The endogenous money supply: crises, credit cycles and monetary policy

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Abstract

The given paper represents theoretical and empirical analysis of credit-cycles. Having considered theoretical foundations of credit-driven business cycles including financial instability hypothesis of Minsky, we formulate a predator-prey model of "bad" debt-driven credit cycles and include liquidity into the system, which allows us to account for monetary policy. After running simulations we show that counter-cyclical liquidity management performed by central banks allows banking systems to overcome debt deflation with smaller losses and raises the debt ceiling. HP filtered series of real loans clearly exhibit cycles and with the help of VAR models we were able to verify the validity of the predator-prey model and its liquidity extension for the US. Russian data showed that "bad" debt-driven credit cycles are to a certain extent relevant for countries with emerging financial and banking systems.

Keywords: financial instability, debt deflation, predator-prey, vector autoregressions, Granger causality

Introduction

The goal of this paper is to revise the endogenous money supply and credit-driven business cycle theories in terms of new economic reality and stress their viability after accounting for credit cycles and monetary policy. The recent economic crisis has demonstrated the relevancy of financial instability and shown that credit disruptions pose a serious threat to corporate and, as it becomes more and more obvious, sovereign solvency. Needless to say, once being forced to implement such unprecedented measures as exogenous quantitative easing, one should at least consider the endogenous nature of money supply variations in order to understand the potential consequences. The endogenous money supply theory provides solid grounds for such considerations. Let us briefly present the theory, which will serve as a starting point of the paper. It is essential to note in advance that we see the endogenous money supply theory as a crucial element of credit-driven business cycles.

Endogenous money supply

The most precise formulation of the main postulate of the given theory is that money supply is endogenously determined by the demand for bank credit as in Palley (2001). By putting a borrower, who is eager to take the burden of credit and intends to realize an end surplus over his costs and debt service payments, on the first place of the causal chain, one can conclude that in a monetary economy, loans make deposits and deposits make reserves as in Lavoie (1984). A more precise and less radical definition of the given theory is that money supply to a certain extent, or at least its components, is privately created in the process of financing spending as in Wray (2007). Referring to a monetary economy one can assume that the degrees of money supply endogeneity, or the fraction of money supply which is determined endogenously, is closely related to the composition of the money supply in a given economy, the state of the financial and banking system and the behaviour of the monetary authorities. Even though these factors might be related to each other, we can assume that the given theory would be one of the main explanations for money supply dynamics in the countries with higher fraction of credit money in the total money supply, in the countries with developed and sophisticated financial and banking systems, capable of producing financial innovations, and in the countries with politically independent central banks, which refrain from active exogenous interventions or manipulations with money supply. Consequently, if a central bank of a given country performs active and frequent interventions on financial markets, the degree of endogeneity of money supply would be diminished by numerous exogenous shocks.

Whereas the credit-driven endogenous money supply is often attributed to post-Keynesian school of economic thought, the origins of this theory can be traced in the creditary approach and in the works of Mitchell Innes. As Wrey (2007) indicates, Innes, as early as in 1913 and 1914, postulated “exchange of a commodity for a credit” as one of the “laws of commerce”, which is represented by the process of “creating credits and debts and their extinction by being cancelled against one another”. Nevertheless, attributing the given theory to the post-Keynesian school is justified due to enormous contribution of the proponents of J. M. Keynes. It was indeed Keynes who stated that in the modern economy the effective demand fluctuations are a monetary phenomenon as in Lavoie (1984, p. 773).

It is important to shortly discuss two main views on the endogenous money supply theory, known as: Horizontal and Structural approaches. Once the details are considered, endogenous money supply becomes a highly sophisticated concept. The horizontal approach can be summarized in the following way: the money supply is endogenously determined to meet the needs of banks and their customers, whereas the only exogenous factor is the short-term interest rate, set by the central bank. At this rate the reserves are supplied to commercial banks ‘horizontally’, or according to their demand as per Wray (2007, p. 10), or in other words, to accommodate their needs. In addition, one of the key assumptions of horizontalists is an infinitely inelastic loan supply at a market interest rate. In this light, the role of monetary policy or fiscal policy may be diminished due to the fact that the government is seen as an equal economic agent, financing it’s spending in a manner similar to other agents. The distinctive feature of this approach is that banks are guided by the demand for credit.

On the contrary, the structuralists see banks as active economic agents, engaged in a continuous process of financial innovation reacting to constraints. In this case, banks are not solely responding to the needs of borrowers but also seek profits. For example, according to Minsky (1957, pages 174-175) the development and of the federal funds market was a reaction of banks to higher interest rates: the banks which lend their reserves generate real profits, whereas the banks which borrow virtually profit from the difference between the federal funds rate and the discount rate. Various financial innovations including, but not limited to, securitization, swap agreements and other derivatives contribute to the soundness of the statement in favour of the profit-oriented nature of banks. Contrasting the statement that loan supply is horizontal, structuralists claimed that such a supply would face certain constraints. Structuralist approach seems to be more plausible since the assumptions of entrepreneurial banking and constrained loan supply are more realistic. Moreover, the latter approach allows a certain interaction between monetary authorities and commercial banks, since banks, keeping in mind the previously stated assumptions, would more likely react to policy changes. However the proportion and direction of such reaction are hard to define, therefore, in this paper we will make an attempt to analyze the given issue.

It is essential to note that the proponents of both approaches to endogenous money acknowledge the impact of microeconomic aspects of bank behaviour. Thus, and especially referring to structuralist's views, the decision making mechanism, management, strategy and awareness of a particular bank shape its behaviour and loan/deposit activities. Acknowledging microeconomic factors as deep determinants of endogenous money, has made the given theory more realistic, however adding more complications and details may make aggregated macroeconomic analysis less precise.

One of the main reasons of considering the endogenous money supply theory is that it can be used to explain credit-driven business cycles. In the next section of the paper, we will discuss the established financial business cycle theory and existing credit-driven business cycle models in order to proceed to expanding credit-cycle interactions.

Financial instability and credit-driven business cycles

The first attempt to incorporate finance and credit into the business cycle concept was made by the early proponents of the quantity theory. Price dynamics was one of the key business cycle features to be observed and analyzed by the classics. Mill, for example, was fully aware of the direct impact of anticipated inflation on nominal interest rates as in Laidler (1991, p. 19). One of the remarkable achievements, which can be attributed to classical economists, is the credit and business cycle theory. Crises, which occurred in 1825, 1836, 1847, 1857 and 1866, were considered by many economists as a part of a cycle rather than random events. Cyclical fluctuations in prices and economic activity were first formally postulated by Juglar in 1860. Mill and Jevons later contributed by elaborating the cycle theory and attributing fluctuations in real variables to economic cycles. Classical economists saw crises as a phase of a cycle related to speculative activities in commodity and financial markets involving the banking system. Such events would be followed by internal and external drain of gold due to the shortage of liquidity. As in Laidler (1991), both internal and external drain would occur together and thus, bank reserves would be emptied resulting into increases of interest rates, which would frighten the markets. In the 19th century in case of a market crisis, participants tended to dispose less liquid assets in favor of more liquid assets. This behavior pattern is similar to modern strategies. Mill's understanding of a credit cycle and a crisis phase may appear relevant even in the modern times since he was able to notice that price fluctuations may be independent of changes in money supply. In 1871, Mill presented a bright description of a credit cycle, starting from boosted expectations of prices and speculative purchases leading to a great extension of credit, which becomes a dangerous burden to all involved once the purchases slow down and price expectations fall. Thus, rapid over proportionate extension of credit caused by exaggerated expectations according to Mill results in financial contagion and insolvency risks once the purchasing boom is over leaving an excessive supply of goods. Credit has been an integral part of many business cycle theories including the works of Juglar and Schumpter as stated in Legrand & Hagemann (2007). However, Juglar focused on the so-called commercial "collective enthusiasm" as in Legrand & Hagemann (2007, p. 4), whereas Schumpeter focused on innovation and the role of credit in financing it. One has to mention that Keynes (1936) has largely contributed to understanding the financial nature of real business cycles and the demand side of their development. For the goal of our research, we will mainly refer to Minsky and his views on debt-driven cycles. In addition, we will show how the ideas of Minsky were absorbed in more modern credit-cycle models.

