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Volume 6

ACTA VŠFS

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Ekonomické studie a analýzy

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STATĚ

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EDITORIAL

ARTICLES / STATĚ

FROM NEW ECONOMIC LITERATURE / Z NOVÉ EKONOMICKÉ LITERATURY

Current Problems of Economic Theory and Economic Policy

Aktuální problémy ekonomické teorie a hospodářské politiky

BOHUSLAVA ŠENKÝŘOVÁ

Dear Readers,

The first this year's issue of the scientific journal of the University of Finance and Administration brings four essays to you. The first two essays are the award winning works of the Prof. František Vencovský Prize held by the University of Finance and Administration every two years. The information of the contest and the subsequent conference held in 2011 was brought to you in the previous issue of ACTA VŠFS.

The essay of Filip Matějka deals with "Information Frictions and Monetary Policy". Here, the rational inattention theory serves as the basis for analysis. Despite the fact that economic subjects are overwhelmed by large volumes of information; they do not pay much attention to each of the information received. Partial filtering of information may be economically effective. By this, the efficiency of monetary policy is determined. This path of research is further developed by Filip Matějka in cooperation with Christopher Sims, the last year holder of the Nobel Prize in Economic Sciences.

The essay of Soňa Benecká "International Reserves and the Financial Crisis: Monetary Policy Matters" shows that international and economic openness of a given economy and exchange rate arrangement are key factors determining the amount of reserves. Other factors are credibility of the central bank and stability of the financial sector in a given country. International reserves continue to have importance for prevention and alleviation of the impact of currency crises.

Another essay of Miroslav Hrnčíř "Monetary Policy and Financial Stability" poses a question of whether or not the price stability and financial stability remain to be separate objectives with different policies and instruments of the central bank. Up to the present, the monetary policy has provided for price stability and responded to financial assets market bubbles only retrospectively. The financial crisis shifted this view in a sense that the financial stability has a growing importance for determining the monetary policy.

The final essay of Katarína Hilovská and Peter Koncz revives a purely economic issue of the previous essays by giving an unconventional view on financial markets. It concerns the "Application of Artificial Intelligence and Data Mining Techniques to Financial Markets". The article seeks mechanisms for adaptation in ever changing environment including an ability to refuse non-probable solutions. In the essay, genetic algorithms for problem optimization, both for time optimization of the stock market and portfolio creation, are used.

The section "From New Economic Literature" includes reviews of two publications. The first deals with the new book on management and controlling of small and medium enterprises. The second review brings a critical view on the book concerning the current development and future of the single European currency – the euro.

I believe that this issue of ACTA VŠFS will bring you new and inspirational pieces of knowledge and that you will continue to remain our loyal readers.

Dr. Bohuslava Šenkýřová
Editor in Chief
Rector, University of Finance and Administration

Vážení čtenáři,

první letošní číslo vědeckého časopisu Vysoké školy finanční a správní vám přináší čtyři stati. První dvě patří mezi vítězné práce soutěže o Cenu prof. Františka Vencovského, kterou pořádá Vysoká škola finanční a správní ve dvouletých intervalech. O průběhu této soutěže a o navazující konferenci v roce 2011 jsme vás informovali v předchozím čísle ACTA VŠFS.

Stať Filipa Matějky se zabývá *Informačními frikcemi a měnovou politikou*. Základem analýzy je teorie racionální nepozornosti. Ekonomické subjekty jsou zavaleny množstvím informací, ne všem však věnují pozornost. Částečné filtrování informací může být ekonomicky efektivní. To determinuje také účinnost měnové politiky. Tento směr výzkumu rozvíjí Filip Matějka ve spolupráci s loňským nositelem Nobelovy ceny za ekonomii Christopherem Simsem.

Stať Soni Benecké *Devizové rezervy a finanční krize: úloha měnové politiky* ukazuje, že klíčovou okolností, určující výši rezerv, je zahraničně ekonomická otevřenost dané ekonomiky a režim měnového kurzu. Dalšími faktory jsou kredibilita centrální banky a stabilita finančního sektoru dané země. Mezinárodní rezervy stále zůstávají důležité pro prevenci a zmírnění následků měnových krizí.

Další stať Miroslava Hrnčíře *Měnová politika a finanční stabilita* si klade otázku, zda cenová stabilita a finanční stabilita zůstávají oddělenými cíli s odlišnými politikami a nástroji centrální banky. Měnová politika doposud zajišťovala cenovou stabilitu a na bubliny na trzích finančních aktiv reagovala pouze následně. Finanční krize tento pohled změnila v tom smyslu, že roste váha finanční stability pro nastavení měnové politiky.

Závěrečná stať Kataríny Hiľovské a Petera Koncze oživuje čistě ekonomickou problematiku předchozích statí netradičním pohledem na finanční trhy. Jde o *Využití technik umělé inteligence a dolování dat na finančních trzích*. Článek hledá mechanismy adaptace v měnícím se prostředí včetně schopností odmítnout nepravděpodobná řešení. Jsou v něm použity genetické algoritmy pro optimalizační problémy, a to pro časovou optimalizaci akciového trhu a pro tvorbu portfolia.

V rubrice *Z nové ekonomické literatury* si můžete přečíst recenze dvou publikací. První z nich je věnována nové knize o managementu a controllingu malých a středních firem. Druhá recenze přináší kritický pohled na knihu o dosavadním vývoji a budoucnosti jednotné evropské měny eura.

Věřím, že toto číslo ACTA VŠFS vám přinese nové a inspirativní poznatky a zůstanete nadále našimi čtenářskými příznivci.

Dr. Bohuslava Šenkýřová
šéfredaktorka
rektorka Vysoké školy finanční a správní

Information Frictions and Monetary Policy
Informační frikce a měnová politika

FILIP MATĚJKA
CERGE-EI[1]

Abstract
Real effects of monetary policy depend crucially on the nature of nominal rigidities. These rigidities are typically modelled as sticky prices with explicit assumptions on either frequency of price adjustments (Calvo-style models) or on the cost of adjustment (menu cost models). However, recent empirical work cast doubts on these workhorses of standard New Keynesian models. This paper discusses another approach to nominal frictions, which is based on the assumption that agents face difficulties processing information. If, for instance, price-setters learn about an interest rate cut with a delay, then their price also responds sluggishly. This rigidity implies positive temporary effects on output and unemployment. We conclude that models based on information frictions can account for several empirical facts other model have difficulties reconciling with, such as sluggish responses of both real and nominal variables, frequent but staggered price changes or a steeper Phillips curve and higher profit losses with more volatile environments. Moreover, rational inattention provides important implications for policy.

Keywords
nominal rigidity, information frictions, monetary economics

JEL Codes
D21, D83, E31, E52

Introduction

Models that are used to assess the optimal monetary policy are typically built around certain assumptions about the nature of nominal rigidities. Different assumptions generate different results and thus also potentially drastically different prescriptions for optimal policies. This paper argues that there are several good reasons to built such models around information frictions in the form of agents' inattention. We also discuss the basic policy implications of such models.

The most common nominal friction are driven by explicit assumptions of price stickiness using Calvo-style adjustments or some form of menu cost. Bils and Klenow (2002), however, cast doubts on these assumptions by finding that individual prices do not stay fixed for long periods of time. When the models are calibrated to fit the observed frequency of price changes, then the implied real effects of nominal shocks are very small. Bils and Klenow (2002) thus motivated macroeconomists to focus on prices at the micro level, too.

1 *A joint workplace of the Center for Economic Research and Graduate Education, Charles University, and the Economics Institute of the Academy of Sciences of the Czech Republic.*

An alternative line of the modeling of nominal rigidities is based on the assumption that agents cannot attend to all the available information about new shocks. This idea was proposed by Christopher Sims, formulated in a framework called "rational inattention"(Sims, 1998, 2003). Simply put: if price-setters do not pay attention to new shocks, they can not respond to them and their prices thus stay rigid.

Mackowiak and Wiederholt (2007) showed that rational inattention can generate real effects of monetary policy. While nominal aggregates, e.g. the price level, respond to monetary shocks with a delay, individual prices change all the time, which is, however, counterfactual. This problem was resolved in Matějka and Sims (2010) and Matějka (2010a). These papers expand the approach of Mackowiak and Wiederholt by not only modeling of how much information price-setters process, but also what they process information about.

Rationally inattentive agents in these models actively seek those pieces of information that carry the most value. It turns that the implied price dynamics of such price-setters corresponds very well with the data: prices stay rigid for a while, but not for too long, and aggregates respond with a delay to aggregate shocks, which generates real effects of monetary policy.

Rational inattention describes the humans' limited ability to process information. Most of policy-related information is accessible with very little cost. We could, in principle, find out what the current federal funds rate is at every single moment, we could find out the last reported unemployment rate or the GDP growth. These pieces of informational are easily attainable at most major business magazines or on the internet. Few of us, however, do so very frequently.

Intuitively, the less the information is important for one's business the less likely it is that the individual bothers to devote time to acquire it. For example, most bankers know the current level of the funds rate at least approximately, lower number of academics know about it, and some local businessmen would not even know whether the rate moved in the last two years at all.

Although the papers above show that rational inattention can account for realistic dynamics of prices, it has been criticized on the grounds that the required amount of information price-setters process is too low. This criticism was addressed in Matějka (2010b), where the author shows that inattentiveness on the consumers' side suffices to generate rigidity of prices. The intuition for this result goes as follows: consumers who dislike processing information prefer stable prices. If prices are not stable, then the consumers have to pay extra cost finding out what the current prices are. Price-setters consider effects of their dynamic pricing strategies and choose to keep their prices relatively stable, in order to attract more consumers and induce higher sales.

This paper expands on Matějka (2010a) and Matějka (2010b). It does so by studying dynamic effects of aggregate shocks and by exploring implications of inattention in various environments. We find that, for instance, that nominal rigidity is weaker in more competitive industries or under more volatile aggregate conditions. This is particularly important at times of crises, such as in 2008 and 2009, when the resulting responses to monetary

shocks can be quite different from those during normal times. When we account for endogenous choice of attention level, prices are more flexible during times of high volatility, since agents choose to process more information. This implies that monetary policy has little real effects.

These findings have numerous implications for policy, which we briefly discuss in the final section.

1 Nominal Rigidity

Rational inattention allows for endogenizing what pieces of information to process. Decisions of rationally inattentive agents are not a priori biased by a specific form of any mechanism by which they process information. All pieces of information are freely available and agents can select which of them to process. It sounds intuitive that agents want to be more aware of variables that are important to them, such as income to a household or input cost to a producer. Or for instance, a price-setter in a highly competitive industry could devote more attention to prices of his competitors than if the competition were low.

Agents not only differentiate between variables (e.g. attention to inflation or GDP, etc.), they can also pay different amounts of attention to different levels of the same variable and also different amounts of attention to the same variable under different conditions. If an agent uses a credit card, he may not pay full attention to the level of his debt and may consume some typical amount. However, once his debt approaches the credit limit, he needs to be more aware of exactly how much more he can charge on the card. Furthermore, economic actors do not need to pay much attention to slowly moving variables such as to most of the aggregate indices. The more predictable variables are, the less information needs to be processed about them. In case volatility of these variables increases, agents might check on their current values more often, to keep being informed reasonably precisely.

This section focuses on nominal rigidity. It first presents two examples of static problems studying effects of competition on what sources trigger swifter responses, on the informational content of prices and on the rate of responses. Next, we present a dynamic model studying trade-offs between attention devoted to stable aggregate variable, such as a price level, and volatile input cost, such as commodity price. We also discuss implications of varied levels of the respective volatilities, which provides us with intuition about monetary policy effects on different industries. The section is concluded with a dynamic model of an inattentive consumer.

1.1 Allocation across Variables: When Sellers Respond to Cost Shocks and When to Changes of Competitor's Prices

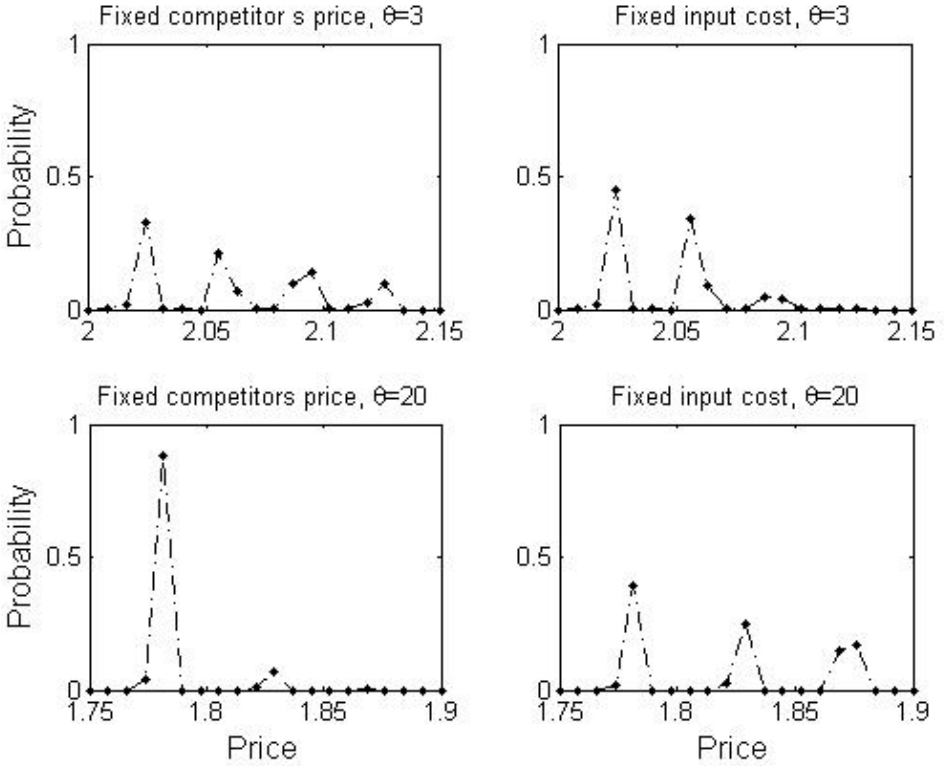
Let us study a model of a seller allocating his attention between unit input cost of his product and competitor's price. The seller faces a consumer, who has nominal endowment e = 1, she desires to consume two different products, whose prices are p1 and p2, to maximize the CES utility aggregate

$$U = \left(c_1^{r} + c_2^{r} \right)^{1/r}, \tag{1}$$

subject to a budget constraint: $c_1 p_1 + c_2 p_2 \le e$. $\theta = 1/(1 - r)$ is the elasticity of substitution, $\theta \in (1, \infty)$. The consumer is assumed to have unlimited abilities to process information about the two prices, her demand for the product 1 is:

$$c_1(p_1, p_2) = \frac{1}{p_2 \left[p_1/p_2 + (p_1/p_2)^{\theta} \right]}. \tag{2}$$

Figure 1: Distribution of price



A seller of the product 1 maximizes the expectation of his profit,

$$\Pi(p_1, p_2, \mu) = c_1(p_1, p_2)(p_1 - \mu). \tag{3}$$

He first processes information about the competitor's price, p_2, and his unit input cost, μ. Finally, he selects his own price, p_1. For the purposes of this example, we study a partial equilibrium only, taking distributions of p_2 and μ as given. Let μ be uniformly distributed in (1, 1.1) and p_2 uniformly in (2, 2.2). We need to solve (11) – (15) in Appendix. A source variable is a vector (p_2, μ), while the response variable is the seller's price, p_1.

Figure 1 summarizes responsiveness of the seller's price to unit input cost and to competitor's price, both in less and more competitive markets. When θ = 3, i.e. goods are relatively poor substitutes, price p_1 varies relatively more with changes in input cost than with shocks to competitor's price. A distribution of prices for flexible input cost and a fixed competitors price (upper left graph) is more spread out than when input cost is fixed and competitor's price is varied (upper right).

On the other hand, when θ = 20, i.e. goods are much better substitutes - the market is more competitive, price p1 responds more or less to changes in the competitors price only.

When θ = 3, the seller possesses tighter knowledge about μ, while if θ = 20, then almost all information capacity is spent on tracking p2.

1.2 Choice of Information Amount: Competitive Industries Generate Flexible Prices

In the first example, we addressed the question of attention distribution, while the total amount of information was kept fixed. However, we could assume that agents also choose how much information to process. Let RIκ stand for the original model of a rationally inattentive seller with a fixed information and RIλ denote a model with fixed unit cost of information. In RIλ, sellers find the processing somewhat unpleasant and process more information only as long as its cost is lower than the marginal benefits from it. Agents maximize expectation of profit,

$$\tilde{\Pi}(\mu,\ p,\kappa) = p^{-\theta}(p - \mu) - \lambda\kappa, \tag{4}$$

where λ is the cost of processing 1 bit of information about μ, and κ is the amount of information the price-setter chooses to process.

It turns out that sellers in highly competitive industries decide to process more information about input cost, because their profits are more sensitive to suboptimal pricing. We compare sellers of the same size that face demands with different elasticities. Elasticity of demand is a measure of the degree of competition in an industry. Magnitude of demand (size of the firm) determines shadow price of information and thus influences choices of how much information to process. Larger sellers decide to process more information. Normalizing the magnitude thus allows for unbiased comparisons of information choices across markets.

The seller maximizes

$$\tilde{\Pi}(\mu,\ p,\kappa) = \left(\frac{p}{p_{opt}(\mu_0)}\right)^{-\theta}(p - \mu) - \lambda\kappa. \tag{5}$$

Figure 2 shows computational results of the dependence of a selected κ on demand elasticity, θ, for unit input cost uniformly distributed in (0.8, 1.2) and λ = 0.5 · 10−3 . Optimal information capacity is an increasing function of θ.

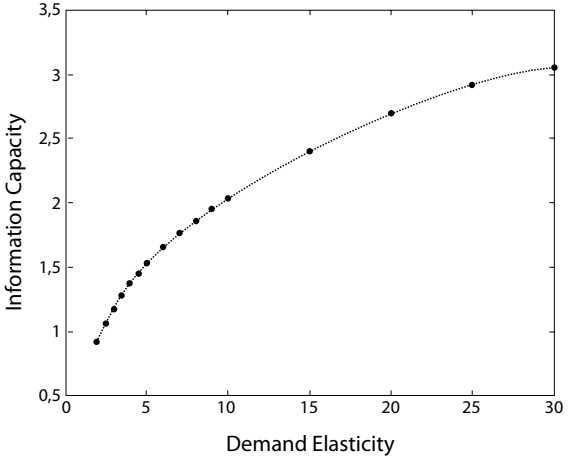
To justify this result analytically, we can apply the approach developed in Matějka (2010a). The corresponding approximate loss factor at μ_0 is

$$L(\mu_0, \theta) = \frac{\theta}{2\mu_0}. \tag{6}$$

It is a decreasing function of θ. The higher elasticity of demand, e.g. degree of competition, the bigger the loss from imperfect information about the input cost. Given the same levels of input cost and the same firms' sizes, agents process more information in more competitive industries. Moreover, since the price is tracked more closely, more information leads to more flexible prices.

Mutual information between two random variables is a measure of how much about one variable can be inferred from learning about the other. Even for an outside observer, the seller's higher information capacity implies that prices carry more information about the input cost.

Figure 2: Comparisons across industries



This finding relates to Hayek's famous defense of free markets, Hayek (1945), specifically on the grounds of markets' ability to convey information. Rational inattention implies that the more competitive a market is the more information can be extracted by observing its prices.

1.3 Dynamics and Aggregate Trade-Offs

In this section, we will use a model introduced in Matějka (2010a). It shows that unlike sticky-price models, rational inattention can generate frequent price changes together with delayed aggregate responses. The model's results agree very well with the empirical findings in Eichenbaum, Jaimovich, and Rebelo (2008).

In the following model, there are two stochastic variables to which the seller responds. Let the unit input cost be composed of two parts: an i.i.d. real unit input cost denoted by

μ and the second one be a serially correlated nominal variable A. μ is supposed to be an idiosyncratic volatile part of the input cost specific to the seller, while A plays the role of a slowly moving aggregate variable, e.g. a price level. The profit function takes the following form.

$$\Pi(A,\mu, p) = p^{-\theta}(p - A\mu). \tag{7}$$

A is a price index shifting the distribution of the nominal input cost Aμ. The aggregate variable takes two different values only and that it is Markov. Let the Markov process be symmetric with a probability of transition to the other state equal to t. A is binary, its distribution is determined by the probability of either one of the two states. Let the state variable be $x = P\,rob(A_L)$, where A_L stands for the lower value of A. The model's equations are formulated in Appendix.

For computations, I used $\kappa = 1$, $\theta = 3$, μ uniformly distributed over (0.8, 1.2), $A_L = 1$, $A_H = 1.1$, $t = 0.002$ and $\beta = 0.9992$. One period is supposed to be one week. $t = 0.002$ implies that the probability of changing a state (a 10% shock to the aggregate variable) at least once during a year is about 10%. The annual discount factor is 0.96.

Figure 3 shows the results of simulations over 120 periods. There is a shock to A in the period denoted as 1, when A switches from A_L to A_H. The top series in the figure presents one realization of a price series and the second one shows a time-series of knowledge about A in the same simulation.

The price setter processes information about Aμ and responds to it, trying to target the optimal price $\theta/(\theta - 1)A\mu$. Although Aμ is distributed over a continuous range in every period, prices again exhibit lots of rigidity of the values as well as in the i.i.d. case. Given prior knowledge about A, together with its true value, the distribution of prices as responses to realizations of μ is discrete. However, when knowledge about A changes, the distribution of prices changes too. For the used values of parameters (κ, t, A_H, etc.), knowledge adjustment is rather abrupt. The second series in Figure 3 shows a knowledge adjustment that is quite typical for all realizations of single simulations with these parameters. What varies from one simulation to another is the period in which the seller finds out that A has probably switched to a new value. The sudden change of knowledge is, however, not inherent to all solutions under rational inattention. The next subsection discusses this point in a little more detail.

