Banks Paying for Banks:
A Dynamic General Equilibrium Perspective

Tsvetomira Tsenova[1]

Senior Economics Consultant
EMEA Advisory Team
Experian
E-mail: Ts.Tsenova@abv.bg

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Abstract

This paper presents a dynamic general equilibrium approach to analysing recent policy proposals on a resolution fund for direct recapitalisation of banks financed by banks. The model incorporates endogenous risk inherent in any economic activity due to imperfect information and incomplete financial markets, giving rise to dependence on banking finance and the possibility of default. Financial intermediaries could assume this risk ex-ante and support economic activity in expectation of ex-post monetary refinancing and recapitalisation. The downside of such policies and practices would be the resulting financial repression, i.e. erosion of household savings, and the instalment of moral hazard incentives in the economic decisions of banks and enterprises. In this setting we explore the short and long-term consequences of a burden-sharing scheme whereby banks contribute towards their own refinancing and recapitalisation.

JEL classification: E5, D5.

Keywords: bail-ins, burden-sharing, regulatory forbearance, financial intermediation, endogenous partial default, imperfect information and incomplete markets.

1 Introduction

The beginning of the recent financial and economic crisis was marked with a diverse mix of bold policy actions of monetary and fiscal nature, designed to mitigate the adverse consequences on real economic activity from tighter financial constraints in the presence of rising uncertainty. Implemented policies include ample liquidity provision to the banking system, fiscal spending programmes and bank recapitalisations. While the crisis turned out to be long-lasting and resilient, the policies proved expensive, unexplored and therefore potentially dangerous. Consequently, the issue of a fare sharing of the financial burden of policies arose naturally.

Alternative policy strategies were put forward, promoted under the technical term 'bail-in' and catchy phrases like 'banks paying for banks', which essentially aim at the creation of a resolution fund for direct recapitalisation of banks funded by banks.[2] This approach is generally implemented though imposing a levy on banking liabilities and targets fiscal neutrality in the long-run to alleviate the financial burden on households both in their role as tax-payers and consumers, whose savings in the form of future consumption could be eroded by potential inflationary pressures due to ample liquidity provision.

This paper is contributing towards the enlightenment of a number of theoretical and conceptual issues related to this policy proposal. For example, what would be the short- and long-term consequences of the new burden-sharing arrangement on economic activity in the presence of endogenous default risk and dependence on external banking finance? Given the role of banks as financial intermediaries, where would risk accumulate eventually in a general equilibrium setting? In other words, could the assertion "what happens in Vegas stays in Vegas" really hold in a dynamic general equilibrium environment? What could be the optimal mix of bank refinancing policies and banking levies that capture the price of risk and ensure dynamic stability?

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[2] The approach in general and phrase in particular were coined by Michel Barnier, European Union's Commissioner on Financial Affairs, stating *"What I'm proposing is logical – banks paying for banks, not taxpayers"*, Interview at France 24 International News, "EU Commission Wants Bank Levy to Pay for Future Crises", 26 May 2010.

The paper analyses these issues in a dynamic general equilibrium context where incomplete information on the product markets and financial markets imperfections underlie the presence of uninsurable risk to economic activity. Banks as financial intermediaries could assume a share of the ex-ante risk in expectation of ex-post refinancing, thus reducing default risk, increasing the risk appetite of otherwise risk neutral companies and stimulating economic activity. Ample provision of liquidity and banks' refinancing could negatively affect households' savings (and thus current and future consumption) through the potential for inflation in a low-interest environment, a phenomenon also known as financial repression. In other words, inflation represents tax on household savings. Banks are levied in order to partially compensate the households for the latter, while at the same time produce stable and sustainable outcome in the short- and long-run. The model considers ex-ante incentives on decisions of rational, but heterogeneous economic agents (banks, households, enterprises) operating under uncertainly and perfect competition, as an important benchmark for future exploration.

The dynamic general equilibrium approach is employed in order to take into account the complex spillovers and feedback loops between various economic agents and institutions, such as between borrowers and savers, consumers and producers, banks, regulatory and monetary authorities. The fundamental structure of the model incorporates economic uncertainty, default risk and ex-ante incentives in economic decision-making.

The model builds on the dynamic micro-founded literature that incorporates incomplete information, financial markets' imperfections and endogenous default inside the equilibrium fundamentals, such as Greenwald and Stiglitz (1987, 1990, 1993a and 1993b), Gatti and Galegati (1996 and 1997). This approach distinctly differs from the standard in the New Keynesian dynamic general equilibrium literature, in the spirit of Bernanke and Gertler (1989) and Gertler and Gilchrist (1994), where market imperfections generate only short-lived deviations from equilibrium of complete

markets and perfect foresight. The presented model furthermore relates to the literature on financial intermediation, incomplete markets and endogenous default in a finite horizon optimisation setting, such as Tsomocos (2003), Goodhart et al. (2005, 2006) and Tsenova (2014). Evidence for the importance of information imperfections, imperfect knowledge and learning by economic agents is presented in a rapidly growing literature, which includes Orphanides and Williams (2008) and Tsenova (2012).

Another important pillar is the literature on incentives and moral hazard under uncertainty and financing constraints, including Goldfeld and Quandt (1988 and 1992), Dewatripont and Maskin (1995) and Kornai (1992). Moreover, the analysis carries the spirit of public sector economics and the importance of tax incidence in prospective policy analysis, for the entity that pays a levy does not necessarily bear the full cost. The ultimate burden-sharing is determined by the market, economic interaction and complex feedback loops captured only in a dynamic general equilibrium context. The paper contributes towards an ongoing policy debate, such as Onofri and Tsenova (2014), as regards the most efficient and sustainable way out of the Great Recession, as well as reconsideration of the role of financial intermediaries and the macro-prudential policies interlinking monetary, fiscal and regulatory institutions.