To briefly consider the understanding of a debt-driven business cycle by Minsky, let us break up an economic system into three elements: debt, service payments and income. The "debts are originated in exchanges by which the debtor receives money today and promises to deliver money tomorrow" as in Minsky (1986, p. 8). Here we inevitably face other important aspects of debt financing such as debt horizons and credibility, the latter being largely related to income. While diminishing the role of government and households, Minsky focuses on commercial debts and identifies "investment determined profits" as in Minsky (1986, p. 9), which links income flows to investment flows and thus, to credit. However, the cycle of debt-investment-profit-payback, which is driven by investment-sustained profits, is not seen by Minsky as a static system, but rather as a dynamic and evolving one: economics systems and interactions evolve, economic agents learn and alter their behaviour, regulatory systems and institutions change. Thus, the amplitude, magnitude and position of waves of debt-driven cycle waves may also change through time – the only constant element of the cycle is its essence. In addition to non-stationarity of such cycles, Minsky elaborates the role of government and suggests that institutional regulation and financial reforms are far more effective as a measure against crises than solely standard monetary interventions: Minsky notes that lender-of-the-last-resort interactions should be enforced by regulations and reforms impacting financial market practices as in Wolfson (2002, p. 395). As financial institutions evolve, the regulation, as well as state policy, has to consequently adapt to financial innovations and dynamic environment, keeping in mind that eventually old regulations will be outmanoeuvred and new ones will be needed.

The key idea of the credit-driven business cycle is that debt deflation is an inevitable consequence of the preceding debt inflation. Wolfson (2002) states that financial crisis triggers decline in investments and consequently decline in profits, which leads to higher default risks and financial disruptions. The increase in leverage and growth of the Ponzi finance contributes to financial fragility and endorses debt deflation as in Minsky (1986). Keeping in mind that theoretically debt deflation can be easily explained, it is hard to trace this process empirically due to interventions of monetary authorities. Indeed central bank interventions and increase of refinancing at the first site of crisis developments may smoothen the down-waves of such cycles and minimize debt deflation. However, one could empirically identify the situations which cause financial fragility – debt bubbles. This will be elaborated in the succeeding sections of the paper.

Another crucial aspect of Minsky's perception of debt-driven business cycles is the open economy and related issues. Interest rate differentials between countries attract capital flows, which encounter less and less limitations. Free capital movement may create financial fragility on an international level. In addition, exchange rates come into play. Thus, the debt deflation process in an open economy will be related not only to credit exposure but also to foreign exchange exposure and the share of foreign debt. This aspect is discussed in Wolfson (2002) as an extension to the ideas of Minsky.

Having considered the theoretical background of debt-driven business cycles, we can now proceed to analysing the models based on the above-mentioned ideas.

Theoretical modelling

Let us start with the model formulated by Palley (1994). Whereas Minsky mainly focuses on commercial and industrial scales, the model described below places households in the centre of attention. The idea of the given model is that aggregate demand can be decomposed into autonomous expenditures and consumption of debtor and creditor households. Consequently, the consumption of debtors is expanded by debt and inhibited by debt service payments. On the contrary, the service payments contribute to the consumption of creditor households and the debt is subtracted from it. The system of equations is based on the differences in marginal propensity to consume between debtors and creditors ($a_1 > a2$, applied to the model below). The main assumption of the given model is that creditors have a lower propensity to consume comparing to debtors as stated in Palley (1994, p. 374).

$$
\begin{aligned}
&y_t = a_0 + c_{1,t} + c_{2,t} \\
&c_{1,t} = a_1(zy_{t-1} - S_t) + \hat{D}_t; \;\; c_{2,t} = a_2((1-z)y_{t-1} + S_t - \hat{D}_t) \\
&\hat{D}_t = D_t - D_{t-1}; \; D_t = a_3 zy_{t-1}; \;\; S_t = rD_{t-1}
\end{aligned}
\tag{1}
$$

In this system y is the level of real output, c_1 is the real consumption of debtor households, c_2 is the real consumption of creditor households, a_0 denotes autonomous expenditures, a_1 is the MPC of debtors, a_2 is the MPC of creditors, a_3 denotes debt/income leverage ratio, z is the share of income received by debtors, r is the real interest rate, S is the level of real interest service payments on debt, D denotes level of real debt. Since the above presented system of equations is taken from Paley (1994), we will omit indicating additional restrictions applied. It is essential to note that the system represents a second order differential equation with the following particular solution:

$$
y_p = b_0 \big/ (1 - b_1 - b_3 a_3 zr) \;\text{ with }\;
\begin{aligned}
&b_0 = a_0 \\
&0 < \mathrm{b}_1 = a_1 z + a_2(1-z) < 1 \\
&0 < \mathrm{b}_2 = (1-a_2) < 1 \\
&0 > \mathrm{b}_3 = (a_2 - a_1) < -1
\end{aligned}
\tag{2}
$$

We will refrain from initiating the stability analysis and discussing further modifications of the model as in Palley (1996), since for the purpose of the given paper it is sufficient to present the main conclusion of the model: increases in debt are expansionary and consequent increases in service payments are contractionary. Thus, one might assume an equilibrium relation between debt and service payments, ensured by constant interest rates, which may cause an oscillating path for the debt-driven output.

A completely different model, which is based on the oscillation principle, is the predator-prey relation presented in Asada (2011). Predator-prey relation represents a dynamic way of formulating co-existing processes and interactions between them. The Lotka–Volterra model originates from biological process of population growth of predators and their prey. The formulation suggested by Asada (2011) is the following:

$$\begin{aligned} d' &= f_1(D/K, Y/K) \\ y' &= f_2(D/K, Y/K; \alpha) \end{aligned} \quad \text{with } \alpha > 0 \qquad (3)$$

In this model D is the stock of real debt of private firms, K is the real capital of private firms, Y is real national income and α is the equilibrium adjustment parameter. Asada (2011, p. 5) explains the mechanics of the model: "the 'quantity adjustment' process in the goods market disequilibrium, which implies that the rate of utilization of the capital stock fluctuates accordingly as the excess demand in the goods market per capital stock is positive or negative". Thus, the first equation symbolizes the predator, the second one symbolizes the prey. The functionality of the model can be changed as in Kiyotaki-Moore (1997, p. 229-235): capital, or landholdings, can play the role of a prey and debt can play the role of the predator. Another example would be the following: borrowed capital as a predator and money as a prey as in Cordoba & Ripoll (2004). The latter relation is plausible due to realization of liquidity aspects of borrowing: in case of increased investments financed by borrowing, money holdings would decrease; however, during disinvestment phase, money holdings would rise and liquidity will be freed.

The role of monetary policy

Obviously, the model of Palley (1994) does not leave much room for a separate monetary policy function, which could alter the debt levels; however, one could introduce an artificial leverage coefficient. It is empirically shown that among failed banks the proportion with low leverage was the largest as in Haldane (2012, p. 13). The latter statement refers to a typical banking leverage, or the capital-to-assets ratio. Nevertheless, the statement can be expanded on a macro-level. Thus, the real debt function could take the following form after addition of an artificial leverage coefficient ϕ given that $0 < \phi < 1$:

$$D_t = a_3 \phi z y_{t-1}$$

$$y_p = b_0 \big/ (1 - b_1 - b_3 a_3 \phi z r) \qquad (4)$$

As was shown in Asada (2011), the predator-prey model can be extended and further functions can be added. For example, by adding a third function denoting price dynamics, one could incorporate monetary policy in the framework by suggesting that prices follow a certain inflation-target rule.