The bottom two series in Figure 3 are prices and knowledge averaged over 10 000 runs. The average knowledge about A shifts slowly, while the average price does actually change abruptly in period 1. The variable of interest to the seller is in fact Aμ, not values of A and μ separately. Due to different dynamical properties of A and μ, and a non-uniform prior on Aμ, the agent does not process information exactly about Aμ only. Although, the seller does pay special attention to Aμ, he also refines knowledge about other regions in the whole $A \times \mu$ space. In period one, after a positive shock to A, the seller is likely to find out that the value of Aμ is high and thus the probability that a distribution's top price is realized increases. Due to the prior knowledge that A is probably at the lower state, the agent underestimates the true value of Aμ. Expected price adjusts abruptly, but still less than optimally. Since A stays at the higher level, the agent obtains signals on a high Aμ several

periods in a row and slowly learns that it is not due to a streak of high μ, but rather due to a jump in A. The average price further increases towards the new optimal level. Prices change frequently, but responses to shocks to the aggregate variable are delayed.

The difference between RIκ and RI_{λ} versions of the dynamic model correspond to differences between their static counterparts. Stochastic properties of the variables of interest (μ and A) influence the agent's choice of what pieces of information and potentially how much information to process. Let us vary these properties and study their implications for responses to shocks to the aggregate variable A.

1.3.1 Idiosyncratic Volatility

Thus far, μ was uniformly distributed in (0.8, 1.2). Table 1 summarizes numerical results for RIκ with κ = 1, θ = 3 and t = 0.002 for three different widths of the distribution of μ:

Figure 3: Two stochastic variables, sudden learning, t = 0.002, κ = 1

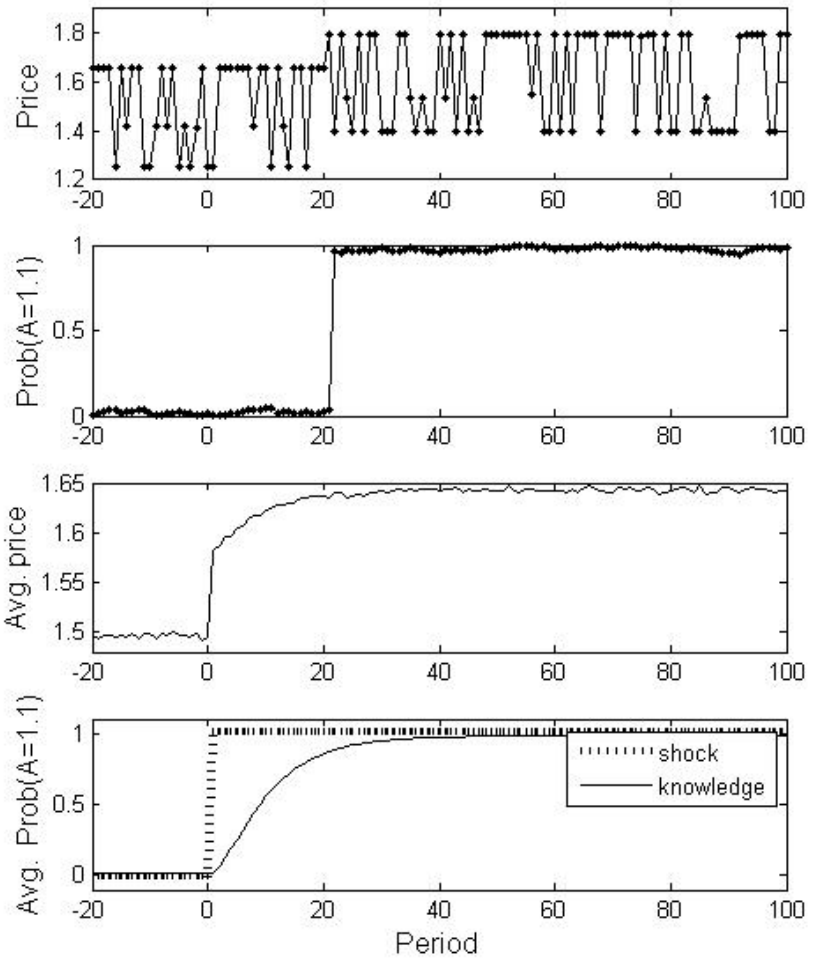
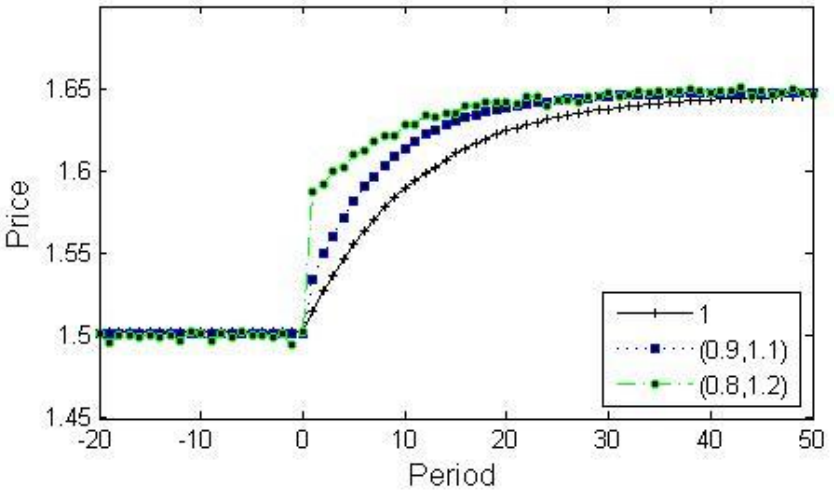


Figure 4: Average price response, 3 distributions of μ, λ = 0.003



for μ fixed at 1, uniformly distributed in (0.9, 1.1) and in (0.8, 1.2). Two characteristics of responses to a shock to A averaged over 10 000 runs are in columns 2 and 3. "1st per. adj." represents a portion of the average long-term adjustment that was realized during the first period, while "90% adjustment" denotes the number of periods it takes the average price until 90% of the full adjustment is realized.

Table 1: Implications of idiosyncratic volatility for average responses, κ = 1

μ	1st per. adj.	90% adjustment	profit loss
1	100%	1	0%
(0.9,1.1)	83%	2	0.28%
(0.8,1.2)	61%	11	1.09%

The more volatile is the seller's idiosyncratic part of the input cost the slower he responds to aggregate shocks. When μ is fixed at 1, 1 bit of information is sufficient to track innovations of the binary variable A perfectly. The column "profit loss" presents seller's losses in comparison with pricing under perfect information - this quantity was evaluated with both μ and A simulated according to their stochastic properties. As expected for RIκ, losses are higher in more volatile environments.

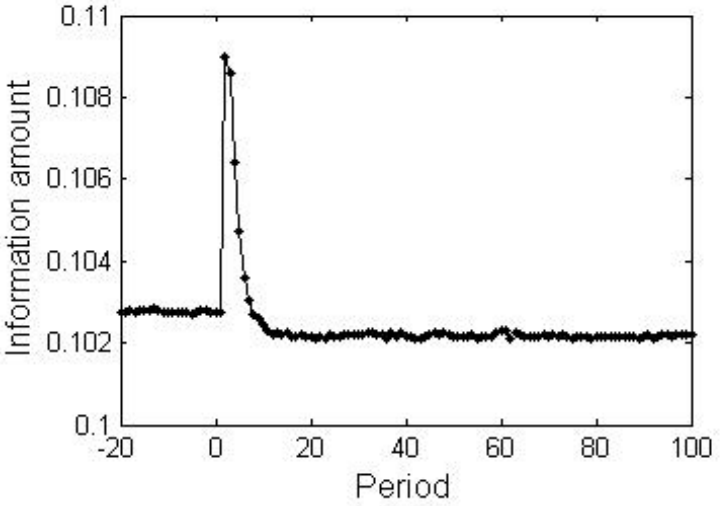
Results of the similar experiments for RI_λ, λ = 0.003, are shown in Table 2 and in Figure 4. Unlike RIκ, RI_λ generates faster responses to aggregate shocks when μ is more volatile.

Table 2: Implications of idiosyncratic volatility for average responses, λ = 0.003

μ	1st per. adj.	90% adjustment	profit loss	mean κ
1	8%	25	0.08	0.0086
(0.9,1.1)	22%	17	1.34%	0.014
(0.8,1.2)	60%	12	1.34%	0.86

The table also presents average κ that was selected by the seller during the simulations. Agents in RI_λ choose to process more information when volatility of input cost increases,

Figure 5: Average processed information, $\mu \in (0.9, 1.1)$, $\lambda = 0.003$, $t = 0.02$



which increases the marginal value of information. Since a rationally inattentive agent processes optimal joint signals about $A \times \mu$, then more total information also implies moreinformation about A. However, faster average responses do not always mean more precise responses - profit loss is the same for $\mu \in (0.9, 1.1)$ and $\mu \in (0.8, 1.2)$. The loss dropsdramatically when μ is fixed at 1. Input cost becomes a binary variable, therefore, the intuition derived from the linear-quadratic approximation does not apply very well.

In RI_λ , the amount of processed information is not constant. It varies according to the expected value of information given a prior. Figure 5 presents average information amount as a function of time. Immediately after the shock occurs, a large fraction of sellers realize there might have been a shock and they choose to process more. Later on, average selected capacity decreases. Once the transition period is over, the new equilibrium information capacity is actually below the initial level - the new average input cost is higher and the marginal value of information is thus lower.

1.3.2 Aggregate Volatility

Aggregate volatility can be adjusted by varying the Markov parameter t, the probability of transition between the two states. Tables 3 and 4, present characteristics of average responses for $\kappa = 1$ and $\lambda = 0.003$ for four different levels of t.

Table 3: Implications of aggregate volatility for average responses, $\kappa = 1$

t	1st per. adj.	90% adjustment	profit loss
0.001	56%	18	1.08%
0.002	61%	11	1.09%
0.006	73%	7	1.13%
0.02	80%	4	1.20%

Table 4: Implications of aggregate volatility for average responses, $\lambda = 0.003$

t	1st per. adj.	90% adjustment	profit loss	mean κ
0.001	55%	19	1.34%	0.86
0.002	60%	12	1.34%	0.86
0.006	73%	5	1.35%	0.88
0.02	83%	3	1.35%	0.92

More volatile A generates faster responses to its innovations in both of the models, RI_κ and RI_λ. This is due to a higher marginal value of processing new information about A if A is more likely to vary and due to the signal extraction of A from Aμ. When volatility of A increases, shocks to Aμ are more likely to be attributed to A. However, unlike in the Lucas' signal extraction of the whole Aμ, profit losses are higher when the aggregate environment is more volatile. Less stable Aμ is more difficult to be tracked precisely.

The effect of accelerated average adjustment is slightly stronger in RI_λ, since higher volatility provides additional motive for processing more total information.

Volatile aggregate environment generates higher losses and swifter responses and thus potentially also a steeper Phillips curve.

1.4 Nominal Rigidity Driven by Consumers' Inattention

In the previous sections, one has to use quite low information capacity, κ, or high cost of information, λ, to be able to generate quantitatively realistic rigidities. In many cases, low information capacity is not unappealing, consider a local businessmen selling home-made honey, but corporations such as Microsoft, IBM or GM also set prices rigidly, while probably having very good information about economic aggregates. In these cases, it is perhaps less likely that nominal rigidities would be driven by information constraints of the price-setters. This section shows that consumers' inattention suffices to generate the rigidity.

Consumers often do not realize what a product's exact price is at the moment of a purchase decision. This is inspired by the observation that some consumers just grab certain products in a supermarket without even looking at their prices. Many of us at least read price's first few digits, while ignoring the cents. Typically, we implicitly assume that prices end with .95 or .99. If the number of cents is actually 85, we may not spot it and still keep our initial guess. Sometimes, we read just the first digit only or none at all.

If it is unpleasant, i.e. costly, to inspect prices and if uncertainty about the true price can discourage consumption, then sellers could try to accommodate consumers with more predictable prices. It might be optimal for the seller not to respond to every minor change of input cost. Such frequent price changes would require consumers to pay lots of attention to the price, and if they did not want to, then they could rather decide to consume less.

Rationally inattentive agents learn about new innovations slowly. If there is a shock to an aggregate variable and if the seller's input cost is correlated with this variable, then the seller chooses to respond to such a shock gradually - he chooses to price in line with the consumer's expectations.

Imagine a consumer has some partial knowledge about shocks to energy prices. She also knows that energy prices are the main determinant of the input cost for her favorite local sauna club. The consumer's expectations about the admission prices to the sauna vary with what she knows about the current prices of energy. The sauna owner might postpone new price changes until consumers expect them to occur.

1.4.1 Model

The model has these features:

i) The input cost is drawn from a binary distribution in the period 0.
ii) The consumer's knowledge of the seller's cost evolves independently of the seller's actions. Knowledge is gradually refined.
iii) The seller's price is a function of the unit input cost and the time elapsed from the initial shock.

Let the seller's unit input cost be equal to an aggregate variable A. The seller is small and has a negligible influence on the consumer's knowledge about shocks to A - the knowledge evolves independently from the seller's pricing responses to A. A is drawn from asymmetric binary distribution $\{A_L, A_H\}$ in the period 0 and stays constant forever after. Consumers know that one of the two possible shocks is realized, but need to process information to find out which one it is. Such a setting with a one-time shock is both simpler to solve and yet illustrative enough to document the implications of gradual knowledge adjustment.

In fully-fledged models under rational inattention, we would specify consumers' preferences and allow them to choose what pieces of information to process. I will, however, assume one specific form of information structure. The qualitative properties of the results do not rest on this assumption.

Let us assume that the consumer's knowledge in period t has the same form as if the consumer acquired one signal through a binary channel with a noise level X (t). X (t) is decreasing in t, which models knowledge refinement[2]. With increasing time, there is

2 No sequence of signals across periods is considered, just one signal, which gets tighter in latter periods.

a higher probability that agents receive the correct signal. Posterior knowledge is thus more concentrated.

If $A = A_H$, then the probability that an agent receives the correct signal, $(A = A_H)$, is $1 - X(t)$. The posterior knowledge of an agent having received such a signal is $\{P(A_L) = X(t), P(A_H) = 1 - X(t)\}$. The posterior knowledge of agents who received the corrupted signal, $(A = A_L)$, is $\{P(A_L) = 1 - X(t), P(A_H) = X(t)\}$.

The seller chooses his pricing strategy. Unlike in the earlier sections of this paper, the strategy is not a function of the input cost only. The consumer's knowledge evolves even after period 0, when the input cost is kept fixed. Different consumer's knowledge can imply a different optimal pricing response to the same input cost. The pricing strategy takes the form $p = \tilde{p}(A, \{g(A)\}) = \tilde{p}(A, t)$, where $\{g(A)\}$ is the distribution of knowledge[3] in the population of consumers. $\{g(A)\}$ is determined by $X(t)$, which is pinned down by time t. The strategy can be expressed using two functions, $\tilde{p}_L(t)$ and $\tilde{p}_H(t)$, each corresponding to one level of unit input cost:

$$p = \begin{cases} \tilde{p}_L(t) & \text{if } A = A_L, \\ \tilde{p}_H(t) & \text{if } A = A_H. \end{cases} \tag{8}$$

Consumers are rational, they know the form of $\tilde{p}_L(t)$ and $\tilde{p}_H(t)$. Together with their knowledge about the aggregate shock (A determines which one of $\tilde{p}_L(t)$ and $\tilde{p}_L(t)$ is to be applied), the pricing strategy generates the consumer's prior on price. More specifically, the pricing strategy forms the prior's support, while knowledge about A determines the relative probabilities of its two points. The term prior reflects knowledge "before" a consumer processes information about the seller's price, but it is "after" she has processed information about the aggregate shock. Since the consumer's knowledge about A is independent of the seller's actions, optimal prices at different levels of X (t) can be set independently of each other.

Definition 1. Model: X (t) is given for all $t \in \{0.\infty\}$; it is a non-increasing function. For each t, the seller chooses $\tilde{p}_L(t)$ and $\tilde{p}_H(t)$, maximizing the expectation of his profit

$$\begin{aligned} \{\tilde{p}_L(t), \tilde{p}_H(t)\} = \arg \max_{\{\tilde{p}_L^0(t), \tilde{p}_H^0(t)\}} & \frac{1}{2}(\tilde{p}_L(t) - A_L) \\ & (1 - X(t))E[C|t, A_L] + X(t)E[C|t, A_H] \\ + \frac{1}{2}(\tilde{p}_H(t) - A_H) & \\ & X(t)E[C|t, A_L] + (1 - X(t))E[C|t, A_H] \end{aligned} \tag{9}$$

3 *It is actually a distribution of distributions.*

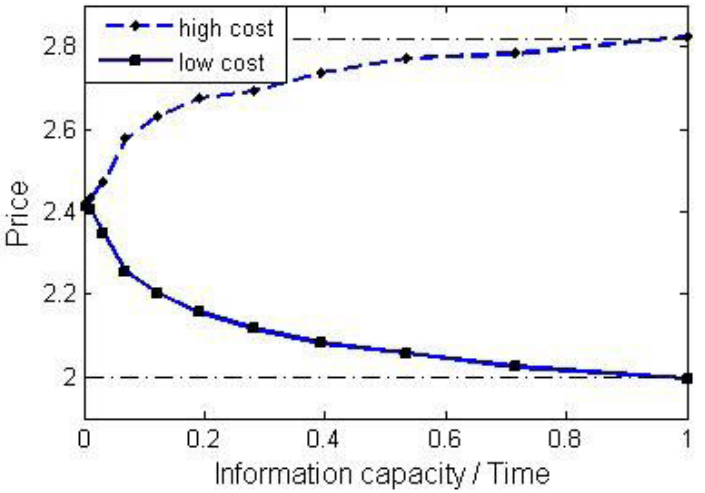
The expression for expected profit weights the true realizations of A_L and A_H and also the consumer's priors generated by receiving signals on A_L or A_H. E[C |t, A_L] denotes the consumption expectation when a consumer's prior is determined by a signal pointing to AL with a noise level X (t) - the corresponding prior is $\{g(\tilde{p}_L(t)), g(\tilde{p}_L(t))\} = \{1 - X(t), X(t)\}$. On the other hand, a prior determining E[C |t, A_H] is {1 − X (t), X (t)}.

For each X (t), the numerical representation of the optimal pricing strategy can be found simply by evaluating the expected profit for all combinations of $\{\tilde{p}_L(t), \tilde{p}_H(t)\}$. Let noise decrease at the following rate:

$$X(t) = 0.5 - 0.05t, \forall t \in \{0..10\}. \quad (10)$$

If the realized value is $A = A_H$, then the seller's price gradually increases until it reaches the full information price in period 10. Otherwise, it gradually decreases. For simplicity,

Figure 6: Gradual price adjustment, scaled to information amount



let κ = 0. Consumers do not process any additional information about the seller's price, they only use their knowledge about the aggregate variable. If κ > 0, the same optimal prices would correspond to higher levels of X.

Figure 6 shows the resulting solution. Consumers possess very little knowledge about A in early periods. They know the seller's pricing strategy, but have difficulties distinguishing between the two different values of prices, $\tilde{p}_L(t)$ and $\tilde{p}_H(t)$, that can be realized in the particular period. If X (t) = 0, consumers always acquire the correct signal, then the seller sets the perfect information optimal prices, which are represented by the dash-dotted bounds. If X (t) = 0.5, consumers can not tell at all which of the two prices was realized - in such a case, the seller chooses to set one price only. Like in the static model, consumers consume more when they are less uncertain about prices. With the increasing probability of the correct signal, optimal prices $\tilde{p}_L(t)$ and $\tilde{p}_H(t)$ are set further and further away from each other.

Figure 6 presents the impulse response of prices to an aggregate cost shock. Although the price-setter is perfectly attentive, prices adjust slowly. The more information the consumer processes, the faster the prices adjust. This implies that prices adjust faster if, for instance, the price makes up for a relatively large portion of the consumer's budget.

2 Implications and Conclusions

Most importantly, this paper shows that rational inattention can generate several properties of price dynamics that are observed in data. We find that prices can change quite frequently and yet generate inertial of nominal aggregates, Section 2.3. In data, Bils and Klenow (2002); Eichenbaum, Jaimovich, and Rebelo (2008), prices in retail stores stay fixed on average for less than 4 months. On the other hand, price level fully responds to an aggregate shock only after at least a year. The presented model reconciles with such findings. We thus conclude that rational inattention could provide the proper microfoundations for the models of nominal rigidities used in monetary policy.

Moreover, all of the following implications of the presented model agree with the evidence.

1) Prices are more flexible in volatile and competitive industries, Sections 2.3.1 and 2.3.1.
2) Prices are more flexible in volatile aggregate environments, Section 2.3.2.
3) Prices of small-budget products are less flexible, Section 2.4.