2 Model Setup and Equilibrium Analysis on Different Markets

The model has a dynamic general equilibrium nature and consists of a production sector, banking sector, household sector and a general state sector comprising of monetary authority, regulatory authority and a fiscal authority as the ultimate source of fiscal backing of a fiat currency. The productive sector operates under inherent price uncertainty and furthermore needs to resort to bank loans, in excess of own liquid asset, to finance its economic activity. This generates endogenous and costly probability of default.

The banks provide loans to enterprises at a nominal interest rate, which ensures perfect arbitrage for risk across firms within each period. However, banks could accumulate additional risks in their balance sheets, encouraged by higher regularory forbearance of the regulatory authority aiming at relaxing financial constraints of firms to encourage production. A balanced fiscal budget requires this policy to be funded by the monetary authority through endogenous money creation. That could genertate errosion of household savings, in other words financial repression. Households use money as the only sore of value and choose optimally their consumption and saving. Therefore, in addition to the bail-out of banks through regulatory forebearance and monetary funding, the regulatory authority requires banks to provide and endogenously determined compensation to households in the form of a banking levy. This provides a feedback loop, which on one side relaxes the budget constraint of households, while on the other diminishes liquidity within the banking system and firms to fund future production.

2.1 Production Sector

Following Greenwald and Stiglitz (1993), in the model the corporate sector is composed of a continuum of firms, each using a productive technology exhibiting decreasing returns to scale. The production function *y=f(x)* depends on labour *x* and possesses the following properties: (1) differentiability and decreasing marginal product i.e. *f'(x)<0* and *f''(x)<0; (2) f(x)≥0* and *f(0)=0;* (3) the Inada conditions are satisfied. Capital in the production function is normalised to unity with labour being the only variable factor.

$$y_t^i = f\left(x_{t-1}^i\right)$$

Firms operate in an environment of perfect competition and rational expectations, but incomplete markets and information imperfections. Production,

employment and borrowing decisions are made one period before output is sold and at individual firm's level price uncertainty exists. Each individual firm is a price taker on its own product market, but due to market separability and information imperfections, at the time of production a firm has incomplete information as to the pricing of its product relative to the general price level.

An individual firm's price is a random variable p^i with mean equal to the general price level - P, and finite variance. The relation between the individual firm's price and the general price level $\dfrac{p^i}{P} = \theta^i$ is also a random variable with mean 1 and finite variance. $G(\theta)$ is the distribution function of θ and $g(\theta)$ is its density function.

Due to the assumption of incomplete financial markets, firms cannot issue state contingent bonds or assets to finance their operating costs in production. Instead, for that purpose firms use bank loans in addition to own liquid buffers generated through accumulating profit from previous periods, referred to as financial asset. A firm's real borrowing from the banks b at time t is determined by:

$$b_t = w_t x_t - a_t$$

where w is the real wage; x - labour input; a - real financial asset, i.e. financial result from the previous period; nominal variables are divided by the general price level P_t.

At time t, when production takes place, firms make production and borrowing decisions based on their expectations of prices they would face on their product market at time $t+1$ being equal to the general (average) price level P, i.e. $E_t[p^i_{t+1}] = E_t[P_{t+1}]$. However, actual revenues and profit of firms when their products are sold at time $t+1$ would depend on the sectorial prices they face on their particular goods' market represented by the realisations of the random variable p^i_{t+1} falling both above and below the general price level in the economy P_{t+1}. Under rational expectations the actual general price level turns out to be the expected price level, i. e. $E_t[P_{t+1}] - [P_{t+1}] = E_t[\varepsilon_t] = 0$.

However, the individual producer faces price uncertainty related to the realisation of its sectorial price p_{t+1}^i and resulting revenues.

A firm's realised profit in real terms would be expressed as:

$$\pi_{t+1} = \theta_{t+1}^i f(x_t) - (1+i_t)\frac{P_t}{P_{t+1}}(w_t x_t - a_t) \qquad (1)$$

where π is the real financial profit realised at $t+1$; θ - relative sectorial price realisations; i - nominal interest rate on loans from the bank; $\frac{P_t}{P_{t+1}}$ - ratio between the current t+1 and previous prices t.

Because firms are functioning under both price uncertainty and borrow to finance production, they constantly face the possibility of getting bankrupt. It is assumed that in every period the **bankruptcy condition** holds: if a firm realises a negative profit (a firm's revenues after the sale of its output are less than the firm's obligations towards its bank) it is either liquidated or bailed out initially by the bank with the tacit permission of the regulatory authority. For a firm to obtain profit, it is essential that its released price exceeds the general price level.

The bankruptcy threshold $\hat{\theta}$ is defined as the relative price ratio θ below which a firm receives negative profit. Taking into account the formation of profit expressed in **Equation 1** and setting it at zero delivers the formal definition for the bankruptcy threshold below.

$$\hat{\theta}_{t+1} = (1+i_t)\frac{P_t}{P_{t+1}}\frac{(w_t x_t - a_t)}{f(x_t)} \qquad (2)$$

The macro-economic meaning of the bankruptcy mechanism is that after uncertainty is resolved, different firms receive different prices along the distribution of the random variable p^i which form different relative price ratios $\theta^i = \frac{p^i}{P}$. The bankruptcy threshold θ is unique for the whole economy, and firms that obtain relative

price ratios above the economy's bankruptcy threshold ($\theta_{t+1}^i > \hat{\theta}_{t+1}$) realise profits, firms that obtain relative price ratios below the bankruptcy threshold ($\theta_{t+1}^i < \hat{\theta}_{t+1}$) realise losses. We assume that firms must satisfy a bankruptcy condition that holds every period: if a firm realises a loss, it must enter a bankruptcy procedure: either receive a bail-out or get liquidated. Consequently, the individual financial assets must be non-negative, $a_t \geq 0$. New firms might enter to replace the bankrupt ones, but have to start with zero asset level. Negative profits cannot be accumulated.