The flexibility of the predator-prey model will be further exploited in the succeeding section. We will try to recall the key assumptions of Minsky and take advantage of the predator-prey framework in order to simulate credit-cycles.

The "bad" debt-driven credit cycle

Let us revise the debt deflation process. Assuming a mixture of hedge, speculation and Ponzi entities, we can formulate the real debt process playing the role of a prey. The predator process is somewhat more complicated. We could have formulated it referring to Palley (1994) and assign debt service payments as the predator function; however, this would be a simple replica of the well-established model, besides it is hard to find a proxy for service payments. The latter would be needed for an empirical demonstration. One could, of course, assume the intrinsic nature of credit cycles, as can be concluded from Kindleberger (2005), in this case a different approach could be used with a focus on only one variable, which significantly limits the scope of our research.

There is one aspect, which deserves special attention, and that is the defaults on debt. Indeed, the debt deflation process is largely triggered by over-proportionate debt. Defaults, as in Wray & Tymoigne (2008), had often been only partially considered by many mainstream economists. In addition, defaults are closely related to the quality of debt and the Ponzi financing, so often mentioned by Minsky, since the latter entities are more likely to default once the crisis outbreaks. One should note that recognition or news of payment delays, debt restructuring, delinquencies and defaults can serve as trigger events for financial crises and thus, to debt deflation. Such examples can be found in Saquib (2001): once a certain part of debt turns into a “bad” debt due to a payment delay, or even worse, a default, the panic is likely to start. One could assume that once accumulated unobserved “bad” debt reveals itself both, profit taking and panic starts. A chain of such events serves as a signal that a certain optimal debt-ceiling or a leverage level was exceeded; however this knowledge is often delayed due to prolonged euphoria or the very well known psychological “Cassandra” effect: even if the potential dangers are known, the collective euphoria can be self-sustained by high profits and optimistic forecasts, based on ex-post data.

Having defined that the predator-process has to be related to real “bad” debt, we have to specify the term “bad”. In fact, we would not like to speculate on the definition, but rather specify it as a delinquent or non-performing debt. Since such “bad” debt impacts loan provisions, it drains liquidity and thus, may consume regular debt, as a predator, in the Lotka-Volterra terms.

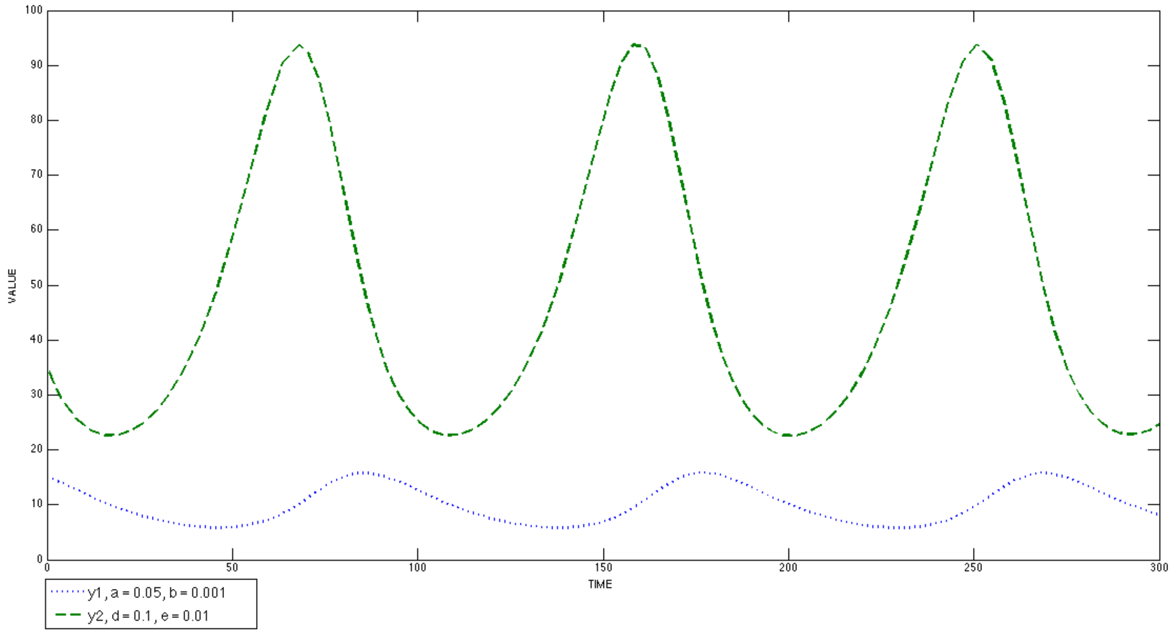
Let us formulate the given relation between regular debt and “bad” debt:

$$\begin{aligned} y1' &= -ay1 + by1y2 \\ y2' &= dy2 - ey2y1 \end{aligned} \qquad (5)$$

In this system $y1$ is the level of real “bad” debt, playing the role of a predator, and $y2$ is the level of regular real debt, playing the role of a prey.

The main components of the predator-prey model are intrinsic growth rates and interaction coefficients, which in fact determine the logic, amplitude, periodicity and overall output of the model. We assume that increases of debt cause expansion and over-proportionate optimism, in sound with ‘animal spirits’ as per Keynes (1936, p. 161-162). Thus, in addition to regular or payable debts, ambitious “bad” debts are created, the latter being unobserved; however, they result in observed delinquencies and non-performing loans as proxies for “bad” debt. The accumulation of the latter literally drains business confidence and puts pressure on regular debt dynamics thus, causing a debt deflation, which can be no longer maintained at previous levels in a given economy. The ‘animal spirits’ are embodied in a certain relation of coefficient magnitudes: $b < e$. This condition denotes the fact that regular credit dynamics are highly sensible to bad debt. On the contrary, “bad” debt is assumed not to exceed the regular debt. The latter condition is not dictated by the system and can be changed; however is still necessary for the interaction to be realistic. Another condition is that $a < d$, otherwise the intrinsic growth rate of "bad" debt would exceed the growth rate of regular debt. The dynamics for the "bad" debt-driven credit cycle with initial values of 15 and 35 is shown on graph 1 below.

Graph 1



One may note that debt deflation may not necessarily lead to a decrease in "bad" debt: a crucial element has to be added.

Liquidity extension

Paying the tribute to the qualitative side of debt, we have an opportunity to expand the framework and add other interactions. Let us recall the Keynesian liquidity preferences and transpose them to liquid assets other than cash. Liquidity aspect would complete the picture: debt deflation coupled with a rise in "bad" debt would cause the assets to shift from less liquid to more liquid ones, including money in order to ensure transactions and payments. Thus, we can add a third interaction function, denoting pooled highly liquid assets (not necessarily money; however more liquid in contrast to loans or deposits held by banks):

$$\begin{aligned} y1' &= -ay1 + by1y2 - cy1y3 \\ y2' &= dy2 - ey2y1 - fy2y3 \\ y3' &= -gy3 + jy3y1 + hy3y2 \end{aligned} \qquad (6)$$

