also influential quarters for two of the other European countries (NO, DK). The main economic event around that time was the onset of EMU and the single currency. For some of these countries the single currency brought the attraction of low and stable interest rates, while it also led to some of the changes in financial markets which enabled greater levels of cross-border lending to occur. More influential observations also tend to occur earlier in the sample for the other European countries (DE, FR, UK, IE, SW).

Particularly influential observations do not arise before the mid-2000s for the US, UK, CA, AU and NZ, while influential, observations arise in the second half of that decade for IE and SW also. For some of these countries, the relevance of the observations around this period is most likely related to the credit-fuelled housing bubbles which had emerged during the 2000s. The period around the financial crisis of 2008 and 2009 then seems to contain influential observations for those countries (that around the introduction of the euro had little influence on their full sample estimates). Those, and later quarters, are not quarters that are influential for the euro area and Northern European countries, with the exception of IE and SW and, to a lesser extent, DE and FR. IE, in particular, experienced a substantial correction in its financial sector post 2007 with both lending and house prices falling sharply due to the presence of overvaluation

in the Irish property market.

With such variation in the influence of observations over the period and between countries, an obvious extension to the modelling is to examine for changes in coefficient values over time across countries. Equation (3) was then estimated on a recursive basis. For each country, the coefficient values for RUSER are shown in the left-hand-side column of Figure 6, while those of ACRED are on the right-hand-side. The first estimate from the recursive estimation shown in each chart is for 1998Q4. The behaviour of RUSER across the countries is relatively uneventful, with the coefficient most usually keeping its sign and significance/insignificance as the window length is extended forward.

The behaviour of ACRED, in the right-hand-side column, is more interesting. A hump shape is a common feature of many of the country charts for the recursive estimation of this coefficient, with the coefficient initially rising and then declining. For most countries, the ACRED coefficient reaches its largest positive value in the early-to-mid 2000s before declining steadily thereafter. The earliest times of decline arise for the UK (2000), NE (2001), SW (2001), and DK (2001). The remaining euro area member states FR (2003), IE (2003), IT (2005), FI (2005) and ES (2006) start to experience a decline in the ACRED coefficient a little later. AU's coefficient starts a slow if steady decline after 2004. CA's coefficient starts to decline after 2007, while the US's falls from 2006 onwards and then recovers. NO and NZ have no noticeable decline in coefficient value from the mid-2000s on. In the preceding years, however, NZ's ACRED coefficient rises sharply. The initial rise in this coefficient's value is shared then by all the euro area countries, as well as by the US, the UK, SW, AU and CA (i.e. thirteen countries in total).

What the pattern of many of these estimates suggest is that the relevance of changes in credit markets on the house price to rent ratio changed substantially over the period 1994 - 2015. To varying degrees, in the period up to 2007, changes in financial markets led to credit playing a greater role in the evolution of the house price to rent ratio. After that, when many of these countries experienced difficulties in their financial sectors, the resulting deleveraging which took place caused credit conditions to have a reduced impact on the ratio.

5.   Concluding Comments

Using a new dataset combining cross-country housing and mortgage market information, this paper empirically examines the impact of credit, alongside the user cost of capital, on the house price to rent ratio. Movements in this ratio, which is an important metric in assessing the stability or otherwise of property market developments, have until recently been examined solely using the user cost of capital as its determinant. The results presented here, in the first instance, establish the relevance of both variables to the relative movement of house prices and rental values over time. These findings, at an aggregate, cross-country level, are in line with the literature that uses microeconomic data, which typically finds that changes in credit markets have a significant impact on tenure choices across markets.

The panel estimates, however, also suggest some variation in the relative importance of both variables to the house price to rent ratio depending on the econometric methodology used. The next step undertaken then was to look at regression results for individual countries and to assess differences between them. At the country level, the credit variable is usually found to dominate the user cost of capital in explaining the house price to rent ratio. Its influence is at its strongest before the credit crisis of the late-2000s, a period when many national housing markets also experienced considerable disruption. The introduction of the euro coincides with observations that were particularly influential on the house price to rent ratio for many of the European countries in the dataset, while the period of financial crisis in the late 2000s was one when influential observations arose for the North American countries, the UK and Australia.

This finding that credit conditions can have a critical influence on housing market variables and tenure choice is of relevance to macroprudential policy, which is becoming increasingly popular as a means of tempering house price inflation and influencing market developments more generally. Our results indicate that insofar as central banks and regulatory authorities can control credit availability for house purchase, doing so can have an effect on households' tenure choice. While financial stability issues are the primary consideration in the application of macroprudential policy, the results in this paper emphasise that policy-makers should be aware of the broader implications of such measures, including in the housing market.

References

[1] Acolin A., Bricker J., Calem P. and S. Wachter (2016), "Borrowing Constraints and Home-ownership over the Recent Cycle", *American Economic Review*, Volume 106, Issue 5, pp. 625, pp. 625-629.

[2] Bernanke, B. Bertaut, C. DeMarco, L. P. and S. Kamin (2011). International Capital Flows and the Returns to Safe Assets in the United States, 2003-2007. Board of Governors of the Federal Reserve System, International Finance Discussion Papers No. 1014, February; www.federalreserve.gov/pubs/ifdp/2011/1014/ifdp1014.pdf

[3] Bičáková A. and E. Sierminska (2007). Homeownership inequality and the access to credit markets. Can credit availability explain cross-country differences in the inequality of homeownership across income of young households?, LWS Working papers 5, LIS Cross-National Data Center in Luxembourg.