From **Equation 2**, the bankruptcy threshold is increasing with respect to labour input, output, and nominal interest rate, while decreasing with inflation and asset level. Note that the bankruptcy threshold is derived as a ratio between enterprise nominal debt and nominal output in the economy. At the same time, the bankruptcy threshold is a realisation of the random variable θ that is a price ratio and as such its value must be positive implying that also the value of the bankruptcy threshold will be positive.

The modelled firms are risk neutral and maximise their expected profit in each period *t+1*, looking forward from period *t*, in order to decide what amount of resources to employ in period *t*. A ratio *s* of unprofitable enterprises could be bailed out by the banks through loan refinancing. ***The ratio s is a parameter, which epitomises the regulatory forbearance set by the regulatory authority*** and could take values between *0* and *1*. Although at individual level an enterprise facing a bankruptcy would either be bailed out or liquidated, for the continuum of firms comprising the production sector, *s* represents the perceived probability of a bail-out. This parameter characterises the economic environment and its ***financial softness***. In the model, it is assumed that *s* is common knowledge; the forbearance policy set by the regulatory authority is credible and perceived by all economic agents. Given the presence of bailing out of unprofitable enterprises, the firms profit expectations include this possibility.

$$E[\pi_{t+1}] = E\left[\theta_{t+1}f(x_t) - (1+i_t)\frac{P_t}{P_{t+1}}(w_t x_t - a)\right] =$$

$$= f(x_t) - (1+i_t)\frac{P_t}{P_{t+1}}(w_t x_t - a) - f(x_t)s\int_0^{\hat{\theta}_{t+1}^e}\theta g(\theta)d\theta + (1+i_t)\frac{P_t}{P_{t+1}}(w_t x_t - a)\int_0^{\hat{\theta}_{t+1}^e}g(\theta)d\theta$$

where $\quad G(\theta_{t+1}) = \int_0^{\hat{\theta}_{t+1}^e} g(\theta)d\theta \quad$ is the probability of a firm to obtain a loss and

$sG(\theta_{t+1}) = s\int_0^{\hat{\theta}_{t+1}^e} g(\theta)d\theta \quad$ is the probability being bailed out after receiving a loss.

The firms' profit-maximising level of labour input and output is chosen in order to equalise the expected marginal product of labour with the expected marginal factor cost.

$$\frac{d}{dx_t}f(x_t) = (1+i_t)\frac{P_t}{P_{t+1}^e}w_t\left(\frac{1 - s\int_0^{\hat{\theta}_{t+1}^e}g(\theta)d\theta}{1 - s\int_0^{\hat{\theta}_{t+1}^e}\theta g(\theta)d\theta}\right) \tag{3}$$

The effect of the bailing out policy on the firms' production decisions is a function of the bankruptcy threshold and captured by the term

$$k(\hat{\theta}_{t+1}^e) = \frac{1 - s\int_0^{\hat{\theta}_{t+1}^e}g(\theta)d\theta}{1 - s\int_0^{\hat{\theta}_{t+1}^e}\theta g(\theta)d\theta}.$$

Because $\int_0^{\hat{\theta}_{t+1}^e}g(\theta)d\theta > \int_0^{\hat{\theta}_{t+1}^e}\theta g(\theta)d\theta$ the function $k(.)$ is smaller than unity for any θ between zero and 1 and any $0<s\leq1$. This, and the assumed decreasing returns to scale of the production technology, leads the firms to choose to employ more labour and financial resources and produce more than if bailing out policy did not exist. This is a conclusion already well established in the micro literature on soft budget constraints

(for example, Goldfeld and Quandt (1988), Goldfeld and Quandt (1992), Prell (1996)). Rewriting the output profit maximising decision of firms, nominal interest rates, inflation and real wages have a direct effect on output: optimum labour input and output are increasing with nominal interest rate and real wage decreasing and inflation rising.

$$x_t = \frac{d}{dx_t} f^{-1}\left[(1+i_t)\frac{P_t}{P_{t+1}^e} w_t k\left(\hat{\theta}_{t+1}^e\right)\right]$$

However, nominal interest rates, inflation and real wages can also affect output through their influence on the bankruptcy threshold (**Equation 3**). A firm level analysis (partial equilibrium analysis) cannot draw a definite conclusion on how output will react on changes in variables in the model. Because $k(.)$ is not a monotonic function for any value of s within its range $0<s\leq1$, the relationship between the maximising level of labour input (output) and the bankruptcy threshold is dubious and could only be established through a general equilibrium analysis at macroeconomic level. For example, an increase in the nominal interest rate could discourage output because the costs of borrowing would increase, and at the same time it could stimulate production because due to the higher interest rate, the bankruptcy threshold could rise, increasing the chances of being bailed out after receiving a loss.