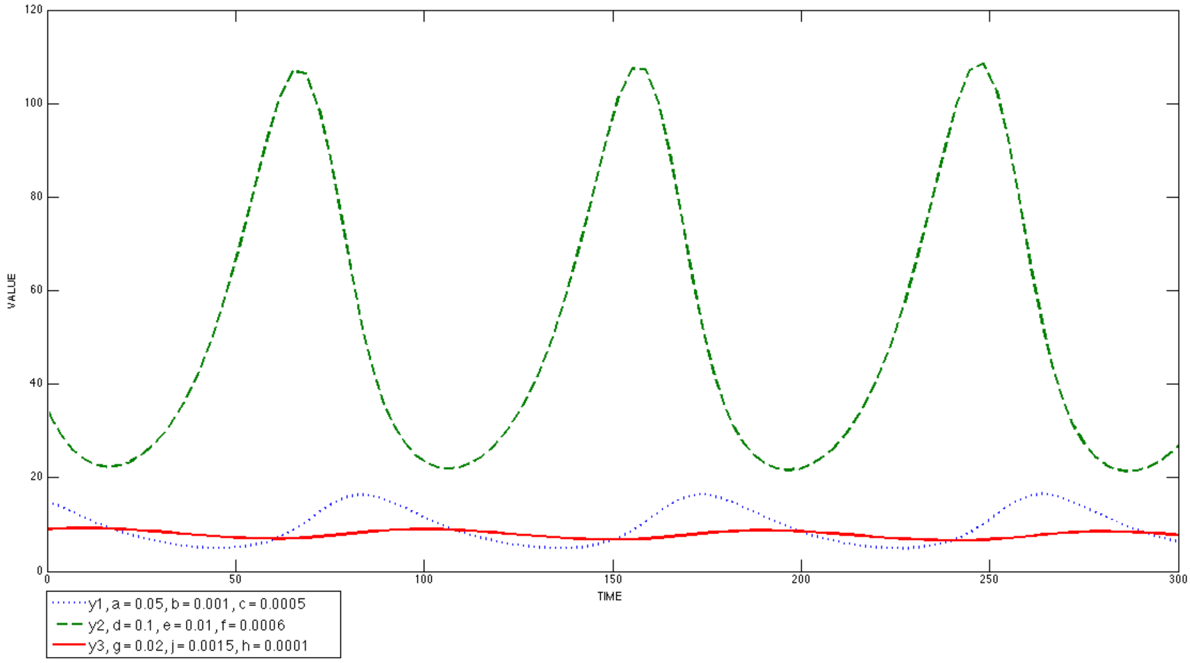
Where $y1$ is the level of a real "bad" debt, playing the role of a predator, and $y2$ is the level of a real regular debt, playing the role of a prey and $y3$, which denotes highly liquid assets, an ultimate predator for both $y1$ and $y2$. Many proxies can be selected to denote liquid assets: starting from cash, cash equivalents, accounts, bonds of different issuers and other assets. We will refrain from strictly defining the third function as cash (even though that in general we allow such definition) due to the fact that in the empirical section a specific ratio will be used involving money base and higher monetary aggregates. This will help us to show that during the crises and debt deflation process, the preference schedule shifts and agents dispose less liquid assets in favour of more liquid ones – it can be cash or a foreign currency, which is considered as a more liquid asset in contrast to the domestic one (as in the example of Russia). The third function allows interventions from monetary authorities such as quantitative easing, refinancing or other operations.

It is necessary to make certain initial assumptions, which would make the interactions more plausible. In Palley (1994), one of the conditions was that interest rate, applied to the debt service payments, is supposed to be constant. In this case, the interest rate is not present in the interactions, however the assumption about a stationary environment is crucial, since the parameters are constant. Varying parameters would completely change the oscillating behaviour of the given functions. Since we assume a certain constant moral hazard, which drives "bad" debts, we need an additional assumption that this moral hazard is not connected to liquidity provision from monetary authorities. These assumptions might be questionable in the light of Mundaca (2008), who used a theoretical model to show that banks with moral hazard would tend to exploit the emergency liquidity provisions and increase their risk appetites according to expected help from the central bank. Nevertheless, a constant independent moral hazard is necessary for the interactions to hold.

Let us observe the results of simulations with initial values of 15, 35 and 9. The initial values will remain the same, however the parameters will be changed according to the aims of simulation.

The simulation pictured on graph 2, is intuitive since here $y3$ plays a role of predator aimed at decreasing "bad" debts. As a result of liquidity oscillation, the regular debt magnitude will exceed the upper bound of 100, remaining above the lower bound of 20. Even an infinitely small positive change in liquidity would increase regular debt by damping the bad debt peak. Considering monetary policy, the central bank can increase liquidity in the times of debt deflation, so that the peaks of liquidity would correspond to falls of debt.

Graph 2



Another way to incorporate monetary policy in such a framework would be simply introducing an "extinction rate" for regular debt and "bad" debt; however, this would limit the scope of our empirical analysis, which follows in the next section.

Related empirics

In this section we confront the above-mentioned theory, assumptions and models with real data on the US and Russian economies. These two countries have completely different economies and financial sectors, which allows us to obtain sharp contrasts and see whether some of the given assumptions are internationally applicable. The data was obtained from Federal Reserve Bank of St. Louis and Central Bank of Russia. The quarterly time series have the following frames: 1980 – 2010 for the US and 2000 – 2012 for Russia. Firstly we will analyse the US data. It is important to note that empirical analysis of business cycles is a challenging task and often theories require data which may not be completely observed, thus, from the very start we have to acknowledge the existing problems with measurement errors and proxy selection. All the data is in real values, which were constructed using Consumer Price Inflation index.

Let us begin with focusing on real commercial and industrial loans. Stationarity is a rare property of aggregated series; however in this case a test on stationarity would help us to determine whether real loans exhibit stable oscillation or the data evolves, following a random walk. In the first case one could assume stationarity due to intrinsic stability of real loans or in other words, self-sustained cycles, which experience only temporarily shocks. In case of a random walk, the process would involve persistent shocks, which would completely change the levels of the series.

Table 1

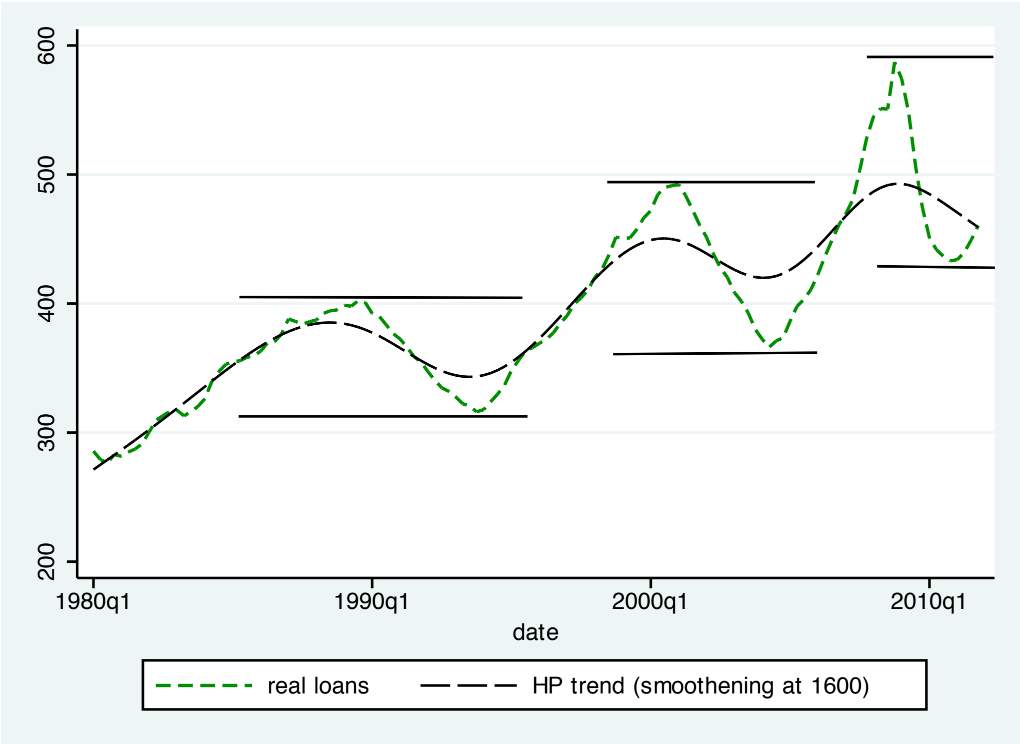
1980q1-2011q4	Condition	Augmented Dickey-Fuller test	DFGLS test (drift)
ln real loans	RW	0.4891	
	Trend	0.8995	
	Drift	0.0573	x

The Augmented Dickey-Fuller as in Hamilton (1994, p. 516-518) and the Feasible Generalised Least Squares version of the given test suggest that real loans exhibit a random walk with drift, which means that the series are developing around a non-zero constant and are subject to permanent shocks. However, is there a link between non-stationarity and credit cycles? Having concluded that the real loans are not stationary let us now apply a Hodrick—Prescott (HP) filter as in Hodrick & Prescott (1997), with the smoothening parameter λ of 1600, to obtain a smoothed long-run trend and display the series together with peaks and falls, denoting phases of the cycles. Graph 3 presented below allows us to draw 2 important conclusions.

