Credit and business cycles, searching dependencies

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Abstract

The relationship between financial shocks and business cycles has been studied extensively through both theoretical and empirical approaches, establishing various transmission channels between them. However, there has been limited research examining how this relationship varies in strength and timing over different periods. This study introduces a novel methodology to analyze when and how strongly credit and business cycles are interconnected. The approach is applied to six countries from 1970Q1 to 2017Q4 using a Markov-Switch Kalman Filter framework (Kim, Nelson et al., 1999) to identify periods of cycle interdependence.[1]

The findings reveal two key insights: First, the interdependence between credit and business cycles was stronger before countries adopted inflation-targeting monetary policies. Second, this interdependence tends to spike during periods of financial crisis. Notably, European countries in the study showed weaker interdependence overall, which can be attributed to their participation in the monetary union.

Contents

[1] Find the replication package of the paper here

1 Introduction

Since the financial crisis in 2008, the study of the relationship between the real and the financial sides of the economy has been growing in importance. The theoretical nexus has been established, as some literature explains the channels throughout the financial cycle impact on the business cycle. Other branches point out the mechanisms of the inverse relation, the business cycle as a factor of reinforcement of the financial cycle.

Empirically, both relations have been tested, but the methods used to support them mainly focus on proving the existence of the two-sided relation. However, there is no literature related to the identification of periods when the relation holds and if there are changes in the relationship's magnitude.

In order to solve this issue, we propose a State Space model to make inferences about the non-observable states, such as the cyclical components of variables related to the real business and financial cycle. Furthermore, we will allow changes in the interdependence of these cycles through a Markov Switching structure. Therefore, we can obtain a model where the relationship between these two sides can change over time. The findings could help in modelling the non-linear effects of cyclical interdependence and the transition dynamics of innovations in cycles.

The document has the following structure: section (2) analyzes the previous works on related fields and their main findings. Section (3) presents our methodology: the trend-cycle decomposition and our measure of interdependence, then section (4) shows the application and empirical results obtained in a group of 6 countries. Finally, section (5) concludes and describes our main findings and limitations for future studies.

2 Literature

The understanding of the credit cycle can be seen as the result of two main drivers. The first one is the growing competence among banks to gain market share by offering weaker credit requirements (Gorton and He, 2008). Credit growth rates will be high until delinquency rates start rising. This fall makes the banks tighten their requirements and reduce their credit offer. Here, the main driver of the credit cycle is the existence of competence between banks and the imperfect information about the credit takers.

The moral hazard is the second main driver of the credit cycle (Myerson, 2012). Bankers tend to overtake risk looking after high returns and the investors can only trust them in periods of high expected returns. A change in expectations modifies the equilibrium in the financial system, with investors trying to rescue their funds and the entities in the financial system facing liquidity problems if their high-risk investments do not get enough return.

The literature studies how the relationship holds on the collateral requirements' multiplicative effect and how it varies across the business and credit cycles Kiyotaki and Moore (1997). This interaction mechanism predicts a positive, stable relation between credit and output.

Another view that links the business and credit cycle is the existence of adverse selection in

credit markets, producing multiple equilibria in the economy (Azariadis and Smith, 1998). One equilibrium happens when capital investment is fully financed, and there are no credit constraints, and the other occurs where adverse selection problems arise, and the economy enters a state of credit-rationing, a mechanism of the financial system to induce self-selection in the demands of funds.

Monetary policy is one of the main factors affecting the credit markets. Monetary policy operations affect the financial and real dependence. For example, setting the interest rate instead of the money quantity denies the effect of the monetary shocks on the real part of the economy (Poole, 1970). As we will see later, this explanation will serve us in interpreting the fall in the credit-output dependence.

The moral hazard problem as a driver of the cycle is also seen but from a monetary policy perspective. The mismatch maturity taken by the banks is a risky action that sustains expansions in credit. This over-taken risk is motivated by the central bank bailouts, which are seen as a potential rescue, in case a financial problem (Farhi and Tirole, 2012).

The empirical literature does not have a uniform method to identify this relation. Many studies analyze this topic by identifying the cyclical turning points and explaining the amplitude of both cycles by exogenous characteristics (Claessens, Kose and Terrones, 2012).

A second proposed methodology identifies the financial spillovers on the output for the G7 countries using a rolling window VAR (Claessens, Kose and Terrones, 2012) or with a financial spillover index (Diebold and Rudebusch, 1994).

A third procedure consists of estimating the financial cycle from a multivariate spectral measure in order to obtain a common cycle index and a country-specific index. This method was applied to identify the common and specific credit cycle in European economies (Hiebert, Schüler and Peltonen, 2015).

Furthermore, there are methods based on Kalman Filter using variables such as the gross domestic product, credit, and housing prices (Rünstler and Vlekke, 2018). Also, some authors consider a structural multivariate time series model to account for different cycles of each variable (Harvey et al., 1997).

3 Trend-cycle decomposition and interdependence

In this section we present the model in order to identify the periods of interdependence and the logic behind the structure.

To start off, y_t and f_t are variables of the economic activity and the stock of credit provided to private sector[2], so they could be used as inputs to measure the business and financial cycle.

Then, we propose a baseline trend-cycle (Clark, 1987) decomposition of both variables:

$$y_t = t_t^b + c_t^b$$
$$f_t = t_t^f + c_t^f$$

The trend of y_t (t_t^b) is an I(2) depending only on potential economic growth, g_t^b, which is an I(1). In the case of the financial side's trend, growth is explained by economic growth and the proper long-run dynamic of the financial sector, t_t^f. This second component could be seen as the financial sector development component effect.

$$t_t^b = t_{t-1}^b + g_{t-1}^b$$
$$t_t^f = t_{t-1}^f + g_{t-1}^f + g_{t-1}^b$$

where

$$g_t = g_{t-1} + e_t$$

The cyclical components are modeled as AR(2) processes (c_t^b or c_t^f), where the innovations of the process can affect both cycles, depending on the state s. The state space model baseline only focuses on this non-linear characteristic[3].

$$c_t^b = \rho_1^b c_{t-1}^b + \rho_2^b c_{t-2}^b + \eta_t^b + \alpha_s \eta_{t-1}^f$$
$$c_t^f = \rho_1^f c_{t-1}^f + \rho_2^f c_{t-2}^f + \eta_t^f + \beta_s \eta_{t-1}^b$$

The states, s, should be interpreted as (i) s=1, the one with low dependence on economic and financial cycles and as (ii) s=2, the state where there is high dependence on financial and real business cycles. These depend on the values of α_s and β_s, which are the coefficients of the business and credit cyclical innovations crossed effects. Finally, the parameters ρ indicate the lags' importance.

