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SHORT AND MEDIUM TERM FINANCIAL-REAL CYCLES: AN EMPIRICAL ASSESSMENT

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ABSTRACT

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Key words: Minsky, financial accelerator, financial cycle, business cycle

JEL codes: E32, G01

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1 Introduction

Theories of financially driven business cycle dynamics have enjoyed a resurgence of interest since the financial crises of 2007-8. The literature takes a variety of theoretical standpoints, including Minskyan theories of financial instability (Minsky, 2008, 2016; Nikolaidi and Stockhammer, 2017), and New Keynesian theories of the financial accelerator (Kiyotaki and Moore, 1997; DeGrauwe and Macchiarelli 2015). Despite some disagreement about the exact channels, these theories share a common core. They all postulate an interaction mechanism between the financial and the real side of the economy that drives macroeconomic fluctuations. Expansions in real activity gradually lead to a financially fragile environment, which in turn has a negative effect on the real economy. The interplay of these two channels over time generates what we call a 'financial-real cycle'.

Recent empirical research has highlighted different frequencies of business cycles on the one hand, and financial cycles on the other (Drehmann et al., 2012; Borio, 2014; Aikman et al., 2015; Strohsal et al., 2015). While regular business cycle dynamics in real activity are considered to take place with periods of up to 8 years, financial cycles appear to have a lower frequency with cycle lengths between 8 and 30 years (Borio, 2014).[1] Real activity, however, has also been found to have medium-frequency fluctuations of around 10-12 years (Comin and Gertler, 2006; Drehmann et al., 2012). The findings of different cycle frequencies of output and financial variables have interesting implications for theories of financial-real cycles. It suggests that different cycle frequencies in time series of real activity may be explained by different financial variables.

Thus there is an interesting literature comparing financial and real cycles, but the empirical literature that exists to date has largely remained at a descriptive level. In particular, although there are some theoretical investigations of the subject (e.g. Kiyotaki and Moore 1997; Bernanke et al. 1999; Ryoo 2010, 2013, 2016), there appear to be no empirical investigations attempting to disentangle the causal mechanisms driving financial-real interactions. A recent exception is the study by Ma and Zhang (2016), which jointly estimate an output gap equation, a Phillips curve, a monetary policy function, and an equation with a composite

[1] The length of a cycle is measured by the number of time periods between two adjacent peaks (or troughs). The frequency of a cycle is the inverse of its length.

financial cycle index for the USA, UK, Japan, and China. They find that shocks to the financial cycle index explain between 35% to 44% of the variance in the output gap and interpret this as evidence for an important role of the financial cycle in business cycle dynamics. However, the key source of fluctuations in this approach are exogenous shocks to the financial cycle index, rather than an endogenous interaction mechanism between the financial and real economy. The contribution of the present paper is to estimate this endogenous interaction mechanism. To achieve this, we use a simple VAR-based method, in which the necessary conditions for the existence of an interaction cycle can be evaluated empirically. At the same time, the cycle period implied by the VAR can easily be computed, allowing us to map specific interaction mechanisms onto specific cycle lengths. The model is estimated for seven OECD countries over the period 1970 to 2015. Using this method, we find evidence for a financial-real interaction mechanism, (i) at high frequencies between interest rates and GDP for five countries, and (ii) at low frequencies between business debt and GDP for six countries.

The remainder of the paper is structured as follows. Section 2 provides a short review of the literature on financially driven business cycles and financial cycles. Section 3 presents a simple empirical framework for investigating financial-real cycles. Section 4 describes the data set and presents stylized facts. Section 5 presents the main estimation results with GDP as the real variable, while section 6 provides further results with those subcomponents of GDP which are expected to be affected by the financial variables. Section 7 concludes.

2 Financial-real cycles: A brief review of the theory

As noted above, there are two broad research programmes examining financial-real cycles: the Minskyan literature and the New Keynesian literature on the financial accelerator. Hyman Minsky's financial instability hypothesis (Minsky, 2008 [1975]; Minsky, 2016 [1982]) has become a classical account of financially driven business cycles, which has slowly moved into the mainstream since the 2007-8 crises (Eggertsson and Krugman, 2012). A key aspect of Minsky's theory is the claim that financial fragility increases during economic expansions. Specifically, during periods of confidence, firms increase their investment, and adopt increasingly risky financial positions to do so. At a certain point, however – due to accelerator effects, debt overhang, or endogenous increases in interest rates – a tipping point is followed by a bust.

A sizeable theoretical literature studies various formalisations of Minsky's financial instability hypothesis, a large part of which is surveyed in Nikolaidi and Stockhammer (2017). Some authors assign a key role to the rate of interest in the cycle mechanism (Foley, 1987; Jarsulic, 1989), and a small number to household debt (Ryoo, 2016; Palley, 1994), but the vast majority focus on corporate debt. Whilst the majority of papers appear to assume financial-real cycles at business cycle frequency, Ryoo (2010, 2013, 2016) offers various models in which long financial cycles in business or household debt and asset prices coexist with high frequency business cycles.

The benchmark New Keynesian model of financially driven business cycles is the financial accelerator model (Kiyotaki and Moore, 1997; Bernanke et al., 1999). In a similar manner to Minsky's theory, balance sheets play an important role in financial accelerator models, creating a link between the financial and the real economy. As asset prices inflate over the business cycle, credit constraints relax, so that the credit supply exerts a pro-cyclical effect. This mechanism is integrated into the standard New Keynesian model, so that stochastic shocks create output fluctuations that are amplified by the financial accelerator.

In Kiyotaki and Moore (1997), credit limits vary endogenously over the business cycle due to their dependence on pro-cyclical asset prices. A predator-prey type of interaction mechanism between debt and asset holdings then generates damped oscillations: a rise in asset prices increase net worth, which leads to more borrowing. Higher leverage, in turn, reduces aggregate demand which pulls down asset prices. Similarly, in Bernanke et al. (1999), a shock may lead to an increase in investment and asset prices. Recently, the financial accelerator has been integrated into behavioural models of business cycle dynamics in which heterogeneous agents and credit networks allow for a rich description of the propagation process of adverse shocks (Delli Gatti et al., 2010; Bofinger et al., 2013;De Grauwe and Macchiarelli, 2015).

Thus, there exists a rich theoretical literature postulating interactions between the real economy and financial variables, where the latter includes interest rates, business debt, and household debt. In the next section we propose a simple empirical framework in which these interaction mechanisms can be examined.

3 A simple empirical framework for financial-real cycles

The cycle-generating interaction mechanism that is at the heart of financially driven business cycle theories can be formalised in a simple manner as follows. Consider a reduced form system in which a real variable (y) and a financial variable (f) interact with each other over time:

$$(1)\qquad \begin{aligned} y_t &= \alpha_0 + \alpha_1 y_{t-1} + \alpha_2 f_{t-1} \\ f_t &= \beta_0 + \beta_1 y_{t-1} + \beta_2 f_{t-1} \end{aligned}$$

The system in (1) is consistent with the reduced forms of the financial accelerator model in Kiyotaki and Moore (1997, p. 235), and in the Minsky model in Asada (2001, p. 79), for example. The Jacobian matrix $\boldsymbol{J}$ of the system has the following structure:

$$(2)\qquad \boldsymbol{J} = \begin{bmatrix} J_{11} & J_{12} \\ J_{21} & J_{22} \end{bmatrix} = \begin{bmatrix} \alpha_1 & \alpha_2 \\ \beta_1 & \beta_2 \end{bmatrix}$$

Oscillations in (1) exist when the eigenvalues of the Jacobian in (2) are complex conjugates.[2] As the eigenvalues (λ) are the roots of the following characteristic equation

$$\lambda^2 - \lambda Tr(J) + Det(J) = 0,$$

with roots $\lambda_{\pm} = \frac{Tr(J) \pm \sqrt{Tr(J)^2 - 4Det(J)}}{2}$,

the condition for oscillations can be expressed in terms of the discriminant Δ which must be negative for complex eigenvalues. This condition can be re-written as follows:

$$\begin{aligned} \Delta &= Tr(J)^2 - 4\,Det(J) < 0 \\ &= (J_{11} + J_{22})^2 - 4(J_{11}J_{22} - J_{21}J_{12}) < 0 \\ &= (J_{11} - J_{22})^2 + 4J_{21}J_{12} < 0. \end{aligned}$$

[2] Note that the presence of complex eigenvalues is a necessary condition for damped oscillations in (1), as well as closed orbits.

The first term of the condition is always positive. Then it is immediate that a necessary condition for the existence of oscillations must be $J_{21}J_{12} < 0$, or $\alpha_2\beta_1 < 0$ in (1). This condition has a clear economic intuition: cycles in both variables of the system in (1) can only emerge if there is an interaction between the two state variables of the system by which an increase in one variable induces an acceleration of the second variable, which in turn drags down the first. As noted in sections 1 and 2 above, theories of financial-real cycles generally assume that the financial variable exerts a negative effect on the real variable, whereas the real variable pushes up the financial variable.

As a system of difference equations is closely related to a VAR model, in principle the system in (1) can be estimated in a straightforward manner by the addition of a vector white noise error process. However, the system in (1) potentially constitutes a simplification of the data generating process, which may be a higher-dimensional, higher-order dynamic system. In principle, almost any linear dynamic system can be approximated by a VAR with sufficient lags (Lütkepohl, 2005, chap. 15), and if these higher-order lags are omitted from the estimated model, they will be reflected in serial correlation in the error terms. To allow us to estimate the financial-real interaction mechanism without misrepresenting the data generating process, the fully specified empirical framework for financial-real cycles utilised in the present paper is therefore as follows:

(3) $$y_t = \alpha_0 + \alpha_1 y_{t-1} + \alpha_2 f_{t-1} + u_{yt}$$
$$f_t = \beta_0 + \beta_1 y_{t-1} + \beta_2 f_{t-1} + u_{ft},$$

with

(4) $$u_{yt} = \sum_{i=1}^{p} \rho_i u_{yt-i} + \epsilon_{yt}$$
$$u_{ft} = \sum_{i=1}^{p} \theta_i u_{ft-i} + \epsilon_{ft}$$

where $\epsilon_{yt}$and ϵ_{ft} are white noise error terms. Substituting (3) into (4) and re-arranging, we have,

(5) $$y_t = \alpha_0 + \alpha_1 y_{t-1} + \alpha_2 f_{t-1} + \sum_{i=1}^{p} \rho_i (y_{t-i} - \alpha_0 - \alpha_1 y_{t-i-1} - \alpha_2 f_{t-i-1}) + \epsilon_{yt}$$
$$f_t = \beta_0 + \beta_1 y_{t-1} + \beta_2 f_{t-1} + \sum_{i=1}^{p} \theta_i (f_{t-i} - \beta_0 - \beta_1 y_{t-i-1} - \beta_2 f_{t-i-1}) + \epsilon_{ft}$$

which is a VAR with p lags[3] in which α_2 and β_1 are the only parameters in (1) which are uniquely identified. By estimating the higher-order VAR in (5), we can therefore evaluate the necessary condition for the existence of financial-real cycles in (1), i.e. $\alpha_2\beta_1 < 0$.

