Research Series

Characterising the Financial Cycle in Ireland

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Abstract[4]

The financial cycle remains outside the mainstream of macroeconomics, perhaps because of its tendency to sit better in the realm of economic history rather than mathematical equilibria. This is surprising, as evidence suggests that recessions since about 1985 have been triggered by financial excesses (Borio et al, 2018). Ireland in the period 2001-2011 provides a microcosm of this recent dominance of the financial cycle over the traditional business cycle.

This is the first paper that aims to characterise Ireland's financial cycle from 1971 – 2017. To do so we employ turning point analysis and frequency-based filters. We rely mainly on credit and property price variables to characterise the cycle, in keeping with the growing literature. We identify the dates of peaks/troughs for the financial cycle, describe the characteristics of cycle phases and analyse the synchronisation between cycles for each macrofinancial variable.

We find that the co-movement of credit and property prices best characterise Ireland's financial cycle. This corresponds with literature on the subject, such as Drehmann et al. (2012). Credit leads property prices by at least one year. As of early 2019, we find that Ireland's banking system has just embarked on a new credit cycle, while property prices are perhaps at the midway point. The latest aggregate medium-term cycle that commenced in about 2012 appears to be different from the last one in that it has been augmented by non-bank finance as opposed to lending by deposit-taking institutions. This regime could be safer for the Irish taxpayer: it is majority financed by overseas equity funding rather than through Irish-owned banks. But our analysis of the existing cycle remains incomplete as we have yet to identify a long-run time series to supplement credit, which has less explanatory power than in prior phases. This drawback could be rectified by further research.

Key words: Financial cycle, credit, property prices, frequency-based filter, medium-term turning points

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1. Introduction

'In the environment that has prevailed for at least three decades now, just as in the one that prevailed in the pre-WW2 years, it is simply not possible to understand business fluctuations and their policy challenges without understanding the financial cycle…macroeconomics without the financial cycle is like Hamlet without the Prince.'

Claudio Borio (2012)

Financial cycle was out of vogue until the last decade

Borio (2012) argues that the financial cycle preceded thinking about the business cycle. There are many differences between the two (Drehmann et al., 2012): the salient one being that the business cycle is centred around a neat mathematical equilibrium whereas the financial cycle is founded on disequilibrium, pro-cyclicality and violation of the assumption of rationality. The financial cycle also encompasses still non-mainstream ideas from the discipline of behavioural economics.

For at least sixty years following the Great Depression, the concept of the financial cycle developed slowly. It came into vogue fleetingly when localised financial crises hit, for example in Latin America in the 1980s, the early 1990s in the US, Britain and Australia, the mid-1990s in the Nordic region and in 1997-98 in emerging markets.

But it took the Global Financial Crisis (GFC) of 2007-2008 to highlight the analytical value of the approach: financial excesses may lead to economic contractions. Put another way, good times sow the seeds of their own destruction.

Recessions since the 1970s have arguably been triggered by financial excesses

The initial impetus for what is known as the financial cycle might have been provided by the 1929 crash and ensuing Great Depression. But the concept lay undeveloped through the period of financial repression from the Second World War to the early 1970s.[5] The deep slumps of the 1970s appeared to be driven by the exogenous shocks beloved of general equilibrium models (Romer, 2016). Financial, and indeed economic, history appeared to fall out of favour in research circles.

Arguably, the reaction of monetary policy to the oil crises of the 1970s brought relevance to the concept again. Paul Volcker was determined to rein in the out-of-control inflation that he inherited when taking the post of Federal Reserve (Fed) Chairman in 1979. Severe interest rate hikes in the U.S. during the early 1980s contributed to two recessions in quick succession. Volcker's work helped to create the conditions for the reduction in inflation and interest rates that followed over the subsequent two decades. It ushered in a period of non-inflationary economic growth for the developed world that lasted, with only short shallow

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[5] See next section for examples of the limited research on the financial cycle in the period 1929-1995.

interruptions, until 2007.[6] U.S. non-financial debt as a share of GDP had been flat for three decades, but the reduction of nominal and real interest rates sparked a doubling of that ratio over the following 25 years to 168.5% by the fourth quarter of 2007 (Federal Reserve Bank of St. Louis).

The arrival of Volcker's successor, Alan Greenspan, at the Fed corresponded with the period of dramatic financial liberalisation of the late 1980s. Greenspan's period in charge from 1987 to 2006 coincided with the beginning of the dominance of the financial cycle over the business cycle in developed economies.

The last three recessions since 1990 had proximate financial causes, following periods of easy monetary policy (Taylor, 2013). In 1990, it was the excesses of the late 1980s in US, British and Australian real estate. The Fed had cut its funds rate by three quarters of a percentage point in 1987 following the idiosyncratic Black Monday crash in financial markets even though the economic cycle was mature.

In 1997, excessive return-seeking capital flows blew up in emerging markets. A year later Long-Term Capital Management (LTCM), an enormous hedge-fund, collapsed, its principals seemingly oblivious to the risk of "Black Swan" events (Taleb, 2007).[7] The Fed again cut interest rates and saved the firm, despite the fact that the US economy was already running hot on the back of the Dotcom capital expenditure bubble.[8]

The Fed's easing of financial conditions inflated an equity bubble of extreme proportions over the next eighteen months and U.S. stocks reached their highest valuations ever based on cyclically-adjusted earnings, price as a ratio of book-value and price to sales. This bubble burst in March 2000, causing a mild global recession in 2001.

Financial market commentators coined the moniker of the "Greenspan Put" to term these propping-up interventions (in 1987 and 1998) implemented to save risky assets in difficulty (Dahiya et al, 2017). The reaction of monetary authorities around the world to the minor 2001 recession possibly contributed to an even bigger problem that manifested itself in 2007.[9] In 2001-03, base interest rates were slashed to 1% from 6.5% in the U.S., from 4.75% to 2% in the Euro Area and to from 6% to 3.5% in the U.K. By this stage, in the mid-2000s, financial innovation had reached its zenith. Ultimately, it led to the bursting of a mania in credit and property this time, the classic financial cycle nexus culminating in the biggest synchronised global downturn since the 1930s.

It is difficult to see the cause of the GFC as something other than the denouement of an epic financial cycle beginning after the 1990 downturn. This 15-year cycle had an unfinished recession in 2001, when the aggressive policy response of the Fed prevented a sharper downturn, only for larger financial excesses to manifest by 2007-08. The "unfinished

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[6] US GDP growth was -1.4% from Q3 1990 to Q1 1991 and -0.1% from Q4 2000 to Q3 2001.

[7] Occurrences that ex-ante are perceived to be extremely low probability, but whose impact is high. Probability here is not defined in bell curve terms. See Taleb, 2007.

[8] In Q4 1998, US GDP quarterly growth was 1.6%, the unemployment rate had dropped to 4.4% and consumer confidence had reached its highest level since the 1960s.

[9] The European Central Bank (ECB) cut rates to 2%, while the Bank of England base rate fell to 3.5%.

recession" phenomenon may occur when policy responses fail to take into account the length of the financial cycle. Looser monetary policy may help contain recessions in the short run at the expense of larger recessions down the road (Drehmann et al., 2012).

Ireland's crisis: a microcosm of the danger of the financial cycle

Ireland's small open economy has been buffeted by global capital flows since about the 1970s (Buckley and Ruane, 2006). Between 1922 and 1959 its economy was broadly closed off to the rest of the world, which was especially the case in the 1930s when Ireland fought an ill-fated economic war with Britain at the time of the Great Depression (O'Rourke, 1991). The Irish economy flourished as it gradually opened up to trade and investment in the 1960s. It was a time of low interest rates thanks to financial repression in the western world, particularly in the first half of the decade.

Ireland joined the European Economic Community in 1973 and broke the link with sterling in 1979 (de facto severed prior to that), which plugged its economy into the global financial cycle more so than at any time since unofficial independence in 1922. As our research will show, there seems to be clear evidence of a financial cycle in the 1970s when land and house prices soared. The Government also introduced incentives for home buyers, while the Central Bank of Ireland (CBI) cut interest rates from 15% to 5%. Mortgage volumes rose by an eighth on average each year in 1970-1974.

Ireland's ill-fated fiscal expansion of the economy in the late 1970s was partially reversed during 1983-1984 (FitzGerald and Kenny, 2018). Financial conditions were also depressed, as the CBI also kept monetary policy tight. As a consequence, real house prices fell for most of the 1980s. Belatedly, Ireland enjoyed some blow-back from Britain's major "big bang" financial liberalisation beginning in 1986. Its own version would arrive much later, around the turn of the century.

The financial cycle was not dominant in Ireland through the late 1980s and early 1990s, although there were periodic episodes of stress such as in the Exchange Rate Mechanism crisis of 1992-1993.

The lead up to Economic and Monetary Union in the mid-to-late 1990s was the first necessary step towards financial disaster a decade later. Nominal and real interest rates fell at a time when the economy was driven by classic delayed convergence (Honohan and Walsh, 2002). In other words, Ireland should have converged with European income per capita levels earlier but was held back by poor policy decisions. This was a benign economic period - the genuine "Celtic Tiger" lasted from 1994 to 2001 - supercharged by rapid export growth spilling over to the rest of the economy.[10] Property prices rose throughout the 1990s from depressed levels at the start of the decade. Credit growth was robust in the late 1990s (driven

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[10] Growth in exports was 17% a year, while GNP expanded at an annual rate of 7.2%. The "Celtic Tiger" was coined by British Economist Kevin Gardner, as Ireland mirrored the rapid growth of the Asian "Tiger" economies.

by fundamentals rather than speculation (Whelan, 2014)): real estate valuations nudged above long-run averages compared with rents and incomes by the turn of the century.[11]

Ireland suffered a short-lived shallow recession in 2001, following the bursting of the US DotCom bubble the previous year, as some technology companies retrenched. Commercial property also suffered for a year or so. The ascent of house prices stalled temporarily. That brief interlude was not enough to deter foreign banking entrants and the rapid expansion of incumbent Irish-owned banks. Credit growth took off around 2003. Lending to real estate developers rose 10-fold in five years, financed by foreign wholesale funding from the issuance of fixed income securities to overseas investors and corporate deposits. One third of first-time buyer mortgages were issued at 100% loan-to-value or greater in 2006; the average loan-to-value ratio for all mortgages issued peaked at almost 90% before the bubble burst (Duffy, 2012). House prices doubled as a multiple of disposable income per capita from 7.7 times in 1995 to 15.7 times in 2007 (Central Statistics Office). Rental yields in both the housing and commercial property markets dropped below yields on Irish Government bonds (White, 2006).

In effect, the property market became a Ponzi scheme, fuelled by inflows of foreign capital. It became increasingly susceptible to a liquidity freeze. Cracks showed long before the collapse of Lehman Brothers when the European Central Bank (ECB) hiked interest rates eight times from 2% to 4% in the eighteen months to mid-2007. Inward capital flows plateaued around that time before dramatically reversing in September 2008. Ireland's domestic banks were insolvent. House prices collapsed by 55%, while commercial property lost two-thirds of its value. Gross national income per capita declined by 21% between 2007 and 2011. The financial cycle had accompanied the genuine boom in the late 1990s but discovered a life of its own to drive the extension of the cycle in the 2000s; with ruinous cost.

In this paper, we characterise Ireland's financial cycle using credit and property prices. Cycles are long relative to business cycles, extending noticeably since U.S. monetary policy began to react to asset prices the late 1980s. Their amplitude also increased over the last few decades compared with the 1970s and 1980s. Peaks and troughs coincide with recognizable triggers, whether domestic or external. This is the first paper to attempt this exclusively for Ireland and we intend others will follow.

The rest of the paper is laid out as follows. The next section explores the expanding literature. We describe the data used in Section three. We outline the methodology in Section four and discuss the results in the fifth Section. We then conclude.

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[11] By 2001, Ireland's house price to rent ratio was already 110% above its long-run average since 1970. But the 1980s was marked by depressed economic conditions in Ireland that caused real property prices to decline. The 15.4% average growth in house price between 1994 and 2001 was supported by an 11.4% annual growth in GNI per capita driven by exports.

2. Financial cycle research

Financial crises date back centuries. One of the first theories to explain them originated in what became known as the Austrian school. Von Mises (1912), followed by Hayek (1933), hypothesised that Central Banks caused economic cycles by pushing the "money rate of interest below the natural rate". The increase in credit flow that resulted from the suppression of interest rates typically led to mal-investment, an excess of speculative investment that turns out to be unproductive, such as "ghost" housing estates.

Fisher's (1933) theory of debt-deflation began to formalise thinking that financial booms led ultimately to busts.[12] He also championed the idea of financial cycles, seeing equilibrium as "imaginary"; whereas disequilibrium constituted "economic dynamics". The study of financial cycles should marry economic history with the study of tendencies or laws, what he called "economic science". Later, Eichengreen and Mitchener (2004) added more ballast to the argument that asset prices and credit led to the bust in 1929. They explore the interplay of cheap credit and innovation as a contributing factor to the bust that followed. There were eerie echoes of this chain of possible causation, especially with regard to financial innovation, when the credit boom of the 2000s burst in the Great Financial Crisis of 2007-08.

There is a significant difference between the contemporary view of the financial cycle and that of a century ago. The Austrians invariably viewed equilibrium as important, whereas, like Fisher suggested, financial cycles have disequilibrium at their heart. In practice, equilibrium might prove to be elusive, or at best fleeting, because financial factors such as credit growth and asset prices have non-linear tendencies (Misina and Tkacz, 2009). The Financial Instability Hypothesis of Minsky (1992) also contested that business cycles result from the internal (endogenous) dynamics of the capitalist system, not from exogenous shocks. Finance was at the core of the system: as the cycle moved to greater degrees of leverage from hedge finance (where cash flows covered all debt repayments) to speculative and ultimately (what he termed) Ponzi it became progressively unstable. Interventions from policy makers can cause financial crises, highlighting the risks from activist monetary policy. Minsky saw that prolonged prosperity sowed the seeds for the financial cycle's ultimate demise.

Models (of the standard economic cycle) may be poor representations of the real world (Zarnowitz 1999). Commenting on why Borio and White's seminal speech at Jackson Hole (2003) did not get more attention from mainstream macroeconomists, Stephen Cecchetti, former Economic Advisor at the Bank for International Settlements (BIS), noted that an economic model can only be defeated by an opposing model. Yet the development of models where *'financial stress'* is endogenous - in which booms and busts are *'normal'*- may not be achievable (Cecchetti, 2009).

In the interregnum between the Great Depression and the late 1990s, financial cycle research tended to be largely qualitative, focusing on financial and economic history. Kindelberger

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[12] Rising debt during the boom period leads to depression.

contributed heavily with his seminal first edition of '*Manias, Panics and Crashes: A history of financial crises*' in 1978. This documented the long history of financial manias ending badly.

Characterising the financial cycle before the Global Financial Crisis

The aforementioned papers did not characterise the financial cycle empirically in the way that Burns and Mitchell (1946) attempted to capture the business cycle just after World War II. Almost half a century later in the mid-1990s, economists at the BIS began to quantify the nexus of credit, asset prices and monetary policy. Borio et al (1994) commenced by constructing an aggregate asset price index from equities plus commercial and residential real estate prices. The paper examined co-movements in this aggregate variable versus output, exploring the implications for monetary policy. This pioneering effort ignored credit growth or the build-up of debt beginning in the early 1980s.