To compute the inference of non-observable and states, we use a Kalman Filter in Markov

[2]The financial series usually take the form of stock, like aggregate credit to non-financial private sector

[3]There could be more state-dependent parameters, but this makes the identification of the cyclical dependence more diffuse.

Switching State Space Models (Kim, Nelson et al., 1999) . We estimate the specification by the maximum likelihood method, in order to obtain a set of parameters $(\beta, \alpha, \rho, \sigma)$. Then, we proceed to obtain a smoothed process of the unobserved cyclical parameters.

In order to get more accurate estimates, we use inflation as an additional observable variable. This macroeconomic variable can give more information to the model, as the switching point can be endogenous and dependent on economic indicators. In some countries, this variable has not followed a stationary process, so we consider the long-run inflation as a non-observable state, which behaves as an $I(1)$ process:

$$\pi_t = (1 - \zeta_1 - \zeta_2)\bar{\pi}_t + \kappa c_t^b + \zeta_1 \pi_{t-1} + \zeta_2 \pi_{t-2} + v_t$$
$$\bar{\pi}_t = \bar{\pi}_{t-1} + \psi_t$$

Where π represents the inflation, $\bar{\pi}$ is the long-run inflation, ζ indicates the lag coefficients of the AR process for inflation and κ is the interaction of cycle and inflation. Finally, v and ψ are perturbations.

In the next section, we will estimate these parameters to model the interaction of both cycles in each state and the change in this relationship.

4 Empirical results

We estimate by Maximum Likelihood the structure presented in the previous section for some developed countries (USA, Canada, United Kingdom, France and Germany) and Peru. Then, we describe the findings about the smoothed states where the economy is located and the significance, magnitude and sign of the α_s and β_s coefficients.

Furthermore, we present graphics relating the changes in states of interdependence, the credit cycle estimates, and an HP filter estimation of the credit cycle during the period of study for comparison reasons. The interdependence graphic shows the change in probability of being in a determined state, where s=1 indicates a state of low interdependence and s=2 a state of big interdependence. Meanwhile, the credit cycle graph highlights the period of high interdependence on the credit cycle.

4.1 United States

Estimates about the American interdependence coefficients are presented in Table 1. The results show that there is both a big expansionary impact of financial shocks to real cycles and an important shock of real business on credit cycles in a state with high interdependence. Moreover, the coefficients on the state of low interdependence are non-significant, showing that in those periods, the relationship is lower.

Then, we observe the states' transition for the period 1970Q1 to 2017Q4 in Figure 1. This figure shows the changes in the smoothed probabilities of having a strong interdependence

between the business and financial cycle. During this period, the US had three important crises: the oil crisis in 1973, the dotcom crisis at the beginning of the millennium, and the subprime crisis in 2008. The events had significant impacts on the American economy, especially on how they managed their monetary policy to reactivate the economy.

First of all, we have to point out that the FED managed their monetary aggregates as their main instrument of monetary policy, influenced by Keynesian theories. Later, in the period of Volcker as the FED Chairman (1979-1987), the Reserve started using other types of instruments and communication tools, such as press releases and the movement of intermediate interest rates, as the Monetary revolution started.

As it is seen in Figure 1, the change from a state with high dependence on output and credit cycle to a lower one *first* happens in the period where the monetary policy instrument was changed to an intermediate interest rate instead of a monetary aggregate on the 1980s. The new monetary procedure of the FED made the economy less dependent of the impacts to the money market and financial shocks (Poole, 1970). These results would become a standard as the main economies reduce their output-credit dependency once the interest rate is established as an intermediate policy objective.

Nevertheless, there were two periods of time when this high dependence appeared again: the dotcom and the subprime financial crises. This could give us another potential explanation to the interdependence between credit and output: the financial crises.

The dotcom crisis was an event characterized by the rising market value in the stock of electronic and Internet-based firms at the beginning of the century. In 2002, the bubble burst, generating a massive fall in the value of these firms, making a reallocation of this sector, effects on employment and the growing globalization.

Meanwhile, one of the most important events was the financial crisis in 2008. This event caused a break in the monetary macroeconomics applications and theories because of the new phenomena observed in the market and the fundamentals of the economy. To start off, multiple jobs were lost as a result of massive defaults on mortgages. As the production fell, the prices followed their tendency, creating a scenario with growing unemployment and falling prices (Rünstler and Vlekke, 2018).

Conventional theory would suggest lowering the interest rate to reactivate the economy, but the rates were low and near zero before the crisis. Therefore, the FED and other central banks had to use unconventional monetary policies, such as Quantitative Easing, Zero or Negative Interest Rates, or Forward Guidance.

Evidence corresponds with the probabilities presented, as the probability of being in a state with higher interdependence rises near one between 2007 and 2010. The following lower probability reflects the slow recovery during the last years and that agents started internalizing monetary policy to continue on their decisions and activities (Boháček and Mendizábal, 2007).

Finally, Figure 2 presents the credit cycle estimations obtained from the filter and compared to the Hodrick and Prescott filters. Our filter estimates are highly persistent. We can observe two long credit complete cycles in the sample; the first starts in the late 70s and ends in 90s.

The second starts in 90s, becomes an expansion after the dotcom crises, and finalizes with the financial crises. The proposed filter shows up a better performance than the Hodrick and Prescott filter in characterizing the credit cycle, as it presents the longer and higher magnitude of the different crises.

4.2 Canada

The second case of analysis corresponds to the Canadian economy. Table 2 shows the sign, magnitude, and significance of each coefficient. In this case, the coefficients related to the first state are negative and without significance, while the associated with the second state previous to the analysis are positive and significant. Furthermore, the coefficient of the financial shock to the business cycle, α_2 is bigger than the reverse, β_2.