What does all this imply? For monetary policy, the findings have three main implications:

1. The proposed modeling approach based on rational information.
2. Monetary policy can become ineffective in stimulating output during crises. We find that prices become flexible when the aggregate environment is more volatile. In such cases, the price-setters choose to pay more attention to new shocks. Paying more attention then implies that prices adjust faster. If prices are flexible, then real effects of monetary policy diminish. Unfortunately, this can occur at exactly the times when the stimulation of output could be highly desirable.
3. Optimal monetary policy should focus on stabilizing the price level. The big question in monetary economics is how to balance trade-offs between stabilizing price-level and output. Recently, Paciello and Wiederholt (2011) find that when decision- makers in firms choose how much attention they devote to aggregate conditions, complete price stabilization is optimal also in response to shocks that cause inefficient fluctuations under perfect information. This finding goes in the opposite direction to what standard sticky-price models imply. Under sticky-prices, i.e. when explicit adjustment costs occur, pure price level stabilization is not optimal in case when mark-up shocks or taste shocks occur. Rational inattention thus provides additional reassurance that central banks having the price level stabilization as their primary objective, e.g. the Czech National Bank, choose the optimal policy objective.

The presented model provides some intuition for implications for fiscal policy too. The model we studied, and is formulated in Appendix, is a general setup of responses of inat-

tentive agents to exogenous shocks. Those shocks can be of non-monetary nature too, while most results would still hold.

In 2008 and 2009, policy-makers around the world considered what actions to take to stimulate the output and employment as quickly as possible. Rational inattention implies that while the adjustment of the federal funds rate may be ineffective at turbulent times, fiscal policy can generate desirable results. This is exactly for the reason that at such time agents pay more attention, which weakens the effects of monetary policy, but can strengthen effects of fiscal policy.

Lower taxes go sometimes wasted when public does not notice them. During 2008-2009, public paid much more attention to business news than usually. This period was thus particularly receptive to the lowering of income taxes, including the social security payments. At the same time, higher consumption taxes were the prime candidate to fill the government budget. When noticed, higher consumption taxes increase inflation expectations, which only increases current consumption and thus output too.

On the other hand, increased government spending may be far from being the optimal action. It is true that effect of such spending would be the quickest, but it might be very weak. When agents know about the negative nature of the aggregate shock, then they are better aware of the future budget consequences of the current spending and may not increase their consumption. In other words, Ricardian equivalence becomes stronger during such volatile times.

The model presented in Section 2.4 and its extended version in Matějka (2010b) also provide a novel framework for quantification of costs of too complicated laws and tax codes. It has become common knowledge that complicated tax codes are detrimental. We, however, still do not know what the proper trade-off between the code's theoretical optimality and the optimal complexity that can be handled by real citizens. The presented model of the rationally inattentive consumer has the features needed to tackle the problem: the consumer (citizen) finds it complicated to understand all details of the pricing strategy (tax code), so the seller (government) chooses to keep the prices more rigid (simpler tax code) to accommodate the consumer.

Although, this is mainly a theoretical paper, the potential implications seem important enough to further study and develop the theory of rational inattention.

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Contact adress / Kontaktní adresa:

Filip Matějka
CERGE-EI
(Filip.matejka@cerge-ei.cz)

Appendix: Formulation of Models under Rational Inattention

Response strategy under rational inattention. Let g(Y) be the agent's prior knowl-edge about Y , κ be her information capacity and U (y, z) be the indirect utility function. Her decision strategy f (Y, Z) is a solution to the following maximization problem.

$$\mathbf{f}(Y,Z) = \arg\max_{\mathbf{f}^{0}(\cdot,\cdot)} E[U(Y,Z)] = \arg\max_{\mathbf{f}^{0}(\cdot,\cdot)} \int U(y,z)\mathbf{f}^{0}(y,z)dydz, \tag{11}$$

subject to

$$\int \mathbf{f}^{0}(z,y)dz = g(y) \quad \forall y \tag{12}$$

$$\mathbf{f}^{0}(y,z) \geq 0, \quad \forall y,z \tag{13}$$

$$\mathbf{I}(Y;Z) \leq \kappa, \tag{14}$$

$\mathbf{I}(Y;Z)$ is mutual information between Y and Z, defined as

$$\mathbf{I}(Y;Z) = H(Y) - H(Y|Z) = \int \mathbf{f}(y,z)\log\frac{\mathbf{f}(y,z)}{g(y)\mathbf{f}(z)}\,dydz. \tag{15}$$

(12) requires consistency with prior knowledge, agents can not process more information simply by forgetting what they knew in advance, and (13) states non-negativity of a probability distribution. (14) is the information constraint.

The recursive formulation of the seller's dynamic problem, a RIκ version, is as follows.

$$V(x) = \max_{\mathbf{f}} \int_{(x^{0})} \Pi(A,\mu,p) + \beta V \mathbf{i} \mathbf{f}(A,\mu,p)dAd\mu dp, \tag{16}$$

subject to

$$x^{0} = \mathbf{f}(A_L|p)(1-t) + 1 - \mathbf{f}(A_L|p)\ t \quad Z \tag{17}$$

$$\mathbf{f}(A,\mu,p)dp = g(A,\mu) = g_1(A)g_2(\mu) \tag{18}$$

$$g_1(A_L) = x \tag{19}$$

$$\mathbf{I}(A,\mu;P) \leq \kappa. \tag{20}$$

f (A, μ, p) is a joint distribution summarizing the seller's choice of signals and responses in the given period, (17) is law of motion for knowledge, it generates a prior on A in the following period from a posterior in the current period via a Markov process with the transition probability t. (18) is the constraint on a prior, μ and A are assumed to be independent. $g_2(\mu)$ is fixed, $g_1(A_L) = x$,(19), which implies $g_1(A_H) = 1 - x$. (20) is the traditional constraint on mutual information between the source variables μ and A, and a response variable p.

International Reserves and the Financial Crisis: Monetary Policy Matters

Devizové rezervy a finanční krize: úloha měnové politiky

SOŇA BENECKÁ[1]

Abstract

The global financial crisis in 2008 and 2009 renewed interest for the role of international reserves in preventing and mitigating currency crises. The findings usually support the view that higher (or excess) reserves provided insurance against currency instability, which is considered as a good measure for evaluation how successful countries were in international comparison. Large depreciation of the currency is even explained as a fear of losing international reserves. But in case of inflation targeting countries (IT), which during the crisis witnessed sharp depreciations, this may be of a limited value. This paper enlighten the importance of monetary policy regime in estimating the level of international reserves and extends the current literature with the discussion on central bank credibility.

Keywords

foreign exchange reserves, inflation targeting, crisis

JEL Codes

F31, F33

Introduction

The currency crises in late 1990's in several Asian countries gave rise to investigation which measures are appropriate to minimize costs and prevent future attacks. One important finding, not only, from the literature is that reserves may serve as a form of protection against currency crisis and improvement of external vulnerability. The global financial crisis in 2008 and 2009 gave a chance to critically review this stance, i.e. if countries with larger reserves coped better with crisis. Several papers suggest so, but the results strongly depend on how the eventual success is measured.

This paper expands the current literature at least in two ways. First, it brings back a discussion on the role of monetary policy for international reserves determination and presents the estimated impact on the level. More, it extends the trilemma framework not only with the international reserves but the central bank credibility. Based on new findings, it revises

1 *This work was supported by Czech National Bank Research Project No. A5/11. All errors and omissions are mine. The views expressed in the paper are the views of author and do not necessarily represent the view of the affiliated institution.*

the current understanding of the role of reserves in global financial crisis and proposes alternative solutions to external vulnerability.

The international reserves belong to standard monetary policy instruments, despite their limited inclusion in monetary policy framework. All instruments are interlinked and any changes to goals and the overall settings impacts substantially the role of reserves. So if the role of reserves should be changed, other monetary policy instruments should gain importance.

The global financial crisis showed that countries are well able to create ad hoc instruments to improve international liquidity (e.g. swap lines) to substitute standard monetary policy instruments but their use is rather limited in time and between countries. Of course, this stream may be developed further on international level.

On country level, the possibilities are rather limited. The experience of the inflation targeting countries suggests that central bank credibility can become also a monetary policy instrument. The empirical evidence supports this view, but of course, appropriate model is necessary. This task is beyond the scope of this paper.

The remainder of the paper is structured as follows. Section 2 summarizes main findings from the literature. Section 3 presents the main working framework, the data and estimation results.

Section 4 offers an alternative view on external vulnerability with an empirical assessment. Finally, section 5 concludes the paper.

1 Literature Review

The literature on determination of international reserves has long tradition dating back 1960s and 1970s. The first studies, which are often called ***buffer stock,*** comprise work of Heller (1966) and Olivera (1969). According to these papers the optimal reserve level should be determined by balance-of-payments disequilibria, propensity to import and opportunity cost. In this notion, the reserves serve as a buffer stock to fluctuations in external transaction and so positively effected by the variance of these fluctuations.

With the collapse of Bretton Woods system in 1973 the discussion on international reserves changed substantially. Capital mobility together with floating exchange rate brought a new trilemma with no explicit solution for reserves, especially for advanced countries. Free floating regimes do not require by definition reserves, while liberalized financial account would minimize the need for reserves to absorb a given set of balance-of-payments shocks. But free capital movements can generate more instability and certainly monetary authorities are not indifferent to exchange rate movements.

In fact, currency crisis in developing countries like Mexico (1973-1982) and Argentina (1978-1981) gave a rise to ***currency crisis literature***. So called *first generation models*[2] show that expansive domestic policies together with fixed exchange rate regime lead to

2 For literature review see Flood and Marion (1998).

currency crises. Higher reserve level can postpone the crisis until the reserves are depleted and the fixed exchange rate regime abandoned. *Second generation models* stressed a self-fulfilling aspect of currency crisis (Obstfeld, 1986, 1996; Morris and Shin, 1998). Here the reserves can be understood as reflecting fundamentals or commitment to defend the peg (as in Obstfeld, 1996). If the reserves are not high enough (or commitment is weak) so the speculators may be able to break the peg, the speculative attack seems a rational response. In this view, the level of the reserves has a self-fulfilling nature.

As a response to currency crisis in late 1990's, the economic research turned back attention to the role of reserves in crisis prevention and mitigation. Asian countries were extremely vulnerable to what Calvo (1998) defines as the sudden stop syndrome: a massive reversal of capital inflows. A large stream of literature appeared suggesting how to indicate vulnerable countries and what measures are appropriate to minimize current costs and future attacks.

The first attempt to propose adequate indicators in International monetary fund (IMF, 1998) suggests that the overvaluation of the real exchange rate, M2-to-reserves ratio and the growth of domestic credit tended to signal a currency crisis quite well. Based on more profound research, IMF prepared a set of indicators (reserve adequacy, debt-related) which are currently used in Staff Reports for the Article IV Consultation. So called External Vulnerability Indicators play an important role in vulnerability assessment relative to more detailed country-specific analyses and based on them statistical models to predict future currency crisis are built. Later work of Berg and others (1999) improved the technical background and had more success in predicting the crises out of sample.

The ratio of short term debt to reserves is a key indicator of early warning systems and the level of reserves is required at least to cover the short term debt. The ratio proved to be important in many studies, e.g. Bussiere and Mulder (1999)[3]. Similarly, Chang and Velasco (1999) find that the short term debt should be taken into account when trying to measure potential illiquidity of the country. They are rather critical to the involvement of IMF in crisis, as it insists on fiscal austerity as a precondition for lending.

On other hand, Mr. Guidotti argued that reserves should cover scheduled external amortization for one year. Further, according to Mr. Greenspan, country's external liquidity position should be calculated over wide range of possible outcomes, taking into account full set of external assets and liabilities („liquidity at risk"). The adequate level should reflect probability that external liquidity will be sufficient to avoid new borrowing for one year.

The lesson learned from Asian crisis is straightforward. If the economic fundamentals are weak and the risk of contagion is high, the policy response can contain built-up of reserves and/or extension of liquidity by an international body or lender of the last resort.

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3 This study also implies that a benchmark of one for the ratio of reserves to short-term debt is broadly appropriate. To avoid any impact of contagion, reserves should be such that the reserves to short-term debt ratio is one plus 5 percent for every percentage point of GDP current account deficit, and an additional 1 percent for every percent the real effective exchange rate has appreciated in the previous 4 years. In this sense, the reserves can offset weak fundamentals and prevent crisis spreading.

But are there any alternatives? Garcia and Soto (2004) tested the importance of accumulation of reserves in crisis prevention compared to measures like the quality of political institutions and the soundness of the financial system. In this view, the reserve accumulation is rather costly approach; the countries should improve their political and financial systems.

Despite these findings, the policy makers now see the reserve management as a strong instrument in crisis mitigation and prevention. In fact, the rise in reserve levels became a global phenomenon and its impact is substantial. Recently, Mendoza (2010) found that policy makers in developing countries are now more responsive by holding reserves than in pre-Asian crisis period. The elasticity of the reserves to several indicators (external debt and liabilities) increased indicating that the level of reserves became one of the true measures with regard to crisis prevention.

So last ten years were marked by an increase in international reserves worldwide by far larger than what "crisis prevention" literature would imply. New theories like "mercantilist motives" (Aizenman and Lee, 2007) or "financial globalization motives" (Obstfeld et al., 2008) appeared to explain recent developments.

Finally, the global financial crisis in 2008 and 2009 renewed interest in the role of reserves, i.e. if countries with higher reserves coped better with crisis. Obstfeld et al. (2009) showed that countries holding more reserves relative to M2 (relative to a measure of predicted reserves based on financial motives) have tended to appreciate in the crisis. Aizenman a Sun (2010) studied how emerging markets reacted on liquidity stress and they found that countries sensitive to trade shocks used their reserves up to no more than one third of their level, to mitigate currency movements. In case of countries, where financial factors play important role in determining the level of reserves, the depletion of reserves was limited. As they conclude, "the adjustment of EMs was constrained more by their fear of losing IR [international reserves] than by their fear of floating".

If we take a closer look on actual data, it becomes evident that Aizenman and Sun (2010), in their evaluation of the global financial crisis impact, underestimated the role of monetary policy setting. In fact, as Table 1 in Appendix shows 17 countries were hit by large currency depreciation (more than 35% between March 2008 and 2009, with limited impact on reserves), out of which 13 were inflation targeting. Inflation targeting countries do not use FX interventions as a standard instrument, although temporary interventions may occur to reduce volatility. These findings suggest that monetary policy settings may drive the actual development of the reserves and so called fear of losing reserves may be of a limited relevance. Therefore, I will continue the discussion on the role of the reserves in global financial crisis with regard to monetary policy.

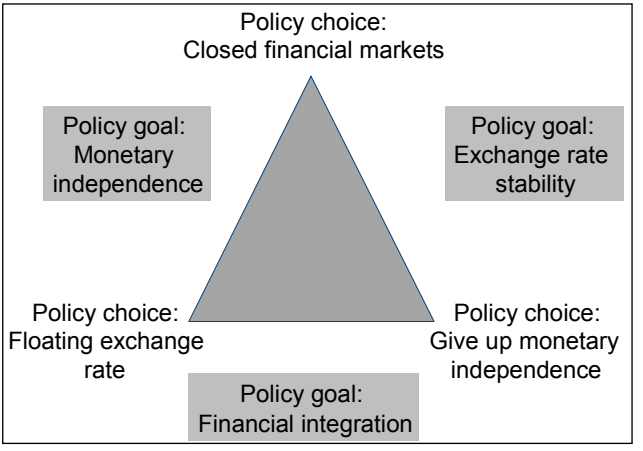
2 International Reserves and the Role of Monetary Policy

This chapter will present the link between monetary policy and international reserves, including empirical analysis and critical reviews.

2.1 Trilemma, Quadrilemma and the Role of Monetary Policy Regimes

In order to understand the link between monetary policy and international reserves we can start with simple Mundell-Flemming model of impossible trinity. This framework (see fig. 1) shows that in any point of time the country may choose two but not three of policy goals: monetary independence, exchange rate stability and financial integration. For example, to gain exchange rate stability and financial integration euro area countries had to give up monetary independence.

Figure 1: Mundell-Flemming's Trilemma framework



Aizenman, Chinn and Ito (2008) investigated empirically this issue. Their testing showed that higher flexibility of the exchange rates in recent decades was accompanied by reserve accumulation, which is in contrary to what the simple Mundell-Flemming model shows. So they suggested an extension of this classical framework with financial stability issues and international reserves. Globalization and financial integration worldwide may force developing countries to improve their financial stability by accumulation of the reserves, as their exposure to capital flights and deleveraging crises increased. So, the financial integration was followed by accumulation of the reserves as a self protection against financial turbulences. In this sense, the new dimension of the triangle includes financial stability, which proved to be highly topical in recent years.

Therefore the first step in my analysis comprises the evaluation of the relationship between reserves and different monetary policy settings after 1999[4]. I will use the hints from the trilemma, e.g. countries with desire to keep exchange rate stable and financial markets integrated will improve their position in the triangle using accumulation of the reserves. The accumulation of the reserves worldwide may than well reflect only changing structure of the moentary policy settings.

4 *Most of the studies use the data from 1990's.*

2.2 Model and Data

In empirical estimation I followed Obstfeld et al. (2008) with the traditional and financial stability model estimated on large panel of countries during 1990's. Here the dependent variable is the (natural) log of the reserves to GDP ratio.

The panel dataset covers 123 countries during 1999 and 2009 and the summary (as well as sources) is in Table 1. The basic explanatory variables are population, trade openness (exports and imports to GDP), GDP per capita (in current prices, USD), all expressed in log. The inclusion of trade and capital account openness is motivated by findings from the literature; these indicators are used to capture external vulnerability of the country[5]. GDP per capita should measure the relative wealth so richer countries can afford to keep larger reserves. As an alternative, I included a dummy for advanced countries as they are defined by IMF.

More, it contains the share of the country on the world net exports as these countries may prefer to hold larger international reserves to ensure stable oil revenues in domestic currency and even transfer part of the revenues to reserves.

Table 1: Summary statistics

Variable	Observations	Mean	Std. Dev.	Min	Max
Reserves on GDP	1353	0.189	0.189	0.001	1.583
Population (mil)	1353	46.329	157.117	0.250	1345.750
GDP per capita	1353	11.606	15.916	0.086	117.955
Trade openess	1353	0.933	0.564	0.190	4.381
Capital account openess	1353	0.864	1.577	-1.844	2.478
Oil exports	1353	0.673	2.266	0.000	19.030
HIM	1305	0.764	0.109	0.000	0.954
M2 to GDP	1353	0.788	0.818	0.067	6.639
Banking crisis	1353	0.061	0.239	0.000	1.000

Source: author's calculation from World Development Indicators (Worldbank), IFS IMF (April 2011), Economic Intelligence Unit (for several data missing), Heritage Foundation website and Laeven and Valencia (2010) database.

Newly I added a set of variables representing the angles of the trilemma triangle. To capture ***financial market integration*** I used a measure of financial openness - Chinn-Ito capital market openness index which measures a country's degree of capital account openness, namely restrictions on cross-border financial transactions reported in the IMF's Annual Report on Exchange Arrangements and Exchange Restrictions (AREAER)[6].

5 As literature shows, one of the most important indicators of external vulnerability is the ratio of short term debt to GDP. Due to limited data availability it is not included in this study.

6 See http://web.pdx.edu/~ito/Chinn-Ito_website.htm.

Monetary independence, or how successful countries were in monetary policy conduct, will be represented by Heritage monetary freedom index[7] (HMFI), defined as follows:

$$HI\_M_i = 100 - \alpha\sqrt{\theta_1\pi_{it} + \theta_2\pi_{it-1} + \theta_3\pi_{it-2}} - PC_i,$$

where π is inflation, PC is an adjustment for price controls, i stands for country and t time. Eventually, it is a weighted average of the inflation over last three years adjusted for price controls. Higher value of the index indicates monetary independence, as it shows that the financial authority was successful in achieving and maintaining price stability. As an alternative I included a dummy variable from monetary policy arrangement according to IMF (data available after 2001). We may expect that countries with no monetary independence (like currency unions) will have lower reserves. This classification has 5 categories, but I added one more for countries with monetary union. These are: Inflation targeting (1), Monetary aggregate targeting (2), Fund-supported or other monetary program (3), Exchange rate anchor (4), Other[8] (5), Monetary union (6).

Newly I added variables capturing differences in ***exchange rate arrangements***[9]. A dummy variable for exchange rate regime is according two classifications:

- IMF classification of exchange rate arrangements, de facto after 1997[10], available from AREAER annually. It has 7 categories from "no separate legal tender" to "independently floating", as shows Table 2.
- de facto classification according to Reinhart and Rogoff (2004), which used historical chronologies and data on market-determined parallel exchange rates. There are two kinds of classification schemes – one consists of 14 types of arrangements and the other with aggregated 5 categories (so called coarse grid). It allows form much finer grid and newly it adds a category of "freely falling" with inflation over 40 %. While the coarse grid in Table 3, the fine one you can find in the appendix (Table 2).

7 *It is rather a rough measure of independente. Data are possible to download from HI website: http://www.heritage.org/index/monetary-freedom*

8 *The country has no explicitly stated nominal anchor, but rather monitors various indicators in conducting monetary policy.*

9 *The impact of exchange rate regimes on international reserves was estimated also by Choi, Ch. and Baek, S. (2004): Exchange rate regimes and the international reserves, unpublished, but this study used a different specification with large potential bias and Reinhart and Rogoff (2004) classification only.*

10 *Before 1997 IMF used classification based on official Exchange rate arrangement, which was in several cases quite different from de facto development. Therefore the revision brought a new methodology and the studies showed that differences between the classification schemes now became much lower than in 1990's.*

Table 2: Exchange rate system classified by IMF

1	Exchange arrangement with no separate legal tender
2	Currency board arrangement
3	Conventional pegged arrangement
4	Pegged exchange rate within horizontal bands
5	Crawling peg
6	Crawling band
7	Managed floating with no predetermined path
8	Independently floating

Source: IMF.