Furthermore, in our model the labour supply is assumed to be perfectly elastic and wages are fixed at their market clearing level. There is no involuntary unemployment and labour is perfectly mobile across firms. This simplifying assumption about the labour markets is made in order to isolate the effect of financial market imperfections and soft budget constraints on macro level. Thus, for equilibrium on the labour market

$$w_t = w_t^d = w_t^s = \overline{w} \tag{4}$$

2.2 The State

The State is encompassing term for the regulatory authority setting the regulatory forbearance parameter *s*, the monetary policy authority providing endogenous monetary financing (non-standard monetary policy affecting the quantity of fiat money, not its price) and the fiscal authority delivering a balanced budget and ensuring equilibrium-consistent compensation to households T. This way, the model considers the interlinkages between regulatory, non-standard monetary and regulatory policies, which are implemented through bank-refinancing and fiat money creation, which are ultimately guaranteed by the State.

The regulatory policy sets the parameter *s*, the ratio of firms with negative profits, which banks are allowed to refinance, in expectation of respective refinancing from the monetary authority. If banks are not refinanced, losses would accumulate within the banking sector and future recapitalisation would be required by the state. The parameter *s* could be considered as the regulatory forbearance or financial softness of the business environment.

The bankruptcy condition always holds (i.e. firms that obtain negative profit are either bailed out or get liquidated). That is why a monetary refinancing cannot be partial for the individual firm: it is either zero or full. On aggregate, however, the bail-out funds are equal to a fraction of the negative profit in the economy. The bail-out funds *S* are paid after the price uncertainty about the current period is resolved. The bail-out funds are a function of output, the bankruptcy threshold and the probability of a firm to be bailed out.

$$\frac{S_t}{P_t} = s \int_0^{\hat{\theta}_t} \pi_t g(\theta) d\theta = f(x_{t-1}) s \int_0^{\hat{\theta}_t} (\hat{\theta}_t - \theta) g(\theta) d\theta \tag{5}$$

The monetary authority refinances the banks and increases the money supply with the amount necessary to support the chosen degree of regulatory forbearance *s*

ensuring that the corresponding fraction of firms' bad debt (negative profit) is not accumulated at banking level.

$$\frac{M_t - M_{t-1}}{P_t} = \frac{S_t}{P_t} \qquad (6)$$

Aware that the financial softness for enterprises, as result of the regulatory forbearance funded by money creation, could generate inflationary pressures representing a tax on household savings, the State requires the banks to pay a portion of their liabilities consisting of aggregate financial asset of enterprises τ_t to households. As result households budget constraint is also relaxed with the amount T_t, this way sharing the benefits of financial softness across diverse economic agents. In the model, the bail-in levy τ is determined endogenously to explore the conditions for its sustainability in the long and short run.

2.3 Firms' Aggregate Financial Asset

Firms' financial asset, i.e. retained financial profits, become aggregated and accumulated in the economy similarly to Greenwald and Stiglitz (1993). The firms on aggregate sell their output at the general price level and the aggregate level of financial asset is determined as the difference between the mean of the firms' revenues minus other sources of net costs. In the model the aggregate financial assets are augmented with the bail-out funds. Asset are reduced by the bail-in funds, i.e. banking levies charged on accumulated asset and transferred to households to share costs and risks of banking support and re-financing. In other words, the bail-in levies on enterprise profits are paid to households to share the burden of monetary stimulus on economy through the banking system.

Because bail-out of losses exists, the aggregate level of asset will increase with the amount of the bail-out funds. At the same time, the levies on banks, ultimately paid by profitable enterprises would decrease the amount of net asset. Aggregating across firms,

$$A_t = E[A_t^i] = E[p_t^i]f(x_{t-1}) - (1+i_{t-1})P_{t-1}(w_{t-1}x_{t-1} - a_{t-1}) + S_t - T_t P_t =$$
$$= P_t f(x_{t-1}) - (1+i_{t-1})P_{t-1}(w_{t-1}x_{t-1} - a_{t-1}) + S_t - T_t P_t$$

Through substitution from Equation 5 and rearrangement, the real bail-in levies could also be expressed as a proportion τ from firms' real asset, which is bailed-in.

$$T_t = \tau_t f(x_{t-1})\left(1 - \hat{\theta}_t + s\int_0^{\hat{\theta}_t}(\hat{\theta}_t - \theta)g(\theta)d\theta\right) \tag{7}$$

$$a_t = (1 - \tau_t)f(x_{t-1})\left(1 - \hat{\theta}_t + s\int_0^{\hat{\theta}_t}(\hat{\theta}_t - \theta)g(\theta)d\theta\right) \tag{8}$$

From the assets accumulation **Equation 8**, the aggregate asset are increasing with output and decreasing with the bail-in levy and with the bankruptcy threshold. The aggregate assets are an important source of propagation and persistence for the entire economy.

2.4 Banks

The role of the banks as financial intermediates is to supply the firms with credit and determine the nominal interest rate in order to internalise the cross-sectional bankruptcy risk in each period. On their asset side, the banks are interested in their expected nominal revenues on loaned funds $E[1+\rho_t]$ (where ρ is the bank's nominal return on loans) which is formed by the following three sources of income weighed by their probabilities: the successful (returned) loans plus the interest rate; the output revenues of all enterprises that have realised a loss, but were not bailed out by the state; and bail-out funds for the loss-making firms, which are bailed-out by the state.

$$E[1+\rho] = (1+i_t)\left(1 - \int_0^{\hat{\theta}_{t+1}^e}g(\theta)d\theta + s\int_0^{\hat{\theta}_{t+1}^e}g(\theta)d\theta\right) + (1-s)\frac{P_{t+1}^e}{P_t}\frac{f(x_t)}{(w_t x_t - a_t)}\int_0^{\hat{\theta}_{t+1}^e}g(\theta)d\theta$$

Reorganising the above equation and assuming for simplicity that the banks nominal return on loaned funds is 0, we receive the equilibrium condition for the nominal interest rate as a function of the bankruptcy threshold and the regulatory forbearance.

$$i_t = \frac{(1-s)\int_0^{\hat{\theta}_{t+1}^e}(\hat{\theta}_t - \theta)g(\theta)d\theta}{\hat{\theta}_{t+1} - (1-s)\int_0^{\hat{\theta}_{t+1}^e}(\hat{\theta}_t - \theta)g(\theta)d\theta} \tag{9}$$

The nominal interest rate is increasing with the bankruptcy threshold. The higher is the bankruptcy threshold in the economy, more will be the bankruptcies, and the banks will be asking for a higher interest rate in order to retrieve their loaned funds.