A year later, Borio (1995) rectified this omission by exploring the build-up of credit in fourteen industrial countries. The link back to asset prices and monetary policy would come later. Zarnowitz (1999) tied credit with profits, investment, stock prices, inflation and interest rates as endogenous factors central to economic fluctuations. Behavioural economics also came into play in this work, through the presence of bias in the form of over-confidence. By late 1999, there still appeared to be little appetite among economists to characterise the financial cycle, despite the emerging markets crisis of 1997-98. Kaminsky and Schmuckler (2001), focusing more on equity market cycles, summed up the apathy towards the financial cycle: "*for the United States there is also an official classification of the (business) cycle in expansions and contractions. No similar interest has flourished in characterizing boom-bust cycles in financial markets*".

The BIS continued to publish work which increasingly filled the gap with chapters in the Annual Reports of 2001 and 2002 that formalised the concept of the financial cycle. This explored the links between credit, property prices, credit spreads, banking capital and equity prices. In an important initial finding, the BIS found that the ties between credit and equity prices are looser historically than for credit and property prices. That would be made clear half a decade later when the US housing market was at the root of the GFC. Borio and Lowe (2002) elaborated on this theme: '*In particular, sustained rapid credit growth combined with large increases in asset prices appears to increase the probability of an episode of financial instability*'.

This initial phase of research on the financial cycle culminated in the Borio-White paper presented at Jackson Hole In August 2003.This explored the idea that the financial cycle was highly pro-cyclical and that monetary policy could be lifting the elasticity of the system – in other words increasing the likelihood of boom-bust cycles. The contention at that time was that central bankers should take endogenous financial factors like credit growth and asset prices into account when framing monetary policy, even if it was not explicit in their mandates. They should lean against the wind, rather than react to prop up asset prices any

time something went wrong in financial markets. If not, financial stability could be endangered with devastating consequences.

Characterising the financial cycle after the Global Financial Crisis

Empirical research on the financial cycle has blossomed since the crisis, including at the ECB and IMF.

Aikman et al. (2014 for speech) sketch a theoretical model of what they label the "credit cycle". Empirically, they also compare the amplitude and frequency of business cycles with credit cycles. Since 1945, they discover that the standard deviation of credit growth is five times real activity. The credit cycle seems to be well-defined (characterised) empirically: they find that it is longer (8-20 years) than the business cycle (2-8 years). The authors suggest that the credit cycle has been operating for well over a century, positing that its frequency might be attributed to financial liberalisation and competition.

Claessens et al (2011) analyse credit and asset price cycles in 21 advanced economies from 1960 to 2007. The paper concludes that long cycles in asset prices are synchronic across countries and accentuate each other during recession periods.

Drehmann, et al. (2012) characterise the cycle using turning point analysis as presented by Burns and Mitchell (1946) and frequency-based filters. They identify the financial cycle with the medium-term component in the joint fluctuations of credit and property prices.

Stremmel (2015) approximates the financial cycle in Europe by combining common and relevant financial indicators. The paper uses data for 11 European countries and develops seven different synthetic measures to best capture the characteristics of the financial cycle. It is found that the best-fitted financial cycle measure includes a credit-to-GDP ratio, credit growth and house-prices-to-income ratio.

Ireland's financial cycle has yet to be characterised in detail, hence the purpose of this paper. Though it was one of the 11 countries that Stremmel (2015) examined. He characterised the Irish cycle using credit to GDP, house price and banking metrics. The time series for the banking indicators is not long enough to be useful. Credit and house prices seem to provide a clear picture of the Irish financial cycle over time. This makes intuitive sense, given that financial liberalisation and the advent of the euro led to rapid credit growth financed by foreign flows of capital into Ireland's banks from about 2001 onwards.

In another ECB paper, Schüler (2015) et al. use a multivariate spectral measure of power cohesion to capture common cycle frequencies across a group of economic data. Their approach is based on correlations of estimated spectral densities. Meanwhile, they construct a composite cycle to depict the economic fluctuations with time-varying aggregation method. The authors cover 13 European Union (EU) countries from 1970 to 2013. Their financial cycle analysis suggests that banking crises are predictable (up to three years in advance). They find that heterogeneity of financial cycles is high between countries. Ireland is reported to have a relatively long financial cycle in the range of 15 to 20 years. House prices are found

to be the most important variable behind the Irish financial cycle in history. Ireland also has the highest concordance between the financial and business cycle in the 13 EU countries analysed, which reflects the inherent volatility of the Irish economy.

The above papers have a number of common findings:

I.   Financial cycles are longer than the traditional business cycle, lasting between 10 and 20 years.
II.   The co-movement of credit and property prices tends to best characterise the financial cycle; movements in equity prices are less optimal albeit important too.
III.   Peaks in financial cycles tend to coincide with financial crises, so they lead to bigger output dislocations than those of the business cycle (e.g. GFC 2008, Nordics early 90s).
IV.   A structural break occurred in the mid-1980s: the length and amplitude of financial cycles has increased. Financial deregulation and operational changes in monetary policy reaction functions probably caused this.

3. Data

Table 1 summarises the variables utilised in the analysis, along with their sources and sample periods. The bulk of the literature to date finds that the co-movement of credit and property prices best characterise the financial cycle. We employ the longest time period possible in an attempt to cover multiple financial cycles.

Table 1: Data

Variable	Source	Sample period
Real house prices	OECD	1970 Q1 - 2017 Q2
Real commercial property prices	CSO, IPD, Lisney	1983 Q1 - 2017 Q3
Mortgage volume	CSO, BPFI	1970 Q1 - 2017 Q4
Household mortgage credit as % GNI*	CSO, CBI	1971 Q2 - 2017 Q4
Household non-mortgage credit as % GNI*	CSO, CBI	1971 Q2 - 2017 Q4
Total household credit as % GNI*	CSO, CBI	1971 Q2 - 2017 Q4
Credit to non-financial corporates % GNI*	CSO, CBI	1971 Q2 - 2017 Q4
Total private sector credit % GNI*	CSO, CBI	1971 Q2 - 2017 Q4
House price to income ratio	OECD	1977 Q1 - 2017 Q2
House price to rent ratio	OECD	1970 Q1 - 2017 Q2
German 30 year Government bond yield	Bloomberg	1976 Q1 - 2017 Q4
Residential property yield	CSO, ESRI	1975 Q1 – 2017Q4
Average price of dwellings from transactions	BPFI	2010 Q1 - 2018 Q2
Number of mortgage drawdowns for house purchase	BPFI	2010 Q1 - 2018 Q2
Number of total property transactions	BPFI	2010 Q1 - 2018 Q2
Commercial property investment turnover	Lisney	2011 Q4 - 2018 Q2
TARGET2	ECB	2001 Q1 - 2018 Q2

For real estate, we include residential and commercial property prices. Data for house prices stretch back to 1970; unfortunately the times series is not quite as long for the commercial market although it dates back to 1983.

Mortgage volume provides the longest time series to illustrate trends in credit, also beginning in 1970. This is complemented by a relatively new series for the euro value of household credit and non-financial credit. We disaggregate these series into component parts of interest such as mortgage and non-mortgage credit, real estate and land development lending plus construction loans (for working capital). These data are available from the first quarter of 1972. In order to scale credit growth, we favour Gross National Income (GNI). National Accounts from 1970 are published by the Central Statistics Office. Recent data distortions in Ireland led to the advent of modified GNI*, which we splice with GNI from 1995.[13]

The role of other risky financial variables such as equity prices is less clear-cut. Moreover, Irish stock prices are subject to significant data qualifications. Over the last two decades, Ireland's ISEQ index has become dominated by multinationals that earn most of their profits overseas. Therefore, the explanatory power of Ireland's equity index as a guide to domestic financial developments has diminished. We therefore exclude stock prices from this study.

Ireland's latest financial cycle commenced in about 2012 and does not appear to be fuelled by credit in the same way as previous ones (particularly the cycle of the 2000s). Domestic banks were deleveraging following the financial crisis of 2008, which led to them requiring nationalisation or, at a minimum, substantial injections of fresh capital. The phase of post-crisis debt reduction complicates the comparison of the current cycle with history: the co-movement of credit and property prices does not tell the complete story. Because domestic credit has not been a factor since the crisis yet there have been other reflationary capital inflows, we endeavour to produce novel variables to characterise the current financial cycle equivalently to the pre-crisis period. These include our property risk premium, which we construct back to the mid-1970s.

4. Methodology

Frequency-based filter analysis

Following Drehmann et al (2012) we use a band-pass filter to estimate short-term cycles, lasting between five and 32 quarters (the typical duration of a business-cycle), and medium-term cycles, lasting between eight and 30 years (or 32 and 120 quarters). We use the band-pass filter suggested by Christiano and Fitzgerald (2003). This enables us to segregate the element of each series that relates to the frequency interval.

The data are filtered in annual growth rates (i.e. four-quarter differences in log levels), as in Comin and Gertler (2006). The filter implies a zero trend (or drift), based on the assumption that growth rates of macroeconomic series are stationary. Again following Drehmann et al (2012), we transform the resulting series into log levels by cumulating growth rates from zero beginning at the start of the sample period, in order to compare results with the following turning-point analysis.

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[13] See Lane (2017).

Turning-point analysis

We also perform turning point analysis to complement the frequency-based filter. The turning point analysis of Burns and Mitchell (1946) identifies cyclical peaks and troughs in the series.

Drehmann et al (2012) outline that the algorithm comprises two key steps: (1) the identification of local maxima and minima over a specific window; (2) the imposition of censoring rules to guarantee a minimum length of the cycle (i.e. the distance between two consecutive peaks or troughs) as well as a minimum length of each phase (i.e. from peak to trough or trough to peak). In addition, the algorithm requires peaks and troughs to alternate and a trough (peak) to be lower (higher) than the preceding peak (trough).

Different calibrations of these parameters result in different sets of peak and trough dates. To capture cycles that are longer than those typically considered in business cycle analysis, we implement a medium-term algorithm. This determines local maxima and minima over a nine-quarter window, and sets the minimum cycle length equal to 5 years (40 quarters).[14] We implement this method through computer algorithms. This approach identifies the vast majority of peaks and troughs.

We do not include the turning point analysis in the charts that follow, for the sake of clarity and simplicity. However these results correspond with those obtained using the band-pass filter (they are available upon request).

5. Results

The results of the frequency-based filter analysis are presented below. The dashed lines represent the medium-term cycles in the individual variables with the long-run trend and short-term fluctuations removed. Thus the medium-term cycles fluctuate around zero over time.

Our aim is to find the variables that best characterise Ireland's financial cycle. First, we assess the property cycle. Second, we turn to credit. Third, we introduce other variables to account for the changed circumstances since the Ireland's deep recession of 2008-11. Bank credit has actually been shrinking for most of that period, so relying on property prices alone to frame the financial cycle is unsatisfactory. We introduce the idea of a long-run risk premium for Irish property to explain the non-bank financial flows that reflated the Irish real estate market over the last five or six years. Finally, we aggregate the most robust property and credit cycles to characterise the most precise financial cycle for Ireland since 1971.

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[14] Arguably, five years is still at the low end for a medium-term cycle. In fact, the lower bound for the medium-term cycle length we use for the band-pass filters is eight years. We chose it nonetheless because the minimum distance between two financial crises in a given country in a much broader sample than that employed here is five years (Drehmann et al (2011)). If anything, this choice will bias the algorithm towards identifying shorter rather than longer cycles. But, as we show below, it still allows the approach to identify the key medium term peaks and troughs.

Cycle A: Irish property

In Figure 1, we examine real house prices. There is an obvious cycle throughout the 1970s that peaked in 1980 in both analyses. The 1980s were marked by a slump for most of the decade until a brief rally in the latter years of the decade. Post 1995, the medium-term cycle of real house price becomes longer and the amplitude increases dramatically compared with the previous 25 years. The cycle swings dramatically between 2000 and 2015. This reflects the pre-crisis housing bubble in Ireland and the collapse that followed its bursting. The dating of the turning points of house prices in 2007 and 2013 coincide exactly with the peak and trough of medium-term cycle.

House price valuation indicators are mainly driven by house prices, rather than incomes and rents. The medium-term frequency-based analysis of the ratio of house prices to incomes and rents confirms the trend of the real house price cycle (Figures 2 and 19 in Appendix 2).

Interestingly, the commercial property cycle deviates from housing around the turn of the century (Figure 3). The medium-term cycle troughs around 1995 and then accelerates almost vertically. Then we observe an extra cycle, between 2000 and 2004. Ireland's exposure to U.S. foreign direct investment (FDI) in the technology sector is one possible explanatory factor, as a result of the retrenchment in internet-based companies of the time.

The peak in 2000 reflects the zenith of the dotcom bubble and its deflation afterwards. U.S. equities stabilised in 2003 following a near-50% decline, closely leading the Irish commercial property market which bottomed in 2004.[15]

Figure 1: Real house prices

32-120Q cycle (lhs)   Real house price (2000 Q1 =100, rhs)

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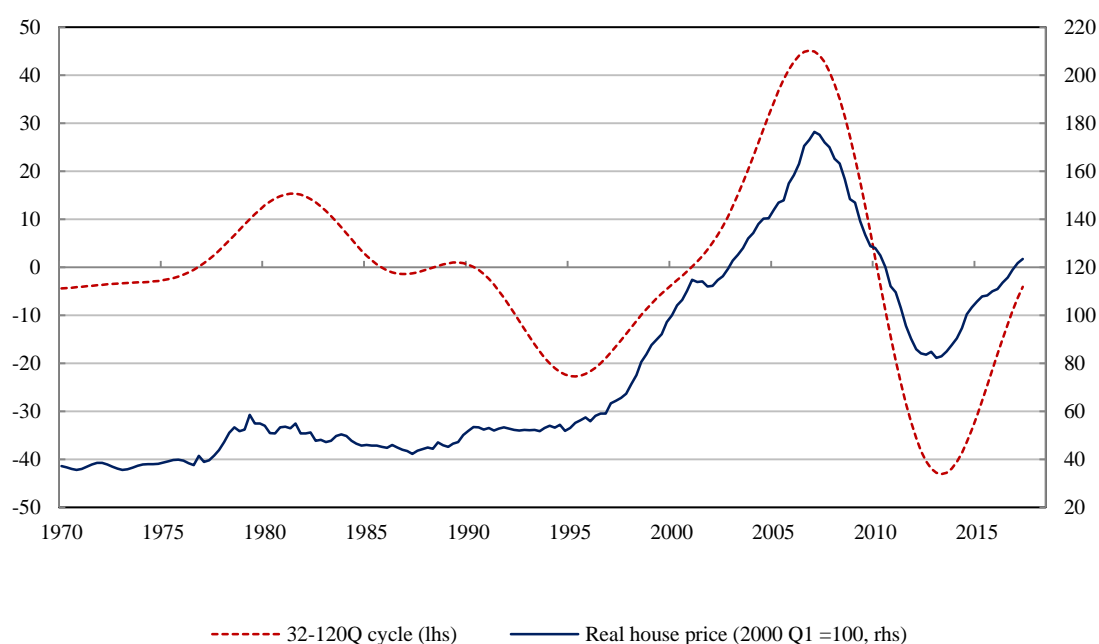
[15] Among risky assets, commercial property tends to move more coincidentally with publicly-quoted equities than with housing which is pretty illiquid.