[4] Blackey D.M. and J.R. Follain (1995). In search of empirical evidence that links rents and user costs, NBER working paper No. 5177.

[5] Borio, C. and Disyatat, P (2011). Global Imbalances and the Financial Crisis: Link or No Link? BIS Working Paper No. 346, Bank for International Settlements, May.

[6] Breitung, J. (2000): The Local Power of Some Unit Root Tests for Panel Data, in: B. Baltagi (ed.), *Nonstationary Panels, Panel Cointegration, and Dynamic Panels, Advances in Econometrics, Vol. 15*, JAI: Amsterdam, pp. 161-178.

[7] Browne F., Conefrey T. and G. Kennedy (2013). Understanding Irish house price movements - a user cost of capital approach, *Central Bank of Ireland Research Technical Paper* 4/RT/13.

[8] Bruno, V. and Shin, H. S. (2012a). Capital Flows, Cross-Border Banking and Global Liquidity. Working paper, Princeton University, March 15.

[9] Bruno, V. and Shin, H. S. (2012b). Capital Flows and the Risk-Taking Channel of Monetary Policy. Working paper, Princeton University, July 6.

[10] Campbell S. D., Davis M.A., Gallin J. and R. F. Martin (2006). A trend and variance decomposition of the rent-price ratio in housing markets, Finance and Economics Discussion Series 2006-29, Board of Governors of the Federal Reserve System (U.S.).

[11] Chiuri M. and T. Jappelli (2003). "Financial market imperfections and home ownership: A comparative study". *European Economic Review*, 2003, vol. 47, issue 5, pp. 857-875.

[12] Cronin D. and K. McQuinn (2016). "Credit availability, macroprudential regulations and the house price to rent ratio". *Journal of Policy Modeling*, 38, pp. 971-984.

[13] Diaz, A. and M.J. Luengo Prado (2012). Homeownership: Economic benefits in: Susan J. Smith, Marja Elsinga, Lorna Fox O'Mahony, Ong Seow Eng, Susan Wachter, Richard K. Green, editors. International Encyclopedia of Housing and Home, Vol 2. Oxford: Elsevier; 2012. pp. 439-445.

[14] Duca J., Muellbauer, J. and Murphy, A. (2011). "House prices and credit constraints: Making sense of the U.S. experience", *Economic Journal*, Royal Economic Society, vol. 121(552), pp. 533-551, 05.

[15] ECB (European Central Bank) (2003). Structural factors in the EU housing markets, Working paper, March.

[16] European Systemic Risk Board (2014). Reports of the Advisory Scientific Committee, Is Europe overbanked? No. 4/June.

[17] Fernandez-Corugedo, E. and J. Muellbauer.(2006). Consumer credit conditions in the U.K. Bank of England Working Paper 314.

[18] Gallin, J. (2008). "The long-run relationship between house prices and rents," *Real Estate Economics*, vol. 36, no. 4, pp. 635-658.

[19] Gourinchas, P. (2012). Global Imbalances and Global Liquidity. Prepared for the 2011 Asian Economic Policy Conference of the Federal Reserve Bank of San Francisco, 2012.

[20] Hadri K. (2000). "Testing for stationarity in heterogeneous panels." *Econometrics Journal*, vol.3, pp. 148-161.

[21] Himmelberg. C., C Mayer and T. Sinai (2005). Assessing high house prices: Bubbles, fundamentals, and misperceptions, Federal Reserve Bank of New York Staff Report No. 218, September.

[22] Im, K., Pesaran, Hashem, M. and Y. Shin (2003). "Testing for unit roots in heterogeneous panels," *Journal of Econometrics*, 115 (2), 53-74.

[23] Kao, C. and M. H. Chiang. (2000). "On the estimation and inference of a cointegrated regression in panel data," *Advances in Econometrics*, 15, 179-222.

[24] Kelly R. and K. McQuinn (2014). "On the hook for impaired bank lending: Do sovereign-bank inter-linkages affect the net cost of a fiscal stimulus?" *International Journal of Central Banking*, Volume 10, Number 2, pp. 95 - 128.

[25] Kennedy G. and K. McQuinn (2011). Scenarios for Irish house prices, Central Bank of Ireland *Economic Letter*, Number 2.

[26] Kim Y. (2007). Rent-price ratios and the earnings yield on housing, Unpublished manuscript, University of Southern California.

[27] Mark, N. and D. Sul (2003). "Cointegration Vector Estimation by Panel DOLS and Long-run Money Demand," *Oxford Bulletin of Economics and Statistics*, 65(5), pp. 655-680.

[28] McCarthy Y. and K. McQuinn (2017). "Credit conditions in a boom and bust property market: Insights for macro-prudential policy". *The Quarterly Review of Economics and Finance*, Volume 64, pp. 171-182, May.

[29] Murphy, A. (2005). Modelling Irish house prices: A review and some results, mimeo, December. http://www.nuff.ox.ac.uk/Users/MurphyA/Irish$%$20House$%$20Prices.zip

[30] Obstfeld, M. (2012). "Does the Current Account Still Matter?" *American Economic Review*, 2012, 102(3), pp. 1-23.

[31] Pedroni, P. (1999). "Critical values for cointegration tests in heterogeneous panels with multiple regressors," *Oxford Bulletin of Economics and Statistics*, 61 (Supplement 1), pp. 653-670.