The VAR approach also allows us to obtain the eigenvalues of the Jacobian matrix of the system. If there is at least one pair of complex conjugate eigenvalues, the implied cycle length can be calculated. To see this more clearly, consider the complex eigenvalue $\lambda = h \pm \Omega i$. The polar form of this eigenvalue is $\lambda = R(cos\theta \pm i.sin\theta)$, where $R = \sqrt{h^2 + \Omega^2}$ is the modulus of the complex eigenvalue and θ is an angle measured in radians. In the solution to the difference equation system (3), the eigenvalue will appear in the form λ^t. By De Moivre's theorem, this expression can be transformed into polar form as follows: $\lambda^t = [R(cos\theta \pm i.sin\theta)]^t = R^t(cos\theta t \pm i.sin\theta t)$. In the latter trigonometric expression, the implied length of the cycles is given by: $\frac{2\pi}{\theta} = \frac{2\pi}{arccos\left(\frac{h}{R}\right)}$. Thus, each complex eigenvalue of the estimated dynamic system corresponds to a distinct cycle frequency in the solution path to the system (Shibayama, 2008).

Note, however, that since the VARs generally have a lag-order of more than one, the existence of complex eigenvalues in the VARs by itself does not necessarily imply that there is a cycle mechanism of the kind described above. On the other hand, if there are no complex eigenvalues, it can be concluded that the system does not generate cycles (although the necessary condition for a cycle mechanism may be satisfied). The existence of complex eigenvalues is therefore a second necessary condition for a financial-real cycle, along with the interaction mechanism given by $\alpha_2\beta_1 < 0$.

For the real variable in (5), we use the log of real GDP. As the theoretical literature discussed in section 2 is relatively agnostic concerning the crucial financial variable, we consider the short-term real interest rate (*INTR*), the ratio of non-financial corporation debt to GDP

[3] In practice, as most of the parameters in (5) are not uniquely identified, we estimate unrestricted VAR(p) models. To determine the lag length, we start with a minimum lag length of 2, unless the Bayesian Information Criterion (BIC) suggests a higher value. We then check for serial correlation in the residuals and successively increase the number of lags until all serial correlation is removed. Note that we impose a minimum lag length of 2 to permit complex eigenvalues (oscillatory dynamics) even when $\alpha_2\beta_1 \nless 0$. Thus the existence of a cyclical component *per se* does not bias our results.

(*NFCD*), and the ratio of household debt to GDP (*HHD*).[4] To see how each of these interact with output, consider the interest rate first. There is broad agreement that if increases in real interest rates have an effect on the real economy, it is negative. If the central bank follows a Taylor rule with an output gap in its loss function, one would expect rising policy rates during the boom phase. This can reduce aggregate output either via a contractionary effect on investment or consumption. The effect on investment may be due to a reduction of internal sources of finance (i.e. the net worth of the firm). Contractionary effects on consumption are expected if households increase their savings to smoothen consumption or due to a redistribution of income to creditors with a lower propensity to consume.

The case of business and household debt is similar. In the Minskyan theoretical literature, for example, high levels of corporate debt will generally discourage business investment in the capital stock. Corporate debt is thus expected to interact mostly with non-residential investment. Household borrowing acts as a dampening factor in the financial accelerator models discussed in section 2. Here one would expect the contractionary effect to run mostly via consumption and/or residential investment, which are the components of aggregate output that are most directly linked to the spending decisions of households. Lastly, an expansion in the real economy encourages a relaxation of lending standards in this class of models, and therefore has an expansionary effect on leverage ratios. Based on the foregoing, we expect $\alpha_2 < 0$ and $\beta_1 > 0$ in (5), yielding the necessary condition $\alpha_2\beta_1 < 0$ for oscillations.

4 Data and stylized facts

Our data set is at annual frequency, and consists of seven OECD countries: Australia, Canada, France, Finland, Germany, Great Britain, and USA. Depending on the financial variable, the sample size ranges from 1970 to 2015.[5] The data are at annual frequency for three reasons. First, the lag length multiplies rapidly when quarterly data is used, which in turn multiplies the potential pairs of complex eigenvalues. Thus, for example, a bivariate quarterly model with 8 lags could potentially have 8 pairs of complex eigenvalues, and thus 8

[4] The two-dimensional financial-real cycle interaction mechanism we propose does not readily incorporate asset prices, which in contrast to our financial variable are expected to have a positive effect on real activity. We conjecture that the inclusion of asset price dynamics into a financial-real cycle model requires a more complex model which would lack the simple intuition of the framework suggested in this paper. We thus leave it for future research.

[5] A detailed description of our dataset can be found in appendix A1.

distinct cyclical frequencies. This would considerably reduce the interpretability of the estimates, making the identification of financial-real cycles effectively impossible. Second, the use of annual data allows us to avoid seasonal adjustment filters, which potentially induce spurious cyclical dynamics (Ghysels et al 1993). Clearly, spurious cyclicality would be a serious problem when attempting to identify cyclical mechanisms. Finally, (auto)correlation between the regressors is significantly greater for observations in quarterly series than in annual series, which raises the well-known possibility of multi-collinearity problems in VAR models. As we are evaluating a necessary condition based on point estimates, we require estimates that are as precise as possible. Whilst the use of annual data reduces the number of observations, we consider this cost to be outweighed by the foregoing benefits.

Prior to computing descriptive statistics, we conducted Augmented Dickey Fuller unit root tests on all series.[6] For *GDP*, the tests suggest the presence of a unit root in all countries. For *INTR*, we also fail to reject the null hypothesis of a unit root in all countries. For both debt ratios we find unit roots for all countries, although in the case of *HHD* we reject the null of a unit root in Great Britain and the USA when a trend term is included. For *NFCD*, inclusion of a linear trend renders *NFCD* trend stationary only in Australia.

Table 1 presents the results of spectral analysis on all series; this allows us to identify which frequencies make the largest contribution to the overall variance of the system (Hamilton, 1994, chap. 6). In order to obtain stationary series, we use two different methods: first differencing and bandpass (BP) filtering.[7] Following the literature on financial cycles (Drehmann et al., 2012; Aikman et al., 2015), we extract fluctuations with a length between 8 and 30 years from the debt-to-GDP series. For interest rates, we use a more standard business cycle frequency with a length between 2 and 8 years. *GDP* was filtered at the 8-30 year frequency.[8] For *INTR*, *NFCD,* and *HHD*, we report the local maximum of the spectral density function to obtain the cycle frequency that contributes most to the overall variance. For *GDP*, we report two local maxima.

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[6] The optimal lag length for the ADF test equations was chosen based on the Bayesian Information Criterion (BIC). We performed tests with drift only, and with drift and time trend.

[7] We used the Christiano-Fitzgerald method with a symmetric and fixed lead/lag length of 3 years for all bandpass-filtered series in this article.

[8] Estimating the spectral density functions for GDP on BP-filtered data at the range of 2-8 years yielded an average cycle length of 5½ years, which is almost identical to the average length of 5 1/3 years obtained with differenced data. We thus focus on the longer range of 8-30 years.

Table 1: Cycle length (in years) according to spectral density function

Country	Detrending method	*GDP*, Max 1	*GDP*, Max 2	*INTR*	*NFCD*	*HHD*
AUS	Diff	4.40	8.80	4.40	7.60	n/a
	BP	7.80	4.33	3.90	6.60	16.50
CAN	Diff	15.00	5.62	2.75	9.00	15.00
	BP	10	2.67	2.60	8.00	10.00
DEU	Diff	5.62	3.46	3.38	9.00	22.50
	BP	5.71	10	3.90	8.00	13.33
FIN	Diff	15.00	7.50	2.37	7.50	15.00
	BP	8	13.33	6.67	8.00	13.33
FRA	Diff	15.00	5.62	3.38	9.50	19.00
	BP	8	3.08	3.55	8.25	16.50
GBR	Diff	5.00	9.00	3.08	19.50	15.00
	BP	8	2.86	2.91	8.50	20.00
USA	Diff	5.50	14.67	2.59	9.00	15.00
	BP	5.57	9.75	2.60	10.00	13.33
Average length	Diff			3.14	10.16	16.92
	BP			3.73	8.19	14.42
		Long *GDP* cycle	**Short *GDP* cycle**			
Average length	Diff	11.87	5.30			
	BP	8.96	5.20			

Notes: BP: Bandpass-filtered with bounds from 8 to 30 years (*GDP, NFCD, HHD*) or 2 to 8 years (*INTR*) under the assumption of nonstationarity. Diff: First-differenced series. Cycle lengths were obtained from the local maximum of estimated spectral density functions using a Bartlett window and a truncation parameter of 20. For some shorter series, truncation parameters of 19 or 18 were used. To identify the second local maximum in *GDP*, we imposed the condition that it must differ from the first maximum by at least 3 ½ years. For Australia, no cycle frequency for *HHD* could be obtained for the differences series, as the maximum occurred at zero frequency. Average long *GDP* cycle length is the average over the higher of the two local maxima in *GDP*, whereas the average short *GDP* cycle length is the average over the lower of the two local maxima in *GDP*.

We note that the two filtering methods yield broadly similar results. For *GDP* we find a lower and a higher cycle frequency. No general pattern as to which of the two frequencies has the largest contribution to the total variance emerges. The high frequency implies cycle lengths ranging from about 2½ years (Canada; BP-filtered) to about 8 years (Finland; BP-filtered).

