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Structural credit ratios

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Abstract

This paper studies the relation between the credit-to-GDP ratio and macroeconomic trends. We estimate a long run equation on a sample of EU countries; our findings suggest that the macroeconomic factors with which the credit ratio associates most strongly are economic development, the investment share in GDP, and inflation. We then obtain projections for past and future trends. First, we study the evolution of the credit ratio in the past. We find that most of the increase starting in 1985 is associated with economic development and falling inflation, while the decrease of investment may have slowed down this trend. Second, we offer a forward-looking estimate of the structural credit ratio, defined as the long run, or sustainable, component. We offer band estimates based on two alternative assumptions on future economic outcomes, which can be interpreted as a structural and a cyclical view of current macroeconomic dynamics. Estimates of structural credit ratios based on this method are useful to policy makers having to decide on the activation of the countercyclical capital buffer, especially when assessing the sustainability of credit growth.

Keywords: Equilibrium credit; Credit gap; Macro-prudential analysis; Long run modelling.

JEL classification: E51, G01, E44.

1 Introduction

Since the end of World War 2, excessive credit growth is associated with financial instability. However, while many crises are preceded by credit booms, not all credit booms are followed by financial crises (Gourinchas, et al., 2001; Reinhart & Rogoff, 2008; Schularick & Taylor, 2012). One reason is that fast credit growth may come without the emergence of financial imbalances when financial and economic systems are developing fast. Strong growth rates can be observed not only during cycles, but also when the long run component is shifting. Thus, for crisis prediction and activation of corrective policies, the level of credit relative to its trend has been shown to be superior to growth rates according to measures of signalling quality such as the noise-to-signal ratio and the AUROC curve (Borio & Lowe, 2002; Drehmann, et al., 2011; Detken, et al., 2014).

In these works, the identification of the long run trend is achieved by techniques based on univariate filtering. The BIS proposes the Hodrick-Prescott filter as a guide to set the counter-cyclical capital buffer, applied to the ratio of private credit to GDP and calibrated to match the average length of financial cycles. The distance from the filtered series is a useful common reference guide for taking buffer decisions (BCBS, 2010). In the credit-to-GDP gap guide, the BIS cautions that the credit-to-GDP gap does not always work well in all jurisdictions and all times. In particular, sudden structural changes may result in the credit-to-GDP gap sending misleading signals. This is because the filtering approach is purely statistical and does not take into account structural changes shifting the trend.

An early warning literature analyses the real and financial outcomes which are most often associated with vulnerability in financial markets (Kaminsky, et al., 1998; Bussiere & Fratzscher, 2006; Alessi & Detken, 2011). The approach in these studies is to identify patterns indicative of financial imbalances and produce warning signals based on short-run indicators.

In this paper, we take the reverse approach. We identify economic patterns historically associated with financial development and credit sustainability. We empirically test the existence of a long run relationship between these factors and aggregate credit. The existence of a common trend allows us to estimate the long run level of aggregate credit based on economic theory. Deviations from the long run trend can be interpreted as inconsistent with long run equilibrium, therefore signalling imbalances.

For the selection of factors which matter for credit in the long run, we draw from the financial development literature. Studies of the determinants of size, efficiency and technology of financial markets find that among the most important factors in explaining country differences in financial development is economic and social development (Robinson, 1952; Guiso, et al., 2004; Huang, 2011). Furthermore, the macroeconomic outcomes which typically accompany economic development, such as competition and financial integration, are also found to support financial development (Rajan & Zingales, 2003). Finally, if higher income associated with GDP growth reduces the vulnerability to adverse shocks, then growth allows agents to borrow more as a proportion of income.

The long run component of the ratio of private credit to GDP is often used as a measure of financial depth in studies of the interaction between financial development and growth. A positive correlation between the depth of credit markets and long run growth supports the view that economic and financial development are mutually reinforcing (King & Levine, 1993; Rajan & Zingales, 1998; Levine, 2005).

Even after controlling for economic development, large differences in financial depth persist across countries. Some of this difference is due to institutions. Property rights, accounting systems, and political and social structures that facilitate the development of financial markets go some way in explaining residual differences (La Porta, et al., 1998; Beck, et al., 2003; Pagano & Volpin, 2005).

Other macroeconomic factors are important for financial development independently of the current level of economic development. An important one is inflation. Inflation correlates negatively with financial market activity in the long run. If an important function of finance is to allocate resources to their most productive use, a high inflation environment hinders allocative efficiency by increasing uncertainty around the identification of profitable opportunities (Huybens & Smith, 1999; Boyd, et al., 2001).

Moreover, the share of investment in GDP is positively correlated with financial development in the long run. The direction goes both ways, with investment generating demand for financial intermediation, and financial markets channelling financial resources towards productive uses. Investment also makes indebtedness more sustainable thanks to its effect on future growth (Huang, 2005).

A number of studies use a long run approach and estimate the structural level of credit based on common trends. This approach has been especially important in the study of transition countries, where swift structural changes complicate the interpretation of growth rates as crisis signals (Cottarelli, et al., 2005; Ègert, et al., 2006; Kiss & Nagy, 2006). In advanced countries, some applications of this long run approach have focused on a specific segment of the credit market, the household sector (Albuquerque et al, 2014; Hannes-Lang Weltz, 2017). While focusing on the household sector is useful given the role of housing markets in recent crises, broader macroeconomic equilibria may be missed if the variables considered are specific to a subset of the market.

Other papers disentangle long and short run credit dynamics on the basis of macroeconomic factors associated with deeper financial markets (Cerutti, et al., 2017; Chen, et al., 2017). In these works, an important theme is the tension between the long term objective of increasing access to finance and the short term objective of avoiding credit booms. Finally, (Hofmann, 2001) shows empirically the importance of asset prices for aggregate credit in the long run.[2]

2 Data

The focus is on EU countries in order to work on a relatively homogenous sample in terms of institutions and other legal and cultural factors, which may affect the relationship between credit and the macro-economy. We work on two samples. The full sample includes 19 countries for which BIS credit data are available. A restricted sample comprises 14 countries with at least 20 years of data. This results in an unbalanced panel in which the shorter time span is Q1 1997 - Q4 2016 and the longest is Q4 1968 – Q4 2016. In a later section, we show that results do not change when including the countries with shorter time series.

To capture the concepts highlighted in the literature, we select the following variables.[3] Credit series are from the BIS; real GDP per-capita and the share of investment in GDP are from the World Bank; the interest rate and inflation are from the AMECO database; house prices are from the OECD. Interest rates for Norway are from the Norges Bank. Irish data on investment, GDP and credit are from the Central Bank of Ireland and the Central Statistics Office.[4]

Private credit includes credit from all reporting lenders to households and non-financial corporations (Dembiermont, et al., 2013). Figure 1 depicts the ratio of private credit to GDP (GNI* for Ireland). In some instances, such as Italy, Portugal and Sweden, the credit ratio decreased before 1985, coinciding with a period of high inflation. Between 1970 and 2016, the credit ratio increased in all countries in the sample, most notably

[2] Models where financial frictions are attenuated by the use of collateral generate a relationship between asset prices and credit in the steady state. See Kiyotaki and Moore, 1997.
[3] Other factors were considered, such as the structure of the financial system, but were excluded since estimation showed them irrelevant.
[4] These data are modified to exclude the impact of multinational corporations on Irish national accounts.

from 1990 onwards. In the countries hit hardest by the recent crisis, credit ratios decreased since approximately 2010.