The higher is the number of firms to be bailed out in case of bankruptcy (higher s), the less the banks will care about the level of the bankruptcy threshold. In the extreme case when $s = 1$, the interest rate i will be zero.

On the liability side of banks' balance sheets, enterprises keep their liquid financial asset. Bail-in levies τ are charged on the liability side of the banks' balance sheets and transferred to households.

2.5 Households

The households obtain utility from consumption and holding money. To explore the dynamics of households savings and the banks lending policy separately, and at the same time retain model simplicity, we assume that no bonds exist in the economy, and the only form of savings are the money holdings carried over by the households from one period to another. In other words, the only way to postpone consumption for the future and engage in consumption smoothing is through holding money, which in the model resembles non-interest bearing household deposits. Fiat money is used as a store of value. Inflation is able to erode the value of money and household's future consumption.

The households' optimisation problem is rather standard. Households maximise their representative intertemporal utility of consumption and real money balances. Preferences are of the most basic form, with utility of consumption and utility of holding money being separable, implying money superneutrality.

$$\max U(c_t, m_t) = \max \sum_{t=t_0}^{\infty} \beta^{t-t_0} \left[c_t + \upsilon(m_t) \right]$$

$$s.t.\ c_t = w_t x_t + T_t - m_t + \frac{P_{t-1}}{P_t} m_{t-1} \tag{10}$$

where c is consumption in real terms; m_t - real money balances held until the end of period t and carried over to the beginning of period $t+1$; β - a discount factor s. t. $0<\beta<1$; υ - utility of holding real money balances, which is increasing, strictly concave, continuously differentiable.

From the above consumer maximization problem, the households derive their optimum choice of money holdings. Optimum money holdings fall with the expected inflation rising.

$$\upsilon'(m_t) = 1 - \beta \varphi_{t+1}^e \tag{11}$$

$$\varphi_t = \frac{P_t}{P_{t+1}} \tag{12}$$

Concerning the money supply process, the money supply increases to finance the bail-out of enterprises, implemented through the banks. The money supply growth is μ and defined as $M_t^s = M_{t-1}^s(1 + \mu_t)$. Thus, money supply growth and inflation are endogenously determined.

Reorganizing the money supply side and taking into account that for equilibrium on the money market $M_t^s = M_t^d = M_t$, we derive a rule for money growth, where money growth increase with the amount of current bail-out funds and inflation in the economy, and decrease with the previous period real money balances.

$$\mu_t = \frac{1}{\varphi_t m_{t-1}} \frac{S_t}{P_t} \tag{13}$$

Also, to have equilibrium on the goods market, consumption in period t has to equal to production in the previous period $t-1$ due to the one period lag in production:

$$c_t = f(x_{t-1}) \tag{14}$$

For the goods markets to clear, current consumption is equal to the previous period production.

3   Equilibrium Solution and Model Evaluation

The general equilibrium model consists of the equilibrium solutions for each market, the policy rules and equilibrium conditions described in Equations 3-14. The model is further evaluated under unpresumptuous and widely accepted functional form specifications, such as Cobb-Douglas production function, i.e. $y=f(x_t)=x^a$ where $0<a<1$ and $x>0$, logarithmic utility of holding real money balances and symmetric uniform distribution for the relative price ratio $\hat{\theta}$. With unitary mean, the relative price ratio has upper bound equal to 2 and lower bound equal to 0.

Through substitution the system could be represented into a system of two forward-looking dynamic simultaneous equations of the bankruptcy threshold and the inverse inflation factor. The other variables and their dynamics are expressed to depend on their path.

Instead of assuming a specific value for the policy parameter s, characterising the regulatory forbearance, the structure of the model is solved numerically for the full range of values of financial softness in the economy $0<s\leq0$. Assumed values for the structural parameters are: $w=0.5$, $a=0.8$, $\beta=0.8$.

3.1 Steady State Analysis

Steady states are estimated for *t+1=t* and expected values equal to actual realisations. Under these conditions the system of dynamic simultaneous equations on the bankruptcy threshold and the inverse inflation factor are simplified into a static one, but still highly non-linear. The non-zero roots of the system, which fall within the permissible range for the variables, provide the long run equilibrium solution. The steady state for the other variables is obtained on the basis of that solution too.

The steady state general equilibrium solution for the bankruptcy threshold for the full range of regulatory forbearance *s* is plotted on **Figure 1.** It shows that the resulting bankruptcy threshold decreases with the regulatory forbearance. This means that higher financial softness enjoyed by banks and enterprises, would lead to reduced likelihood for bankruptcies and bail-out necessity in the first place.