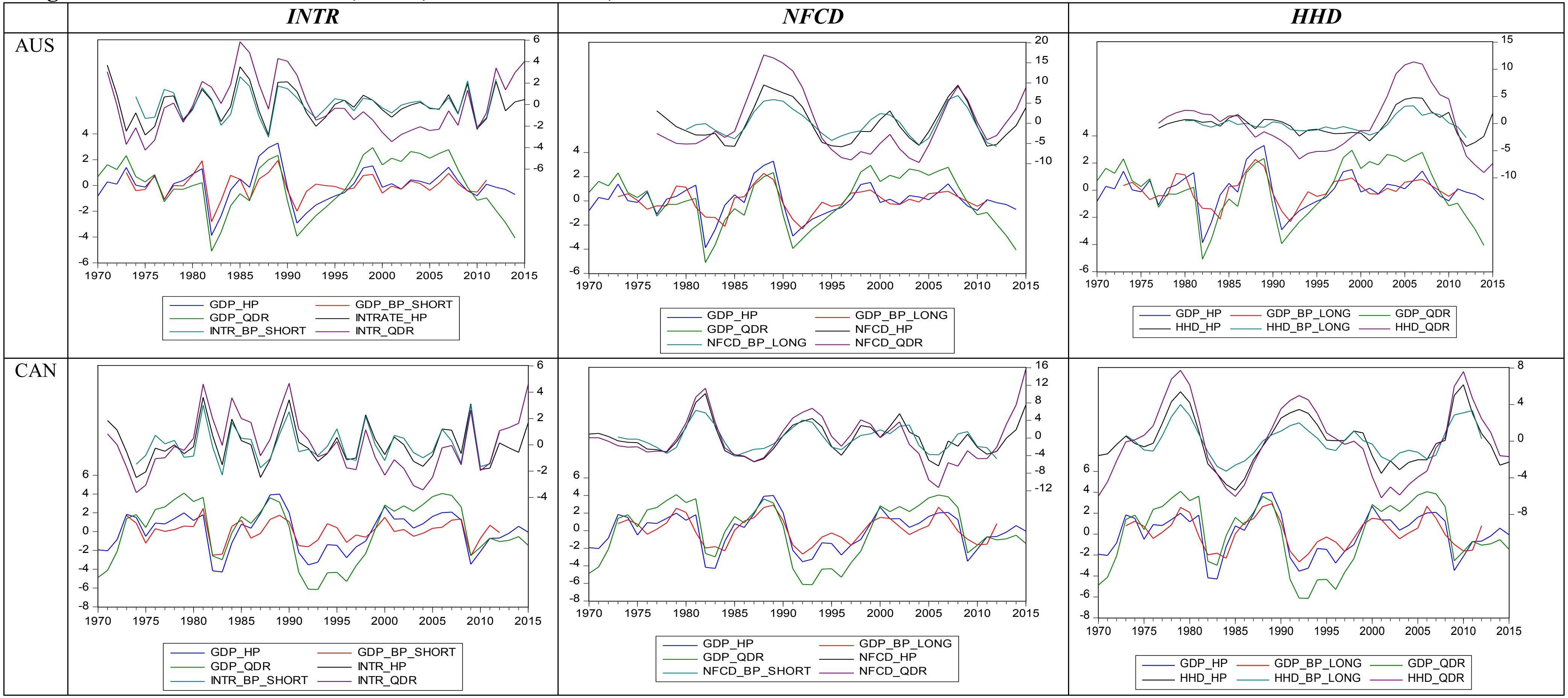
The average short frequency is 5 years. This is in line with the conventional business cycle frequency of up to 8 years (Comin and Gertler, 2006; Borio 2014). The low frequency in *GDP* ranges from about 5½ years (USA; BP-filtered) to 15 years (Canada, Finland, and France; first-differenced). On average, we find cycles between 9 and 12 years. This is consistent with the medium-run US business cycle frequency found by Comin and Gertler (2006).

For *INTR*, we note a relatively high frequency ranging from about 2½ years (Finland; first-differenced) to about 6½ years (Finland; BP-filtered). On average, we find a cycle length of about 3 to 4 years. *NFCD* exhibits lower frequencies ranging between 6½ years (Australia; BP-filtered) to 19½ years (Great Britain; first-differenced). On average, we find a cycle length of 8 to 10 years. Lastly, for *HHD*, we find substantially longer cycle lengths ranging from 10 years (Canada, BP-filtered) to up to 22½ years (Germany; first-differenced). The average cycle length is between 14½ and 17 years.

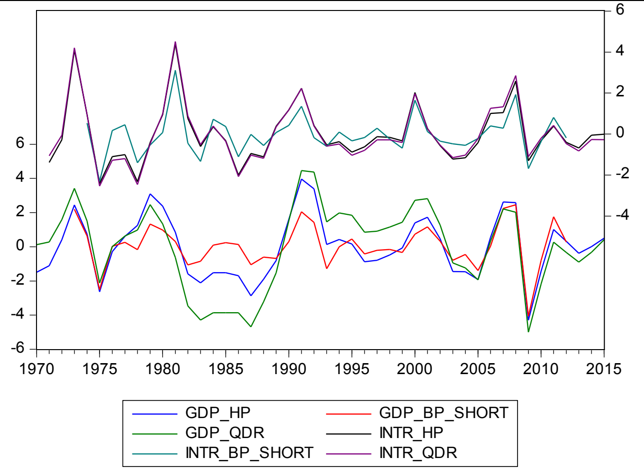
Overall, these findings indicate that real activity as measured by real output exhibits different cycle frequencies of about 5 and 10 years, respectively. We observe a high cycle frequency in short-term real interest rates of around 5 years, and longer debt cycles of about 10 years for business debt, and around 16 years for household debt. We further note that the higher cycle frequency in *GDP* corresponds closely to the frequency found in *INTR*. The lower frequency in *GDP*, on the other hand, is closer to the frequency in *NFCD* rather than *HHD*.

To obtain further visual evidence for these cycle frequencies, we jointly plot each financial variable along with GDP against time, using three different de-trending methods: the Hodrick-Prescott (HP) filter, the BP filter as before, and quadratic de-trending. Figure 1 depicts the results. Overall, the filters support the findings of the spectral density analysis: *INTR*, *NFCD*, and *HHD* exhibit cycle frequencies of around half a decade, a decade, and about two decades, respectively. *GDP* exhibits at least two frequencies, of which the higher one appears to be correlated with *INTR*, whereas the lower frequency seems to correspond closer to *NFCD* rather than *HHD*.

Figure 1: Filtered series of *GDP*, *INTR*, *NFCD* and *HHD*; 1970-2015



DEU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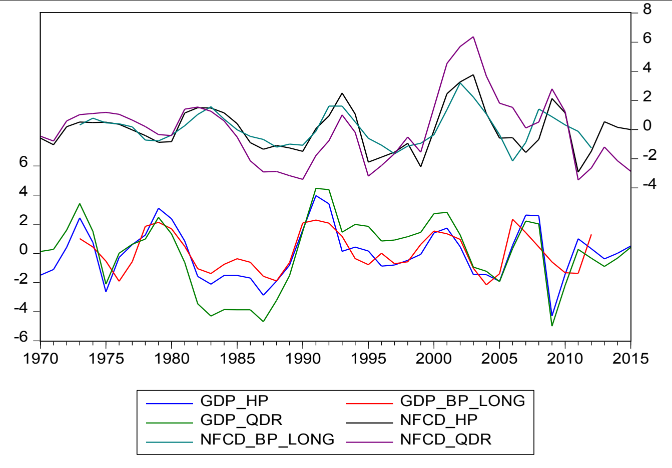
GDP_BP_SHORT
GDP_QDR
INTR_HP
INTR_BP_SHORT
INTR_QDR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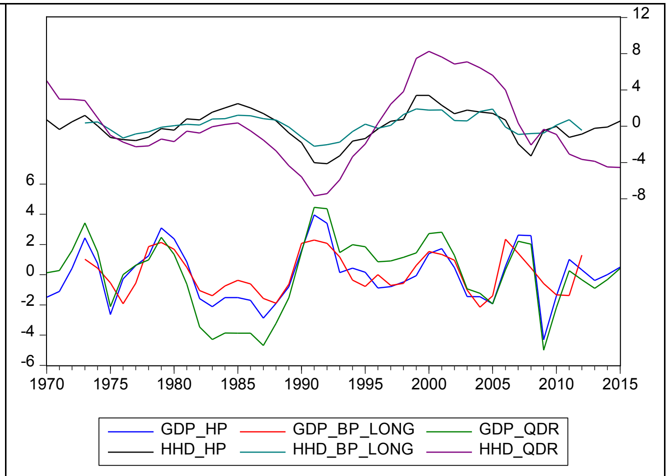
NFCD_QDR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GDP_BP_LONG
GDP_QDR
HHD_HP
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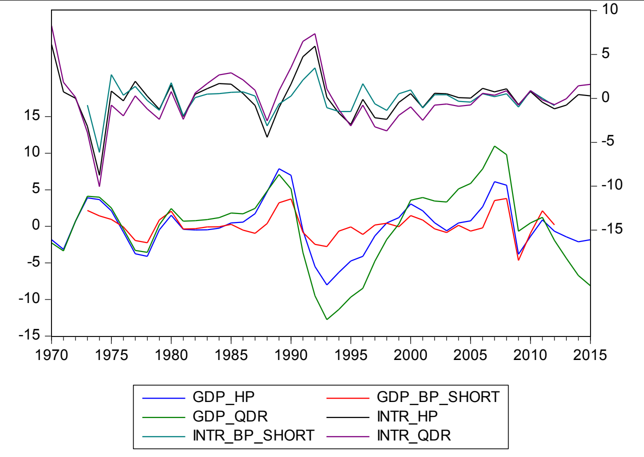
HHD_QDR