**Figure 2: House price to disposable income ratio**

Legend: 32-120Q cycle (lhs) · · · · · · House price to disposable income (2000 Q1=100, rhs) ───
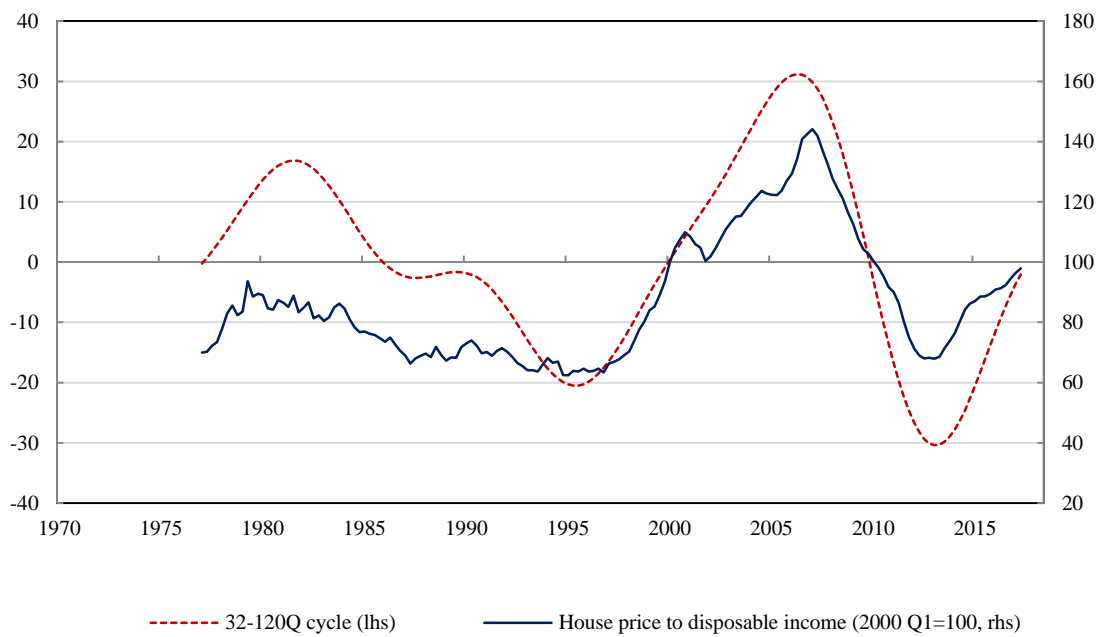
Figure 3: Real commercial property prices

Legend: 32-120Q cycle (lhs) · · · · · · Real commercial property price (2000 Q1=100, rhs) ───
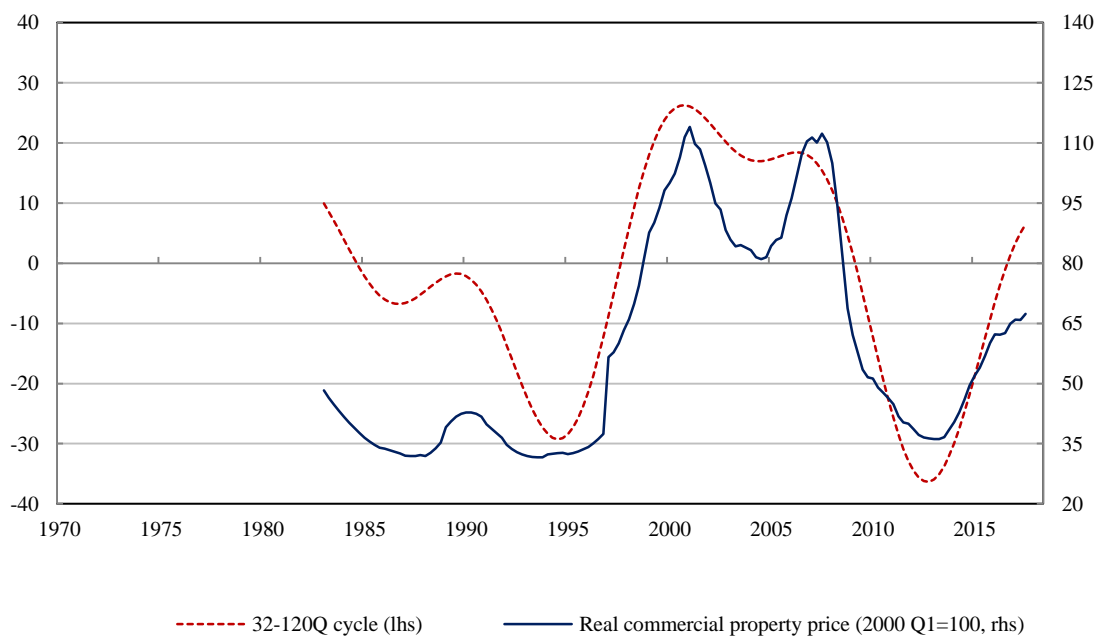
Historically, Ireland's commercial property market leads housing by a number of quarters. In the latest cycle, the trough in both markets was more coincident in 2012 – though commercial still bottomed first. This probably reflected the inflow of foreign (mainly US) capital to Ireland's real estate markets that had dropped by more than 50% (55% housing; 65% commercial property) The medium-term cycle nudged above the (central) zero axis in 2017.

Figure 4: 32-120Q cycles in real house prices and commercial property prices

Real commercial property price (lhs) ----- Real house price (rhs)
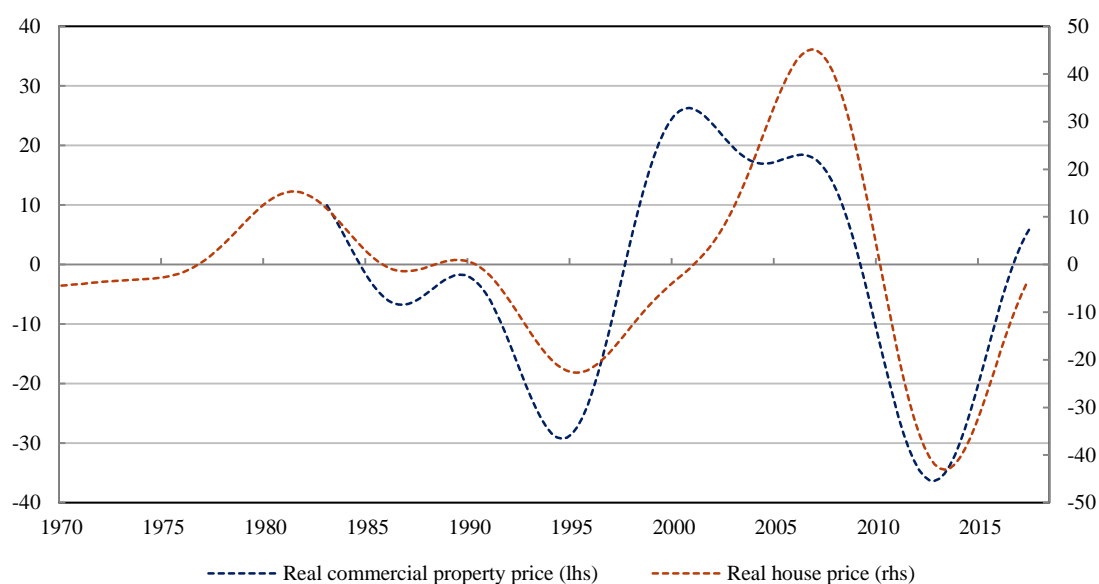
Cycle B: Irish credit cycle

Mortgage lending leads house prices

Drehmann (2012) finds that credit displays the longest medium-term cycle. Credit cycles can be divided into credit to households and credit to non-financial corporates (NFCs).

Mortgages tend to account for the majority of credit to households. The total nominal value of credit equals price by volume. For mortgages, that means that it is a combination of house prices and the number of mortgages issued. There exists a useful Irish long-run series for mortgage volumes which dates back to 1970. Figure 5 shows the relationship between mortgage volumes and house prices. Mortgage volume seems to lead house prices (by at least one year), which implies that the influence of credit institutions in kick-starting or curbing the cycle (or non-bank providers of loans) is significant. This pattern is also apparent in the raw data, particularly since the 1980s.

Again, the amplitude of both series has increased markedly since the mid-1990s. Prior to this the first definite cycle was in the 1970s. Mortgage lending accelerated in 1970, peaking five years later. Credit for house purchases turned more than five years before the peak in house prices. This may suggest a role for the fiscal laxity of the late-1970s in prolonging the financial cycle, even though underlying demand for houses was waning. It is claimed, for example, that there was a coincident price bubble in land (including agricultural) in the 1970s (Murphy (1995); Roche and McQuinn (2000)).

Figure 5 also hints that this financial cycle is more advanced than other variables would suggest. In other words, if we characterised the Irish cycle simply with house prices and mortgage volumes there has been quite a recovery since the trough in 2011. Mortgage volumes were above the zero reference point in the band-pass filter by the end of 2017,

similar to the point in the previous cycle reached in 1997 (seven years on from the bottom in that case; six years this time).

Figure 5: 32-120Q cycles in real house prices and mortgage volume
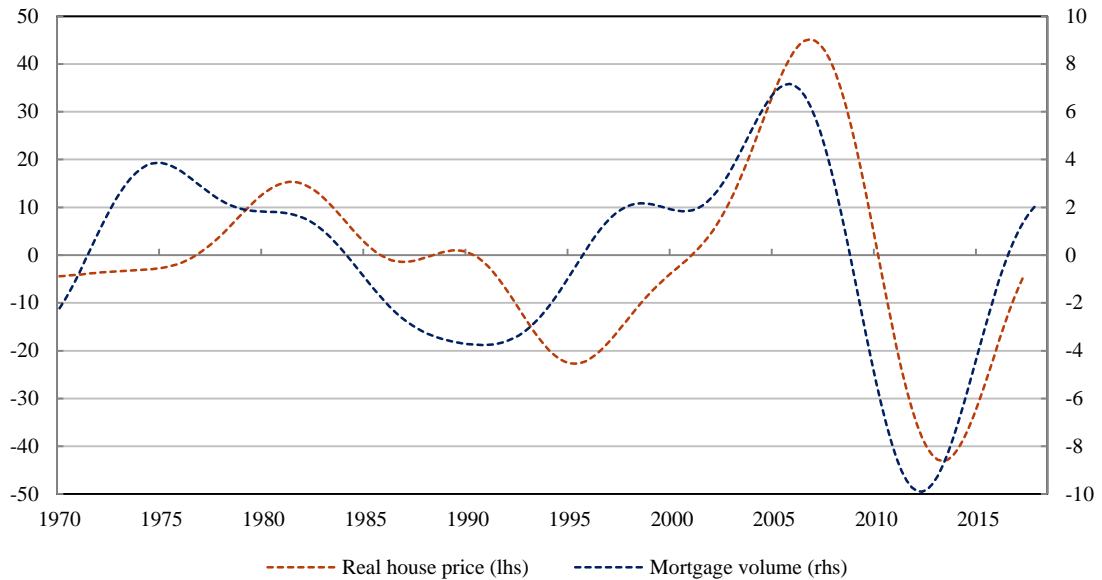
Corporate credit cycle has been driven by construction and land speculation

The trend in mortgage credit is quite clear. Now we turn to non-financial corporate credit. The series we use proxies indigenous lending, more closely related to GNI rather than GDP. Domestic banks lend little to foreign-owned multinationals (Cussen, 2013).

**Figure 6: Growth of credit to non-financial corporates**
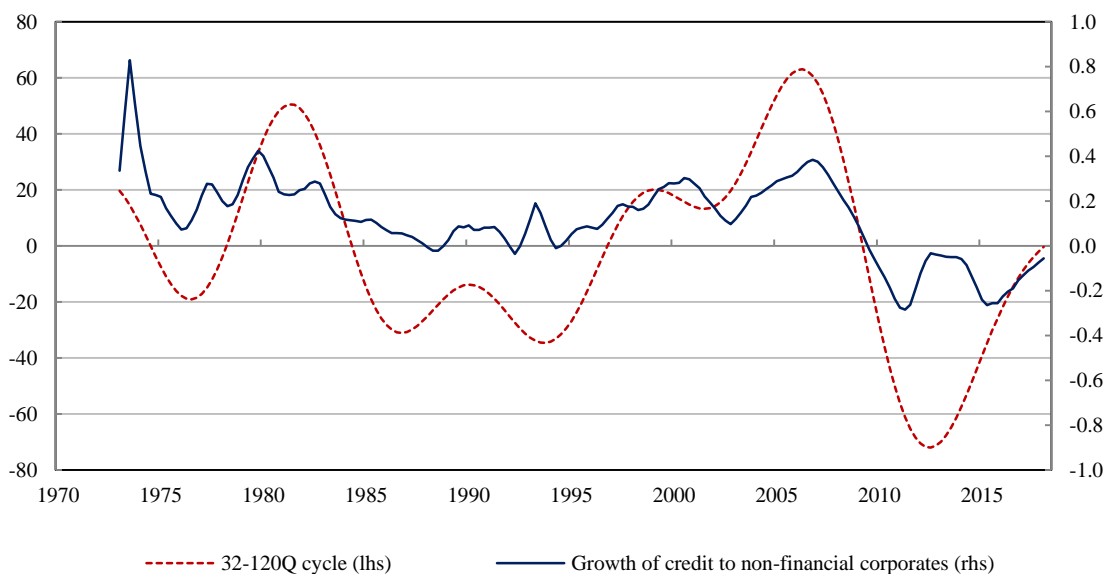
We find four full cycles (and two half cycles) in the growth of business loans over the near fifty year sample (Figure 6). First, there was an upswing from the mid-1970s to the severe US recession of 1981/82. The second half of that cycle saw credit contract for five years to 1986. The next recovery coincided with strong UK expansion in the latter part of the decade, before the brief U.S. recession of 1990-1991 and the ERM crisis caused credit conditions to tighten. The third cycle was driven by the export-led "Celtic Tiger" of 1994-2001. Following the U.S. recession of 2001, the full effects of financial liberalisation in Ireland and rock bottom interest rates in the Euro Area curtailed the downswing of the credit cycle; à la the "unfinished" recession phenomenon of the BIS. A new euphoric corporate credit cycle emerged, driven by property development and speculation. Its amplitude was greater than anything experienced before in Ireland. The bust was just as big as the boom: the trough in late 2011/ early 2012 plumbed depths not witnessed before.

We delve deeper, comparing the medium-term cycles in total credit to the (non-financial) corporate sector (Figure 7) with lending to property development and land purchase both as a share of GNI* (Figure 8). This comparison produces two additional findings. A sub-set of lending, loans to real estate activities and construction (lending for land purchase, development and contracting, Figure 8), dictates the credit cycle for all businesses. The medium-term trend in Figure 8 is almost identical to Figure 7. That was especially the case for the land development bubble that began in the early 2000s: lending for real estate activities jumped from €16bn to €106bn in the five years from 2003 to 2008 according to data from the CBI.

