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**CREDIT FRICTIONS, FINANCIAL LEVERAGE  
AND ASSETS PRICES: NONLINEAR DYNAMIC INTERRELATIONS**

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*The main purpose of the paper is to develop the ideas of procyclical leverage behavior and reverse of the normal demand for assets emphasized by Adrian and Shin (2008). We analyze nonlinear interrelations between credit frictions, banks' balance sheets, leverage, and assets prices in the structure of reinforcing and balancing feedback loops. Also we develop an Adrian and Shin's interesting hypothesis of about fundamental changes of the microeconomic foundations of demand curve in conditions of lending expanding.*

**Keywords:** *credit frictions, financial leverage, assets prices, reinforcing and balancing feedback loop.*

**Introduction.** The ongoing global financial and economic crisis is often referred to as overwhelming credit friction, which led to an economic recession. Therefore, understanding the deep connections between credit frictions, leverage cycles, asset markets and economic activity becomes vitally important for the development of adequate measures of macroeconomic regulation.

**Analysis of recent researches and publications.** In response to this request, there has been intensive developing of DGE-models with taking into account the financial frictions and assets prices. The methodological basis of DGE-models is the theory of general equilibrium, the foundations of which are developed in the works of Leon Walras K. Arrow and G. Debreu. The basic idea of this theory is that the development of the economy as a whole system can be understood from the analysis of the equilibrium state.

**Previously unsettled problem constituent.** Economy achieves this state as a result of market agents' optimizing behavior. As known, currently the Dynamic General Equilibrium models can be divided into the three groups: General Stochastic Equilibrium Models - DSGE, computable general equilibrium models – CGE, and

applied general equilibrium models – AGE. Also there are Agent-based Computational economics – ACE and Agent-Based Models – ABM.

DSGE-models are the most popular. The main idea of such type models is the modeling of economic agents' rational choice and the integration of the results of this choice into equilibrium framework. Macroeconomic movement toward equilibrium is determined by the microeconomic foundations, that is, by independent choice of many economic agents. Each of these agents maximizes himself utility for a given budget constraint. Stochasticity is introduced into the model through a probability distribution of income, which is assumed to be known to market agents.

Even before the global crisis, there were some modifications of DSGE-models with analysis of the financial processes' impact on real business - cycles. There are Ben S. Bernanke, Mark Gertler and Simon Gilchrist "The Financial Accelerator in a Quantitative Business Cycle Framework" (1999), Nobuhiro Kiyotaki, John Moore "Credit Cycles" (1997). After 2008 it has begun a new round of intensive evolution in the field of DSGE-modeling. There are a lot of models DSGE, the structure of which are expressly incorporated banking and credit processes. They include, for example, models of Gertler and Karadi (2010), Gertler and Kiyotaki (2010), Gerali, Neri, Sessa and Signoretto (2010), Dib (2010), Ragna Alstadheim (2011), Ansgar Rannenberg (2012), Tobias Adrian and Nina Boyarchenko (2013), Tobias Adrian and Hyun Song Shin (2013). In these models there is in-depth analysis of the different channels of financial frictions, credit cycles, bank capital, and leverage influence on the assets prices and economic fluctuations.

**Main purpose of the article.** The main purpose of my paper is to develop the ideas of procyclical leverage behavior and reverse of the normal demand for assets emphasized by Adrian and Shin (2008). I analyze nonlinear interrelations between credit frictions, banks' balance sheets, leverage, and assets prices in the structure of reinforcing and balancing feedback loops. Also I develop an interesting hypothesis of Adrian and Shin about fundamental changes of the microeconomic foundations of demand curve in conditions of lending expanding.

**Results and discussions.** Systemic structure of interrelated feedback loops between leverage, credit frictions and assets prices. There are a few misconceptions of common sense, which clearly manifest themselves when they begin to be applied to the understanding of complex economic systems. These misconceptions relate to the understanding of nature of the cause-effect relationships. In particular, in the framework of common sense is considered that: a cause and an effect can be separated, and the effect comes after the cause; over time and space the effect comes after the cause at once; the effect is proportional in relation to the cause.