First of all, even though that the real loans are not stationary, they have an obvious oscillating pattern. The oscillation is captured by the HP-filtered long-run waves. Thus, one could apply an assumption about intrinsic nature of credit cycles – significant deviations from the long run trend have both positive and negative magnitude and the cycles can be self-propelled by these deviations. However, in this case one will have difficulties explaining the HP-filtered waves, since it is also obvious that oscillation is persistent in the smoothed trend as well.

This oscillation requires considering other variables, which may drive the cycles. The second conclusion is that drift stationary series can be viewed as an evolving system, which corresponds to Minsky super-cycles as in Palley (2009). Clearly the phases of the cycle with time become shorter and the magnitude increases – this can be seen with the help of peaks and falls. One can conclude that debt ceilings and floors are dynamic and real loans evolve.

Graph 3

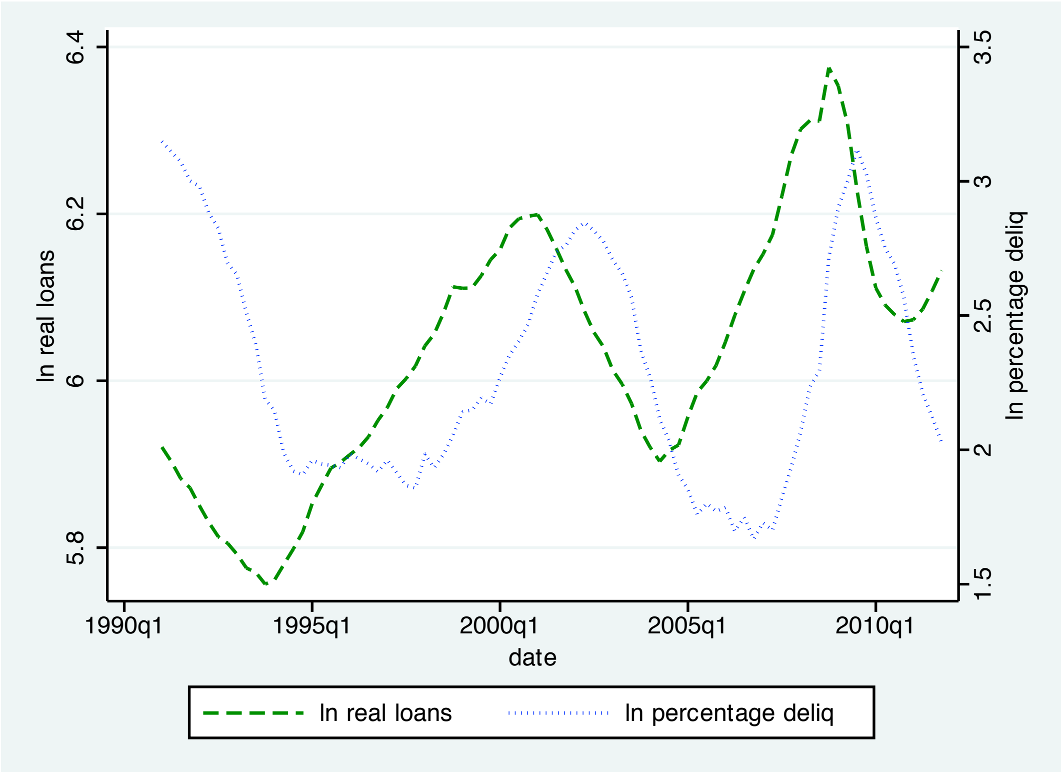


Keeping in mind system (5), let us add a proxy for “bad” debts: the delinquencies. Overlaying two time series on graph 4 would allow us to observe peaks and falls of each series in a more comfortable and comprehensive manner since the obtained data on delinquencies is relative.

It appears that peak of delinquent loans follow the peaks of loans and, in fact, correspond to the down-waves of the credit cycle as suggested in system (5) and graph 1. Even though that the sign of the magnitudes coincide with the modelled interactions, one has to note that the magnitudes of delinquent loans are highly volatile: for the given period standard deviation of loans is 0.169; however, the standard deviation of the share of delinquent loans is significantly higher and reaches 0.481. This fact does not correspond to graph 1 where the volatilities are quite the opposite.

Indeed, both loans and delinquencies may follow the predator-prey paths, but only to a certain extent.

Graph 4



Checking for cointegration would allow us to conclude if there is a long-run equilibrium relationship between loans and delinquencies. Consequently, we could exploit this equilibrium and estimate a Vector Error Correction model or take advantage of the short-run relation and apply a simple Vector Autoregressive model.

Table 2

1988q3 - 2011q4	Engle-Granger cointegration test (second step)
ln real loans and ln % delinquencies	0.8472

Unfortunately due to absence of cointegration, as in table 2, we cannot state that there exists a long-run equilibrium between real loans and delinquency rates. Nevertheless, we can still proceed to analyzing short-run interaction via VAR modelling.

$$\begin{aligned} loans_{t,1} &= C + \alpha_{1,1} loans_{t-1} + \alpha_{2,1} loans_{t-2} + \alpha_{3,1} deliq_{t-1} + \alpha_{4,1} deliq_{t-2} + u_t \\ deliq_{t,2} &= C + \beta_{1,2} loans_{t-1} + \beta_{2,2} loans_{t-2} + \beta_{3,2} deliq_{t-1} + \beta_{4,2} deliq_{t-2} + e_t \end{aligned} \tag{7}$$

In these equations $loans$ are ln of real commercial and business loans, $deliq$ are ln of delinquency rates on commercial and business loans, α, β and C are coefficients, t is a time operator and u, e are shocks. Short-run VAR model, with differenced data to ensure stationarity, yields stable and interesting results, presented below:

Table 3

VARIABLES	(7.1) D_ln_deliq (y1)	(7.2) D_ln_loans (y2)
LD.ln_loans	1.503***	0.704***
	(0.553)	(0.114)
	2.715	6.182
L2D.ln_loans	-0.0276	0.204*
	(0.548)	(0.113)
	-0.0503	1.812
LD.ln_deliq	0.168*	-0.0782***
	(0.0972)	(0.0200)
	1.729	-3.909
L2D.ln_deliq	0.544***	-0.0147
	(0.108)	(0.0222)
	5.045	-0.664
Constant	-0.00874	-0.000189
	(0.00728)	(0.00150)
	-.1.200	-0.126
Observations	97	97

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

Lag selection of 2 was made according to the Akaike Information Criterion (AIC) as in Akaike (1974). At the first glance at table 3 we see that the signs of the empirical coefficients correspond to the predator-prey model (5): thus, lagged delinquencies have a negative impact on current loans in equation y2, whereas lagged loans have a positive impact on delinquencies in equation y1. Another interesting point is that the above-mentioned effect is significant on all levels. Empirical results hint on the debt deflation process, caused by “bad” debts. Let us check the short-run causalities: according to the predator-prey model (5), causality should be in both directions.

One of the econometric methods which can be applied to test causality is the Granger causality test as in Granger (1988) which tests whether the lags of series A determine current values of series B and vice versa.

Table 4

1991q1 - 2011q4	Granger causality test	
	ln loans	ln deliq
ln loans→	-	0
ln deliq →	0	-

Results in table 4 clearly suggest granger causality in both directions, which fits the predator-prey framework: in other words, loans are Granger causing delinquencies and delinquencies are Granger causing loans.