FIN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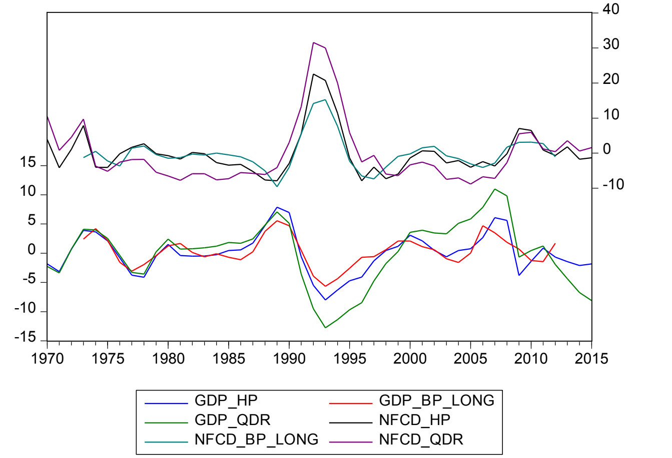
GDP_QDR
INTR_HP
INTR_BP_SHORT
INTR_QDR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NFCD_HP
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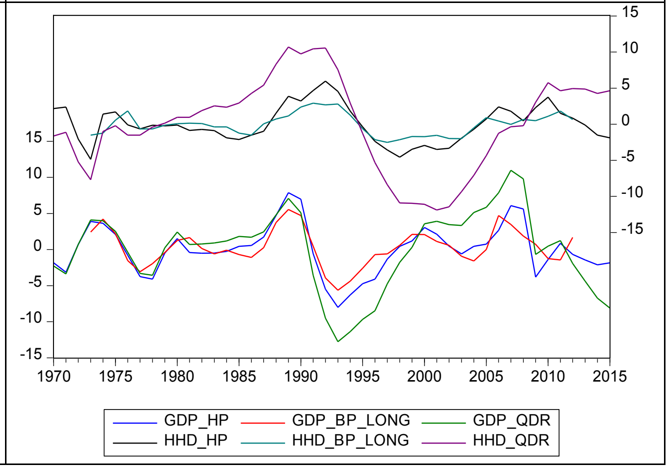
NFCD_QDR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HHD_HP
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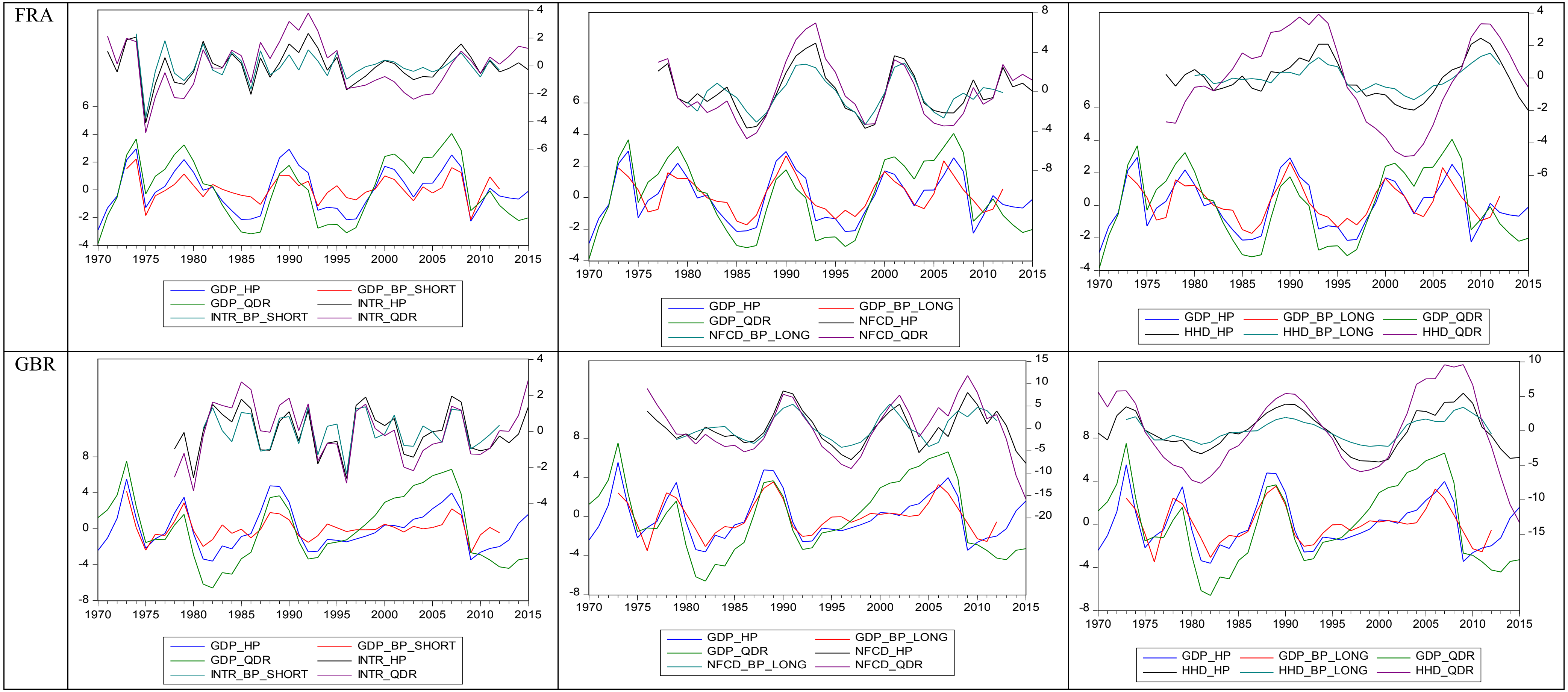
FRA
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NFCD_HP
NFCD_BP_LONG
NFCD_QDR
GDP_HP
GDP_BP_LONG
GDP_QDR
HHD_HP
HHD_BP_LONG
HHD_QDR
GBR
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INTR_QDR
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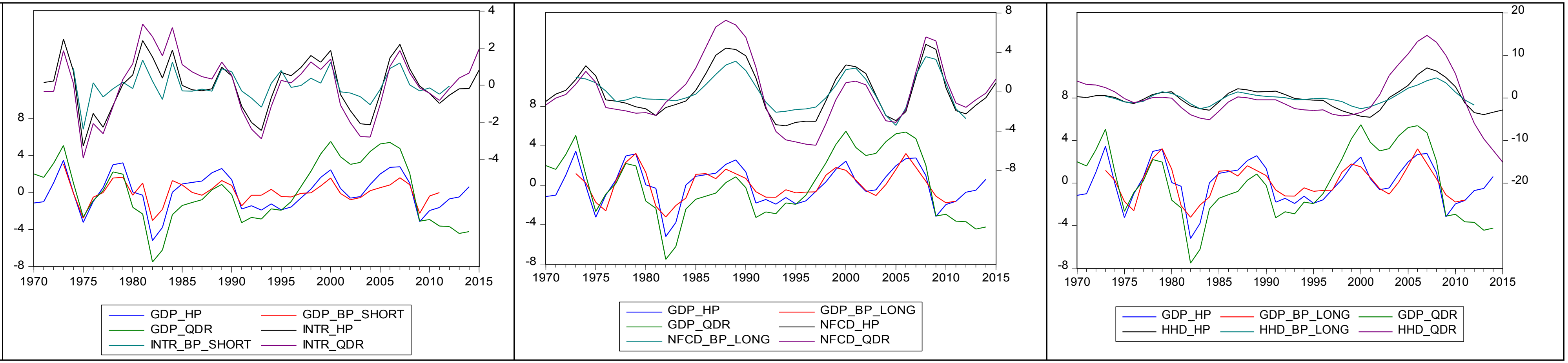
USA



Notes: AUS: Australia; CAN: Canada; DEU: Germany; FIN: Finland; FRA: France; GBR: Great Britain; USA: United States of America. HP: Cyclical component from Hodrick-Prescott filter ($\lambda = 100$). QDR: Cyclical component from quadratic detrending. BP_LONG: Cyclical component from bandpass filter with bounds from 8 to 30 years under the assumption of nonstationarity. BP_SHORT: Cyclical component from bandpass filter with bounds from 2 to 8 years under the assumption of nonstationarity. Left axis: *GDP*. Right axis: Financial variable. The left axis is measured in percent deviation from trend, whereas the right axis can be read as percentage-point deviation from trend.

5 Estimation results

The results in section 4 are suggestive of common cycles in GDP and at least a subset of the financial variables under consideration. To gain structural insight, we now proceed to estimate the empirical system in (5), described in section 3 above. Note, importantly, that the VAR models are estimated on the data in levels, not the de-trended data used in section 4.[9]

5.1 Cycles between GDP and the interest rate

Table 2 summarises our estimation results for interest rates.[10] First, we note that the coefficients α_2 and β_1 exhibit the expected signs in six out of seven countries. In Australia, Canada, Germany, France, United Kingdom, and the USA, *INTR* has a negative effect on *GDP*, whereas *GDP* exerts a positive effect on the rate of interest. Thus, the basic cyclical interaction mechanism hypothesised in section 3, where the real variable pushes up the financial variable which in turn depresses the real variable, is supported by our findings. In Finland, *GDP* exerts an unexpected negative effect on *INTR*, so that there is no evidence for a cycle mechanism. We further note, that in Australia both α_2 and β_1 are statistically significant at conventional levels. In Finland, France, and the USA, only the coefficient in the regression of *GDP* on *INTR* is statistically significant. Thus, our estimates have to be taken with caution. However, note that statistically insignificant coefficients are a frequent finding in VARs due to multicollinearity inherent in the VAR approach, notwithstanding the use of annual data, and this does not bias our estimates.

Looking at the implied cycle length in the VARs, we note that in only four out of the six countries in which the necessary condition for a cycle mechanism is satisfied, we find complex eigenvalues. In Canada and France, the eigenvalues of the VAR are real, implying that the second necessary condition for financial-real cycles is not satisfied. For the remaining countries, we find cycle lengths ranging from about 4 to 7 years, yielding a total average of

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[9] Inclusion of level variables is common in the VAR literature. The fact that some variables may be I(1) does not constitute a problem because the slope coefficients on the I(1) variables could be re-written as coefficients on differenced (and thus I(0)) variables (Sims et al., 1990). We also estimated our models with a linear time trend, which did not alter our results significantly.

[10] Serial correlations tests (see appendix A2) confirm that all VARs except the one for France are free from autocorrelation. In the VAR for France, serial correlation did not fully vanish even after including up to six lags. We thus use the baseline specification with two lags, which still exhibits some third-order autocorrelation.

about 5 years. This is slightly longer than the length of 3 to 4 years obtained from the spectral density functions, but quite close to it. Overall, our results provide partial support for the existence of short-run cycles in output and interest rates at a length of about 4-5 years that may be driven by an interaction mechanism described by our stylized financial-real cycle model.

Table 2: VAR models with *GDP* and *INTR*

Country	DV	EPV	Coeff LDV	Coeff EPV	Lag order	Necessary condition satisfied?	Sample	Cycle length
AUS	*GDP*	*INTR*	1.040 (0.151)***	-0.234 (0.112)**	2	yes	1973-2015	3.91
	INTR	*GDP*	0.799 (0.153)***	0.369 (0.206)*				
CAN	*GDP*	*INTR*	1.176 (0.159)***	-0.262 (0.158)	2	yes	1973-2015	No complex eigenvalue
	INTR	*GDP*	0.666 (0.159)***	0.177 (0.160)				
DEU	*GDP*	*INTR*	1.231 (0.192)***	-0.362 (0.225)	3	yes	1973-2015	4.59; 3.53
	INTR	*GDP*	0.607 (0.188)	0.121 (0.160)				
FIN	*GDP*	*INTR*	1.369 (0.141)***	-0.299 (0.159)*	3	no	1972-2015	No complex eigenvalue
	INTR	*GDP*	0.748 (0.155)***	-0.092 (0.137)				
FRA	*GDP*	*INTR*	1.268 (0.165)***	-0.270 (0.151)*	2	yes	1973-2015	No complex eigenvalue
	INTR	*GDP*	0.625 (0.166)***	0.124 (0.180)				
GBR	*GDP*	*INTR*	1.600 (0.161)***	-0.302 (0.202)	3	yes	1981-2015	5.96; 3.45
	INTR	*GDP*	0.426 (0.158)**	0.060 (0.126)				
USA	*GDP*	*INTR*	1.472 (0.164)***	-0.719 (0.253)***	2	yes	1973-2014	7.29
	INTR	*GDP*	0.856 (0.180)***	0.130 (0.117)				

Avr. cycle length	With all eigenvalues	4.79
	Only with longer length	5.44

Notes: AUS: Australia; CAN: Canada; DEU: Germany; FIN: Finland; FRA: France; GBR: Great Britain; USA: United States of America. DVL: Dependent variable. LDV: First lagged dependent variable. EPV: First lag of explanatory variable. Standard errors in parentheses. *, **, *** denote statistical significance at the 1, 5, and 10%-level, respectively. Necessary condition: $\alpha_2\beta_1 < 0$. All specifications were estimated with a constant (not reported).