Table 3: Exchange rate system classified by Reinhart and Rogoff (2004) – coarse grid

1	No separate legal tender; Pre announced peg or currency board arrangement; Pre announced horizontal band that is narrower than or equal to +/-2%; De facto peg
2	crawling peg and band that is narrower than or equal to +/-2%
3	Pre announced crawling band that is wider than or equal to +/-2%; De facto crawling band that is narrower than or equal to +/-5%; Moving band that is narrower than or equal to +/-2%; Managed
4	Freely floating
5	Freely falling
6	Dual market in which parallel market data is missing.

Source: Reinhart and Rogoff (2004).

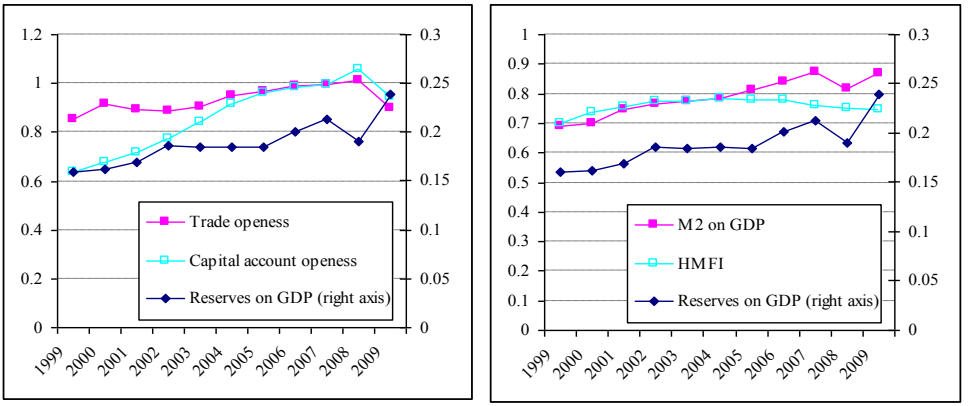
Finally, ***financial stability*** dimension will be represented by the ratio of M2 to GDP, which represents a potential domestic capital flight. It can be originated from internal reasons as banking sector crisis (so called internal vulnerability). More generally, it can represent liquidity conditions in the country. As literature showed, the level can differ between countries due to their local conditions, but any shock to liquidity like the global financial crisis will be reflected in the indicator. As a novelty I tested directly if the realization of the banking crisis has impact on the level of reserves. The banking crisis dummy used in this paper come from Laeven and Valencia (2010) database[11].

2.3 Trends in Reserve Accumulation after 1999

Before presenting the estimation results, I will describe shortly the overall development of the variables, as most of the studies cover only 1990's. The overall trend in increase of reserves (scaled by GDP) after 2000 continued, mainly in case of emerging countries. It was accompanied both by increase in trade and capital account openness. The global financial crisis brought a sharp interruption due to liquidity slump, which is particularly evident in case of M2 on GDP. The reserves lowered as well because many countries were hit by depreciation in 2008 or even used reserves to provide foreign liquidity temporarily. Monetary freedom index grew until 2004, while the global rise of prices (e.g. for commodities) lowered the indicator in the following years.

11 The data can be downloaded from author's website: http://www.luclaeven.com/Data.htm

Figure 2: Trends in explanatory variables (average over cross-section)



Source: author's calculation.

As for the exchange rate systems, we cannot see a trend of growing flexibility as described in literature for 1990's. Both classification schemes indicate a return to more fixed arrangement in recent years; for example the share of countries with fixed or pegged regime (categories 1-3 according to IMF) increased from 37 % in 2000 to 48 % in 2008 (see Figure 1 in appendix). This evidence is supported also by data Reinhart and Rogoff (2004) and also the share of countries with exchange rate anchor increased (Figure 2 in appendix).

Also looking at monetary policy arrangements, again there is no clear trend towards more flexibility. The number of countries in monetary union increased, due to enlargement of the euro area, as well as the number of countries with exchange rate anchor. Inflation targeting as a monetary arrangement has gained a lot of attention in recent years and the number of countries in my sample increased from 16 to 26 between 2001 and 2008.

2.4 Estimation Results

Using pooled data I estimated an equation using OLS (ordinary least squares) and with fixed effects, although scaling reserves by GDP make the time series stationary. More, the standard errors are clustered by country to allow for heteroscedasticity across countries. The first estimate gives us more details on cross-country aspects, so it is a preferred choice also in the literature. Still, the fixed effects (capturing more time dimension) are significant and not to be omitted. The correlation matrix is in Table 3 of the appendix.

In line with previous findings I estimated first a ***standard model*** including all basic macroeconomic variables and the results are shown in Table 4.

As expected, countries more open to external transactions have higher reserves as a buffer to fluctuations and this effect is still large. Similarly, oil exporters tend to have larger reserves. On the other hand, GDP per capita has negative sign, while previous studies found positive or insignificant coefficient. This may be due to inverted-U relationship with reserve holdings. Middle income countries tend to have larger reserve than high- and low-income, and as a number of countries with high income grows, the overall effect

becomes negative. So I included a dummy for advanced countries directly (equation II) and its impact is substantial.

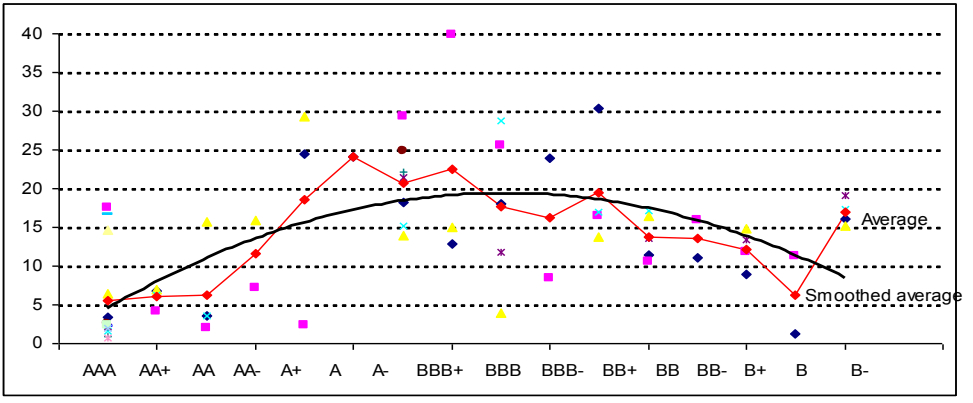
Table 4: Estimation results - baseline

	I		II		III	
	Traditional model		With advanced country		With interaction term	
	Pooled OLS	Fixed effects	Pooled OLS	Fixed effects	Pooled OLS	Fixed effects
Population	-0.067	0.475				
	0.049	*0.441*				
GDP per capita	-0.195***	0.074				
	0.052	*0.084*				
Trade openess	0.579**	0.614***	0.575***	0.702***	0.604***	0.731***
	0.224	*0.151*	*0.204*	*0.145*	*0.198*	*0.144*
Capital account openess	-0.071	-0.075	-0.019	0.004		
	0.045	*0.055*	*0.044*	*0.051*		
Net oil export	0.083***	0.19***	0.041**	0.194***	0.048***	0.19***
	0.020	*0.056*	*0.016*	*0.062*	*0.017*	*0.063*
Advanced country dummy			-1.154***	-1.696***	-0.858***	-1.457**
			0.240	*0.565*	*0.242*	*0.601*
Interaction term					-0.049**	-0.048*
					0.024	*0.026*
Constant	-1.555***	-3.184***	-1.725***	-1.696***	-1.688***	-1.621***
	0.128	*0.922*	*0.088*	*0.130*	*0.085*	*0.136*
R-sq (overall/within)	0.218	0.076	0.315	0.144	0.329	0.159
Obs	1353	1353	1353	1353	1353	1353

*Note: author's calculations. Robust standard errors in italics, ***, **, * denote statistical significance at 1%, 5% a 10% levels, respectively.*

This variable was intended to proxy the creditworthiness and ability to issue debt (and access swap lines in case of liquidity crisis). Country's long-term credit rating is another indicator and plotting it against reserves brings forward that again countries with middle rating feel more vulnerable and accumulate reserves.

Figure 3: Long-term rating (Fitch) and reserves on GDP in 2003



Note: author's calculations.

This is closely related to a topic of capital account openness (see equation III). Its sign is negative and insignificant, so I tried an interaction term between GDP per capita and KAOPEN. In fact, a small country with fully open capital account may feel much vulnerable to external shocks than a big country. Opening capital account was a very dynamic process in 1990's, while after 2000 it slowed down and/or the indicator is less suitable for this analysis.

Table 5: Estimation results – exchange rate arrangements

	I		II		III	
	IMF classification		**Intermediate regimes**		**Reinhart and Rogoff coarse classification**	
	Pooled OLS	**Fixed effects**	**Pooled OLS**	**Fixed effects**	**Pooled OLS**	**Fixed effects**
Trade openess	0.504***	0.874***	0.509***	0.878***	0.696***	0.826***
	0.163	*0.156*	*0.162*	*0.155*	*0.187*	*0.154*
CO interaction term	-0.048*	-0.066***	-0.046*	-0.063***	-0.127***	-0.096***
	0.024	*0.020*	*0.023*	*0.020*	*0.025*	*0.028*
Net oil export	0.028*	0.212***	0.027*	0.213***	0.061***	0.183***
	0.015	*0.062*	*0.015*	*0.060*	*0.018*	*0.060*
Regime 1	-1.39***	-1.405**	-1.401***	-1.485**	0.059	-0.242
	0.301	*0.554*	*0.298*	*0.587*	*0.395*	*0.248*
Regime 2	0.475**	0.327*	0.471**	0.322	0.331	0.008
	0.219	*0.196*	*0.216*	*0.198*	*0.358*	*0.180*
Regime 3	0.493***	0.043	0.495***	0.065	0.511	-0.114
	0.157	*0.136*	*0.157*	*0.128*	*0.378*	*0.171*
Regime 4	0.402**	0.275				
	0.163	*0.218*				
Regime 5	0.192	-0.143			-0.938**	-0.485**
	0.214	*0.180*	0.2*	0.054	*0.370*	*0.196*
Regime 6	0.071	0.022	*0.113*	*0.068*	0.492	-0.029
	0.235	*0.121*			*0.500*	*0.256*
Regime 7	0.183	0.052				
	0.123	*0.070*				
Constant	-1.999***	-1.824***	-2.002***	-1.829***	-1.967***	-1.755***
	0.116	*0.121*	*0.116*	*0.121*	*0.349*	*0.184*
R-sq (overall/within)	0.472	0.191	0.470	0.185	0.352	0.150
Obs	1230	1230	1230	1230	1137	1137

*Note: Author's calculations. Robust standard errors in italics, ***, **, * denote statistical significance at 1%, 5% a 10% levels, respectively.*

The next step will be the results for equation with ***exchange rate arrangements*** (Table 5). As a benchmark I chose freely floating regimes, as two classifications differ in categories (but broadly they are from fix to float). Of course, the results for OLS estimations yield more information as dummy variables are usually time variant to a limited extend. It can be summarized, that compared to freely floating regimes, countries in monetary union or no separate legal tender hold less reserves. Most reserves are held by de facto pegs. In appendix (Table 4), there are also results for fine grid and they support the results for IMF

de facto classification[12]. This inverted-U relationship may indicate that growing number of countries with pegged regimes gave rise to enormous accumulation of the reserves while regional monetary union can be a way to reach more exchange rate stability. The reason, why managed floating regimes hold the same amount of reserves as free floaters, can be that the latter may claim not to intervene on the markets but they eventually do. Finally, freely falling regimes have lower reserves, as their economies are transition or developing with large fiscal deficits, external indebtedness and political instability.

With regard to ***financial stability,*** as Table 6 shows the results are not as convincing as in Obstfeld et alt. (2008). The coefficient for M2 to GDP is statistically significant only with fixed effects, in OLS estimation it is positive but insignificant. More, it is sensitive to inclusion of other variables in the equation. On the other hand, dummy for banking crisis has expected negative sign. Countries, which suffer from banking crisis, have to face pressure on currency and the use of reserves is obvious.

Finally, with regard to ***monetary independence,*** low inflation countries have higher reserves so HMFI reflects more the general development of the country rather than monetary independence. Also a dummy for different monetary policy arrangements does not yield any convincing answer (see Table 5 in the appendix). The results are broadly similar to exchange rate regimes. The lowest levels of reserves have countries with monetary union. Inflation targeting countries have lower reserves than countries, that follow several indicators ("other"). Countries with exchange rate anchor hold more reserves, but the coefficient is not statistically significant. Generally, the differences are rather small. It is rather difficult to capture the monetary independence and for that reason the last part of this paper will give a first glimpse on the relationship between central bank independence, which is connected with monetary independence, and reserve holdings.

12 The basic classification by IMF performs now well compared to other classification schemes. This is due to change to de facto classification in 1997 and lower number of "free falling" regimes in last decade compared to previous years. This certainly simplifies the use of classification in future research.

Table 6: Estimation results – financial stability and monetary independence

	I		II	
	Financial stability		**With monetary independence**	
	Pooled OLS	**Fixed effects**	**Pooled OLS**	**Fixed effects**
Trade openess	0.464***	0.787***	0.506***	0.803***
	0.158	*0.165*	*0.160*	*0.173*
CO interaction term	-0.061***	-0.074***	-0.069***	-0.074***
	0.023	*0.020*	*0.023*	*0.020*
Net oil export	0.035**	0.216***	0.04**	0.193***
	0.016	*0.054*	*0.018*	*0.057*
M2 on GDP	0.225**	0.35**	0.136	0.276*
	0.101	*0.143*	*0.108*	*0.157*
Banking crisis	-0.336***	-0.359***	-0.29**	-0.336***
	0.116	*0.072*	*0.119*	*0.073*
Regime 1	-1.528***	-1.457**	-1.47***	-1.455**
	0.333	*0.569*	*0.325*	*0.574*
Regime 2	0.47**	0.179	0.436**	0.183
	0.202	*0.155*	*0.216*	*0.142*
Regime 3	0.446***	0.026	0.401**	0.000
	0.154	*0.120*	*0.159*	*0.129*
Regime 4-7	0.245**	0.027	0.295**	0.043
	0.116	*0.071*	*0.119*	*0.074*
HMFI			1.206**	0.495*
			0.492	*0.270*
Constant	-1.823***	-1.575***	-2.787***	-1.988***
	0.143	*0.139*	*0.431*	*0.278*
R-sq (overall/within)	0.492	0.235	0.509	0.238
Obs	1230	1230	1182	1182

*Note: Author's calculations. Robust standard errors in italics, ***, **, * denote statistical significance at 1%, 5% a 10% levels, respectively.*

3 Monetary and Central Bank Independence

The previous analysis showed that accumulation of reserves in recent years was to a large extent driven by external and internal vulnerability. Openness to trade as well as financial globalization certainly puts a pressure on central banks to increase barriers to shocks, especially if they decide for any fixed form of exchange rate regime. But are there any alternatives? As shown in previous chapters, a monetary union brings exchange rate stability with full open financial markets and the need for reserves is limited. This step has disadvantages, as recent experience with euro debt crisis showed. Therefore, a search for another approach is highly topical.

In previous analysis the attempt to measure monetary independence by HMFI did not give the expected result. It was due to the assumption that more independent central bank is more successful in achieving and maintaining low inflation levels. But it possible to employ directly central bank independence index (CBI), as it is in Crowe and Meade (2008). The data are available only for 2003 and smaller sample of countries; the estimation result is in Table 7. The sign of CBI indicates that more independent central bank can afford to have lower reserves, which is in line with the discussion. The evidence is rather weak, though. The central banks do not follow any optimal path for the level of reserves, as one generally expected model is missing. Generally more credible central banks may stop accumulating reserves, as this is a costly approach and their external vulnerability decreases. Of course, appropriate model is necessary but this task is beyond the scope of this paper.

Table 7: Estimation results – Central bank independence (CBI)

Number of obs = 81						
R-squared = 0.253						
Number of clusters (code) = 81						
	Coeficient	Robust Std. Err.	t	P>|t|	[95% Conf.	Interval]
Trade openess	0.538	0.258	2.08	0.041	0.024	1.052
Capital account openess	-0.269	0.073	-3.71	0.000	-0.414	-0.125
Net oil export	0.033	0.029	1.12	0.268	-0.026	0.091
HMFI	0.020	0.010	1.95	0.055	0.000	0.040
CBI	-0.769	0.462	-1.67	0.100	-1.688	0.150
Constant	1.782	0.892	2	0.049	0.008	3.556

Note: author's calculations. Cross-section for 2003.

Conclusions

This paper extended the current literature on international reserves with the discussion on the link with monetary policy. It showed the position of the country within a trilemma triangle influences the level of reserves and monetary policy decisions are all interlinked, though the relationship is not always linear. To summarize main results, the countries more open to external transactions have higher reserves as a buffer to fluctuations and this effect is still large. The overall wealth effect is also important. As for monetary policy settings, the exchange rate regimes are key determinants; inverted-U relationship may indicate that growing number of countries with pegged regimes gave rise to enormous accumulation of the reserves while regional monetary union can be a way to reach more exchange rate stability. Also financial stability issues are reflected in the level of reserves, any banking crisis has substantial effect on the current level of reserves. Finally, improving central bank independence may be an alternative to accumulation of reserves.

Finally, this framework offers an explanation for mixed results for inflation targeting countries. Although these countries do not hold lower level of reserves, they prefer the side of triangle associated with monetary independence and floating regime. Here the relevance of the reserves is limited and building up of central bank credibility is a crucial task. This is also an inspiration for countries looking for an alternative to current approach in international reserves accumulation.

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Contact adress / Kontaktní adresa:
PhDr. Soňa Benecká
University of Finance and Administration / Vysoká škola finanční a správní
Czech National Bank / Česká národní banka
(sona.benecka@cnb.cz)

Appendix

Table 1: Exchange rate movements (% change between March 2008 and 2009)

Depreciation				Appreciation
> 35 %	25 - 35 %	15 - 25 %	0 - 15 %	
Iceland	Mongolia	Kazakhstan	Costa Rica	Hong Kong
Poland	Belarus	Jamaica	Thailand	Trinidad and Tobago
Ukraine	Norway	Kenya	Paraguay	Japan
Zambia	South Africa	Uganda	Peru	Laos
New Zealand	Swaziland	Croatia	Madagascar	China
South Korea	Pakistan	Botswana	Algeria	Azerbaijan
Russian Federation	Gambia, The	Latvia	Georgia	Bolivia
United Kingdom	Canada	Macedonia	Tanzania	
Sweden	Indonesia	Guinea-Bissau	Libya	
Colombia	Czech Republic	Cape Verde	Singapore	
Hungary	Mauritius	Bosnia & Herzegovina	Kuwait	
Australia	Bhutan	Bulgaria	Sri Lanka	
Turkey	India	Estonia	Haiti	
Mexico	Nigeria	Denmark	Guatemala	
Chile	Albania	Lithuania	Dominican Republic	
Romania		Armenia	Nicaragua	
Brazil		Israel	Burundi	
		Philippines	Sierra Leone	
		Ethiopia	Rwanda	
		Uruguay	Egypt	
		Argentina	Angola	
		Switzerland	Bangladesh	
		Morocco		
		Kyrgyz Republic		
		Malaysia		

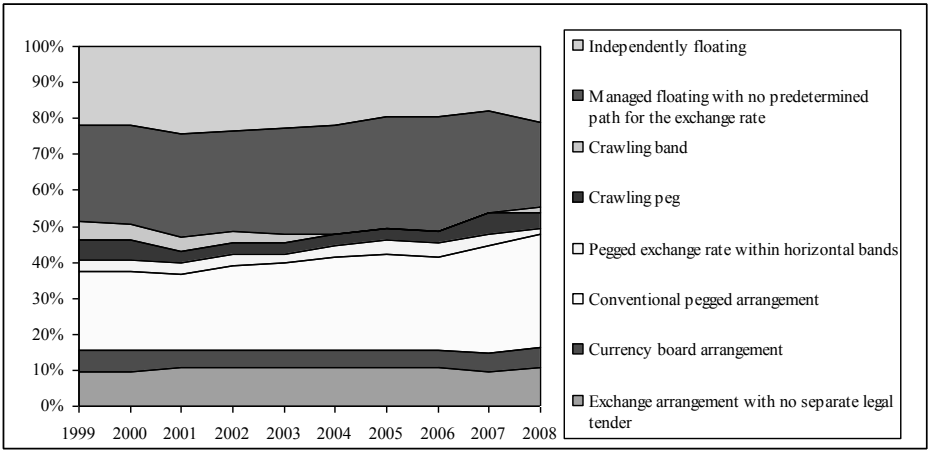
Note: inflation targeting countries are highlighted; the table covers only countries included in this study.

Table 2: The fine classification according to Reinhart and Rogoff (2004)

1	No separate legal tender
2	Pre announced peg or currency board arrangement
3	Pre announced horizontal band that is narrower than or equal to +/-2%
4	De facto peg
5	Pre announced crawling peg
6	Pre announced crawling band that is narrower than or equal to +/-2%
7	De factor crawling peg
8	De facto crawling band that is narrower than or equal to +/-2%
9	Pre announced crawling band that is wider than or equal to +/-2%
10	De facto crawling band that is narrower than or equal to +/-5%
11	Moving band that is narrower than or equal to +/-2% (i.e., allows for both appreciation and depreciation over time)
12	Managed floating
13	Freely floating
14	Freely falling
15	Dual market in which parallel market data is missing.

