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on a common system of financial transaction tax and amending Directive 2008/7/EC

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ANNEX 15

EFFECTS ON MACROECONOMIC VARIABLES

A. ANALYSING THE EFFECTS OF A FINANCIAL ACTIVITY TAX AND A BANK LEVY

1. INTRODUCTION AND SUMMARY

The financial crisis of 2008/09 had major budgetary implications and increased levels of public debt in the EU from slightly below 60% of GDP to more than 80% of GDP. There is a debate on how to make the financial sector contribute to the budgetary cost of the bank rescue measures plus other fiscal stimulus packages. Also the question has been raised whether tax policies could be used to affect leverage of the banking sector. Possible benefits of financial sector taxation must be evaluated against potential costs resulting from higher capital costs for borrowers which can result if banks are shifting taxes onto lending rates.

This paper analysis the macroeconomic consequences of two financial sector tax instruments, namely a financial activity tax and a bank levy, using a DSGE model with a banking sector. For this purpose, we disaggregate the household sector into borrowers and lenders and introduce a corporate banking sector. The banking sector provides loans to entrepreneurs. Liabilities of banks consist of deposits and bank capital. The banking sector can be subject to various forms of taxation. As noted by Keen (2011), the public finance literature so far provides little guidance on financial sector taxation, the model presented in this paper tries to partially fill this gap.

We are interested in the following aspects:

- What are the macroeconomic effects of taxes on bank activities?
- What is the potential of these taxes to raise government revenue?
- Do taxes affect bank leverage?

2. THE MODEL

This section describes in more detail the decision problems faced by individual sectors of the economy. In order to allow for a meaningful financial intermediation function of banks we disaggregate the household sector into savers and borrowers (entrepreneurs). Saver households allocate their savings across government bonds, deposits and bank equity. In order to allow for interbank lending and borrowing we split up the banking sector into "savings" and "investment" banks. Savings banks collect deposits from households, and only lend to investment banks in the interbank market. Investment bank can borrow from households in the form of deposits or from savings banks. Investment banks provide loans to entrepreneurs.

2.1. Entrepreneurs

There is a continuum of entrepreneurs distributed over a unit interval $i \in (0,1)$. Entrepreneur i uses a CRS technology to produce goods (*Y*) which are imperfect substitutes for goods produced by its competitors and we assume monopolistic competition. In addition we assume that price changes are subject to adjustment costs. Entrepreneurs maximise an intertemporal utility function over distributed profits (C^E) which they use for consumption. At the beginning of each period, the entrepreneur makes investment (*I*) and labour demand (*N*) decisions. Firms partly finance investment by taking out loans (*L*) from the banking sector. To prevent over borrowing, banks impose a collateral constraint by restricting loan supply to fraction ξ of the value of the capital stock. It is assumed that entrepreneurs have a higher discount rate compared to savers. This ensures that entrepreneurs have a positive stock of outstanding loans in the steady state. The optimisation problem of entrepreneurs can be written as follows

(1)

$$Max\, V_0^E = \sum \beta^{Et} \log C_{it}^E +$$

$$\sum \lambda_{it}^E \beta^{E,t} \left[L_{it} - (1+r_{t-1}^L) L_{it-1} - C_{it}^E - q_t^K I_{it} + (\frac{P(Y_{it})}{P_t} Y_{it} - W_t N_{it}) - \gamma_p (\frac{P(Y_{it})}{P(Y_{it-1})} - \overline{\pi})^2 \right] -$$

$$- \sum \lambda_{it}^E \theta_t^E \beta^{Et} \left[Y_t \ (K_{it}, N_{it}) - Y_{it} \right]$$

$$- \sum \lambda_{it}^E \phi_{it}^K \beta^{E,t} \left[K_{it} - I_{it} - (1-\delta) K_{it-1} \right]$$

$$- \sum \lambda_{it}^E \psi_{it}^E \beta^{E,t} \left[(1+r_t^L) L_{it} - \xi (1-\delta) q_t^K K_{it} \right]$$

First order conditions

(2a) $$\frac{\partial V_{it}^{E}}{\partial C_{it}^{E}} = \frac{1}{C_{it}^{E}} - \lambda_{t}^{E} = 0$$

(2b) $$\frac{\partial V_{it}^{E}}{\partial L_{it}} = \lambda_{it}^{E}(1-\psi_{it}^{E}(1+r_{t}^{L})) - \lambda_{it+1}^{E}\beta^{E}(1+r_{t}^{L}) = 0$$

(2c) $$\frac{\partial V_{it}^{E}}{\partial K_{it}} = -\lambda_{it}^{E}\phi_{it}^{K} + \lambda_{it}^{E}\psi_{it}^{E}\xi(1-\delta)q_{it}^{K} + \lambda_{it+1}^{E}\phi_{it+1}^{K}\beta^{E}(1-\delta) + \lambda_{it}^{E}\theta_{it}Y_{K,it} = 0$$

(2d) $$\frac{\partial V_{it}^{E}}{\partial I_{it}} = -\phi_{it}^{K} + q_{it}^{K} = 0$$

(2d) $$\frac{\partial V_{it}^{E}}{\partial Y_{it}^{E}} = -\lambda_{it}^{E}(1+\varepsilon(1+\gamma_{p}(\beta^{E}{}_{t}\pi_{it+1}-\pi_{t})))\frac{P_{it}}{P_{t}} + \lambda_{it}^{E}\theta_{it} = 0 \quad , \quad \varepsilon = \frac{\partial Y_{it}^{d}}{\partial P_{it}}\frac{P_{it}}{Y_{it}^{d}} < 0$$

How the collateral constraint affects consumption (distributed profits) and investment can be illustrated by looking at the consumption and investment rules

Consumption of entrepreneurs

(2b') $$\frac{C_{it+1}^{E}}{C_{it}^{E}} = \frac{(1+r_{t}^{L})\beta^{E}}{(1-\psi_{it}^{E}(1+r_{t}^{L}))}$$

ψ_{it}^{E} **:** Lagrange Multiplier of Collateral constraint

Investment

(2c') $$Y_{K,it} = r_{t}^{L} + \delta + \psi_{it}^{E}(1-\xi)$$

The Lagrange multiplier of the collateral constraint ψ_t^E acts like a risk premium to the interest rate of entrepreneurs. A tightening of the constraint thus lowers consumption and investment. The effect on consumption and investment is, however, not symmetric. Collateral tightening reduces consumption more strongly than investment. This asymmetric response is optimal for the entrepreneur, who takes into account that reducing investment would further tighten the borrowing constraint.

2.2. Capital producers

Capital producers transform a fraction of final goods into investment goods. They are perfectly competitive and maximise profits, using a technology which is subject to convex adjustment costs. They use the discount factor β^K

(3) $$\text{Max } E_t \sum \beta^{K\,t} \left\{ q_t^K I_t - \left(I_t + \frac{\gamma_K}{2}\left(\frac{I_t^2}{K}\right) + \frac{\gamma_I}{2}\left(\frac{I_t}{I_{t-1}} - 1\right)^2 I_t \right)_t \right\}$$

The first order condition of this maximisation problem yields a price for the capital good which is equal to

(3a) $$q_t^K = 1 + \gamma_K \left(\frac{I_t}{K}\right)\frac{1}{K} + \gamma_I \left(\frac{I_t}{I_{t-1}} - 1\right)\frac{I_t}{I_{t-1}} - \gamma_I \beta^K \left(\frac{I_{t+1}}{I_t} - 1\right)\left(\frac{I_{t+1}}{I_t}\right)^2$$

2.3. Savers

Saver households have a standard utility function over consumption (C_t^S), deposits (*D*) and leisure (*1-N*). Households make portfolio decisions about government bonds *B*, bank deposits *D* and bank equity *E*, i. e. by holding shares in banks which pay a dividend div_t in period t and have a price q_t^E. Savers pay a lump sum tax *T*.