However, the complex dynamic systems as the economy have such level of complexity that we cannot comprehend deeply their interrelations if our mind stays within the framework of these misconceptions and stereotypes.

Responses that seem obvious from the standpoint of common sense in some economic conditions can become drugs that are worse than the disease. To understand the deep roots and fundamental causes of disease and to address them we need a systemic view or metaposition that leading out beyond the usual misconceptions and enables to see the system as a holistic process.

For this we have to think not in the linear structure of mind within the stereotype “cause-effect”. We need to use contour thinking in that we see causes and effects in their nonlinear interrelations and as inseparable things in the process of mutual influence on each other. Contour thinking provides a holistic understanding of the fact that all parts of the system are connected, directly or indirectly.

Therefore a change in one part generates a wave of changes that reach all the other parts. Eventually, these waves reach the part of system at which the change has begun. Thus, it is returned to the starting point in a modified form. Therefore this is not a one way street "cause and effect", but it is the feedback loop, in which the cause and effect are two sides of a whole process.

It is known, there are two types of the feedback loops: positive (reinforcing) feedback and negative (balancing) feedback. In essence, they are blocks of the all systems. As the economy has high level of dynamic complexity the several interrelated different type feedback loops can be activated at the same time.

All the variety of financial and economic phenomena is the result of the interactions of complex combinations of reinforcing and balancing feedback loops. There are several common patterns in dynamics of complex systems that are called by *systemic archetypes*. The systemic archetype "growth limits" is the one of the most interesting for our analysis.

I developed the structure of feedbacks that emphasized by Adrian and Shin in more details (Figure 1). The increase of leverage, balance sheets expanding, lending growth, and rising of assets prices interrelate with each other within the dynamic process of reinforcement feedback loops. This process leads to increase of banking system vulnerability and growth of systemic risks. Systemic risks' increasing characterizes accumulation of structural deformations in the banking system, which are not measured or monitored by regulators. The minimum level of systemic risk is a public good for the economy and society as a whole.