To explain the results, we present in Figure 3 the relation between the credit and business cycle and how it has changed in the 90s, corresponding also with a change in the monetary policy design.

The Canadian Central Bank changed its framework to an inflation-targeting regime in 1991. We observe a transition to an independent state between credit and output after this year, only responding to the subprime crisis. This characteristic was pointed out previously and explained by institutional factors of the Canadian financial system, mainly regulations imposed to the banks to avoid the spread to real variables (Bordo, Redish and Rockoff, 2015).

Specifically, Canada controls their interest rates and works on a flexible exchange rate scheme in joint work between the Bank and the federal government. Moreover, they make revisions to their objectives every five years, establishing a medium-run forward guidance policy. For example, in the 2006 Statement, the Bank expressed that they will not have a special answer to the asset prices behavior (Bank of Canada, 2006). Nevertheless, in the 2011 Statement, they adapted the scheme to the new needs, especially to the expansionary monetary policy (Bank of Canada, 2011). Later, they used the crisis as a way to expand their regime, seeking lower rates and ensuring prices and financial stability for joint development.

These mechanisms, along with the financial regulations, made high management of both cycles and sustained a lower interdependence, as fiscal and monetary policy include financial stability as an input on their objectives, as can be seen in Figure 4.

We observe two complete cycles; the first one with a wide amplitude started in the 70s and ended in 90s. The second cycle started in 90s and ended in 2010. This second cycle is flatter than the first. The lower amplitude may be explained by the importance of the Canadian inflation targeting regime and its policies to ensure financial stability. These integral policies dissipate volatility and provide a stable financial framework.

4.3 United Kingdom

Estimates of the United Kingdom are presented in Table 3. Data shows a bigger effect of financial shocks on business cycles than the reverse at periods of high interdependence. While there is no significant relation during periods of low interdependence.

To analyze this economy, one has to check their monetary policy regime and how it changed this relationship. First, monetary policy at the Bank of England was managed by monetary aggregates, showing a great response to financial shocks. Then, UK applied to the Exchange Rate Mechanism (ERM), which is one of the precursors of the Monetary Union with Europe. However, the results of this exchange rate policy as an intermediate objective raised interest and inflation rates in UK. These facts motivated to leave this regime in 1992, and by 1997, they became an independent central bank with an inflation targeting regime and interest rates as their instrument (King, 1994).

These changes in monetary policy are related to the dynamics of the change of interdependence states. Figure 5 presents the higher interdependence before the measures implemented for the ERM and the null interdependence after the bank left this approach and stated interest rates for price stability and autonomy.

The credit cycle estimated shows the same pattern as the instruments applied by the central bank. First, interrelation was high, then there was an expansion due to the attempts to integrate into Europe and a final rise before the crisis, as it is seen in Figure 6.

There is a little recovery on UK variables, as it is seen on the last part of the graphic. Although the financial crisis diminished the cycle, the recovery on credit lasted 5 years approximately. Also, the cycle completed is lower than the one experienced before the ERM. This is evidence, joint with a more prudential management as an objective, that changes in monetary regime to an inflation targeting reduce the impact of financial channels.

4.4 France

In Europe, France is an example of how a regime as the Monetary Union responds to the financial and business cycle. The first estimates are shown in Table 4 and state that there is a significant and positive relation between cycles, especially of real shocks on financial cycles on the state of low interdependence. In the one with low interdependence, there is a positive impact of real shocks on the financial side. However, the results are lower in comparison to the USA and Canada, showing the minor impact in a commonly managed economy.

Figure 7 shows how the relationship has changed during the analysis period. The relation is little or near zero in the most of the sample, except by higher dependence before the beginning of the Eurozone and the period of the subprime crisis, where there is a state change.

The introduction of the Economic and Monetary Union of Europe created common economic policies, such as free mobility, the same objectives, a new Central Bank, the European Central Bank (ECB), and a common currency, the euro. This global policy aimed for coordinated

growth and stability among the members.

The ECB monetary policy is guided by a monetary and economic analysis, using many mechanisms according to the independence and price stability objectives. The main instrument is the management of short-run interest rates in order to change the market interest rates and their activity. Also, they started using non-conventional policies by 2008, especially the Quantitative Easing and the Forward Guidance.

It has to be highlighted that the ECB has to coordinate the monetary policy of 19 countries; therefore, expectations and communication have an important role (European Central Bank, 2011).

The case of France, as the second biggest economy of the Union, summarizes the Union's impact on the interaction of real and financial cycles. To start off, Figure 8 is presented.

Data reveals that there was an expansion of the cycle during the implementation of the Eurozone on late 80s and that the years with high dependence were before the union and in the crisis period. Those credit fluctuations lowered after some years, showing the adequacy of the new policy. Even the response to the crisis was minor compared to the experienced before the Union. This evidence shows that the monetary regime gives plenty of information about the relationship on business and credit cycles.

4.5 Germany

To finish with the European analysis, we present the case of Germany and the relation of their cycles. Germany is also part of the Eurozone, and the ECB implements its monetary policy. Moreover, Germany is the biggest economy in the Union, so they have an active role as a leader. As in the case of France, Table 5 shows that the relation is not significant, mainly influenced by the common policy.

Since its foundation in 1957, the Bundesbank defined its main objectives as price stability and its independence from other aspects, like fiscal policy (Clarida and Gertler, 1997). This regime was the first in the world, and it can be their importance for prices in Figure 9.

It was in the early 70s that the Bundesbank had attenuated its response to credit cycles. This might be explained by the adequacy of the price stability policy and the beginning of the Monetary Revolution. Before, the Bundesbank reacted to any shock to avoid high inflation periods (like the one experienced at the beginning of the century). Then, the application of common policy, the search for stability, and the financial crisis generated a major stability, resulting in a change of state to one with low dependence during the last 40 years.

Figure 10 shows that the amplitude of credit shocks is at high levels before and after the introduction of the Union. It seems that the financial side has a major impact on the economy, first because of the lack of response of the Central Bank due to their objectives and later for the implementation of ECB and the higher weight of macroprudential policies.

4.6 Peru

Peru is an economy that moved toward an inflation-targeting framework in monetary policy in the early 2000s. This new guide to monetary policy also implemented the interest rate as an intermediate target (Armas et al., 2007). Prior to this change, the Peruvian economy experienced high inflation rates and very volatile output cycles.