(4)

$$Max \quad V_0^S = \sum_{t=0}^{\infty} \beta^{St} \left(\log(C_t^S) + \frac{\omega_D}{1-1/\kappa_D} D_t^{1-1/\kappa_D}) + \frac{\omega_N}{1-1/\kappa_L}(1-N_t)^{1-1/\kappa_L} \right) -$$
$$\sum_{t=0}^{\infty} \lambda_t^S \beta^{St} \begin{bmatrix} \Delta D_t + \Delta B_t + q_t^{IB} \Delta E_t^{IB} + q_t^{SB} \Delta E_t^{SB} - \\ r_{t-1}^D D_{t-1} - r_{t-1}^B B_{t-1} + C_t - div_{t-1}^B E_{t-1}^B + risk_{t-1}(E_{t-1}^B) - W_t N_t - T_t \end{bmatrix}$$

Financial wealth: $FW_t = D_t + B_t + q_t^B E_t^B$

First order conditions

(4a) $\frac{\partial V_t^S}{\partial C_t^j} => \frac{1}{C_t^S} = \lambda_t^S$

(4b) $\frac{\partial V_t^S}{\partial D_t} = \omega_D D_t^{-1/\kappa D} - \lambda_t^S + \lambda_{t+1}^S \beta^S (1 + r_t^D) = 0$

(4c) $\frac{\partial V_t^S}{\partial B_t} = -\lambda_t^S + \lambda_{t+1}^S \beta^S (1 + r_t^B) = 0$

(4d) $\frac{\partial V_t^S}{\partial E_t^{IB}} = -\lambda_t^S q_t^B + \lambda_{t+1}^S \beta^S (q_{t+1}^B + div_t^B - risk_t^E) = 0$

(4e) $\frac{\partial V_t^S}{\partial N_t^{SB}} = \omega_N (1-N)^{-1/\kappa_L} + \lambda_t^S W_t \quad = 0$

The following arbitrage condition holds between the return on bank equity r_t^E and the riskless rate

(5) $$(1+r_t^E) = \frac{q_{t+1}^E}{q_t^E} + \frac{div_t^E}{q_t^E} = (1+r_t^B + risk_t^E)$$

Consumption

(4c') $$\frac{C_{it+1}^S}{C_{it}^S} = (1+r_t^B)\beta^S$$

Demand for Deposits

(4b') $$D_t = \left(\frac{\omega_D C_t^S}{r_t^B - r_t^D}\right)^{\kappa D}$$

Labour supply

(4d') $$N_t = 1 - \left(\frac{\omega_N C_t^S}{W_t}\right)^{\kappa N}$$

2.4. Banks

The banking system transforms savings of households into loans for entrepreneurs. We assume that there is a continuum of monopolistically competitive banks indexed by j. They face a demand function for loans

(5) $$L_{jt} = s_j \left(\frac{r_t^L}{r_{jt}^L}\right)^{\varepsilon^L} L_t$$

At the beginning of period t, banks make decisions about loans L_t, deposits D_t liquid assets B_t and loan interest rates r_t^L, taking r_t^D and r_t^B as given. Banks face capital requirement and liquidity requirement constraints.

We consider a simple balance sheet, where total assets consist of loans and liquid assets (B) . Total liabilities are the sum of deposits (D) and bank equity (V^B). The banking sector faces a capital requirement and a liquidity requirement constraint. The capital requirement is formulated in terms of risk weighted assets

(6) $$V^B = \Gamma(\omega_L L + \omega_B B)$$

In addition there is a liquidity requirement, which restricts banks to hold liquid assets as a fraction Γ^B of loans

(7) $$B = \Gamma^B L$$

We assume that banks buy (labour) services from the household sector and use the following simple technology to manage their activities. Total employment in the banking sector N_t^B is divided into overhead labour $N_t^{B,F}$ and labour used for intermediation services $N_t^{B,V}$ which is proportional to loans

$$N_t^{B,V} = \theta L_t$$

Let w_t^B be the wage rate in the banking sector, then total and marginal wage cost are given by

$$C_t^B = w_t^B (N_t^{B,F} + N_t^{B,V}) = w_t^B N_t^B$$

$$MC_t^B = w_t^B \theta$$

The cash flow of the bank in each period is given by equation 8.

(8)

$$div_{jt-1}E^B_{jt-1} = (1-t^A)(r^L_{t-1}(L_{t-1})L_{jt-1} + r^B_{t-1}B_{jt-1} - r^D_{t-1}D_{jt-1}) - t^L D_{j,t-1} - w^B_t (N^{B,F}_t + \theta L_t) + \Delta D_{jt} - \Delta B_{jt} + q^B_{jt}\Delta E^B_{jt} - \Delta L_{jt}$$

Each period the investment bank pays out dividends to its shareholders. Dividend payments are constrained by the cash flow of the bank. The cash flow consists of revenues from loan interest payments of entrepreneurs ($r^L_{jt-1}L_{jt-1}$) and interest receipts from holding liquid assets ($r^B_{t-1}B_{t-1}$) minus interest payments on deposits ($r^D_{t-1}D_{t-1}$) and minus wage costs ($W^B_t N^B_t$). Interest receipts and expenditures are based on loan and financing decisions of the previous periods. The current period cash flow can be increased by increasing deposits and bank capital and is reduced by increasing loans or liquid assets. The variables (t^A, t^L) are financial activity tax rates and a bank levy. The financial activity tax, taxes current bank profits, however wage costs are not deductable. The bank levy taxes the stock of bank debt[1].

Let us define the stock market value of the investment bank as

(9) $$V^B_t = q^E_t E_{t-1}$$

And take into account the discount rate (r^E_t) the household applies to bank equity, the stock market value of the bank is given by

(10) $$V^B_{t-1}(1+r^E_t) = DIV^B_{t-1} + {}_{t-1}V^B_t \quad \text{where } DIV^B_{t-1} = div^B_{t-1}E^B_{t-1}$$

Solving forward (10) gives the stock market value of the bank as the PDV of dividends

[1] Notice, the model does not make a distinction between deposits and other liabilities. The bank levy is regarded as a tax on other rliabilities only, the bank levy rate must be scaled appropriately.

(11) $V_t^B = \sum_{f=0}^{\infty} \prod_{k=0}^{t} (1 + r_{t+k}^E)^{-k} DIV_{t+f}$

The bank maximises (11) w. r. t. L, B and D, subject to (6), (7) and (8). One technical problem arises because the value to be maximised (V^B) appears itself in a constraint. This problem can be handled by using dynamic programming

$$V^B(L_{t-1}, B_{t-1}, D_{t-1}) = Max\left\{DIV_t + E_t \frac{1}{1+r_t^E} V^B(L_t, B_t, D_t)\right\}$$

(12)
$$- \lambda_t [8]$$
$$- \mu_t [6]$$
$$- \psi_t [7]$$

Then we can write the first order conditions of the bank's maximisation problem as follows

(13a) $$\frac{\partial V_t^B}{\partial DIV_t} = 1 - \lambda_t = 0$$

(13b) $$\frac{\partial V_t^B}{\partial L_t} = -\lambda_t + \frac{(1-\mu_t\ (1 + (r_t^L(1-\varepsilon^L)(1-t^A) - w_t^B \theta))}{(1+r_t^E)} + \mu_t \Gamma \omega_L + \psi_t \Gamma^B = 0$$

(13c) $$\frac{\partial V_t^B}{\partial B_t} = -\lambda_t + \frac{(1-\mu_t)(1 + (1-t^A) r_t^B)}{(1+r_{t+1}^E)} + \mu_t \Gamma \omega_B - \psi_t = 0$$

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(13d) $$\frac{\partial V_t^B}{\partial D_t} = \lambda_t + \frac{(1-\mu_t)(1+(1-t^A)r_t^D + t^L)}{(1+r_{t+1}^E)} = 0$$

Rearranging the FOC's yields

(14a) $$(1-t^A)r_t^L(1-\varepsilon^L) = w_t^B\theta + \left\{\Gamma\omega_L r_t^E + (1-\Gamma\omega_L)((1-t^A)r_t^D + t^L)\right\} + \left[\Gamma\omega_B r_t^E + (1-\Gamma\omega_B)((1-t^A)r_t^D + t^L) - (1-t^A)r_t^B\right]\Gamma^B$$

Or

(14b) $$r_t^L(1-\varepsilon^L) = \frac{w_t^B\theta}{(1-t^A)} + \left\{\frac{\Gamma\omega_L r_t^E}{(1-t^A)} + (1-\Gamma\omega_L)(r_t^D + \frac{t^L}{(1-t^A)})\right\} + \left[\frac{\Gamma\omega_B r_t^E}{(1-t^A)} + (1-\Gamma\omega_B)(r_t^D + \frac{t^L}{(1-t^A)} - r_t^B)\right]\Gamma^B$$

Equation (14b) shows the loan interest rule that can be derived from the bank's optimisation problem. The loan interest rate is determined as a mark up over marginal cost (the mark up factor is given by $1/(1-\varepsilon^L)$. The marginal cost items have a quite intuitive interpretation and show in particular how the regulatory constraints and taxes affect marginal cost.

The first term on the RHS (in curly brackets) is the weighted average of the return on equity and the deposit rate and the weights are the share of equity and deposits in total assets. An increase in capital requirements (Γ), increases marginal costs for banks, since they have to finance a larger share of loans with more expensive bank equity.

