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Synchronization of monetary, credit and business cycles

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Synchronization of monetary, credit and business cycles.

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Contents

Abstract

In this article, we analyze the synchronization of the credit and monetary cycles with the business cycle. Our study is based on a database about the United States from January 1972 to October 2020. Using an Hodrick-Prescott filter to define the cycles we then use two methods: the cross-correlation and the synchronization event. We obtain common results between the two methods. The synchronization between money and production is generally weak, which explains the inefficiency and abandonment of monetary policies. While the synchronization between credit and production is generally high. However, we do not end up with to a perfect synchronization. This imperfect synchronization explains the difficulties of Government intervention to promote growth.

1 Introduction

In 2020 the "Covid crisis" began, an economic crunch due to sanitary factors. The emergence of a new type of economic crisis puts in perspective our vision of economy and its operations. It is the very first time that all countries in the world have stopped producing. In order to understand our Economic system and its process, it is useful to pay attention to what happened in the past. In the Economic field, we usually try to explain production and growth by two major factors: credits and money stock. The two mainstream theories about business cycles are the neoclassic and new Keynesian ones. According to them, cycles are made of a period of fiscal and monetary policies made to lower the unemployment rate, causing an increase in production. Then, Governments are unable to stop at the right time and it generates inflation and then recession. Inflation enhances investment because arbitrage is in favor of productive assets and debt, to the detriment of money holding and creditor status. This investment stimulates production, then a new cycle begins. Monetary policies and credit policies are therefore closely linked to production, we will consequently concentrate on these two components and their relationship with production for the past 48 years.

The United States has known many changes since 1972: oil crisis, changes in taxation (Economic Recovery Tax Act in 1981), or the subprime crisis to name but a few examples. Taking a look at all these periods and events will enable us to see if there are interactions and significant connections between credits, money and production.

In order to analyze 48 years of changes, we will base this study on classic cycles. They refer, according to the NBER (Nation Bureau of Economic Research), to periods of absolute declines and increases in the level of economic activity. To analyze the business cycle, we will use the manufacturing production between January 1972 and October 2020, with index 100 for January 2012. For the credit cycle, we will be using the consumer credit for households in billions of dollars, adjusted for breaks, for the same dates. Finally, the monetary cycle is the M2 money stock in billions of dollars for the same period of time.

This study will then enable us to analyze the theories of money and credit as well as their links with production. Do monetary policies have an impact on production? Are household consumption credits a good way to boost economic activity? These are the questions we will try to answer in this report.

Specifically, one would ask whether the cycles of credit and money synchronize with the cycle of production. We would also query whether they are pro-cyclical or counter-cyclical.

In order to answer these questions, we will first focus on the existing literature on the subject. In particular, a report on the economic events that have occurred in the United States since 1972, the link between money and production and the link between credit and business. We will continue with an empirical study between 1972 and 2020 by analyzing the cycles and their synchronization. We will therefore present our data and the methods used to finally submit our results.

2 Background Literature

When looking at the cycles of production, money and credit, it is interesting to begin by considering the existing literature on the subject. We will thus present the evolutions of the United States's economy over the last 48 years, and then present the money and credit cycles and their links with the production cycle.

2.1 USA Economy since the 70's: a retrospective

Ever since 1970s, the American economy took advantage of and suffered from globalization (a new concurrent appears at the beginning of the (21^{th} century). In 1973 and 1979, there were two oil crises which declined the productivity growth until 1990. The first one came from a peak in oil production in United Stated and the stopping in the Bretton Woods System. This system provided the convertibility between dollar and gold and a fixed exchange rate system. In March 1973, the United Sates switched to a floating exchange rate regime. This created a devaluation of the dollar, so a devaluation of oil prices which were libeled in dollar. Until 1975, there was a Great Recession. In fact, productivity fell by 1.5% but quickly recovered in 1975. There were a stagflation (high rate of unemployment and high inflation) and a stagnation of the economy. In the beginning of 1978, Jim Carter (President at the time) proposed to put voluntary ceilings on price and wage increases, which created employment. In November, the Administration (the executive branch of the country) decreed measures as interest rate hikes to prevent dollar from collapsing and to reduce the inflation. Between 1975 and 1979 the unemployment rate dropped a little, in 1978 it was less than 6%. We noticed that the unemployment rate came back as it was before the recession in 1997. The second appeared with the Iranian war which included the stop in Iranian export. As a consequence, there were increase of oil prices, a decrease of investment, an inflationist effect and an augmentation of the unemployment rate. This crisis triggered a monetary crunch in 1980. In early 1980, to reduce the inflation, the FED raised the interest rates and caused a sharp recession. In March 1980, president Carter did his own policies to reduce inflation. This allowed the Federal Reserve to lower interest rates. Another recession took place in 1981 and finished in 1982. This first years of the 80's, the Fed and the government tried to reduce the inflation and the effects of the second oil crises. Between 1982 and 1990, the United States had a strong expansion.

Stock and Watson denoted that before 1990 the business cycle was very volatile. We note that in 1990, there was strong growth with low inflation and significant job creation. Between 1990 and 2001, there was a decline of this volatility. Volatility is high if there are very high and very low peaks over short periods. There are two possible explanation for these authors. Firstly, this event took place because the inflation of prices and wages fluctuations were more moderated than before 1990. Secondly, there was change in the economic structure. In fact, the production was before 1990 for the most part a production of goods than a production of services. The production changed because of exogeneous shocks. The conclusion was that the management of stocks and the market changes don't explain the moment and the extent of the decline of the volatility. The majority of this decline seems to be due to the reduction of the structural shock's volatility [Stock and Watson, 2002]. During this period, the production growth rate was comparable to the one during the post-war boom. From 1994 to 2000, the real output rose, inflation was manageable, and unemployment fell below 5% resulting in a stock market surge known as the dot-com boom. The Internet bubble was caused by excessive internet-related speculation made ten years ago. The results were a higher unemployment rate and the

crash of the stock market. On September 11^{th}, 2001, there was a series of four terrorist attacks in the United States. This deteriorated the economy. This year the production increased only by 0.3% and the unemployment increased too. Between 2001 and 2008, the United Sates had a high growth rate.

In 2005 the price of oil started to rise. The price of a barrel of crude oil rose to $147.30 in July 2008 (before that, it usually costed $25). In the short term, the sharp rise in oil prices has had an inflationary effect. Some international heads of states talked about a third oil crisis. Many factors explained it as the falling value of U.S. dollar, the financial speculation, the soaring demand from China, the reports showing a decline in oil reserves ... The oil prices stabilized in 2009, which marked the end of the third oil crisis. In 2007, the famous subprime mortgage crisis started. One year later the financial bubble burst. This created a recession with a collapse in house prices. The unemployment rate was 10% in 2009. In 2013, Detroit became the largest U.S. city to file for bankruptcy with a debt reaching $18.5 billion. Moreover, the city had experienced industrial desertification and a demographic fall. It was an industrial city which lived mainly thanks to the automobile industry. In some neighborhoods the unemployment rate exceeded 50%. In September 2019, the Federal Reserve System invested to provide funds in the repo market. This was necessary because the loan debt rate jumped above 8% which limited the supply of available funds. At the end of 2019, the unemployment rate was 3.6%. This has been the lowest unemployment rate that the United States has known since the Second World War. Right after, U.S. stock markets suffered from their biggest crash in modern U.S. history amid concerns over the coronavirus pandemic and the oil price war between Russia and Saudi Arabia. In fact, the unemployment rate was 14.9% in 2020.