In order to identify general structural changes in the economies in the sample, Figure 2 to Figure 6 show the minimum, median and maximum value of the demeaned macroeconomic variables at each point in time.[5] In Figure 2, median growth of real GDP per-capita is approximately 40% between 1970 and 2008; growth is nil, or negative, for the most recent period. Figure 3 shows demeaned inflation rates from the GDP deflator. Inflation increases in all countries between 1970 and 1975, stays relatively constant and high until approximately 1982, then decreases to levels well below the average in the recent period.

Figure 4 shows nominal short term interest rate. This increases in the first part of the sample and decreases since 1980. This largely reflects the decrease in inflation and the convergence before the launch of the euro. The fall of the interest rate starts later, in 1995, in Greece. Figure 5 depicts the share of investment in GDP. The share has decreased throughout the sample period, but the fall is faster in the first half of the sample. Finally, Figure 6 shows real residential property price index with base year 2010. A dramatic increase of this index is apparent in all countries over the period, part of which may be cyclical.

In the next section, we establish the empirical framework which will be used in later sections to tie these macroeconomics trends to the structural level of credit.

3 Empirical approach

Adjusted Dickey-Fuller tests for unit roots in panels reveal that four of the selected variables are integrated of order one. These are the credit ratio, GDP per capita, the interest rate and the house price measure. Inflation and the investment ratio are stationary.

To ascertain cointegration amongst the non-stationary variables, we proceed in two steps. First, we run Johansenn cointegration tests on individual panels. The results indicate that 10 countries out of 14 have one cointegrating vector. Second, we run panel cointegration tests where the null hypothesis is no cointegration with the same cointegrating vector across panels. The null hypothesis is rejected at the 5% significance

[5] These statistics concern the restricted sample.

level. This means that we can estimate a single cointegrating vector with common coefficients for all countries, allowing for panel-specific constants.

A panel setting gives an important advantage in comparison to individual time series analysis, owing to data limitations. Estimating long-run relationships requires long time series, which are not always available. Pooling the data reduces the bias associated with structural breaks in the individual series.[6] Fixed effects control for time-invariant country specific characteristics, such as the legal system and other slow-moving institutions.

Given our focus on the long run as opposed to adjustment dynamics, we assume that only credit can adjust to the common trend. This choice permits to estimate a parsimonious model and is consistent with standard economic models of the determinants of macroeconomic variables in the long run.

We select the number of lags in the autoregressive distributed lag representation based on the Akaike's information criterion (AIC), the Bayesian information criterion (BIC), and the Hannan and Quinn information criterion (HQIC). The tests are run separately for each country. For 11 panels, all three tests indicate two lags are appropriate; two out of three tests select two lags in the remaining 3 countries. Based on these results, we estimate an ARDL(2,2) in error correction form to ensure appropriate inference on the OLS estimates.

The estimated error-correction coefficient confirms the presence of cointegration. The adjustment coefficient suggests that the credit ratio adjusts towards the common trend by 2.3% per quarter. There is no autocorrelation in the residuals. Due to the presence of heteroscedasticity, we use Newey-West standard errors.

4 Results

Results are presented in Table 1. Real GDP is the most relevant variable in explaining the long-run credit ratio. In column 1, GDP explains 19% of the within variation of the dependent variable in the error correction model. The coefficient is stable when controlling for the other macroeconomic factors. A 10% increase in GDP per capita is associated with an increase in the credit ratio by 25 percentage points. To put this in perspective, the change in average GDP per capita between the decade starting 1990 and the period 2010-2016 ranges between 3% in Italy and 32% in Poland. Our estimates

[6] This is standard in the literature on real-financial interactions (see for example Chen et al., 2017)

suggest that the long run component of the credit ratio associated with this growth has increased by approximately 7 percentage points in Italy, and 80 percentage points in Poland during this period.

The credit ratio is significantly related to the interest rate in column 2. Controlling for inflation reduces the statistical significance of the nominal interest rate coefficient in column 3, although the magnitude remains unchanged. Controlling for investment in column 4 permits to identify the relation between credit ratio and inflation. The magnitude of the interest rate coefficient in column 4 is largely reduced and the estimate is not statistically significant. This suggests that the interest rate matters for the credit ratio through the investment channel.[7]

Inflation is important over and above the level of investment. If allocating resources towards their most productive use is easier in low inflationary environments, then a higher level of credit is sustainable for any level of aggregate investment. The estimated coefficient suggests that for a median country like Sweden, where inflation decreased by 2.2 percentage points between the decade starting 1990 and the period 2010-2016, the structural credit ratio has increased by approximately 15 percentage points. In contrast, in a high-inflation country, such as Hungary, which reduced its price growth by 16.9 percentage points since 1990, the structural component of the credit ratio associated with inflation has risen by over 110 percentage points.[8] For a country where inflation was already low and decreased by 0.39 percentage points, such as Germany, the structural component of the credit ratio increases by 2.6 percentage points.

The investment ratio is an important variable in explaining the long-run dynamics of the ratio of credit to GDP, both statistically and economically. The estimated coefficient suggests that a 1 percentage point increase in investment is associated with an increase of the credit ratio by 11.5 percentage points. This is a large, but not implausible effect, if one considers the small variation in investment ratios over time. A decrease of investment by 2.5 percentage points of GDP, the median change between the decade starting in 1990 and the period 2010-2016, is associated with a decrease in the credit ratio by 28 percentage points. In only two countries, changes of investment are above 5

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[7] When the estimated equation excludes inflation but includes the interest rate, investment ratio and GDP, then the interest rate is significant. This suggests that it is only capturing inflation. In the model in column 3, inflation is not significant because its effect is counteracted by the opposite effect of investment (which is positively correlated with inflation).

[8] For reference, the credit ratio has increased by approximately 100 percentage points in Hungary over this period.

percentage points of GDP (in absolute value) over this period. These countries, Greece and Portugal, had a dramatic decrease in investment during the crisis.

The credit ratio is positively associated with real house prices, though statistical significance is weak. An increase in the real house price index by 10% is associated with an increase in the credit ratio by 4 percentage points.[9] The median change since the 1990 decade is 37%. This is associated with an increase in the structural level of credit by 15 percentage points.

In Table 2, we show the estimates obtained from the restricted sample, with only countries for which there are long time series available.[10] All the coefficients are statistically not different from those estimated on the full sample.

One difference is that property prices are not significantly different from zero in the restricted sample. The instability of the statistical significance of property prices is also evident from a cross-validation exercise reported in Table 3. The model in column 5 of Table 1 is estimated 19 times, each time removing one country. The estimates confirm that the results are not driven by any individual country. Whether property price coefficient estimates are statistically different from zero depends on the sample; however, there is no statistical difference between the coefficients across the columns in Table 3.