Figure 7: Total credit to non-financial corporates % GNI*
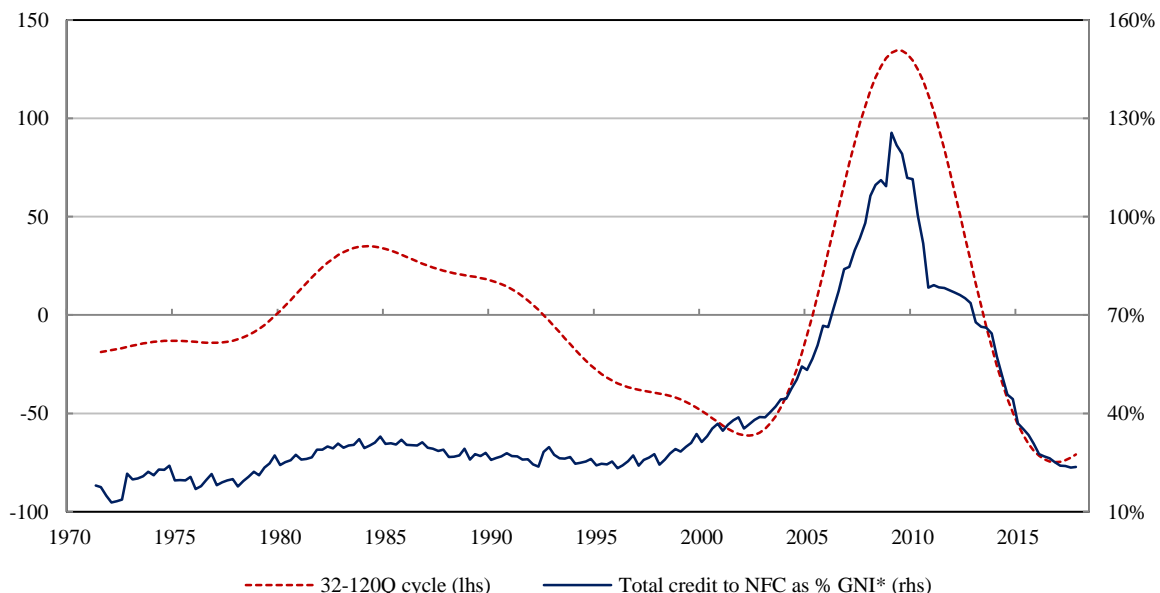
Yet the cycles for overall credit to business and for construction and development activities are also coincident for the period 1971 to the turn of the century before the property market became unhinged. This suggests that Irish banks have invariably favoured lending against

collateral; it also hints at the relative dearth of (non-construction related) indigenous companies that have grown to scale financed domestically by credit institutions. Multinationals (whose loans are not included here because they are mainly financed abroad) have dominated Ireland's medium to large corporate sector.

Figure 8: Credit to construction/ property development % GNI*

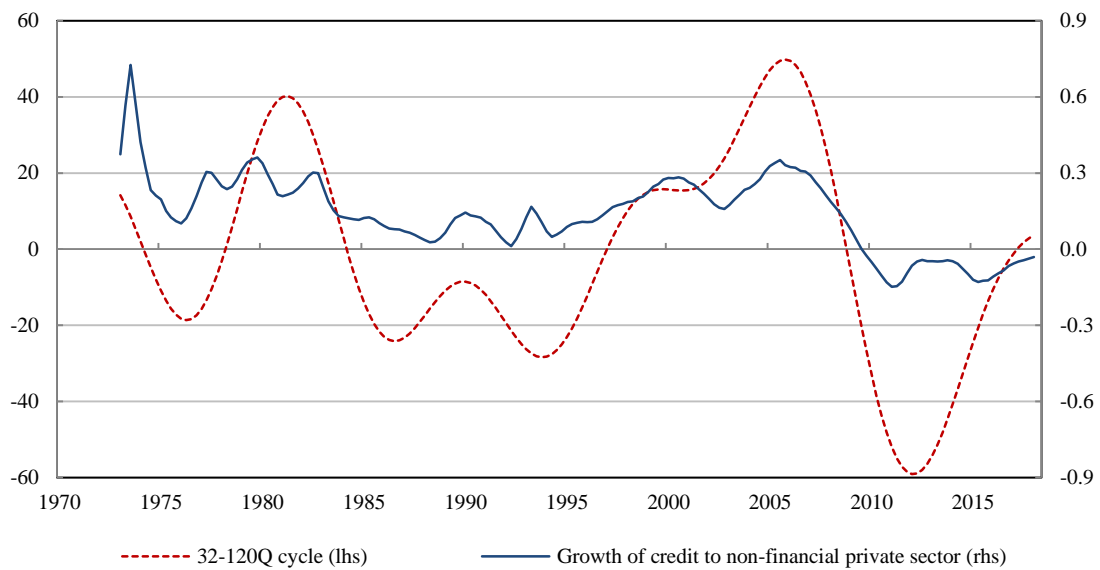----- 32-120Q cycle (lhs)   —— Credit to Construction & real estate activities as % GNI* (rhs)
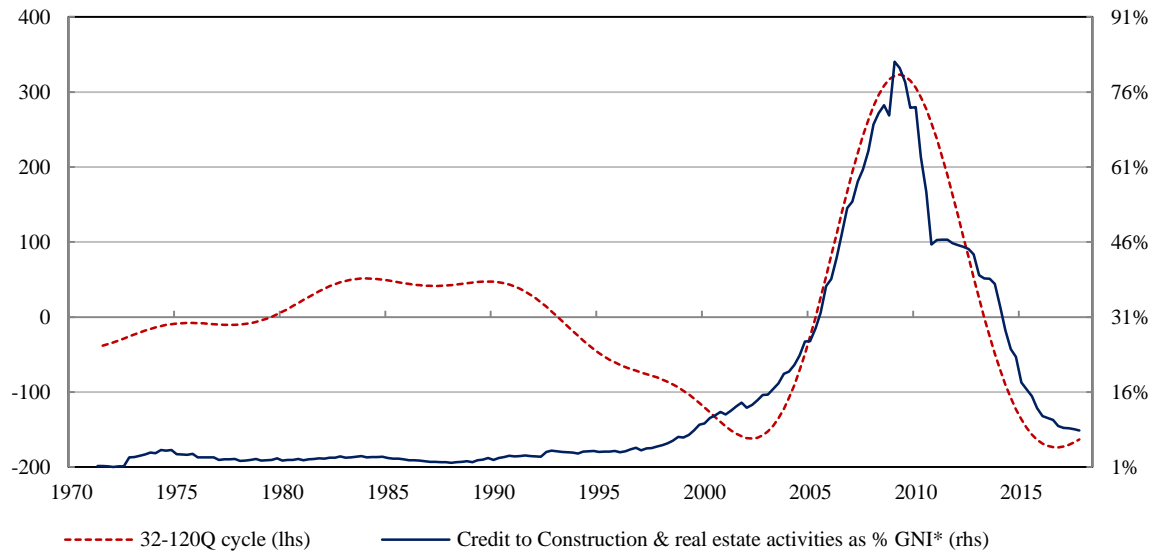
In the previous sections, we discussed the behaviour of consumers and businesses. Figure 9 combines household and corporate lending to display total private sector credit growth. We find five (32-120q) cycles in private credit over the sample. First, there was an upswing from the mid-1970s to the severe US recession of 1981/82. Second, credit contracted through most of the 1980s until the recovery later in the decade coinciding with strong UK conditions and fiscal rectitude in Ireland. The ERM crisis led to another dip in the early 1990s. Third, the "Celtic Tiger" of 1994-2001 when credit followed the rapid expansion in exports that led to the delayed convergence of Ireland with European living standards. This period was not blighted by speculative domestic lending. The U.S. recession of 2001 led to flatter credit growth for a year or two before the fourth property-inspired development frenzy of the noughties. That cycle peaked in 2005, reaching a trough when the latest cycle began in 2012.
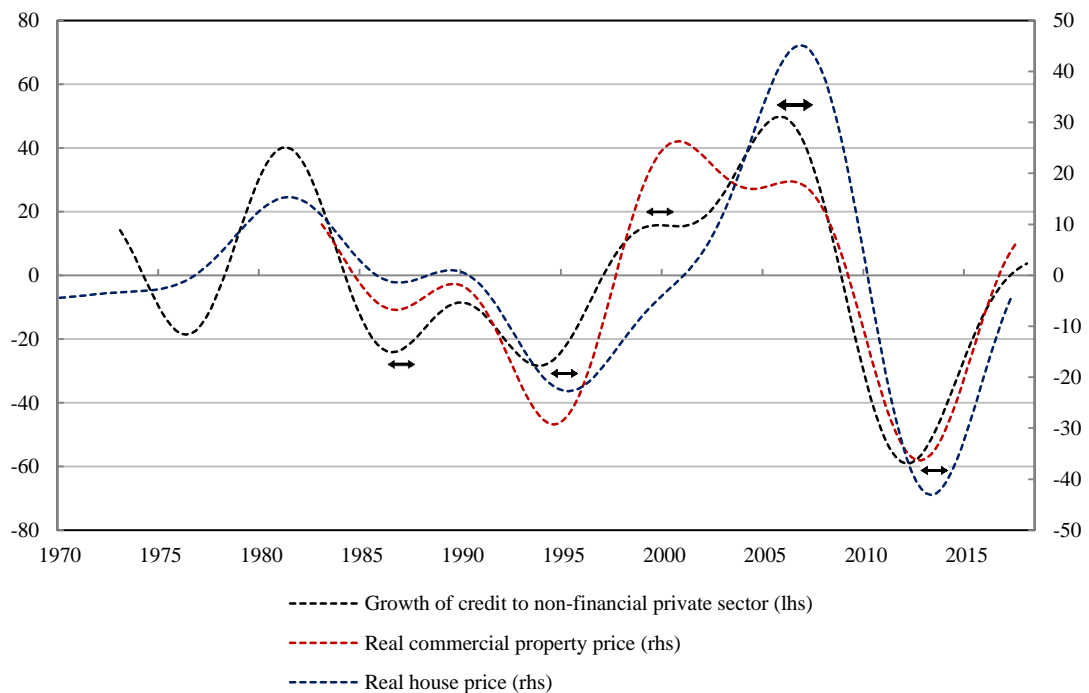
We observe a recovery in the credit cycle in the last few years, mainly driven by mortgage lending (see Figure 5). But there is an important contrast between growth in the series itself on the right-hand side of Figure 9 and the longer 32-120Q cycle on the left axis, which always gravitates towards zero. The missing piece is lending based on property collateral, this has not been financed by Irish banks. Total spending on property is much lower than in the mid-2000s; moreover the financing has come largely from foreign-owned non-banks.

Figure 10 shows the medium-term trend in the property prices and total credit cycles (rather than the series themselves). We can clearly see that credit leads asset prices over time (marked by arrows in the chart), even in the current cycle.

Figure 9: Growth of private credit (households and NFCs)

- - - - 32-120Q cycle (lhs) ——— Growth of credit to non-financial private sector (rhs)

Figure 10: Comparison of medium-term cycles: total credit and property prices

- - - - Growth of credit to non-financial private sector (lhs)
- - - - Real commercial property price (rhs)
- - - - Real house price (rhs)
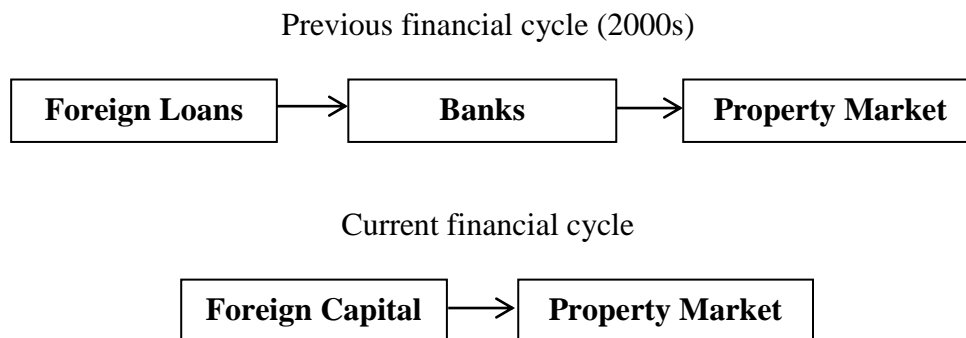
Alternative measures are required to fully capture the current financial cycle

The picture that we have presented so far is, however, incomplete. Much of the reflation of the Irish economy since 2011 has been financed from non-traditional sources. Irish banks were husbanding capital and restructuring. Their risk appetite was low following the crisis. So foreign providers of capital - such as hedge funds, private equity funds, private lenders and sovereign wealth funds - stepped in to take the place of domestic banks. These funds have provided capital (debt and equity) to Irish entities, taking over full companies, loan

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books or the underlying property collateral itself. Because Ireland has such large portfolio and direct investment inflows via the multinational corporate sector, it is near impossible to disaggregate this flow of capital. Yet the amplitude of the medium-term financial cycle that began in 2011/2012 would be underestimated if we ignore these crucial capital flows.

Figure 11: Domestic banks bypassed in this financial cycle

Previous financial cycle (2000s)

| Foreign Loans | → | Banks | → | Property Market |

Current financial cycle

| Foreign Capital | → | Property Market |

Unfortunately, it is not easy to capture this using the financial cycle measures outlined in the literature. We introduce new metrics for illustrative purposes: the drawback is that these time series are not as long as for credit or property prices (which stretch back to 1970). We propose two new metrics:

1. Non-bank credit capital flows into property

2. A risk premium for the property market

Surge in non-bank flows into real estate since the crisis low

As discussed above, the Irish property cycle has diverged with its typical credit cycle. The current financial cycle could be different as global central banks have pursued non-conventional monetary policy instruments since the crisis. Quantitative Easing (QE) began in the U.S. in 2009, leading to ample liquidity conditions. American monetary policy has been on the loose side of neutral for almost a decade. The European Central Bank followed by easing Euro Area financial conditions since 2012. It began with the Outright Monetary Transactions (OMT) promise, followed by its Public Sector Purchase Programme (de facto QE) in 2015. Meanwhile, short-term rates were cut to 0% (below 0% for deposits, setting a new unprecedented floor).

Ireland benefits disproportionately from the double-whammy of loose U.S. and EA monetary policy because of its strong ties to America as well as being a member of the Euro.[16] Ireland's credit cycle looks moribund through the lens of the period before the Financial Crisis, focusing on domestically-generated bank credit alone. Yet capital has flowed freely into the
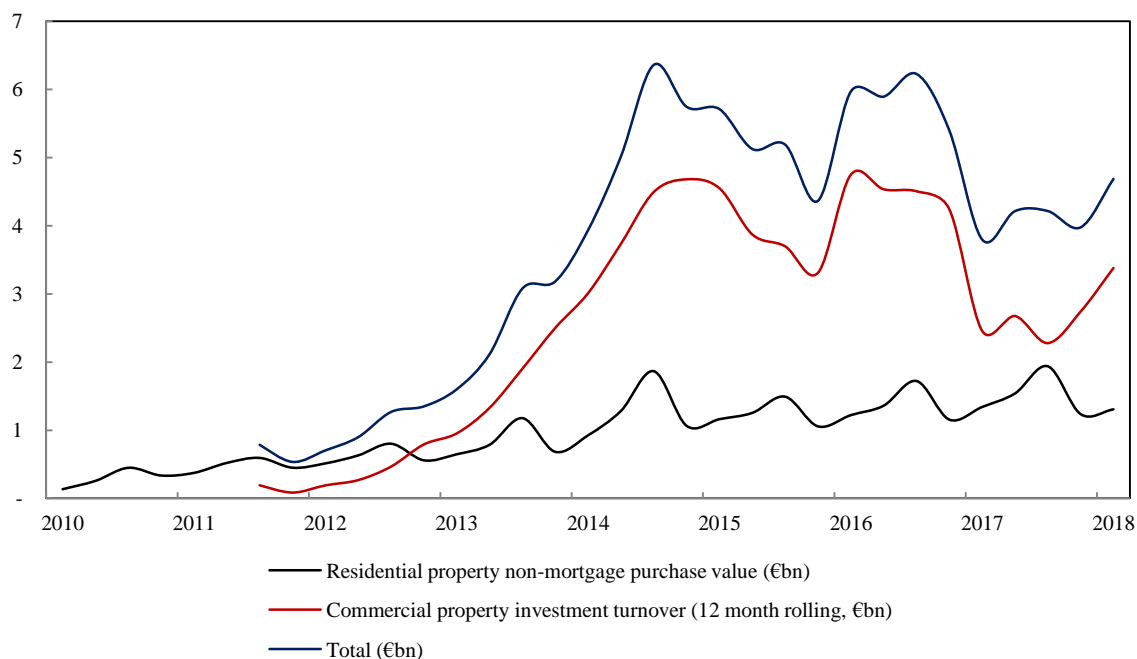
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[16] See Purdue (2018), http://www.ntma.ie/download/publications/Impacts-of-the-US-economy-on-Ireland-August-2018.pdf

property market and business economy in a search for yield since 2011. This liquidity injection caused property prices to recover.