14

[32] Pedroni, P. (2004). "Panel Cointegration; Asymptotic and Finite Sample Properties of Pooled Time Series Tests with an Application to the Purchasing Power Parity Hypothesis," *Econometric Theory*, 20, pp. 597-325.

[33] Shin, H. S. (2012). Global Banking Glut and Loan Risk Premium. Working paper, Princeton University, January.

[34] Trucchi S. (2016), "Credit markets and housing choices", *Bulletin for Economic Research*, Volume 68, Issue S1, December, pp. 1-19.

15

Table 1: Summary of Data: 1994Q4 - 2015Q1

	Interest Rates	House Prices	Price to Rent	Unemployment	Household Credit to GDP	Rates Classification
Germany	3.9	97.2	108.7	8.1	63.3	F
France	4.2	74.7	82.8	9.4	42.4	F
Italy	3.9	80.8	91.2	9.4	30.9	V
US	4.4	94.7	102.6	6.0	80.3	F
GB	3.8	77.1	82.5	6.3	78.5	V
Australia	5.0	68.3	80.3	6.1	88.7	V
The Netherlands	4.1	80.8	90.3	5.4	94.5	F
Sweden	3.2	71.3	76.5	7.5	60.4	V
Norway	4.3	73.8	81.9	3.7	67.9	V
Finland	2.7	77.8	83.9	9.5	45.1	V
New Zealand	5.5	77.2	81.8	5.6	73.9	F
Ireland	2.9	88.8	98.5	8.5	72.9	V
Canada	3.0	73.8	78.9	7.6	72.9	V
Spain	3.0	69.6	81.7	16.0	60.4	V
Denmark	4.3	80.1	90.2	5.6	106.1	F

Note: Interest rates, unemployment and credit to GDP are in percentages. Price to rent and house prices are in index form. House prices and the price to rent ratios = 100 in 2010. "F" refers to fixed and "V" refers to variable interest rates. Entries in the first five columns are averages over the period.

Table 2: Panel Unit Root Test Results

	Variable		
Test	$hp_t/rent_t$	$RUSER_t$	$ACRED_t$
Im, Pesaran & Shin (2003) ADF	-1.315	-1.465	-0.195
	(0.094)	(0.071)	(0.422)
Breitung (2000)	-0.221	-0.564	-0.244
	(0.413)	(0.286)	(0.403)
Hadri (2000)	865.31	324.41	1086.92
	(0.00)	(0.00)	(0.00)

Note: P-values are in parentheses.

Table 3: Panel Cointegration Test Results

Tests	Statistic	Critical Value
panel v-stat	-1.53	27.01
panel rho-stat	2.34	-27.65
panel pp-stat	2.28	-43.73
group rho-stat	3.85	-53.01
group pp-stat	3.71	-82.11

Note: Panel-v is a non parametric variance ratio statistic; Panel-rho and panel-pp are analogous to the nonparametric Phillips-Perron rho- and t-statistics. Group rho, is analogous to the Phillips-Perron rho-statistic, while Group-pp is analogous to the Phillips-Perron t-statistic.

Table 4: House price to rent model

			Estimator	
		$Dependent\ Variable:\ l(hp_t/rent_t)$		
Variable	OLS	Fixed Effects	Random Effects	Panel FM
Constant	4.35		1.56	
	(110.63)		(9.24)	
$RUSER_t$	-0.03	-0.01	-0.01	-0.01
	(-11.43)	(-7.69)	(-7.82)	(-1.81)
$ACRED_t$	0.05	0.99	0.98	1.08
	(3.73)	(36.66)	(36.48)	(26.60)
F-Test		(0.000)		

Note: Estimation is with quarterly data covering the period 1994Q4 to 2015Q1 and T-Stats are in parentheses. The F-Test is for the null hypothesis that the country specific dummies are insignificantly different from 0.