The second term (term in square brackets) can be interpreted as the opportunity cost for the bank arising from holding liquid assets. The term in square bracket is the difference between the costs of raising funds for financing liquid assets and the return from liquid assets. This term is multiplied with the required liquidity ratio Γ^B . This constitutes the marginal cost to the bank of increasing loan supply (notice is a cost to the bank only if the term in square brackets is positive).

Equation (14b) also shows how individual taxes affect the loan supply/loan interest rate decision of the bank. First, it can be seen that a financial activity tax is effectively a tax on bank equity and bank employment. This tax is shifted onto the loan interest rate. The size of the tax shift depends on the (risk adjusted) ratio between bank equity and loans ($\Gamma\omega_L$) and marginal employment cost ($w^B\theta$). Similarly a bank levy on bank debt is also shifted onto the loan interest rate.

2.5. Government

The government budget constraint is standard. Government spending (G) is financed by (lump sum) taxes (T) from the non financial sector, a bank levy, a financial activity tax[2] and government bonds which can either be sold to households (B) or to the central bank (B_t^{CB}). Other financial market policies such as taxing financial transactions and bank profits could in principle be modelled by adjusting the government budget constraint and modifying the budget constraints of banks, households and firms

(18) $$B_t + B_t^{CB} = (1+r_{t-1}^B)(B_{t-1} + B_{t-1}^{CB}) + G_t - T_t - T_t^B - profit_t^{CB}$$

T^B denotes the sum of financial activity tax and bank, levy and is given by

$$T_t^B = t^A(r_{t-1}^L L_{t-1} + r_{t-1}^B B_{t-1}^B - r_{t-1}^D D_{t-1}) + t^L D_{t-1}.$$

2.6. Central Bank

The central bank generates profits from providing household with cash (*M*) and earns interest from purchasing government bonds (B_t^{CB}) (currently B_t^{CB} is set to zero).

[2] Both the financial activity tax and the bank levy is zero at the baseline.

(19) $$\frac{\Delta M_t}{P_t} - B_t^{CB} = -(1 + r_{t-1}^B) B_{t-1}^{CB} + profit_t^{CB}$$

Policy rule I: (price level targeting)

(20) $$P_t = \overline{P}$$

Policy Rule II: (Taylor rule, inflation targeting)

The CB can influence the nominal interest rate (of government bonds) via changing the supply of money. Since money demand is a function of the nominal interest rate on government bonds, a money supply rule can be formulated where the CB responds with the supply of money in order to stabilise some targets (e. g. inflation or nominal interest rate);

A general rule would be

(21a) $$t_M (M_t - M_t^T) = -t_\pi (\pi_t - \pi_t^T) + t_{inom} (inom_t - inom_t^T)$$

Where $inom_t = rb_t + \pi_{t+1}$

A special case would be a Taylor rule

(21b) $$\Delta inom_t = t_\pi (\pi_t - \pi_t^T)$$

An equilibrium in this economy is given by a set of optimality conditions for savers, entrepreneurs, investment and savings banks concerning consumption, investment, labour supply and demand as well as asset allocation. The set of relative prices and rates of return ($w_t, q_t^E, r_t^L, r_t^D, r_t^{DIB}$) clear markets labour, bank equity, loans, deposits and interbank loans and establish an equilibrium between investment and savings.

3. CALIBRATION

All parameters describing behaviour of the non financial sector are taken from Ratto et al. (2009). As a baseline for the financial sector tax we assume that the capital requirement directive (CRDIV) is implemented starting in 2012 with the banking sector adjusting to new capital and liquidity requirements (with a transition period lasting until 2019), the implementation of a deposit guarantee scheme (reaching 2% of eligible deposits) and the build-up of a countercyclical buffer. We use information from the EU Quantitative Impact Study (QIS), which suggests that the ratio of tier 1 capital to risk weighted assets at the end of 2009 was around 6%. The risk weight for the two types of assets is 55% for loans and 5% for government bonds respectively. Also based on the EU QIS report we assume that the ratio of liquid to non liquid assets in the balance sheet of the banking sector is 8.5% at the end of 2009. Our preferred balance sheet concept for the banking sector is a consolidated balance sheet, which provides information about the stock of loans to the non financial sector. This gives us the leverage position of the non financial private sector, and yields an accurate estimate of the (loan) capital cost of the private sector. This is important for calculating the macroeconomic impact of the regulatory measure[3].

Concerning aggregate lending of banks to the non financial private sector the model must replicate a loan to GDP ratio of about 1.3. The interest data are from the ECB and other EU27 central banks. The pre-crisis figures suggest a loan interest rate of 5.2%, a deposit rate of 2.5% and a rate on government bonds of 4.2%. The rate of return on bank equity was at a historical low because of the financial crisis. We therefore use an average value from previous years (14.3%). Based on data from Eurostat, V. Escudero (2009) reports that the employment share of financial intermediaries in total employment is about 3% in EU27.

The interest semi-elasticity of the supply of deposits of households (ISED) is a crucial parameter for this exercise, since it determines by how much deposit rates will fall if the demand for deposits by banks declines. Unfortunately ISED is not very precisely estimated and is likely to be time varying with standard CRRA specifications of the utility function. For the US, the semi elasticity estimates vary between 5 and 10 (see Ball (2001)), For the EA estimates of ISED range between 1 and 3 (see, for example, Beyer (2009), Bruggemann et al. (2003) and Dedola (2001)). Especially Dedola et al. point out that data and aggregation problems in Euro area countries may significantly bias downwards the interest elasticity estimates in the Euro area. In a recent paper Inagaki (2009) estimates a time varying semi elasticity for the US and Japan and notes that the semi elasticity can be high in low inflation environments. For the US his ISED estimate ranges between 4 and 36 (with a peak reached in 2003) while in the case of Japan the estimate ranges between 2.5 and 874 (in 2005). As a benchmark we use ISED=10, but we provide results for higher vales as well.

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[3] Because we only have an unconsolidated balance sheet of the banking sector for EU27 we make the assumption that the ratio of loans to the non financial sector and interbank loans is identical in the EU27 and the EA. And we know from the consolidated EA balance sheet that loans to the non financial sector are about 130% of GDP.

4. SIMULATION RESULTS

We are interested in the following questions:

- What are the macroeconomic effects of axes on bank activities?
- What is the potential of these taxes to raise revenue for the government?
- Do taxes have an impact on bank leverage?

We look at two types of taxes, a financial activity tax which is a tax on bank profits (without deductibility of wage costs) and a bank levy which is a tax on bank debt.

Financial Activity Tax (FAT)

Table (1): The effect of a 5% FAT (anticipated to be introduced in 2015). Share of fixed employment: 0.5

	2012A	2013A	2014A	2015A	2020A	2050A	2150A
Y	-0.05	-0.06	-0.09	-0.12	-0.21	-0.44	-0.50
I	-0.81	-1.31	-1.49	-1.58	-1.47	-1.21	-1.19
C	0.13	0.24	0.25	0.22	0.06	-0.36	-0.47
K	-0.02	-0.06	-0.11	-0.17	-0.42	-1.01	-1.18
LO	-0.13	-0.35	-0.46	-0.49	-0.67	-1.09	-1.21
D	0.59	0.45	0.40	0.40	0.28	-0.03	-0.01
VB	-0.15	-0.36	-0.44	-0.50	-0.68	-1.09	-1.22
RD	-4.05	-2.89	11.39	-2.32	-2.30	-0.76	-0.16
RE	-5.90	-4.29	10.19	-3.41	-3.16	-0.73	-0.26
RLO	-10.13	-7.22	15.41	10.58	12.54	13.86	14.70
SPREAD	-6.08	-4.33	4.02	12.90	14.84	14.63	14.85
CCSHADOW	20.44	3.54	-2.25	3.19	3.43	5.39	6.04

L	-0.07	-0.06	-0.07	-0.08	-0.07	-0.05	-0.05
TLEVY	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TFATY	0.00	0.00	0.00	0.18	0.22	0.21	0.21

Note: Y: GDP, I: Investment, K: Capital stock, C: Consumption, LO: Stock of loans, D: Stock of debt/depoits, VB: stock market value of the bank, RD: Deposit rate, RE: rate of return on bank equity, RLO: Loan rate, SPREAD: difference between loan and deposit rate, ZETA: Lagrange multiplier of collateral constraint ,CCSHADOW: Capital cost including Lagrange Multiplier of credit constraint, L: employment, TLEVY: Bank levy as a share of GDP, TFATY: Financial activity tax as a share of GDP. Y, C, I, K, LO, D, VB, N are % deviations from baseline. RD, RE, RLO, SPREAD, CCSHADOW: are in BP. TLEVY, TFATY: are % point deviations.

