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## On the Bottom-up Foundations of the Banking-Macro Nexus

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**Abstract**

The complexity of credit money is seen as the central issue in the banking-macro nexus, which the author considers as a structural as well as a process component of the evolving economy. This nexus is significant for the stability/fragility of the economic system because it links the monetary domain with the real domain of economic production and consumption. The evolution of credit rules shapes economic networks between households, firms, banks, governments and central banks in space and time. The author discusses the properties and characteristics of this process in three sections. First, he discusses the origins of the theory of money and its role in contemporary monetary economics. Second, he briefly discusses current theoretical foundations of top-down and bottom-up approaches to the banking-macro nexus, such as DSGE or ABM. Third, he suggests an evolutionary framework, building on the generic-rule based approach, to arrive at standards for bottom-up foundations in agent-based models of the banking-macro nexus.

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## 1 Introduction

Credit crunches and liquidity traps are highly complex economic phenomena, because their origin and nature lies in systemic characteristics concerning the evolving economy and not only the financial markets. Moreover the provision and control of credit-money sustains the financial as well as the goods market by connecting them both; thereby it guarantees a continuity of economic operations. In the evolution of money we consider the innovation of banks as a significant institutional process in capitalist development capable of providing exactly this continuity, compare for instance Schumpeter (1954: 276-335) or Ferguson (2009). The complex logic of this process represents a very interesting but difficult economic topic, especially from the perspective of the actors. Uncertain economic actors incorporate roles of agenda setters and agenda receivers.

In this paper we focus on the complexity of credit-money to arrive at new standards for modelling the banking-macro nexus from bottom-up. Of course such an endeavour needs to address a diversity of economic thought and theoretical foundations of modelling strategies. The endogenous instability of capitalist production has reached a new climax with the autonomous financialization of all economic realms during the twentieth century. Minsky (1986) communicated this climax in such a pointed way, that for the first time a greater audience within the economic discipline recognized the importance of institutional factors for (in)stability of the economy. His question '*Why is our economy so unstable?*' Minsky (1986: 109) should disappear step-by-step the realm of what he called 'non-sense questions' in the economic science. Within this context Minsky pointed out that any satisfactory theory needs to recognize endogenous instability as a problem. Today we can argue that such theories concerned with phenomena such as *self-criticality* or *phase-transition* need to incorporate the notion of entropy or more generally of evolution then. This is probably something which Minsky could have learned as a graduate student of Schumpeter in Harvard, compare Knell (2012: 5). Minsky (1986: 279-282) considers the banks as the endogenous destabilizers in the monetary circuit. In the '*Financial Instability Hypothesis*' Minsky (1992) concretized this perspective along an integration of Schumpeterian and Keynesian economics. Knell (2012: 3) points out that '*His main contribution was to link financial market fragility and speculative investment finance*'. Obviously the instability within the banking-macro nexus deals with the dynamic change in bankers' and investors' behaviour, since in good times they are lured to take more risk. In consequence it is necessary to elaborate on these bottom-up foundations. Banks institutionalize credit-regimes via their lending capabilities. Hence the evolution of lending standards represents crucial significance for the contingent development of the economy's dis-equilibrium path, a notion highlighting the institutional nature of the monetary circuit in Schumpeterian credit-driven innovation and more generally in

the endogenous demand for money in Keynesian terms. Schumpeter objected the *Quantity Theory of Money* as well as Keynes. This notion makes them theoretical allies for institutional arguments in the monetary circuit. We elaborate on this topic in section two of the paper, by giving insights from a history of economic thought perspective, discussing a credit-centred perspective of money.

Still, the textbook model of monetary economics works with a different theoretical heritage of economic thought, in particular the *Quantity Theory of Money*. We outline the history of economic thought with special respect to the theory of money in order to show the origins and fundamental differences between top-down and bottom-up approaches to the banking-macro nexus. In section three of the paper we look into current attempts within these two approaches seeking for a proper understanding of the origin and management of crisis in capitalism. As the elaboration of both modelling systems shows, significance is given to the bank as a central organ in the institutional intermediation of money. But we observe that the current models lack appropriate micro-foundations of the bank as a systemic carrier of credit-rules. Following the methodological premises and perspectives of top-down and bottom-up approaches it is undoubtedly clear that such challenges may only get met by the latter. However, within the realms of agent-based modelling and endogenous dynamic network theory we identify an absence of theoretical standards about the involved bottom-up process.

We consider the institutional process of bank lending as essential for the banking-macro nexus and provide a theoretical framework to analyse the evolution of generic credit-rules. This framework may host as a standard for further bottom-up models of the banking-macro nexus, building upon Dopfer and Potts (2008). Its application to the credit realm may serve as a blueprint for individual and social learning in local artificial neighbourhoods between firms, households and banks, shaping the monetary circuit. In this outline the bank is considered as a rule-guided actor under bounded rationality (Simon 1991) and nested cognition (Kawamura 2009). The subject characteristics (cognition, habit of thought, behaviour) of credit rule-sets are understood as micro-foundations for bank lending with regards to risk perception and financing needs for instance. Otherwise we consider their co-evolution with object characteristics (market and organizational rules, technical rules) of credit-rule sets as constitutive for the bottom-up institutionalization of credit-regimes. Thereby object credit-rules deal with competitive pressure, alternative financing and short-, long-term interest rates, cost of funds or the balance sheet constrain for instance. This co-evolutionary bottom-up foundation of credit-rules and evolving lending standards is empirically grounded with the Bank Lending Survey of the European Central Bank, because focus is given to the Euroarea at the moment. The potential of this approach is given by its synthesizing nature of pluralist evolutionary economic programs, compare Wäckerle (2013).

## 2 The Complexity of Credit-Money: A History of Economic Thought Perspective

Monetary theory deals with the relation between money supply and demand. Money is defined along its functions as a medium of exchange, store of value and unit of account. The first two functions deal with money as a means of payment - as an exchange medium - and the circumstances that money can be hold for future consumption or investment, a store of value. Money represents a unit of account when it emerges in balance sheets, which involves all commercial operations. Furthermore money is pragmatically defined along its statistical properties for monetary policy. Here we deal with money aggregates - Bofinger (2001: 5) - M1 (currency in circulation), M2 (M1 + bank deposits), M3 (M2 + repurchase agreements + market funds + debt securities), which serve as operative aggregation measures for the central banks.

The most essential and rivalling problem in monetary theory deals with the explanation of money demand. In the history of economic thought three basic attempts were made to articulate the demand for money. Those were the *Quantity Theory of Money*, the *Cambridge or Keynesian approach* and the *Inventory or Transactions approach*, where we concentrate on the differences between the first two, for the latter's original elaboration compare Baumol (1952) and Tobin (1956). All of them are related to the equation of exchange, firstly stated by Irving Fisher. The Quantity Theory reached its popular status in Friedman (1956) with the introduction of an additional basic relation, between money-to-hold and wealth. In general the Quantity Theory proposes c.p. a substantial and direct proportional relation between a quantitative money supply and the price level of the economy in the long run. The Cambridge approach emphasises that money is not immediately spent for goods, but certain ratios of income are held or invested according to one's liquidity preference. Keynes thus introduced socio-psychological constants ('propensities' towards certain economic actions) on a macroeconomic level, which allowed him to replace the strict proportionality of the quantity theory of money by a more flexible framework - at least for short-run dynamics. Conclusively, following Bofinger (2001. 20), the quantity theory shows that '*...demand for money is a demand for real balances and depends proportionately on real GDP. Its main assumption is a stable velocity of money. Keynesian approaches explain the role of the interest rate as a determinant of money demand.*' The Keynesian model introduces a speculative motive towards the theory of money demand. Keynes (2008: 126) [1936] emphasises the incentive to buy interest-bearing assets (bonds) instead of consuming goods and services. In this way he reinforces the role of the interest rate within M2 and broader aggregates.