To summarize, the United States experienced several recessions and expansions in the past 48 years. We are now going to look at whether these recessions or expansions in the United States economics can be explained by the monetary cycle.

2.2 Monetary and business cycles: 40 years of changes

More than just an instrument, money is a major debate in the economic field. Seen as useful for business or not, monetary policies discussions were central for many centuries. The debate is not only on the question of the importance of money for the Economy of countries, but also which measures we should take? For a long time M1, or the "exchange" money was the reference. But with the growing usefulness of credit cards and banks, Economists began to take M2 as a reference. But then again, the evolutions of M2 were not able to explain the changes in business cycles. Economists began to take M3 or L but it still really is difficult to explain business by money. Despite these dilemmas on the definition of money, monetary policies were rooted in economic policies. For Lucas, Friedman, and even the new monetarists, money was the one issue. Central bank had to prevent inflation. Yet, as James K. Galbraith, an American Economist, reminds us, the subprime crisis changed everything. Overlooking on speculation or fraud are the two big mistakes of monetarism and its new doctrines that make this Economic Theories outdated [Galbraith, 2008]. Looking at the European Central Bank we realize that monetary policy is not a go-to for production. Finance or innovation have a huge impact on economy and it would be interesting to take a look at these cycles rather that the monetary ones.

Still, we will concentrate on the operation of the FED and present one of the major theories on the relationship between money and growth.

In order to have a better understanding on the monetary policy in the United States, we will right away present the FED. The two major FED's characteristics are that it has the same organization as in 1913 (the year of its creation) and it is one of the only private central banks in the world. It is composed and owned by the 12 federal banks of the United States. The FED is led by a Board of governors, composed of seven members, a president and a vice-president both appointed by the President of the United States of America. The monetary policy is governed by the FED, in particular the policy interest rate. The interesting thing about the United States is that, having their own central bank, they can do monetary policies. But on the 5 key functions of the FED, only one is actually about monetary policies: the conduction of the nation's monetary policy. The other functions are more or less about finance and the financial system.

In the economic theories of cycles many focus on the relation between monetary shocks and production. One of the emblematic theories on the subject has been conceived by Robert E. Lucas (1977). His position has been formulated in a criticism of Keynesianism that did not take into account the anticipations of economic agents. Joseph E. Stiglitz joins his point saying that what really matters is not money but the anticipated money [Stiglitz, 1989].

In the Lucas paradigm, there is a double problem. First, the information should be perfect in order to have good predictions but is very difficult to obtain. The second problem is up to the price. More specifically the price has a signal that depends on inflation and gives an information to economic agents and will therefore have an impact on consumption and production. On another hand, Lucas thinks that monetary policy has no impact on long-term and short-term because of the perfect anticipations.

Looking more precisely at the Lucas's model, it considers the monetary factors on business cycle as a demand. Then the impact of money on production is only based on the demand of money. In Lucas' model it is explained by the perfection of information requested to have perfect anticipation as formulated before. In fact, if the information is perfect, you know how much a good will cost in the next period of time, and then your actions will therefore depend on this price anticipations. But having no perfect information, producers will make wrong anticipations. If the prices grow on a time t, he will expend his production in time t. The problem is, having wrong anticipations, producers can make mistakes on the work demand for time $t+1$, leading up to higher numbers of unemployment, resulting in recession. Finally, in Lucas' theory, the deviation around the trend is the consequence of unexpected shocks on the current offer. These unexpected shocks being the resultant of the errors of anticipation on prices.

Even if no empirical evidence has been found to validate the cycle and monetary theory of Lucas, it gives a major insight: it is the offer and demand of money that makes the monetary cycle.

To summarize, the monetary cycle is made of demand for consumption and inadequate anticipation on prices. Having no information on the anticipation of economic agents, synchronization between monetary and production is hard to make. Second point, money demand being a demand for consumption, it is related to the household demand of credit and not on monetary mass. We will therefore concentrate on this point now.

2.3 Credits and business cycles: the credit demand channel and its impact on production

In this development, we show that credit cycle impacts the business cycle. Any recession is driven by an increase in debt. Historically, we can see when the debt is very high, so is the crisis. There would therefore be a more or less delayed synchronization effect between the credit cycle and the economic cycle.

The first debate on this subject bears upon the destination of the credit supply. One wonders whether the credit supply is intended for households or businesses. First, companies get into debt to increase their production capacity (firms invest and innovate) and consumers borrow to consume. According to the microeconomic data of the analysis [Mian and Sufi, 2010], the demand channel is the most probable. Two indicators allow us to observe these channels in practice. First, if it is a demand channel then prices are experiencing inflationary trends. Conversely, if the channel is made by supply then prices are evaluated downwards. Second, the demand channel generates an increase in employment in the non-tradable good sector. While the supply channel generates an increase in employment in the non-tradable and tradable goods sector [Mian et al., 2017]. In the 1980s and 2000s, respectively with the deregulation of banks and the subprime crisis, we observed an increase in employment and prices in the non-tradable goods sector. Thus, we focus on the demand channel. The demand channel makes it possible to understand the boom-bust effect and to assess the severity of crises. In the short term, household debt has a positive effect on the economy. In the long term, the trend is reversed.

A few years after the increase in credit supply, consumption increases. The correlation between household credit and real economic results is strong. When household debt increases, investment and production also raise. The correlation between firms' credit and real economic performance is less than the one with household. When household debt increases employment and prices increase in the non-tradable goods sector and construction sector [Mian and Sufi, 2018].

The contraction in economic activity can be explained by six factors: individual behavior, a major banking crisis, prices frictions, frictions in the labor market, falling real estate prices and long-term distortions. First, the households that go into debt the most are those who spend the most. The crux of the matter is that when the debt of these households increases, they decrease their consumption. Also, people without debt are those who consume the least. Thus, consumption drops substantially. Global demand is falling. People who are not in debt do not consume. The prices are too rigid, so it remains high after the boom period and the interest rates are not beneficial to households. We can therefore see that in the developed economies the prices are rigid downwards. It is a real problem that often leads to recessions. Second, the frictions of the labor market stop the fall in wages instantly. As wages are too high, unemployment is rising sharply. The first sector affected is the non-tradable goods sector. Real estate prices are also one of the causes of the crisis. People in debt cannot pay off their mortgage. Second-tier banks therefore seized their homes. The banking institutions sold the houses at the foreclosure price. As a result, the prices of foreclosed houses and other houses drop. The banking crisis reinforces the crisis of the real economy. After a period of strong increase in the supply of credit, the banks cut loans. However, during this period, companies have a greater need to finance themselves because consumption drops. As an illustration, in the United States during the recession of 2008, the cars credit fell. The auto industry has suffered greatly. Finally, the long-term consequences must be taken into account. When debt increases, the construction sector employs more workers. This workforce is often young. Young workers leave school for the job market. However,

unemployment raises a few years later, offering no prospects for the future.