A financial activity tax is shifted onto loan interest rates. This increases capital costs for firms and lowers investment and the capital stock[4] and reduces GDP. The loss in GDP is predominantly generated by a reduction of investment. The negative effects of the FAT on employment are minor. With standard wage setting rules wages are determined by productivity in the long run. I. e. real wages decline and stabilise employment. One important policy issue concerns the impact of a FAT on bank leverage, in particular on the ratio of bank equity to debt. Given the capital requirement which links bank equity to loans, the ratio between loans and bank equity is not affected by taxation. However this does not rule out that the ratio between bank equity and bank debt (deposits) changes. As can be seen from the table above, banks find it optimal to increase debt relative to bank equity. The economic intuition in the context of this model is as follows: Given the optimal loan interest rate rule, a unit increase of t^A lowers after tax revenues from lending per unit of loan by $r^D(1-\Gamma)/(1-\varepsilon^L)$ and lowers cost roughly by $r^D(1-\Gamma)$. The loss in revenue exceeds the cost reduction by the factror $1/(1-\varepsilon^L)$, because the FAT also taxes monopoly rents. In order to increase dividend payments it is optimal for the bank to increase indebtedness. Notice however, there are limits to this because an increase in the demand for deposits raises interest rates on deposits (which leads to second round effects on loan rates). Also the capital requirement constraint imposes a limit on bank debt. The FAT introduced with a rate of 5% would generate additional government revenues of 0.2% of GDP. [5]

A Levy on bank debt:

[4] Notice, the tax are given back to households in the form of an increase in lump sum transfers. The GDP losses would be smaller in the case of a budgetary neutral reduction of distortionary taxes. Lump sum transfer compensation was chosen here in order to show the effects of the FAT without mixing them up with the effects of a distortionary tax.

[5] Note that if the baseline would be Basel II, the results would barely change. Actually, the FAT base is slightly larger under Basel III. In the long-term, under Basel II, a 5% FAT would collect 0.19% GDP (comp. 0.20% under Basel III) and lead to -0.45% GDP (comp. -0.54% under Basel III).

Table (2): The effect of a bank levy of 0.05% on other liabilities (anticipated to be introduced in 2015)

	2012A	2013A	2014A	2015A	2020A	2050A	2150A
Y	-0.00	-0.00	-0.01	-0.01	-0.02	-0.03	-0.03
I	-0.04	-0.08	-0.11	-0.13	-0.12	-0.10	-0.08
C	0.01	0.02	0.02	0.02	0.01	-0.03	-0.03
K	-0.00	-0.00	-0.01	-0.01	-0.03	-0.08	-0.08
LO	-0.00	-0.02	-0.03	-0.04	-0.05	-0.09	-0.08
D	-0.38	-0.39	-0.39	-0.39	-0.41	-0.44	-0.48
VB	-0.00	-0.01	-0.02	-0.04	-0.05	-0.09	-0.08
RD	-0.23	-0.18	0.30	-2.25	-1.79	-1.73	-1.82
RE	1.20	1.30	1.84	-0.83	-0.17	0.00	0.04
RLO	-0.67	-0.56	0.30	0.45	1.01	1.08	0.96
SPREAD	-0.44	-0.38	-0.00	2.70	2.80	2.82	2.78
CCSHADOW	0.12	-0.46	-0.85	0.58	0.22	0.41	0.39
L	-0.00	-0.00	-0.01	-0.01	-0.01	-0.00	-0.00
TLEVY	0.00	0.00	0.00	0.07	0.07	0.07	0.07
TFATY	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Like in the case of a FAT, a levy on bank debt is also shifted onto loan interest rates and reduces capital formation and GDP. In contrast to the FAT, a bank levy reduces debt relative to bank equity, since banks shift away from debt financing in order to reduce increased costs of debt. By reducing the demand for debt banks can shift the burden of the levy onto depositors. This policy measure would generate additional revenues as a share of GDP of about 0.07% in the medium to long run[6]. The magnitude of the GDP loss (if one controls for the revenues generated) seems smaller compared to the FAT. The next section will explore the sensitivity of the macroeconomic effects of both tax policies to underlying model assumptions.

[6] Other liabilities, which are tax base for the bank levy constitute about 170% of EU27 GDP.

Financial activity tax and bank levy:

Table (3) shows the combined effect, which is essentially the sum of the two effects.

Table (3): The combined effect of a 5% FAT and a 0.05% Bank levy on other liabilities (both anticipated to be introduced in 2015)

	2012A	2013A	2014A	2015A	2020A	2050A	2150A
Y	-0.05	-0.07	-0.09	-0.12	-0.22	-0.47	-0.53
I	-0.85	-1.39	-1.61	-1.71	-1.60	-1.30	-1.26
C	0.14	0.25	0.27	0.24	0.06	-0.39	-0.50
K	-0.02	-0.07	-0.12	-0.18	-0.45	-1.09	-1.26
LO	-0.14	-0.36	-0.49	-0.53	-0.72	-1.18	-1.30
D	0.18	0.04	-0.03	-0.02	-0.16	-0.50	-0.53
VB	-0.15	-0.37	-0.46	-0.54	-0.73	-1.18	-1.30
RD	-4.28	-3.07	11.68	-4.70	-4.20	-2.62	-2.11
RE	-4.64	-2.91	12.11	-4.29	-3.34	-0.72	-0.21
RLO	-10.82	-7.79	15.70	11.04	13.58	14.96	15.65
SPREAD	-6.54	-4.72	4.01	15.74	17.78	17.58	17.76
CCSHADOW	20.52	3.04	-3.16	3.80	3.67	5.81	6.43
L	-0.07	-0.07	-0.07	-0.09	-0.08	-0.05	-0.05
TLEVY	0.00	0.00	0.00	0.07	0.07	0.07	0.07
TFATY	0.00	0.00	0.00	0.18	0.22	0.21	0.21

The ratio of the GDP loss to revenues raised is 2.4 in the case of a financial activity tax but only 0.4 in the case of a bank levy, suggesting that the bank levy may be a more efficient revenue generating instrument. This section explains how this result emerges in the model and provides additional sensitivity analysis concerning the robustness of this result. The reason for this result is that the burden of the two types of taxes is differently borne by depositors[7], equity owners and banks and this has implications for the lending rate. As shown in the previous section, the FAT is a tax on equity and variable bank employment while the bank levy is a tax on bank debt. Therefore the interest elasticity of the supply of deposits and the supply of equity matters as well as the extent in which bank employment is a variable factor of production. A crucial distinction between deposits and bank equity in the household portfolio is the liquidity service provided by deposits. This results in a finite (semi) interest elasticity of the supply of deposits in the short and the long run and we use estimated values for this elasticity. As is standard with infinitely lived households, the supply of funds is completely elastic in the long run and the rate on equity is determined entirely by the rate of time preference (and a constant equity premium). This elasticity difference between the supply of bank equity and the supply of deposits is crucial for the incidence of the two taxes. For FAT it is also important by how much the bank bears the tax on bank employment. This depends crucially on whether bank employment is a fixed or a variable factor of production. In the fixed factor case the bank shifts the tax onto bank equity holders, while in the case of variable labour the bank regards the FAT as a tax on marginal wage costs and is shifting it onto lending rates[8] and thus on investors. The following table provides results from a sensitivity analysis which looks at the impact supply elasticity for deposits and the nature of bank employment.

Table (4): Sensitivity Analysis (long run effects)

		GDP	Revenue	Spread	Loan rate	Deposit rate	GDP Loss over Revenue
A: Base Model	FAT	-0.50	0.21	14.9	14.7	-0.2	2.4
	Levy	-0.03	0.07	2.8	1.0	-1.8	0.4
B: High deposit elasticity	FAT	-0.47	0.20	13.4	13.5	0.1	2.6
	Levy	-0.14	0.08	3.8	3.8	0.0	1.8
C: High fixed	FAT	-0.28	0.18	1005	8.2	-1.8	1.5

[7] We use the term bank debt and deposits interchangeably. We speak of bank debt when we look at bank liabilities - other than bank capital - from the perspective of the bank and we use the term deposits when we look at bank liabilities (excluding bank capital) from the perspective of the household. In this model bank deposits serve two functions for households. First they provide a risk free rate of return and second, they provide liquidity services. The liquidity service function has implications for the long run interest elasticity of debt/deposit supply to the banking system and therefore for tax incidence.