In summary, GDP, inflation and the share of investment in GDP are the most important factors explaining the variation in the ratio of credit to GDP in the long run. In a later section, we put together the structural changes in these variables, broadly described in Section 2, with our model estimates, to illustrate how countries' long run evolution of the credit ratio matches the evolution of these macroeconomic factors. Before doing that, we perform additional robustness checks in the next section.

5 Robustness

In this section, we estimate alternative specifications aimed at ensuring that the assumed structural form is appropriate. We start by studying the ability of the model to fit the data compared to a benchmark trend. Then, we study whether the assumed linear relationship is appropriate. We do this in two stages. First, we test whether the relationship with the selected variables captures other, unobservable factors. Second,

[9] Base year of the index is 2010.
[10] At least 20 years of data must be available for inclusion in the restricted sample.

we test for a form of non-linearity in the coefficients; in particular, allowing the coefficients to vary over time and across countries in accordance with the extent of international financial integration.

In column 1 of Table 4 are reported the estimates of a model where the long run component of the credit ratio is approximated by a linear trend; short run dynamics identical to the original model are also in the estimated equation, to allow direct comparison. The trend implies growth of the credit ratio by 2 percentage points a year, with adjustment of deviations from trend by 1% every quarter. This basic model explains 19% of the within variation and 22% of the total variation in the dependent variable. Compared with column 2 where our preferred model is reproduced, the latter increases the explained within variance by 7 percentage points, or 37% more than the linear trend. The explained variance does not increase when we add the linear trend to the preferred model in column 3.

Column 4 reports estimates of a model including time fixed effects. While these effects increase the fit substantially, they do not affect the estimated coefficients. Thus, the selected variables are not capturing common time-varying factors correlated with them. However, the GDP coefficient is no longer statistically significant. This is not surprising, since economic development, as well as financial development and the other concepts captured by real GDP per-capita, tend to occur in waves, introducing collinearity with the time effects. Given our interest in creating projections for the credit ratio, our preferred model remains the one estimated in column 2.

A major structural change in financial systems in the recent past has been international financial integration (Lane & Milesi-Ferretti, 2007 and 2017). The long run relationship between credit and the macro-economy could change as the economy becomes more financially integrated with the rest of the world, to the extent that financial openness reduces the link between domestic saving and investment. This can occur through both capital inflows and outflows. On the one side, capital inflows can fuel domestic credit growth.[11] On the other side, capital outflows may reduce available savings if the wider investment opportunities granted by access to global markets divert domestic savings into foreign undertakings.

To test the impact of financial integration on our estimated equation, in Table 5 we estimate augmented specifications including a measure of international financial integration, namely external assets plus external liabilities over GDP (Lane & Milesi-

[11] Credit growth is typically associated with debt inflows, gross and net (Calderon & Kubota, 2012; Lane & McQuade, 2013).

Ferretti, 2003). When added alone, this measure is not statistically significant in column 1, and it does not affect the other coefficient estimates. This is a first indication that financial integration does not have a significant impact on domestic credit in the long run. In the remaining columns of the table, we check if it has an effect on the estimated relationships by interacting the international financial integration (IFI) variable with each of the variables in the original model.

Columns 2 to 6 present the estimates of models where each interaction term is included individually; in column 7, all interactions are included simultaneously. The estimates suggest that a non-linearity with GDP and investment exists in columns 2 and 5, but disappears when controlling for other forms of non-linearity in column 7. In this latter model specification, the interaction terms involving the interest rate, inflation and the house price index are significant. However, for the interest rate and the house price index, for which the single (non-interacted) coefficient is not statistically significant, the sum of single and interacted coefficients is also not significant . To see this, we calculated the marginal effects at two values at the extremes of the distribution of the IFI measure: 100% and 500%.[12] The sum of single and interaction coefficients, calculated under both IFI scenarios, are not statistically significant at the 5% level.

Economic significance of the difference between marginal effects is negligible. An increase in the interest rate by 1% is associated with an increase in the credit ratio by 0.2 percentage points in the 100% IFI scenario, and 2 percentage points in the 500% IFI scenario. An increase in the house price index by 10% is associated with a higher credit ratio by 11 and 58 basis points in the 100% and the 500% IFI scenarios, respectively. In the case of inflation, it appears that financial integration reduces the negative relationship. However, the effect is small. The fall in the credit ratio associated with prices rising by 5% yearly is 7.7 percentage points in the 100% IFI scenario, and 4.7 percentage points in the 500% IFI scenario.

The IFI measure captures pure financial integration as well as financial intermediation, i.e. transactions which appear in both the asset and liability sides of a country's balance sheet, but do not pertain to domestic residents. This inflates the IFI measure for financial centres, and could affect the results. To account for this, in column 8 we re-run the non-linear regression excluding Belgium, Ireland, Luxembourg, Netherlands and the United Kingdom. When these countries are excluded, all interaction terms become not

[12] Excluding financial centres, 100 is approximately the median IFI value for the period 1980-2000, the interquartile range for that period being (73-132). Approximately, 500 is the median for the period 2005-2015; interquartile range (288-525).

significant. For completeness and comparison, we run the baseline model on this subsample in column 9. The results are equal to the full sample estimates, which further reassures us on the robustness of the results.

6 Past projections

We now turn to using the estimated relation to illustrate the impact of structural changes on credit trends. In this section, we take a historical perspective and study structural changes of past decades and their association with the development of deeper credit markets. The next section looks at current and future macroeconomic outcomes to provide an estimate of the credit gap.

For past projections, we approximate structural changes in the macroeconomic variables with 10-year moving averages. Before analysing the individual contributions of each macroeconomic factor, we check the reliability of the overall projections by comparing them with an HP filtered series. This is not meant to compare the predictive abilities of the two trends. Our proposed credit gap is based on forward-looking projections and is presented in the next section. Instead, the comparison with the HP filter is aimed at ensuring that the historical decomposition of the trend, which we analyse in the remainder of this section, is based on a model which is consistent with what is generally regarded as a good estimate of the long run trend.[13]

Figure 7 shows the ratio of credit to GDP, the HP filter and the model projections for a selection of countries.[14] The two trends are strongly correlated. Between 1970 and 1985, the trends are flat or decreasing. The increasing part starts between 1985 and 2000, depending on the country. In all economies except the UK, there is an acceleration in both estimates around the year 2000. In the presence of wide boom-bust cycles, both estimates capture some cyclical dynamics: The model projections overstate the trend in the later period in the case of Italy, but in the cases of Ireland, Netherlands and the UK, the projections smooth the cycle better than the HP filter.

Figure 8 depicts the model projection alongside its components. Individual components are rescaled to eliminate the constant, therefore the levels are not meaningful. Differences between points along the lines represent the projected change in structural

[13] The HP filter has drawbacks (Hamilton, 2016). Nevertheless, the cyclical component identified by this filter performs remarkably well in predicting past crises (Drehmann & Tsatsaronis, 2014; ESRB, 2014).