5.2 Cycles between GDP and corporate debt

The results of our estimations with corporate debt are depicted in Table 3.[11] We find that all countries except for Finland exhibit the expected signs: *NFCD* exerts a negative effect on *GDP*, while *GDP* in turn raises *NFCD*. In Finland, the necessary condition for a cycle mechanism is not satisfied as *GDP* appears to have a negative effect on corporate debt. Looking at the time series chart for Finland in Figure 2, this finding is not very surprising as the relationship between *NFCD* and *GDP* appears to be largely dominated by a large negative shock to *GDP* in the early 1990s that came with a significant rise in corporate leverage ratios. We further note that the coefficient in the regression of *GDP* on *NFCD* is statistically significant at conventional levels only in Canada and the United States. The coefficient on *GDP* in the regressions with *NFCD* as the dependent variable is statistically significant in Australia, Germany, Finland (with an unexpected sign), and France.

Examining the estimated cycle length, we first note that we find complex eigenvalues in all VARs. Second, the value of about 181 years for France constitutes an outlier. Since we do not trust this result, we exclude the implied cycle length for France from further analysis. Third, due to the higher lag order of the VARs for Germany and the USA, we find two pairs of complex eigenvalues implying two distinct cycle frequencies of around 4-5 and 7-9 years, respectively. For the remaining countries, we find cycle lengths ranging from 9 to 15 years. This corresponds to the medium-term frequency found in the spectral density functions and visible in Figures 1 and 2. To obtain the average cycle length, we thus choose the frequency found for Germany and the USA that is closer to the other countries. We then find an average cycle length of about 11 years, which is surprisingly close to the length found in the spectral density functions and observed visually in Figures 1 and 2. Overall, the results point to the

[11] Serial correlation tests (see appendix A2) confirmed that all VARs are free of serial correlation.

existence of medium-run cycles in corporate debt and output at the length of about 11 years. The necessary condition for a real-financial interaction mechanism that generates these fluctuations is satisfied in 6 out of 7 countries.

Table 3: VAR models with *GDP* and *NFCD*

Country	DV	EPV	Coeff LDV	Coeff EPV	Max. lag order	Necessary condition satisfied?	Period	Cycle length
AUS	*GDP*	*NFCD*	1.097 (0.179)***	-0.003 (0.077)	2	yes	1979-2014	15.15
	NFCD	*GDP*	1.554 (0.120)***	0.117 (0.279)***				
CAN	*GDP*	*NFCD*	1.127 (0.157)***	-0.188 (0.102)*	2	yes	1972-2015	13.09
	NFCD	*GDP*	1.413 (0.155)***	0.381 (0.239)				
DEU	*GDP*	*NFCD*	1.065 (0.165)***	-0.103 (0.238)	3	yes	1973-2015	7.00; 3.52
	NFCD	*GDP*	1.153 (0.147)***	0.058 (0.101)***				
FIN	*GDP*	*NFCD*	1.297 (0.163)***	-0.121 (0.092)	2	no	1972-2015	13.38
	NFCD	*GDP*	0.946 (0.149)***	-0.705 (0.263)**				
FRA	*GDP*	*NFCD*	1.226 (0.172)***	-0.085 (0.117)	2	yes	1979-2015	181.24
	NFCD	*GDP*	1.318 (0.149)***	0.673 (0.220)***				
GBR	*GDP*	*NFCD*	1.427 (0.169)***	-0.038 (0.106)	2	yes	1978-2015	8.77
	NFCD	*GDP*	1.191 (0.158)***	0.231 (0.252)				
USA	*GDP*	*NFCD*	1.251 (0.166)***	-0.170 (0.346)***	3	yes	1972-2015	9.29; 5.19
	NFCD	*GDP*	1.938 (0.149)***	0.315 (0.072)				
Avr. cycle length								11.11

Notes: AUS: Australia; CAN: Canada; DEU: Germany; FIN: Finland; FRA: France; GBR: Great Britain; USA: United States of America. DVL: Dependent variable. LDV: First lagged dependent variable. EPV: First lag of explanatory variable. Standard errors in parentheses. *, **, *** denote statistical significance at the 1, 5, and 10%-level, respectively. Necessary condition: $\alpha_2\beta_1 < 0$. All specifications were estimated with a constant (not reported). For the average cycle length, we excluded the outlier France and used the longer cycle period, when the system has more than one complex eigenvalue.

5.3 Cycles between GDP and household debt

Finally, table 4 presents the results for household debt.[12] First, we note that *HHD* exerts a positive effect on *GDP* in all countries, which is inconsistent with the sign predicted by the financial-real cycle model. Moreover, in Canada, Germany, Finland, and France, *GDP* further has an unexpected negative effect on *HHD*. Although formally the necessary condition for a cycle mechanism is satisfied in these countries, it contradicts the structure of the financial-real cycle model given by (1) - (2), as the implied cycles would be clockwise in the (financial-real)-space. In Australia, the United Kingdom, and the USA, in contrast, the conditions for a cycle mechanism is not satisfied as the coefficients on the explanatory variables is positive in both equations. Overall, we conclude that there is no evidence for the existence of a financial-real cycle mechanism between *HHD* and *GDP* of the type considered in section 2 above.

Nevertheless, our VARs do allow us to estimate the implied cycle lengths of the system in *GDP* and *HHD*. Since most VARs have a lag order higher than two, we obtain more than one complex eigenvalue for most countries except Australia (with no complex eigenvalue) and Germany (with one complex eigenvalue). Based on the evidence from the spectral density function and the visual evidence of Figures 1 and 2, we suspect cycles with a medium-frequency of 17 to 20 years. Thus we focus on the eigenvalues with the lowest frequency. These range from about 17 years (United Kingdom) to 49 years (Germany). On average, we have a length of about 26 years, which is not only substantially longer than the short-run cycles in *INTR*, but also longer than the medium-run cycles of about 11 years found with *NFCD*. Excluding Germany, whose estimated length of 49 years may be regarded as an

[12] Serial correlation tests (see appendix A2) showed that all VARs are free of serial correlation.

outlier, yields a total average 21 years, which is higher but close to the length of 17 years obtained from the spectral density functions.

Table 4: VAR models with *GDP* and *HHD*

Country	DV	EPV	Coeff LDV	Coeff EPV	Max. lag order	Necessary condition satisfied?	Period	Cycle length
AUS	*GDP*	*HHD*	1.089 (0.179)***	0.030 (0.145)	2	no	1979-2014	No complex eigenvalue
	HHD	*GDP*	1.485 (0.142)***	0.135 (0.175)				
CAN	*GDP*	*HHD*	1.331 (0.154)***	0.393 (0.194)*	3	yes	1973-2015	17.70; 3.60
	HHD	*GDP*	1.617 (0.161)***	-0.115 (0.128)				
DEU	*GDP*	*HHD*	1.114 (0.166)***	0.142 (0.206)	2	yes	1972-2015	49.21
	HHD	*GDP*	1.583 (0.129)***	-0.058 (0.104)				
FIN	*GDP*	*HHD*	1.313 (0.164)***	0.273 (0.224)	4	yes	1974-2015	25.99; 6.15; 3.47
	HHD	*GDP*	1.445 (0.155)***	-0.006 (0.113)				
FRA	*GDP*	*HHD*	1.401 (0.168)***	0.485 (0.300)	3	yes	1980-2015	26.32; 4.64
	HHD	*GDP*	1.515 (0.180)***	-0.042 (0.101)***				
GBR	*GDP*	*HHD*	1.345 (0.147)***	0.052 (0.275)	4	no	1974-2015	17.99; 5.12; 2.67
	HHD	*GDP*	1.443 (0.132)***	0.194 (0.097)*				
USA	*GDP*	*HHD*	1.076 (0.163)***	0.639 (0.308)***	4	no	1974-2015	19.34; 5.91; 3.50
	HHD	*GDP*	1.996 (0.161)***	0.076 (0.085)				
Avr. cycle length								26.09; 21.47 (without DEU)

Notes: AUS: Australia; CAN: Canada; DEU: Germany; FIN: Finland; FRA: France; GBR: Great Britain; USA: United States of America. DVL: Dependent variable. LDV: First lagged dependent variable. EPV: First lag of explanatory variable. Standard errors in parentheses. *, **, *** denote statistical significance at the 1, 5, and 10%-level, respectively. Necessary condition: $\alpha_2\beta_1 < 0$. All specifications were estimated with a constant (not reported). For the average cycle length, we use the longest implied cycle length of each country.

Overall, we conclude, first, that our VAR results support the existence of joint fluctuations in real and financial variable at different frequencies. We find cycles with a length of 5, 11, and 21 to 26 years on average between *GDP* and *INTR*, *NFCD*, and *HHD*, respectively. These results from the VAR estimations are highly consistent with the stylized facts presented in section 4. We conclude, second, that for *NFCD* and, to a lesser extent, for *INTR*, financial-real cycle mechanisms exist for a majority of countries, and that these mechanisms produce clockwise cycles in the (financial-real)-space, which is in line with theories of financially-driven business cycles discussed in section 2. Third, for *HHD* there is no evidence for such a financial-real cycle mechanism.

6 Further results: Which components of output matter for the financial-real cycle?

To investigate further which components of GDP are essential for the financial-real interaction mechanism, we re-estimate our models with subcomponents of total output, such as total investment (*INV*), non-residential investment (*INV_NONRES*), residential investment (*INV_RES*), and consumption (*CONS*). For *INTR*, we separately use total investment, as well as consumption. For *NFCD*, we use total investment, as well as non-residential investment. Lastly, in the system with *HHD*, we separately use residential investment, as well as consumption. The estimation results are reported in appendix A2.

Using *CONS* instead of *GDP* in the estimations with *INTR*, we find the necessary condition for a financial-real interaction mechanism satisfied in all countries except Australia. With *INV* instead of *GDP*, we find the necessary condition for a financial-real interaction mechanism satisfied in all countries. This is very similar to our baseline estimations with *GDP* and *INTR*, where the condition is satisfied for all countries except Finland. Looking at the implied cycle length, with *CONS* we find complex eigenvalues in four countries, but the implied cycle lengths exhibit a much larger variance than in our baseline estimations. Canada, Great Britain, and the USA have cycle lengths of around 4 to 5 years as found in our baseline, but also contain eigenvalues with lower frequencies. Germany constitutes an outlier with an implied cycle length of 142 years. In the estimations with *INV*, six of the VARs have complex eigenvalues. For Australia, Canada and Great Britain, the implied cycle lengths are in line with the results from the baseline (4-5 years). Germany and the USA exhibit slightly lower cycle frequencies of 7 and 11 years, respectively. Finland is an outlier. Further eigenvalues imply a lower frequency than the one found in the baseline. Overall, we find slightly stronger evidence for a short-run interaction mechanism between *INTR* and *INV,* rather than *CONS*.