Otherwise Hicks (1935) claimed that money needs to have a marginal utility as all other goods and services: *'People do choose to have money rather than other things, and therefore, in the relevant sense, money must have a marginal utility.'* Hicks (1935: 3). Hicks argued that whenever there is a choice to make between alternatives that can be expressed in quantitative terms, we shall apply the concept of marginal utility as for other commodities. Finally Friedman's (1956) restatement of the Quantity Theory of Money meets these claims for a marginal theory of money and introduces the argument of individual wealth of utility-maximizers as the decisive determinant for money demand. Thereby he considers money as a commodity as all other goods and services. Today money is still considered within this mere quantity picture, mostly captured within Hicks' (1980) modern IS-LM model, compare Blanchard (2000) or other macroeconomic textbooks. Modern quantitative approaches in monetary economics by New-Classicals or New-Keynesians work usually with the mechanics of the Quantity Theory of Money, providing the prototypes for the central banks. An overview to the theoretical and modelling foundations of current top-down approaches in monetary economics is given in sub-section 3.1.

The assumption that money is a commodity represents a key assumption within the standard model of money supply. This claim is scrutinized from several perspectives within the discipline, for instance from Post-Keynesian approaches or from Schumpeterian economists. Schumpeter (1954: 317-322) objected the application of a demand and supply apparatus for a value theory of money, because money does not represent a commodity in his terms. Schumpeter associates trust and security with the emergence of bank notes. Bank money, understood as transferable deposit, was not the great novelty in the late 17th and 18th century, but the new practices and conducts involved with it made up the novelty, compare also Ferguson (2009). It is the credit-form of money which rearranged its institutional features and functions. Credit-money constitutes a socio-economic institution, capable of creating and destroying money, where we define institutions broadly as *'...ystems of established and prevalent social rules that structure social interactions.'* Hodgson (2006: 2). Taking Schumpeter's arguments seriously, money cannot be understood simply as an object yielding marginal utility. In Schumpeter's (1970) *'Das Wesen des Geldes'*, published posthumously, he refers to the sociological role of money as a unit of account. Schumpeter considers the *'carriers of the social accounting process'* as the households, the firms, the banks and the central bank. Insofar we consider the evolution of credit-rules as an evolving social accounting system within the banking-macro nexus. Banks create and destroy money endogenously from a demand and supply perspective, where the borders between demand and supply get vaguer and vaguer. Regarding the perspective of the Quantity Theory of Money, money tempts to be regarded as exogenous only. Post-Keynesian - compare Lavoie (1984) or Fontana (2003) - and institutional perspectives - compare

Ferguson (2009) or Hall (2008) - suppose a more systemic, historical and therefore evolutionary approach to the theory of money and credit, which addresses the complexity of money in flow. This scepticism also originates from the exaggerated use of the general equilibrium framework, the efficient market hypothesis, the representative agent and the rational expectations approach in monetary theory and policy. Following Schumpeter this is immediately clear since any innovation will need the disequilibrating force of a more or less daring credit. A general equilibrium framework - where the state of all markets is simultaneously determined by the set of exogenously given preference orders of all market participants - leaves no room for singular, credit supported novelty. The missing property describing social and technical innovation (including the role of credit) from an empirical point of view leaves behind the most essential characteristics of industrialized economies in the last 300 years. These innovated advances observed in products, production processes and socio-economic relationships (again including credit) are the core of what is considered to be economic progress. Crisis is just the mirror image of progressive innovation, it thus represents an innate property of capitalist development. All economic operations are executed under uncertainty, as also Keynes (2008) [1936] emphasised in a Knightian tradition. Time is irreversible. For Keynes to overcome the poverty of equilibrium analysis in the face of the Great Depression, the introduction of independent socio-psychological constants made errors of investors possible - but just on a short-run aggregate level. The challenge for a modern analysis is to go beyond (or better, to go underneath) such an aggregate consideration of error-driven, evolutionary credit dynamics; i.e. to provide theoretical as well as empirical arguments for the aggregate level of structural macro analysis.

*'The basic fact underpinning is that all money is credit. Money is the expression of an accounting relation of liability and asset, created as one agent extends credit to another, who assumes a debt.'* Bezemer (2009: 2). Credit-money is a socio-economic institution which highlights the bank in economic analysis as one of its major institutions. The bank's central role is accompanied by an increase in its economic and political power; moreover its decisions and actions may carry crucial ramifications for the whole economy. Banks need to be considered as crucial institutions today, since they may act as endogenous destabilizers by challenging the monetary authorities, compare Minsky (1986: 279). Minsky called the game between central banks and banks unfair, because *'The profit-seeking bankers almost always win their game with the authorities, but, in winning, the banking community destabilizes the economy; the true losers are those who are hurt by unemployment and inflation.'* Minsky (1986: 279). But how did the institutional innovation of credit change the bank's position? Schumpeter's (1954: 317-322) interest in the novelty of issuing money is connected with the rise of new analytical economic practices. He argues that in earlier times, trade was always considered as perfect



trade, so that commodities were exchanged exactly, without any residue. The monetary system has changed with the evolution of money to credit-money. The new possibilities, enabled by credit, changed the monetary system tremendously. The credit system represents therefore one of the most influential and powerful institutional networks in the global political economy.

Arena and Festré (1996: 117) argue that banks cannot be characterised as pure contractors or intermediaries, because of informational asymmetries between all the participating parties. The authors support the idea of Stiglitz and Weiss (1988) that banks appear as social accountants in the economy, instead of mere brokers. The consequential role of the bank is to synchronize informational asymmetries between firms, households and banks. The Schumpeterian story tells us that these functions characterise capitalist development, the evolution of business cycles and the evolution of institutions in a very dominant way. Insofar Arena and Festré (1996) focus on the monetary aspect of entrepreneurship, innovation and business cycles. They also argue that neoclassical economics considered the implications of capitalist development too narrowly by concentrating too much on factors of the real side of the economy, i.e. technology and structural change. The crucial point in their analysis faces Schumpeter's break with the Walrasian general equilibrium system. *'However, it is the finance side of Schumpeter's writings that demonstrates his break with Walras, especially in light of the history of economic dynamics and of monetary theory.'* Arena and Festré (1996: 117)