In Table 6, we observe that state 2 is the one characterizing high dependency between credit and output cycles. The coefficients are positive and significant, while the coefficients of low dependence state are nonsignificant. This relationship held previously to the implementation of the inflation targeting scheme and during the financial crises, but is lower than in the USA or Canada.

The case of Peru differs from the European one as this country experienced hyperinflation during the 80s and 90s. After this period, the Central Bank obtained autonomous management and was concerned only on price stability. This new policy was reinforced in 2002 with the inflation targeting regime, lowering the inflation and the respond to financial shocks (Castillo, Montoro and Tuesta, 2006).

Figure 12 shows the cyclical component of the credit cycle in the Peruvian economy. As we can see, there was a strong expansion of credit in the 90s until the 2000s. Then, there was an increase in regulation of the commercial banks, implying a decrease of credit delinquencies.

Also, the global economy had an important impact on the late 90s, as the Asian and Russian crises worsened the financial conditions and stressed the liquidity needs in the emergent economies. These main changes in the banking business provoked the bankruptcy of some financial institutions and a period of recession in the credit cycle.

Furthermore, the rise in the cyclical component of the credit was stopped by the financial crisis, but it was not a persistent nor big shock. After this change in the cyclical component, we see a weak expansion of the credit between 2012 and 2015, mainly explained by the lower commodity prices.

Finally, we have different experiences on the interrelationship and how monetary policy can impact these dynamics. The results are similar and differ by the autonomy or common policy of Central Banks.

5 Conclusion

In this document, we propose an empirical method to recognize the periods of dependence between credit and output cycles, as it is the first study of the region to identify this issue. Our results show that this dependency was stronger in periods when the monetary policy was conducted by monetary aggregates as intermediate targets for countries with monetary independence (USA, Canada, UK and Peru). In the other cases (France and Germany), we see that this dependency has become weaker since the creation of the European Union.

The second main source of dependence between credit and output cycles is a financial crisis. As we have seen, the high dependence state has been reactivated in two specific periods in many countries: the dotcom and the subprime crises. Our credit cycle estimates are much persistent than the ones obtained by an Hodrick and Prescott filter. Moreover, in all cases, the duration of credit cycles is longer than estimated by the HP filter.

The evidence supports the idea of a regime-switching in the business cycle caused by the financial side of the economy, joined with the idea of modeling the unobserved cyclical components of credit and economic growth (Azariadis and Smith, 1998; Kim, Nelson et al., 1999). Furthermore, our results correspond with the view that setting interest rates as an intermediate target reduces the impact of the money-market shocks and, consequently, of the financial side of the economy (Poole, 1970). Future studies should analyze the use of asset prices as additional information to obtain the estimates of credit cycles and the interdependence, following the idea that credit constraints would bind when the collateral value falls (Kiyotaki and Moore, 1997).

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Table 1: Interdependence estimates, USA