When using *INV* instead of *GDP* in the estimations with *NFCD*, we still find the necessary condition satisfied in all countries except Finland. The only difference occurs with Australia, where the necessary condition is not satisfied anymore. In estimations with *INV_NONRES* instead of *GDP*, where the necessary condition for a cycle mechanism is satisfied in Australia, but now with unexpected signs. The estimated cycle average lengths[13] of 11 years (with *INV*) to around 11½ years (with *INV_NONRES*) strongly correspond to the frequencies obtained in the main estimations. Overall, the estimations suggest that the interaction mechanism between *NFCD* and *GDP* is largely governed by the investment component of GDP, with little difference between residential and non-residential investment.

Lastly, re-estimation of the system with *HHD* and *CONS*, as well as *INV_RES,* leads to a mixed picture. Replacing *GDP* by *CONS* yields qualitatively different findings for each country of our sample due to changes in signs. Interestingly, for Germany, France, Great Britain, and the USA, we now find the expected signs of the financial-real cycle model. When using *INV_RES* instead of *GDP*, the results are more in line with the baseline estimations. Only for Canada do we find the necessary condition for a financial-real cycle satisfied, with expected signs. With respect to the cycle frequency, the robustness test suggests average cycle lengths of 24 years (*CONS*) and 22 years (*INV_RES*), which is broadly in line with the 26 years length found in the main estimations. In sum, it appears that the failure to find evidence for a financial-real cycle mechanism between *HHD* and *GDP* stems from different behavioural relationships between *HHD* and the different

[13] Several specifications of the robustness estimations required a lag order of more than two, which often yielded multiple eigenvalues. In order to calculate the average cycle length, we chose the eigenvalue being closest to the average cycle length found in the spectral density functions.

subcomponents of *GDP*. When using *CONS* rather than *INV_RES*, we find evidence for a cycle in 4 out of 7 countries.

7 Conclusions

In this paper, we have presented empirical evidence for theories of financial-real cycles. We find that output exhibits at least two cycle frequencies of about 4-5, and 9-12 years respectively. Interest rates, business debt, and household debt exhibit cycles lengths of about 4-5, 8-11, and 14-26 years, respectively. We further find evidence for interaction mechanisms between corporate debt and GDP at a medium-run frequency that is consistent with theories of financial-real cycles in Australia, Canada, Germany, France, Great Britain, and the USA, and between short-term interest rates and GDP at a short-run frequency that is consistent with theories of financial-real cycles in Australia, Germany, Great Britain and the USA. There is no evidence for such an interaction mechanism between household debt and GDP, but some support for a cycle between household debt and consumption in Germany, France, Great Britain, and the USA.

Our findings have interesting theoretical implications. While they generally support theories of financially driven business cycles, Minskyan and New Keynesian, they shed further light on the relevant financial variables, as well as the frequency of financial-real cycles. Importantly, we highlight the distinction between short and long business cycles and suggest that the different frequencies are driven by different financial variables. Our results lend support to models in which real activity interacts with interest rates (Foley, 1987; Jarsulic, 1989) as well as to models in which the main cycle mechanism is between business debt and output (Asada, 2001; Fazzari et al., 2008; Ryoo, 2010; 2013; Bernanke et al., 1999), however the two cycle mechanisms operate at different business cycle frequencies. This suggests that the two cycle mechanisms are distinct. With respect to the discussion in the Minskyan literature (Nikolaidi and Stockhammer 2017), we confirm that there is some evidence for a financial-real interaction mechanism with business debt. For household debt the picture is more complicated: while we do not overall find cycles in GDP and household debt, our findings suggest that for some countries, there might be a cycle mechanism between household debt and consumption (which however does not carry over to total output).

Our findings might appear surprising, given that it was household debt, not business debt that was at the heart of the Great Financial Crisis, and that Jordà et al. (2017) find that higher household debt leads to deeper recessions. However, while our results suggest that there is no interaction mechanism between total output and household debt that can drive the business cycle, they do not imply that household debt does not play a role in the business cycle. Our findings are not inconsistent with the claim that the level of household debt affects the depth of downturns, but question whether household debt is a key variable in the business cycle mechanism. Given the empirical finding of an important role of house prices during the business cycle (Igan et al., 2011), we conjecture that there is a more complex interaction between household debt, house prices, and real activity that may generate business cycle dynamics. Future research could aim to integrate such a mechanism into our framework.

Our results also have important empirical implications. The stylized fact that financial cycles are longer than business cycles (Drehmann et al., 2012; Borio, 2014; Aikman et al., 2015; Strohsal et al., 2015) has to be amended. Different financial variables exhibit different cycle frequencies. While interest rates exhibit a short-run frequency in line with conventional business cycles frequencies, business debt has a medium-run frequency that matches the medium-run frequency found in output. Only household debt exhibits a frequency that is significantly lower than the medium-run frequency in output. Therefore, it is important to distinguish between different measures of the financial cycle, and in particular to disaggregate total credit into corporate and household debt.

References

Aikman, D., Haldane, A. G. and Nelson, B. D. (2015) 'Curbing the Credit Cycle', *The Economic Journal*, **125**, 1072–1109.

Asada, T. (2001) 'Nonlinear Dynamics of Debt and Capital: A Post-Keynesian Analysis'. In Aruka, Y. (ed) *Evolutionary Controversies in Economics. A New Transdisciplinary Approach*, Tokyo, Springer Japan, pp. 73–88.

Bernanke, B. S., Gertler, M. and Gilchrist, S. (1999) 'The Financial Accelerator in a Quantitative Business Cycle Framework'. In Taylor, J. B. and Woordford, M. (eds) *Handbook of Macroeconomics*, pp. 1341–1392.

Bofinger, P., Debes, S., Gareis, J. and Mayer, E. (2013) 'Monetary Policy Transmission in a Model with Animal Spirits and House Price Booms and Busts', *Journal of Economic Dynamics and Control*, **37**, 2862–2881.

Borio, C. (2014) 'The Financial Cycle and Macroeconomics: What Have We Learnt?', *Journal of Banking & Finance*, **45**, 182–198.

Comin, D. and Gertler, M. (2006) 'Medium-Term Business Cycles', *The American Economic Review*, **96**, 523–551.

De Grauwe, P. and Macchiarelli, C. (2015) 'Animal Spirits and Credit Cycles', *Journal of Economic Dynamics and Control*, **59**, 95–117.

Delli Gatti, D., Gallegati, M., Greenwald, B., Russo, A. and Stiglitz, J. E. (2010) 'The Financial Accelerator in an Evolving Credit Network', *Journal of Economic Dynamics and Control*, **34**, 1627–1650.

Drehmann, M., Borio, C. E. and Tsatsaronis, K. (2012) *Characterising the Financial Cycle: Don't Lose Sight of the Medium Term!*, BIS Working Papers 380.

Eggertsson, G. B. and Krugman, P. (2012) 'Debt, Deleveraging, and the Liquidity Trap: A Fisher-Minsky-Koo Approach', *The Quarterly Journal of Economics*, **127**, 1469–1513.

Fazzari, S., Ferri, P. and Greenberg, E. (2008) 'Cash Flow, Investment, and Keynes–Minsky Cycles', *Journal of Economic Behavior & Organization*, **65**, 555–572.

Foley, D. K. (1987) 'Liquidity-Profit Rate Cycles in a Capitalist Economy', *Journal of Economic Behavior & Organization*, **8**, 363–376.

Hamilton, J. D. (1994) *Time Series Analysis*, Princeton, New Jersey, Princeton University Press.

Igan, D., Kabundi, A., Nadal De Simone, F., Pinheiro, M. and Tamirisa, N. (2011) 'Housing, Credit, and Real Activity Cycles: Characteristics and Comovement', *Journal of Housing Economics*, **20**, 210–231.

Jarsulic, M. (1989) ‘Endogenous Credit and Endogenous Business Cycles’, *Journal of Post Keynesian Economics*, **12**, 35–48.

Kiyotaki, N. and Moore, J. (1997) ‘Credit Cycles’, *Journal of Political Economy*, **105**, 211–248.

Ma, Y. and Zhang, J. (2016) ‘Financial Cycle, Business Cycle and Monetary Policy: Evidence from Four Major Economies’, *International Journal of Finance & Economics*, **21**, 502–527.

Minsky, H. P. (2008) *John Maynard Keynes.*, McGraw-Hill.

Minsky, H. P. (2016) ‘The Financial Instability Hypothesis: A Restatement’. In *Can ‘It’ Happen Again? Essays on Instability and Finance*, Oxon and New York, Routledge.

Nikolaidi, M. and Stockhammer, E. (2017) *Minsky Models. A Structured Survey*, PKSG Working Paper 1706.

Palley, T. I. (1994) ‘Debt, Aggregate Demand, and the Business Cycle: An Analysis in the Spirit of Kaldor and Minsky’, *Journal of Post Keynesian Economics*, **16**, 371–390.

Ryoo, S. (2010) ‘Long Waves and Short Cycles in a Model of Endogenous Financial Fragility’, *Journal of Economic Behavior & Organization*, **74**, 163–186.

Ryoo, S. (2013) ‘Minsky Cycles in Keynesian Models of Growth and Distribution’, *Review of Keynesian Economics*, **1**, 37–60.

Ryoo, S. (2016) ‘Household Debt and Housing Bubbles: A Minskian Approach to Boom-Bust Cycles’, *Journal of Evolutionary Economics*, **26**, 971–1006.

Shibayama, K. (2008) *On the Periodicity of Inventories*, Working Paper. Department of Economics, University of Kent at Canterbury, Canterbury, Kent.

Sims, C. A., Stock, J. H. and Watson, M. W. (1990) ‘Inference in Linear Time Series Models with Some Unit Roots’, *Econometrica*, **58**, 113–144.

Strohsal, T., Proaño, C. R. and Wolters, J. (2015) *Characterizing the Financial Cycle: Evidence From Frequency Domain Analysis*, SFB Discussion Paper 649.