Authors (Mian and Lopèz-Salido) also emphasize the importance of individual behavior in the economic downturn [Mian et al., 2017]. On the one hand, forecasting issues seem to be an important point. Lack of anticipation creates a gap between the moment when consumers go into debt and the moment when economic growth increases. Debt heightens at time $t-4$ until $t-1$. Despite the knowledge of the debt in past years, economists and forecasters make errors on the measurement of production for the times $t+1$, $t+2$ and $t+3$. Thus, production is increased with a delay of two periods of time (t representing a year). The surplus production therefore creates significant economic losses [Mian and Sufi, 2018]. On the other hand, changes in financial behaviour lead to changes in the real economy. This analysis comes from behavioral finance. Until now our reasoning was based on a major hypothesis: individuals are rational. This means that their behavior responds correctly to economic changes. In behavioural theory, this hypothesis is lifted, and the choice of economic actors reveals important changes. To measure changes in financial behavior, we use the credit spread. The credit spread represents the difference between the quoted rates of return on two different investments. Thanks to this measurement, we can know the risk of defaulting payments of the borrower, that is, the risk that borrowers do not repay their debts. Historically, the spread reduces in period of economic expansion. Conversely, in times of economic recession the spread increases. Lopèz-Salido, Stein and Zakrajsek explain that cycles are actually produced by investor sentiment regarding the financial and real market [Lopèz-Salido et al., 2017]. However, they in no way call into question the multiplicative aspect of the demand channel. Extrapolation of behavior begins when household debt increases. During this period the economy seems to be quite good and investors are more optimistic. These irrational behaviors are at the origin of the substantial fall in the spread. In reality, the economic situation is not particularly good and the consequences of these behaviors are significant. Investors observe poor economic results and lose their optimism. They reduce their supply of credits. The market is therefore experiencing a major recession. Overall, these behaviors should be added in the analysis of the synchronization between credit cycle and business cycle.

We will now demonstrate the impact of credit cycle on business cycle through two historical changes. Between 1980 and 1990, the United States experienced a change in the organization of its banking system: it was the banking deregulation. Next, we will analyze the causes and consequences of the 2008 Subprime crisis.

In the 1980s, banking deregulation was organized in the United States. It goes through two major principles: it reduces the number of constraints for credit offers and allows second-tier banks to grant loans to actors from other States. This deregulation is progressive. Mian, Sufi and Verner separate the American states into two categories: the early states which deregulated their banking systems before 1983 and the others [Mian et al., 2017]. In their analysis, they confront these two categories. The first opposition is the total household debt. States which deregulated early have seen household debt increase more rapidly than other States. Globally, household debt in the United States increased by 218 percentage points of GDP between 1982 and 1988. Second, there is a cycle during the period from 1980 to 1992. The unemployment rate is countercyclical. It declines with the expansion and increases with the recession. In the United States, between 1982 and 1989, the unemployment rate fell by 0.6 points between 1982 and 1989 but it increased by 0.9 points. Growth rate and GDP are procyclical, increasing with expansion and decreasing with recession. The consequences are all the more pronounced on the construction and housing market. Prices increased sharply between 1983 and 1989. However, it fell less significantly. This is explained by rigid prices. There is an amplification

of cycles for States having deregulated early.

As we explained earlier, debt creates growth in local demand. This leads to increase inflation and employment in the non-tradable goods sector. However, when households become insolvent, the mechanisms are reversed, and the economy plunges into a recession all the more important for the States which deregulated early.

The Great Recession was a turning point in the history of the American and world economies. We will try to understand these causes and consequences thanks to the economic analysis of Mian and Sufi [Mian and Sufi, 2010]. Between 2003 and 2005, the authors first find low interest rates. Indeed, household credit demand is increasing. These credits are mortgages. At first sight, mortgage credit represents a high risk of default. The authors use micro-data between postcodes that have experienced the high increase in debt and those that have experienced to a lesser extent. Thus, the growth in house prices was significantly stronger in postcodes where the debt was greater. The correlation between house prices and income growth were negative between 2002 and 2005 unlike other periods. As a result of the increase in debt, households could not repay their credit. There was a sharp rise in mortgage debt defaults. In addition, the use of micro-economic data shows that the propensity to consume for people in debt is greater. However, in a period of economic recession both debt and non-indebted households reduced their consumption. Finally, the unpaid mortgages were seizured by banks and put-on the market at a seizure price. The house supply was therefore significantly higher than the demand. As a consequence, real houses prices in the United States have fallen by 62% for seized houses and 28% for neighboring houses.

To sum it up, the credit cycle has a decisive impact on the business cycle. This synchronization between cycles is explained by the demand channel. When household debt increases the economy experiences a period of boom and then of bust. Two historical moments illustrate these cycles: the banking deregulation in the 1980s and the 2008 Subprime crisis.

3 Empirical study

Now that we know the economic evolution of the United States over the period and that we know the main informations and theories on the money and credit cycles and their links with the production cycle, we will present our study. We will first present our data, then continue with the synchronization methods used and finally present our results.

3.1 Our Data

Our database is made up of three variables and 586 observations. The data was found on ALFRED (ArchivaL Federal Reserve Economic Data). It is a database owned and managed by the Research division of the Federal Reserve Bank of Saint-Louis. It brings together temporal data on financial, monetary and economic topics.

The observations correspond to the months from January 1972 to October 2020. The variables used are monthly seasonally adjusted (SA). The first variable is household consumer credit to represent the credit cycle. It is given in billions of dollars. We have chosen this variable because we have seen in the literature that the credit cycle is carried out through the channel of household demand. The second variable is monetary aggregate M2 to represent the monetary cycle. It is given in billions of dollars. The M2 aggregate is better suited than the inflation rate to represent money because the inflation rate is calculated annually. The third variable is industrial manufacturing production. It represents the economic cycle and is given as an index relative to the January 2012 equal to 100. We have chosen this variable because these variations correspond to variations in production in the United States. In addition, we did not choose the variable Gross Domestic Product because it is calculated each year.

These temporal series are not stationary. The first thing to do to analyse macro-economic series is to transform them in a logarithm function. This will stabilize the variance of the temporal series. This transformation has an impact on the distribution of a variable. This reduces variations by reducing the impact of extreme values on the series. It then reduces the volatility of the series. The logarithm of the industrial manufacturing production tends to increase over time despite downward peaks which slows its increase [Figure 1]. The logarithm of the monetary aggregate M2 only increase over time [Figure 2]. Finally, the logarithm of consumer credit is the only one that varies between positive and negative values [Figure 3]. We see several low peaks before 1995 which represents the two-oil crisis and the banking deregulation. We notice that there are no large peaks towards the top.

For now, on, we are not going to specify once we take the logarithm of the series.