Banks are capable of creating money independently from certain, custom deposits, so they do not merely exchange (understood as bilateral bank relations) money anymore, they expand or restrict it depending on its demand. Here we may also find the most crucial link between the real and the monetary sector of the economy. Money is not a mere commodity, only in the eyes of a theoretical metallist, as Schumpeter (1954) notes. The evolution of money also implies the evolution of the most dominant modern economic institutions. Hanappi (2009: 4) explains that money as credit becomes a process, because its value gets continuously judged along different social and cultural environments. Credit is about the trustworthiness of an economic system, with the rise of banks this trustworthiness got institutionalised during the Middle Ages. Money changed dramatically, from a commodity-based, feudal, metallist structure to a financial social contract. Within this specific development lies a very deep evolutionary process of economic institutionalisation, indicating that property and wealth got completely redefined. Though the banks' essential socioeconomic and political task has not changed over hundreds of years, they still evolve tremendously, regarding the ever increasing diversity of products and banking methods. Credit is the most essential feature for investments in future projects. Companies, private as well as public households have to rely on creditability. Every economic step means a certain trade of trust versus money. Various but still similar manifestations of banks, money and credit

have evolved in economic history, compare Ferguson (2009) and Hanappi (2009). Therefore banking underlies an evolutionary speciation process, where different lineages of credit-rules have evolved in history. These lineages emerged in certain periods of economic evolution: The introduction of banknotes, the innovation of credit, the establishment of central banks, but also the rather new development of micro-credits in and macro-credits for developing countries.

Post-Keynesianism suggests that money supply gets endogenously determined by its demand for bank credits by other banks, firms and private households. Fontana (2003) explains that there are basically two major approaches to the theory of endogenous money, the accommodationist and the structuralist approach. Credit-money refers to the flow of money and balance sheets refer to the stock of money. The starting point of the analysis within the accommodationist approach is that supply for credit-money is infinitely elastic. Accommodationists argue majorly in tradition of Keynes, Kaldor and Robinson, as Fontana (2003) elaborates. Money is explained via the demand of entrepreneurs or investors. This notion is coined through Keynes' position, that money plays a part of its own. Then money needs to be considered as a social relation of credit, where accommodationists argue along the idea of a social convention. In consequence it expresses the value of a contract, rather than the value of a commodity, which in fact seizes a fundamental economic difference. Fontana (2003: 296) argues that the accommodationist approach to endogenous money considers the real economic production of commodities as a time intense process, where money supply needs to get explained by a sequential analysis of the production process. *'The supply of bank credit originates in the firms' need to finance production costs.'* Fontana (2003). Conclusively banks are considered as institutions in the business of selling credit, hence they are price-makers in terms of interest and quantity-takers in terms of the amount of credit-money which is demanded by firms. Thereby banks accommodate the demand for additional funds, whereas the central bank accommodates the demand for reserves of banks.

Otherwise structuralists criticise the accommodationist approach regarding its assumption on an infinite elasticity of credit supply, primarily. Further distinctions deal on the one hand with the liquidity preference of central banks, banks, firms and households and on the other hand with the role of private households in credit relations. Advocates of the structuralist approach argue that the behaviour of private households on capital markets has changed fundamentally in the last decades. Today money supply also depends on the demand for bank credits by households. The overall money supply is then influenced by a three pillar system in an endogenous way: liquidity preference of all participating parties, household demand for credit and firm demand for credit. One of the central claims relates to the very archaic relationship between lenders and borrowers, which depends foremost on preferred liquidity. In this picture households gain equal



importance within the monetary circuit. Of course there are several interpretations of the monetary circuit in French, Italian or Canadian tradition. A common strategy of Post-Keynesian theory and modelling concerns the concept of stock-flow consistency, as outlined in Godley and Lavoie (2012: 21): *'This sounds very much like Minskyan economics, and indeed it is, as Roe explicitly refers to the work of Minsky on financial fragility, showing that a stock-flow consistent framework is certainly an ideal method to analyse the merits and the possible consequences of Minsky's financial fragility hypothesis.'*

Otherwise monetary circuit theory was not only considered by Keynesians, as we already have shown the Schumpeterian system of thought follows the same outline. Bertocco (2007) as well as Knell (2012) shows how one can connect Schumpeterian and Keynesian economics, best shown in the work of Minsky (1986, 1992). Of course this aspect deals with the influence of the Austrian as well as the German historical school on Schumpeter's vision of economics. Elsewhere Steele (2006) discusses the main differences between Hayekian and Keynesian economics with an emphasis on their theory of money. We can also argue that the circuitist approach is something which brings them together, of course the conclusions and implications with regards to economic policy are perfectly diametric. The Quantity Theory of Money represents an economic doctrine which is objected by economists with an institutional focus. This emphasis brings heterodox economists from several schools together and may also function for potential synthesis in the future. It is interesting to note that proponents of the Quantity Theory of Money still emphasis the top-down modelling approach, whereas proponents of the Cambridge school of an endogenous theory of money in more general focus bottom-up modelling approaches, even Post-Keynesians emphasis change in such a direction.

### **3 Modelling approaches in monetary economics with respect to the credit channel**

The history of economic thought perspective has shown that monetary economics is a highly contested terrain, including a variety of heuristic projections on the banking-macro nexus. But it has also shown that the bank needs to move into the centre of economic analysis and moreover the institutional nature of credit-money. Both aspects are addressed within current top-down and bottom-up approaches, from different angles with different implications.

### 3.1 Top-down approaches

Central banks are in the focus of economic attention as agenda setters today. They increasingly fulfil and represent powerful roles within global political economy. The economic power of nation states has decreased in the last decades, since financial complexity has grown to immense extents. In consequence financial intermediation needs to be investigated more extensively, since in times of non-growth or recovery the interconnectedness between systemic institutions is crucial for real economic activity. The impact of monetary policy on the economy is investigated along the monetary policy transmission mechanism. Central banks argue that the policy rate manifests itself in wages, prices and output along four major transmission channels, compare Mishkin (1996), the interest rate channel, the credit channel, the exchange rate channel and the wealth channel. In general the interest rate channel represents the quantity theory of money in its purest sense, because cost-of-capital gets influenced by the central bank's leverage on short-term interest rates. Nowadays it is well known that arguments relying just on this perspective may not be satisfactory for the greater picture, as also admitted by Bernanke and Gertler (1995). The credit channel works along the external finance premium representing the difference between firms' internal and external costs for capital, consequential for investment operations. This channel also involves the goods and the labour markets, since households and firms have to rely on the provision of credits. Wage and price formation follow therefore a more complex evolution, because more stakeholders are involved in general. The exchange rate channel is dependent on currency fluctuations and respectively on the degree of openness of the economy. The wealth channel is related to movements within the stock market and its asset price fluctuations.

Bernanke and Gertler (1995: pp2) conceive the credit channel as an enhancement mechanism of standard monetary transmission and identify two components of it: the balance sheet channel and the bank lending channel, where the latter accounts that *'...monetary policy affects bank loan supply, which in turn affects aggregate economic activity.'* as considered by Diamond and Rajan (2006: 3). In this section we basically concentrate on the bank lending channel. However, in the neo-classical picture it is not quite well articulated how the game between central banks and commercial banks is played, referring again to Minsky (1986). It seems that banks are not considered as a source for crisis or instability, furthermore there is not much talking about the origins of crisis in this literature, but rather more on the consequences as well as the potential fighting of it via monetary policy. The central bank acts as a hero in this outline. In times of a crisis this game becomes crucial, because less liquid financial institutions will have trouble to refinance. Diamond and Rajan (2006) make specific adjustments to the bank lending channel, by arguing that banks may find different forms of financing once reserve require-

ments are eliminated. Nevertheless there is evidence that monetary policy affects particularly the liquidity of banks with worse balance sheets and foremost small banks with initial low liquidity. Obviously these effects are seriously affecting overall bank liquidity and consequently real economic activity in times of crisis or even recession. Diamond and Rajan (2006) focus on demand deposits as a crucial factor, with emphasis on capital flights or even bank runs in times of crisis. Insofar, money and money-to-hold represents a complex and critical phenomenon with far reaching consequences, as also Kiyotaki and Moore (2012) argue.