Contrary to the common belief that bail-in policies would install ex-ante incentives for financial discipline, thus hardening the budget constraints of enterprises and banks, the model shows that this is unattainable when taking into account general equilibrium links and spillovers. In the considered setting, low degrees of regulatory forbearance for *s* between *0* and *0.28* are unsustainable. The reason for that is the high long-run equilibrium bankruptcy threshold leading to nearly half of firms realising negative profit, i.e. to be either bankrupt or in need of a bailout. The aggregate level of liquid asset in the economy becomes too low or negative, drained by the demand for bail-in funds by households and insufficiently supported by the ever increasing need of bail-out funds. Unless the economy is constantly funded by foreign liquid asset, it would be unable to engage in future production. In other words, the economy is paralysed by *a liquidity freeze*.

Figure 1 Long-term equilibrium bankruptcy threshold for the full range of regulatory forbearance s
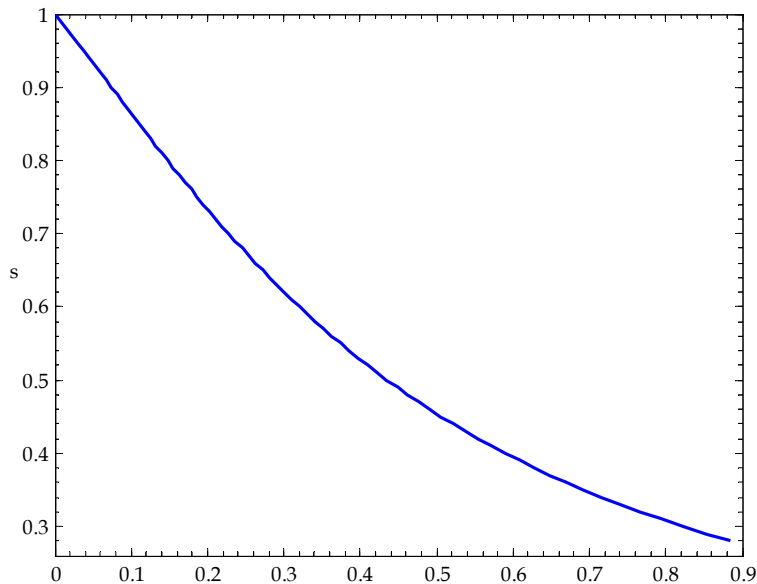

The equilibrium steady state of inflation, derived on the basis of the solution for the inverse inflation factor, happens to be decreasing with the regulatory forbearance in the economy, see **Figure 2**. This is because inflation represents one of the burden-sharing devices in the model: it supports the production sector, while financially represses households by eroding the value of their savings as result of money creation. At low level of financial softness, the equilibrium inflation is due to relatively high share of bankruptcies in the economy. With more forbearance on the side of regulators, the bankruptcies in the economy decline, the need for monetary funding declines and banks (and ultimately enterprises) are able to pay higher bail-in funds under lower levy rate on banking liabilities. Due to monetary financing of the bail-outs, in the long-term the rate of money growth coincides with the inflation rate.

Due to the bail-in policy, which is another mechanism for sharing the financial burden between households and enterprises, the equilibrium risk-neutral nominal interest rate coincides with the inflation rate. The bail-in equalises the funding costs of firms with the cost on households' savings in the form of inflation. The nominal interest

rate deciles with higher regulatory forbearance, due to resulting lower economic uncertainty, see **Figure 2**.

Figure 2 Long-term equilibrium inflation, money growth and nominal interest for the full range of regulatory forbearance s
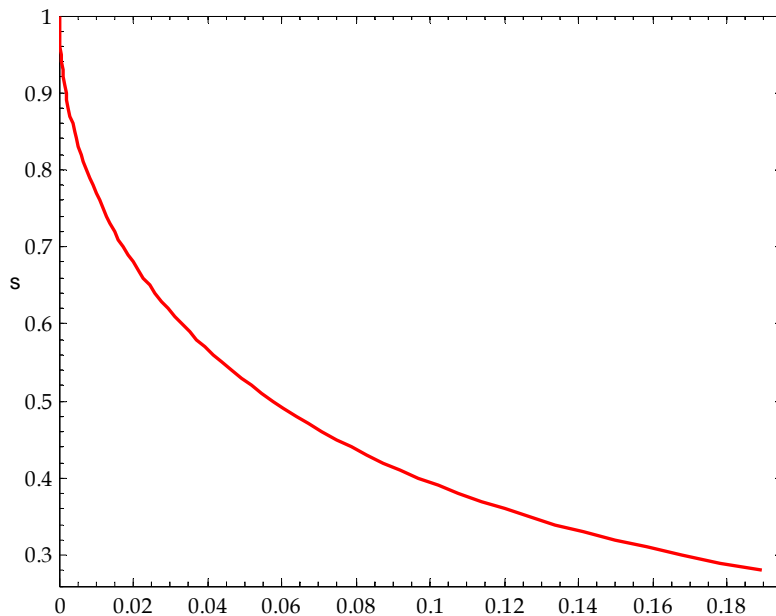
The regulatory forbearance is non-neutral and non-monotonic with respect to the long-run equilibrium economic activity, see **Figure 3**. Output and employment initially increase and reach their maximum at medium degree of financial softness in the economy, i.e. at *s=0.48 x=16.59* and *y=9.46*.

Higher regulatory forbearance would contribute towards higher liquid asset of enterprises, as well as banking liabilities, but lower economic welfare with declining equilibrium output, employment and consumption. The economy could potentially reach a low inflation, low interest rate, Minsky's (1986) liquidity trap. In such case, there is abundance of financial liquidity, but production and consumption are stifled. And indeed, at relatively high degree of financial softness, aggregate liquid asset in

enterprises reach their maximum, i. e. at *s=0.80* and *a=5.74*. While the bail-in levies reach their minimum at the same point, at s=0.80 and τ=0.18, the bail-in funds *T* increasingly relax the budget constraints of households. Instead of leading to higher equilibrium consumption, this is translated into higher real savings of households, supported also by the declining inflation rate, see **Figure 4**.