3.2 Methodology

3.2.1 Hodrick-Prescot Filter

The use of the Hodrick-Prescot (HP) filter will generate economics cycles. This filter was created in 1981 by Hodrick and Prescott to represent American's cycles. In 1993, King and Rebelo found that this filter can transform series which are integrable to order 4 or less to stationary series. This fact is very interesting because the most of macro-economic series are not stationary and integrable to order two. This method is used in the literature even if there are some criticisms of it. One of them is that the

filter can create cycle although there is no cycle in the series [Cogley and Nason, 1993]. Moreover, the filter would affect stochastic properties of data as the variance and the covariance. This implies that the comparison of two filter series is wrong [Boone, 1997]. So, the properties of the filter series will reflect more filter properties than original properties of the data. Finally, the filter cannot make the difference between short-term fluctuations which have an economic sense and measurement errors which are white noise without economic interpretations. Mathematically, the HP filter decompose the time series, y_t, in two components which are a long-term non-stationary trend, y_t^p , and short-term stationary fluctuations called y_t^c.

$$y_t = y_t^p + y_t^c$$

Hendrick and Prescott considered that on average on the long-term the cyclical fluctuations should be zero and that the long-term trend should reflect a growth rate fluctuating a little. The filter will smooth the series which amplifies growth cycle frequencies and amortize the long and short-term fluctuations. The HP method consists in solving a minimisation program which minimise the variance of y_t^c and the variation penalty in the second difference of y_t^p:

$$\min_{y_t^p} \sum_t^T [(y_t - y_t^p)^2 + \lambda(y_{t+1}^p - 2y_t^p + y_{t-1}^p)^2]$$

λ is the smoothing constant, the higher its value, the smoother the long-term trend will be. The extreme case is a deterministic trend. . If $\lambda = \frac{\sigma_2^2}{\sigma_1^2}$ then the minimisation program can be written:

$$\min_{y_t^p} [\sigma_1^{-2} \sum_t^T (y_t - y_t^p)^2 + \sigma_2^{-2} \sum_t^T (y_{t+1}^p - 2y_t^p + y_{t-1}^p)^2]$$

In this case, σ_1 represents the standard deviation of y_t^p and σ_2 is the standard deviation of y_t^c. 1440 will be the lambda value because the temporal series studied are monthly and American [Burns and Mitchell, 1946].

The results to this program is :

$$y_t^{HP} = [\frac{\lambda(1-L)^2(1-L^{-1})^2}{1+(1-L)^2(1-L^{-1})^2}]y_t$$

y_t^{HP} corresponds to the value of the smooth series values.

Applying this method to our data provides us 3 smoothed cycles and 3 smoothed trends. For the business cycle, we observe that it varies between -0.2 and 0.1. As said by Stock and Watson, we notice that it is very volatile before the 90's and less volatile between 1990 and 2001. We can also

clearly see that there is a major decline for the first oil crisis and the subprime crisis. The biggest peak down is in 2020 and it is surely due to the sanitary crisis of the COVID-19 [Figure 4]. The curve of the business smoothed trend is rather increasing then decreases slightly for the crisis of 2007 [Figure 5]. The smoothed cycle for M2 is not volatile and is not exactly cyclical. The curve turns around 0 except in 2020 [Figure 6]. The M2 smoothed trend can be related to an increasing linear line [Figure 7]. The curve of the smoothed cycle for credit varies between -2 and 1. We clearly see the cycle. We observe 4 big declines that represents the two-oil crisis, the banking deregulation and the subprime crisis [Figure 8]. Its smoothed trend curve is cyclical too. It is between 0 and 4 [Figure 9].

3.2.2 Cross-Correlation with sliding window

Cross-correlation is a measure of similarity between two series. The measure of simple correlation between two variables X and Y gives a correlation matrix and a number of similarities between the numbers of X and Y. The cross-correlation gives, on another hand, the similarity between the distribution of X and Y. For example, the correlation between X and Y will give a number between -1 and 1 on how X and Y are similar. If they are alike, then the correlation will tend to 1. Cross-correlation is, furthermore, the similarity between X and Y in time series. If X and Y experience the same variations in time, they will have a significant level of cross-correlation.

It is useful to take a look at the cross-correlation in our study to estimate the synchronization level. In fact, it is a way to see if the events experienced by the business cycle are related to the ones experienced by the credit cycle or monetary cycle. If they are synchronized, then the level of cross-correlation expected is high. Otherwise, it would tell us that if household demand of credit increase, it has no impact on their consumption and then no impact on the business cycle, for example. The analysis of smoothed cycles requires their stationarity. This stationarity is confirmed by the HP cycle and by the Augmented Dickey-Fuller (ADF) test that we performed. Thanks to the Breush-Godfrey test, we analyze if the model is Autoregressive of order 2. This allows us to obtain the residuals. We use the residuals to calculate the cross correlation because it gives information on the innovation that are not present in the unadjusted series.

In this analysis we will use cross-correlation combined with sliding window, a physical tool often used to measure cross-correlation as a function of time [Guedes and Zebende, 2019]. Guedes and Zebende define cross-correlation with sliding window as follow:

Step 1: Starting from two time series, x_i and y_i, with $i = 1, 2, ..., N$ (time series length), two new integrated time series are obtained:

$$X_k = \sum_{i=1}^{k} [x_i - \bar{x}]$$

and

$$Y_k = \sum_{i=1}^{k} [y_i - \bar{y}]$$

where $\bar{x}$ and $\bar{y}$ represent the mean value of each time series, and $k = 1, ..., N$.

Step 2: We divide these two integrated time series, X_k and Y_k, into $(N-n)$ overlapping boxes of equal length n.

Step 3: After this previous step, the polynomials (order one here) that best adjusts the points (by least-squares fit) in each box of each series, $X_{k,i}$ and $Y_{k,i}$, are calculated and therefore the covariance of the residuals in each box (length n):

$$f_{xy}^2(n,i) = \frac{1}{(n+1)} \sum_{k=i}^{i+n} (X_k - X_{k,i})(Y_k - Y_{k,i})$$

Step 4: The mean over all $(N-n)$ overlapping boxes is calculated in order to obtain the detrented covariance function:

$$F_{xy}^2(n) = \frac{1}{(N-n)} \sum_{i=1}^{N-n} f_{xy}^2(n,i)$$

Step 5: Finally,ρ_{DCCA} can be calculated by:

$$\rho_{DCCA}(n) = \frac{F_{xy}^2(n)}{F_{xx}(n)F_{yy}(n)}$$

The functions F_{xx} and F_{yy} are respectively the root mean square fluctuation of each time series x_t and y_t separately. $\rho_{DCCA}(n)$ ranges from : $-1 \leq \rho_{DCCA}(n) \leq 1$. When $\rho_{DCCA}(n) = 1$ this means a perfect cross-correlation, $\rho_{DCCA}(n) = 0$ there is no cross-correlation, and $\rho_{DCCA}(n) = -1$ means a perfect anti cross-correlation. The DCCA cross-correlation coefficient has the advantage of measure cross-correlations between two non-stationary time series at different times scales, and it can be used with sliding windows. The equation of $\rho_{DCCA}(n)$ with sliding windows approach, with windows of size ω, T the period of time $(1 \leq T \leq (N-\omega))$ and n the time scale is:

$$\rho_{DCCA}(n,\omega,T) = \frac{F_{xy}^2(n,\omega,T)}{F_{xx}(n,\omega,T)F_{yy}(n,\omega,T)}$$

In this study x_i represents the residuals of the business cycle and y_i correspondingly to the residuals of the M2 cycle and the credit cycle.

The use of a sliding window cross-correlation is pretty common since the late 90's (Laurent and Davidowtz 1994, Bäcker and Cassenaer, 2002, ...). It allows to observe correlation between two signals for every couple "lagtime" pair of values. This means that we will calculate for each moment the impact of the event happening on the business cycle one year after (the best lag being 12 months) it

happened on the monetary and business cycles.