Monetary economics and corresponding DSGE (Dynamic Stochastic General Equilibrium) models work mostly with frictionless markets, compare Christiano et al. (2005) or Smets and Wouters (2007). By focussing on the transmission mechanism of conventional monetary policy, they are unable to capture financial market disruptions. For that reason, recent studies tried to conduct a theory and implement models with financial frictions in order to discuss the reaction of unconventional monetary policy, i.e. credit policy. Gertler and Kiyotaki (2010: pp566) identify three different credit policy options, also operated by the Federal Reserve Bank during the crisis: (1) discount window lending to banks secured by private credit, i.e. liquidity facilities, (2) lend directly in relatively high grade credit markets, i.e. lending facilities, (3) direct assistance to large financial institutions (TARP), i.e. equity injections. In such a perspective frictions need to get addressed seriously, as also indicated by Gertler and Karadi (2011). The authors keep up with the problem, that any deterioration in balance sheets of financial intermediaries disrupts the flow of funds between lenders and borrowers. This process leads to a symptomatic rise in various credit spreads as well as a significant tightening of lending standards, as described by Gertler and Karadi (2011: 20). Therefore a tightening raises the costs for borrowing and enhances the downturn on the real side of the economy, which reduces asset values throughout. Consequentially an expansion of central bank credit might offset a disruption of private financial intermediation, as articulated by the contributions of Bernanke et al. (1999) with a focus on the financial accelerator, or Christiano et al. (2010) with a focus on risk shocks.

However, these contributions don't go into details about the rather 'new' endogeneity of risk, which reflects the ultimate reason for a more macroprudential regulation policy. Brunnermeier and Sannikov (2012) explain that securitization and derivative contracts might lead to a better sharing or hedging of exogenous risk, though these vehicles also increase endogenous systemic risk, which can be addressed as one source for the subprime crisis. Insofar the authors build on recent research on the agency and information sharing problem between financial intermediaries, compare Brunnermeier and Sannikov (2011), Gorton (2009). The main conclusions of Brunnermeier and Sannikov (2012) can be summarised to: (1) the system reaction to shocks is highly non-linear, (2) in a 'normal regime' only

unusually large shocks get much more amplified, in a 'crisis regime' even small shocks get amplified â leading to significant endogenous risk, (3) system reaction to shocks is asymmetric and (4) increased volatility in the crisis regime affects the expert's precautionary motive, also called volatility paradox.

The argument shades more light on the very painful reality central bankers need to face more and more: Financial intermediation involves a tremendously complex process, especially the various aspects within the credit channel of monetary transmission. Furthermore if we concentrate more on the European situation, apparent solutions from US monetary economists are not easily treatable. For instance Eurozone countries, such as Greece, Italy, Portugal, Ireland and Spain face an even more difficult situation, since they are not able to issue riskless government debt as the US is capable of - the standard procedure by the FED as illustrated by most of the authors mentioned above. With regards to this issue, other political and institutional dimensions need to get highlighted as well. Moreover contagion effects are even more complex, when we are not able to speak of an Optimal Currency Area, as it is the case with the Eurozone. Insofar monetary unions face crucial problems if the real side of the economy is not structurally synchronized. Such premises also demand for political and fiscal integration, as many experts argue, compare de Grauwe (2009). Otherwise the top-down approach in theory and modelling of the most prominent New-Keynesian macroeconomists and US central bankers also faces significant limits, since modern DSGE systems are not capable to include the emergence of discrete events. Crisis is always conceived as an exogenous phenomenon, meaning also that DSGE systems are not prepared for the modern globalized economy. Cumulative causation and interdependency indicates the contemporary problems of our economy. Others such as Mitnik and Semmler (2012) emphasise the notion of regime change within the banking-macro nexus. Different regimes face different systemic vulnerabilities, triggered by a variety of endogenous shocks. We are confident that the occurrence of regime changes can be investigated efficiently via bottom-up approaches, as discussed in the next sub-section.

### **3.2 Bottom-up approaches**

Interbanking is the central issue of financial intermediation, nevertheless we still don't have acquired much knowledge on the structure of interbank and firm-bank networks. Here the distribution of institutional power plays a significant role; consider the aspect of shadow banking for instance, Pozsar et al. (2012). This notion - especially the aspect of interconnectedness, contagion and systemic risk - gets more and more investigated via bottom-up approaches, for reasons we show in the following. DSGE systems don't feature evolutionary system characteristics such as adaptation/adoption, selection and retention, which shape the structuring

processes of financial intermediation by the nature of the approach. The essence of population thinking as well as the developmental aspect of evolution (Callebaut and Rasskin-Gutman 2009) opens a variety of qualitative and quantitative aspects for an extensive research of this domain, such as institutional and organizational learning, niche construction and emergence. Hitherto top-down approaches worked along the general equilibrium framework, where representative agents resemble the average of economic actors within a homogenous population of financial and non-financial firms. Empirical investigations, such as Schweitzer et al. (2009) and de Masi et al. (2011), show that the degree of heterogeneity and consequential complexity is much higher as assumed in DSGE systems. The theory of networks provides substantial support for such empirical observations of firm-bank and interbanking networks. Network theory as stream of the science of complexity has grown tremendously in the last decades. Nowadays, network scientists apply findings, especially from biological and social networks, in the economic domain, compare Barabási (2003) or Csermely (2009). The substantial advantage of network theory lies in the potential identification of weak links via clustering methods. Additionally network theory allows computing degree distributions of networks indicating weights for systemic interconnectedness. Financial orders evolve in a nested way within top-level and bottom-level networks. Those can be visualised with the tools of network theory, as scholars such as Schweitzer et al. (2009) have already shown. The authors highlight the interconnection of financial institutions as nodes and the strongest existing relations among them as weighted and directed links. The saturation of links stands for the weight between two nodes, the thicker a link the more important it is. Schweitzer et al. (2009) argue that the global banking sector is highly interdependent, which makes the structure highly vulnerable for breakdowns of important nodes and weak links, as we have seen with the insolvency of Lehman Brother in 2008. The global financial network inhabits a serious degree of systemic risk.