Figure 3 Long-term equilibrium asset a, output y and employment x for the full range of regulatory forbearance s
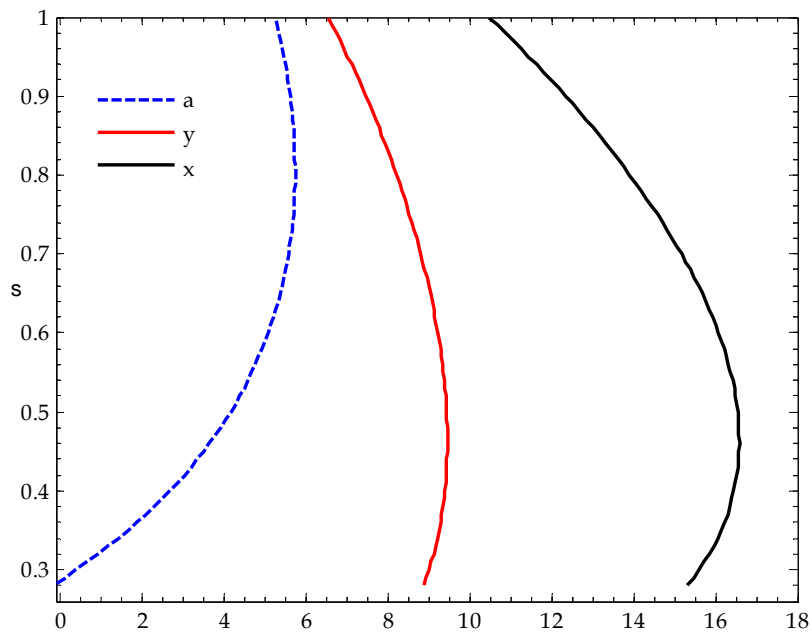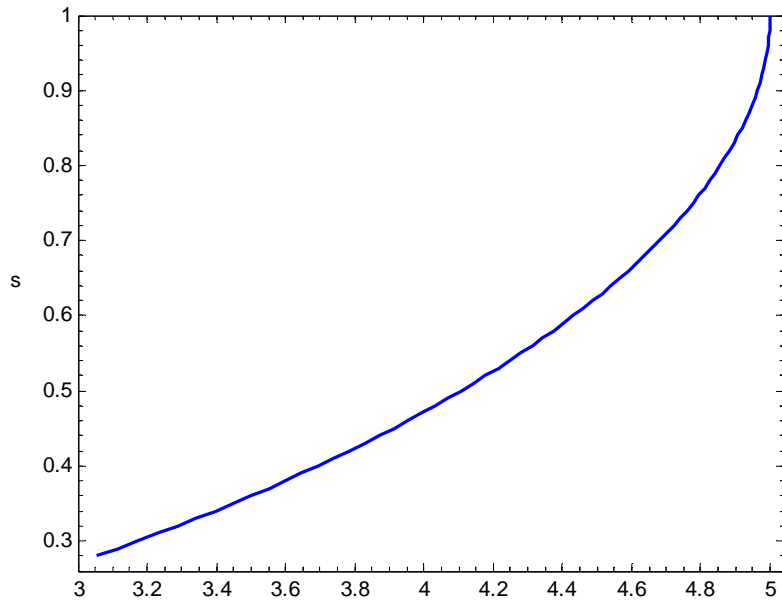
Figure 4 Real money balances m for the full range of financial forbearance s


3.2 Equilibrium Dynamic Analysis

The dynamic solution is obtained through log-linear Taylor approximation around the steady state of the system for the full range of regulatory forbearance s. The reduced system of equations on two key forward-looking variables, i.e. the bankruptcy threshold and inverse inflation factor, is characterised by one stable and one unstable unit root of the characteristic equation. The system is saddle path stable with the inverse inflation factor a jump variable and the bankruptcy threshold adjusting smoothly towards the equilibrium steady state.

Most importantly, the regulatory forbearance affects the speed of convergence of the economic system, i.e. the time it takes for the economy to converge to its steady state, which is captured by the stable eigenvalue. Lower degrees of financial softness lead to relatively fast convergence. On the opposite, higher regulatory forbearance would drive the stable eigenvalue closer to *1*, and in essence produce slow convergence towards long-term equilibrium. This could result in deviations from equilibrium to be

long-lived and with pronounced persistence on the entire economy. Shocks could become so embedded in the dynamics of the economy that they might seem permanent.

Figure 5 and Figure 6 show the time path of the bankruptcy threshold and output in percentage deviations from their steady states at varying degrees of financial forbearance, when the financial softness increases by 0.01 percentage point. The regularity policy is very potent since small deviations in the regulatory parameter cause real effects of sizable magnitude. However, higher regulatory forbearance coincides with prolonged and seemingly almost permanent deviation from equilibrium.