The choice of this measure of synchronization has been motivated by the fact that we know, from literature, that credits have an impact on business. But if this impact was simple and constant, then Governments would only have to ensure those conditions are satisfied to safeguard growth. Cross-correlation with sliding window allows us to evaluate synchronization including time variations. We also made the choice to put a lead on credit and money because production is the target. The ambition of every economy is to provide full-employment and prosperity. To active this goal monetary and budget policies exist and will therefore be the building block of our analysis.

3.2.3 Event Synchronization

In addition to the cross-correlation with sliding window, we use a tool of econo-physics created by Quiroga and Kreuz [Quian Quiroga et al., 2008]. We will analyze the data without the HP filter in order to see if the results are the same as with the cross-correlation.

We have 2 series x_n and y_n with $n \in \{1,...,586\}$. With x_n the production in period n and y_n the credit or M2 in period n. We also have the events that occur on the dates t. The event are the optimum of the series x and y. We note: t_i^x and t_i^y with $i \in \{1,...,m_x\}$ and $j \in \{1,...,m_y\}$. m_x being the optimum number in x and m_y the optimum number in y.

First, we calculate the number of times events appear more or less simultaneously:

$$c^{\tau}(x|y) = \sum_{i=1}^{m_x} \sum_{j=1}^{m_y} J_{ij}^{\tau}$$

With $c^{\tau}(x|y)$ = the number of times an event occurs in production knowing either credit or M2 and $c^{\tau}(y|x)$ = the number of times an event occurs in credit or in M2 knowing the production.

And:

$$J_{ij}^{\tau} = \begin{cases} \tau_{si} & \text{if } 0 \leq t_i^x - t_j^y \leq \tau \\ \frac{1}{2} & \text{if } t_i^x = t_j^y \\ 0 & \text{else.} \end{cases}$$

$J_{ij}^{\tau} = \frac{1}{2}$ when the events appear at the same time. $J_{ij}^{\tau} = 1$ when the events appear shifted in time. $J_{ij}^{\tau} = 0$ when events are not simultaneous.

τ cannot be chosen. It should be calculated by the following equation in order to avoid double counting problems. We calculate the delay as:

$$\tau_{ij} = \min_{\tau}\{t_{i+1}^{x} - t_{i}^{x}, t_{i}^{x} - t_{i-1}^{x}, t_{j+1}^{y} - t_{j}^{y}, t_{j}^{y} - t_{i-1}^{y}\}/2$$

The total degree of synchronization of the series can be obtained with:

$$Q_{\tau} = \frac{c^{\tau}(y|x) + c^{\tau}(x|y)}{\sqrt{m_x m_y}}$$

$Q_{\tau} \in [0,1]$. $Q_{\tau} = 1$ there is a perfect synchronization between two time series. $Q_{\tau} = 0$ there is no synchronization between two time series.

Then, we seek to obtain the degree of synchronization for each period with:

$$Q(n) = c_n(y|x) + c_n(x|y)$$

With:

$$c_n(x|y) = \sum_{i} \sum_{j=1} J_{ij} \Theta(n - t_i^x)$$

The J_{ij} are those determined previously. The Θ function takes the value 1 if two events do not occur simultaneously otherwise it is equal to 0.

Finally, we obtain the level of synchronization at time n, averaged over the last Δn time steps:

$$Q'(n) = \frac{Q(n) + Q(n - \Delta n}{\sqrt{\Delta n_x \Delta n_y}}$$

Δn is chosen. Δn_x and Δn_y are the numbers of events in the interval $[n - \Delta n, n]$.

We thus obtain the impact of what happens on cycle x and on cycle y at time $t - \Delta n$ on synchronization at time t. If the synchronization level is close to 1 then the synchronization of the two series is important. Conversely, if it is close to 0 then it is very low.

3.3 Results

The methods we have seen before will allow us to study our empirical series. Thus, we will now be presenting our results.

3.3.1 Cross-Correlation with sliding window

In this part, we will analyze the results of the cross-correlation with sliding window. First, this synchronization is observed between the monetary cycle (M2 aggregate) and the business cycle (production). Then, it is analyzed between the credit cycle (through household debt) and the business cycle. We analyze the impact of a change in credit and money at time t on the production cycle at time $t+12$. We therefore observe a delay of 1 year. We made the choice to delay production because we are identifying the impact of the money cycle and the credit cycle on the production cycle (not the opposite). As we saw previously, if the cross-correlation is negative then it means that an upward change in one cycle creates a downward change in another cycle (including the lag period) and *vice-versa*. If the cross-correlation is positive, then the changes are procyclical.

First, we will analyze the results of the synchronization between the monetary cycle and the business cycle [Figure 10]. Overall, we notice that the cross correlation varies between -0.6 and 0.6 over the whole period. Nevertheless two correlations are more important. First, in 1975 we observe a cross-correlation equal to 0.8. This strong positive correlation is due to the end of the first oil crisis in 1975 and as we have seen in the literature the United States economy experienced a recovery at this time. The second one is observed in March 2020 and is this time due to the sanitary crisis. The fact that we only find two correlations is due to the fact that the monetary cycle variate around zero and has only two peaks: in 1975 and 2020.

The synchronization between the money cycle and the economic cycle is inconclusive. We are only seeing significant events in history that increase the monetary cycle and create economic loss a year later. This result is confirmed by the economic literature and by the abandonment of monetary policies.

The analysis of the synchronization between the credit cycle and the business cycle is more balanced. On the face of it, we observe a curve that seems cyclical with cross-correlations varying between -0.75 and 0.7. When we observe an upward correlation, we then observe a downward correlation. The upward synchronization occurs at period t and the fall in synchronization occurs at the period between $t+12$ and $t+18$. This means that it varies over the period from a year to a year and a half. However, this analysis remains nuanced. We find that certain period does not exactly confirm this cycle. There are variations very slightly upwards and then very slightly downwards which occur over shorter periods ranging from 1 to 6 months. In the literature we observe two significant events in history for the analysis of the cross-correlation between credit and production: the period of banking deregulation and the subprime crisis. We can see these variations on the chart [Figure 11].

First, we analyze the period following banking deregulation. In 1980, we note a positive cross correlation at 0.6. This period corresponds to the moment when household debt increased in states where banking deregulation was early. The positive cross-correlation demonstrates the link between credit and production. When household debt increases, production increases. In 1989, the cross-correlation is -0.83. This period marked the turnaround in economic activity. From 1990, the economy expe-

rienced a crisis and the unemployment rate increased, reflecting the decline in production capacity. Next, we analyze the subprime period of the 2000s. Between 2003 and 2007, the literature notes an increase in household debt followed by a period of falling unemployment and revival of activity in the United States. Overall, we observe an increase in the cross-correlation between the two cycles nuanced by small declines over this period. In September 2008, we observe a cross-correlation of -0.66. This date marked the unprecedented financial crisis. This crisis will have economic and social repercussions on a global scale. The negative sign of the cross-correlation is therefore justified by the fact that the high debt of previous periods creates a decline in long-term activity.

Finally, the synchronization between the credit cycle and the production cycle is present. There are periods where the credit cycle drives the production cycle as demonstrated by the two historical periods that we have cited. However, it is important to stress that this synchronization is not perfect.