[8] While we allow the bank technology to have an effect on how strongly the bank bears the FAT, the model does not allow for different degrees by which households supplying bank employment bear the tax. There is no bank specific wage because the supply of labour is assumed to be perfectly elastic across the non financial and the financial sector. However indirectly the bank technology affects how (banker households=equity holders) bear the FAT.

labour share	Levy	-0.16	0.08	5.4	4.8	-0.6	2.0

The ROE is not shown in the table since it is unaffected by the tax in the long run.

Elasticity of the supply of deposits:

A crucial difference between a FAT and a bank levy is its impact on the rate in which households are willing to supply funds to banks which we call the deposit rate. Since a FAT reduces the demand for debt while the bank levy reduces debt, the interest elasticity of deposit supply is important for determining how the two taxes affect bank funding costs. With a finite supply elasticity, FAT reduces the deposit rate by less compared to a bank levy. As explained in section 2, we have chosen a high semi elasticity given available estimates, nevertheless, this elasticity could be still too low since we apply it to total bank debt (and not all of it will provide liquidity services[9]). In order to highlight the importance of the elasticity difference between bank equity and bank debt (both provided by saver households) line **B** shows results with a deposit supply elasticity close to infinity. As can be seen, with a high elasticity, the deposit rate remains practically constant and consequently the relative efficiency of both taxes in terms of raising tax revenue becomes much closer. This shows that the efficiency difference between these two taxes is practically entirely explained by the fact that a bank levy under the standard model specification is applied to debt with a finite supply elasticity. If a bank levy is applied to bank debt other than deposits then specification **B** appears to be the more relevant case.

Fixity of Bank employment:

The degree in which bank employment is fixed or variable is crucial for who is bearing the financial activity tax. If employment is fixed banks shift the FAT more strongly to shareholders in the form of lower dividends and only pass on the equity component of the FAT to borrowers. This can be seen from line **C**. With a high share of fixed labour the efficiency of the FAT increases since the tax affects the lending rate and thus capital costs less. The fixity of bank employment also appears to affect the efficiency of the bank levy. This is, however, entirely due to the calibration. With a high fixed labour share a higher mark up in the banking sector must be assumed in order to match the loan rate to marginal funding costs (which are lower with fixed labour). This implies that changes in marginal cost have a larger impact on lending rates. Nevertheless this case is interesting since it shows that there are constellations of overhead labour shares and mark up size for which the efficiency of a FAT is larger than that of a bank levy.

[9] About 55% of bank liabilities (excl. Bank capital) are deposits and 45% are other liabilities.

A corporate income tax for banks (CIT)

Table (5): Effects of a corporate income tax on banks

	2012A	2013A	2014A	2015A	2020A	2050A	2150A
Y	-0.11	-0.13	-0.17	-0.23	-0.41	-0.87	-0.98
I	-1.67	-2.61	-2.89	-3.00	-2.86	-2.40	-2.30
C	0.26	0.48	0.49	0.43	0.11	-0.73	-0.92
K	-0.04	-0.13	-0.23	-0.34	-0.81	-2.02	-2.30
LO	-0.29	-0.74	-0.95	-0.96	-1.31	-2.16	-2.36
D	2.25	2.00	1.93	1.98	1.75	1.18	1.04
VB	-0.35	-0.79	-0.91	-0.98	-1.32	-2.17	-2.36
RD	-14.49	-10.05	23.46	0.10	1.34	3.74	4.30
RE	-22.21	-17.04	16.71	-6.77	-4.92	-0.94	-0.00
RLO	-20.49	-14.09	34.62	22.19	23.98	27.44	28.25
SPREAD	-6.00	-4.04	11.16	22.09	22.65	23.70	23.94
CCSHADOW	48.40	10.82	-2.29	6.30	6.01	10.51	11.57
L	-0.16	-0.13	-0.13	-0.15	-0.13	-0.10	-0.09
TLEVY	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TFATY	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TCITY	0.00	0.00	0.00	0.19	0.22	0.21	0.21

Table (5) shows the effects of an increase in CIT, generating similar revenue as a FAT. The essential difference between the CIT and a FAT is the tax deductability of bank wages. A comparison with the FAT shows that the CIT is more distortionary, i. e. associated with larger GDP losses. This is due to the fact banks only pass on a fraction of the tax deduction for bank wages onto loan interest rates, related to variable employment. Tax deductions for overhead labour increase bank profits.

5. CUMULATIVE EFFECT WITH REGULATORY MEASURES.

It is also interesting to report on the cumulative impact of regulatory measures and the application of a FAT, alone or on top of a bank levy. In the analysis here above, the calibration of the minimum capital requirements (the minimum quantity of capital) as well as the regulatory changes that aim at increasing the quality of bank capital (including the capital conservation buffer of 2.5%), the requirement to hold liquid assets agreed under Basel III and the introduction of harmonized deposit guarantee schemes (DGS) rules and the SIFI surcharge of 2% are considered as part of the baseline scenario[10].

It is however interesting to address the issue of the cumulative impact of the FAT with the regulatory measures (and possibly a bank levy). In the following simulations, a FAT is added to regulatory changes and to regulatory changes and a bank levy. The simulations offer a comparison with a baseline scenario of no regulatory changes (i.e. a Basel II framework).

Modelling the effects of stricter capital requirements necessitate assumptions on the effects holding an increased share of equity in the total funding sources on the cost of capital. Bank equity has indeed generally higher return than wholesale debt because they bear higher risk. This could in essence increase the weighted average cost of capital (WACC) for the financial institutions[11]. This statement has however been challenged by some studies (Admati et al., 2010; Miles et al., 2011). Indeed, at the other extreme, one can assume that the Modigliani-Miller (1958) theorem holds in full. In this case, an increase in capital requirements only redistributes the risks borne by equity owners. In other words, higher capital requirements improve the abilities of banks to withstand systemic pressure and reduce the risk premium on equity, therefore offsetting the increase in cost of capital due to a higher proportional use of equity.

[10] The results presented here are necessarily limited to a number of regulatory reforms for the following reasons. On one hand, many of the planned regulatory reforms have not been finalised and adopted yet, which greatly reduces the possibility to quantify them at this stage. Such reforms include the taxation of financial activities, the introduction of a crisis management framework, the introduction of a "Single Rule Book", etc. On the other hand, the macroeconomic models that include a stylized financial sector limit the possibility of quantifying all the envisaged or adopted financial reforms. For example, the macroeconomic modelling of the reforms undertaken in the derivatives sector or targeting Central Counterparties (CCPs) still represents a challenge. Note that the effects of the DGS are probably overestimated as it is assumed to be financed by 2% of eligible deposits, which is high.

[11] In a stylized representation and in the absence of taxation, the WACC equals $\frac{E}{D+E}r_E + \frac{D}{D+E}r_D$, with E: equity, D: debt, r_E: return on equity and r_D: return on wholesale debt.

In line with Miles et al. (2011), the simulations here refer to a baseline scenario where the direct impact of the capital requirement on the cost of capital is 50%. This is the middle-case scenario in terms of economic effects. We will then refer to additional scenarios under which all of the cost are transferred and under which the cost of capital remains unchanged (in line with Modigliani-Miller, 1958). The three scenarios (No MM, 50% MM and 100%MM) lead to economic impacts of the regulatory measures as indicated in tables (6) and (7). It is shown that the assumptions about the direct pass-through of the capital requirement into the weighted-average cost of capital are keys to the results. In the worst-case assumption, an increase in the cost of capital by 14 basis points (0.14 percent) leads to a long-run GDP impact of -1.02% while in the optimistic assumption, the increase in the cost of capital is 2.9 basis point (0.029 percent) and leads to a long-run impact on GDP of -0.11%. It is very important to stress here that the simulation only considers the costs of stricter regulation and does not look at the benefits in terms of the decrease in the likelihood and consequences on the economy of banking crises.

Table (6). Cumulative impact of regulatory reforms: new quantitative and qualitative capital requirement, capital conservation buffer, the countercyclical capital buffer, SIFI surcharge, liquidity requirements, DGS harmonization vy (no loan-bond substitution - 50% MM offset).