Having empirically shown the plausibility of the predator-prey model (5) we now proceed to the liquidity extension (6) and add an equation for highly liquid assets. One could select various proxies: yields on government debt securities, spreads between interbank rates, swap rates and many other indicators; however, a simple ratio between money base and higher monetary aggregates, for example m3, would suffice, since in addition to aggregate liquidity dynamics it will also reveal the proportion of exogenous money (since money base can be partly managed by the central bank) and endogenous, or banking money. As in model (6) we would expect that in times of debt deflation liquidity will rise with the assistance of monetary authorities in order to resolve financial and credit disruptions which would later result in decreases in "bad" debt.

Overlaying delinquencies on the money base and m3 ratio helps to visualize their interaction: peaks of liquidity correspond to falls of delinquencies, whereas falls of liquidity correspond to peaks of delinquencies – this dynamic relation is similar to simulation on graph 5; however, liquidity amplitudes vary. If the monetary authority to a certain extent exogenously manipulates the given ratio, then obviously, a sharp jump of the ratio after 2008 can be attributed to quantitative easing and other interventions.

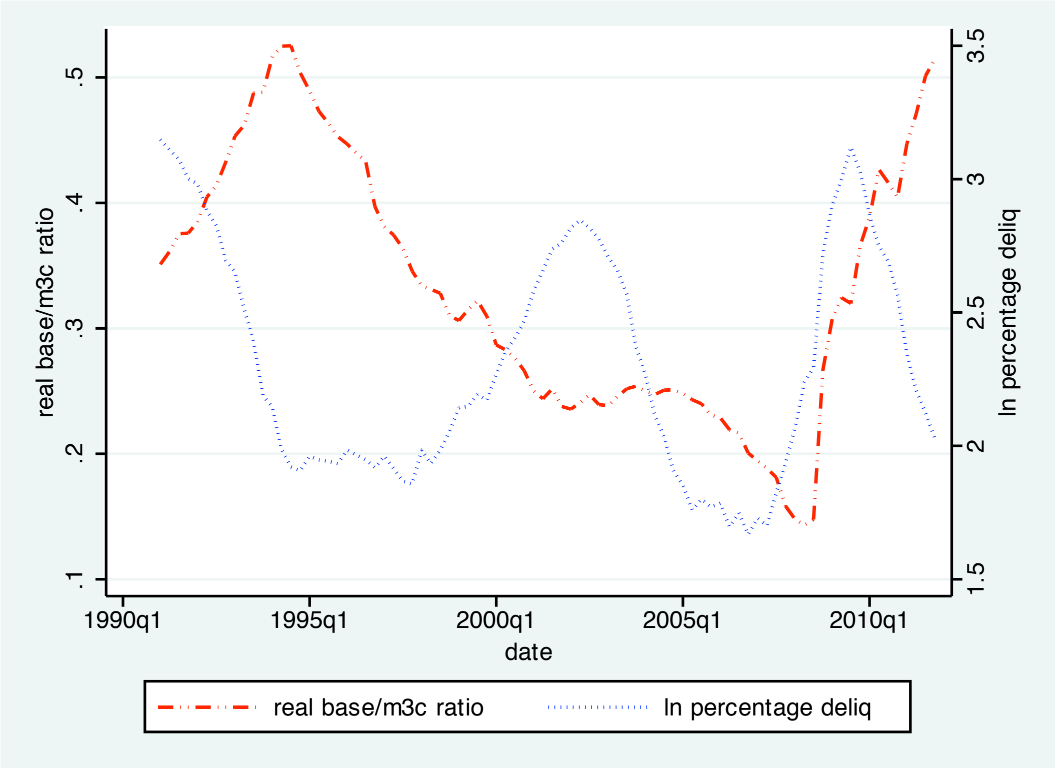
Let us proceed to analysis of the extended model:

$$\begin{aligned}
loans_{t,1} &= C + \alpha_{1,1} loans_{t-p} + \alpha_{2,1} deliq_{t-p} + \alpha_{3,1} multip_{t-p} + u_t \\
deliq_{t,2} &= C + \beta_{1,2} loans_{t-p} + \beta_{2,2} deliq_{t-p} + \beta_{3,2} multip_{t-p} + e_t \\
multip_{t,3} &= C + \theta_{1,3} loans_{t-p} + \theta_{2,3} deliq_{t-p} + \theta_{3,3} multip_{t-p} + \upsilon_t
\end{aligned} \tag{8}$$

here the new variable *multip* denotes money base to m3 ratio and the lag length p is such that the AIC is minimised. The data on m3 was generated using FRS data according to a well established conventional methodology[1].

[1] http://www.shadowstats.com/article/money-supply

Graph 5



Estimations of model (8) due to the enormous size of the table are placed in the appendix as table A – the minimum AIC value was found at the lag length of 4. According to table A in the appendix, the signs of the coefficients in equation y1 and y2 correspond to model (6): lagged y3, or liquidity has a negative impact on loans and delinquencies; however the role of liquidity is much more complex. First crucial point which we should highlight, is that lagged delinquencies do not determine the given liquidity proxy in the current period: this means that current liquidity changes are partly determined by lagged loans and partly by exogenous shocks which are not observed within the system. The given money base to m3 ratio is weakly determined by lagged loans dynamics which leaves the room for an assumption that liquidity can be exogenously managed. Related Granger causalities can be found below in table 5.

Table 5

1991q1 – 2011q4	Granger causality test		
	ln loans	ln deliq	ln multiplier
ln loans →	-	0	0.028
ln deliq →	0	-	0.255
ln multip →	0.003	0.011	-

According to equation y1, the lags of the given liquidity proxy have a negative impact on delinquencies: this tells us that shifting assets toward more liquid ones or simply increasing the amounts of liquid assets would push down delinquencies. Thus, deleveraging as a part of debt deflation process seems to be a plausible statement, keeping in mind the obtained coefficients.

The next step of the research is to verify whether the empirically shown "bad" debt-driven credit cycles are relevant for other countries. Let us consider a completely different economy – Russia. We have selected this country since we are very much interested if the data from emerging financial and banking systems exhibit cycles, which were observed in the US data. In addition, Russia has experienced a sovereign debt default in 1998. As displayed on graph A in the appendix, the since the crisis of 1998 the Russian government has been decreasing its sovereign foreign debt whereas the private sector has been increasing it – inflating corporate foreign debt is another side of the Minsky theory. Needless to say, that foreign exchange exposure is one of the channels for financial contagion, which can significantly contribute to domestic debt deflation.

Let us recall model (5) with interactions between loans and "bad" debt. In case of Russia, the role of "bad" debt would be played by non-performing loans. The time frames for the data are shorter; however at least one phase of the cycle can be captured.

It is complicated to state that the rapid growth of non-performing loans was driven solely by over-proportionate growth of loans: in the last quarter of 2008 and the first quarter of 2009 the USD/RUB nominal exchange rate has dramatically risen from 26 to 36.45 which means that the foreign debt payments became more expensive. The dramatic rise of the USD exchange rate by 38% could have triggered this sharp rise of non-performing loans, keeping in mind the high corporate foreign debt level. A rather short debt deflation followed.