3.3.2 Event Synchronization

The Event Synchronization gives two major results. First, we obtain the result of the global synchronization thanks to the total degree of synchronization denoted by Q_τ. When the degree of synchronization over the whole period is close to 1, the synchronization of the series is strong. Second, we have the evolution of synchronization thanks to the level of synchronization at each instant n denoted by $Q'(n)$. It allows us to analyze the impact of series events occurring at time $t+12$ (i.e. one year earlier) on the synchronization at time t. In our analysis, the events correspond to the maximums and minimums occurring in the series (production, money and credit). In order to carry out this analysis, we analyze the synchronization between the monetary series and the production series and the synchronization between the credit series and the production series. Before any analysis, it is important to point out an important limit of the event synchronization analysis. The degree of synchronization must be between 0 and 1. However, in the analysis, it can exceed 1 [Quian Quiroga et al., 2008]. In this case, we do not consider a perfect synchronization but a strong synchronization.

The total degree of synchronization between money and production is 0.2. We consider that this coefficient is low. There is therefore very little synchronization between these two series. Indeed, when we analyze the number of maximum and minimum of the M2 series, we observe very few optimums. There are 20 minimums and 20 maximums only. However, the production series has 115 maximums and 115 minimums. This analysis confirms the results of the cross-correlation. The analysis of the level of synchronization over the whole period is more mixed. If we analyze the charts of the synchronization of maximums and minimums [Figures 12 and 13], we see times in history when the synchronization between money and production is strong. The year 1991 marks a synchronization between the monetary series and the production series when analyzing the maximums. Indeed, at the end of the 1990s, the period of banking deregulation in the United States, we notice an increase in prices on the market and on the labor market in the construction and housing sector. The economy was also well-functioning. However, this observation corresponds to a correlation and not a causal link. Production is healthy because of the increase in credits, not the increase in inflation. Also, we observe periods of non-synchronization. For example, over the period from 1973 to 1990, we observe no synchronization on none of the optimum. To summarize, there is no synchronization between M2 and production. This is confirmed globally and by the evolution of synchronization. This conclusion is logical in relation to the results of the cross correlation. Also, this justifies inefficiency and abandonment of monetary policies.

The degree of total synchronization between the credit series and the production series is different in the analysis of maximums and minimums. There is a stronger degree of synchronization in the maximum analysis. It is 0.75 for the maximums against 0.68 for the minimums. Overall, the coefficients are strong: the synchronization between the credit series and the production series is important. This finding corresponds to the results of the literature. We can do a two-point comparison. First, when the supply of credit increases (through the household demand channel) household demand increases. To meet this demand, firms are increasing their production. Maximums are therefore observed in the credit series and in the production series with a delay. Second, when actors become insolvent, then the credit default increases. The banks are becoming more reluctant and lowering their credit supply. Globally, there is a drop in debt. The indebted agents lower their consumption. Thus, demand falls first and then supply drops. There is a slowdown in credit supply and production within more or less than a year. The minimums occur simultaneously over a period of 12 months.

In the literature, we have observed two important moments of sharp increase in the supply of credit first creating a period of economic expansion and then a period of economic recession: the banking deregulation of the 1980s and the Subprime crisis of 2008. We also analyzed these periods with the cross-correlation. These two periods are also represented by the synchronization event [Figures 14 and 15]. On the one hand, we analyze the period following bank deregulation. Until the end of the 1980s, household debt increased, creating a fall in unemployment and an increase in production. The synchronization observed with a 12-month window shows a very strong synchronization in 1991. However, this date marked the turnaround of the economic situation. From the end of 1991 to 1992, we observe no synchronization of minimums and maximums. This is due to a period of economic hardship. On the other hand, we analyze the period of the Subprime. From 2002 to 2005, the supply of mortgage credit increased sharply in the United States. Banks granted loans that will not be repaid. Thus, second-tier banks subsequently cut the supply of credit creating a turnaround in economic activity a year later. We observe a very strong synchronization of minimums between the credit series and the production series in 2008. This historic moment refers to the subprime crisis. Also, the economic difficulties known thereafter are confirmed by the absence of maximums over the period from August 2008 to 2011.

As a conclusion, the optima of the credit series and the production series are globally synchronized (be it maximums or minimums). However, some periods show no synchronization. Therefore, we cannot outline that there is a perfect synchronization between credit and production. This conclusion confirms our analysis of the cross-correlation.

4 Conclusion

In this paper we analyze the synchronization between the business cycle and respectively the monetary and credit cycle. As one observes, the United States underwent many changes between 1972 and 2020. In particular, the end of the Bretton Woods system, the various oil crises, the deregulation period of the 1980s, the subprime crisis and finally the COVID crisis.

The literature has taught us that the synchronization between the monetary cycle and the business cycle was not achieved. In addition to problems in theory, the measurement of money is a semantic problem that diminishes its scope. Moreover, the example of the European Central Bank proves that monetary policy and growth are dissociable. These are results that we find in our study. Consequently, there is no synchronization between these two cycles, but the money stock M2 is not cyclical, it is trending.

As far as the credit cycle is concerned, the findings are quite different. The economic literature informs us that consumer credit is a mean of reviving the economy but can also cause recessions. We note a significant degree of synchronization between the credit cycle and the production cycle. Our study confirmed that the credit cycle is pro-cyclical and has an impact on the production cycle. However, it is important to note that at certain periods no synchronization is estimated.

We also find that the cycles are endogenous. They are therefore only caused by themselves and what happens to them. The credit cycle has an impact on production but does not create it. In fact consumer credit will generate an increase in demand for goods and services that will increase production, but this raise in production will also generate an increase in investment that will cause an increase in production. Thus, we cannot say that one cycle creates another. We also see that exogenous shocks have an almost simultaneous impact on cycles and that they are synchronized when these moments appear (this can explain synchronization between monetary and business cycles). However, the occasions when we observe no synchronization are also moments when there is no exogenous shock.

Finally, the use of cross-correlation and event synchronization methods allow us to find similar results. This validates our analysis. However, event synchronization gives us more information on the impact of one cycle on another.

This work makes it possible to link the credit cycle to the production cycle. However, using the monetary cycle reduces our impact. It would be more relevant to look at the U.S. trade balance cycle. Indeed, living in a globalized world, U.S. production cannot be explained only by variables related to the United States alone.