	Estimates	T
α_1	0.56	1.83
α_2	3.98	6.08
β_1	0.09	0.50
β_2	1.29	5.15

Figure 1: Smoothed probabilities of states, US

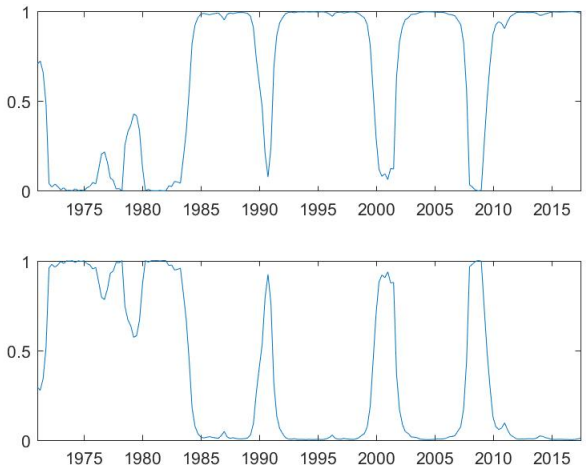


Figure 2: Credit Cycle, US

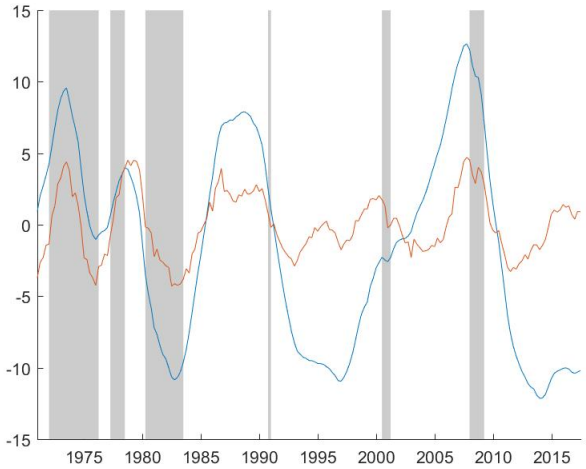


Table 2: Interdependence estimates, CAN

	Estimates	T
α_1	0.26	0.94
α_2	2.51	5.83
β_1	-0.37	-1.62
β_2	1.24	5.16

Figure 3: Smoothed probabilities of states, CAN

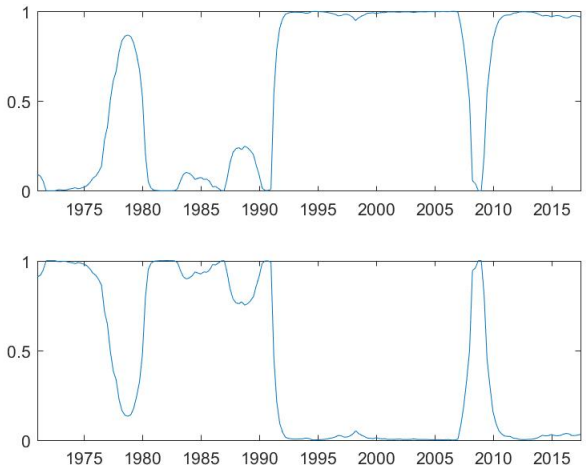


Figure 4: Credit Cycles, CAN

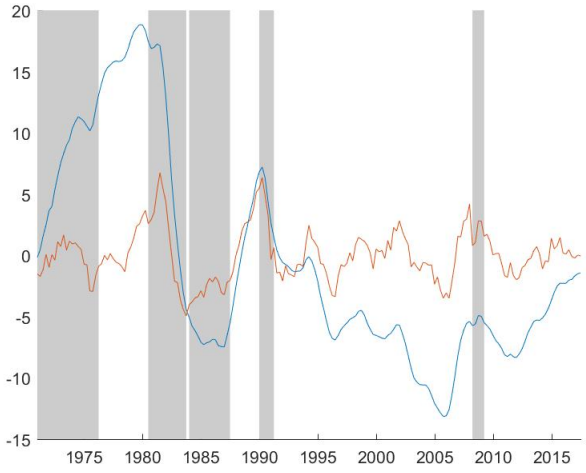


Table 3: Interdependence estimates, UK

	Estimates	T
α_1	0.37	1.78
α_2	3.02	4.82
β_1	0.31	1.54
β_2	1.98	3.81

Figure 5: Smoothed probabilities of states, UK

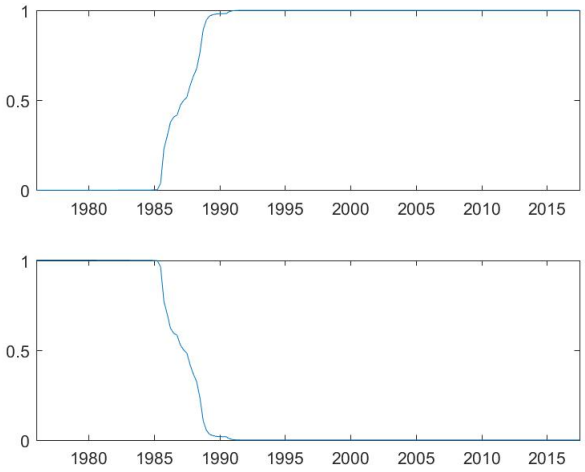


Figure 6: Credit Cycles, UK

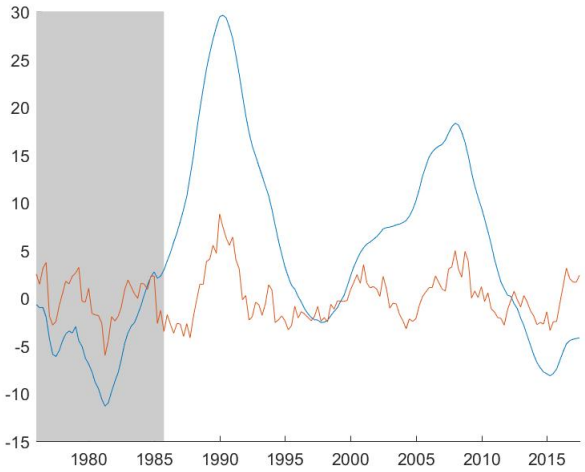


Table 4: Interdependence estimates, FRA

	Estimates	T
α_1	0.21	1.88
α_2	2.09	2.81
β_1	0.43	2.62
β_2	4.75	4.44

Figure 7: Smoothed probabilities of states, FRA

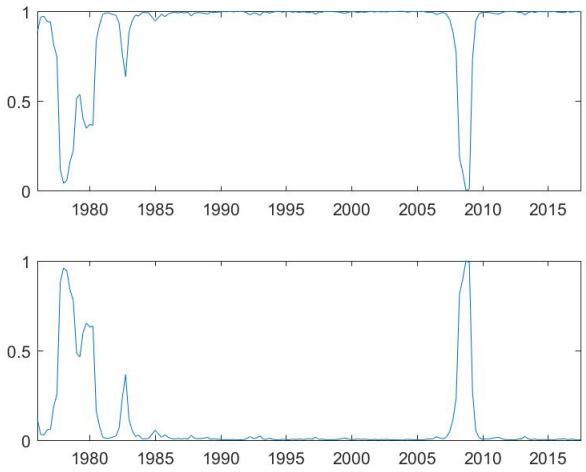


Figure 8: Credit Cycles, FRA

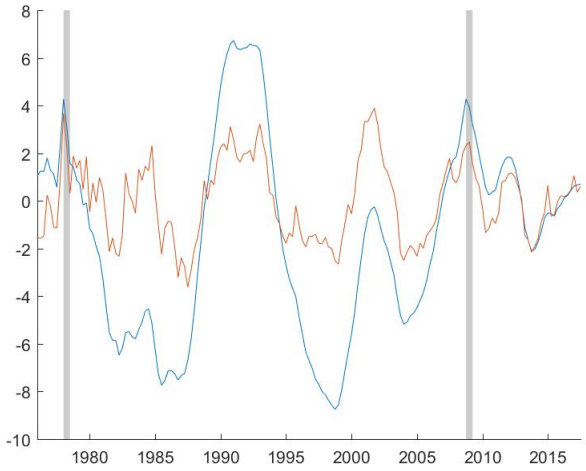


Table 5: Interdependence estimates, GER

	Estimates	T
α_1	0.97	1.19
α_2	0.40	0.35
β_1	0.00	0.02
β_2	1.13	1.92

Figure 9: Smoothed probabilities of states, GER

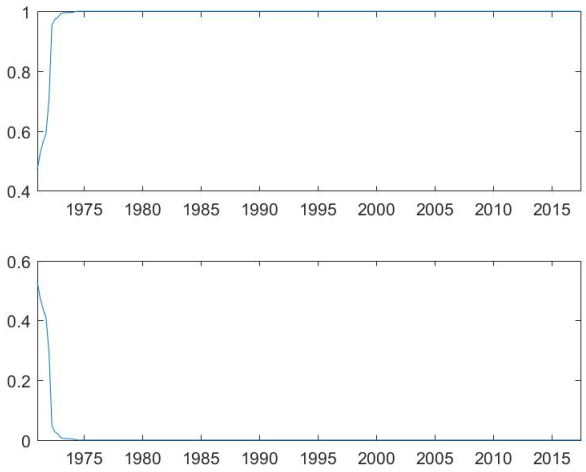


Figure 10: Credit Cycles, GER

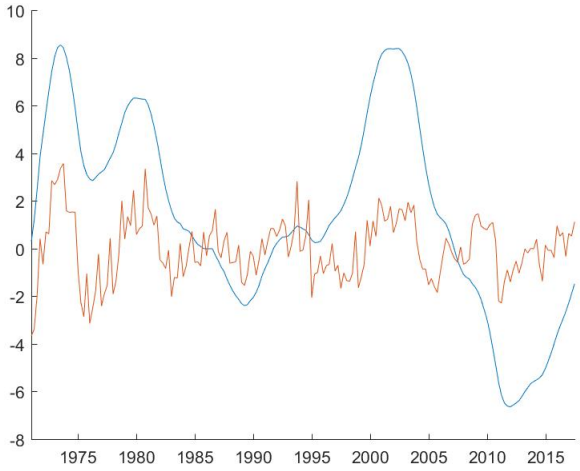


Table 6: Interdependence estimates, PER

	Estimates	T
α_1	0.11	0.71
α_2	0.93	3.98
β_1	-0.44	-0.25
β_2	6.00	3.37

Figure 11: Smoothed probabilities of states, PER

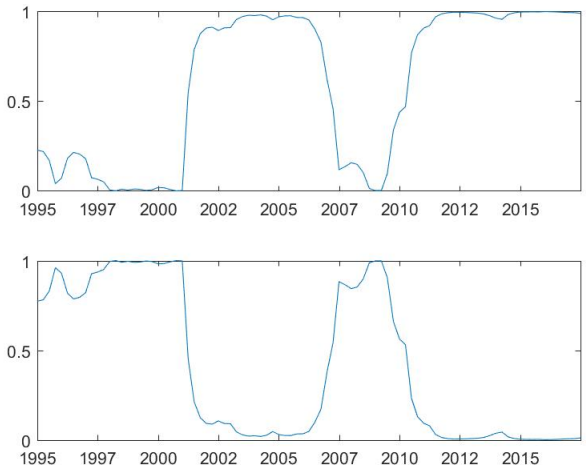