Figure 1

Coefficient of Variation for Price to Rent Ratios: 1994:4 - 2015:1

Figure 2

Coefficient of Variation for Nominal House Prices: 1994:4 - 2015:1

Figure 3

Coefficient of Variation for Household Credit to GDP: 1994:4 - 2015:1

Figure 4

Full sample OLS coefficient estimates – country by country

RUSER

ACRED
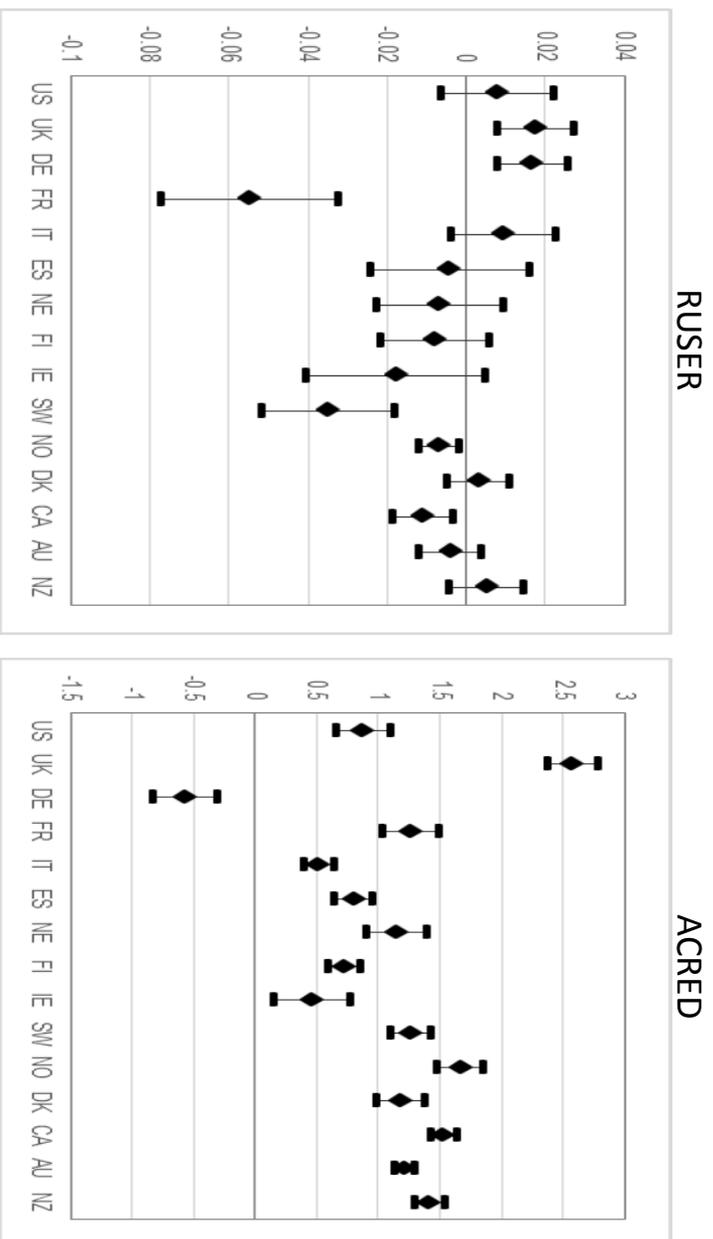
Note: Diamonds represent coefficient values for each country and the width of the lines extending from the diamonds are +/- two standard errors of the coefficient estimate.