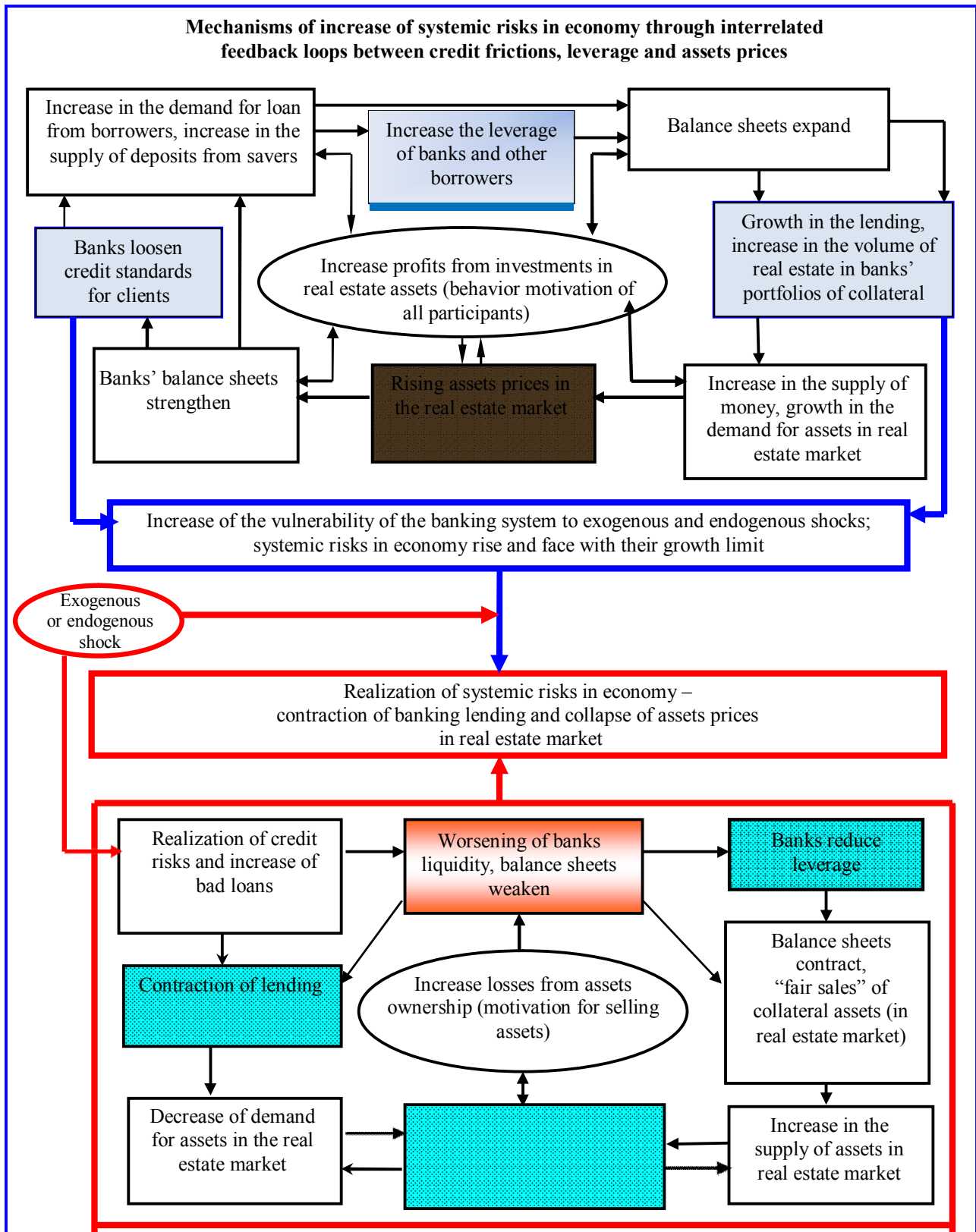


Figure 1. Mechanisms of increase of systemic risks in economy through interrelated feedback loops between credit frictions, leverage and assets prices

Growth of systemic risk results in reducing of this public good. There are some limits to the growth of systemic risk that is its critical level after that the system comes into the collapse station. The attainment of this level stops the credit expansion, the asset prices' rising and switches the system dynamics on a downward spiral in accordance with the negative feedback loops (the lower part of Fig. 1).

We understand this as the crisis, because it is associated with painful credit frictions, deleveraging, falling asset prices and economic recession. But from the point of view of systemic dynamics this is a natural response of system on excessive structural deformation. The correct crisis-proof strategy must be built on the basis of deep understanding the ways for rearranging systemic structure with taking into account the interrelated reinforcing and balancing feedback loops.

Appendix 1. An optimal level of leverage

$$F = \frac{\pi}{W} = \frac{(r - i_d L)(1 - n)}{W} = \frac{(\gamma i_a (W + L) - i_d L)}{W} (1 - n) \quad (1)$$

$$F(l) = (1 - n)\gamma i_a + (1 - n)(\gamma i_a - i_d)l \quad (2)$$

$$i_d = i_0 + \alpha l \quad (3)$$

$$F(l) = (1 - n)[\gamma i_a + (\gamma i_a - i_0)l - \alpha l^2] \quad (4)$$

$$\frac{dF(l)}{dl} = (1 - n)(\gamma i_a - i_0 - 2\alpha l) \quad (5)$$

$$l_{opt} = \arg \max(F(l)) = \frac{\gamma i_a - i_0}{2\alpha} \quad (6)$$

The second idea that we consider is the reverse of the normal demand for assets in conditions of excessive leverage and lending expanding. Let's consider a classical model of demand and supply with accounting of amount of loans that increases demand for assets:

$$S(p) = c + dp \quad (7)$$

$$D(p) = a - bp + L(p) = a + (zc - b)p + zdp^2, \quad (8)$$

Where  $L(p) = zS(p)p = z(c + dp)p = zcp + zdp^2 \quad (9)$

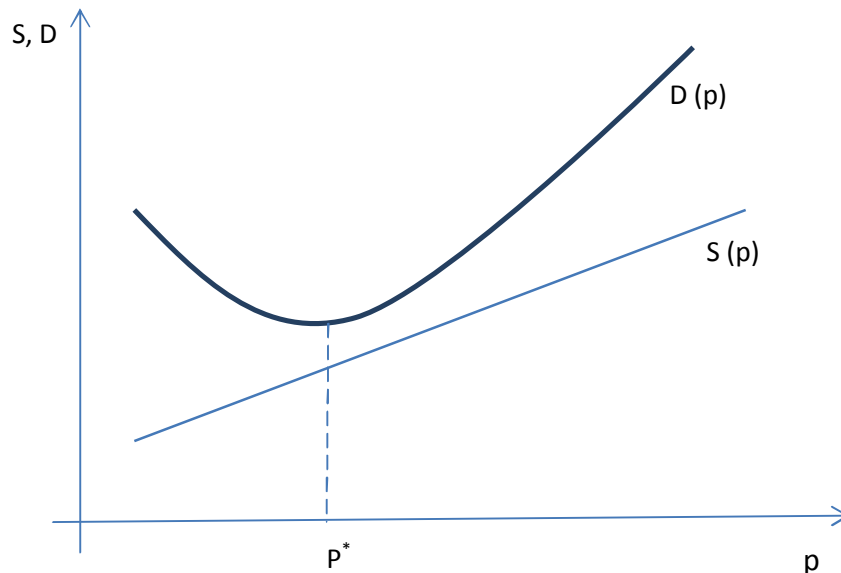


Figure 2. Reversal of the normal demand curve

$$p^* = \frac{1}{2d} \left( \frac{b}{z} - c \right)$$

$$\frac{dp}{dt} = h(D(p) - S(p)) = h[(a - c) + (zc - b - d)p + zdp^2] \quad (10)$$

**Conclusions and further researches directions.** We see that dynamics of assets price is described by differential equation that can use to research more detail the phenomenon of demand curve reverse in the situation of lending expanding.

We analyze nonlinear interrelations between credit frictions, banks' balance sheets, leverage, and assets prices in the structure of reinforcing and balancing feedback loops. Also we develop an Adrian and Shin's interesting hypothesis of about fundamental changes of the microeconomic foundations of demand curve in conditions of lending expanding.

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**КРЕДИТНІ ФРІКЦІЇ, ФІНАНСОВИЙ ЛЕВЕРИДЖ ТА ЦІНА АКТИВІВ:  
НЕЛІНІЙНІ ДИНАМІЧНІ УМОВИ**

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Головна мета статті – це розвиток ідей проциклічної поведінки впливу на зміну нормального попиту на активи, відзначені Адріаном і Шином (2008). Проаналізовано нелінійні відношення між кредитними фрікціями, балансами підприємства банків, впливом цінових умов в структурі зміцнення і балансування петлі зворотного зв'язку. Також ми продовжуємо розвивати гіпотезу Адріана і Шина щодо корінних змін мікроекономічної основи кривої попиту в умовах розширеного кредитування.

**Ключові слова:** кредитні фрікції, фінансовий леверидж, ціна активів, укріплення і балансування петлі оборотного зв'язку.

**КРЕДИТНЫЕ ФРИКЦИИ, ФИНАНСОВЫЙ РЫЧАГ,  
И ЦЕНА АКТИВОВ: НЕЛИНЕЙНЫЕ ДИНАМИЧЕСКИЕ УСЛОВИЯ**

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Главная цель статьи – это развитие идей проциклического поведения влияния на изменение нормального спроса на активы, отмечены Адріаном и Шином (2008). Мы анализируем нелинейные взаимоотношения между кредитными фрикциями, балансами предприятия банков, влиянием ценовых условий в структуре укрепления и балансировки петли обратной связи. Также мы продолжаем развивать гипотезу Адріана и Шина относительно коренных изменений микроэкономической основы кривой спроса в условиях расширенного кредитования.

**Ключевые слова:** кредитные фрикции, финансовый рычаг, цена активов, укрепления и балансировки петли обратной связи.