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Appendices

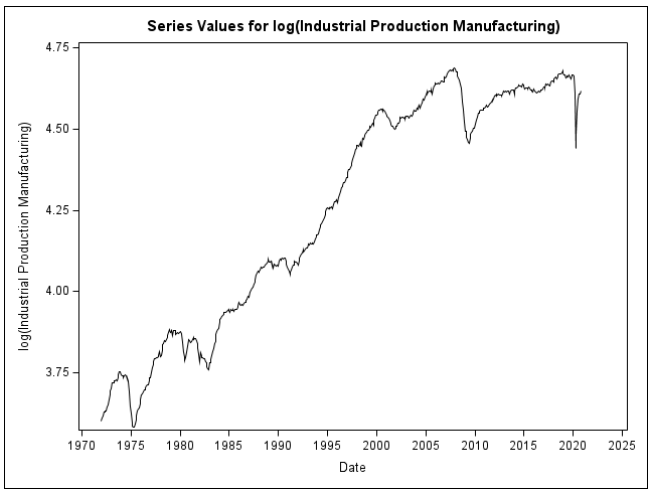

Figure 1: The logarithm of the industrial production manufacturing

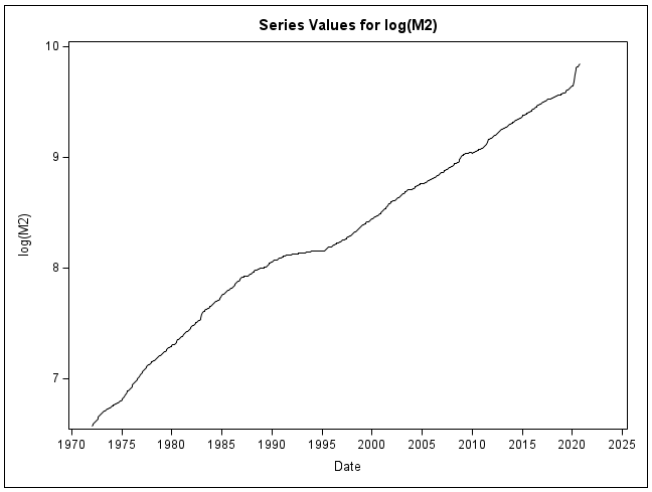

Figure 2: The logarithm of M2

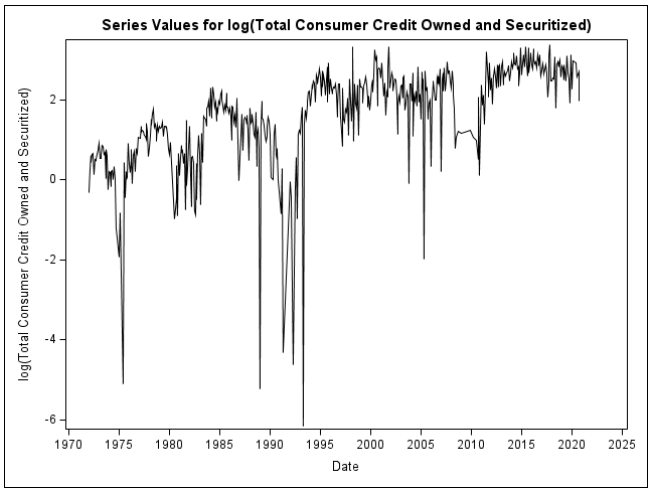

Figure 3: The logarithm of the total consumer credit owned and securitized

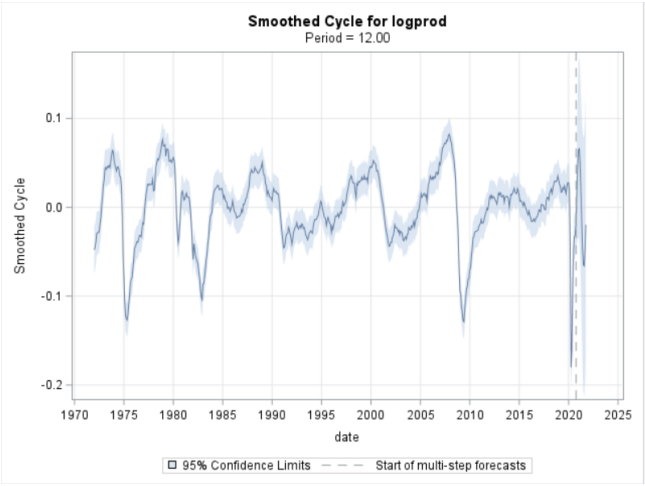

Figure 4: Smoothed business cycle

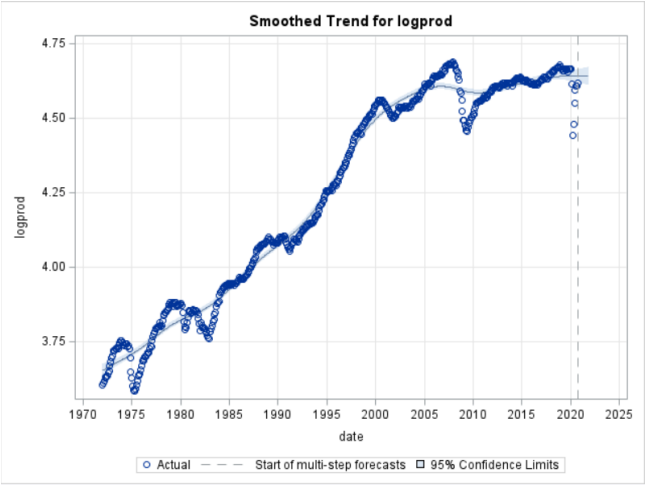

Figure 5: Smoothed business trend

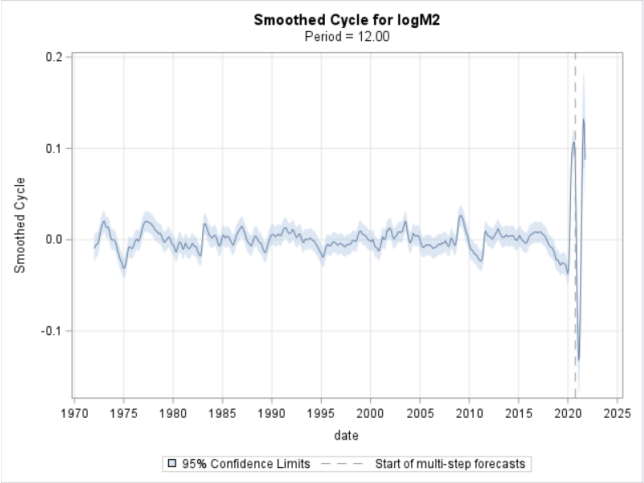

Figure 6: Smoothed M2 cycle

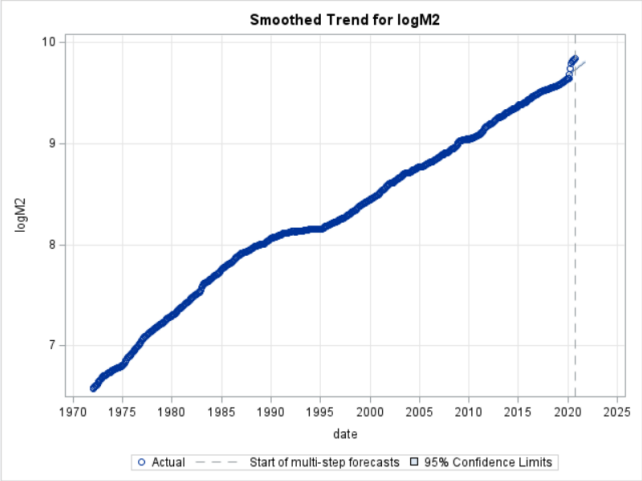

Figure 7: Smoothed M2 trend

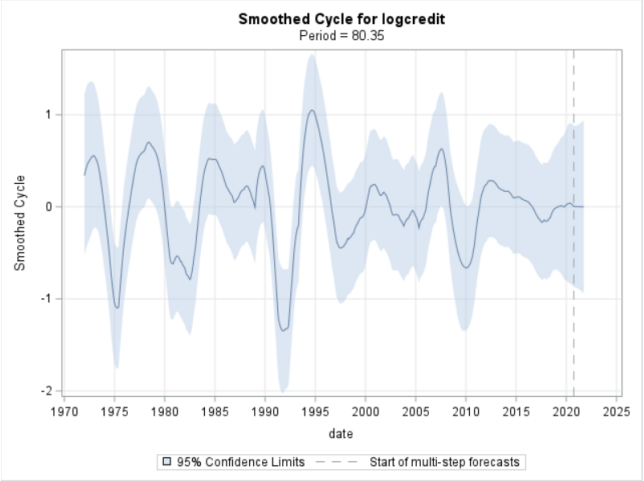

Figure 8: Smoothed credit cycle

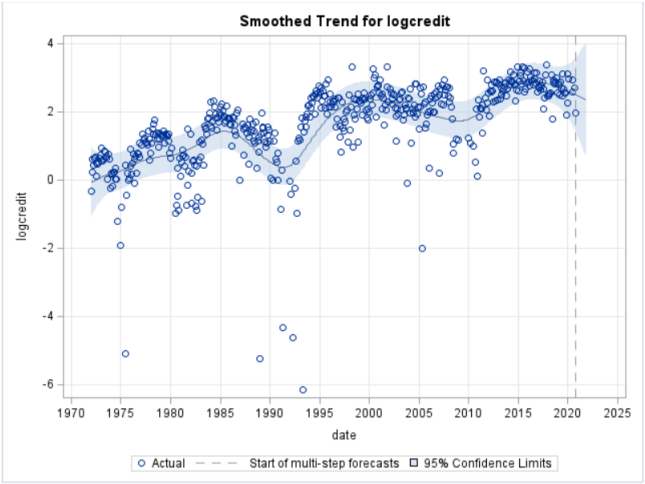