We have attempted to quantify these flows, but our answer is incomplete. Figure 12 documents two ways to describe the trend. The first is to look at the non-mortgage flows into the real estate sector, which includes purchases of residential property and land for residential construction. The second focuses on commercial property investment in existing property (dry purchases rather than development). There are a few drawbacks with the data. The series for cash purchases only dates back to 2010. Commercial investment is available for longer but this would have been dominated by domestic purchases financed by bank loans pre-crisis, so it double-counts some portion of corporate credit and does not identify the structural break whereby foreign purchases have dominated real estate investment since the nadir of the crisis. We are also missing a proportion of the capital flows to finance commercial property development.

These incomplete flows (due to data unavailability) are nonetheless significant, rising from €1bn to €6bn at the peak. The combined flow has dropped by 25% since, perhaps signalling that the potency of this cycle is fading since prices have breached fair value.[17] The reason for such a short series is that Ireland's property price register began as recently as 2010. If data were available for longer, we could glean great insight by adding cash purchases to credit provided by banks back to 1970.

Figure 12: Proxy for non-credit liquidity flow into property market

Residential property non-mortgage purchase value (€bn)

Commercial property investment turnover (12 month rolling, €bn)

Total (€bn)

[17] According to the OECD, Ireland's house prices are now above long-run averages of income and rents.

Risk premium for property market may augment credit growth to proxy non-bank lending

Property is a risky asset like equities, commodities and corporate bonds. Market participants habitually value such assets by constructing premia over (conventionally) risk-free securities such as German bunds or U.S. treasuries. We construct a long-run time series for the risk premium (or excess return) of Irish property yields over German 30-year bond yields (as property is a long duration asset) deducting one percentage point from that premium for fixed notional costs.[18] The disadvantage is that commercial rental yield data on which we base our risk premium only date back to 1990; though residential rents span an extra 15 years.

The advantage of this exercise is that we can now compare the recent cycle to prior ones when credit was the dominant source of liquidity. We see similar cyclical trends in the property risk premium to the price data in Figure 4. The additional insight is to capture investor behaviour. Cycles become frothy once investors allocate capital when there is zero or negative excess return over the risk-free rate. This pertained for much of the late 1990s and the bubble years of the mid-2000s. Since 2012, the risk premium for commercial property – a proxy for yield chasing behaviour – has eroded far more than its residential equivalent.[19]

Of course, risk free rates are debased compared with history so what looks like an excess return today could evaporate quickly in the event of a rapid inflationary scare. But property is a real asset where rents should adjust upwards with wages and consumer price inflation.

Figure 13: Commercial property risk premium

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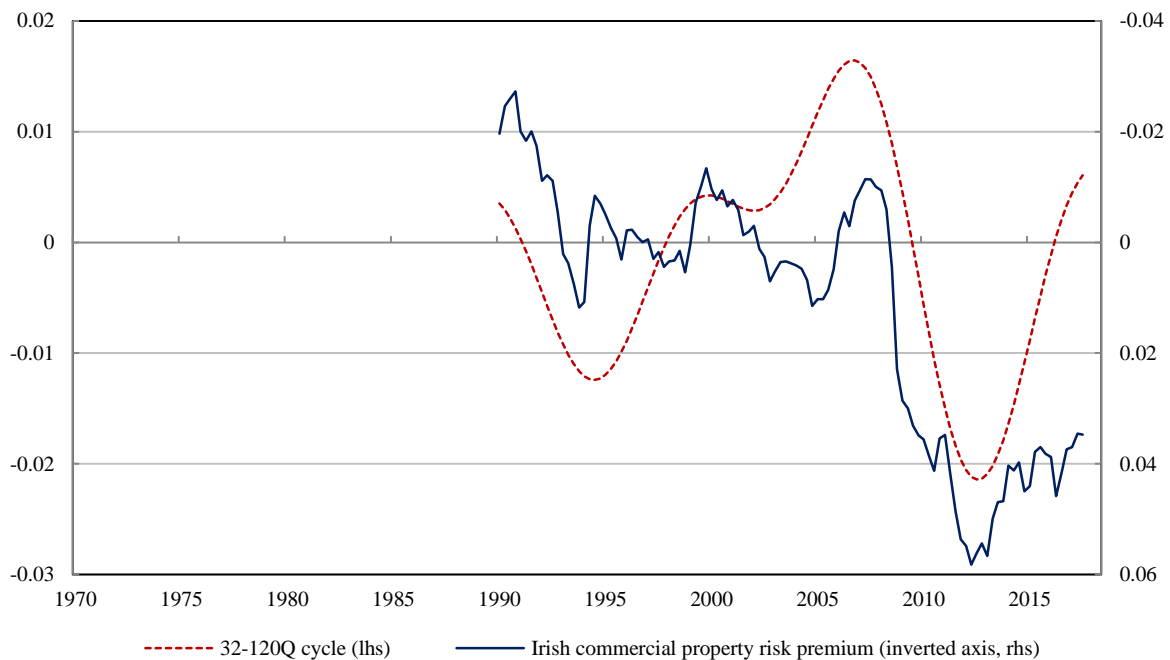
[18] Costs such as tax, administration, voids etc. This will vary over time but we keep it fixed for convenience.
[19] This also reflects the unusually high level of housing rents because of the supply shortage, keeping the risk premium artificially high.

If we link the recent trend in Figure 13 with the rebound in the medium-term series of private sector credit (Figure 9), the latest financial cycle looks a bit more advanced. Perhaps one could say it is near its mid-point.

Figure 14: Residential property risk premium

32-120Q cycle (lhs)

Irish residential property risk premium (inverted axis, rhs)
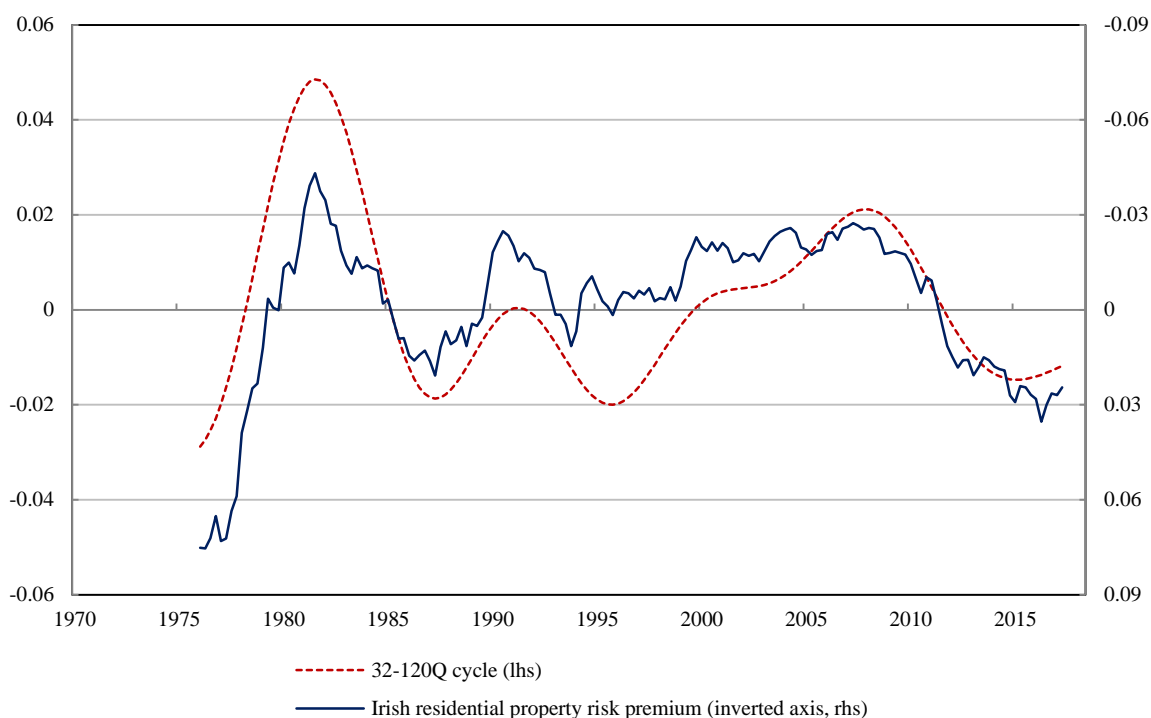
TARGET2 may help to characterise the cycle in future but for now series is too short

TARGET2 is the real-time gross settlement (RTGS) system owned and operated by the Eurosystem. Central banks and commercial banks can submit payment orders in euro to TARGET2, where they are processed and settled in central bank money, i.e. money held in an account with a central bank.

TARGET2 settles payments related to the Eurosystem's monetary policy operations, as well as bank-to-bank and commercial transactions.[20]

We examine TARGET2 (Figure 21, Appendix 2) to attempt to capture the trend in capital flows from overseas (mainly into real estate), which is problematic to separate accurately in the Balance of International Payments data from the Central Statistics Office. TARGET2 is a net asset balance notionally within the Eurosystem, comprising flows into and out of domestic financial systems. Ireland is back in credit, having seen severe capital flight and recourse to borrowing from the Eurosystem during the financial crisis.

The trend in TARGET2 suggests in that Ireland's current financial cycle is in its infancy, in concert with other variables. Unfortunately the series only began in 2001 and, given that

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[20] https://www.ecb.europa.eu/paym/target/target2/html/index.en.html

Figure 11 illustrated that banks have been largely absent, we would not expect TARGET2 to depict the present cycle. TARGET2 is possibly an angle for future research to compare financial cycles across the euro area, but the absence of a long-run time series means that we cannot use it to characterise Ireland's aggregate financial cycle.

Aggregate financial cycle of Ireland

This paper analyses a range of series of property prices and credit in order to illustrate Ireland's financial cycle. As we have noted, the latest financial cycle may not be characterised comprehensively using the standard base of real estate prices and credit provided by the domestic group of credit institutions because of the legacy of the crisis. Households and businesses had to deleverage after the crisis, while banks repaired their capital base. We attempted to fill the gap with a proxy for the flow of capital into Ireland's property market from overseas funders, the risk premium or extra return from property compared with safe securities. Fine-tuning this "property risk premium", reflecting the search for yield that in part drives capital flows might be the basis for future work. Researchers could focus on uncovering alternative indicators that account adequately for the rise of non-bank funding.

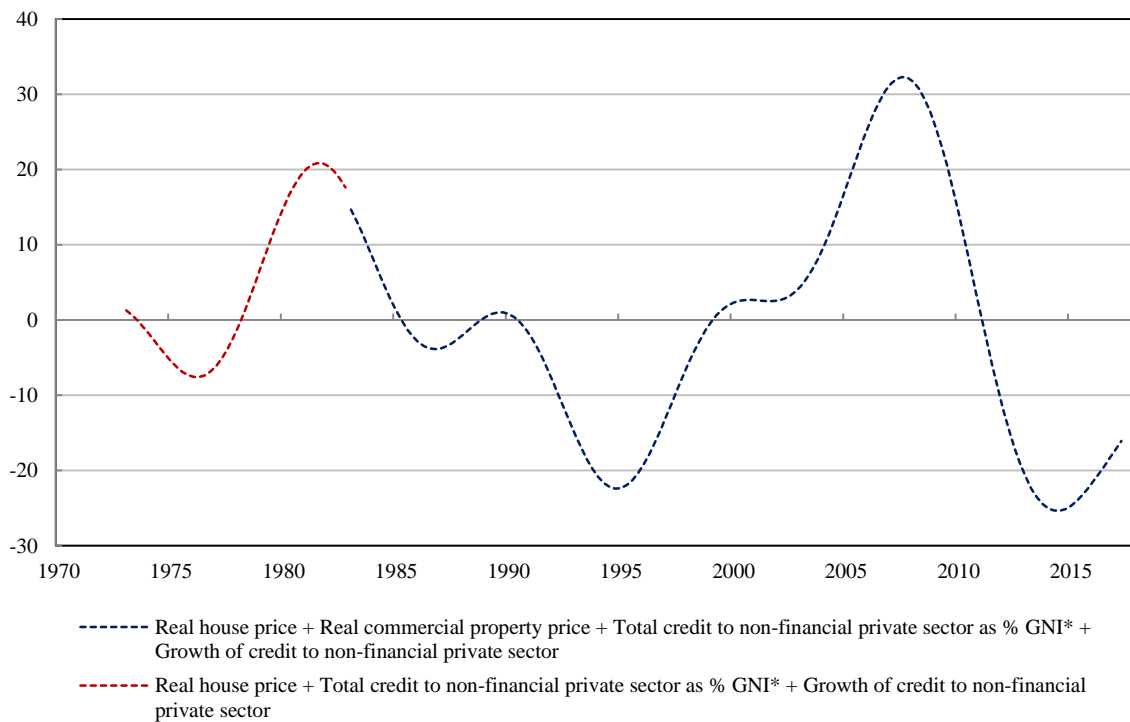Our analysis encompassed the following salient variables:

- Real house prices

- House price valuation ratios

- Real commercial property prices

- Total non-financial credit as a percentage of GNI*

- Total credit growth

- Credit to development, land speculation and construction as a percentage of GNI*

- Alternative metrics of recent capital flows into Ireland

We now aggregate a number of these series to best characterise Ireland's financial cycle. Our preferred metric is what we consider to be the richest combination: house and commercial property prices, total credit as a percentage of GNI* and its growth rate. Figure 15 captures the long run trend (pre-1983 commercial property prices are unavailable so we rely on real house prices for asset prices in property in 1971-83). The following explains the inclusion of each of the four variables in turn.

Real house prices are core (Figure 1) to an economy's financial infrastructure, as the fundamental collateral in the banking system. The housing cycle does not change much at all if we scale real house price changes by incomes or rents (Figures 2 and 17), so we stick with the frequency-based filter of the basic time series of prices.