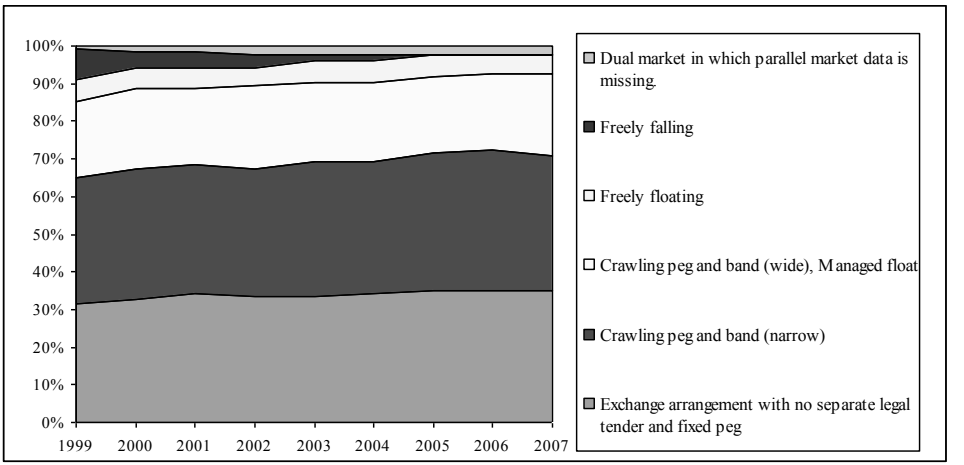
Source: Reinhart and Rogoff (2004).

Figure 1: Exchange rate system classified by IMF in 1999-2008



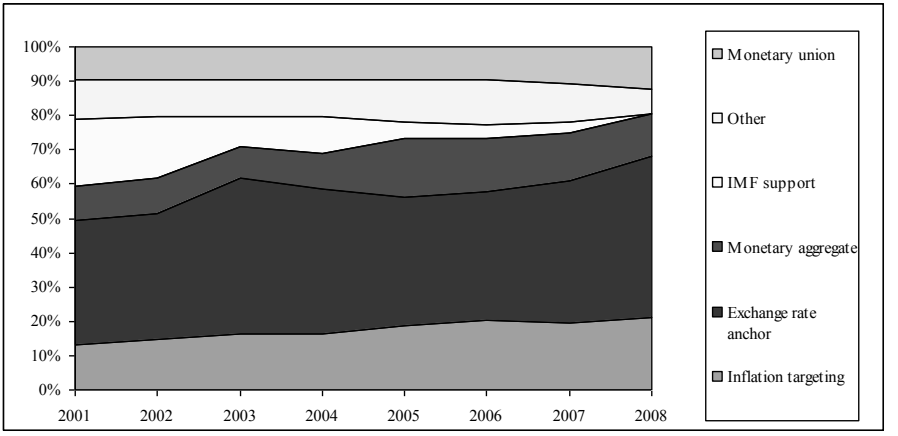
Note: author's calculations based on data from IMF.

Figure 2: Exchange rate system classified by Reinhart and Rogoff (2003) in 1999-2008



Note: author's calculations based on data from Reinhart and Rogoff (2003).

Figure 3: Monetary policy arrangements by IMF in 1999-2008



Note: author's calculations based on data from IMF.

Table 3: Correlation matrix

	log(reserves/ GDP)	log(population)	log(gdp per capita)	log(trade openess)	log(m2 to gdp)	Interaction term	Advanced countries	Banking crisis dummy
log(reserves/GDP)	1							
log(population)	-0.173	1						
log(gdp per capita)	-0.263	-0.137	1					
log(trade openess)	0.261	-0.556	0.219	1				
log(m2 to gdp)	-0.142	-0.033	0.623	0.231	1			
Interaction term	-0.399	-0.030	0.702	0.133	0.489	1		
Advanced countries	-0.482	0.058	0.688	0.044	0.574	0.734	1	
Banking crisis dummy	-0.163	0.066	0.146	-0.009	0.119	0.113	0.128	1
HMFI	-0.037	-0.113	0.460	0.075	0.506	0.407	0.425	-0.017

Note: author's calculations.

Table 4: Estimation results – fine grid from RR

Number of obs = 1128						
R-squared =	0.5562					
Number of clusters (code) = 122						
	Coeficient	Robust Std. Err.	t	P>|t|	[95% Conf.	Interval]
Trade openess	0.518	0.150	3.46	0.001	0.221	0.815
CO interaction term	-0.045	0.023	-1.94	0.055	-0.090	0.001
Net oil export	0.018	0.013	1.41	0.161	-0.007	0.043
Regime 1	-1.134	0.450	-2.52	0.013	-2.026	-0.243
Regime 2	0.837	0.369	2.27	0.025	0.106	1.568
Regime 3	1.418	0.307	4.62	0.000	0.811	2.024
Regime 4	0.884	0.350	2.53	0.013	0.191	1.577
Regime 6	0.459	0.353	1.3	0.196	-0.240	1.158
Regime 7	0.547	0.344	1.59	0.114	-0.134	1.227
Regime 8	0.714	0.339	2.11	0.037	0.043	1.386
Regime 9	0.614	0.368	1.67	0.098	-0.115	1.342
Regime 10	0.870	0.417	2.08	0.039	0.044	1.695
Regime 11	0.666	0.549	1.21	0.227	-0.421	1.753
Regime 12	0.439	0.364	1.2	0.231	-0.283	1.160
Regime 14	-0.473	0.333	-1.42	0.159	-1.133	0.187
Regime 15	1.008	0.559	1.8	0.074	-0.100	2.115
Constant	-2.386	0.319	-7.48	0.000	-3.017	-1.755

*Note: author's calculations. Robust standard errors in italics, ***, **, * denote statistical significance at 1%, 5% a 10% levels, respectively.*

Table 5: Estimation results – monetary policy arrangements (2001-2008)

Compared to inflation targeting		**Compared to other**	
Trade openess	0.573***	Trade openess	0.573***
	0.166		*0.166*
CO interaction term	-0.043*	CO interaction term	-0.043*
	0.024		*0.024*
Net oil export	0.034**	Net oil export	0.034**
	0.014		*0.014*
Monetary aggregate ta	0.126	Inflation targeting	-0.321**
	0.148		*0.156*
Fund-supported or oth	-0.023	Monetary aggregate tar	-0.195
	0.152		*0.133*
Exchange rate anchor	0.035	Fund-supported or othe	-0.345**
	0.288		*0.141*
Other	0.321**	Exchange rate anchor	-0.286
	0.156		*0.245*
Monetary union	-1.824***	Monetary union	-2.145***
	0.250		*0.259*
Constant	-1.861***		-1.54***
R-sq (overall/within)	0.535		0.535
Obs	984		984

*Note: author's calculations. Robust standard errors in italics, ***, **, * denote statistical significance at 1%, 5% a 10% levels, respectively.*

Monetary Policy and Financial Stability
Měnová politika a finanční stabilita

MIROSLAV HRNČÍŘ

Abstract
The article deals with the interaction between monetary policy and financial stability. The discussion is focused on the impact of the world financial crisis on monetary policy orientation. The question is raised whether the established consensus on the goals and instruments of monetary policy still holds. In the pre-crisis period the mainstream approach considered price stability and financial stability as two separated goals to be achieved through different policies and instruments. Monetary policy safeguards price stability whereas regulatory and supervisory framework is responsible for financial stability. The instruments of monetary policy were expected to cope only with the consequences of financial imbalances and asset price bubbles, ex post correcting their negative impact on the economy. Lessons from the financial crisis heed to a reassessment of that approach. In the article the ways towards a more active engagement of monetary policy in preserving financial stability are examined. The view is held that financial imbalances should be reacted to already in the process of their formation, once they create a systemic risk and threaten to cause financial disarray. Though the views on the possible options diverge as yet, the role of financial stability concerns in monetary policy making is likely to keep increasing in the foreseeable future.

Keywords
monetary policy, central banking, price stability, financial stability, asset prices, flexible inflation targeting, monetary policy framework, leverage

Abstrakt
Stať rozebírá závislosti mezi měnovou politikou a finanční stabilitou. Klade si otázku, jaké důsledky má světová finanční krize na zaměření měnové politiky. Dochází k přehodnocení dosavadního konsenzu o cílech a nástrojích měnové politiky? V předkrizovém období převažující přístup teorie i praxe měnové politiky považoval cenovou stabilitu a finanční stabilitu za dva zcela oddělené cíle, jejichž zajišťování vyžaduje odlišné politiky a nástroje. Měnová politika zajišťuje cenovou stabilitu a na bubliny na trzích finančních aktiv reaguje pouze následně, když tlumí jejich důsledky. Zkušenosti z krize vedou ke korekci těchto přístupů. Ve stati jsou diskutovány náměty na aktivnější roli měnové politiky již v procesu tvorby finančních nerovnováh. I když se názory na možné směry řešení různí, nárůst váhy finanční stability pro nastavení měnové politiky se bude zřejmě prosazovat v teorii i praxi měnové politiky.

Klíčová slova
měnová politika, centrální bankovnictví, cenová stabilita, finanční stabilita, ceny aktiv, pružné cílování inflace, měnově-politický rámec, pákový efekt

1 Introduction: Monetary Policy in the Aftermath of the World Financial Crisis, Outline of the Challenge

What should be the aims monetary policy is striving for, what can it accomplish and what would only be a futile endeavour? The evolution of the theory and practice of monetary policy is in its essence a permanent search for the answers to those questions.

In the period prior to the world financial crisis of 2007-8 central bankers and academic economists seemed to reach a consensus on both the goals of monetary policy and on the instruments to achieve them. The conviction gained ground that price level stability is the right way in which central banks and monetary policy can best contribute to macroeconomic stability and sustainable growth. That consensus was as follows: the dominant goal is price stability and the key instrument is policy short term interest rates.

What did the outbreak of the world financial crisis mean for the mentioned consensus? Are its principles still valid or undermined? Will central banking be quite the same after the global crisis or never again? What are likely challenges in the years ahead? Those are the issues vividly discussed in the contemporary central banking community, by the central bankers and academics as well.

The discussion is focused on two interrelated issues:

i) The goals of monetary policy
Neither successful monetary policy nor the attainment of a low inflation environment in the past decade, however conducive to growth, prevented the onset of financial imbalances and high volatility in asset prices. The world financial crisis thus exposed the relationship between monetary policy and financial stability[1] and asset prices. Is the orientation of monetary policy on price stability too narrow? Should it embrace financial stability?

ii) Monetary policy implementation
Not only in the course of the financial crisis, but also in its aftermath, major central banks had to resort to non-standard instruments (far beyond interest rates), aggressively engaging their balance sheets and adopting various forms of direct (Fed, Bank of England, Bank of Japan) or indirect (ECB) quantitative easing. Are those operations and instruments only a temporary phenomenon or a more durable one? Could it signal a revival of the role of monetary aggregates in monetary policy implementation?

This article concentrates on the former issue: should the monetary policy framework be adjusted to reflect more closely the challenge of financial stability and if so, how? The approaches of the pre-crisis period are confronted with the views and arguments evolving in the post-crisis atmosphere.

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1 *Unlike standardized and clear cut definitions of macroeconomic and price stability, the concept of financial stability remains vague. It is as a rule interpreted as a situation when the financial system can fulfil its main functions (providing payments, channelling savings into investment, effecting risk sharing) smoothly, without disturbances that have significant social costs.*

Without doubt, there are significant interrelations between monetary policy and financial stability. On the one hand, balance sheets of economic agents, asset prices and the entire environment of financial markets are affected by monetary policy. Through this impact monetary policy and its changes have a role in creating conditions for financial stability, contributing to preserve it or, in turn, causing instability.[2] It is hard to imagine that the prolonged period of negative real policy rates in the 2000s did not contribute to the boom in credit and asset prices that preceded the crisis, although it did prove consistent with low inflation in prices of goods and services.

As a feedback, the state of financial environment is the key factor in the transmission of monetary policy, through which the path of policy rate affects economic activity and inflation. The degree of financial stability or instability thus predetermines the efficiency of monetary policy and the impact its instruments are generating.[3] The lessons from the financial crisis revealed that financial factors may have a very strong and constraining impact on the transmission mechanism, making standard interest-rate policy much less effective.

2 Stages of Monetary Policy and the Views on its Role in Maintaining Financial Stability

i) The era of "fine tuning" monetary policy

Monetary policy in the 1960s and 70s was viewed as a means to stimulate economic activity and to reduce unemployment. To achieve those goals central banks aimed at smoothing cyclical fluctuations. That type of monetary policy was therefore labelled "activist" or "fine tuning". Such an orientation on the short term neither required, nor made possible, to follow fixed rules. On the contrary, the decision making was of a discretionary character. Monetary policy making was veiled in secrecy; central banks had to try to "surprise" if not to "cheat" economic agents to achieve their aims.

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2 *The assessment of the resulting impact of monetary policy may, however, diverge. The discussion on the causes of the world financial crisis is just an example of such a disagreement. Even with the benefit of hindsight the views on the role of monetary policy clash. Was the crisis caused mainly by regulatory and supervisory failures or by monetary policy? Was the Fed the culprit, leaving its monetary policy too loose for a too long time? This is claimed e.g. by J. B. Taylor, father of the often cited Taylor rule of monetary policy which he derived on the basis of the empirical assessment of Fed´s behaviour since the early 1980 ies . According to Taylor, the divergence from this rule in the years preceding the crisis was Fed´s crucial mistake contributing to the outbreak of the crisis. Cf. TAYLOR, J. B., The Financial Crisis and the Policy Responses: An Empirical Analysis of What Went Wrong, 2009.*

3 *The world financial crisis undermined the smooth functioning of financial markets. As a result, the normal transmission channels of monetary policy were jammed and the standard instruments were loosing their function. Under those conditions some central banks (among them the important ones, the Fed, Bank of England and ECB), had to resort to non-standard forms of monetary policy, in particular to the waves of quantitative easing.*

ii) Monetary policy in the pre-crisis period.

A comparison of the recent decades with the 1960s and 1970s reveals that the shift towards price stability has been accompanied by profound changes in the role, approaches and orientation of central banking. Monetary policy turned into technical mode: setting one instrument (short-term interest rate) so as to achieve one goal (price stability). The technical character of monetary policy allowed for the adoption of monetary policy rules and called for increasing independence of central banks. Unlike the secrecy and discretion in the past, the new framework was based on an active role of inflation expectations shared by economic agents. For this purpose, monetary policy had to become transparent and predictable.

From the macroeconomic point of view, the decade preceding the first signals of the financial crisis in 2007 and its spread in 2008 appeared as an extremely favourable period in the modern history of the world economy[4]. Stable and relatively dynamic economic growth coexisted with low and non-volatile inflation. Such an environment resulted in increasing credibility of central banks. Their anti-inflationary orientation found its verification.

However, with the benefit of hindsight, there is no doubt that the primary causes of the crisis were already built into the "golden" period, its seeds were sown just when the world economy seemingly flourished. Stable growth rates and a low inflation environment of the Great Moderation period were not accompanied by the commensurate stability of financial markets and asset prices. On the contrary, with growing liberalisation of the financial sector, massive spread of financial innovation and advancing globalisation, the tendency towards imbalances and bubbles in financial markets has grown. The long-lasting favourable macroeconomic trends fostered undue satisfaction and expectations within the financial community as well as real economy agents. As a result, the arising imbalances and implied risks were mostly underestimated and neglected. An environment prone to bubbles was thus created.

In a way, a successful monetary policy may have contributed to such an environment. Given that a monetary policy focused on price stability is credible, inflationary pressures may accumulate for some time without being reflected in actual inflation as routinely measured, i.e. in the prices of goods and services. The more successful and credible an anti-inflation policy is, the longer the signs of growing imbalances may remain hidden below the surface, and the more intense is likely to be the negative impact of bubbles when they burst. A credible central bank focusing on price stability can thus contribute to the build-up of uncontrolled financial imbalances. It follows, the impact of monetary policy "suffers" a credibility and success paradox.

2.1 Pre-crisis Principles Compared with the Lessons from the Crisis

The outbreak of the financial crisis shook confidence in the applied regime and policies. Despite the low and stable inflation and dampened cyclical fluctuations, financial crisis hit

4 Dubbed in the literature as the "Golden" or the "Nice Decade" (Non-Inflationary Consistently Expansionary Decade). Economists started to speak of a "Great Moderation", i.e. of a period in which the traditional business cycle was dampened at last.

the world economy, with an imminent risk of a deep recession and deflation, and inflation threatening in the longer run. As a result, many pre-crisis "certainties" have gone.

i) Pre-crisis concepts:

- Success in stabilizing inflation is the key for macroeconomic stability, price stability is therefore the best contribution monetary policy can provide to the sustainable development.
- Once the low inflation environment is achieved, the economy was viewed as broadly capable to adjust itself. This belief was underpinned by the experience from the Great Moderation era.
- Monetary policy operating through the control of a short-term interest rate is sufficient to capture the impact of monetary policy on the economy. Although short-term interest rates alone have only a modest influence on economic activity, their transmission affects medium- and long-term interest rates, which do have a substantial role in the economy. A short term interest rate, together with expectations about its future path, is thus capable to affect the entire range of interest rates and their impact on the economy.
- The implementation of monetary policy through interest rate instruments, which are entirely in the domain of the central bank only, established a clear cut division between monetary and fiscal policy making.

ii) Financial crisis undermined those established beliefs:

- The crisis demonstrated that the existence of price stability could not secure and guarantee financial and macroeconomic stability.
- Central banks had to resort to unconventional monetary policies (more precisely: balance sheet policies), well beyond standard interest rate policy, to influence longer term interest rates, credit spreads and financial conditions in general. They engaged in massive purchases of government and private sector assets (such as mortgage backed securities) and extended large scale long-term liquidity support to the banking sector.
- Due to those non-standard, balance-sheet operations the division of responsibilities between monetary and fiscal policy has become fuzzy. Such a trend was all the more problematic as it evolved in the conditions of soaring public sector debts and rising sovereign risk.

This confrontation of the pre- crisis views with the lessons from the crisis reveals how a radical shift occurred under the impact of the crisis.

2.2 Monetary Policy and Financial Stability: "Mainstream" Approach

The conventional mainstream approach assumed that monetary policy can do little more than deal with the fallout from the unwinding of asset price bubbles. Central banks should step in only after bubbles burst, supplying the necessary liquidity to mitigate the adverse

effects on the macroeconomic situation.[5] The most influential supporter of the given approach was Alan Greenspan, the then chairman of the Fed.[6]

The mainstream view seemed to be vindicated against the backdrop of a number of persuasive arguments why central banks should not try to "deflate" asset market bubbles:

- the experience showed that to distinguish bubbles ex ante from normal adjustments to fundamentals is highly uncertain, bubbles are hard to identify before they burst,
- a monetary policy deflation of such bubbles carries a risk of major negative effects on the real economy,
- even if a central bank could identify bubbles, the instruments of monetary policy are not appropriate tools to cope with them. The policy interest rate, in particular, is too coarse to calibrate the desirable tightening,
- setting a separate financial stability objective for monetary policy would compromise its main goal to deliver price stability and most likely it would lead to public confusion about monetary policy orientation.

The mainstream approach may be therefore summarized as follows: price stability and financial stability are viewed as separate goals and, accordingly, their attainment requires separate policies to deliver. Monetary policy operating through interest rates is called to secure price stability along with the stability of the aggregate output, while prudential instruments, regulatory and supervisory tools are expected to provide for financial stability and the smooth functioning of financial markets. Central banks should react to bubbles only if they pose a direct threat to price stability. If it is not the case, their reaction should come only after the bubble bursts, supplying the necessary liquidity to mitigate the adverse consequences on the real economy (to clean).

Such a view on policy reaction was widely adhered to not only before, but also after the outbreak of the world financial crisis.[7]

2.3 Monetary Policy and Financial Stability: an "Alternative" Approach

In the opposition to the mainstream concepts there were some voices - already before the outbreak of the crisis - calling for a more active reaction of monetary policy to the risks of

5 *This is the principle of the Jackson Hole consensus (named after the location of annual conferences of leading world bankers and economists). Cf. MISHKIN, F. Will Monetary Policy Become More of a Science?, 2007.*

6 *"We need to focus on policies to mitigate the fallout when it occurs and, hopefully, ease the transition to the next expansion". GREENSPAN, A., Economic Volatility, 2002.*

7 *E.g. Fed´s Vice Chairman Donald L. Kohn addressing 26th Cato Institute´s Annual Monetary Policy Conference in November , 2008, underlined he was not convinced that " the current crisis demonstrates that central banks should switch to trying to check speculative activity through tighter monetary policy whenever they perceive a bubble forming". Cf. KOHN, D. L., Monetary Policy and Asset Price Bubbles Revisited, 2008.*

financial instability. They expressed dissatisfaction at how financial imbalances are treated in standard monetary policy and its models.[8]

The opponents of mainstream approach, based particularly in the Bank for International Settlements, pointed out that the debate on the monetary policy role in preserving financial stability was flawed. It has often been cast almost entirely whether central banks are able to judge the degree of overvaluation of particular assets. According to the "alternative" view, this was, in fact, a misplaced focus. What should be assessed is not whether assets are overpriced, but the formation of imbalances. The experience suggested that nearly all major unsustainable booms in asset prices were accompanied or preceded by strong increases in credit and/or money supply.[9] Therefore what matters is the degree to which the positions taken by leveraged investors pose a risk to financial stability.