[14] The selection broadly reflects the composition of the overall sample in terms of EA membership, recently distressed economies, size and geographical dispersion. Conditional on this partition, longest times series countries were chosen.

credit associated with the individual factor and orthogonal to the other variables. For instance, between 1984 and 1994 in Italy, falling inflation contributed to an increase of the structural ratio by approximately 70 percentage points. At the same time, falling investment contributed to a decrease of the structural ratio by approximately 50 percentage points. Adding the GDP component, the overall projection increases by approximately 50 percentage points in 1984-1994.

A number of patterns are common to all the countries in Figure 8. The trend was subdued or even negative between 1970 and 1985 due to the high inflationary environment. Most of the increase starting 1985 is associated with economic development and falling inflation. More recently, long-run increases of residential property prices are also contributing to the positive trend. The upward trend has been slowed down by the decrease of the investment ratio.

Overall, economic development is the most stable factor associated with trends in the credit ratio. Structural changes in inflation, investment and house prices are associated with variability in the structural credit ratio. The behaviour of these factors in the future is going to determine the sustainable level of credit. We turn to this issue in the next section.

7 Future projections

The structural level of credit depends on the structural features of the macro-economy. For example, if credit is sustainable conditional on current asset prices, it will not be sustainable if these prices are overvalued. For this reason, it is appropriate to derive structural credit based on structural estimates of the macroeconomic factors.

There are two prevailing views on the current state of European economies, each with its implications for financial stability: the structural and cyclical views (ESRB, 2016a). According to the structural view, growth and interest rates have declined permanently, due to total factor productivity, demographic trends, income and wealth inequality, and a preference for scarce safe assets. In the cyclical view, interest rates declined, partly in response to the recession induced by the global financial crisis, and growth rates are subdued and will gradually return to pre-crisis levels.[15]

To these divergent interpretations, a second layer of uncertainty is introduced by the pro-cyclicality of potential output estimates. Overly pessimistic potential output

[15] See (ESRB, 2016b) for a summary of the evidence for these views and respective references.

estimates during a downturn can have permanent detrimental effects on subsequent growth by exaggerating perceived adjustment needs (Fatás, 2018). Finally, a third important point on the macroeconomic projections applied to the model is that they should be depicting a consistent scenario, where the variables are derived from an internally consistent model.

For these reasons, we suggest using a band estimate for the structural credit ratio, with bounds corresponding to an optimistic and a pessimistic view. A pair of internally consistent estimates for all the variables in our model is provided by the macroeconomic projections in the 2018 EBA stress test exercise. The baseline scenario is an optimistic view of the future, where the economy continues on the current recovery trend. The adverse scenario is a pessimistic view where negative shocks will bring the economy on a recessionary path.

Specifically, in the baseline scenario interest rates remain low, the economy remains on the current trend growth rate, inflation is sustained, residential real estate prices increase only slightly, and the investment share remains constant. In the adverse scenario, interest rates increase, cumulative growth to 2020 is nil or negative, the price level remains relatively constant or decrease; residential real estate prices sharply decrease, and the investment share in GDP falls.

Figure 9 shows the result of bringing these assumptions to the model. Up to 2017, the projection is based on current output, inflation, interest rate, house prices and investment; after 2017, the two lines reflect the two scenarios of the EBA stress test exercise.

Projections up to 2017 can be interpreted as structural credit only to the extent that current macroeconomic conditions are considered structural. In all the selected countries, favourable conditions since 2014 are contributing to an increase in the projection; the point after which the recovery becomes an excessive expansion is uncertain. The adverse scenario can then be interpreted as assuming that the current recovery is excessive; the baseline assumes that the recovery is structural. The adverse scenario is a more conservative view; it minimises missed crises but possibly increases false alarms. Considering both scenarios then gives policy makers guided room for discretion.

In Italy and Ireland, the conclusion is uncontroversial regardless of assumptions: there is room to substantially increase credit in Ireland, whereas in Italy more deleveraging is needed.

In both Denmark and France, the credit ratio is at or below its structural level. In Denmark, deleveraging is ongoing but need not necessarily continue. In France, the slowdown of the positive trend in recent quarters is welcome according to the conservative view. In both countries, there does not seem to be the need for a corrective policy.

In Netherlands and UK, the credit ratio is excessive according to the pessimistic view and not excessive according to the optimistic view. The bands are about 20 percentage points. While we believe a conservative view should be preferred, country specific considerations play a role. The risks to the UK economy owing to the exit from the EU may justify a more conservative view in this country. The decision taken by UK authorities in 2017 to activate the countercyclical capital buffer is consistent with this approach. In the Netherlands, the adverse scenario would mean a credit gap smaller than 10 percentage points; considering the downward path of the ratio in recent years, there may not be the need for policy action in this country.

8 Conclusions

In this paper, we have studied the long run variation in the ratio of aggregate private credit to GDP in conjunction with the macro-economy. We propose a method to estimate structural credit ratios based on an estimated common trend and on structural changes. This means that we can leverage on existing evidence on the state of the economy and derive their implications for the sustainability of aggregate credit.

The method can be used by policy makers when taking policy decisions, for example on the activation of the countercyclical capital buffer. The credit gap proposed here is consistent with macroeconomic modelling and is not subject to the critiques often made to purely statistical filters. The amplitude and length of previous cycles do not impinge upon the accuracy of the estimated trend. Moreover, the model allows understanding the impact of the economic outlook on the trend estimates. Furthermore, this approach enables to identify the contributions of macroeconomic factors to the estimated trend, thereby ensuring a transparent identification of the impact of the assumptions made on the estimated gap.

Importantly, the approach taken in this paper is forward-looking. In the presence of a positive credit gap based on current economic conditions, appropriate policies may be different if future projections contribute to closing the gap, than if future projections tend to widen the gap further. The method in this paper gives our gap estimates a dynamic nuance, in addition to an interpretation linked to the consequences of structural change.

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Tables and Figures

Figure 1 Private credit-to-GDP ratio by country, 1970 to 2016.