Figure 15: Complete characterisation of Ireland's financial cycle

- - - - - Real house price + Real commercial property price + Total credit to non-financial private sector as % GNI* + Growth of credit to non-financial private sector

- - - - - Real house price + Total credit to non-financial private sector as % GNI* + Growth of credit to non-financial private sector

We include commercial property prices, as they reveal an extra cycle (Figure 4) in the first half decade of the new century (2000-04) that is absent from the trend in house prices. Commercial property is also more heavily influenced by inward capital flows and global financial conditions. It is also more liquid than housing, as was demonstrated during Ireland's financial crisis: institutions play more of a role in the market. Commercial prices fell by more than residential (two-thirds versus half) and led the price movement in housing in the downswing and upswing.

Like in other countries, credit and property cycles in Ireland are closely correlated (see Figure 10). Rapid lending growth by Irish domestic banks amplified the boom and bust in the first ten years of the new century. Credit is therefore a vital component of the characterisation of the aggregate cycle. Interestingly, we also find that credit seems to lead property prices in Ireland more clearly since the early 1990s. This is also evident in the raw data.

We also want to scale credit growth by the size of the economy. There are certain periods where credit is growing faster than the economy e.g. 2001-07, amplifying the financial cycle, and other times where it undershoots economic growth. In the first few years after the crisis, credit actually contracted while the economy recovered, hindering the financial cycle. For the credit scaling variable we choose modified Gross National Income (GNI*) because it is the best guide to the true size of Ireland's economy.

There is one drawback which led us to examine the inclusion of a variable ("property risk premium") that might capture the foreign capital inflows in recent years. Further research could examine whether these inflows (Figure 12) have amplified Ireland's financial cycle

recently. The difficulty is that our fourth variable, credit/GNI*, is missing this piece from the numerator but not from its indirect impact on the denominator (Figure 20). In other words, true credit (liquidity) growth may have been closer to economic growth in recent years if there was an adequate way of incorporating foreign capital inflows to real estate in particular.

In our aggregate characterisation, Ireland's current financial cycle is around its mid-point. There are caveats: as note in the above paragraph the absence of full data on non-bank flows to augment credit in the latest medium-term financial cycle might be a drawback. Similarly, the recovery in bank credit growth itself has been confined principally to mortgages and non-construction corporate credit. It is arguable that the cycle is more advanced, accounting for the broader concept of liquidity or shadow banking than credit alone.

Ireland's cycle could come to a premature end if financial conditions were to tighten in the U.S, given our reliance on liquidity from that source in recent years. It is clear from Figure 16 that the equivalent aggregate cycle for the U.S. is more advanced. Since the Federal Reserve is deep into its rate-hiking schedule, the possibility of a top in the U.S. financial cycle is clear. Although this is a clear threat for Ireland's macroeconomy, the domestic banking system is less exposed thanks to its lack of reliance for foreign-financing and drastically reduced exposure to the property market. Foreign owners of dry Irish real estate (and associated loans) may have more reason for concern.

Figure 16: Ireland and the US financial cycle
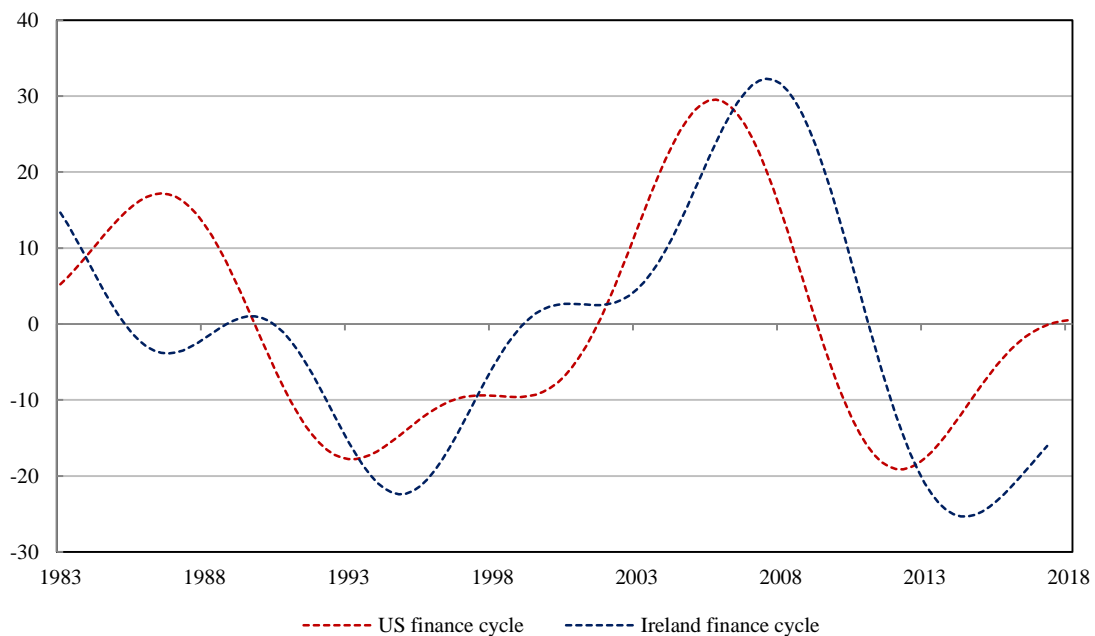
Of course, Ireland would still be affected by another significant downturn in the global financial cycle. Its economy of only five million people is hugely reliant on global capital flows. Some of the effects would be similar to 2008-11: a downturn in fixed investment in the economy as for example business expansion plans of MNCs are reassessed, lower property prices that negatively impact household consumption and business investment) and rising loan losses for domestic banks after a lag. But the liquidity squeeze would probably not be

near as severe as in 2007-08 (the banks are now domestic deposit funded), while Irish-owned banks have thus far avoided lending against overvalued real estate in this cycle.

6. Conclusion

Irish citizens have experienced the power of the financial cycle. The end of an aggressive medium-term cycle in 2007 led to near economic depression. But Ireland was a microcosm of a global trend: the co-movement of credit and asset prices has dominated the traditional business cycle since the late 1980s. This coincided with increasingly activist monetary policy from the Federal Reserve, in effect the introduction of the "Greenspan Put".

In this paper, we have characterised Ireland's financial cycle since 1971. Along the way, we made a number of findings. Mortgage volume leads house prices by at least a year. This emphasises the importance of banks in fuelling financial cycles.

We find that lending for development dominates credit provided to (non-financial) corporates. This was not just the case in the dramatic 2002-2007 cycle when lending for land and development increased ten-fold, but has been consistent through time. In past financial cycles, Ireland's banks preferred to lend against collateral and behaved pro-cyclically.

Fortunately for the economy, the latest Irish cycle is different. Non-banks (mainly foreign-owned) have filled the void left by banks that have been reducing their balance sheets. This means that the Irish banking system is not "on-risk" as much as pre-crisis if something goes wrong with its financial cycle in the next few years. Due to the unique nature of the current financial cycle, we attempt to account for these new liquidity sources that have replaced domestic credit. On the face of it, many of our standard variables for debt (loans to the private sector or their rate of growth) suggest that the financial cycle which commenced in 2012 is not far advanced. Yet as Figure 11 shows, the banking system was disintermediated during its years of deleveraging. In the absence of an adequate data source for these direct capital flows into Ireland's asset markets, we have introduced a proxy: the property risk premium. We hope that this gap – how to fully account for shadow banking liquidity – might be filled by further research on Ireland's financial cycle.

Our results indicate that the current cycle is about half-way complete even accounting for the fact that credit has been augmented by non-bank sources of liquidity since the trough of 2011-2012. Ireland's financial cycle could be curtailed early if credit conditions tightened in the U.S., where the property market and business lending are more advanced (see Figure 18).

Finally, we characterise fifty years of the financial cycle in one series of the medium-term (32-120 quarters) trend. As explained above, the depiction of the cycle is not ideal post-crisis, but it does not lose much potency or consistency. We find that commercial property prices add richness to the observable trend, particularly by identifying a mini-cycle in 2000-2004 and amplifying the two cycles of the 1980s. We favour a four-variable series: real residential and commercial property prices; total credit as a percentage of national income; and credit growth to best characterise Ireland's financial cycle since 1971.

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Appendix 1: Methodology

Christiano and Fitzgerald Band-pass filter

The "ideal" band-pass filter can be used to isolate the component of a time series that lies within a particular band of frequencies, but applying this filter requires a data set of infinite length. Since economic crisis in history visited every 8 years averagely, Christiano and Fitzgerald employed a band-pass filter to isolate medium-term cycles with duration between 8 and 30 years (or 32 and 120 quarters) and short-term with 2 and 8 years. The part shorter than 2 years may be regard as noise and any trend above 30 years could be called super cycle.

The turning-point algorithm

It involves two key steps: (1) identifying local maxima and minima over a specific window; (2) imposing censoring rules, so as to guarantee a minimum length of the cycle (ie the distance between two consecutive peaks or troughs) as well as a minimum length of each phase (ie from peak to trough or trough to peak). In addition, the algorithm requires peaks and troughs to alternate. We also impose the restriction that a trough (peak) has to be lower (higher) than the preceding peak (trough).

Extended HP - filter

We assume the following three relationships between y_t (output, GDP) and observable item g_t (trend) and c_t (cycle):

$$y_t = g_t + c_t$$

$$g_{t+1} = 2g_t - g_{t-1} + \varepsilon_t^g$$

$$c_t = \theta c_{t-1} + \delta z_t + \varepsilon_t^c$$

ε_t^g and $\varepsilon t \ c$ are White noise error term with unit variance and zero mean. z_t is exogenous variable, such as real house price and credit volume. The third equation above is designed to neutralize c_t with financial cycle variables. Similar to the normal HP-filter, we aim to minimise the target equation:

$$\min_{g_t} \left(\sum_{t=1}^{T} (c_t)^2 + \lambda \sum_{t=2}^{T-1} [(g_{t+1} - g_t) - (g_t - g_{t-1})]^2 \right)$$

This extended HP-filter cannot be estimated as original after adding auto-regressive and exogenous items into the c_t equation. It could be estimated by state space model and Kalman filter. After stripping out the financial cycle adjusted cyclical item from output, we construct