Figure 5a

Leverage measures – country-by-country

US

UK

DE

FR

IT

ES

NE

FI
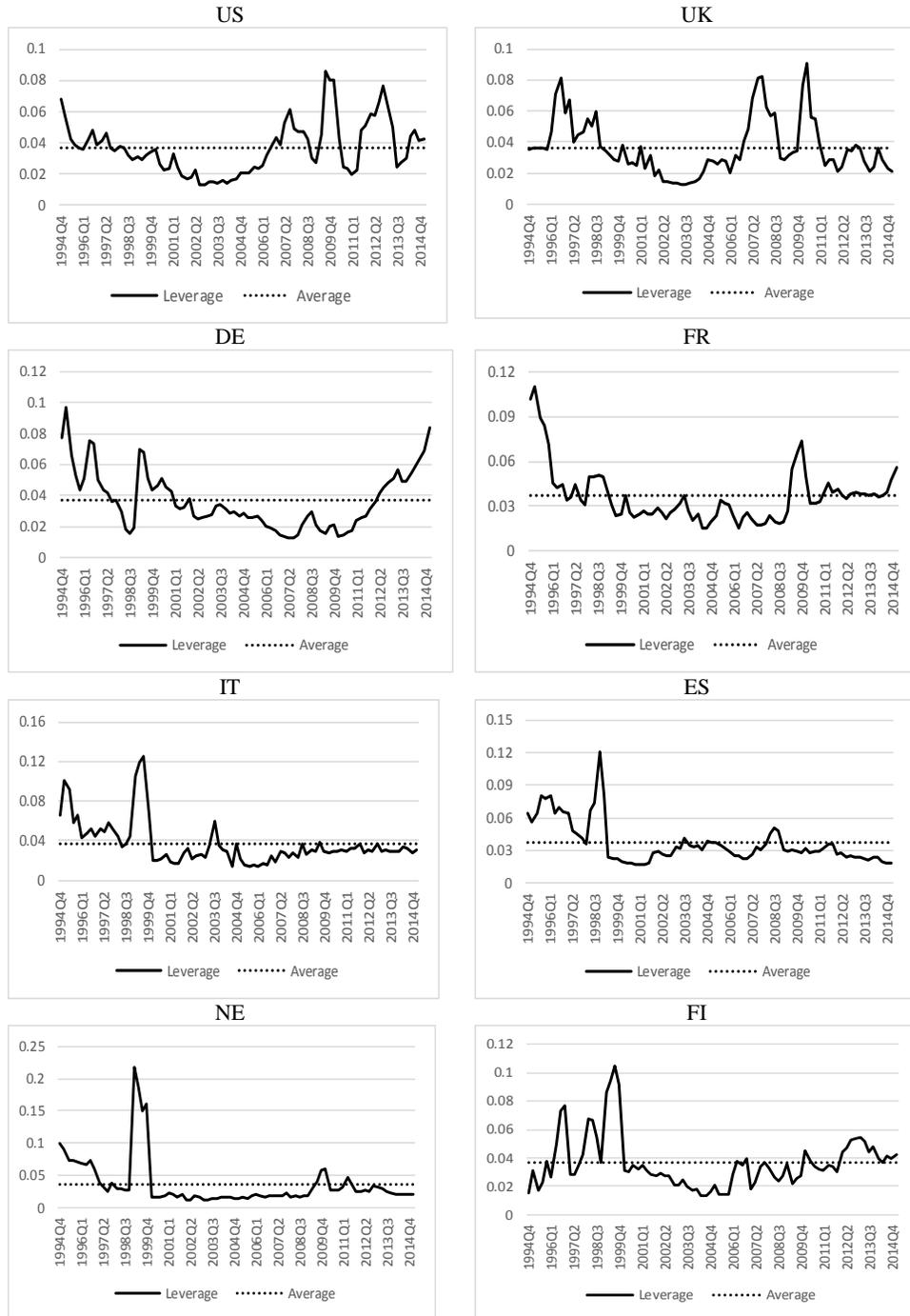
Figure 5b

Leverage measures – country-by-country
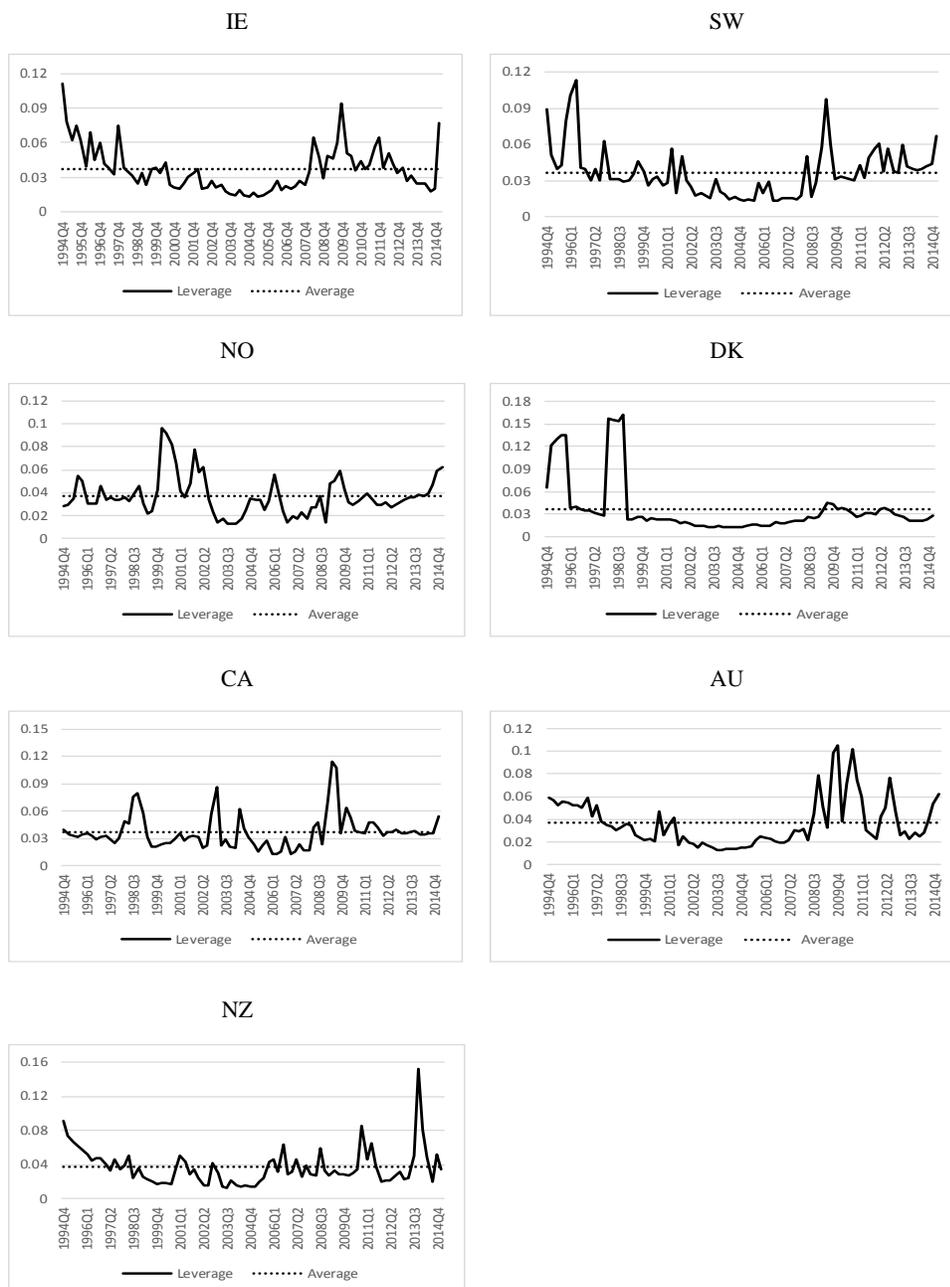
Figure 6a.