As in the case with the US data, the series are not stationary and they are not co-integrated, as stated in table 6:

Table 6

2002q1 - 2012q2	Engle-Granger cointegration test (second step)
ln real loans and ln non-performing loans	0.2747

Graph 6

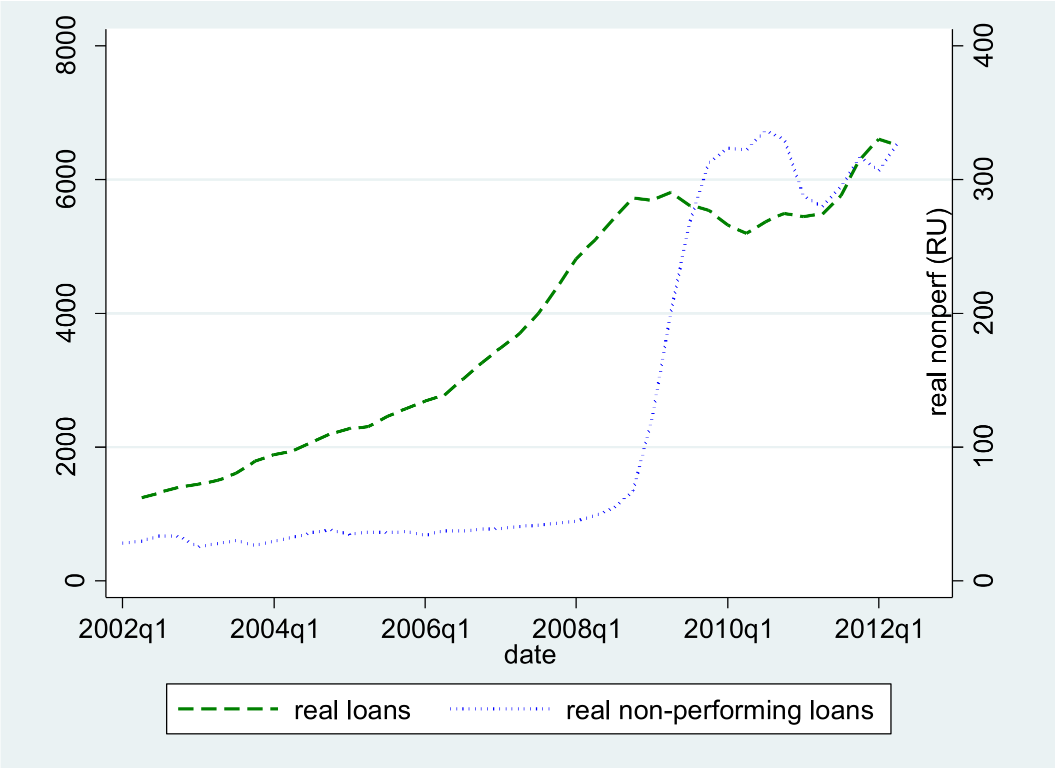


Table 7

VARIABLES	(7.3) D_ln_real_nonperf (y1)	(7.4) D_ln_real_loans (y2)
LD.ln_real_loans	-0.101	0.431***
	(0.717)	(0.166)
	-0.140	2.606
L2D.ln_real_loans	-0.127	-0.176
	(0.722)	(0.167)
	-0.176	-1.054
L3D.ln_real_loans	1.536**	0.160
	(0.623)	(0.144)
	2.466	1.111
LD.ln_real_nonperf	0.492***	0.0318
	(0.142)	(0.0328)
	3.463	0.971
L2D.ln_real_nonperf	-0.0166	-0.0928**
	(0.168)	(0.0389)
	-0.0989	-2.389
L3D.ln_real_nonperf	0.137	-0.0680*
	(0.167)	(0.0386)
	0.819	-1.763
Constant	-0.0220	0.0314***
	(0.0364)	(0.00840)
	-0.606	3.736
Observations	37	37

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

The VAR results for Russian data are similar to the ones obtained for the US series. The model specification is similar to model (7) with one exception: the optimal lag length according to AIC in this case is 3. From table 7 we can conclude that in Russia as well as in the US lagged "bad" loans negatively impact current loans and lagged loans have a positive impact on current "bad" loans.

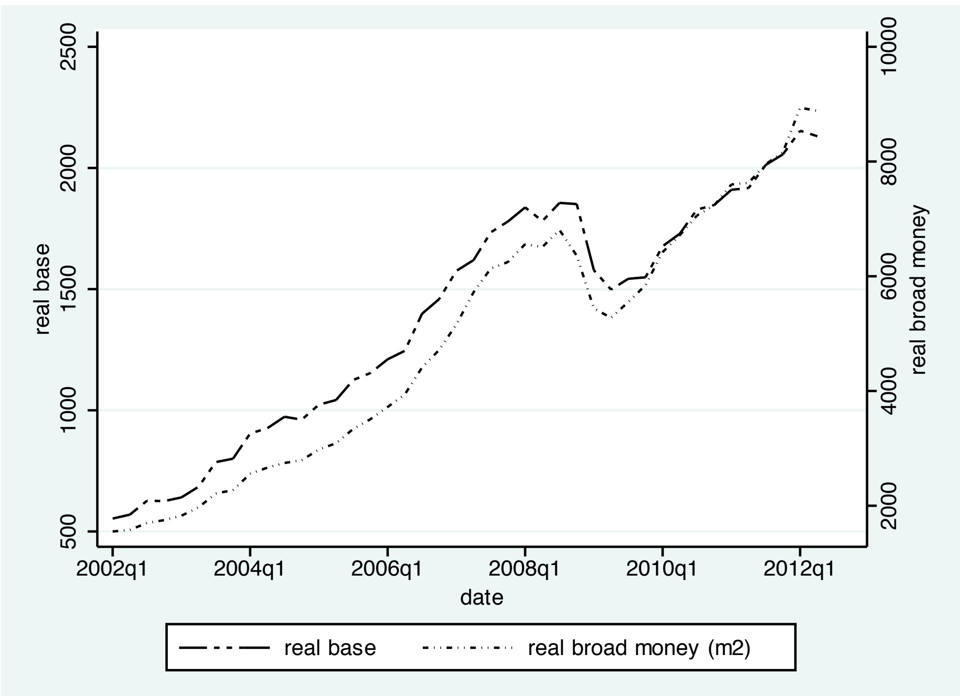
According to Granger causality test in table 8, both series demonstrate mutual causality on a 5% level, which corresponds to the results from the US data.

Table 8

2003q2 - 2012q2	Granger Causality	
	ln loans	ln non-preforming loans
ln loans →		0.035
ln non-performing loans →	0	

The results obtained using the Russian data suggest that the debt deflation process is working in a similar way for countries with small emerging financial and banking systems. In the latter case the debt deflation process may be worsened due to foreign exchange rate exposure of the over-proportionate foreign debt, as in case of Russia. However, adding a liquidity proxy to the picture and implementing model (8) would be problematic due to the following reason – during the crisis of 2008 the money supply did not shift towards a more liquid money base – in fact, the money base decreased as well as higher monetary aggregates. This parallel movement is displayed below on graph 7.

Graph 7



One may be interested in the reason for such negative shifts in money base. The answer would be very trivial: Russian government bond market has an extremely small size and thus, a quantitative easing as performed in the US is not feasible; however, one of the immediate measures of the Central Bank of Russia was to increase the foreign exchange interventions. As can be seen on graph B in the appendix, the peak of selling interventions occurred exactly at the drop in money base – this hints on the fact that during financial disruptions and crises foreign currencies are preferred to roubles as much more liquid assets. This is plausible since Russian economy has experienced dollarization for a long period of time as stated in Ponomarenko, Solovyeva & Vasilieva (2011). Thus, the estimation of the model (8) would yield completely different results.

Conclusion

We have considered endogenous money supply theory and the financial instability hypothesis in order to understand the nature of credit-driven business cycles. A deep understanding of financial aspects of business cycles and models of Palley (1994) and Asada (2011) helped us to formulate a "bad" debt-driven credit cycle model based on the predator-prey framework. By incorporating liquidity to the system, we have demonstrated that counter-cyclical liquidity management from the side of monetary authorities aimed at decreasing "bad" debt would help to overcome debt deflation and would increase the debt ceiling. In reality, the latter could leave room for additional moral hazard.

Empirical observations suggest the validity of "bad" debt driven credit cycles. After implementing the HP filter to real loans we can state that at least several credit-cycle phases took place in the US during the last 30 years. Obviously, the phases of such cycles become shorter and the magnitude increases, which corresponds to Minsky super-cycles. The absence of long-run cointegration urged for a short-run analysis. Thus, the predator-prey equations were estimated using VAR. We were able to empirically verify the signs of the variables and obtained mutual Granger causalities with an exception to causality between delinquencies and base/m3 ratio. Similar results were obtained for Russian data since 2002, however due to certain dollarization, the liquidity schedule of agents in the Russian economy is different and thus, estimation of the extended predator-prey model is problematic.