	2012	2013	2014	2015	2016	2017	2018	2019	average 2020-2030	long term
Impact on macro variables (deviation from baseline in %)										
GDP	-0.14%	-0.14%	-0.17%	-0.24%	-0.28%	-0.32%	-0.35%	-0.37%	-0.47%	-0.72%
consumption	0.25%	0.48%	0.47%	0.41%	0.35%	0.27%	0.19%	0.10%	-0.19%	-0.66%
investment	-1.81%	-2.64%	-2.80%	-2.97%	-3.02%	-2.92%	-2.76%	-2.56%	-2.07%	-1.80%
labour hours	-0.20%	-0.14%	-0.13%	-0.17%	-0.18%	-0.16%	-0.15%	-0.14%	-0.10%	-0.07%
Impact on bank variables (deviation from baseline in %)										
volume of loans	-0.35%	-0.83%	-0.97%	-0.93%	-1.05%	-1.15%	-1.19%	-1.21%	-1.31%	-1.75%
volume of deposits	2.00%	1.69%	1.57%	3.47%	2.13%	1.77%	1.44%	1.10%	1.47%	2.04%
value of bank	-0.48%	-0.99%	-1.02%	-0.25%	64.09%	76.78%	89.52%	102.28%	73.62%	49.30%
Impact on bank variables (deviation from baseline in basis points)										
loan rate	-19.85	-12.26	43.89	24.83	21.93	26.74	28.23	26.97	21.76	20.56
deposit rate	-36.99	-33.65	33.92	21.13	-4.63	-4.91	-7.53	-12.08	0.41	12.65
return on bank equity	-43.66	-39.49	28.44	9.01	-12.03	-11.08	-12.54	-15.93	-5.06	4.75
firm cost of	64.34	23.14	-6.73	-1.62	8.20	7.51	8.52	10.48	7.18	6.64

capital

Table (7). Sensitivity with regards to assumptions on the effect of capital regulations

2020-2030	0% MM	Baseline 50% MM	100% MM
Impact on macro variables (deviation from baseline in %)			
GDP	-1.02%	-0.47%	-0.11%
consumption	-0.22%	-0.19%	-0.16%
investment	-5.18%	-2.07%	-0.06%
labour hours	-0.24%	-0.10%	-0.01%
Impact on bank variables (deviation from baseline in %)			
volume of loans	-2.92%	-1.31%	-0.25%
volume of deposits	3.66%	1.47%	0.05%
value of bank	71.93%	73.62%	74.75%
Impact on bank variables (deviation from baseline in basis points)			
loan rate	47.61	21.76	5.29
deposit rate	5.51	0.41	-3.31
return on bank equity	-7.41	-5.06	-3.53
firm cost of capital	13.88	7.18	2.87

The 100% MM scenario assumes no direct change in the weighted-Average Cost of Capital from higher capital ratios. The baseline scenario assumes a 50% direct effect. The 0% MM scenario assumes full direct effects.

Next, it interesting to see from table (8) hereunder that regulatory changes effects and FAT effects are more or less cumulative. Revenues from FAT are unchanged compared to table (1) and the effects on the other variables are virtually the sum of the effects of regulatory changes and to FAT. In total, there is a cumulated long-term decrease in GDP of -0.83% compared to the baseline scenario. The cost of capital increases by 12.44 basis points and the spread increases by 42.74 basis points.

Table (8). The cumulative effect of a 5% FAT (anticipated to be introduced in 2015) with regulatory changes – 50% MM.

	2012	2013	2014	2015	2016	2017	2018	2019	average 2020-2030	long term
Impact on macro variables (deviation from baseline in %)										
GDP	-0.20	-0.22	-0.28	-0.38	-0.45	-0.51	-0.56	-0.61	-0.81	-1.34
consumption	0.41	0.77	0.78	0.68	0.59	0.47	0.34	0.21	-0.27	-1.23
investment	-2.79	-4.22	-4.61	-4.88	-4.93	-4.81	-4.62	-4.39	-3.76	-3.24
labour hours	-0.29	-0.22	-0.22	-0.27	-0.27	-0.26	-0.24	-0.22	-0.18	-0.13
FAT Revenues (%GDP)	0.0	0.0	0.0	0.16	0.18	0.20	0.21	0.22	0.21	0.20
Impact on bank variables (deviation from baseline in %)										
volume of loans	-0.51	-1.26	-1.54	-1.54	-1.72	-1.86	-1.94	-2.00	-2.27	-3.22
volume of deposits	2.74	2.25	2.07	3.97	2.59	2.20	1.83	1.47	1.70	1.97
value of bank	-0.66	-1.44	-1.55	-0.86	63.05	75.60	88.20	100.81	72.05	47.22
Impact on bank variables (deviation from baseline in basis points)										
loan rate	-32.42	-21.21	63.00	37.95	35.99	42.49	43.74	42.48	37.61	38.33
deposit rate	-42.01	-37.23	48.05	18.21	-8.10	-7.34	-10.34	-15.07	-1.44	12.93
return on bank equity	-60.62	-72.25	-3.66	-61.42	-100.38	-115.98	-135.79	-157.22	-252.53	-354.15
firm cost of capital	89.68	27.53	-9.54	2.35	11.76	10.88	12.20	14.49	11.85	13.77

Assumption: 50% Modigliani-Miller.

Next, another simulation considers the effect of a 5% FAT coupled with a bank levy of 0.05% on "other liabilities" which are liabilities other than equity and deposits and the regulatory changes. Here again, adding the bank levy only marginally affects macroeconomic variables.

Table (9). The cumulative effect of a 5% point increase of a FAT and a 0.05% Bank Levy (anticipated to be introduced in 2015) and regulatory changes.

	2012	2013	2014	2015	2016	2017	2018	2019	average 2020-2030	long term

Impact on macro variables (deviation from baseline in %)										
GDP	-0.20%	-0.22%	-0.29%	-0.39%	-0.47%	-0.53%	-0.58%	-0.62%	-0.83%	-1.38%
consumption	0.42%	0.79%	0.80%	0.71%	0.61%	0.49%	0.35%	0.22%	-0.27%	-1.27%
investment	-2.84%	-4.33%	-4.75%	-5.04%	-5.09%	-4.97%	-4.78%	-4.54%	-3.91%	-3.34%
labour hours	-0.29%	-0.23%	-0.22%	-0.28%	-0.28%	-0.27%	-0.25%	-0.23%	-0.19%	-0.14%
Bank Levy Revenues (% GDP)	0.0	0.0	0.0	0.07	0.07	0.07	0.07	0.07	0.07	0.07
FAT Revenues (%GDP)	0.0	0.0	0.0	0.18	0.19	0.20	0.21	0.22	0.21	0.21
Impact on bank variables (deviation from baseline in %)										
volume of loans	-0.52%	-1.28%	-1.57%	-1.58%	-1.77%	-1.92%	-2.00%	-2.06%	-2.35%	-3.32%
volume of deposits	2.23%	1.73%	1.53%	3.43%	2.04%	1.65%	1.29%	0.92%	1.13%	1.33%
value of bank	-0.66%	-1.45%	-1.58%	-0.91%	62.97%	75.51%	88.10%	100.69%	71.92%	47.07%
Impact on bank variables (deviation from baseline in basis points)										
loan rate	-33.28	-21.93	63.36	38.53	37.09	43.93	45.03	43.77	38.95	39.58
deposit rate	-42.30	-37.46	48.42	15.26	-10.63	-9.61	-12.71	-17.44	-3.79	10.53
return on bank equity	-60.62	-72.25	-3.66	-61.42	-100.38	-115.98	-135.79	-157.22	-252.53	-354.15
firm cost of capital	89.79	26.91	-10.66	3.10	12.10	11.14	12.48	14.78	12.24	14.31

Assumption: 50% Modigliani-Miller.

References

Angelini, P., A. Enria, S. Neri, F. Panetta and M. Quagliariello (2010), Pro-cyclicality of capital regulation: Is it a problem? How to fix it? In: An Ocean apart? Comparing transatlantic crisis resposes. J. Pisani-Ferry and A. Posen (eds.)

L. Ball (2002), Short run money demand, University of Maryland, Mimeo.

Barrell R., E. P Davis, T. Fic, D. Holland, S. Kirby and I. Liadze (2009), Optimal regulation of bank capital and liquidity: How to calibrate new international standards. FSA Occasional paper Series Nr. 38.

Basel Committee on Banking Supervision (BCBS) (2010a) (LEI Report), An assessment of the long-term impact of stronger capital and liquidity requirements, Basel August.

Basel Committee on Banking Supervision (BCBS) (2010b) (MAG Report), The aggregate impact of the transition to stronger capital and liquidity requirements, Basel August.

Biggs, M, T. Mayer and A. Pick (2009), Credit and economic recovery. DNB Working paper 218.

Blum, J. and M. Hellwig (1995) The macroeconomic implications of capital adequacy requirements for banks. European Economic Review 39, pp. 739-749.

Chari, V. V., L. Christiano and P. Kehoe (2008) Facts and myths about the financial crisis of 2008. Federal Reserve Bank of Minneapolis Working Paper 666.