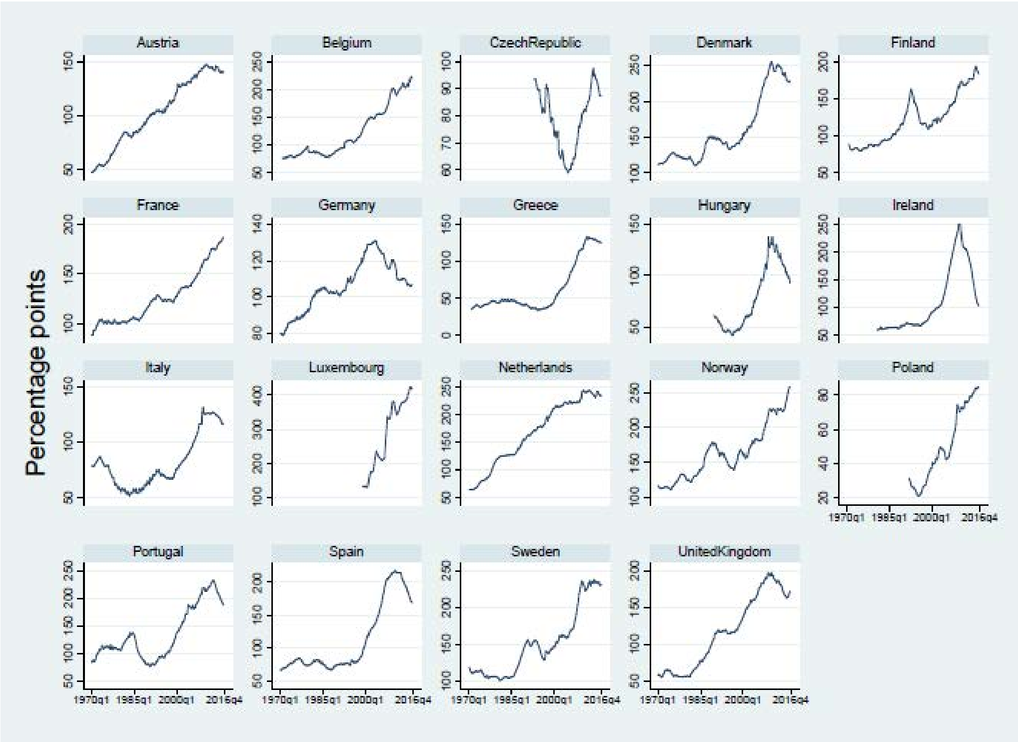

Figure 2 Log of real GDP *per-capita*. Demeaned series, 1970 to 2016.

Figure 3 Inflation rate. Demeaned series, 1970 to 2016.

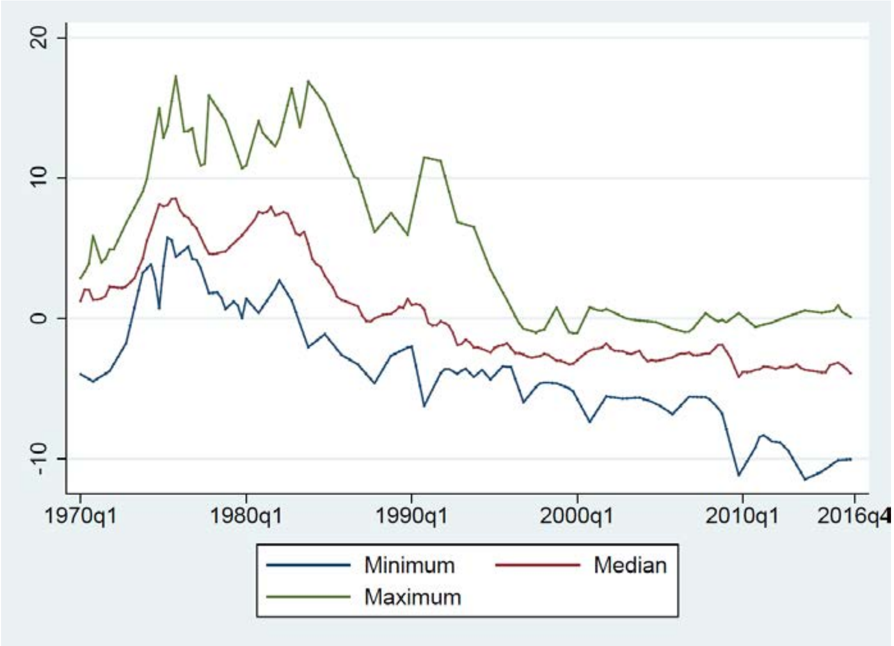

Figure 4 Nominal short term interest rate. Demeaned series, 1970 to 2016.

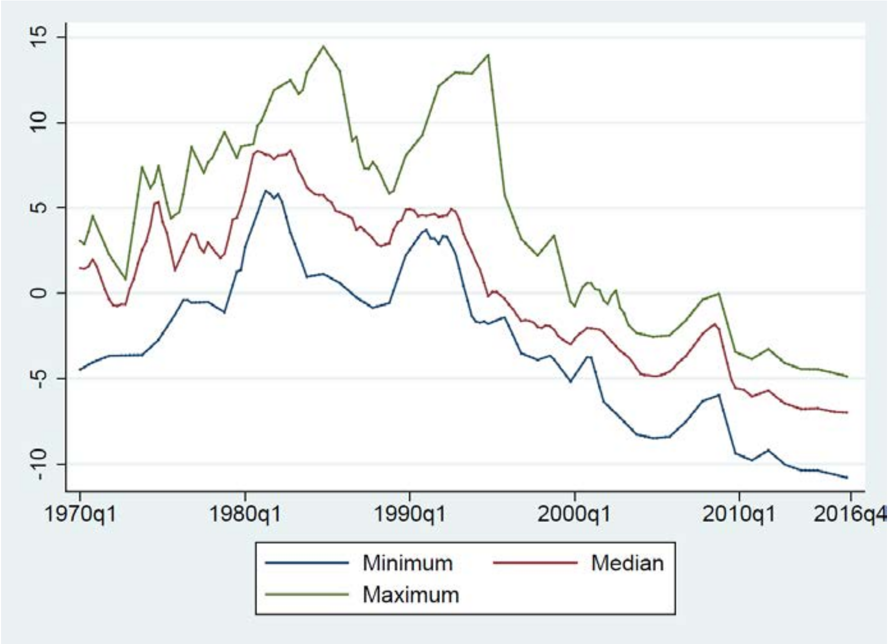

Figure 5 Investment over GDP. Demeaned series, 1970 to 2016.

Figure 6 Real house price index. Base year 2010. Demeaned series, 1970 to 2016.