financial cycle adjusted budget balances with estimated elasticity of tax and government expenditure to output. Here we use historical average elasticity (Borio (2012) used OECD estimates). The differences between the cyclically adjusted budget balances reflect solely those arising from output gap estimates.
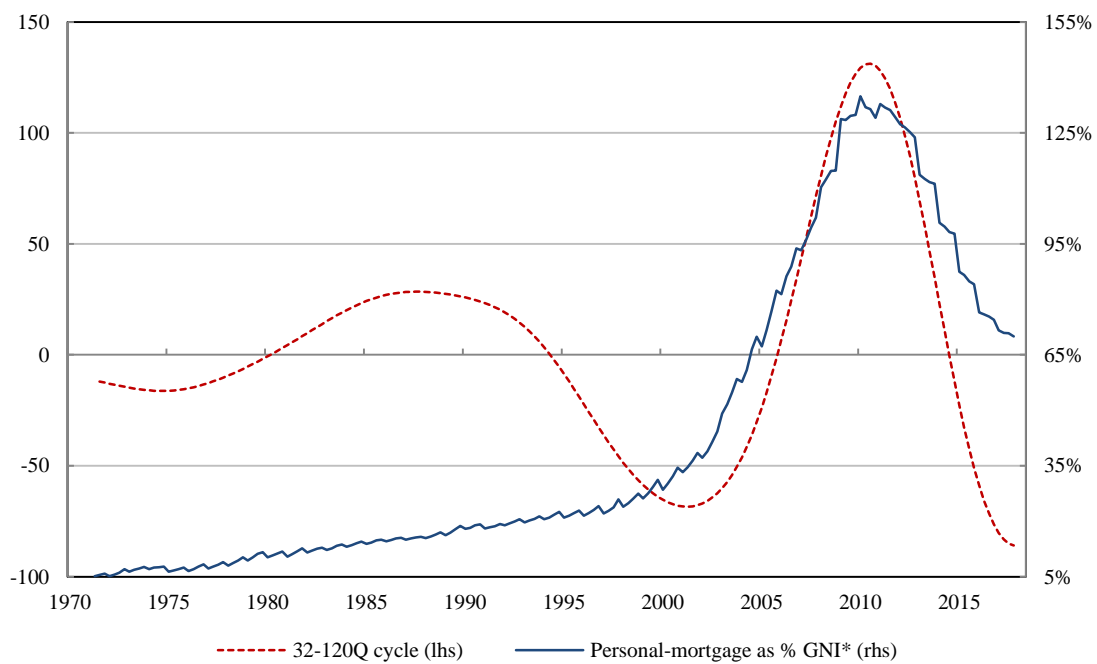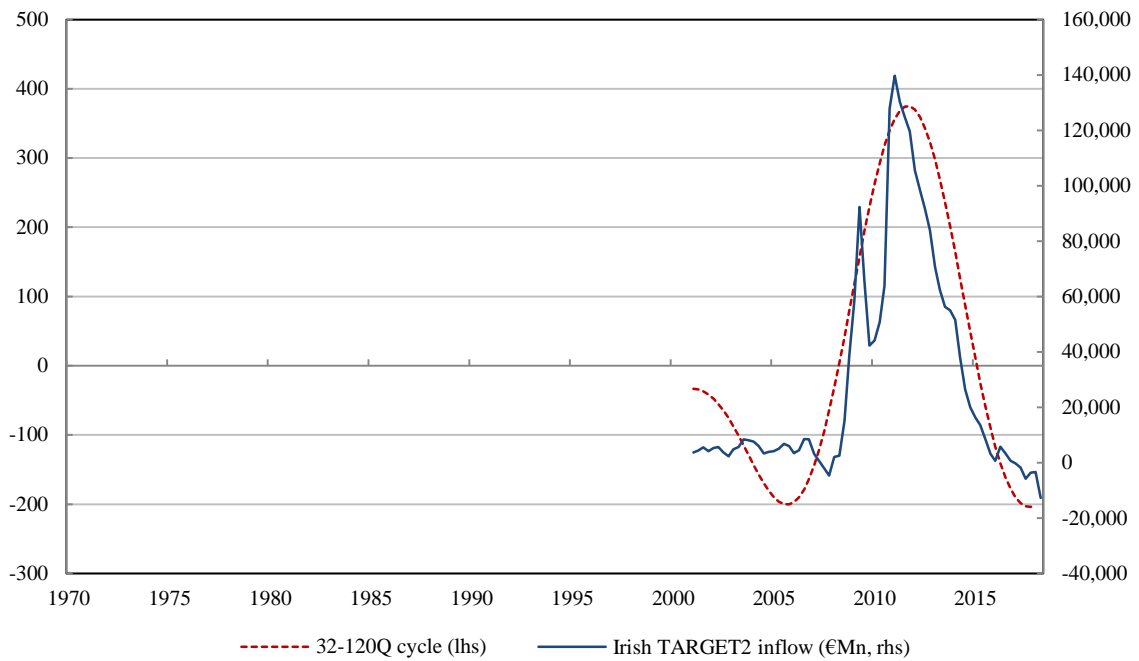
Appendix 2: Results of other variables
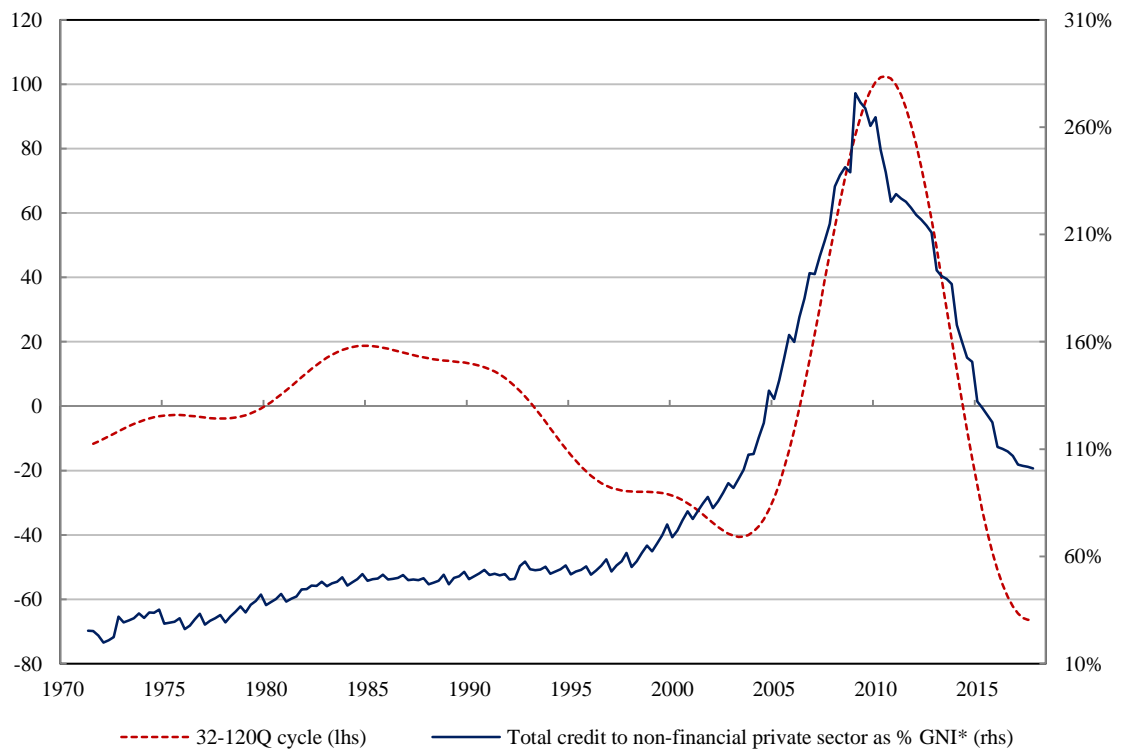
Figure 17: House price to rent ratio
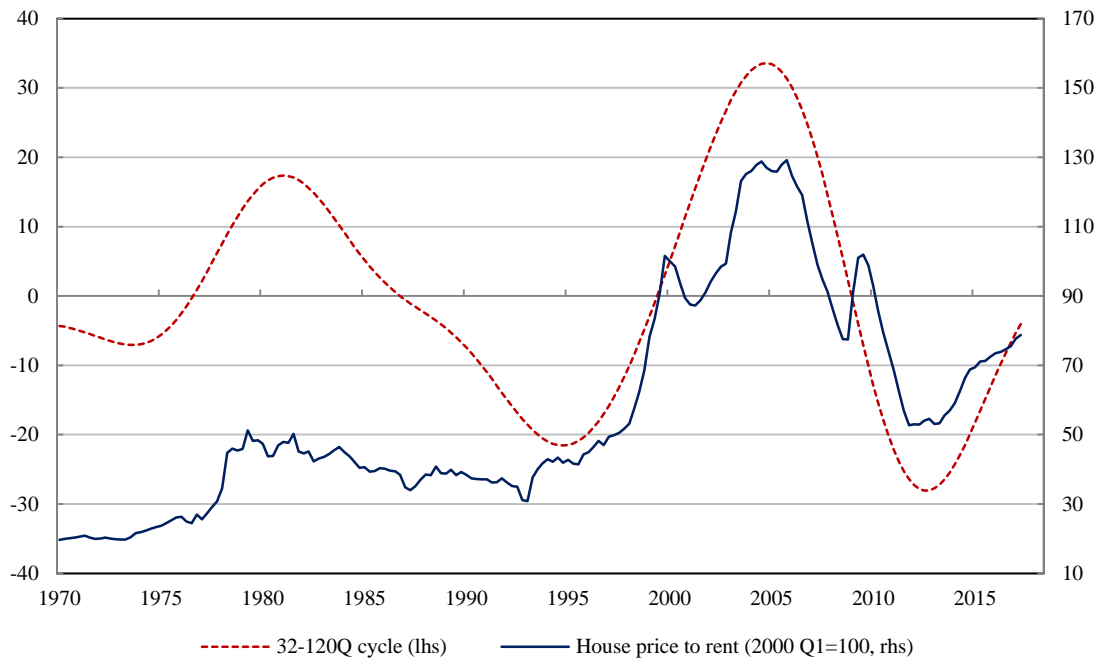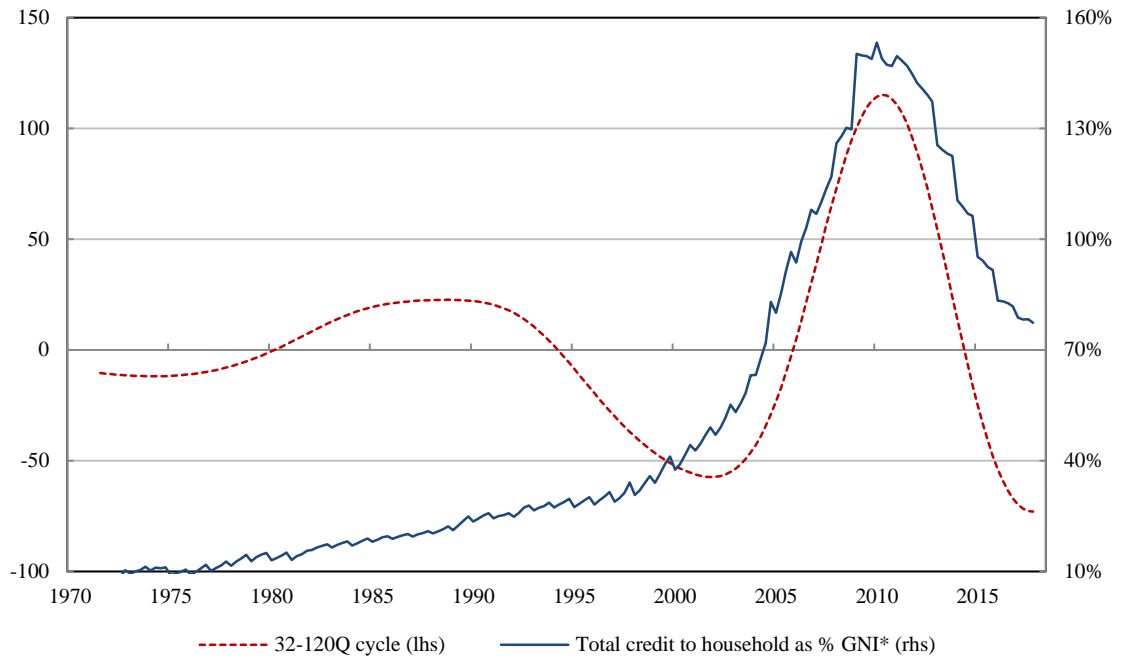

Figure 18: Household mortgage credit % GNI*
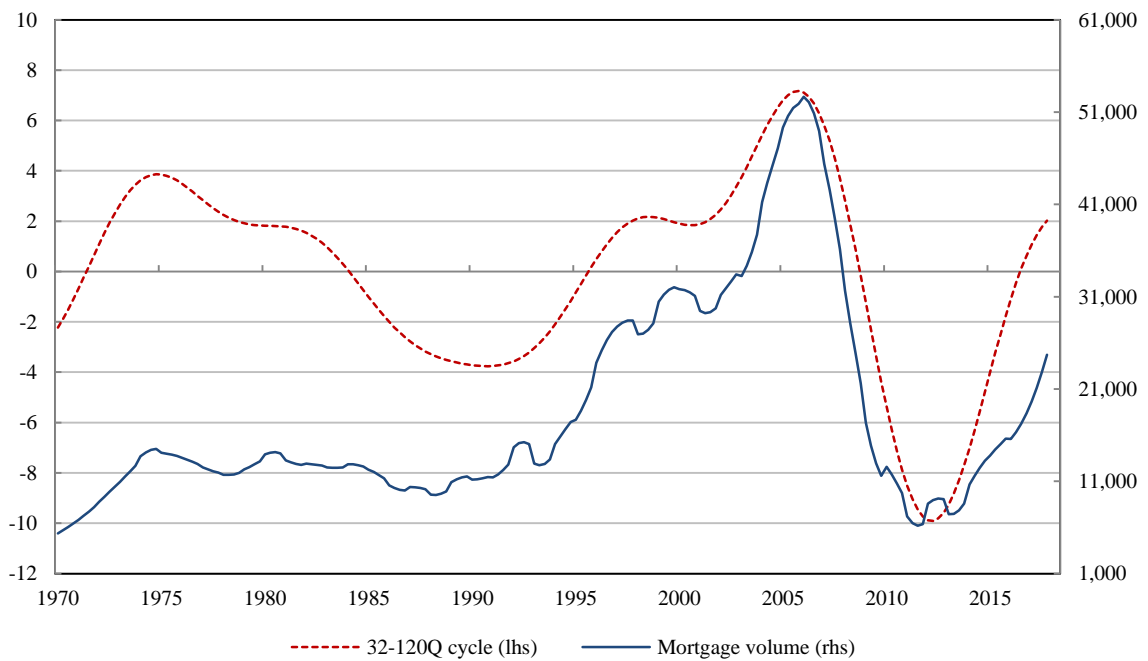
Figure 19: Irish TARGET2 inflow

- - - - 32-120Q cycle (lhs)   ——— Irish TARGET2 inflow (€Mn, rhs)

Figure 20: Total credit to non-financial private sector as % GNI*

- - - - 32-120Q cycle (lhs)   ——— Total credit to non-financial private sector as % GNI* (rhs)

Figure 21: Total credit to households as % GNI*

- - - - 32-120Q cycle (lhs)   ——— Total credit to household as % GNI* (rhs)

Figure 22: Mortgage volume

- - - - 32-120Q cycle (lhs)   ——— Mortgage volume (rhs)

Figure 23: Credit to construction as % GNI*

Legend: - - - - 32-120Q cycle (lhs)   —— Credit to Construction as % GNI* (rhs)
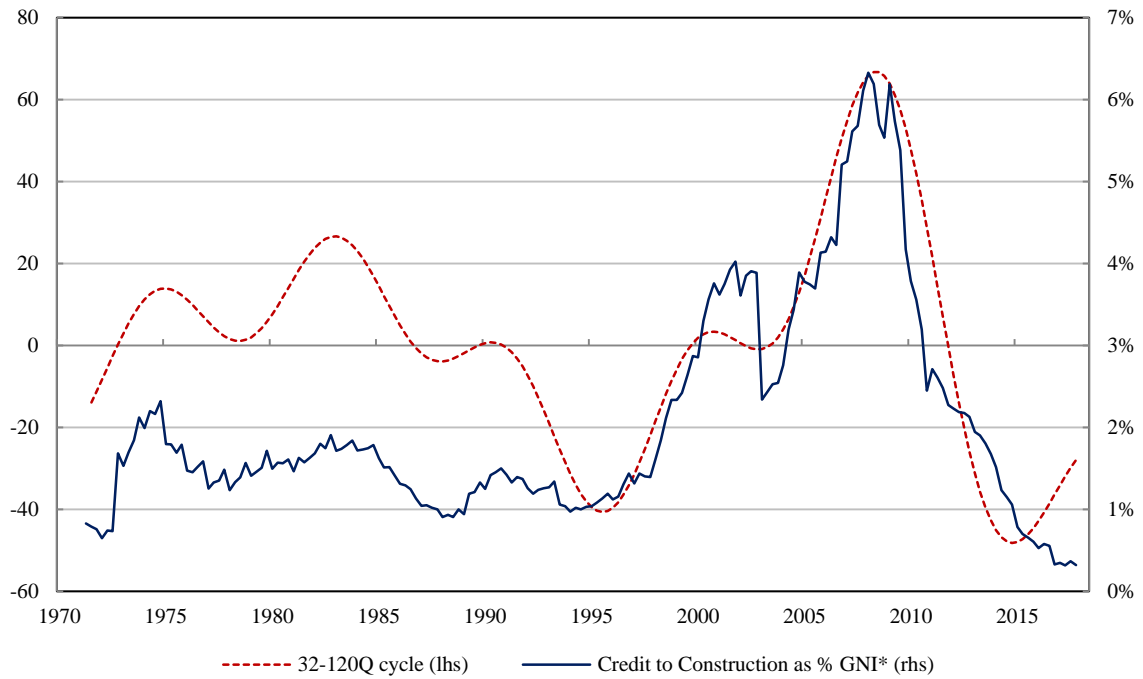
Figure 24: Credit to real estate activities as % GNI*

Legend: - - - - 32-120Q cycle (lhs)   —— Credit to real estate activities as % GNI* (rhs)
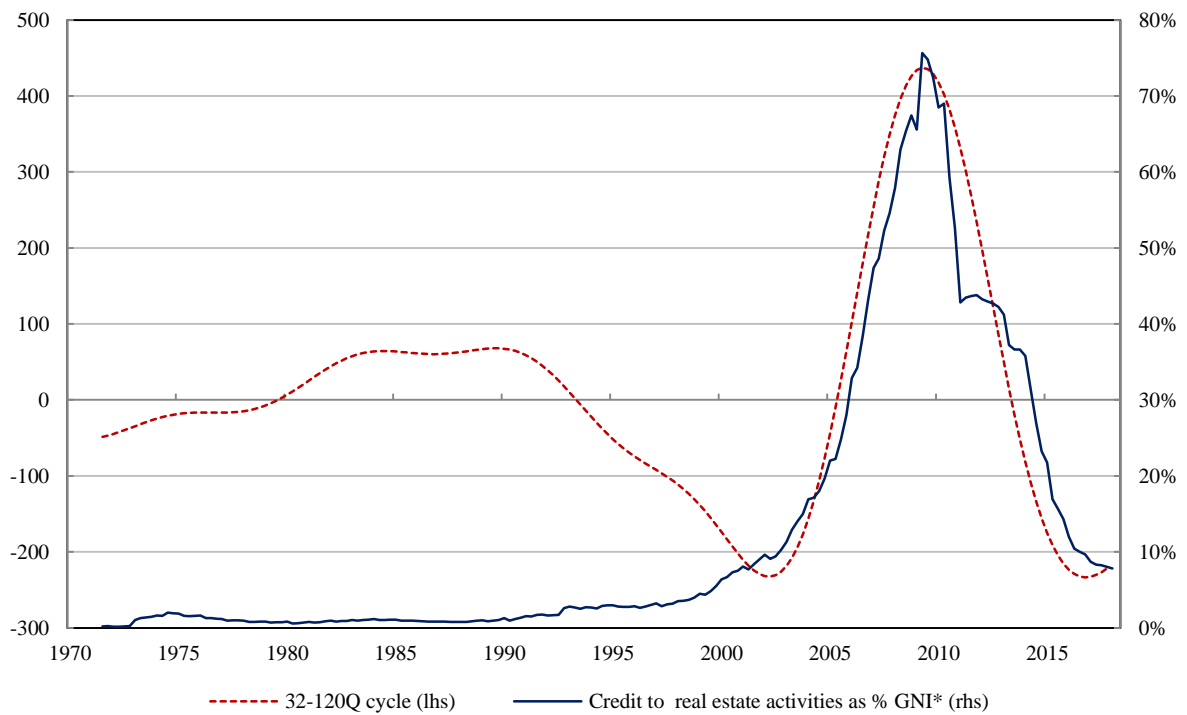
Figure 25: Credit to personal non-mortgage as % GNI*