Dedola, L., E. Gaiotti and L. Silipo (2001), Money demand in the Euro Area: do national differences matter. Banca d'Italia Working Paper No. 405.

De Walque, G., O. Pierrard and A. Rouabah (2008) Financial instability, supervision and Liquidity injections: A dynamic general equilibrium approach; National Bank of Belgium Working paper No. 148.

EEAG (2011), The EEAG Report on the European Economy, Taxation and Regulation of the Financial Sector, CESifo, Munich, pp 147-169.

Escudero, V. (2009), Effects of the crisis on the financial sector: trends and policy issues. International Institute for Labour Studies Working Paper No. 197.

FSF-CGFS Working Group (2009). The role of valuation and leverage in procyclicality. Report prepared for the Financial Stability Forum.

Gerali, A., S. Neri, Sessa, L, F. Signoretti (2008) Credit and banking in a DSGE model. Banca d'Italia mimeo.

Greenlaw, D. J. Hatzius, A. Kashyap, H. S. Shin (2008) Leveraged losses: lessons from the mortgage market meltdown. Proceedings of the US monetary policy forum.

Hatzius, J. (2008) Beyond leveraged losses: The balance sheet effects of the home price downturn. Brookings Papers on Economic Activity (Conference draft, Fall 2008).

Hellwig, M. (2008) Systemic risk in the financial sector: An analysis of the US subprime mortgage financial crisis. Mimeo. Max Planck Institute for Research on Collective Goods, Bonn

K. Inagaki (2009), Estimating the interest rate semi-elasticity of the demand for money in low interest rate environments. Economic Modelling 26, pp.147-154.

Institute of International Finance (2010), Interim report on the cumulative impact of proposed changes in the banking regulatory framework.

Kiyotaki, N. and J. Moore (1997) Credit Cycles, Journal of Political Economy 105, pp. 211-248.

Nolan, C and C. Theunissesn (2009), Financial factors in the US business cycle, Journal of Monetary Economics, pp. 596-604.

Ratto, M., W. Roeger, J. in'tVeld (2009), QUEST III: an estimated DSGE Model of the Euro Area with fiscal and monetary Policy. Economic Modelling, pp. 222-233.

Van den Heuvel, S. (2008), The welfare cost of bank capital requirements. Journal of Monetary Economics, 55, pp. 298-320.

Appendix: Detailed Results Sensitivity Analysis

FAT: High deposit elasticity

	2012A	2013A	2014A	2015A	2020A	2050A	2150A
YDA	-0.04	-0.05	-0.07	-0.09	-0.17	-0.40	-0.47
IDA	-0.66	-1.06	-1.21	-1.29	-1.27	-1.15	-1.11
CDA	0.11	0.20	0.21	0.19	0.06	-0.33	-0.44
KDA	-0.01	-0.05	-0.10	-0.14	-0.35	-0.93	-1.11
LODA	-0.11	-0.29	-0.38	-0.40	-0.57	-1.01	-1.14
DDA	-5.26	-5.39	-5.46	-5.47	-5.75	-7.07	-11.69
VBDA	-0.12	-0.30	-0.36	-0.41	-0.57	-1.01	-1.14
RBDA	-5.60	-3.95	8.85	-3.11	-1.96	-0.46	-0.00
RDDA	-5.89	-4.20	8.59	-3.40	-2.16	-0.41	0.11
REDA	-5.60	-3.95	8.85	-3.11	-1.96	-0.46	-0.00
RLODA	-8.59	-6.13	12.47	8.38	10.20	12.76	13.52
SPREAD	-2.70	-1.93	3.88	11.78	12.35	13.17	13.41
CCSHADOWDA	17.09	3.08	-2.16	2.82	2.48	4.82	5.53
LDA	-0.05	-0.05	-0.05	-0.06	-0.06	-0.05	-0.04
TLEVYDA	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TFATYDA	0.00	0.00	0.00	0.18	0.18	0.18	0.18
TCITYDA	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Levy: High deposit elasticity

	2012A	2013A	2014A	2015A	2020A	2050A	2150A
YDA	-0.01	-0.01	-0.02	-0.03	-0.05	-0.12	-0.14

IDA	-0.19	-0.30	-0.35	-0.37	-0.36	-0.33	-0.32
CDA	0.03	0.06	0.06	0.05	0.02	-0.09	-0.13
KDA	-0.00	-0.01	-0.03	-0.04	-0.10	-0.27	-0.32
LODA	-0.03	-0.08	-0.11	-0.12	-0.16	-0.29	-0.33
BBDA	-0.03	-0.08	-0.11	-0.12	-0.16	-0.29	-0.33
DDA	-3.27	-3.31	-3.34	-3.35	-3.43	-3.82	-5.23
VBDA	-0.04	-0.09	-0.10	-0.12	-0.16	-0.29	-0.33
RBDA	-1.60	-1.12	2.54	-0.89	-0.56	-0.13	-0.00
RDDA	-1.68	-1.20	2.46	-0.97	-0.62	-0.12	0.03
REDA	-1.60	-1.12	2.54	-0.89	-0.56	-0.13	-0.00
RLODA	-2.46	-1.75	3.57	2.40	2.92	3.65	3.87
SPREAD	-0.77	-0.55	1.11	3.37	3.54	3.77	3.84
CCSHADOWDA	4.89	0.88	-0.62	0.81	0.71	1.38	1.58
LDA	-0.02	-0.01	-0.02	-0.02	-0.02	-0.01	-0.01
TLEVYDA	0.00	0.00	0.00	0.08	0.08	0.08	0.08
TFATYDA	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TCITYDA	0.00	0.00	0.00	0.00	0.00	0.00	0.00

FAT: High share of fixed labour

	2012A	2013A	2014A	2015A	2020A	2050A	2150A
YDA	-0.02	-0.03	-0.05	-0.06	-0.11	-0.25	-0.28
IDA	-0.42	-0.69	-0.79	-0.84	-0.82	-0.70	-0.67
CDA	0.07	0.13	0.13	0.12	0.03	-0.21	-0.28
KDA	-0.01	-0.03	-0.06	-0.09	-0.23	-0.58	-0.67
LODA	-0.07	-0.18	-0.25	-0.26	-0.37	-0.63	-0.69
DDA	-0.13	-0.18	-0.21	-0.21	-0.27	-0.44	-0.48
VBDA	-0.07	-0.18	-0.23	-0.27	-0.37	-0.63	-0.69

RBDA	-1.96	-0.98	4.83	-2.19	-1.39	-0.29	-0.00
RDDA	-2.64	-1.87	3.80	-3.21	-2.62	-2.01	-1.86
REDA	-1.96	-0.98	4.83	-2.19	-1.39	-0.29	-0.00
RLODA	-5.44	-3.90	7.62	5.53	6.72	7.90	8.20
SPREAD	-2.80	-2.03	3.82	8.74	9.34	9.91	10.06
CCSHADOWDA	9.74	1.05	-0.91	1.87	1.66	3.01	3.36
LDA	-0.03	-0.03	-0.04	-0.04	-0.04	-0.03	-0.02
TLEVYDA	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TFATYDA	0.00	0.00	0.00	0.17	0.17	0.17	0.17
TCITYDA	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Levy: High share of fixed labour

	2012A	2013A	2014A	2015A	2020A	2050A	2150A
YDA	-0.01	-0.02	-0.03	-0.03	-0.06	-0.14	-0.16
IDA	-0.24	-0.40	-0.45	-0.47	-0.46	-0.41	-0.39
CDA	0.04	0.07	0.07	0.07	0.02	-0.12	-0.16
CLDA	0.12	0.11	0.12	0.12	0.08	-0.04	-0.07
KDA	-0.01	-0.02	-0.04	-0.05	-0.13	-0.34	-0.39
LODA	-0.04	-0.11	-0.14	-0.15	-0.21	-0.36	-0.40
DDA	0.02	-0.01	-0.03	-0.02	-0.06	-0.15	-0.18
VBDA	-0.04	-0.11	-0.14	-0.15	-0.21	-0.36	-0.40
RBDA	-1.26	-0.77	2.03	-1.10	-0.77	-0.17	-0.00
RDDA	-1.27	-0.90	1.84	-1.29	-1.07	-0.74	-0.65
REDA	-1.26	-0.77	2.03	-1.10	-0.77	-0.17	-0.00
RLODA	-3.11	-2.22	4.48	3.25	3.77	4.56	4.78
SPREAD	-1.84	-1.32	2.64	4.54	4.85	5.30	5.42

ZETADA	14.61	4.74	-7.64	-3.81	-4.74	-4.71	-4.70
CCSHADOWDA	5.66	0.63	-0.11	0.96	0.93	1.73	1.95
LDA	-0.02	-0.02	-0.02	-0.02	-0.02	-0.01	-0.01
TLEVYDA	0.00	0.00	0.00	0.08	0.08	0.08	0.08
TFATYDA	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TCITYDA	0.00	0.00	0.00	0.00	0.00	0.00	0.00

B. Securities Transaction Tax in a DSGE Framework

1. INTRODUCTION

This section presents a dynamic stochastic general equilibrium (DSGE) model that can be used as an instrument of qualitative assessment of some of the consequences of the introduction of a securities transaction tax (STT) in an economy. The novelty of the approach lies in the emphasis given to the macroeconomic effects the tax could have and in particular in its potential for capturing some of the endogenous channels via which such effects could emerge. This contrasts our setting with more standard partial equilibrium approaches (see e.g. Kupiec, 1996, Song & Zhang, 2005), which by construction exclude many of these channels.