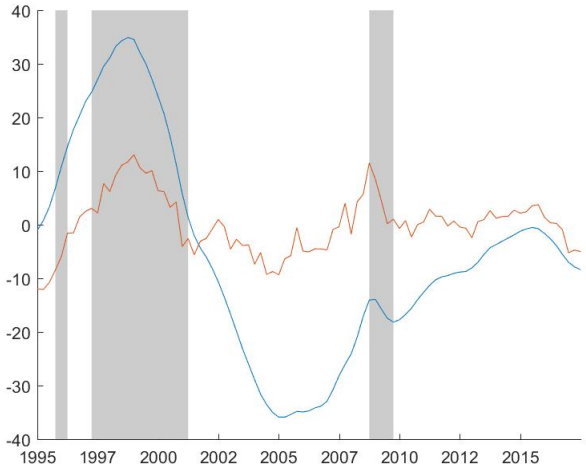


Figure 12: Credit Cycles, PER



Appendix

Estimations results

	CAN	DEU	FRA	UK	USA	PER
ρ_1^b	1.30	1.10	1.40	1.46	1.21	1.50
	0.19	0.57	0.49	1.18	0.06	1.77
ρ_2^b	-0.34	-0.16	-0.43	-0.50	-0.23	-0.57
	-0.19	-0.54	-0.47	-0.97	-0.06	-0.78
ρ_1^f	1.84	1.85	1.78	1.86	1.86	1.87
	1.57	0.00	0.00	0.00	0.82	0.00
ρ_2^f	-0.85	-0.85	-0.79	-0.86	-0.86	-0.87
	0.00	0.00	0.00	0.00	-0.34	0.00
σ_{gb}^2	0.00	0.00	0.00	0.00	0.00	0.02
	10.70	31.14	32.96	17.49	33.09	9.42
σ_{cb}^2	0.18	0.73	0.11	0.17	0.14	0.05
	11.04	8.36	20.83	11.49	11.74	11.23
σ_{gf}^2	0.00	0.00	0.00	0.02	0.00	0.02
	0.00	12.10	22.28	6.98	0.91	4.06
σ_{cf}^2	0.11	0.05	0.13	0.18	0.07	0.46
	9.95	12.51	7.94	6.52	12.08	2.87
σ_v^2	0.27	0.51	0.19	0.84	0.10	2.27
	12.44	11.18	8.98	7.00	18.75	3.05
κ	0.04	0.05	0.09	0.06	0.09	0.18
	1.28	2.38	2.30	1.70	3.39	2.60
ζ_1	0.20	0.09	-0.02	-0.02	0.28	-0.05
	1.32	0.89	-0.18	-0.06	1.72	-0.34
ζ_2	-0.01	-0.00	-0.00	0.19	-0.02	-0.00
	-0.16	-0.20	-0.02	2.83	-0.29	-0.02
$\sigma_{\epsilon_f}^2$	0.34	0.19	0.13	0.63	0.18	0.39
	12.46	18.64	19.34	9.58	15.16	9.12
σ_ψ^2	0.02	0.01	0.02	0.03	0.03	0.02
	8.84	18.61	21.87	10.82	11.38	9.86
p_{11}	0.98	1.00	0.98	1.00	0.96	0.97
	6.17	0.00	6.59	0.01	7.75	4.47
p_{22}	0.96	0.81	0.74	0.98	0.92	0.94
	6.84	2.76	2.97	4.85	7.53	5.79
α_1	0.26	0.97	0.21	0.37	0.56	0.11
	0.94	1.19	1.88	1.78	1.83	0.71
α_2	2.51	0.40	2.09	3.02	3.98	0.93
	5.83	0.35	2.81	4.82	6.08	3.98
β_1	-0.37	0.00	0.43	0.31	0.09	-0.44
	-1.62	0.02	2.62	1.54	0.50	-0.25
β_2	1.24	1.13	4.75	1.98	1.29	6.00
	5.16	1.92	4.44	3.81	5.15	3.37