Recursive regression coefficient values – country-by-country
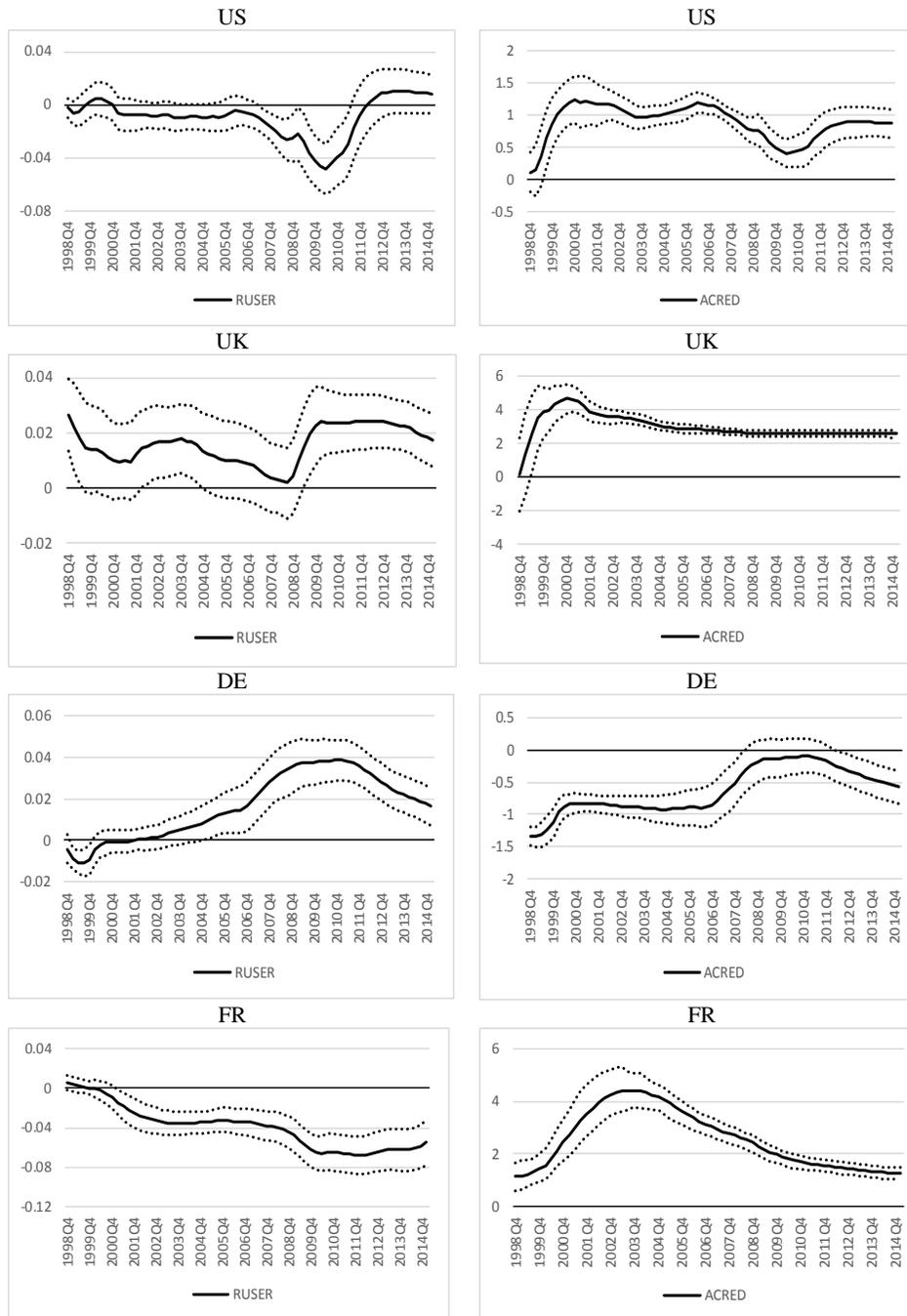
Figure 6b

Recursive regression coefficient values – country-by-country
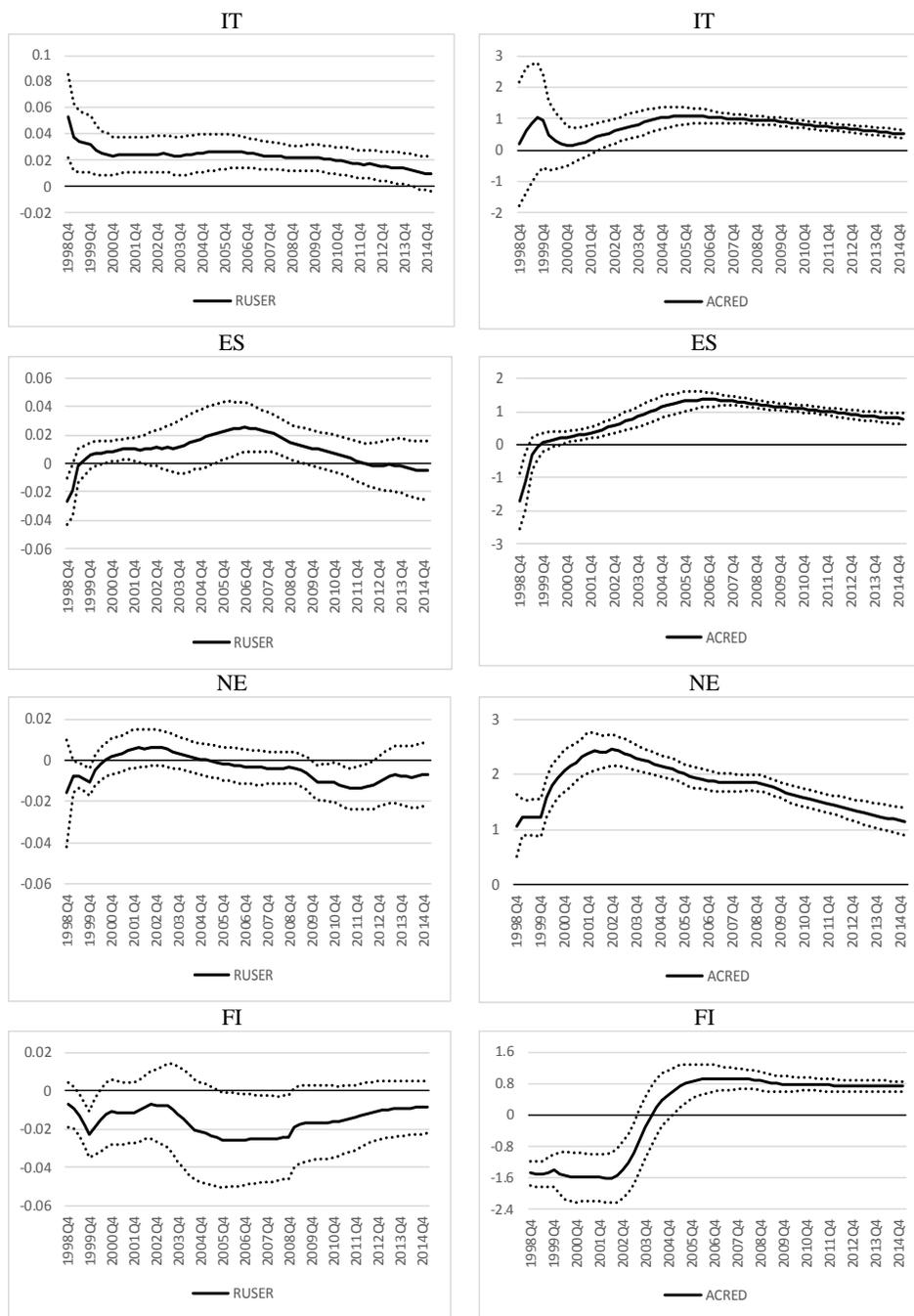
Figure 6c