In the "alternative" view, the mainstream approach, i.e. only subsequent accommodation of the consequences of bubbles and an orientation solely on mitigation of the risks of recession, was unduly asymmetric. The outcome is an environment with too low real interest rates where banks and their customers are stimulated to take on excessive risk, with adverse consequences for financial stability. If growing imbalances are left uncorrected, they tend to deepen and there is nothing to affect expectations during the period the bubble is inflating. When finally bubble bursts, the costs to the real economy are likely to be quite high.

In that line of reasoning the foremost challenge for central banks is to cope with the formation of imbalances, to try to stem them and to prevent the development of bubbles, rather than to concentrate only on what should be done once a bubble bursts. Central banks should react to imbalances once they are growing, even if the outlook for inflation and growth rate does not yet seem to be under threat. Hence, this stance requires a more symmetric approach of central banks: not only should they deal with the impact of imbalances and bubbles ex post (to clean), but they should try to control and constrain their growth ex ante (to lean against the wind).

Though that line of reasoning attracted some professional attention, in the period before the outbreak of the world financial crisis it was not reflected in the policies of central banks and had not prevailed in the theoretical field either.

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8 *"In a monetary regime in which the central bank´s operational objective is expressed exclusively in terms of short-term inflation, there may be insufficient protection against the build-up of financial imbalances that lies at the root of much of the financial instability we observe. This could be so if the focus on short-term inflation control meant that the authorities did not tighten monetary policy sufficiently pre-emptively to lean against excessive credit expansion and asset price increases. If the monetary policy reaction function does not incorporate financial imbalances, the monetary anchor may fail to deliver financial stability." CROCKETT, A., International Standard Setting in Financial Supervision, 2003.*

9 *Cf. DETKEN, C., SMETS, F., Assets Price Booms in Monetary Policy, 2004.*

3 Search for a New Consensus on the Orientation of Monetary Policy

The world financial crisis and its unexpectedly heavy costs have shaken the established concepts and stimulated a reassessment of means and instruments to better preserve financial stability. What should be the role of monetary policy in this reassessment? In the conditions of the financial crisis the interdependency of monetary policy implementation and financial markets functions was particularly exposed. But does it mean that it should be monetary policy which should assume greater responsibility in securing financial stability? Should its goals and framework be adjusted towards more engagement in financial stability? This is the principal question of the on-going discussion.

Reviewing the current views one can see areas of agreement but, as yet, more of a disagreement. All seem to agree that a better theoretical, empirical and operational understanding of the role of financial factors in the transmission mechanism of monetary policy is required. As yet, their role in macroeconomic models used to be only marginal. Applied models should be therefore augmented to better capture the functioning of banks and financial markets and their interplay with the real economy.

The agreement also extends to the need to improve the real-time indicators of the build-up of financial imbalances. Their enhancement should advance our ability to detect when rapid credit expansion and asset price increases only reflect sustainable movements in the underlying economic fundamentals as opposed to the situations of surging imbalances susceptible to future correction.

Unlike the above "technical" issues, disagreement continues on the monetary policy role in supporting financial and macroeconomic stability. The views diverge whether and, if so, how to adjust the monetary policy framework. The range of opinions is wide, starting with the continuity of the hitherto approach to the introduction of financial stability as a separate target into the loss function of central banks. Recognizing that diversity, we structure the on-going debate into two headings: continuity versus adjustment of monetary policy framework.

The continuity view adheres to the principles of the pre-crisis mainstream approach and holds that monetary policy regimes should keep focusing on price stability more or less in the same way as before the crisis.

The distinguishing feature of the adjustment "school" is an endeavour to assign financial factors more weight in the implementation of monetary policy. The most frequented option is the introduction of financial stability as a separate objective of monetary policy, as an additional stabilization goal, alongside the traditional goals of inflation and output gap stabilization. Though the ideas presented so far mostly uphold flexible inflation targeting framework, an extension of monetary policy targets to financial stability would represent a considerable shift from the previous mainstream thinking and signal an obvious departure from a "narrow" concept of central banking, hitherto concentrated on price stability and typical for pre-crisis era, to a more "broader" one.

The adjustment view draws on the ideas of "leaning against the wind" developed in the pre-crisis period in an opposition to the mainstream approach. Since the outbreak of the financial crisis those ideas have been gaining ground. As a result, the once "alternative" approach seems to be currently turning into the mainstream one.

3.1 Continuity View

The continuity view holds that flexible inflation targeting does not require any explicit addition of financial imbalances or asset prices to the formal structure of inflation targets. This stance is clearly stated by L. Svensson, an eminent expert on flexible inflation targeting.[10] In the background is the belief, that the outbreak of financial crisis had relatively little to do with monetary policy and was mainly due to regulatory and supervisory failures, distorted incentives in financial markets and mishandled macro conditions.

The type of inflation targeting which is commonly applied is called "flexible" as it does not pursue price stability as a sole target, though in connection with the real economy performance. As such it aims at stabilizing inflation around the inflation target and resource utilization around desirable output-gap. The concept of flexible inflation targeting thus means that a trade-off between inflation stabilization and output stabilization is built into monetary policy making. The policy implementation then aims at a reasonable compromise between the two.

Because of the time lags between monetary policy actions and their effect on inflation and real economy, inflation targeting is based on macroeconomic forecasts. Accordingly, flexible inflation targeting can be described as forecast targeting. The central bank chooses a policy rate path so that the forecast stabilizes both inflation and resource utilization.

According to the continuity view the targets of monetary policy should remain to be confined to price stability and resource utilization (output gap), i.e. they should not be extended on financial conditions. The arguments for this stance appear persuasive:

- Financial stability and price stability, though interrelated, are different goals. Accordingly, financial stability policy and monetary policy are different, with different objectives, instruments and responsibilities,
- Flexible inflation targeting by itself cannot achieve financial stability. In accordance with Tinbergen separation principle, each goal must have its own instrument, interest rate policy is therefore not enough to achieve financial stability,
- Instruments other than interest rates (credit-to- GDP ratio, capital standards, loan-to-value ratio) are likely to be much more effective in avoiding excessive credit growth and asset-price booms, and are therefore more appropriate to use as a first-best alternative to care of financial stability,

10 *"The main conclusion for monetary policy from the crisis is that flexible inflation targeting, applied in the right way and using all the information about financial factors that is relevant for the forecast of inflation and resource utilization at any horizon, remains the monetary policy before, during, and after the financial crisis that has the best chance to stabilize both inflation and the real economy".*
Cf. SVENSSON, L. E.O., Inflation Targeting, 2010, p.52.

- The extension of the monetary policy targets to financial stability, i.e. a further extension of the implied trade-off, would cause overburdening of monetary policy and loss of its efficiency in securing its main target, price stability.

The essence of the continuity view can be summarized as follows: central banks should continue in the hitherto procedure and take financial conditions such as credit growth, asset prices and imbalances into account only to the extent that they have an impact on the forecast of inflation and resource utilization. They are not target variables, but only indicators providing information to the central bank. Not even the lessons from the financial crisis justify turning those indicators into policy targets, along with price and output stability.

Nevertheless, the challenge of the crisis outbreak made an impact on the advocates of the continuity of the existing monetary policy framework, too. They are striving to prove that the applied regime of flexible inflation targeting has a potential to cope with the risks for financial stability without any substantial change in its operational framework. This potential to be used is seen, in particular, in the enhanced role of financial indicators and in the extension of monetary policy horizon.

i) Why not to increase the weight of financial indicators in setting policy when justified ?

That argument runs as follows: it may appear that financial factors have a larger role in affecting the transmission mechanism and as indicators of future inflation and resource utilization than thought before. If so, central banks should be responding more to financial indicators in the sense of adjusting the policy rate to given changes of the financial indicators.

This stance comes closer to "leaning against the wind" provided credit growth and asset prices are considered just indicators. They are emphasized because they may have increased the potential of negative effects on inflation and resource utilization at a longer period (which actually happened in the course of the world financial crisis). If so, then "leaning against the wind" is considered as completely consistent with flexible inflation targeting and a way to improve the stability of inflation and resource utilization in the longer run.[11] However, a disagreement with "leaning against the wind" approach remains if it implies that credit growth and asset prices should become targets and enter the explicit or implicit loss function alongside inflation and resource utilization.

ii) Why not to extend time horizon of monetary policy ?

The greater emphasis put by central banks in recent decades on achieving price stability through adopting the regime of inflation targeting has already implied a significant lengthening of the policy horizon. Whereas policies of "fine-tuning" had previously focused on the immediate effects of monetary policy on output and employment, under inflation targeting attention shifted to the subsequent effects on inflation over the following one or two years.

11 Cf. SVENSSON, L. E. O., Inflation Targeting, p. 58.

The essence of the standard flexible inflation targeting[12] entails a long run objective with no fixed time frame for which it is to be reached. In practice, however, policy tends to be focused on a horizon which is consistent with the lags of monetary policy and yet at the same time not too far ahead so as to maintain a reasonable degree of confidence about the forecasts. In reality, two years is often chosen as a reasonable horizon that satisfies these two criteria.

Nevertheless, even this relatively extended horizon appears to be inadequate for the ability of inflation targeting to handle financial imbalances which are - as a rule - evolving over a more protracted period. Taking on board the possible risks posed by cumulating financial imbalances may therefore require a further shift in the monetary policy horizon of central banks.

Now, the advocates of the continuity view claim that the inflation targeting framework will automatically take account of risks to financial stability, without requiring any additional stabilization goals, as long as monetary policy decisions are made on the basis of projections that extend far enough into the future. The argument boils down to the link between the consequences of financial imbalances and the policies towards attainment of inflation and output stabilisation targets over a longer period.

In their view, should the financial imbalances deteriorate and should financial crisis occur, it will likely result in output below potential and/or deflation. Hence the standard policies to achieve price and output gap stability – if extended over a long enough horizons – will simultaneously reduce the likelihood of a crisis.

The snag of that reasoning seems to be in the implied sequencing. Within the standard framework of the flexible inflation targeting adjustment in monetary policy to stabilize inflation and output gap is initiated as a reaction to the forecast divergence from the inflation target. It means, monetary policy reaction follows only after deterioration of financial factors threatening to cause deflation and/or negative output gap was evolving. Consequently, considerable economic and social costs are likely to be already incurred.

3.2 Adjustment Oriented Views

According to adjustment "school" the desirable framework should allow monetary policy to tighten even if near term inflation is under control, whenever there are signs that credit and asset price booms threaten financial stability. In their view, extending the horizon per se will not capture the risks of financial imbalances as it does not address the underlying weakness of the applied regime: a concern for financial imbalances is not incorporated either in the adopted forecasting model and/or among the stabilization goals.

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12 Unlike that standard regime, there were cases and/or development stages when interest rates were set to bring inflation forecast to the target over some fixed period, be it a concrete date or period. Such an option has been applied by the central banks particularly in the situation of gradual disinflation to price stability. The Czech National Bank also adopted this fixed period target procedure in the first stages of inflation targeting before reaching the status of the "low inflation economy".

As especially technical challenges make hardly feasible to modify accordingly and to extend the type of the model used, a more practical alternative to such a more complex model is seen in a modification of the loss function to explicitly include a concern for financial imbalances. The central bank, aiming to pre-empt the risks associated with evolving financial imbalances should be guided by a separate operational objective, on top of inflation and output stabilization goals.

There are two principal arguments why it should be not only useful but also desirable to effectively engage monetary policy in financial stabilization:

- The influence of monetary policy on credit conditions, asset prices and yields is hardly in any doubt. Monetary policy setting inevitably affects financial environment, the degree of leverage of financial institutions and hence the probability of occurrence of a crisis.
- However welcomed are the activities towards a more efficient regulatory framework, to strengthen its macro prudential dimension and to change its character from a procyclical to a more counter-cyclical one, the regulatory and supervisory activities can be hardly successful enough without cooperative monetary policy, consistent with the requirements of financial stability.

An extended engagement of monetary policy in financial stabilization is, however, exposed to the constraints:

- there may be conflicts between goals of price and financial stabilization
- the extended policy framework should still provide a clear anchor for medium term inflation expectations
- the technical background as well as the practical experience on how to implement "leaning against the wind" is mostly lacking as yet
- practical aspect of extracting the relevant information from financial imbalances in a way that allows pre-emptive policy to be implemented remains extremely demanding.

3.3 Trade-off: Central Bank´s Inflation and Output Stabilization Objectives against Financial Stability Requirements

The pre-crisis consensus in the sense that price stability is the main goal of monetary policy continues to be widely shared and undisputed even after the crisis. Hence, any extension of monetary policy framework should not imply any significant weakening of the commitment to price stability. Therefore the introduction of financial stability objective into a loss function is at the same time required not to undermine in any way medium term inflation target.

However, it may be only by coincidence if the interest rate policy focused on the traditional stabilization objectives is also the one that best serves the financial stability goal. Therefore a conflict is likely to arise between the use of monetary policy to maintain price stability and stable real activity and its use to diminish risks to financial stability. In such a constellation, monetary policy faces a trade-off.

This trade-off may appear a parallel to that experienced already in a flexible inflation targeting framework between its goals of inflation stabilization and output gap stabilization. Nevertheless, there is a difference. Adding one more target extends the potential frequency of conflict. Moreover, the requirements of price stability and financial stability may be developing in a more or less opposite direction. Such a situation e.g. arises when forecast for inflation signals "no change in interest rates", whereas credit and money are dramatically rising together with asset prices, threatening financial stability. Evidently, a balancing problem of financial stability concerns with price stability objectives arises.

M. Woodford[13] offered a solution to that balancing problem which appears to be promising. It is based on the distinction between normal conditions and a situation fraught with high systemic risk. In normal conditions monetary policy is focused on standard targets. Unlike that, during periods, when increasing leverage signals an increasing probability of a financial distress and possibly crisis, the central bank should "lean against the wind". This implies that the policy ends up with lower inflation and real activity than it would be otherwise the case.[14] In those periods, the central bank deliberately aims at undershooting inflation and output goals in order to reduce the risk of a financial crisis. Hence, financial stability considerations would be "switched on" only temporary, affecting the near-term transition path, in the same way as concerns for stability of the real economy do under conventional flexible inflation targeting.

While a compromise, the presented approach should uphold price stability as a dominant goal of monetary policy and, at the same time, take care of financial stability concerns. Nevertheless, in the periods of financial distress when the central bank "leans against the wind" in order to reduce the risk of financial crisis the inflation and output goals are likely to be undershot. Hence, the short term deviations from the inflation target should be considered justified and tolerated because the central bank has to take into account an additional trade-off between price and output stability on the one hand, and financial imbalances on the other. This requires a corresponding communication strategy explaining why the slower convergence of inflation figures to the target is taking place.

Furthermore, when the inflation and output targets are undershot, the central bank is now committed by the same criterion to a subsequent easing of monetary policy. Consequently, the cumulative effect on the price level in the longer run may be close to zero. Hence, public should be well aware that a more prolonged policy horizon may become relevant once monetary policy is active in preserving financial stability.

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13 An extended version of the new Keynesian model was developed to present the idea. Cf. WOODFORD, M., Forecast Targeting as a Monetary Policy Strategy: Policy Rules in Practice, 2007.

14 This means that the policy rate should be higher during these periods than it would normally be required by standard Taylor rule considerations. It should be noted, however, that higher policy rates tend to boost capital inflows potentially offsetting the efficacy of the policy measure taken, which may be relevant especially in the terms of a small open economy.

3.4 How Can Monetary Policy Be Conducive to Safeguarding Financial Stability?

In what follows, potential ways to cope with the mentioned constraints are identified, recognizing the existence of the three different phases:
i) in the build up of imbalances and rising threats to financial stability,
ii) if financial crisis occurred,
iii) in the aftermath of financial crisis.

ad i) Is there a viable option for monetary policy to reduce the likelihood of occurrence of a crisis?

Unlike the pre-crisis debate whether central banks are able to judge the degree of overvaluation of particular assets (which is hardly feasible), a more workable approach is searched for. A link between monetary policy and leverage of financial institutions[15] may provide a basis for a solution.

Monetary policy choices affect the degree of leverage, since a loosening of monetary policy is generally associated with increased leverage. The greater is the leverage taken on, then the greater the probability of a shock triggering a chain reaction affecting financial sector is. Consequently, the greater is also the probability of systemic risk and the possibility of a crisis evolving. Hence, a conclusion can be drawn: to reduce the likelihood of financial instability requires reducing the too expanded leverage.

From the point of monetary policy it appears attractive that the highly leveraged investing can be effectively limited by relatively small changes in the interest rates, at which the leveraged positions are financed. Given that, the mainstream argument against the use of monetary policy looses much of its relevance. That argument was as follows: if interest rates changes should cope with asset market overvaluation, they would have to be raised so high that their impact on real economy would be disastrous. That conclusion is, by itself, no doubt true. However, in the "leverage" approach, the policy aim is not to cope with the overvaluation of the assets as such, the leverage taken on is considered a critical issue instead.

This line of thinking results in conclusion that it is not only appropriate but also feasible to try to reduce the ex-ante probability of disarray, even at the cost of some loss to other stabilization objectives. To provide for this, introducing minimization of the risk of financial instability as an additional stabilization goal, alongside the traditional goals of inflation and output gap, is considered desirable.

ad ii) Monetary policy once the financial crisis broke out

The disarray of the financial system has negative impact on the transmission mechanism through which policy rate affects inflation and economic activity. If in the crisis conditions

15 Leverage is the ratio of a company's debt to its equity, i.e. to the part of its total capital that is owned by shareholders. High leverage means a high degree of reliance on debt financing.

the policy rate is set as a function of inflation and output gap, i.e. in a standard way (reflecting e.g. Taylor rule), an undesirable decline of the inflation rate (risk of deflation) and of economic activity is likely to occur. Consequently, a modified rule should be applied during a crisis situation to avoid the chain of negative consequences.

Once the financial crisis broke out, an immediate reaction of monetary policy is justified, without waiting for inflation and output to decline. A useful way to adapt the Taylor rule for such a crisis situation may be a response to observed changes in credit spreads (i.e. in the margin between creditor´ s and debtor´ s interest rates).
V. Cúrdia and M.Woodford[16] presented a model version of such an approach. Their model reflects consequences of the increased credit spreads for monetary transmission mechanism and a corresponding reaction of monetary policy to changes in those credit spreads, i.e. a modified path for policy rate. Along that approach, monetary policy reaction does not wait to actual fall in inflation and in economic activity. Rather, policy interest rate is cut already with the changes in credit spreads.

The described approach offers a solution for the crisis, without changing the standard inflation targeting framework. The suggested procedure is consistent with inflation targeting, there is only a shift in the structure of the relevant indicators, and/or in their weight.

ad iii) Monetary policy in the aftermath of financial crisis

There is hardly any unifying view on what should be the course of monetary policy in the aftermath of a financial crisis. This refers to the timing of exit from non-standard instruments, but not only that.

In the view of some the perceived risk is that the policy will not be accommodative enough and/ or not kept long enough given incurred costs and the prolonged consequences of the financial crisis. Central banks should be therefore as accommodative as possible, by driving policy rates close to zero, by committing to keep them low as long as desirable, and by keeping central bank's balance sheet instruments active for a sufficiently long period[17].

16 Cf. CÚRDIA, V.; WOODFORD, M., Credit Spreads and Monetary Policy, 2010, p. 3-35.

17 This stance seems to be followed by the Fed, committing among other to keep low interest rates as long as 2013 (and possibly even 2014), which had hardly any parallel in the past.

An opposite view points to the limitations and unwelcome side effects of such a too long-lasting accommodative monetary policy.[18] Very low interest rates may disguise underlying credit quality weaknesses, encouraging banks to pretend that loans of low-quality borrowers will become good. Moreover, low interest rates, extended central bank funding and asset purchases make the recognition of the incurred costs and the commitment to debts unwinding less binding. Instead, in the post crisis conditions most national economies need balance-sheet repair which accommodative policies are likely to delay.

Obviously, there is hardly any standard solution as for accommodative monetary policy in the aftermath of the financial crisis which would be "right" irrespective of the concrete circumstances. The crucial issue is the realistic assessment of the given stage of the post-crisis environment and its impact on the role and setting of monetary policy, be it interest rate (conventional) or balance sheet (unconventional) policy.

Conclusions

The world financial crisis of 2007-8 casts doubts on the existing consensus on the role of monetary policy, which dominated both theory and the conduct of monetary policy in the previous decades. The crisis revealed some weaknesses of the hitherto approaches. Models applied by central banks did not elaborate extensively enough on the role of financial markets in the transmission channels of monetary policy and did not address the impact of financial frictions and of some other factors leading to the imperfect functioning of financial markets.

Under the pressure of the crisis, non-standard policies and instruments have been resorted to, including some previously regarded as taboo in the developed world. At the same time the unexpectedly high costs incurred because of crisis drew the attention to financial stability concerns and to the ways of its upholding. The debate developed whether monetary policy orientation on price stability did not prove too narrow and whether it should not be more engaged in preserving financial stability. The view is held that however welcomed is the ongoing enhancement of the regulatory and supervisory framework and its macroprudential dimension extended, it can be hardly efficient enough without consistent and cooperating monetary policy. Balance sheets of economic agents, asset prices and the entire environment of financial markets are influenced by monetary policy.

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18 *W. White identified the undesirable medium-term effects of very expansionary monetary policies as follows: "the first worry is that such policies will prove effective only by stimulating a "bubble" in some new market and still further increases in leverage and indebtedness. A second worry is that very easy monetary policy reduces growth potential in various ways. In particular, saving rates are reduced (affecting the capital stock over time) and "zombie" companies and banks are allowed to survive. A third worry is that the "search for yield" will strongly encourage imprudent lending and the development of new instruments to hide risk. Fourth, at very low interest rates, the interbank market will collapse, leaving the central bank as the market maker of last resort. And finally, there is the worry that extraordinary easy monetary policies (various forms of quantitative and credit easing) might inadvertently culminate in rising inflation".*
Cf. WHITE, W. R., Some Alternative Perspectives on Macroeconomic Theory and Some Policy Implications, 2010, p. 50-51.