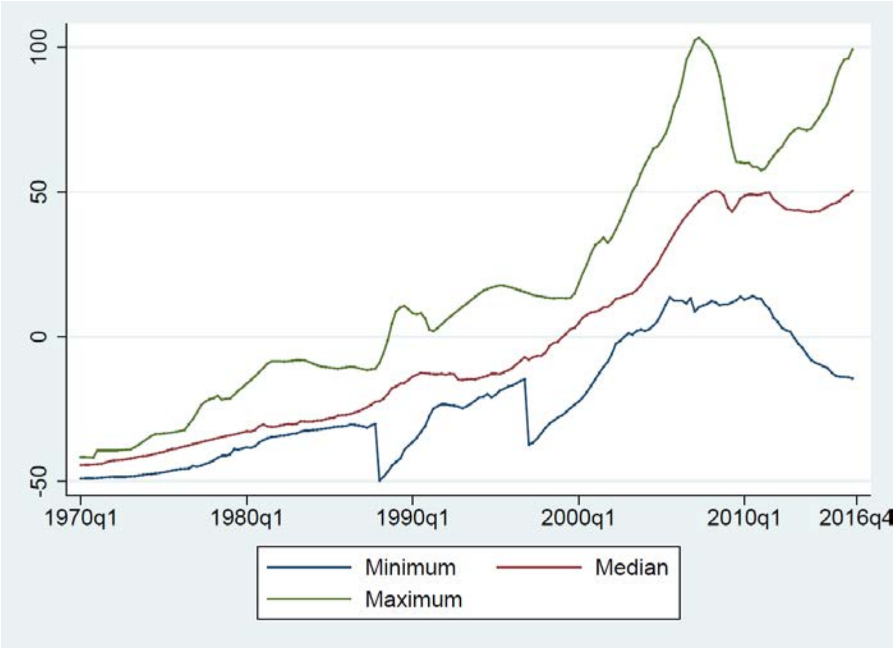

Figure 7 Private credit ratio, model projections and HP filter

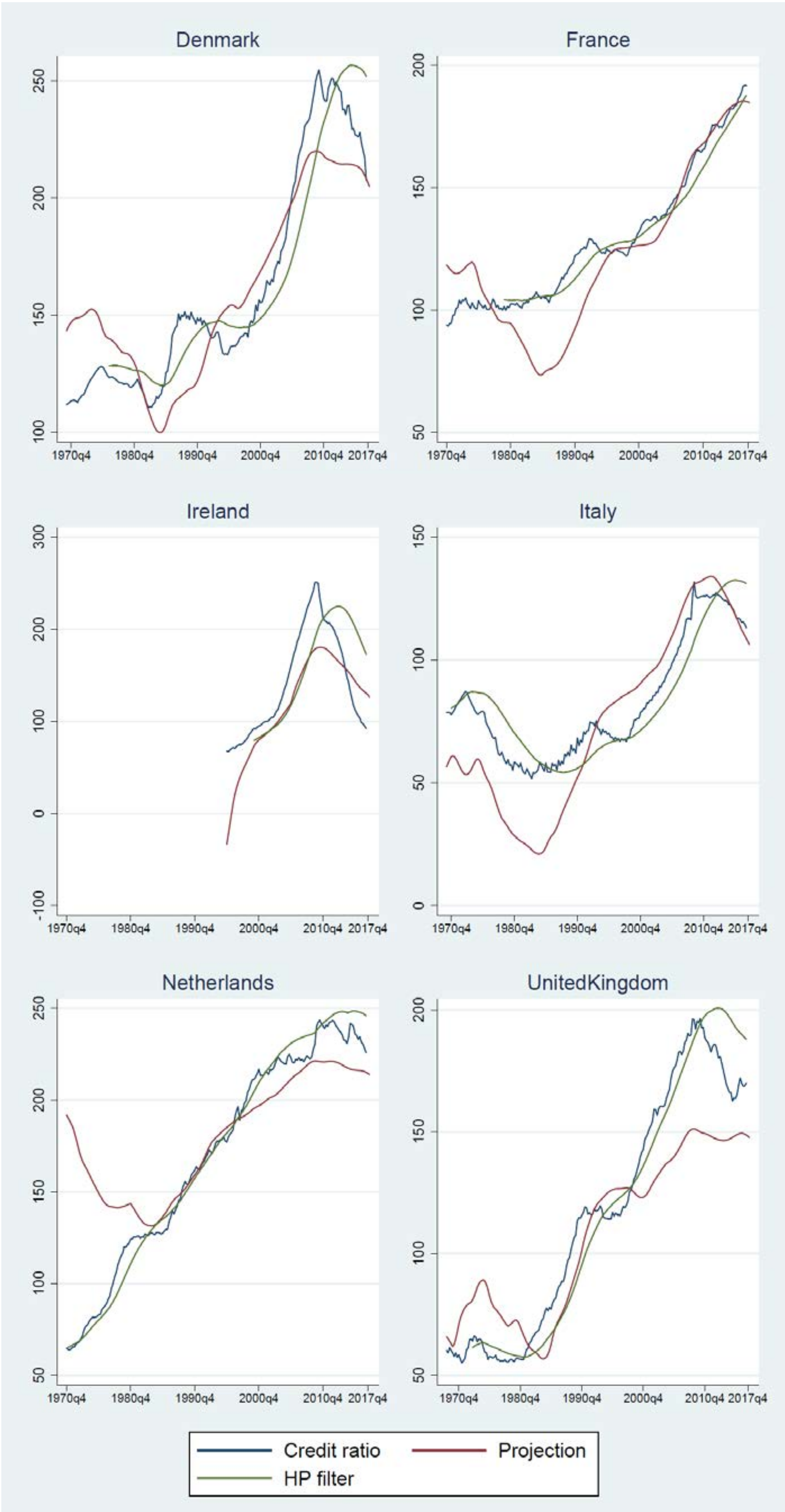

Figure 8 Contributions of individual variables to past projections

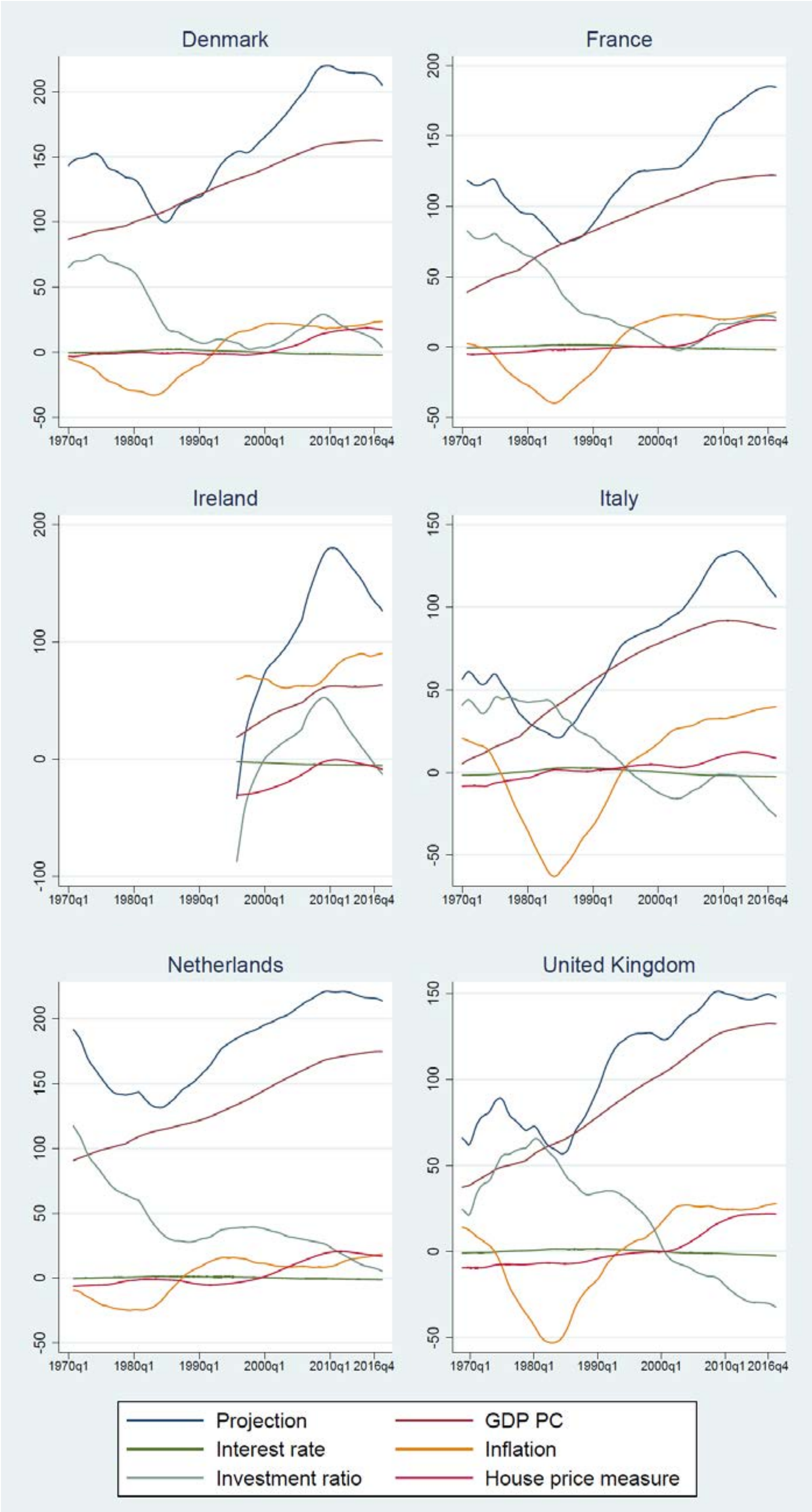

Figure 9 Future projections

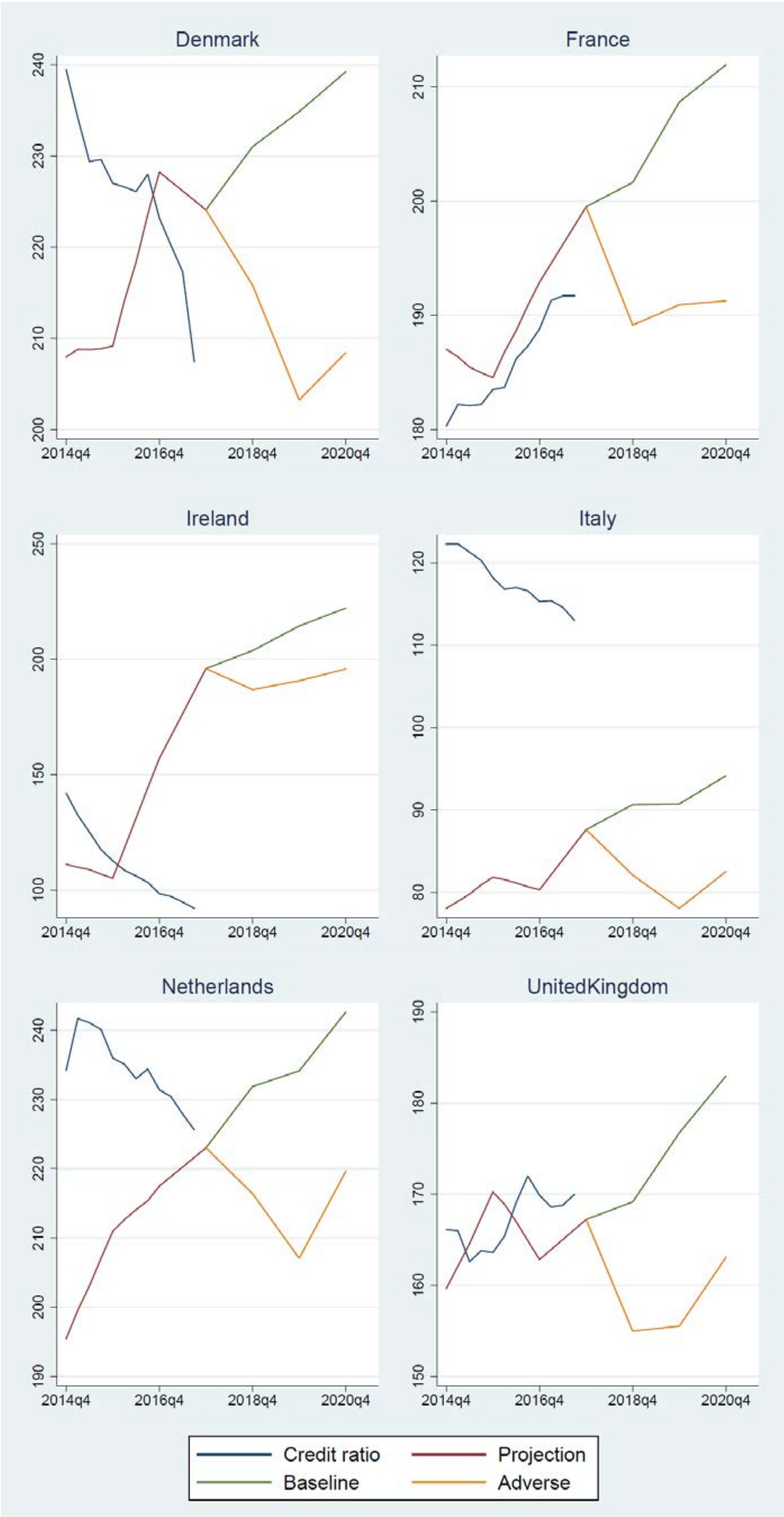

Table 1 Estimates of the cointegrating equation. Full sample

	(1)	(2)	(3)	(4)	(5)
Log Real GDP *per-capita*	3.65***	2.77***	2.59***	3.23***	2.48***
	(0.39)	(0.41)	(0.45)	(0.51)	(0.63)
Interest rate		-2.01***	-1.98*	-0.56	0.36
		(0.76)	(1.03)	(1.08)	(0.99)
Inflation			-1.23	-6.89***	-6.59***
			(1.29)	(2.02)	(1.70)
Investment ratio				14.76***	11.45***
				(3.08)	(2.38)
Real house price index					0.41*
					(0.22)
Adjustment Coefficient	-0.01***	-0.01***	-0.02***	-0.02***	-0.02***
	(0.002)	(0.003)	(0.003)	(0.003)	(0.003)
Observations	3,080	2,869	2,781	2,753	2,300
R squared	0.22	0.23	0.24	0.28	0.28
Adj R squared	0.22	0.22	0.23	0.27	0.27
Within R squared	0.19	0.19	0.20	0.24	0.26

Table 2 Estimates of the cointegrating equation. Restricted sample

	(1)	(2)	(3)	(4)	(5)
Log real GDP per-capita	3.87***	2.67***	2.61***	2.95***	2.76***
	(0.43)	(0.38)	(0.42)	(0.42)	(0.70)
Interest rate		-2.92***	-2.57**	-1.03	0.75
		(0.75)	(1.00)	(0.93)	(1.03)
Inflation			-1.09	-7.77***	-7.34***
			(1.22)	(1.70)	(1.72)
Investment ratio				15.46***	13.90***
				(2.34)	(2.44)
Real house price index					0.37
					(0.24)
Adjustment coefficient	-0.01***	-0.02***	-0.02***	-0.02***	-0.02***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.003)
Observations	2,528	2,350	2,262	2,242	2,098
R squared	0.17	0.18	0.18	0.26	0.28
Adj R squared	0.16	0.17	0.18	0.25	0.27
Within R squared	0.16	0.17	0.18	0.26	0.27