Certainly spill-overs to the real economic sector have far reaching socio-economic and political consequences during breakdowns of institutional networks of financial intermediaries - triggered by liquidity traps for instance. There is no doubt that studying the interconnectedness within banks, between banks and firms is highly promising to analyse the structural composition of the banking-macro nexus. Furthermore we may also highlight the process component of changes within this structure, the evolutionary component. De Masi et al. (2011) have investigated debt-credit relations between Japanese firms and banks with a network theory approach. The authors have shown that the topology of the credit network is significant for its stability, fragility and vulnerability. They indicate crucial bank and firm nodes/links for the stabilisation of the system on the whole. De Masi et al. (2011: 210) argue: *'In the presence of autocatalytic processes, even a small amount of individual heterogeneity invalidates any description of the behavior of*

*the system in terms of its 'average' element: the real world is controlled as much by the tails of distributions as by means or averages. We need to free ourselves from average thinking...*. This quote does not just signalise the importance of new statistical techniques engaged via network theory, but also emphasises that self-organization, autocatalytic processes and selection pressures are highly non-linear phenomena which go beyond the analytical scope of standard methods. Obviously intellectual exchange and dialogue between different economic approaches needs to get intensified. Network theory, agent-based modelling and computational socio-economic simulation play key roles in this theoretical discourse; compare Delli Gatti et al. (2009) for business fluctuations due to bankruptcy chains, Battiston et al. (2009) for systemic risk in evolving networks, Thurner (2011) on systemic risk and the leverage cycle, Cincotti et al. (2010) for an implemented simulator for the European banking-macro link, Stiglitz and Gallegatti (2011) for a critique on the representative agent approach in monetary economics and a proposal for heterogeneous interacting agents, or more generally Delli Gatti et al. (2010) for a proposal towards an agent-based macroeconomics. Recently also Post-Keynesian economists turned successfully to agent-based modelling, as shown by Sepecher (2012) for instance.

Apparently such new attempts need to be present more and more within new models and simulations as well as in empirical research. However we outline that these attempts do not follow a common research methodology, which indicates a big problem for further standardization in bottom-up models of the banking-macro nexus. Heterogeneity is often assumed and associated with a stochastic element, but there is not much about the cognitive, motivational, social and technical origins of the modelled diversity of actions. Additionally the agents move and decide as if they were particles, in particular they are not modelled with an information structure, communication or interaction logic. This notion may be a side problem at the moment, but it needs to be on the future agenda, since agent-based modelling experiences its advantage from the implementation of locally bounded knowledge. Agents learn only through interaction and communication. In particular there is not much explanation of the underlying mechanisms between individual and social learning. We argue that this aspect is essential for the analysis of the banking macro nexus, since crisis is an institutional bottom-up evolving phenomenon. For that reason we present an evolutionary framework which provides theoretical bottom-up foundations for the mentioned problems.



## 4 Evolutionary bottom-up foundations for the banking-macro nexus

The history of economic thought was always shaped by grand theories in the humanities and natural sciences. First attempts to an appropriate theory of money were established in the early 20<sup>th</sup> century, where economics also made its major turn towards a subjective marginal theory of value. Economic theory was constructed as a so-called hard science, building upon classical physics, especially on Newtonian mechanics, compare Mirowski (2002: 7) or Dopfer (2005: 7). This legacy of classical mechanical thinking still dominates the theoretical grounds of the discipline.

Classical mechanics works along a top-down logic where entities are assumed as homogenous atoms. This idea makes economic modelling simple, since actors can get summarized to a single representative agent optimizing its behaviour. Furthermore Newtonian physics has a strong emphasis on equilibria and invariant laws. The laws of movement bring the elements back into equilibrium after the occurrence of an exogenous shock. This notion got translated within the general equilibrium framework of economics, firstly stated by Leon Walras' *Pure Economics* in the late 19<sup>th</sup> century constituting a simultaneous equilibrating system of all involved economic markets. The laws of movement represent perfect competition to a great extent in economics. If money is conceived as a commodity we are able to apply the general equilibrium framework for money markets and consider a marginal theory of its value. This point clarifies the Quantity Theory of Money, that there is a specific amount of money supply which brings the economy back into equilibrium via a trickle-down process initiated by the central bank. Modern monetary economics and DSGE simulations are constructed with this classical-mechanic top-down logic. The central problem of top-down approaches concerns its closed system perspective. However, economies are interconnected and also open to other sub-systems of society and culture. The openness of the economy is shaped by the fast changes in media and technology. Today the economies need to be considered as open, interconnected and highly synchronized today. Modern crises diffuse endogenously like a virus on a network and the interconnectedness of the economy drives the velocity of the diffusion process. These characteristics make traditional monetary policy (controlling money supply via interest rate targeting) to a highly speculative game from a classical-mechanic/top-down perspective.

However, early evolutionary economists such as Veblen, Hayek, Marshall or Schumpeter have recognized that economists may learn a lot by looking into the theory of evolution, compare Dopfer (2005), Hodgson (2004), Nelson and Winter (1982), Shionoya and Nishizawa (2009) or Witt (2003). Darwin's theory of evolution is a theory of speciation and development, a theory of variation, selec-

tion, retention and of modularity. Speciation processes occur endogenously from within the entities and evolution can therefore be denoted as a theory of continuous structural change from bottom-up. Additionally the idea of population thinking contributes to an open system approach in a feasible way. The Schumpeterian and Cambridge approach to the theory of money invite evolutionary ideas concerning especially the institutional dimension of credit-driven endogenous economic change. Then the focus switches to social learning, diffusion and transmission of values within the banking-macro nexus. Uncertainty and innovation drive this self-transformation process from the bottom-up. Thereby trust and power gain more importance for economic operations and foremost for economic policies. The notion of credit inhibits investment and consumption opportunities for economic actors, which make the system disequilibrating and vulnerable to critical mass processes, for the latter compare Schelling (1978). For that reason evolutionary bottom-up logic serves as a theoretical basin to investigate interconnectedness, contagion and systemic risk in firm-bank networks for instance. Monetary policy is then perceived as a cumulative feedback process, where money demand and supply trickle around.

The credit channel is not only an underestimated complex of economic evolution, but foremost a less investigated object of economic inquiry. In fact economists don't know much about the complex evolution of credit-money. Integrating attempts in the theory of money along an institutional approach are already given for instance by Steele (2006) between Keynesian and Hayekian concepts or by Minsky (1986, 1992) and Bertocco (2006) between Keynesian and Schumpeterian concepts. We follow Steele (2006) and argue that heterodox perspectives, which seem to be diametric, are closer together than expected at a first glance. Synthesis of a plurality of economic schools of thought provides new insights for bottom-up foundations in economic theory in general and especially for the theory of money, credit and banking.

Monetary rules are usually associated with the central bank's authority controlling the mechanics of credit expansion and contraction. The central bank's major goal is to guarantee price stability and then financial market stability. Today most central banks follow pre-determined rules (e.g. Taylor rule) instead of discretionary policy to sustain their goals. We may refer to these rules as technical rules. Within this section we want to point out firstly that technical rules are part of a greater ensemble within the channels of monetary policy transmission and secondly we identify dependencies with other types of monetary rules and integrate them in a generic rule taxonomy for credit evolution. Prior to this specific type of credit-rule evolution we introduce the meso-centred, generic rule based approach within evolutionary economics and suggest a proper application to credit evolution.