Appendix

A1. Data description

Table A1: Country list

Code	**Country**
AUS	Australia
CAN	Canada
FIN	Finland
FRA	France
GBR	Great Britain
DEU	Germany
USA	United States

Table A2: Data definition and sources

Variable	Abbreviation	Definition	Source(s)	Note
Real GDP	*GDP*	GDP (B1_GA): output approach, constant prices, millions. Natural logarithm.	OECD stats	
Real consumption	*CONS*	Final consumption expenditure (P3), constant prices. Natural logarithm.	OECD stats	
Real investment	*INV*	Gross fixed capital formation (P51), constant prices, millions. Natural logarithm.	OECD stats	
Real residential investment	*INV_RES*	Gross fixed capital formation: Dwellings (P51N1111), constant prices, millions. Natural logarithm.	OECD stats	
Non-residential investment	*INV_NONRES*	*INV* - *INV_RES*		
Household debt to GDP	*HHD*	Debt of households and NPISH as a percentage of GDP (market value, adjusted for breaks) (HAM770A)	BIS	
Non-financial corporation debt to GDP	*NFCD*	Debt of non-financial corporations as a percentage of GDP (market value, adjusted for breaks) (NAM770A)	BIS	
Short-term real interest rate	*INTR*	Average annual interest rate, %, based on three-month money market rates, deflated by the GDP deflator using Fisher's formula $r = (i-\pi)/(1+\pi)$.	OECD stats; AMECO	GDP deflator for Germany from AMECO; real interest rate for Finland from AMECO; all other series from OECD

Table A3: Data coverage

Country	*GDP*		*NFCD*		*HHD*		*INTR*	
	Period	**Nº of obs**	**Period**	**Nº of obs**	**Period**	**Nº of obs**	**Period**	**Nº of obs**
AUS	1970-2014	45	1977-2015	39	1977-2015	39	1971-2015	45
CAN	1970-2015	45	1970-2015	46	1970-2015	46	1971-2015	45
DEU	1970-2015	45	1970-2015	46	1970-2015	46	1971-2015	45
FIN	1970-2015	45	1970-2015	46	1970-2015	46	1970-2015	46
FRA	1970-2015	46	1977-2015	39	1977-2015	39	1971-2015	45
GBR	1970-2015	46	1976-2015	40	1970-2015	46	1978-2015	38
USA	1970-2014	44	1970-2015	46	1970-2015	46	1971-2015	45

Country	*CONS*		*INV*		*INV_RES*	
	Period	**Nº of obs**	**Period**	**Nº of obs**	**Period**	**Nº of obs**
AUS	1970-2015	45	1970-2015	45	1971-2014	44
CAN	1970-2015	45	1970-2015	45	1972-2015	44
DEU	1970-2015	45	1970-2015	45	1981-2015	35
FIN	1970-2015	45	1970-2015	45	1976-2015	40
FRA	1970-2015	45	1970-2015	45	1971-2015	45
GBR	1970-2015	45	1970-2015	45	1981-2015	35
USA	1970-2015	45	1970-2015	45	1971-2015	45

Table A4: Summary statistics

Country	*GDP* (% growth)			**NFCD (% of GDP)**			**HHD (% of GDP)**			**INTRATE (%)**		
	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean
AUS	-2.3	5.6	3.1	36	82	63	34	123	68	-4.7	10.1	2.9
CAN	-3.3	6.7	2.7	58	112	83	34	96	58	-3.2	9.3	2.3
DEU	-5.8	5.1	2.0	44	61	52	35	71	54	-2.0	7.7	2.3
FIN	-8.6	7.5	2.4	60	115	83	13	67	37	-9.6	12.2	2.2
FRA	-3.0	6.1	2.3	78	125	95	19	56	36	-4.4	8.2	2.1
GBR	-4.4	6.3	2.2	26	93	58	30	96	58	-1.7	6.6	2.8
USA	-2.8	7.0	2.8	47	72	59	43	97	64	-2.2	6.6	2.0

Country	*CONS* (% growth)			**INV (% growth)**			**INV_RES (% growth)**		
	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean
AUS	1.2	5.5	3.2	-10.0	12.0	3.9	-24.7	19.7	2.7
CAN	-1.5	6.0	2.7	-12.0	11.0	3.3	-18.7	16.7	2.6
DEU	-1.0	5.5	1.9	-10.6	7.7	1.4	-9.1	11.0	0.9
FIN	-4.0	7.9	2.5	-18.5	11.8	1.6	-16.7	21.6	0.5
FRA	0.3	5.6	2.3	-9.5	8.3	1.9	-9.7	8.4	0.8
GBR	-2.2	5.8	2.3	-16.5	13.8	2.0	-23.3	14.6	0.6
USA	-0.6	5.1	2.7	-14.0	14.0	3.0	-27.2	35.0	1.6

A2 Serial correlation tests and estimations with subcomponents of GDP

Table A5: Serial correlation LM-tests for VARs with *GDP* and *INTR*

Country	Lag	LM-Statistic	P-value
AUS	1	6.63	0.16
	2	1.87	0.76
	3	5.10	0.28
	4	4.93	0.29
CAN	1	3.35	0.50
	2	6.95	0.14
	3	1.46	0.83
	4	2.47	0.65
DEU	1	2.19	0.70
	2	4.32	0.36
	3	1.14	0.89
	4	0.78	0.94
FIN	1	2.33	0.67
	2	5.49	0.24
	3	2.95	0.57
	4	1.18	0.88
FRA	1	0.83	0.93
	2	3.87	0.42
	3	8.28	0.08*
	4	0.58	0.97
GBR	1	2.49	0.65
	2	1.60	0.81
	3	0.11	1.00
	4	5.83	0.21
USA	1	3.39	0.49
	2	1.10	0.89
	3	5.64	0.23
	4	7.67	0.10

Notes: AUS: Australia; CAN: Canada; DEU: Germany; FIN: Finland; FRA: France; GBR: Great Britain; USA: United States of America. Null hypothesis of LM-test: No serial correlation. *, **, *** denote statistical significance at the 1, 5, and 10%-level, respectively.

Table A6: Serial correlation LM-tests for VARs with *GDP* and *NFCD*

Country	Lag	LM-statistic	P-value
AUS	1	6.08	0.19
	2	4.34	0.36
	3	2.20	0.70
	4	7.31	0.12
CAN	1	2.40	0.66
	2	2.15	0.71
	3	0.19	1.00
	4	0.90	0.92
DEU	1	2.66	0.62
	2	1.76	0.78
	3	1.89	0.76
	4	0.78	0.94
FIN	1	7.46	0.11
	2	6.20	0.18
	3	1.73	0.78
	4	1.74	0.78
FRA	1	7.15	0.13
	2	2.05	0.73
	3	2.30	0.68
	4	0.30	0.99
GBR	1	2.55	0.64
	2	5.93	0.20
	3	5.01	0.29
	4	1.34	0.85
USA	1	3.80	0.43
	2	3.59	0.47
	3	1.31	0.86
	4	3.78	0.44

Notes: AUS: Australia; CAN: Canada; DEU: Germany;
FIN: Finland; FRA: France; GBR: Great Britain;
USA: United States of America. Null hypothesis of LM-test: No serial correlation.
*, **, *** denote statistical significance at the 1, 5, and 10%-level, respectively.

Table A7: Serial correlation LM-tests for VARs with *GDP* and *HHD*

Country	Lag	LM-Statistic	P-value
AUS	1	2.35	0.67
	2	3.48	0.48
	3	4.34	0.36
	4	2.47	0.65
CAN	1	4.61	0.33
	2	0.37	0.98
	3	1.39	0.85
	4	1.77	0.78
DEU	1	7.38	0.12
	2	5.11	0.28
	3	3.24	0.52
	4	2.34	0.67
FIN	1	3.32	0.51
	2	3.15	0.53
	3	3.71	0.45
	4	4.36	0.36
FRA	1	5.26	0.26
	2	2.44	0.66
	3	2.15	0.71
	4	3.55	0.47
GBR	1	5.31	0.26
	2	3.65	0.46
	3	3.13	0.54
	4	4.54	0.34
USA	1	2.11	0.71
	2	3.77	0.44
	3	7.37	0.12
	4	7.23	0.12

Notes: AUS: Australia; CAN: Canada; DEU: Germany;
FIN: Finland; FRA: France; GBR: Great Britain; USA: United States of America. Null hypothesis of LM-test: No serial correlation.
*, **, *** denote statistical significance at the 1, 5, and 10%-level, respectively.

Table A8: VAR models with *CONS* and *INTR*

Country	DV	EPV	Coeff LDV	Coeff EPV	Max. lag order	Necessary condition satisfied?	Period	Cycle length
AUS	*CONS*	*INTR*	1.292 (0.145)***	-0.219 (0.081)**	2	no	1973-2015	No complex eigenvalue
	INTR	*CONS*	0.793 (0.158)***	-0.047 (0.282)				
CAN	*CONS*	*INTR*	1.354 (0.179)***	-0.192 (0.110)*	4	yes	1975-2015	36.52; 5.31; 2.86
	INTR	*CONS*	0.620 (0177)***	0.551 (0.287)*				
DEU	*CONS*	*INTR*	1.429 (0.144)***	-0.202 (0.095)**	2	yes	1973-2015	141.58
	INTR	*CONS*	0.638 (0.160)***	0.316 (0.243)				
FIN	*CONS*	*INTR*	1.526 (0.126)***	-0.286 (0.089)***	2	yes	1972-2015	No complex eigenvalue
	INTR	*CONS*	0.762 (0.155)***	0.000 (0.219)				
FRA	*CONS*	*INTR*	1.176 (0.157)***	-0.097 (0.082)	2	yes	1973-2015	No complex eigenvalue
	INTR	*CONS*	0.670 (0.154)***	0.347 (0.295)				
GBR	*CONS*	*INTR*	1.658 (0.183)***	-0.114 (0.174)	3	yes	1981-2015	3.62; 8.40
	INTR	*CONS*	0.441 (0.155)***	0.015 (0.162)				
USA	*CONS*	*INTR*	1.632 (0.170)***	-0.274 (0.149)*	3	yes	1974-2015	24.58; 5.26
	INTR	*CONS*	0.914 (0.160)***	0.482 (0.183)**				

Notes: AUS: Australia; CAN: Canada; DEU: Germany; FIN: Finland; FRA: France; GBR: Great Britain; USA: United States of America. DVL: Dependent variable. LDV: lagged dependent variable. EPV: first lag explanatory variable. Standard errors in parentheses. *, **, *** denote statistical significance at the 1, 5, and 10%-level, respectively. Necessary condition: $\alpha_2\beta_1 < 0$. All specifications were estimated with a constant (not reported).