Recursive regression coefficient values – country-by-country
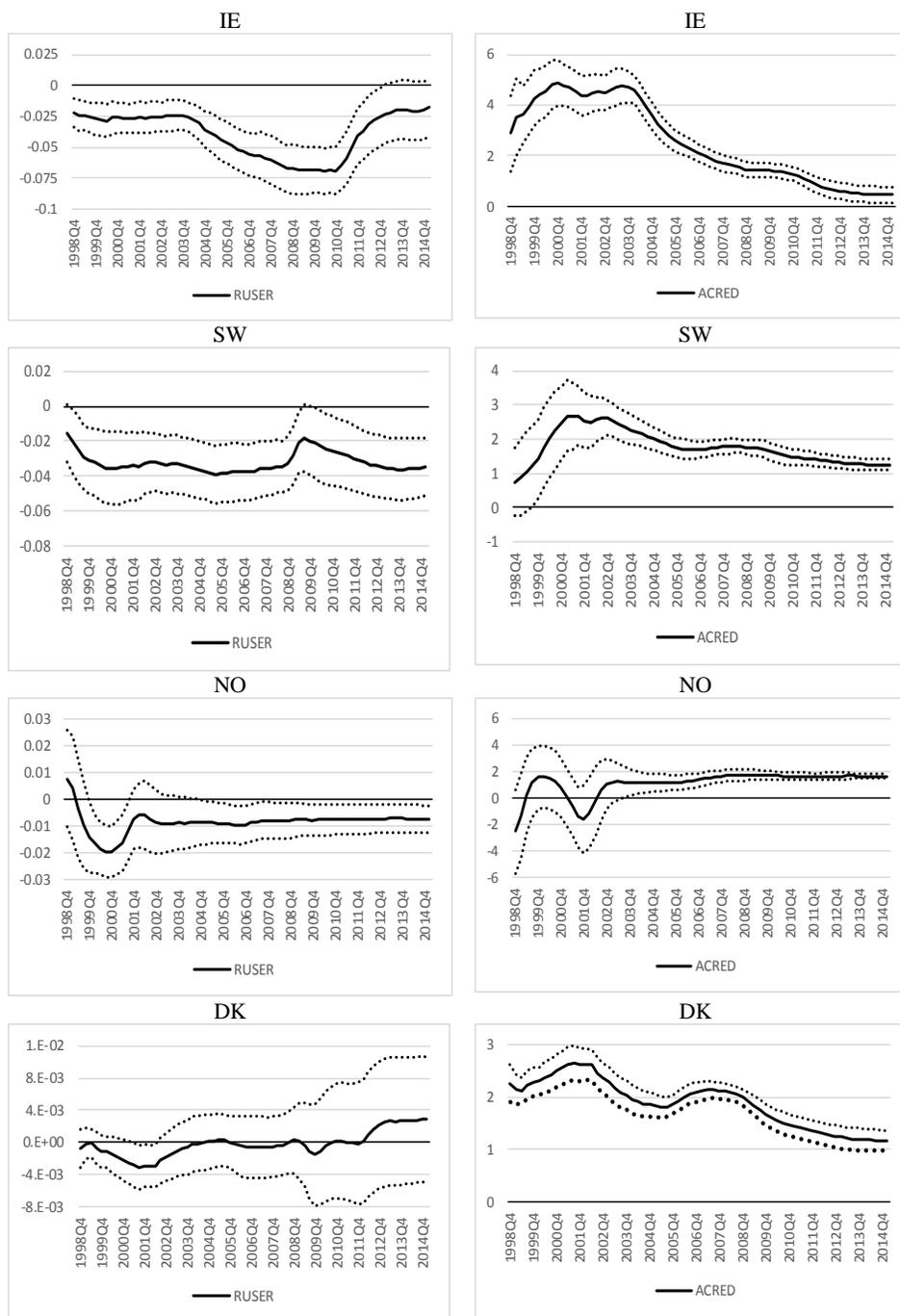
Figure 6d