Non-Observable States Estimates

Figure 13: Non observable states estimates, USA

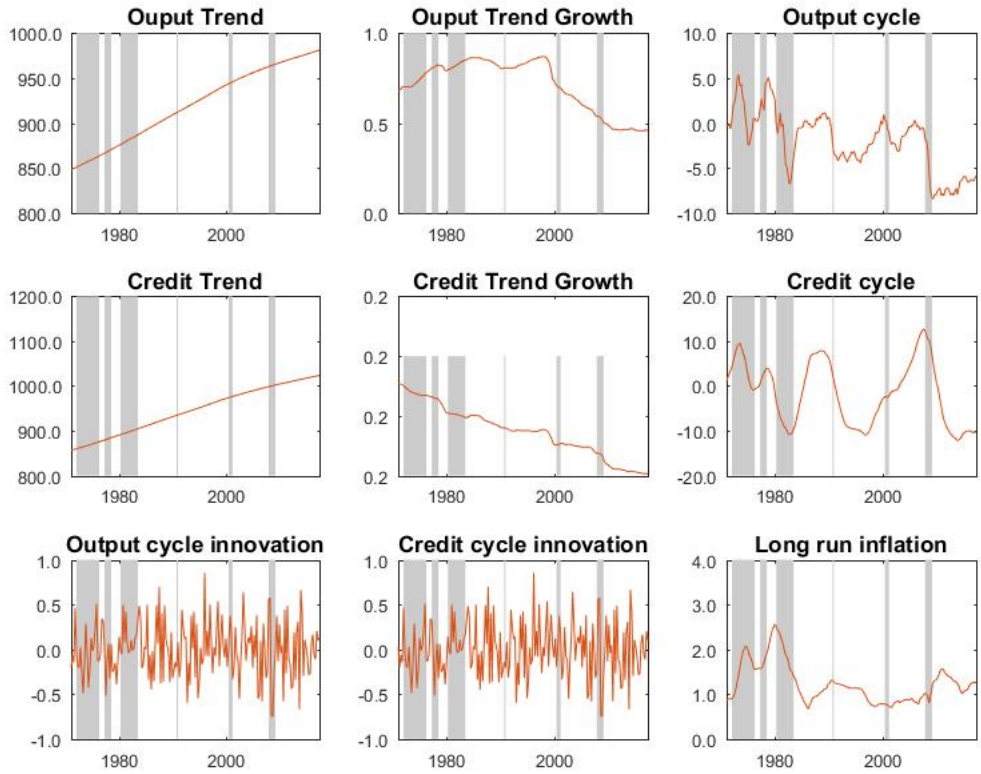


Figure 14: Non observable states estimates, UK

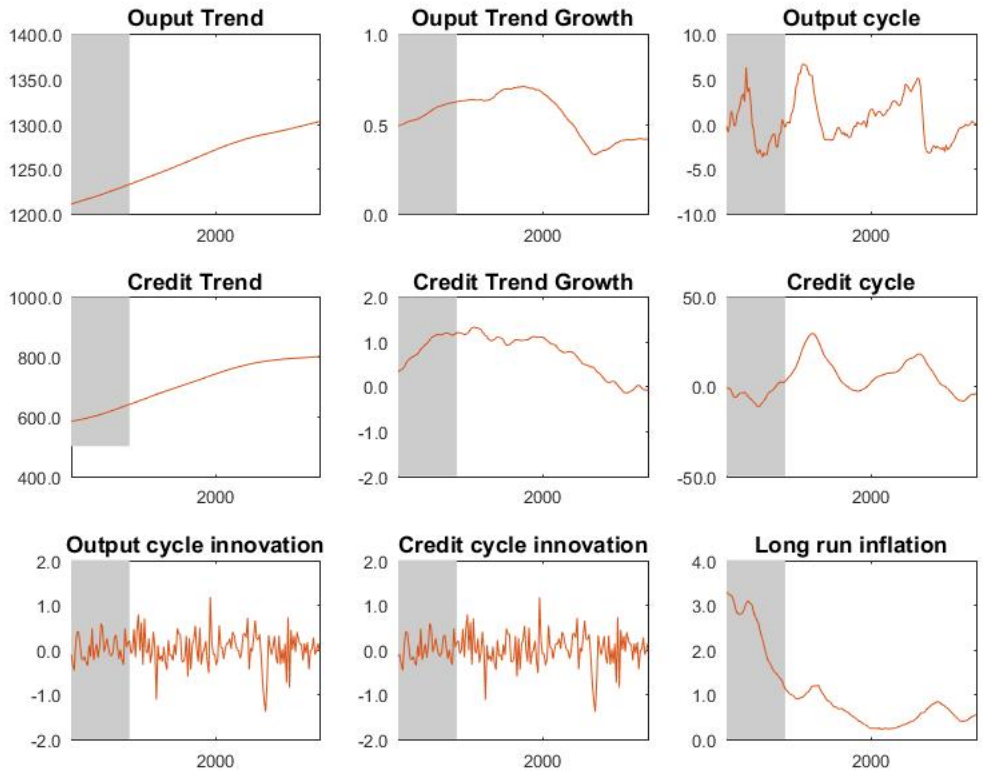


Figure 15: Non observable states estimates, CAN