The credit channel of the monetary transmission mechanism can be conceived as a black box within current modelling approaches the problem. We argue that

this notion needs to be treated with more significance, since monetary stability relies on the complex flow of credit-money and its institutionalization processes in credit regimes. A unified rule-based approach within the realm of evolutionary institutional economics builds the bottom-line of this proposed endeavour and may give new fruitful perspectives for future research in monetary economics. Wäckerle (2013) highlights commonalities and complementarities in the generic characteristics of institutional economics in the work of Th. Veblen, F.A. Hayek and J.A. Schumpeter. In general we follow Hodgson's (2004, 2006) heuristic vision of an evolutionary institutional economics in tradition of the old institutionalism, but vitalised by the institutional thought of Hayek and Schumpeter. Veblen's theory of institutional change – Veblen (1898, 1899, 1904, 1914) – is shaped by the cumulative causation of habits of thought. These habits of thought evolve into institutional settings, creating cultural and socio-economic standards for economic action and operation. In brief, institutions change due to the transmission of economic regularities in production and consumption. Hayek's theory of spontaneous order and rules of conduct is majorly expressed in Hayek (1967, 1973, 1978). Hayek's institutional theory is a theory of cultural evolution, where the socio-economic and cultural interplay of rules of conduct lead to the emergence of a social order, which may occur spontaneously. Schumpeter's theory of entrepreneurship, innovation and business cycles is basically addressed in Schumpeter (1911, 1930, 1939). The Schumpeterian system of technological innovation through emergence of novelties triggers institutional change in the economy. This institutional change originates in the disturbing force of the entrepreneur, who invokes business cycle fluctuations. Schumpeterian institutional change is not driven by economic regularities, but by economic singularities, i.e. creativity-driven change. This notion can be conceived as the rule to innovate or create, whereas the Veblenian and Hayekian approaches capture more the rule to imitate and adapt. Two basic role categories of economic agents appear conclusively: rule-makers (leaders) and rule-users (followers). Such a rule-based micro economic theory of heterogeneous homo sapiens oeconomicus is developed in Dopfer (2004). Rule-making and rule-using constitute generic economic features, like innovation and stability. Dopfer and Potts (2011: pp8) offer a taxonomy of generic rules – illustrated in Table 1 – indicating the potential spread or diffusion of rules from the subject to the object domain and vice versa, shaping the evolving knowledge base of the economy. Furthermore a rule-based approach within evolutionary economics operates on a meso-logic of the economy, compare Dopfer (2012) and Elsner (2007, 2009). Such a generic rule-based approach can get applied to theory and policy of money and credit. Thereby we want to highlight the multidimensional character of credit-money, indicating and investigating the evolving interdependencies between the cognitive, behavioural, socioeconomic and technical aspects of financial institutional intermediation and its effects on the real economic activity.

**Table 1:** Generic rule taxonomy

Generic Rules			
Subject Rules		Object Rules	
<i>cognitive</i>	<i>behavioural</i>	<i>social</i>	<i>technical</i>
e.g. mental models and schemata	e.g. behavioural heuristics, algorithms and norms	e.g. organisation of enterprise or market	e.g. machines, instruments and techniques

*Source:* Dopfer and Potts (2008: 8)

A rule-based approach to the theory of credit-money works with a heterogeneous set of agents, equipped with different cognitive and behavioural rules. Agents learn to adapt modes of borrowing and lending by imitating successful strategies via social learning, according to credit-related criteria of relative fitness (financial needs) and group selection (alternative financing). This approach is significantly different to the standard DSGE framework. We want to emphasise that system properties such as irreversibility, heterogeneity, path dependence, diversity and emerging complexity have to be taken into account in future models of the banking-macro nexus. A rule-based approach operates within a meso-logic of economic processes. Meso serves on the one hand as an intermediate process layer of innovation and retention between micro and macro, compare Dopfer et al. (2004) and on the other hand as a constituent platform size in a group selection processes of institutional change, compare Elsner (2007, 2009).

Current monetary economic models do not integrate the structural role of credit-rule evolution. These days credit-money involves an economic category of creative destruction, consuming and producing on the limits. The creative as well as the destructive characteristics of money creation via credit are well underestimated on the intermediary level of monetary transmission, especially since Ponzi-borrowing became an integral part of creditors' and debtors' monetary habits of thought; compare also Minsky (1992). Even standard creditors (e.g. commercial banks or municipalities) are forced to get involved in Ponzi-games in order to leverage. From a pragmatist's perspective Ponzi games can't be sustainable in a capitalist economy and from a theoretical perspective Ponzi games are currently not treated respectively in modern monetary economic models, because of lacking heterogeneity. It is argued that proper reasons why current top-down models do not integrate this important part of heterogeneity in credit relations stem from an inappropriate connection between micro and macroeconomic theory. The standard micro foundations in macroeconomic models exclude the possibility of so-called irrational behaviour, which is obviously given in case of a Ponzi game. The meso level offers a process dimension for more appropriate micro

**Table 2:** Order of rules

0 <sup>th</sup> order constitutive rules	Social, legal, political, cultural, and other constituent rules that underpin generic rules for economic operations.
1 <sup>st</sup> order operational rules	Generic rules originated, adopted and retained by carriers for operations.
2 <sup>nd</sup> order mechanism rules	Rules for changing rules. The origination, adoption and retention of rules about origination, adoption and retention.

Source: Dopfer and Potts (2008: 9)

foundations in economic theory, a dimension of rule creation (agenda setting) and rule adoption (agenda receiving). Rules are invented, learned and adopted by micro agents. Within an operational context we are able to look into the diffusion of specific rules, highlighting particular states of rule correspondence and synchronisation. Thereby herding behaviour appears as just one facet of such potential transmission mechanisms. Dopfer and Potts (2008) provide a prototype schema for the socioeconomic evolution of rules on the micro, meso and macro level. Generic rules are distinguished from genetic rules, as the latter '*...replicate biologically and the former communicate socially. Economic evolution is the evolution of generic rules relating to the economy, which are rules relating to operations on resources.*' Dopfer and Potts (2008: 6). According to Table 1, these rules are subject rules (cognitive and behavioural) and object rules (social and technical); together they span a rule matrix called [CBST] by the authors. Then, as argued by Dopfer and Potts (2008: 8), '*Economic evolution is the ongoing process of coordination and change in these economic generic rules.*' The classification of these rules in subject and object can get expanded by the introduction of rule orders, formulated within an order vector [0 1 2] - constitutional, operational and mechanism rules. The Cartesian product of [CBST] x [0 1 2] expresses the generic state of the economic system, also expressed by the coordination of its knowledge base. Generally evolutionary economics seeks to investigate changes in this matrix and the interconnection between its rows and columns. The co-evolution and synchronisation between subject and object rules is crucial for a sustainable development of the economy. Conclusively it is of utmost importance which hierarchical level of order is affected and which level is can get addressed in a certain class of model. The hierarchical order of rules is given by Dopfer and Potts (2008: 9) as shown in Table 2.