Table A9: VAR models with *INV* and *INTR*

Country	DV	EPV	Coeff LDV	Coeff EPV	Max. lag order	Necessary condition satisfied?	Period	Cycle length
AUS	*INV*	*INTR*	1.155 (0.158)***	-0.846 (0.445)*	2	yes	1973-2015	4.43
	INTR	*INV*	0.797 (0.149)***	0.113 (0.053)**				
CAN	*INV*	*INTR*	1.043 (0.170)***	-0.478 (0.431)	2	yes	1973-2015	4.16
	INTR	*INV*	0.730 (0.155)***	0.138 (0.061)**				
DEU	*INV*	*INTR*	1.432 (0.160)***	-1.136 (0.405)***	2	yes	1973-2015	7.07
	INTR	*INV*	0.511 (0.163)***	0.152 (0.064)**				
FIN	*INV*	*INTR*	1.493 (0.123)***	-1.080 (0.314)***	2	yes	1972-2015	114.69
	INTR	*INV*	0.757 (0.156)***	0.002 (0.061)				
FRA	*INV*	*INTR*	1.452 (0.147)***	-0.548 (0.335)	2	yes	1973-2015	No complex eigenvalue
	INTR	*INV*	0.583 (0.155)***	0.116 (0.068)*				
GBR	*INV*	*INTR*	1.293 (0.172)***	-0.333 (0.653)	3	yes	1981-2015	86.41; 5.41; 5.74
	INTR	*INV*	0.478 (0.159)***	0.011 (0.042)				
USA	*INV*	*INTR*	1.557 (0.156)***	-1.574 (0.635)**	2	yes	1973-2015	10.84
	INTR	*INV*	0.857 (0.175)***	0.052 (0.043)				

Notes: AUS: Australia; CAN: Canada; DEU: Germany; FIN: Finland; FRA: France; GBR: Great Britain; USA: United States of America. DVL: Dependent variable. LDV: lagged dependent variable. EPV: first lag explanatory variable. Standard errors in parentheses. *, **, *** denote statistical significance at the 1, 5, and 10%-level, respectively. Necessary condition: $\alpha_2\beta_1 < 0$. All specifications were estimated with a constant (not reported).

Table A10: VAR models with *INV* and *NFCD*

Country	DV	EPV	Coeff LDV	Coeff EPV	Max. lag order	Necessary condition satisfied?	Period	Cycle length
AUS	*INV*	*NFCD*	1.127 (0.182)***	-0.132 (0.304)	2	no	1979-2015	14.92
	NFCD	*INV*	1.541 (0.122)***	-0.009 (0.073)				
CAN	*INV*	*NFCD*	0.887 (0.152)***	-0.381 (0.274)	3	yes	1973-2015	15.25; 6.37
	NFCD	*INV*	1.435 (0.178)***	0.204 (0.098)**				
DEU	*INV*	*NFCD*	1.333 (0.179)***	0.012 (0.568)	3	yes	1973-2015	7.10; 3.42
	NFCD	*INV*	1.060 (0.164)***	-0.026 (0.052)				
FIN	*INV*	*NFCD*	1.366 (0.150)***	-0.358 (0.215)	2	no	1972-2015	11.80
	NFCD	*INV*	0.876 (0.168)***	0.167 (0.117)				
FRA	*INV*	*NFCD*	1.442 (0.162)***	-0.247 (0.318)	2	yes	1979-2015	11.24
	NFCD	*INV*	1.269 (0.153)***	0.300 (0.078)***				
GBR	*INV*	*NFCD*	1.427 (0.169)***	-0.038 (0.106)	2	yes	1978-2015	8.77
	NFCD	*INV*	1.191 (0.158)***	0.231 (0.252)				
USA	*INV*	*NFCD*	1.408 (0.162)***	-0.838 (0.794)	3	yes	1973-2015	9.67; 7.46
	NFCD	*INV*	1.922 (0.150)***	0.131 (0.031)***				
Avr. cycle length								11.25

Notes: AUS: Australia; CAN: Canada; DEU: Germany; FIN: Finland; FRA: France; GBR: Great Britain; USA: United States of America. DVL: Dependent variable. LDV: lagged dependent variable. EPV: first lag explanatory variable. Standard errors in parentheses. *, **, *** denote statistical significance at the 1, 5, and 10%-level, respectively. Necessary condition: $\alpha_2\beta_1 < 0$. All specifications were estimated with a constant (not reported). For the average cycle length, we use the longest implied cycle length of each country.

Table A11: VAR models with *INV_NONRES* and *NFCD*

Country	DV	EPV	Coeff LDV	Coeff EPV	Max. lag order	Necessary condition satisfied?	Period	Cycle length
AUS	*INV_NONRES*	*NFCD*	0.684 (0.172)***	0.869 (0.675)	4	yes	1981-2015	4.56; 10.07
	NFCD	*INV_NONRES*	1.660 (0.202)***	-0.036 (0.053)				
CAN	*INV_NONRES*	*NFCD*	1.083 (0.160)***	-0.638 (0.332)*	2	yes	1973-2015	17.03
	NFCD	*INV_NONRES*	1.361 (0.147)***	0.171 (0.071)**				
DEU	*INV_NONRES*	*NFCD*	1.166 (0.207)***	-0.024 (0.654)	3	yes	1983-2015	205.33; 7.41; 2.99
	NFCD	*INV_NONRES*	1.063 (0.169)***	0.008 (0.054)				
FIN	*INV_NONRES*	*NFCD*	1.258 (0.163)***	-0.728 (0.302)**	2	no	1977-2015	11.52
	NFCD	*INV_NONRES*	1.151 (0.192)***	-0.002 (0.104)				
FRA	*INV_NONRES*	*NFCD*	1.356 (0.169)***	-0.344 (0.353)	2	yes	1979-2015	119.54; 9.27
	NFCD	*INV_NONRES*	1.260 (0.140)***	0.307 (0.067)***				
GBR	*INV_NONRES*	*NFCD*	0.877 (0.169)***	-0.175 (0.314)	4	yes	1984-2015	14.15; 3.45; 5.58
	NFCD	*INV_NONRES*	1.384 (0.187)***	0.154 (-0.100)				
USA	*INV_NONRES*	*NFCD*	1.208 (0.151)***	-0.160 (0.650)	3	yes	1973-2015	9.96; 4.74
	NFCD	*INV_NONRES*	1.842 (0.150)***	0.091 (0.035)**				
Avr. cycle length								11.35

Notes: AUS: Australia; CAN: Canada; DEU: Germany; FIN: Finland; FRA: France; GBR: Great Britain; USA: United States of America. DVL: Dependent variable. LDV: lagged dependent variable. EPV: first lag explanatory variable. Standard errors in parentheses. *, **, *** denote statistical significance at the 1, 5, and 10%-level, respectively. Necessary condition: $\alpha_2\beta_1 < 0$. All specifications were estimated with a constant (not reported). For the average cycle length, we use only the eigenvalue per country that is closest to the average.

Table A12: VAR models with *CONS* and *HHD*

Country	DV	EPV	Coeff LDV	Coeff EPV	Max. lag order	Necessary condition satisfied?	Period	Cycle length
AUS	*CONS*	*HHD*	1.175 (0.178)***	0.015 (0.120)	3	yes	1980-2015	4.33
	HHD	*CONS*	1.492 (0.221)***	-0.087 (0.328)				
CAN	*CONS*	*HHD*	1.595 (0.150)***	0.239 (0.109)**	3	yes	1973-2015	14.57; 3.37
	HHD	*CONS*	1.454 (0.151)***	-0.019 (0.208)				
DEU	*CONS*	*HHD*	1.410 (0.138)***	-0.146 (0.095)	3	yes	1972-2015	37.94
	HHD	*CONS*	1.598 (0.122)***	0.048 (0.177)				
FIN	*CONS*	*HHD*	1.698 (0.170)***	0.218 (0.161)	5	no	1972-2015	26.83; 8.47; 3.14; 3.89
	HHD	*CONS*	1.297 (0.137)***	0.218 (0.145)				
FRA	*CONS*	*HHD*	1.250 (0.160)***	-0.030 (0.128)	5	yes	1979-2015	46.90
	HHD	*CONS*	1.623 (0.125)***	0.311 (0.157)*				
GBR	*CONS*	*HHD*	1.445 (0.155)***	-0.066 (0.140)	5	yes	1972-2015	19.50
	HHD	*CONS*	1.523 (0.114)***	0.179 (0.126)				
USA	*CONS*	*HHD*	1.371 (0.156)***	-0.029 (0.095)	2	yes	1972-2015	19.13
	HHD	*CONS*	1.722 (0.074)***	0.230 (0.123)				
Avr. cycle length								24.17

Notes: AUS: Australia; CAN: Canada; DEU: Germany; FIN: Finland; FRA: France; GBR: Great Britain; USA: United States of America. DVL: Dependent variable. LDV: lagged dependent variable. EPV: first lag explanatory variable. Standard errors in parentheses. *, **, *** denote statistical significance at the 1, 5, and 10%-level, respectively. Necessary condition: $\alpha_2\beta_1 < 0$. All specifications were estimated with a constant (not reported). For the average cycle length, we use the longest implied cycle length of each country.

Table A13: VAR models with *INV_RES* and *HHD*

Country	DV	EPV	Coeff LDV	Coeff EPV	Max. lag order	Necessary condition satisfied?	Period	Cycle length
AUS	*INV_RES*	*HHD*	0.630 (0.180)***	0.251 (1.129)	4	no	1981-2015	72.17; 4.44; 3.52
	HHD	*INV_RES*	1.177 (0.217)***	0.099 (0.035)***				
CAN	*INV_RES*	*HHD*	0.908 (0.165)***	-0.251 (0.706)	2	Yes	1973-2015	26.23
	HHD	*INV_RES*	1.413 (0.134)***	0.030 (0.031)				
DEU	*INV_RES*	*HHD*	1.302 (0.168)***	-0.444 (0.524)	2	no	1982-2015	25.12
	HHD	*INV_RES*	1.404 (0.140)***	-0.033 (0.045)				
FIN	*INV_RES*	*HHD*	0.875 (0.193)***	4.078 (1.140)***	5	yes	1980-2015	20.40; 6.19; 3.34; 2.66
	HHD	*INV_RES*	1.810 (0.221)***	-0.033 (0.037)				
FRA	*INV_RES*	*HHD*	1.456 (0.165)***	2.508 (0.710)***	3	no	1980-2015	17.55; 5.46
	HHD	*INV_RES*	1.414 (0.187)***	0.036 (0.043)				
GBR	*INV_RES*	*HHD*	0.991 (0.151)***	0.979 (0.826)	2	no	1982-2015	76.47; 7.85
	HHD	*INV_RES*	1.530 (0.144)***	0.051 (0.026)				
USA	*INV_RES*	*HHD*	0.965 (0.189)***	4.730 (2.089)***	6	no	1976-2015	19.96; 8.82; 5.30; 3.68; 2.49
	HHD	*INV_RES*	1.879 (0.183)***	0.035 (0.017)**				
Avr. cycle length								21.85

Notes: AUS: Australia; CAN: Canada; DEU: Germany; FIN: Finland; FRA: France; GBR: Great Britain; USA: United States of America. DVL: Dependent variable. LDV: lagged dependent variable. EPV: first lag explanatory variable. Standard errors in parentheses. *, **, *** denote statistical significance at the 1, 5, and 10%-level, respectively. Necessary condition: $\alpha_2\beta_1 < 0$. All specifications were estimated with a constant (not reported). For the average cycle length, we use the longest implied cycle length of each country.

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