Recursive regression coefficient values – country-by-country

CA

CA

AU

AU

NZ

NZ
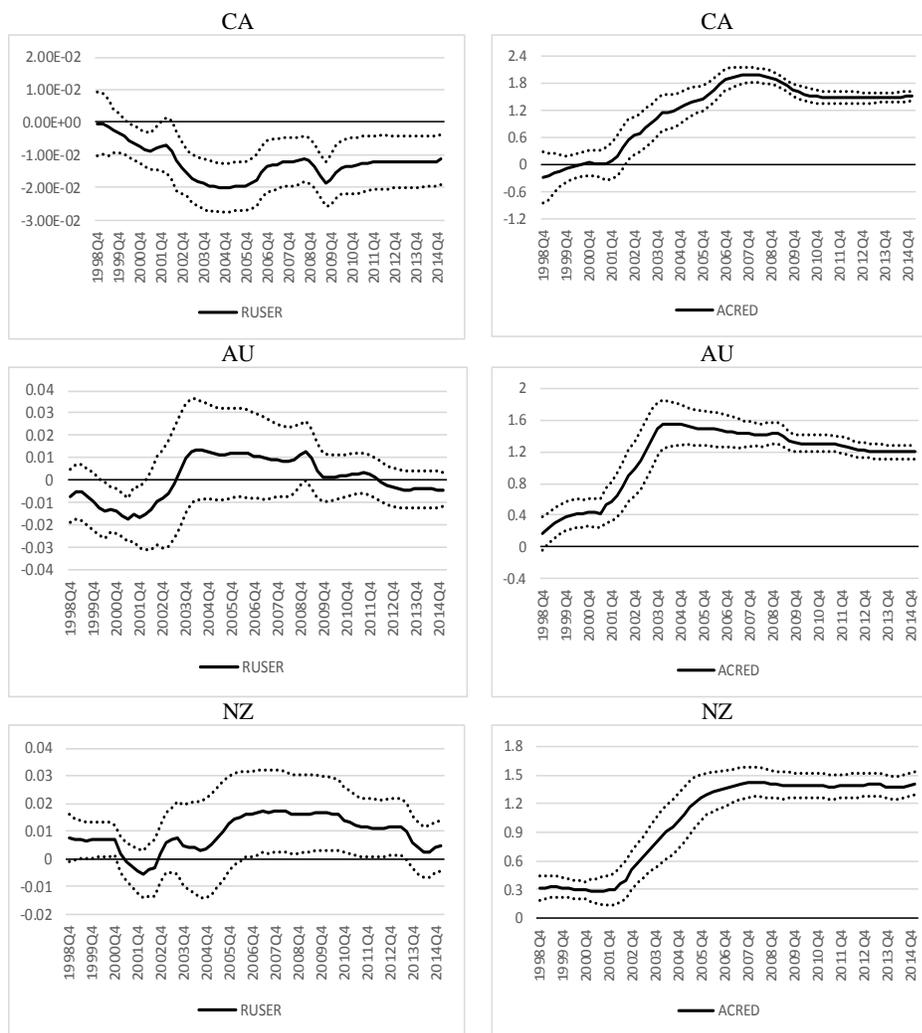
Note: dotted lines are 2-standard error bands

Year	Number	Title/Author(s)
2017		
	581	The cyclicality of Irish fiscal policy ex-ante and ex-post *David Cronin and Kieran McQuinn*
	580	Determinants of power spreads in electricity futures markets: A multinational analysis *Petr Spodniak and Valentin Bertsch*
	579	Gifts and inheritances in Ireland *Martina Lawless and Donal Lynch*
	578	Anglers' views on stock conservation: Sea Bass angling in Ireland *Gianluca Grilli, John Curtis, Stephen Hynes and Paul O'Reilly*
	577	The effect of Demand Response and wind generation on electricity investment and operation *Sheila Nolan, Mel Devine, Muireann Á. Lynch and Mark O'Malley*
	576	Determinants of residential heating system choice: an analysis of Irish households *John Curtis, Daire McCoy, Claudia Novielli*
	575	Estimating, and interpreting, retirement income replacement rates *Alan Barrett and Sanna Nivakoski*
	574	Sea bass angling in Ireland: A structural equation model of catch and effort *Gianluca Grilli, John Curtis, Stephen Hynes and Paul O'Reilly*
	573	Ireland's international trade and transport connections *Martina Lawless and Edgar Morgenroth*
	572	Do youth access control policies stop young people smoking? Evidence from Ireland *Michael Savage*
	571	The impact of investment in innovation on productivity: firm level evidence from Ireland *Mattia Di Ubaldo and Iulia Siedschlag*
	570	The value of tourist angling: a travel cost method estimation of demand for two destination salmon rivers in Ireland *Gianluca Grilli, John Curtis, Stephen Hynes and Gavin Landgraf*
	569	Advertising and investment spillovers in the diffusion of residential energy efficiency renovations *Matthew Collins and John Curtis*
	568	Working at a different level? Curriculum differentiation in Irish lower secondary education *Emer Smyth*
	567	Identifying rent pressures in your neighbourhood: a new model of Irish regional rent indicators *Martina Lawless, Kieran McQuinn and John R. Walsh*

For earlier Working Papers see http://ww.esri.ie