This framework offers an analytical interpretation of economic change on several layers, articulating distinct categories of change. Economic evolution is

basically shaped by coordination and change of 1st order rules, since goods and services are produced along these rules or resources are exploited by these means. Nevertheless evolutionary economics proposes expanding the realm of investigated rules into the dynamics of lower-order constitutive rules as well as higher-order mechanism rules. Insofar we are able to argue that 1st order rules are contingent on changes in lower or higher order. Consequently such a three-order approach allows for a full endogenous analysis of the economic system. The rule taxonomy provides a comprehensive categorisation of what is and what may happen in an economy, but it needs active economic agents, or rule carriers, who transport or even operationalize them, according to Dopfer and Potts (2008). An economic rule is empty and worthless to investigate without specifying its carriers. This notion brings in the population and speciation approach of evolutionary thought, which is open to variety, diversity and heterogeneity of acting carriers. It is worthwhile to note that rules can get operationalized by a multitude of subject and object carriers. Rules can get adopted by human economic agents, but can also be carried by a specific artefact or agency. Then the object transforms generic rule knowledge by its distinct incorporation or internalisation. For instance the authors add that capital stock and physical commodities are economic object carriers. In principle all sorts of carriers use rules to perform transformations and transactions, but for a more detailed explanation of rule carriers compare Dopfer and Potts (2008: p11).

In order to apply this theoretical framework for monetary concerns, we need to discuss the notion of a rule trajectory and of a meso unit. Basically '*A trajectory is the process unit of change,... In evolutionary economics, a trajectory is also a path from one state of order to another, but this process results in generic structural change in the rules, populations and associations that compose the economy.*' Dopfer and Potts (2008: 11). An evolutionary trajectory is composed of a three-phase transitional process:

- Phase 1: Origination of a novel rule*
  - Phase 2: Adoption of that rule into a population of carriers*
  - Phase 3: Retention of that rule in a population of carriers*
- Dopfer and Potts (2008: 12)

Such a trajectory refers to the endogenous change within a business cycle or even a technological cycle. Therefore '*A trajectory is the process by which a novel rule is originated, adopted and retained in a carrier population,...*' Dopfer and Potts (2008: 12). For our concerns we focus on the meso-trajectory as the basic dynamic institutional process of economic evolution. A meso-unit is '*...a population of carriers of a rule and the trajectory or process by which the population emerges as successive adoption of a generic rule.*' Dopfer and Potts (2008: 45) Then the meso unit consists of a generic rule, a population of micro agents and represents the result



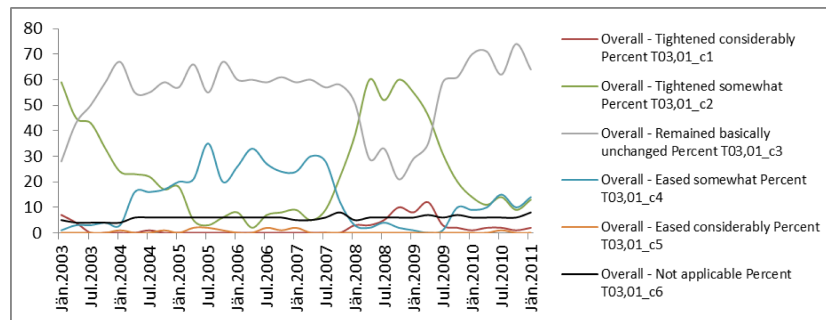
of a corresponding set of micro trajectories. This process is called a meso trajectory. The macroeconomic structure of the economy is composed of the coordination of all meso-units. The meso-level of analysis lies in the heart of institutional economics, where we focus on innovation, maintenance and sustainability of rules. Emergence of a meso-unit means that it can potentially affect the rule structure of the macro economy. For the realm of credit-money, we are concerned with specific monetary rule populations critical to certain path-dependent processes on the macro level, i.e. the investigation of the banking-macro nexus. From a theoretical perspective a monetary meso unit consists of a credit-rule population. The variety within the population of credit-carriers is given by the actual and manifold 1st order operations of micro agents.

In conclusion this paper suggests prototyping a set of generic credit rules in accordance to qualitative empirical studies of bank lending. Hence focus is given to the banking sector as a population of financial intermediary rule carriers. However this first experimental endeavour may easily serve as a schema for interconnections in credit-rule populations. In order to analyse the composition of a credit-rule population we use findings from the Bank Lending Survey (BLS) of the European Central Bank (ECB). The questionnaire gathers periodically qualitative data on the setting of lending standards. Bankers are asked about their reasons for setting a specific lending standard for the next period. The paper suggests using the survey as a categorial proxy for the evolution of credit rules.

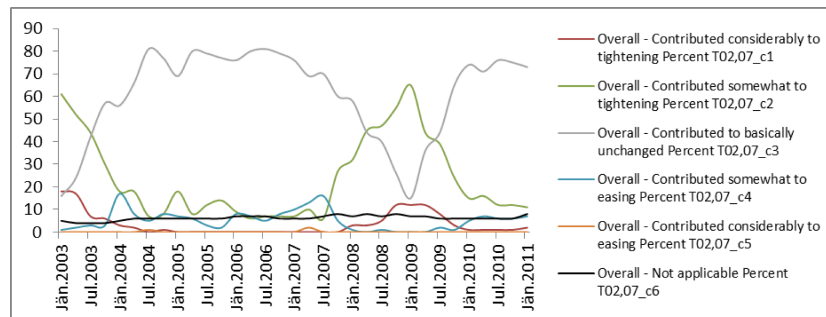
The BLS indicates the important role of the credit channel as an impact stream for monetary policy. Otherwise the BLS also shows that the credit channel delivers new insights into the complex multilateral relations of lending, borrowing and monetary policy. The BLS was launched 2003 by the ECB. It encompasses a questionnaire on bank loan supply and demand within the Euro area. About 90 to 110 banks respond on the survey each quarter, according to de Bondt et al. (2010). The BLS is a qualitative survey and documents changes and expectations in a bank's standard setting for credit tightening and easing from one quarter to the next. The questions do have five possible choices for the setting of a credit standard: (1) tightened considerably, (2) tightened somewhat, (3) remained basically unchanged, (4) eased somewhat and (5) eased considerably. Exemplary illustrations of the questionnaire are given in Figure 1 and Figure 2, data acquired from European Central Bank (<http://www.ecb.int/stats/money/surveys/lend/html/index.en.html>).

Figure 1 indicates changes in the lending standard in dependence on the bank's margin on average loans. Otherwise Figure 2 shows the bank's reaction on changes in the expectations on general economic activity. We can identify upturns in tightening even before the crisis started in September 2008. Hence the banks have reacted even before the general outbreak

We are able to gather more explicit knowledge on the strategic behaviour of banks in certain situations by analysing the BLS, which is of great importance



**Figure 1:** Lending standard setting with regards to bank's margin on average loans



**Figure 2:** Credit reactions with regards to expectations in general economic activity

to anticipate reactions on the interbank market for instance. Banking represents still a black box to economists today; insofar the BLS may serve as a template for modelling and crafting analytical vehicles of credit-rules, like rules of thumb for instance for bottom-up models in the Euroarea. The BLS shows the variety of potential credit reactions, which the banks are anticipating. Again from an analytical perspective, we are able to investigate the significance and correlation of different signalling systems for credit operations between banks, their customers and among them. Thus the BLS can be regarded as a proxy transcript for individual and social learning mechanisms of credit rules. However, the BLS deals with qualitative and foremost anonymous data, which means in particular that the sources do not have any incentive to deliver accurate and reliable responses, which serves as the major critique from monetary economists. General concerns and theoretical foundations of the BLS are provided by Berg et al. (2005). The authors also emphasise the important empirical nexus between monetary transmission, credit and business cycles, highlighting the interconnectedness within monetary transmission. Lending cycles occur due to different activations and rhythms of credit-rule domains; Berg et al. (2005) argue that these cycles serve as proxies for business cycles. Therefore the analysis of credit rules shades more light on the versatile structure of credit expansion and contraction in banks, households,