Note: Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

Table 3 Cross validation

	AT	BE	CZ	DK	FI	FR	DE	GR	HU	IE
Log real GDP per-capita	2.34***	2.09***	2.50***	2.50***	2.73***	2.47***	2.52***	3.16***	2.62***	2.97***
	(0.63)	(0.63)	(0.64)	(0.67)	(0.72)	(0.64)	(0.66)	(0.68)	(0.64)	(0.68)
Interest rate	0.27	0.47	0.37	0.34	0.13	0.44	0.27	0.79	0.04	-0.02
	(0.97)	(1.01)	(1.00)	(1.07)	(1.12)	(1.00)	(1.01)	(1.02)	(0.98)	(1.02)
Inflation	-6.46***	-6.84***	-6.59***	-6.97***	-6.30***	-6.62***	-6.35***	-6.42***	-6.27***	-6.41***
	(1.67)	(1.71)	(1.71)	(1.84)	(1.94)	(1.70)	(1.74)	(1.68)	(1.69)	(1.73)
Investment ratio	11.10***	10.78***	11.56***	11.68***	12.59***	10.92***	11.27***	13.05***	11.50***	11.72***
	(2.32)	(2.31)	(2.40)	(2.58)	(2.79)	(2.29)	(2.37)	(2.53)	(2.41)	(2.66)
Real house price index	0.46**	0.46**	0.41*	0.32	0.31	0.44*	0.39*	0.28	0.35	0.25
	(0.22)	(0.22)	(0.22)	(0.24)	(0.24)	(0.23)	(0.23)	(0.22)	(0.22)	(0.23)
Adjustment coefficient	-0.02***	-0.02***	-0.02***	-0.02***	-0.02***	-0.02***	-0.02***	-0.02***	-0.02***	-0.02***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Observations	2,234	2,117	2,266	2,114	2,117	2,117	2,205	2,222	2,262	2,217

	IT	LU	NL	NO	PL	PT	ES	SE	UK
Log real GDP per-capita	2.64***	2.74***	2.17***	2.43***	2.47***	1.75***	2.29***	2.38***	2.53***
	(0.61)	(0.69)	(0.66)	(0.65)	(0.63)	(0.54)	(0.65)	(0.67)	(0.68)
Interest rate	0.47	1.22	-0.06	0.24	0.35	0.98	0.45	0.68	-0.54
	(0.92)	(1.05)	(1.04)	(1.04)	(0.99)	(0.88)	(1.05)	(1.11)	(1.02)
Inflation	-6.36***	-7.85***	-6.06***	-6.91***	-6.58***	-5.85***	-7.48***	-7.04***	-5.70***
	(1.60)	(1.76)	(1.73)	(1.85)	(1.70)	(1.40)	(1.96)	(1.91)	(1.74)
Investment ratio	9.92***	14.12***	10.45***	11.77***	11.43***	8.82***	11.52***	11.83***	11.91***
	(2.08)	(2.46)	(2.53)	(2.62)	(2.38)	(1.87)	(2.64)	(2.66)	(2.47)
Real house price index	0.37*	0.38	0.45**	0.40*	0.41*	0.77***	0.47**	0.47*	0.28
	(0.21)	(0.23)	(0.22)	(0.23)	(0.22)	(0.19)	(0.23)	(0.24)	(0.25)
Adjustment coefficient	-0.02***	-0.02***	-0.02***	-0.02***	-0.02***	-0.02***	-0.02***	-0.02***	-0.02***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Observations	2,114	2,262	2,117	2,157	2,274	2,186	2,145	2,165	2,109

Table 4 Robustness. Unobservables

	(1)	(2)	(3)	(4)
Trend	0.50***		-1.11***	
	(0.11)		(0.41)	
Log real GDP per-capita		2.48***	6.68***	2.07
		(0.63)	(1.78)	(1.78)
Interest rate		0.36	-1.21	-3.00
		(0.99)	(1.15)	(2.34)
Inflation		-6.59***	-7.71***	-5.56**
		(1.70)	(2.30)	(2.76)
Investment ratio		11.45***	11.73***	11.07***
		(2.38)	(2.96)	(3.51)
Real house price index		0.41*	0.53**	0.81**
		(0.22)	(0.27)	(0.35)
Adjustment Coefficient	-0.01***	-0.02***	-0.02***	-0.02***
	(0.003)	(0.003)	(0.003)	(0.003)
Observations	2,300	2,300	2,300	2,300
R squared	0.22	0.28	0.29	0.39
Adj R squared	0.21	0.27	0.28	0.33
Within R squared	0.19	0.26	0.26	0.37
Time effects	No	No	No	Yes

Table 5 Robustness. Non-linearities

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Log real GDP per-capita	2.969***	4.272***	2.417***	2.549***	2.711***	4.990***	3.891***	0.931	2.611***
	(0.738)	(1.112)	(0.759)	(0.722)	(0.725)	(1.133)	(1.065)	(0.762)	(0.846)
Interest rate	0.203	0.488	-0.443	0.983	0.087	-0.316	-0.657	-2.956*	-0.544
	(1.003)	(1.263)	(1.030)	(0.942)	(0.985)	(1.125)	(1.177)	(1.626)	(1.171)
Inflation	-6.100***	-7.729***	-6.872***	-7.619***	-5.977***	-5.517***	-8.444***	-4.894***	-6.552***
	(1.671)	(2.154)	(1.635)	(1.591)	(1.605)	(1.814)	(1.958)	(1.812)	(1.730)
Investment ratio	11.761***	14.986***	13.279***	12.713***	10.236***	13.343***	15.652***	9.567***	13.829***
	(2.435)	(3.521)	(2.374)	(2.169)	(2.187)	(2.865)	(3.101)	(2.219)	(2.911)
Real house price index	0.512**	0.634**	0.455*	0.495**	0.477**	-0.002	-0.005	-0.114	0.122
	(0.238)	(0.304)	(0.236)	(0.228)	(0.239)	(0.330)	(0.323)	(0.315)	(0.287)
International Financial Integration	-0.013	-0.826**	-0.003	-0.000	-0.101**	-0.184***	-0.734**	0.462	
	(0.011)	(0.356)	(0.012)	(0.011)	(0.040)	(0.056)	(0.365)	(0.593)	
IFI * GDP		0.002**					0.001	-0.002	
		(0.001)					(0.001)	(0.001)	
IFI * Int rate			0.005**				0.007***	0.019*	
			(0.002)				(0.002)	(0.011)	
IFI * Inflation				0.003			0.007**	0.008	
				(0.002)			(0.004)	(0.015)	
IFI * Investment					0.005**		-0.000	0.009	
					(0.002)		(0.002)	(0.008)	
IFI * House price						0.001***	0.001***	0.002	
						(0.000)	(0.000)	(0.001)	
Adjustment coefficient	-0.020***	-0.016***	-0.020***	-0.021***	-0.020***	-0.017***	-0.016***	-0.024***	-0.020***
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.004)	(0.003)
Observations	2,210	2,209	2,206	2,206	2,206	2,203	2,194	1,548	1,622
R squared	0.329	0.349	0.361	0.365	0.346	0.338	0.378	0.268	0.229
Adj R squared	0.318	0.336	0.349	0.353	0.333	0.326	0.363	0.244	0.214
Within R squared	0.303	0.323	0.336	0.340	0.320	0.318	0.359	0.253	0.216

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