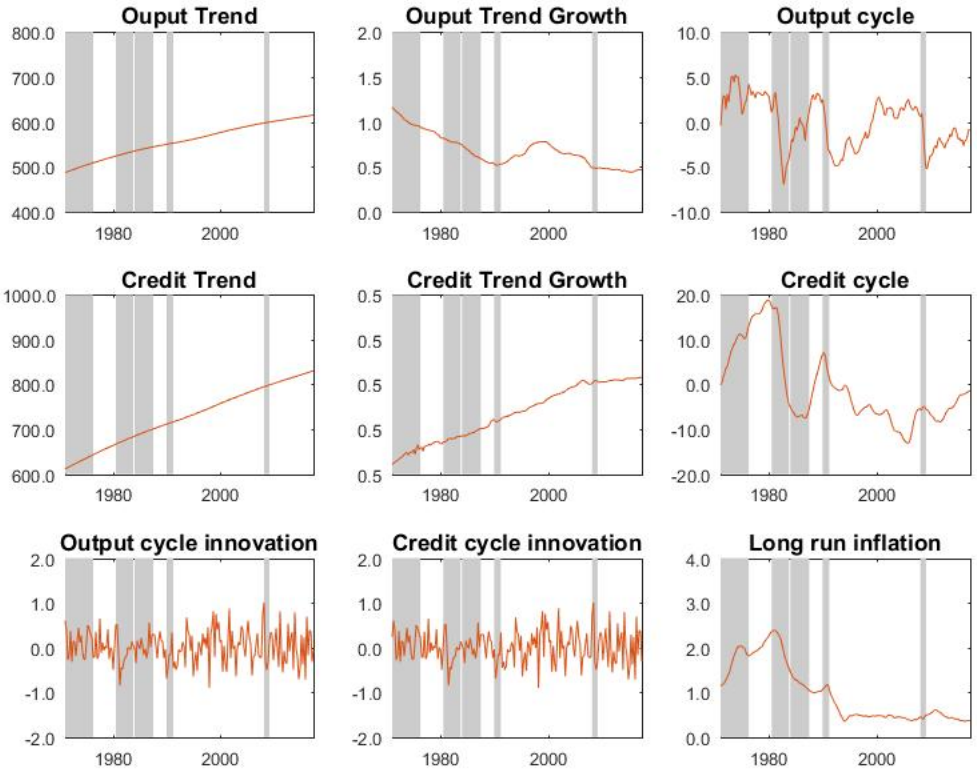


Figure 16: Non observable states estimates, FRA

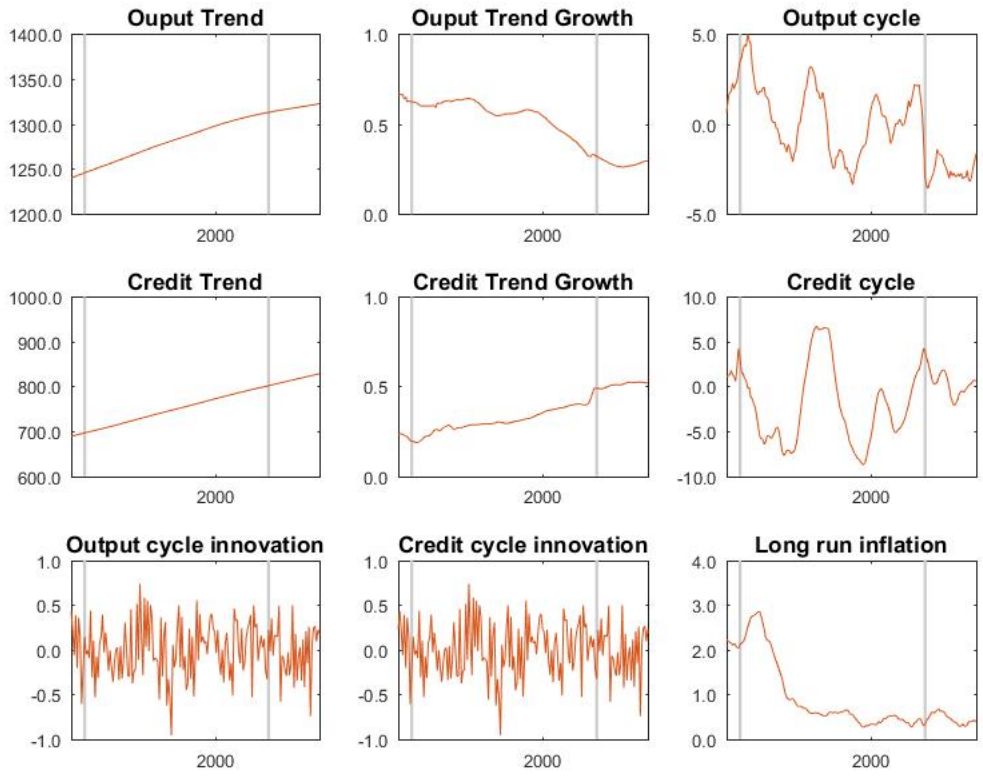


Figure 17: Non observable states estimates, GER

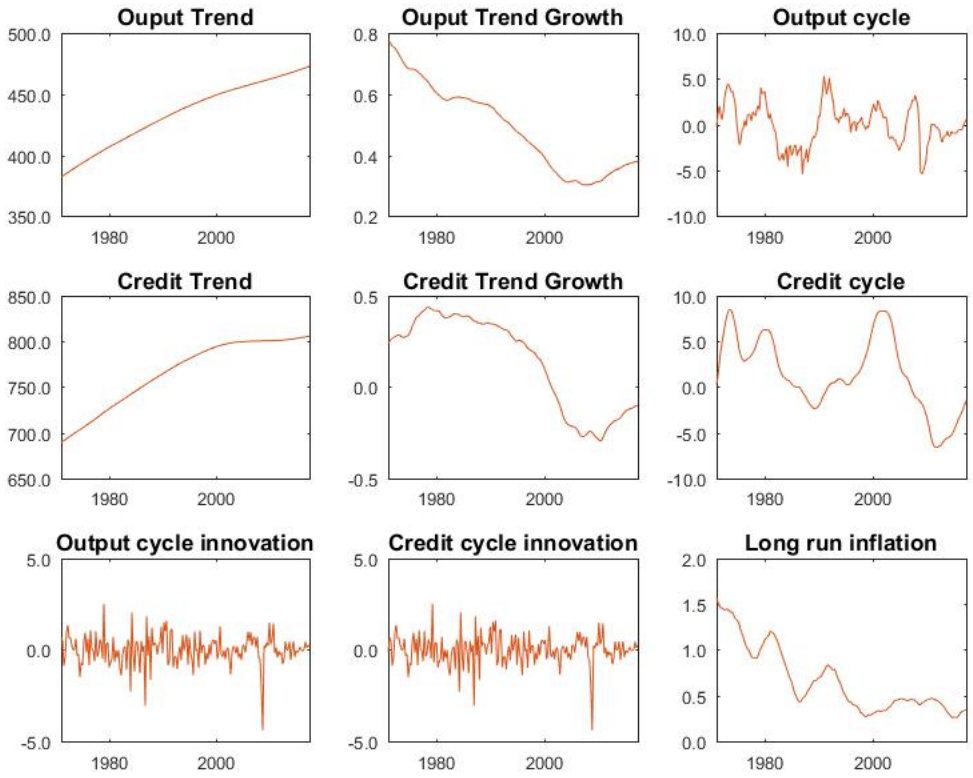


Figure 18: Non observable states estimates, PER