SME and large enterprises. Furthermore the authors also highlight the potential gains from this subjective study of credit standards. ECB studies such as Berg et al. (2005), Maddaloni and Peydró (2010) or de Bondt et al. (2010) serve as first reference points for such an empirical endeavour. The BLS concentrates especially on demand and supply of bank loans for enterprises and households. De Bondt et al. (2010: 8) further argue that '*...cycles in bank lending standards are important in explaining aggregate economic activity.*' In particular the authors conclude that expected net tightening of credit standards leads loan growth to enterprises by four quarters and to households by one quarter on average. These and other significant systemic characteristics on the credit system can be further re-evaluated and incorporated into a bank lending rule taxonomy. The rule taxonomy shall provide a systemic prototype for agent-based macroeconomic models of the banking-macro nexus. Credit demand and supply raises a complex network of rule-makers and rule-users in a non-exclusive way, following the taxonomy of Dopfer (2004).

The significant message for models is to leave sequentially the realm of technical rules in order to bring in cognitive, behavioural and social aspects for monetary analysis. The dimension of technical rules is therefore regarded within a greater ensemble of rules. Concerning the taxonomy of Dopfer and Potts (2008), shown in Table 1, the BLS generally looks into the domain of social and behavioural rules, which cover the organisation of the credit market as well as the diffusion of financial norms and competitive pressures. De Bondt et al. (2010: 20) oppose the versatile factors of the BLS for changes of a credit standard for rule-makers and rule-users, within the credit categories of corporate lending (group 1), SME, short and long term rates (group 2), loans for house purchase, consumer credit and other loans to households (group 3). For credit supply, the BLS shows that group 1 is primarily affected by cost of funds balance sheet constraints, group 2 by competitive pressures and risk perception and group 3 by all three of them. For credit demand, group 1 is affected by financing needs and group 2 is affected by alternative sources of finance and group 3 by all two of them. Maddaloni and Peydró (2010) look into the empirical relation between central bank policies (final sets of technical rules) on the credit setting from the BLS perspective, especially into the different effects of lending for short-term and long-term rates. Insofar we sketch a first proxy for a monetary rule taxonomy for factors operating on the tightening and easing of credit standards in table 3. The different rule factors are operant for either rule-makers or rule-users and operant on the credit rules from tightening to easing of credit from the BLS spectrum; i.e. money contraction and expansion.

Tightening and expanding credit is then considered in subject rules of bounded rationality (Simon 1991) and nested cognition (Kawamura 2009), consider also Noteboom (2009) for the cognitive aspects of the investment decision of the firm.

**Table 3:** An exemplary bank lending rule taxonomy

Subject Rules		Object Rules	
<i>cognitive</i>	<i>behavioural</i>	<i>social</i>	<i>technical</i>
e.g. risk perception	e.g. financing needs	e.g. competitive pressure, alternative financing	e.g. short- and long-term interest rates, cost of funds, balance sheet constrain

These organizational aspects of bank lending highlight the ontological category of a rule from a computational perspective then, whereas the specific structure of the bank’s network (Schweitzer et al. 2009 and de Masi et al. 2011) covers the social object dimension with regards to the evolving environment of credit-rules. It is suggested to identify factors and rules which are operant on several levels of perception, for example risk perception will appear in the realm of cognitive rules as well as in the realm of social rules, since risk is a matter of individual assessment, social and cultural transmission. Furthermore computational bottom-up simulation provides tools to develop algorithms to integrate downward and upward causation in particular between behavioural and social credit rules. A proper evolutionary theory of credit-rules looks into the co-evolution of these rule-sets. Such an empirical investigation may guide the future architecture for a new family of evolutionary monetary economic models. A credit-focused rule-based approach is conceived as a proper methodological standardization for bottom-up foundations within further models of the banking-macro nexus.

## 5 Outline

Many aspects of current top-down and bottom-up approaches within the realm of monetary economics are not investigated substantially in this paper, but that is for good reason. Specific methods, techniques and workarounds for models, simulations and estimations are discussed extensively in economic theory. However novel conceptions, ideas or schemata are often left out of the discussion. This notion represents the major focus of the paper, providing a common thread for thinking about monetary economics from a bottom-up and therefore evolutionary perspective. Top-down and bottom-up approaches in economic modelling have distinct agendas, which are going beyond the mere technical aspects. Their agendas are related to specific heuristics of how the economy is working and how we should conduct monetary policy. Insofar they are primarily related to certain trends in the history of economic thought, broadly the *Quantity Theory of Money* or the

*Cambridge Approach.* It is either the focus on money supply and the price level or the focus on money demand and motives or propensities of economic agents. Obviously a credit-centred rule-based approach suggests further integration of the Schumpeterian aspect of credit-driven innovation with the Post-Keynesian framework, as developed by Godley and Lavoie (2012) for instance. Schumpeter never published a concise theory of money and finance comparable to the Keynesian approach. Minsky - as a graduate student of Schumpeter - took the opportunity to bring these grand scholars closer together along the business-cycle aspects of investment and credit in the Keynesian '*General Theory*' and the Schumpeterian '*Theory of Economic Development*', compare Knell (2012). Perhaps Minsky's (1992) '*Financial Instability Hypothesis*' was the first announcement to study the systemic problems within the banking-macro nexus within such frames, which represents a core issue for future enhancements in monetary economics. However Minsky's legacy remains still in the realm of classical mechanics, although he emphasised vehemently the inherent disequilibrating forces of the capitalist economy in Schumpeterian tradition. As elaborated in this paper, the standard neoclassical methods of analysis - with their origin in classical mechanics - are not sufficient to grasp the versatile properties of endogenous change in complex economic systems. In contrast the evolutionary approach hints exactly at this aspect. Today we are not obliged to discuss the potential of computational methods using evolutionary methods in an appropriate bottom-up way for economic analysis. Many others have shown that the *sciences of the artificial* are prosperous for such adventures, just to mention Simon (1991, 1996) or more recently Beinhocker (2007, 2011). In particular, formal computational methods can synthesize insights from the technical and instrumental knowledge of monetary transmission - object rules - with heterogeneity and diversity in cognition and behaviour. They are able to capture the diffusion of rules along social learning in credit relations - focusing on the feedbacks between subject and object rules. These notions highlight the characteristics of proper bottom-up foundations. Insofar the category of a *rule* enables also an appropriate scientific medium in order to craft more realistic models of monetary transmission. Again we may refer to Herbert Simon when discussing how rules and heuristics serve as an empirical category for novel microfoundations, compare Simon (1997). In this respect there is no doubt that the evolutionary economic agenda - with its emphasis on synthesizing empirical studies and formal modelling along the institutional approach - may contribute substantially to the realm of monetary economics.

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