Though it would be premature to judge whether, and if so, how the established consensus will adjust, price stability is most likely to remain the dominant goal of monetary policy. Nonetheless, an apparent shift in the arguments towards the increased role of monetary policy in safeguarding financial stability is visible. The ways are searched how to integrate financial stability concerns into monetary policy making in general and to a flexible inflation targeting framework in particular.

As yet, the views on the concrete resolution diverge. Some see the argument for the use of monetary policy to cope with the risk to financial stability limited to exceptional situations, as a second best solution only. If there is a threat to financial stability and other, more effective instruments are not available, then the impact on financial stability should be taken into consideration when choosing the policy rate path. It could result in a lower or higher policy rate path than otherwise, in order to trade-off less effective stabilization of inflation and resource utilization for more financial stability.

Unlike that, an option gaining wider support claims a certain weight should be attributed to financial stability along with the standard inflation and output gap targets in setting monetary policy. As a conflict is likely to exist between the requirements of price and financial stability, such an extension of monetary policy targets implies that a trade-off between them is faced. The suggested response assumes a temporary "switch" to the financial stability mode once a situation characterized by substantial financial stability risks develops, while the commitment to the medium term inflation target remains untouched.

Though a compromise, such an approach represents a departure from the previous mainstream view which posited only subsequent reaction to the consequences of asset market bubbles, i.e. "to clean only". Contrary to that, monetary policy is expected to react not only to the fallout of asset price bubbles, but already to the formation of imbalances, provided the risks of financial instability exceed a certain threshold. Hence, the implementation of the presented approach would imply a shift from the ex post solution, "to clean only", to occasional ex ante reaction to financial stability concerns, i.e." to lean against the wind" once desirable.

Concluding, the world financial crisis turned out to be a milestone in the evolvement of the theory and practice of monetary policy. Though the views on the role of monetary policy in safeguarding financial stability continue to diverge as yet, the conviction is gaining ground that monetary policy should reflect financial stability concerns in a more active, ex ante way. Hence, the established consensus on the goals of monetary policy is likely to go through reassessment and adjustment.

It in no way implies, however, that financial stability could be and should be primarily secured through monetary policy. Instead, the regulatory and supervisory instruments are the "first line of defence" and should be capable to carry the main burden. Strengthening their macroprudential orientation, allocating more attention on preventing episodes of systemic distress that have costs for the real economy rather than on preventing the failure of individual institutions are welcomed steps towards consistent and mutually reenforcing monetary and prudential policies in the realm of financial stability.

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Contact address / Kontaktní adresa:

Ing. Miroslav Hrnčíř, DrSc.
Czech National Bank / Česká národní banka
University of Finance and Administration / Vysoká škola finanční a správní
(miroslav.hrncir@cnb.cz)

Application of Artificial Intelligence and Data Mining Techniques to Financial Markets

Využití technik umělé inteligence a dolování dat na finančních trzích

KATARÍNA HIĽOVSKÁ, PETER KONCZ

Abstract

The aim of artificial intelligence is to discover mechanisms of adaptation in a changing environment with utilisation of intelligence, for instance in the ability to exclude unlikely solutions. Artificial intelligence methods have extensive application in different fields such as medicine, games, transportation, or heavy industry. This paper deals with interdisciplinary issues – interconnection of artificial intelligence and finance. The paper briefly describes techniques of data mining, expert systems and agent based computation intelligence and specifies the types of tasks solved by these techniques in the context of financial tasks. It provides deeper insight into potential usage of intelligent systems on financial markets.

Keywords

artificial intelligence, data mining, financial markets, forecasting, stock exchange

Abstrakt

Cílem umělé inteligence je objevit mechanismy adaptace v měnícím se prostředí s použitím inteligence, například ve schopnosti odmítnout nepravděpodobná řešení. Metody umělé inteligence mají rozsáhlé využití v nejrůznějších oblastech jako medicína, hry, doprava a těžký průmysl. Tato práce pojednává o interdisciplinární problematice - propojení umělé inteligence a financí. Práce ve zkratce popisuje techniky dolování dat, expertní systémy a výpočetní inteligenci založenou na agentech a specifikuje typy úkolů řešené pomocí těchto technik v kontextu finančních problémů. Přináší hlubší pohled na možné využití inteligentních systémů na finančních trzích.

Klíčová slova

umělá inteligence, dolování dat, finanční trhy, prognózování, burza cenných papírů

Introduction

Current economics requires a prompt and accurate decision-making process in a constantly changing market environment. There is an increasing tendency in the usage of information technologies in the decisions of economic subjects. Traditional statistic methods are in recent times often complemented by methods of machine learning. The potential of applied machine learning rests not only in prompt and reliable performance but also in its ability to discover hidden knowledge in huge amounts of data. Decision making with artificial intelligence support can partly eliminate the bounded rationality of a decision maker to make better decision with more relevant data and information.

Artificial intelligence deals with problems of classification, prediction and optimization incorporating processes that can be called intelligent in decision making etc. where the problems cannot be simply formalised. These problems are typical also for economics and therefore there is a potential in usage of artificial intelligence techniques in this field.

The main goal of this paper is to point out the artificial intelligence techniques that can be utilised in financial application and to provide an overview of research undertaken in this field. The paper is aimed toward an economic audience unfamiliar with artificial intelligence techniques and may consider utilization of these techniques in further research.

1 Data Mining and Artificial Intelligence

Data mining is defined as the process of extracting valid, previously unknown, comprehensible, and actionable information from large databases and using it to make crucial business decisions (Simoudis, 1996). Data mining is considered as the key process of Knowledge Discovery in Databases (KDD) (Seifert, 2004). The main data mining techniques are Classification and Clustering analysis, Time-series mining, and Association rules mining (Johnson, 2011).

Data mining techniques are mostly based on statistics, as well as machine learning while the patterns may be inferred from different types of data. Methods used in data mining, such as machine learning, belong to the field of artificial intelligence.

Artificial intelligence (AI) systems are designed to adapt and learn. The first definition of AI is based on the Turing test. Alan Turing undertook a test of a machine's ability to demonstrate intelligence. It proceeds as follows: a human judge engages in a natural language conversation with one human and one machine, each of which tries to appear human. The aim of the judge is to distinguish human from machine, only on the basis of conversation (without visual or other help). When the judge cannot distinguish between human and machine, than the machine may be considered as intelligent.

The AI approach can be split into two main approaches – Symbolic (Conventional) AI and Sub symbolic AI (Computational intelligence). Conventional AI uses logic and rules to make decisions. Examples of conventional AI techniques are expert systems and Bayesian networks. It is a top-down approach. Computational Intelligence (soft computing) takes inspiration from biological mechanisms and uses a bottom-up approach. Examples of computational intelligence techniques used in economic application are neural networks, genetic algorithms, fuzzy systems etc. (Johnson, 2011).

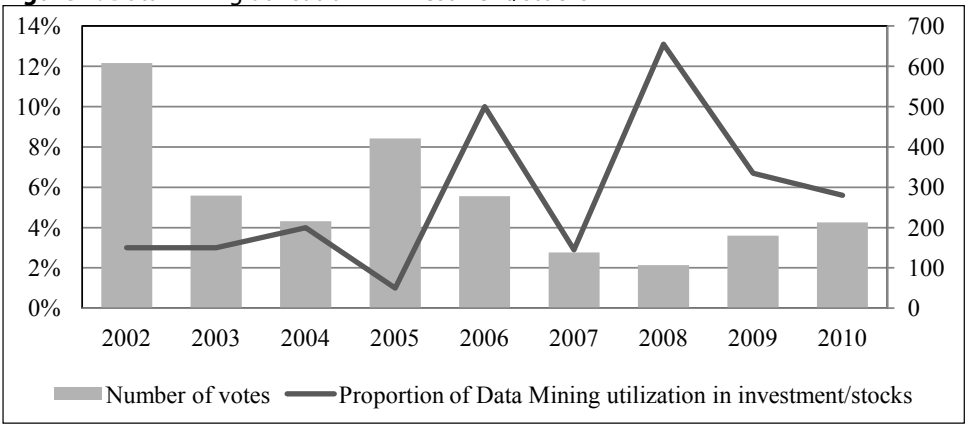
2 Application of Data mining on Financial Markets

According to a poll undertaken by KD Nuggets in 2010 (Figure 1) there was an increasing trend in utilizing data mining techniques in investment until 2008.

Recent research concerns the design of quantitative trading tools based on data mining techniques. Data mining can help to find associations between assets and create forecasting models based on wide ranges of data. Utilizing historical data; short-term exchange rates (Buryan, P., Taušek, J., 2008); interest rates (Liberopoulou, 2006); and stock prices (Shaaf, 2000) can be forecasted. Tung et al. (2003) adopted a simple trading strategy of support and confidence on 10 stock exchange indexes. Association rules have been found to be useful in stock prediction as a form of classification task.

Text mining is also a useful tool for solving the problem of stock price prediction. Schumaker and Chen (2009) applied statistical machine learning methods on financial news. The main goal of proposed technique was to learn what article terms from Yahoo Finance are going to have an impact on stock prices of companies listed in the S&P 500, how much of an impact they will have, and then make an estimate of what the stock price is going to be 20 minutes into the future. To test the effectiveness of proposed system they arbitrarily selected a group of experts and funds for comparison. Their simulated trading return was 8.50% which outperformed S&P 500 index, well known trading experts and top 4 quantitative mutual funds of 2005.

Figure 1: Data Mining utilisation in investment/stocks



Note: Number of votes depicts the absolute number of data miners participating at the poll and the percentages are relative to the number of voters
Source: KDnuggets Pool, 2010 [Online]. [s.a.]. [Cit. 2010-02-01]. Available at: <http://www.kdnuggets.com/polls/2010/analytics-data-mining-industries-applications.html>

Data mining tools are very interactive, easy to understand visually and require low investment cost while they enable identification of significant anomalies which require further examination. Their high potential on financial markets is proved, but utilization of data mining requires attention in data pre-processing. Apparent outliers may in fact be genuine and back-filling of missing data may be needed. It is important to prevention overfitting data and therefore useless in out-of-sample analysis (Johnson, 2011).

3 Application of Artificial Intelligence on Financial Markets

3.1 Expert (knowledge) Systems (ES)

An expert system is a computer-based system with artificial intelligence that emulates the reasoning process of a human expert within a specific domain of knowledge. Expert systems are based on explicitly formulated special knowledge obtained from experts to achieve decision on the expert level (Feigenbaum et al., 1988). The aim of an expert system is not modelling the mental processes of human experts during a decision process but achievement of high quality decision. Expert systems have to provide recommendation even when part of the required data is not available. This requires databases with multiple or alternative inferences. In addition these partial conclusions may be explained by expert system and appropriate additional question may be provided (Mařík et al., 1997).

The study by Collopy and Armstrong (1992), developed a rule base to make annual extrapolation forecasts for economic and demographic time series on M-competition data. Their rule-based expert system produced more accurate forecasts than the random walk and equal-weights combined. They performed better, particularly in long term periods for series with significant trends, low uncertainty, stability and good domain knowledge. Korczak and Lipinsky (2004) compared two real time trading systems using Stochastic Oscillators, Relative Strength Index and Ease of Movement. The first system was based on 350 trading rules and the second on 150 trading rules created by linear combination of the first system. The experiment was realized on Paris Stock Exchange and they found out that reducing the trading rules reduced the computation time without considerable influence on expertise quality.

One of the main advantages of expert systems is that they allow combination of different knowledge sources. The expert system is able to provide permanent documentation of decision making process and overview of all steps.

On the other hand in comparison to human experts the expert system must be explicitly updated and can´t draw analogies from other sources to solve newly encountered problems (Liberopoulou, 2006).

3.2 Artificial Neural Networks (ANNs)

Artificial Neural Networks are composed of simple elements operating in parallel. Likened to a biological nervous system the function of ANN is determined largely by the connections between elements. With explicit knowledge about target values the network is able to "learn" by adjusting the values between connections (weights between elements). ANNs are widely used to solve problems of classification, prediction, and control (Hlaváček et al., 2005).

The main advantage in utilizing ANNs is their ability to capture nonlinearity without prior knowledge about functional relationships between variables. ANNs operate as „universal approximation systems" with the ability to mimic almost any function dependency. They are resistant to outliers and do not require a specific distribution. In comparison to econometric models ANN give results in a shorter time period. By employing ANN the weight

and parametric system are adjustable and it is possible to work with a given degree of accuracy (Fanta, 2001).

The drawback in ANN application is the absence of a standard paradigm to design the network. For ANNs, the main disadvantage in utilization is described by the concept of the "black box". It is difficult to identify the influence of a selected input variable upon the output (Fanta, 2001). When using ANNs a data set of sufficient length is required to prevent overfitting the network during a learning phase (Gonzalez, 2000).

Neural networks have been successfully applied to solve problems of generalization in prediction of corporate bond rating, where traditional mathematical modelling techniques performed weakly (Dutta et al., 1988); (Chaveesuk et al., 1999); (Manzoni, 2004).

Kim et al. (2009) modelled a system evaluating the current time series against the past stable time series by stationary autoregressive model via artificial neural networks. The potential of the proposed model was demonstrated on the Korean stock market.

ANNs are widely used by central banks to forecast the interest rates and the monetary policy of governments (Hlaváček et al., 2005). Utilization of ANNs is common in research regarding inflation forecasting (Haider, 2009); (Choudhary et al., 2008); (Mc Nelis, 2004); (Moshiri et al., 2000); (Nakamura, 2005); and they are mostly focused on prediction accuracy comparison with econometric models (Haider, 2009); (Hlaváček et al., 2005); (Choudhary et al., 2008); (Mc Nelis, 2004); (Moshiri et al., 2000).

Table 1 depicts the comparison between forecasting accuracy of ANN and ARIMA models using MSE on data of the U.S. GDP deflator from the first quarter of 1960 to the third quarter of 2003. The ANN models performed well relative to ARIMA models in the first two quarters on test set. While the early stopping approach was preferable for short horizon inflation forecasting, the advantage disappeared for longer horizon.

Table 1: Ratio of Neural Networks to AR Models

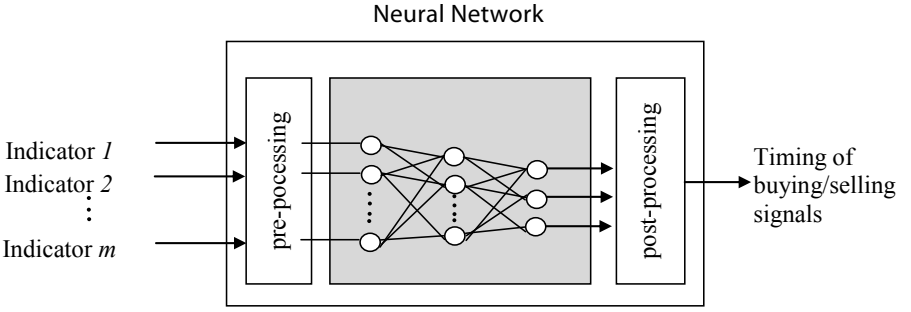
	Test set					Training/validation set			
	Forecast horizon (quarters)					Forecast horizon (quarters)			
	1	2	3	4		1	2	3	4
AR1	0.84	0.77	0.98	1.20		0.85	0.77	0.77	0.72
AR2	0.89	0.84	1.04	1.18		0.86	0.81	0.81	0.73
AR3	0.90	0.83	1.01	1.15		0.90	0.85	0.81	0.73
AR4	0.90	0.82	0.96	1.12		0.90	0.85	0.83	0.72
AR5	0.93	0.80	0.94	1.07		0.90	0.87	0.82	0.72
AR6	0.86	0.79	0.91	1.04		0.92	0.86	0.82	0.72
AR7	0.77	0.75	0.84	0.98		0.94	0.87	0.84	0.74
AR8	0.77	0.73	0.83	0.91		0.93	0.88	0.84	0.76

Note: Each cell shows the ratio of the Mean Square Error of the Neural Network model to the Mean Squared Error to the Auto Regression model.
Source: Nakamura, 2005.

Other research proves that neural networks perform better particularly in long term periods (Moshiri et al., 2000). Higher accuracy in long-term periods was proven also on forecasting of GDP (Tkatz et al., 1999), GNP and unemployment rate (Feinbaum et al., 1988) in comparison to nonlinear regression models. The suitability of ANNs is examined also on time series of financial markets. The researchers are mostly focused on Forex (Gabbi et al., 2000); (Chen et al., 2008); (Kiani et al., 2008); (Nagarajan et al., 2005).

Recently there has been an abundance of research attempting to forecast the price levels of international stock market indices (Egeli et al., 2003); (Gençay, R.; Stengos, T., 1998); (Safer, 2003). Extensive research is concentrated on utilizing indicators of technical analysis as input variables into ANN (Chen et al., 2008); (Mizuno et al., 1998); (Nagarajan et al., 2005); (Yao et al., 2000). The results demonstrate that indicators of technical analysis as inputs into ANN improve the forecasting accuracy although they are only statistical calculations of previous stock prices. Figure 2 depicts the process of data transformation in ANN applied on Tokyo Stock Exchange.

Figure 2: Prediction system composed of ANNs and indicators of technical analysis as inputs into network on TOPIX



Source: Mizuno et al., 1998.

Nagarajan (2005) utilized besides indicators of technical analysis also indicators of fundamental analysis (inflation, interest rates, etc.) but he did not achieve better performance in next day forecasting of USD/GPB exchange rate. Incorporating indicators of fundamental analysis had a negative impact on forecasting accuracy measured by mean error. The highest returns were achieved by forecasting direction of price movement not in specific price level.

Chen et al. (2008) set up a hybrid model containing three neural networks for short-term, midterm and long-term forecasting of TWD/USD exchange rate. For short and midterm period indicators of technical indicators were utilized (*Stochastic Oscillator, MACD, DMI, MA, Momentum, Williams Overbought/Oversold Index* and *RSI*) while for long-term period monthly data of *Price Levels*, Interest Rates, Money Supply, Export/Import and Productivity were used. Model based on monthly data had higher accuracy than models based on indicators of technical analysis. The hybrid model incorporating both indicators of fundamental and technical analysis achieved the best forecasting results (Table 2).

Table 2: Performance of Neural Networks with different input variables

Prediction model	Average	Standard Deviation
NN using indicators of fundamental analysis (FA) as inputs	59.58%	6.23%
NN using 15-day indicators of technical analysis (TA) as inputs	54.78%	4.26%
NN using 1-day indicators of technical analysis (TA) as inputs	49.26%	1.47%
NN using both indicators of technical and fundamental analysis	66.82%	4.21%
"random walk"	47.25%	4.97%

Source: Chen et al., 2008.

Research undertaken by Lam (2004) didn´t validate the forecasting improvement incorporating macro economical input variables into ANN but she proved that utilization data from financial reports into input variables of proposed model exceeded the average rate of return on the market. This study demonstrates the advantage of uniting technical and fundamental analysis particularly in recession.

3.3 Genetic Algorithms

Genetic Algorithms (GAs) are a subset of Evolutionary Algorithms and are inspired by biology (Fanta, 2001). The main idea of genetic algorithms is to increase individual fitness value during the iterations of evolution process through application of genetic operators, such as mutation or crossover. It leads to evolution of individuals which meet given requirements, represented with so-called fitness function, better than their ancestors. Individuals in population are represented with chromosomes, which are often represented by binary strings but generally they may be represented by other value types. Genes, as parts of chromosomes, are related to specific characteristic of individuals.

The main advantage of GAs is that their application doesn´t require any explicit knowledge about the target function. GAs are able to attain good performance within huge amount of potential data set. On the other hand it is difficult to select a sample of primary representative individuals, setting parameters and conditions of selection mechanism.

Genetic algorithms are used for solving optimization problems (for instance portfolio optimization) and problems of retrieval.

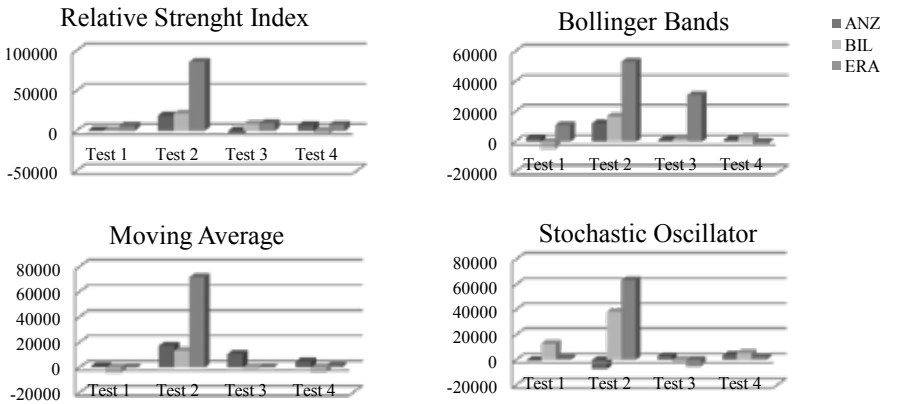
Baba et al. (2003) attempted to improve technical analysis applying intelligent systems to make decisions. They utilized 13 and 26-weeks moving averages and techniques of genetic algorithms to form a trading system on NIKKEI-225 and TOPIX. Undertaking a huge amount of computer simulation they achieved better performance using only technical analysis techniques without GAs.