Figure 5 Time path of the bankruptcy threshold in percentage deviation from its steady state, when regulatory forbearance s=0.3, s=0.5 and s=0.7
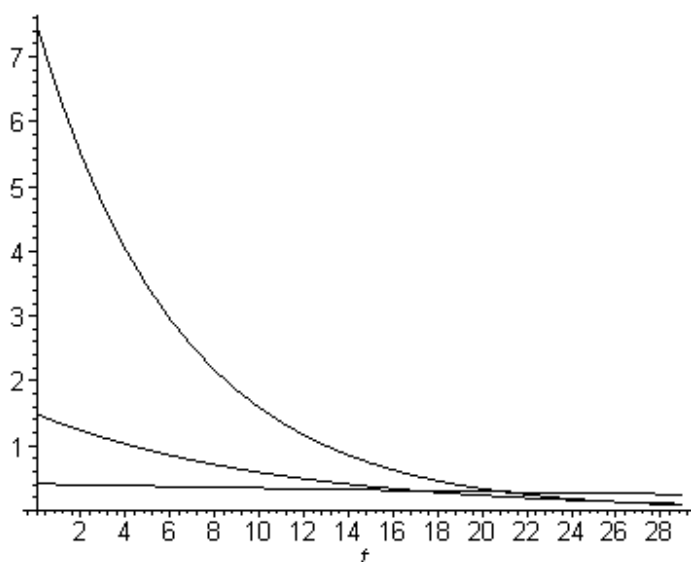
An opportunistic approach of ever rising regulatory forbearance is fraught with dangers. While upward transition from one steady state to another is relatively beneficial in the short term, this policy could lead to liquidity trap and its later reversion would be a prolonged, costly and painful process.

Figure 6 Time path of output in terms of percentage deviation from its steady state, when s=0.3, s=0.5, s=0.7 and 0.9
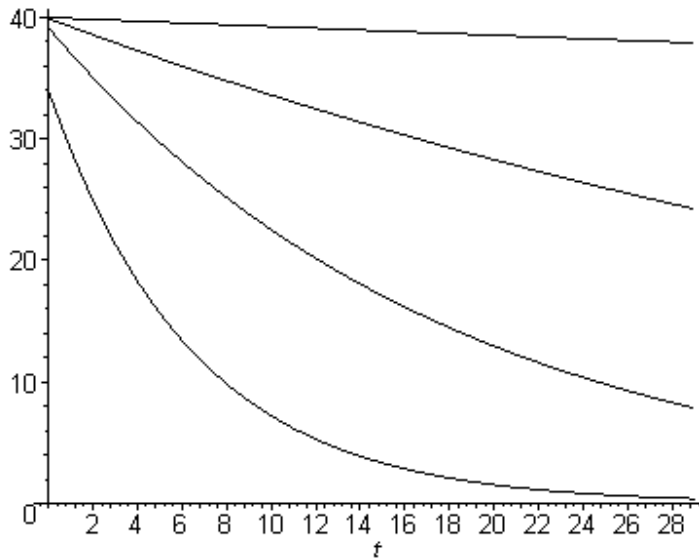
4 Conclusions

This paper presents a dynamic general equilibrium approach to analysing recent policy proposals on a resolution fund for direct recapitalisation of banks financed by banks. The model incorporates endogenous risk inherent in any economic activity due to imperfect information and incomplete financial markets, giving rise to dependence on banking finance and the possibility of default. Financial intermediaries could assume this risk ex-ante, accounting for the level of regulatory forbearance, and support economic activity respectively in expectation of ex-post monetary refinancing and recapitalisation by the state. The downside of such policies and practices would be the resulting financial repression, i.e. erosion of household savings, and the instalment of moral hazard incentives in the economic decisions of banks and enterprises. The bail-in policy in the form of banking levy could act as an additional mechanism for burden-sharing of the financial costs involved in the efforts of the regulatory policy, backed by

non-standard monetary and balanced fiscal policies, to deliver optimal sustainable economic welfare in the long run and fine-tune the economy in the short run.

The theoretical contribution developed in this paper demonstrates that this is indeed the case. Under perfect competition, general equilibrium and banking financial intermediation, a banking levy and monetary refinancing would jointly share the burden of stimulating the economic activity between the households and enterprises. Indeed, as expected from tax incidence studies in public sector economics, under perfect competition banks do not pay for banks, they spread the costs across producers and consumers of final output. Furthermore, the model proves that policy choices related to regulatory policies turn out to be non-neutral and with important amplification effect to the wider economy, which reaffirms the virtue of accounting for market imperfections giving rise to endogenous partial default in equilibrium, when discussing financial and monetary issues.

Bail-in policies deliver sustainable and maximum welfare-improving outcomes at medium degree of regulatory forbearance through the relaxation of companies' borrowing constraints allowing for the intratemporal accumulation of risks at banking level, and subsequently monetary level, while at the same time partially compensating households for ultimately bearing that risk. This is compatible with relatively low banking levy, inflation and interest rate placing balanced and modest burden on both producers and consumers. However, caution is well justified, since further increases in the regulatory forbearance would lead to a Minsky's (1996) liquidity trap, where low bail-in levies, inflation and interest rates are consistent with abundant liquidity, but sub-optimally low equilibrium output, consumption and employment. Furthermore, the economy becomes volatile and vulnerable to policy changes and exogenous shocks. Thus, even coincidental and temporary deviations from equilibrium could become dynamically embedded, long-lived and seemingly almost permanent. Contrary to initial expectations that bail-in policies would automatically contribute towards stricter

discipline for financial intermediaries, they turn out to be inconsistent with very low degree of financial softness (i.e. regulatory forbearance), because that would increase the bankruptcies in the economy, depress the process of asset accumulation and generate a liquidity crunch, which stifles credit, production and consumption.

Great caution needs to be exercised in discretionary changes in the degree of regulatory forbearance, for the way up is much sweeter than the way down. While the regulatory authority could opportunistically decide to exploit persistent, but short-term benefits on economic activity in relaxing the regulatory forbearance above average, it should bear in mind that on reversal such policies would be a long, costly and painful process.

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