In general, empirical data proves the existence of credit-cycles and "bad" debt-driven credit cycles. The lack of econometric tools for analysis of cycles allows us to receive fragmented hints on the nature of the observed oscillation, which is in our opinion related "bad" debt and liquidity, which can be to a certain extent managed by monetary authorities.

Appendix

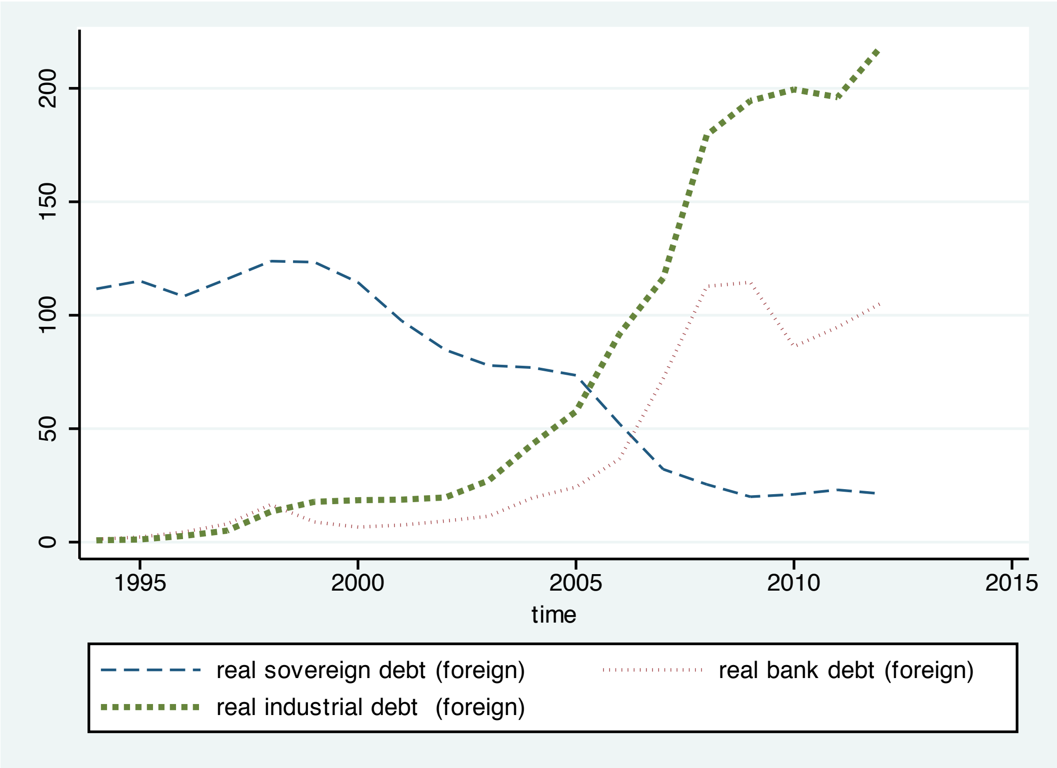
Table A

VARIABLES	(8.1) D_ln_percentage_deliq (y1)	(8.2) D_ln_real_loans (y2)	(8.3) D_ln_multip (y3)
LD.ln_real_loans	1.020*	0.603***	-1.803**
	(0.586)	(0.128)	(0.707)
	1.742	4.696	-2.549
L2D.ln_real_loans	0.330	-0.0100	0.424
	(0.733)	(0.161)	(0.886)
	0.449	-0.0623	0.479
L3D.ln_real_loans	0.847	0.0575	-0.515
	(0.699)	(0.153)	(0.844)
	1.212	0.376	-0.610
L4D.ln_real_loans	-0.179	0.171	1.460**
	(0.559)	(0.122)	(0.675)
	-0.320	1.397	2.162
LD.ln_percentage_deliq	0.0289	-0.0652***	-0.138
	(0.104)	(0.0228)	(0.126)
	0.278	-2.854	-1.094
L2D.ln_percentage_deliq	0.259**	-0.0278	0.140
	(0.107)	(0.0234)	(0.129)
	2.423	-1.184	1.084
L3D.ln_percentage_deliq	-0.0209	-0.00974	-0.172
	(0.111)	(0.0243)	(0.134)
	-0.189	-0.400	-1.281
L4D.ln_percentage_deliq	0.499***	-0.00547	0.000419
	(0.109)	(0.0239)	(0.132)
	4.578	-0.229	0.00318
LD.ln_ multip	-0.0156	-0.0470**	0.506***
	(0.107)	(0.0234)	(0.129)
	-0.146	-2.011	3.930
L2D.ln_ multip	-0.111	-0.00376	-0.200
	(0.127)	(0.0278)	(0.153)
	-0.875	-0.135	-1.302
L3D.ln_ multip	0.142	-0.0499*	0.0433
	(0.124)	(0.0272)	(0.150)
	1.146	-1.834	0.289
L4D.ln_ multip	-0.392***	-0.0234	-0.146
	(0.111)	(0.0243)	(0.134)
	-3.527	-0.960	-1.091
Constant	-0.00994	0.000482	0.00395
	(0.00614)	(0.00135)	(0.00742)
	-1.619	0.358	0.533
Observations	84	84	84

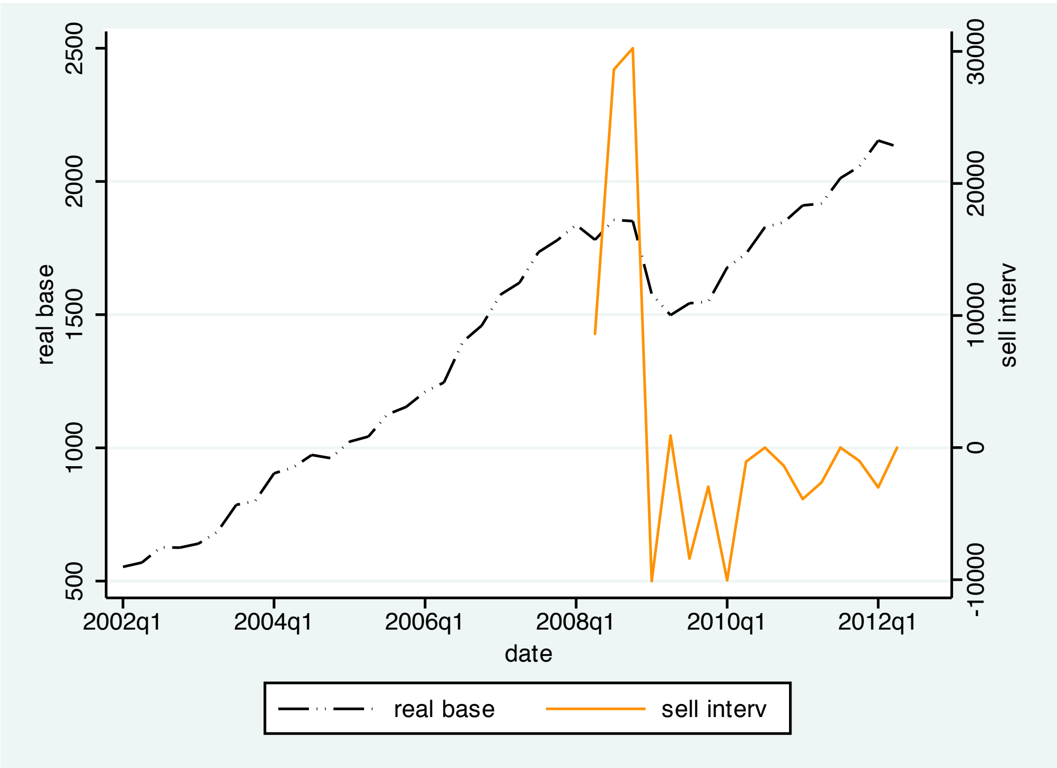
Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Graph A



Graph B



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