Figure 9: Smoothed credit trend

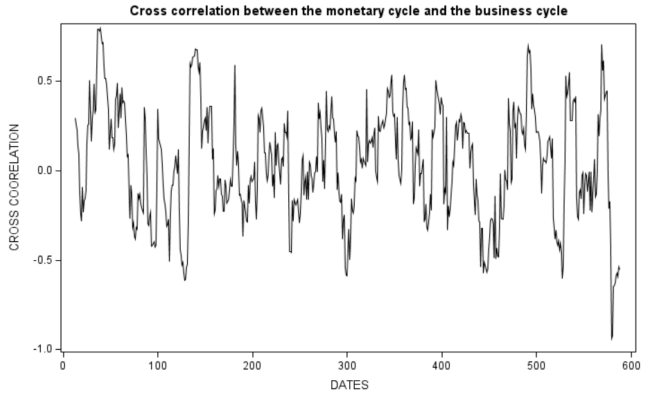

Figure 10: The cross correlation between the monetary cycle and the business cycle

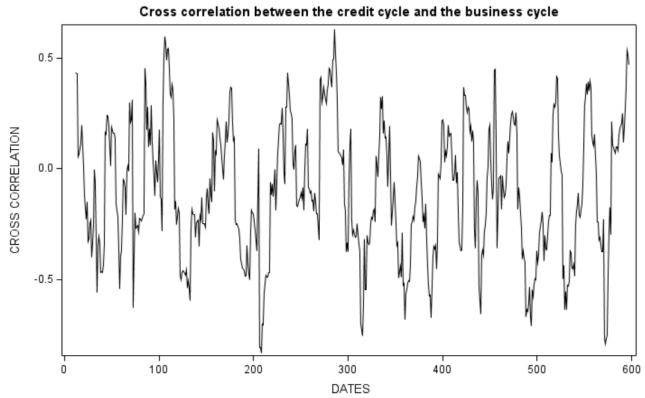

Figure 11: The cross correlation between the credit cycle and the business cycle

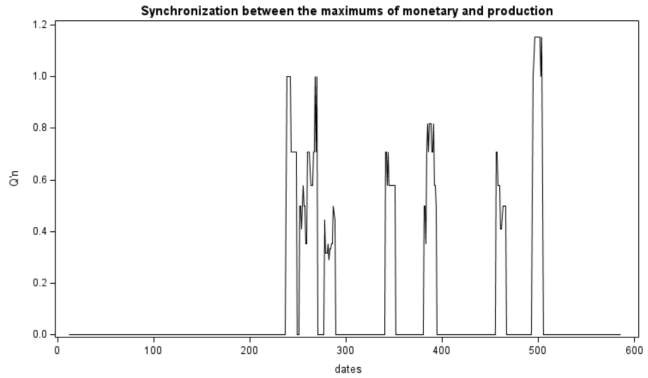

Figure 12: The Synchronisation between the maximum of M2 and production

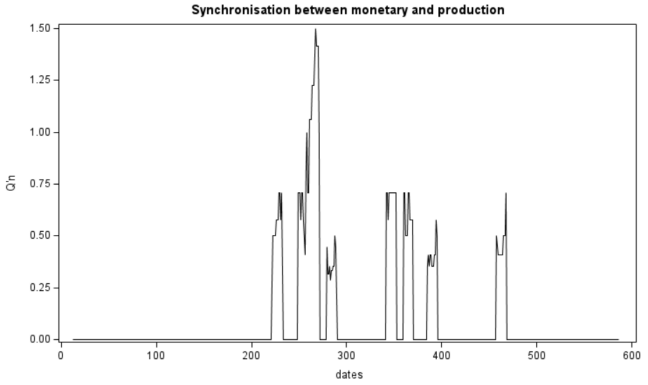

Figure 13: The Synchronisation between the minimum of M2 and production

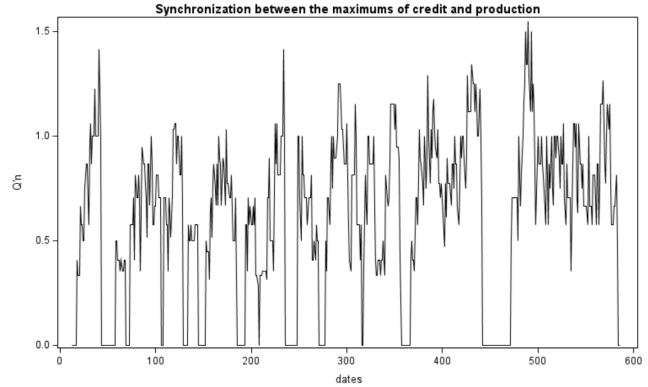

Figure 14: The Synchronisation between the maximum of credit and production

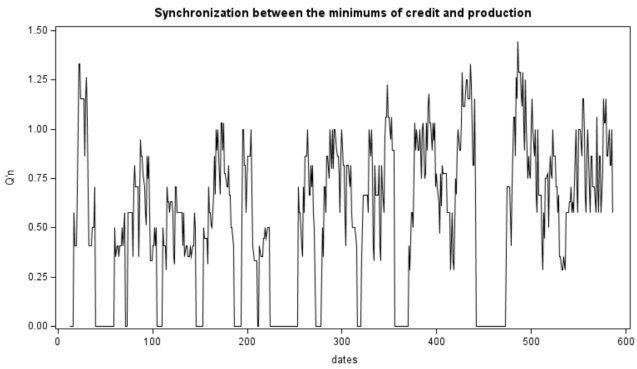

Figure 15: The Synchronisation between the minimum of credit and production