De la Fuente et al. (2006) tried to optimize timing on stock market by automatized trader. They applied genetic algorithm on daily data 2004-2005 of a Spanish telecommunication firm. The decision making was based on indicators of technical analysis (RSI, MACS and Stochastic Index). The fitness function was set up on a rule that unfound data got the worst assessment. Chromosomes that occur repeatedly were evaluated as positive.

This study evidences the possibility of beating the market by application of genetic algorithms.

Ni and Zhang (2005) set up a trading system using GAs and Technical indicators. Figure 3 depicts the results of their models tested on data from 1997 to 2005 on selected indicators of technical analysis. Although their research did not affirm unambiguously higher profitability using trading strategy based on GAs than buy&hold strategy, they concluded that GAs contribute to quick identification of the limitations of strategies based on technical analysis.

Figure 3: Gaining profit/loss (in USD) using Genetic Algorithms based on indicators of technical analysis on Australian indices ANZ, BIL and ERA



Source: Ni; Zhang, 2005.

Genetic algorithms have been used for solving problems of optimization in research undertaken by Hirabayashi et al. (2009). They tried to increase the short term return of investment on Forex by trading systems using GAs. Their objective was to implement an evolutionary system able to learn nuances of trading rules from historical data and adapt to the changing market environment. The learning system is looking for buying and selling signals that combine indicators of technical analysis and their parameters with highest returns. The training set was created using hourly exchange rates of USD/JPY. They achieved a strong tendency of similar behaviour to real exchange rates using four indicators (RSI, MA, $EWMA_M$ and Percent Difference from Moving Average) and a genetic algorithm. The proposed method distinguishes high gain in period of rapid decline of prices caused by collapse of Lehman Brothers. The research validates the ability of techniques of machine learning to gain profit in recession. They found that trend following strategies increase the probability of attaining high return in a short-term period.

Gorgulho et al. (2009) employed GAs to create a portfolio from 100 equities forming index S&P. They applied six indicators of technical analysis (MACD, Hull MA, EMA, ROC, and RSI) to set up a portfolio. They created a new portfolio at the beginning of each month and at the end of the month they closed the positions. The portfolio return was evaluated by Return of Investment. During the trading period they set up a buy&hold strategy and port-

folio based on random selection of stocks into a portfolio during the period 02/01/2005 – 02/01/2005 to compare the performance of the proposed models. The portfolio forms' highest return was achieved by GA.

GAs have been successfully applied for timing the trading position in combination with candle sticks analysis (Belford, 2006). The result of the proposed system was compared with return of agent designed to make random investment strategies.

3.4 Fuzzy Systems

Fuzzy systems are expert systems coming out from fuzzy logic. Fuzzy logic measures uncertainty from membership values in the range <0.0, 1.0> with 0.0 representing absolute Falseness and 1.0 representing absolute Truth. In comparison to probability theory the fuzzy logic does not assume that the sum of occurrences is equal 1. The degree of membership is not explicitly defined and fuzzy set enable work with linguistic variables like probably, maybe and enough.

The scheme of the fuzzy system consists of three steps – fuzzification, fuzzy inference and deffuzification. The whole process starts with fuzzification which is the transformation of real data to fuzzy data. Then the fuzzy logic system is used to make fuzzy inference, usually based on *IF…THEN* rules, and then the fuzzy data are transformed back to real data.

Fuzzy systems are well suited for decision making tasks characterized by uncertainty and therefore they are well suited for application in financial markets when decisions about volume of buying/selling of underlying assets are undertaken. Fuzzy systems used to be utilized in combination with other artificial intelligence techniques. For instance the genetic algorithm based on fuzzy neural networks was applied to form a database for investigating quantitative effects of different events (e.g. political events) on stock markets (Kuo et al., 2001). Romahi and Shen (2000) built an expert system based on evolutionary rules for financial forecasting. They put together fuzzy logic with inductive rules to create a system with the ability of generalization.

Neural networks based on fuzzy rules have been applied to forecast stock market returns many times in research. Ang and Quek (2006) proposed a trading system based on moving average rules which achieved higher paper return than a random trading system. Similar approach of Fuzzy Neural Network (FNN) based on trading rules utilizing fundamental data of 32 companies employed Wong et al. (1992). Kuo (1998) applied a FNN utilizing both quantitative and qualitative factors to set up a decision support system on the Taiwan stock market and achieved better results than single ANNs.

Gil-Aluje et al. (2011) proposed a new framework of portfolio management based on some topological axioms to select the titles of a portfolio. Homogeneity according to some attributes was established to extract one or several titles of each subset in order to get the desired properties. The designed system generalized previous algorithms for portfolio selection.

The main advantage of fuzzy systems is their capability to solve problems with abstention of strict boundaries, vaguely defined concepts and without strict. Every rule within a fuzzy system is easy to understand and revise (for instance *IF* the costs are high *THEN* the manufacturing process in inefficient and vice versa) (Pathak et al., 2003). The disadvantage of fuzzy systems is that they require knowledge about the problem solved.

3.5 Agent-based Computational Economics (ACE)

The economy can be described as a complex adaptive system with the capability to adapt to the external environment. The agents operating in the economy adjust their behaviour to the system without realizing this adaptation. Economic agents' are thinking about their actions and about the consequences of their actions and they adjust their behaviour with concern for these aspects. They form the notion of the system they belong to (Umpleby, 2007) and their behaviour influences the whole system.

From the notion of economy as a complex adaptive system emerges Agent-based Computational Economics (ACE). ACE is a bottom up system forming models of agents and interaction rules which lead to setting up the whole system using simulations (Bruun, 2006). Within this modelling approach the structure evolves without forcing any presumptions upon it. The resulting ACE models must be dynamically complete - the modelled economic system must be able to develop over time solely on the basis of agents' interactions without further intervention from the modeller.

ACE is based on bottom-up approach and requires specific features. Therefore financial markets are a challenging field for ACE application due to high data accessibility and clearly specified goals of agents.

Early researches of artificial agents are based on zero intelligent agents. Le Baron (2000) investigated the efficiency of zero intelligence traders on artificial foreign exchange markets and he found that budget allocation of these agents was similar to human agents. In other studies simulations with more sophisticated agents have evolved. Raberto et al. (2003) set up a model where trading strategies of agents were based on technical trading rules and fundamental values. Kendall and Su (2003) utilized agent based approach on five selected stocks from London Stock Exchange. Trading behaviour of artificial agents was based on indicators of technical analysis. This study demonstrated stable and satisfactory learning abilities of artificial traders. Different learning behaviour related to the different stock price patterns was discovered; an important finding for further research in portfolio selection. Kumar and Bhattacharya (2009) used multi agent approach for portfolio selection and they achieved higher average returns across one month, two months and three months out-of-sample period than the FTSE 100 index.

Viewing markets as very large aggregations of agents with heterogeneous beliefs and goals often reveals very different perspective on traditional theoretical thinking. The main advantage of ACE modelling is the ability of a system to create autonomous agents with more realistic capabilities – they are able to communicate, adapt to an external environment according to previous experiences, mimic, create and maintain patterns of social behaviour etc. These features are based on internal processes which are hidden from

other agent from the external environment. It leads to unpredictable and uncontrolled behaviour of the agents in relation to their external environment. ACE models increase the transparency and clarity of the modelling process and complement analytical and statistical modelling approaches.

The relative disadvantage of ACE modelling is that it requires detailed specification for agent data and methods determining structural attributes, institutional arrangements, and behavioural dispositions. If the agent interactions induce sufficiently strong positive feedbacks, small changes in initial specifications could radically affect the types of outcomes that result. (Tesfatsion, 2005). It is also difficult to get empirical evidence of results obtained by simulation.

Conclusions

Studies offers supportive evidence for suitability of use artificial intelligence methods in various economic applications according to their ability to process nonlinear relationships, ability to learn and evolve in time and also ability to make decisions at expert level.

Genetic algorithms are used for optimization problems – optimization of stock market timing and portfolio creation. When solving prediction problems, genetic algorithms are used in combination with other methods of artificial intelligence. Data mining tools can be used for creation of quantitative tools for short-time prediction of exchange and interest rates. Expert systems try to make decisions on the expert level and they are applied in analysis of securities as well as in company assessment. If we have an uncertain notion of the methods leading to a decision (what is typical for human decision makers), fuzzy systems could be the appropriate solution. Fuzzy systems are used mainly in insurance. In recent years the Agent-based Computational Economics has emerged. Current ACE concentrates on financial market modelling. The approach of Artificial Neural Networks is put into effect thanks to their ability to study the nonlinear relation between variables and their ability to work with uncertainty. They are frequently used for solving prediction problems – forecasting macroeconomic indicators and time series prediction on financial markets.

In following research we would like to focus on analysis of the dependency between fundamental and technical analysis of securities using artificial intelligence.

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Contact adress / Kontaktní adresa:

Katarína Hiľovská
Department of Banking and Investment, Faculty of Economics, Technical University of Košice / Katedra bankovníctva a investovania, Ekonomická fakulta, Technická univerzita v Košiciach
(katarina.hilovska@tuke.sk)

Peter Koncz
Department of Cybernetics and Artificial Intelligence, Faculty of Electrical Engineering and Informatics, Technical University of Košice / Katedra kybernetiky a umelej inteligencie, Fakulta elektrotechniky a informatiky, Technická univerzita v Košiciach
(peter.koncz@tuke.sk)

Modern Trends in the Understanding of Theory and Practice of Management

Moderní trendy v chápání teorie a praxe managementu

OTAKAR NĚMEC

HAVLÍČEK, Karel. *Management & controlling malé a střední firmy (SME Management & Controlling)*. Praha : Vysoká škola finanční a správní, o.p.s., 2011. 212 pages. EUPRESS Edition. ISBN 978-80-7408-056-2.

Readers of this book, particularly from among expert community and students, are presented with not only a technical but also pedagogical text about the management theory and practice, a text that is worth paying attention to for several reasons.

The **author** of the book is a person who has both managerial experience and the ability to theoretically express, describe and analyse the facts relating to the current reality of the operation of organisations, with a predominant focus on the business sector of small and medium-sized enterprises. There are numerous outstanding managers and numerous outstanding theorists. However, only few of those can combine their experiences, share them, use literary language, generalise and, where appropriate, flesh out the complex reality with respect to the current level of knowledge. In this book, the author presents readers with management theory, often general, abstract and sophisticated, by using numerous real-life examples from approximately thirty, mostly domestic, SMEs. Nevertheless, the author is doing so with an explanatory comment relating to the relevant theory rather than just making a statement or a description. This method very effectively animates and clarifies particular management topics – i.e. strategy, marketing, finance, innovation, etc. Naturally, this improves the text readability and intelligibility because the author is thus 'telling' management stories mostly from his own or acquired experience.

The **content** of this publication could be evaluated from multiple aspects, including comparisons to the best-known and most frequently published works, which are mostly used as higher education textbooks. However, let us have a look at where the added value of the book, i.e. of its text, lies. The whole publication is permeated with two words – **management and controlling,** consistently in all chapters, albeit this approach is not at all usual for certain topics. The book is structured in 9 chapters, where business management is seen as the unity of management and controlling, and includes 6 main areas, which virtually any firm needs to understand and master – i.e. marketing, sales, finance, quality, innovation and human resources. An important aspect to understand the message of the book is the perception of the unity and difference of management and controlling. The publication sees management as the management of plans and objectives, research, missions and visions. Controlling is described as the permanent monitoring and assessment of objectives, identification of deviations, and proposals of risk management measures.

Why such an emphasis on the unity of management and controlling? Because the huge changes and turbulent developments in the global economy, with an impact on individual national economies, create an unusually strong competitive environment. This is breeding-ground for marketing wizards with great soft skills, the capability of precisely creating an advertising campaign, and the art of communicating with customers. To that effect, we should state that the crucial activities in a firm include the management of marketing, innovation and human resources. However, this is just one view, just one side of the coin. The logic of the function of market relationships and the profit principle clearly indicate that business is about outcomes, about market success, about economic effects, expressed in specific figures. This is where accounting and tax specialists, financial analysts, risk managers, i.e. people with exact hard skills, gain ground. Even the best knowledge of the market, skilled staff and innovation potential are useless if a firm fails to generate enough cash. That said, a well-balanced implementation of both management methods, i.e. management as well as controlling, is crucial for the competitiveness and success of a firm.

Chapter 1, **Process Management of a Business,** which outlines the essence of the whole publication, can be seen as a **methodically** crucial chapter of the entire book and, as a matter of fact, the topics contained in other chapters are methodically based on that chapter. What is it about?

The author puts it as follows: "Thus the process management of a business can be expressed as a Management Control System, which encompasses a comprehensive view of business management, on the basis of management accounting, management theory and HR management. It is an interdisciplinary management system, where the boundary between the start and the end of another process is not the most important; more importantly, one should understand the essence of managing a business as a whole, master the management tools and controlling tools, and understand that a successful business may only work if we can grasp all of its processes and understand the links between them." (page 17)

From this definition, which sees business management as a comprehensive process management, based on the balance between management and controlling and on the interdisciplinary concept of management, we can derive the following additional implications, to name a few:

- the process model of business management is a guide to management which the model strives to see in mutual relationships,
- the process model of management creates a system of categories, which are the cornerstones of the theoretical approach to management,
- the process model of management in the periods of economic crisis tackles the relationship of management versus controlling, by making more intense comparisons of the plans and objectives to the reality and the measures proposed,
- the process model of management opens up the possibilities of a comprehensive view of teaching the business management and business finance subjects.

As concerns the innovative approach to crisis management we can highlight, for example, the inclusion of what is known as the crisis tooling funding model, the analysis of the processes of operational and financial restructuring. Some of other pioneering deeds contained in the book include the strict distinction between the strategic approaches, which represent the qualitative view, and the flexible approaches, which represent the quantitative assessment. The book is the first to include the breakdown of controlling into the marketing, sales, financial, HR, innovative and quality types.

The book reviewed complies with today's business management requirements while providing practical instructions for tackling such management. Nonetheless, some recommendations for the next edition, if any, can be made:

- it is advisable to complete the comprehensive management with the view of the information system and technology management (the IS/IT units and the use of IS/IT for the SME management in HR, marketing, finance…),
- it is advisable to complete the sales and marketing management with the procurement and logistics management,
- an inclusion of a separate chapter on project management is also worth considering,
- the question is whether to prepare a separate introductory chapter to deal generally with the SME sector, the position of this business in the EU, its importance for the economy, statistics, trends; to include a SWOT analysis of the SME sector, and consequently to show the mistakes in managing the SMEs, with this to be followed by the chapter on the process model of management.

Contact adress / Kontaktní adresa:

doc. Ing. Otakar Němec, CSc.
University of Finance and Administration / Vysoká škola finanční a správní
(nemeco@vse.cz)

The Future of the Euro
Budoucnost eura

MOJMÍR HELÍSEK

BAGUS, Philipp: *Tragédia eura* (The Tragedy of the Euro). Bratislava : Jaga Group 2011. 159 pages. ISBN 978-80-8076-093-9.[1]

The *Tragedy of the Euro*, a book by Spanish professor Philipp Bagus, was published in the English original by the Ludwig von Mises Institute publishing house in 2010. In 2011, publisher Jaga Group from Bratislava published a Slovak translation. The book includes numerous suggestive, inspirational and provocative thoughts, of which we will only try to choose the strongest ones.

In the *Introduction*, the author describes his view of the euro project: it is a project pushed by European socialists to achieve a central European state, a project of intrigue and politicians' fight for power. But the project is about to fail.

Chapter *Two Visions for Europe* continues in the same way. In the European Union, the vision of socialists has defeated that of classical liberalism. However, the particular effect of the euro on European centralisation is not explained through monetary policy centralisation conducted by the European Central Bank (ECB). P. Bagus believes that the creation of the euro has led to EU Member States using a 'printing press' (the ECB probably?) to finance their deficits. This results in the crises of individual countries' government debts. These crises entail fiscal policy centralisation, specifically tax harmonisation. Only marginally the author also admits the anticipated economic benefit of the single currency, i.e. the reduction of transactions costs, stimulation of trade and economic growth.

In chapter *The Dynamics of Fiat Money*, the author draws a conclusion that "Central banks produce money primarily to finance government deficits" (p. 22). This had been previously prevented by Deutsche Bundesbank, whose authority maintained a moderate increase in money supply not only in Germany but also in other EU countries. Naturally, European governments consequently welcomed the establishment of the euro. That said, the establishment of the euro does "open new dimensions for government interventions, and redistribution of wealth" (p. 24).

Chapter *The Road Toward the Euro*[2] also explains why Germany has given up its Mark. The then politicians in Germany as well as abroad systematically used the blaming of Germany for World War II as an argument for Germany giving up its Deutschmark. In this chapter,

1 *The English original of the book by Philipp Bagus is available for download at http://mises.org/books/bagus_tragedy_of_euro.pdf. Quotations in this review were also taken from that version.*

2 *In his interpretation of the Maastricht convergence criteria, the author fails to distinguish between percent and percentage point. The long term interest rate criterion refers to "three governments paying the lowest interest rates".*

P. Bagus again revisits the interests of euro area countries' governments in the introduction of the euro because "if official price inflation rates are low, the ECB can and actually must print money in order to support economic policies" (p. 34). P. Bagus believes that particularly pressure from France was strong in that context.

Chapter *Why High Inflation Countries Wanted the Euro* explains the main benefit of the euro to southern countries of the euro area (except lower interest rates). Money supply grew much faster in those countries than in Germany, and this made it possible to buy German goods. To explain his proposition, the author uses the following example: "The Greek central bank prints money to finance the salary of a Greek politician. The Greek politician buys a Mercedes. [...] In the case of the Euro, paper money flows into Germany where it is accepted as legal tender and bids up prices" (pp. 49-50).

The next chapter is concerned with *Why Germany Gave Up the Deutschmark*. According to P. Bagus, it is possible and even likely that the German government sacrificed the Deutschmark (in 1999) in order to make the winning powers of World War II authorise the reunification of Germany (in 1991). In this context, the author refers to numerous statements by the then European politicians indicating that they had really anticipated the introduction of the single European currency such a long time in advance.

Subsequent chapters *The Money Monopoly of the ECB and Differences in the Money Creation of the Fed and the ECB* explain the author's idea that central banks print new money and put them into circulation through their purchases of goods as well as through the purchases of government bonds. Thus they finance the governments. The conclusion: "The government establishes its own printing press (central bank)" (p. 66).

The content of the next chapter is evident from its title: *The EMU as a Self-Destroying System*. The self-destruction consists in failure to comply with the rules of the Stability and Growth Pact. The same is true of the chapter entitled *The EMU as a Conflict-Aggregating System*. Conflicts arise from the fact that the preparations for an entry into the monetary union require the redistribution of income through cohesion funds. This pushes European integration to the verge of collapse. On the other hand, the author recognises the benefit of European integration in maintaining peace.

In the last chapters *The Ride Toward Collapse*, *The Future of the Euro* and in the *Conclusion*, the author expresses his ideas of the further development of the single European currency. The future of the euro is at risk because of its quality in particular. The author does not relate that quality to the development of the exchange rate; he means the quality of the currency issuer, i.e. the ECB. The quality of the ECB is expressed by its declining credibility. This credibility is at risk because the ECB has failed to resist political interests, and serves politicians in building a transfer union by having started direct purchases of government bonds. The quality of the euro is also affected by what is known as the ECB's Qualitative Easing, i.e. a reduction of the average quality of the assets backing the monetary base (there is a difference between German and Greek government bonds).

The author identifies the future of the euro with the government debt crisis. There are five ways out of the crisis:

- reducing the public spending,
- increasing the competitiveness and boosting tax income,
- tax increase,
- economic growth induced by deregulation,
- credits granted to indebted governments.

An opinion of the future of the euro is not explicitly expressed in the book. However, it can be surmised from the author's negative position on this currency. The euro is not a good quality currency; however, there is no explanation of how this poor quality of the euro makes itself felt. The author asks whether the euro project can be saved. He seeks the answer in the possible solutions to government debts. However, the link between the crisis of those debts (of Greece, Portugal, Ireland) and the future of the euro is not explained in the book either.

The book stresses ideological aspects rather than economic arguments of the benefits and costs of the monetary union. Even in the conclusion, the author reiterates: "The Euro has succeeded in serving as a vehicle for centralization in Europe and for the French government's goal of establishing a European Empire under its control - curbing the influence of the German state" (p. 129). The book does not include many economic arguments for or against the euro. Hence the primary benefit of the book may be the detailed empirical material on the development of the Greek debt crisis. And this is not at all bad; even this benefit should be appreciated.

Contact adress / Kontaktní adresa:

doc. Ing. Mojmír Helísek, CSc.
University of Finance and Administration / Vysoká škola finanční a správní
(mojmir.helisek@vsfs.cz)

PREVIEW /PŘIPRAVUJEME:

Next issue of the journal ACTA VSFS will continue to publish the winning papers of "Prof. F. Vencovsky Price" - the papers about regulate of the banking sector and the decomposition of the financial markets. Other articles will deal with current problems of economic theory and economic policy.

Následující číslo ACTA VŠFS bude pokračovat ve zveřejňování vítězných prací soutěže o Cenu prof. F. Vencovského, a to statěmi o regulaci bankovního sektoru a o dekompozici finančních trhů. Další statě se budou zabývat aktuálními problémy ekonomické teorie a hospodářské politiky.

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In the case of acceptances quoted text in quotation marks indicate the source in numbered footnotes placed below the line. References should contain only references (in alphabetical order) that are cited in the text. References correspond to the usual rules in the area.

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