- - - - 32-120Q cycle (lhs) ——— Personal non-mortgage as % GNI* (rhs)
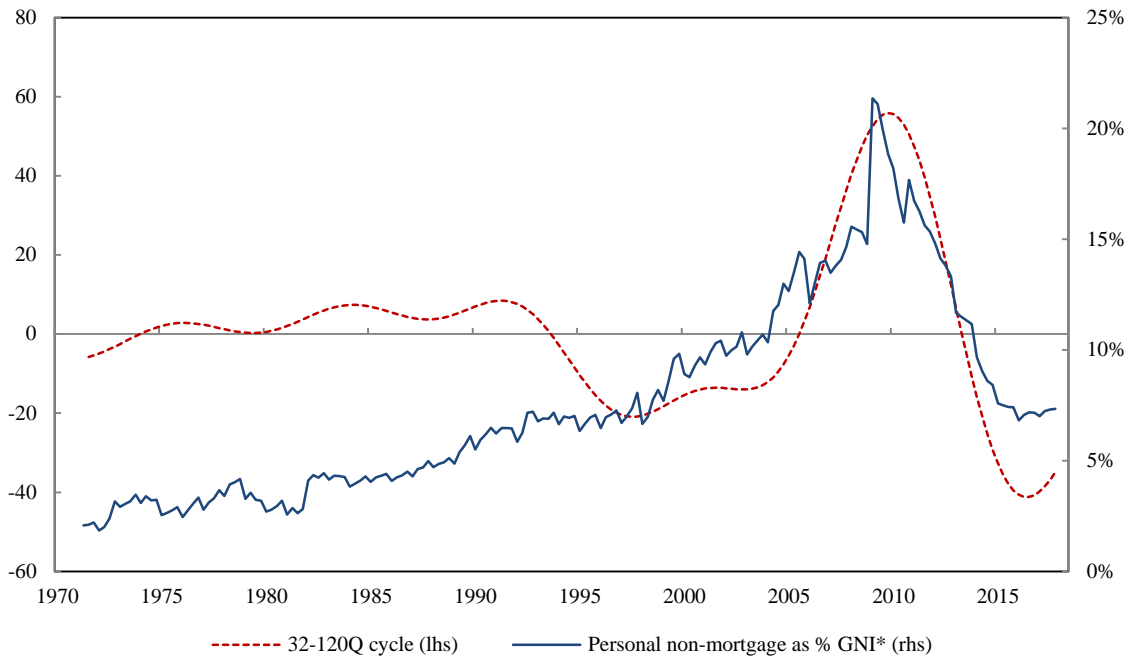
Figure 26: Growth of credit to households

- - - - 32-120Q cycle (lhs) ——— Growth of credit to households (rhs)
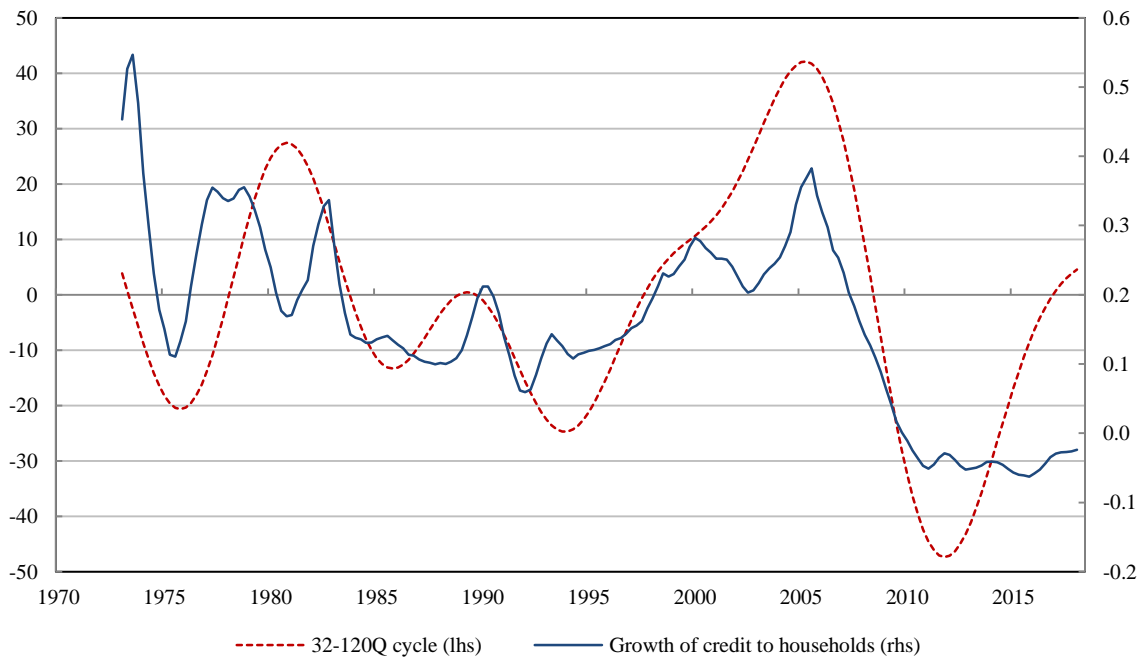
Figure 27: 32-120Q cycles in real house prices and mortgages as % GNI*

Real house price (lhs) --- Personal-mortgage as % GNI* (rhs)
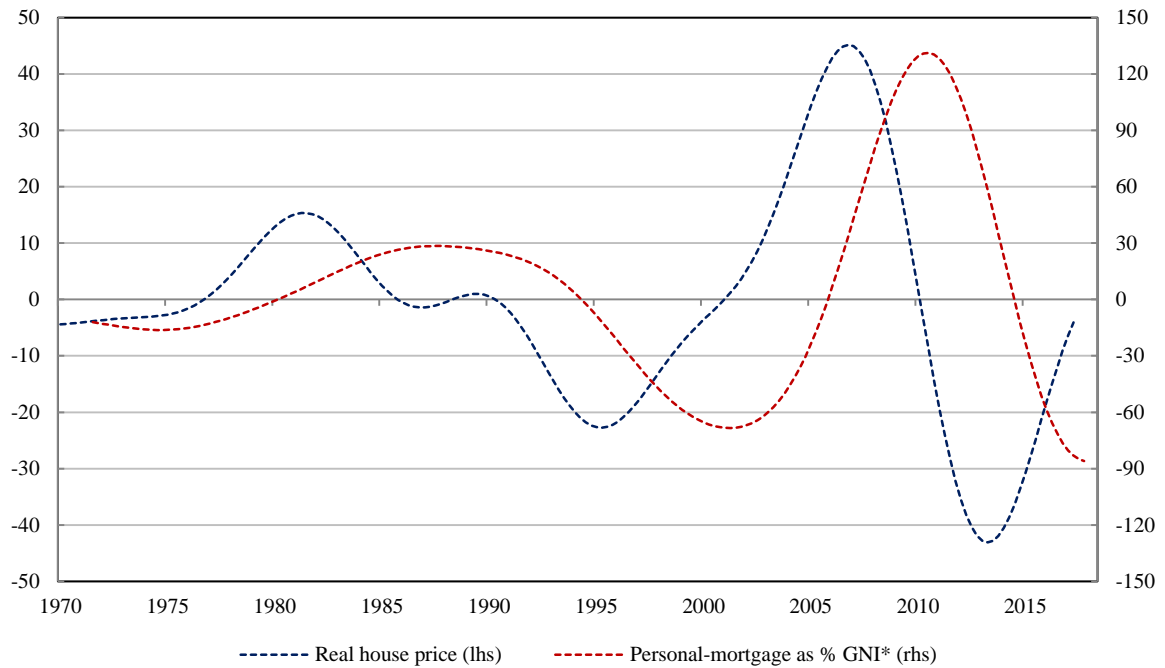
Figure 28: 32-120Q cycles in real house prices and credit to cstr./ real estate as % GNI*

Real house price (lhs) --- Credit to Construction & real estate activities as % GNI* (rhs)
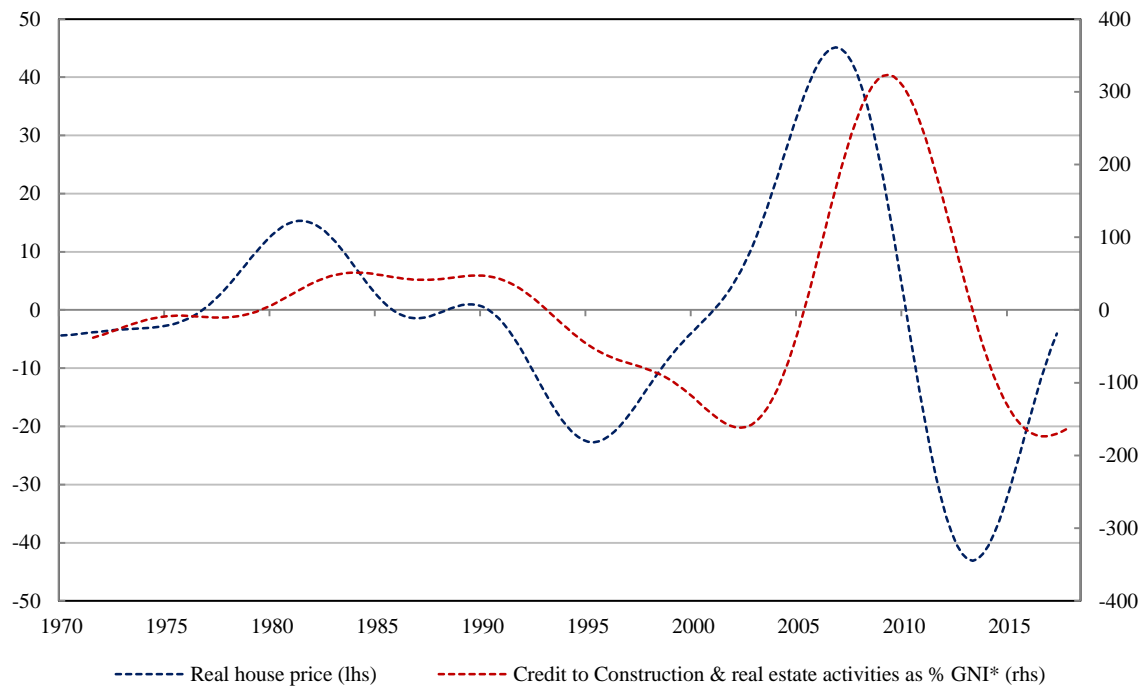
Figure 29: 32-120Q cycles in real commercial property prices and credit to construction as % GNI*
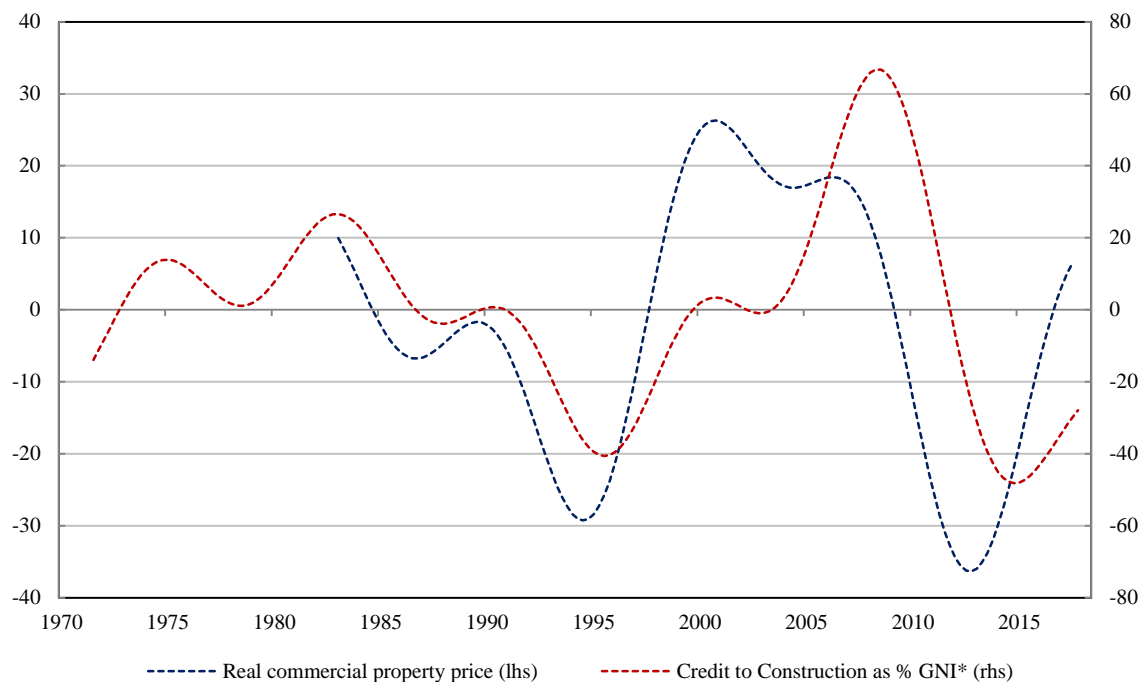
Table 2: Summary Statistics of data series

	Mean	Median	Max	Min	Std
Real house price index	71.3	50.1	163.3	33.0	37.0
Real commercial property price index	263.6	209.3	514.6	142.6	119.6
Mortgage volume (annual)	18,481	13,137	52,662	5,367	11,423
Credit to NFC as % GNI*	54.1%	43.3%	122.3%	23.3%	28.1%
Credit to HH as % GNI*	59.7%	54.2%	103.4%	28.2%	22.9%
House price to income index	101.3	97.2	163.1	74.8	22.0
House price to rent index	80.4	64.5	181.7	26.6	42.5
Private non-financial sector credit as % GNI*	252%	203%	491%	97%	128%
Irish Composite Stress index (ICSI)	10%	6%	58%	1%	11%
IR_TARGET2	-28,985	-6,407	5,857	-139,694	39,992
Irish residential property risk premium	0.01	0.02	0.05	-0.07	0.02
Irish commercial property risk premium	0.00	0.01	0.04	-0.05	0.02
Credit to Construction as % GNI*	2.2%	1.7%	6.4	0.4	1.3
Credit to real estate activities as % GNI*	13.0%	2.9%	75.8%	0.3%	19.3%
Credit to Construction & real estate activities as % GNI*	15.2%	4.2%	82.0%	1.0%	20.3%
Personal-mortgage as % GNI*	42.5%	21.3%	134.9%	5.1%	40.7%
Personal non-mortgage as % GNI*	7.7%	7.0%	21.5%	1.9%	4.4%
Total credit to NFC as % GNI*	39.2%	28.9%	125.6%	12.8%	25.2%
Total credit to HH as % GNI*	50.0%	28.1%	153.2%	7.1%	44.7%
Total credit to non-financial private sector as % GNI*	89.1%	53.7%	275.8%	19.9%	68.1%