Our work contributes to the long (and so far inconclusive) debate on the pros and cons of the STT. A comprehensive overview of the state of this debate can be found e.g. in Matheson (2011). At this place we briefly outline the main arguments.

<u>Pros:</u>

1.) Correcting distortions: The Securities Transaction Tax (henceforth: STT) may reduce short-term speculative trading, thereby limiting the waste of resources, market volatility and asset mispricing.

2.) Raising revenue: The STT raises public revenues and makes the financial sector contribute to the expenses incurred through the banking and financial crisis. Given its broad tax base, the STT may collect substantial revenue at low rates.

<u>Cons:</u>

3.) The short-term trading the STT is meant to eliminate is not proven to be detrimental to price recovery. Neither is there a clear link between short-term trading and long-run cycles of asset mispricing (bubbles). On the contrary, the instruments which led to the 2008 financial crisis do not belong to the set of frequently traded instruments. Moreover, asset bubbles have historically also occurred in markets with high transaction costs (real estate), suggesting that a low-rate STT will not prevent them in the future.

4.) The STT is too crude to target "undesirable" short-term trading. Since all transactions are taxed at equal rates and independent of their risk profile, the STT does not target risk-taking and financial sector fragility.

5.) The STT may lead to a drop in share prices and thereby to an increase in firms' costs of raising capital.

6.) The impact of an STT on the market volatility is not clearcut. The STT may eventually increase share price volatility by reducing liquidity (i.e., trading volume) in the markets and may result into sharper rather than smoother price movements. In general, individual transactions cause larger price fluctuation in thinner markets.

7.) – The tax base of the STT is very elastic. As there are many ways to avoid the tax (incl. creation of new instruments, mobility across market segments and market), effective imposition might require the tax to be introduced on the broadest possible base and in internationally co-ordinated ways.

Our model enters this debate by addressing points 1, 2, 5 and 6. In addition, the general equilibrium model is a valuable complement of the existing approaches by allowing the assessment of feedback effects in the entire economy.

2. THE MODEL

In this note, we study the impact of the introduction of a STT on the economy. For this purpose, we incorporate financial frictions in an otherwise standard closed economy real-business-cycle model. We depart from the usual assumptions along two dimensions.

First, we allow for a 'trader' sector, which is engaged in short-term trading in risk-free and risky financial assets: government bonds and corporate shares, respectively. A fraction of traders is assumed to be 'noise traders' à la De Long et al. (1989): their expectations about future stock returns are noisy in the sense that they may deviate from the rational expectations which are based on economic fundamentals. The non-fundamental shocks hitting the expectations of noise-traders lead to an increased volatility of asset prices.

Second, firms financing is subject to a collateral constraint. In particular, we assume that firms' investment expenditure cannot exceed a given fraction of the firms' outstanding share value. This feature captures in a stylized manner the link between firms' share price and their financing.

In the model, it is assumed that long-lived households own a fixed share of total stocks. They are specified as long-term investors and do not engage in short-term trading. In contrast, both types of traders have a short (2-period) horizon, which further reinforces the speculative character of their financial activities. Traders borrow on the risk-free credit market and invest in risky assets. In the following period, they earn the returns on their risky investment and pay back their debt including (risk-free) interests.

The short–term trading generates transaction costs in terms of limited resources (money, time etc.) which are assumed to be 'wasted'. This captures the aggregate inefficiency due to short-term speculative trading. The structure of the model allows imposing a tax on these transactions (STT) in order to analyze its potentially corrective role.

Share prices are determined in the model as the future discounted flow of dividends. In contrast to standard models, the discount factor used in the evaluation of share prices is that of the short-term investors; thereby, the share price is influenced by the noise shock (positively) as well as the transaction costs and potentially the STT (negatively). By contrast, firms base their investment decisions on long-term investors' discount factor. Since these investors are, by assumption, not influenced by either of the previously mentioned factors, there may be differences between the return on the share in the secondary financial markets and the cost of capital (defined as the return on capital).

The model uses a closed-economy framework and assumes the STT to be effectively implementable and enforceable. In other words, the analysis abstracts from the issue of tax evasion in an open economy with integrated financial markets. It also excludes other important classes of risky assets, in particular derivatives, which cannot be easily incorporated into a general equilibrium model. The appendix to this note presents a detailed description of the model.

3. DYNAMICS OF THE MODEL

The model incorporates two main shocks that influence the economy. One is a total factor productivity (TFP) shock, which in the standard DSGE framework explains an important part of economic fluctuations at business cycle frequencies. The other is the noise shock introduced in section 2, which drives the deviations of the noise traders' expectations from the fundamentals. It is implemented as a shock to the expectations about future returns on the risky asset (shares) and directly affects only the generation of traders entering the market in the period of the shock.[12] The dynamics of the economy hit by each of these disturbances is sketched below.

3.1. Real shock: TFP

The impact of a TFP shock in the model is fairly standard. A positive TFP shock raises the return on capital as well as the marginal productivity of labour. Investment, capital stock, share prices, real wages, output and consumption increase. The income effect leads to a decline in employment as households choose to spend more of their available time on leisure. The productivity shock and the associated expectations of higher returns on capital lead to an immediate jump in the firm's value and share price. Traders' earnings increase in the period of the shock. Aggregate consumption is more volatile than in the baseline RBC model as traders do not smooth consumption from the additional income over time.

3.2. Noise shock

A positive shock of this type propagates in the economy via two channels. First, it directly affects the demand for risky assets on the side of the new generation of noise traders. This has several consequences. Share prices and current returns on risky assets increase on impact. The affected noise traders, in order to finance their increased risky asset positions, resort to more borrowing from the long-lived households, driving up also the risk-free interest rate. Reacting to this incentive, long-lived consumers reduce their consumption and increase savings. There

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[12] The expectations of the previous generation of traders, who in the current period liquidate the asset positions made one period earlier, do not matter.

are also some redistributive effects across the generations of traders: the previous generation of traders, which liquidates its shares position in the period of the shock, benefits from increased asset market earnings, which boosts its consumption. In contrast, the overly optimistic current traders' generation has to pay an elevated price on its borrowing next period. Combined with returns on shares that are lower than expected as well as with higher than usual transaction costs, they have to lower their consumption. Overall, noise shocks working via the demand channel increase the volatility of (both risky and risk-free) asset prices and returns and the volatility of the aggregate consumption.

The second propagation channel of the noise shock affects the behaviour of the production sector. Since the amount of firms' investment is limited by the stock market value of the firm (as reflected by the share prices), volatility on the stock market has a direct effect on the firms' investment decisions, and hence on output. This effect is accelerated by changes in the risk-free interest rate. Hence, noise shocks lead to further increases in the volatility of the main aggregates in the economy.

4. INTRODUCING SECURITIES TRANSACTION TAX

The mechanisms described in section 3.2 lead to the emergence of non-trivial inefficiencies in the economy. In this section a simple experiment is made to assess whether the introduction of an SST can help in attenuating these inefficiencies. We also discuss the potential for the emergence of other inefficiencies linked to the introduction of the SST (by increasing the cost of capital).

The STT is imposed on traders' risky investment and has to be paid in addition to the transaction cost. While the transaction costs are pure waste, the STT is paid to the government and transferred to long-lived households in form of a lump-sum payment.

The impact of the introduction of an STT on financial variables and economic aggregates is summarised in Table 1. The 'mean' corresponds to the steady-state per-capita level of the given variable. The volatilities are generated by simultaneous randomly generated TFP and noise shocks which are assumed to be uncorrelated. For the benchmark no-STT case, we also highlight in the table the share of total volatility specifically generated by the noise shock. The standard deviation of the TFP shock is calibrated in line with the DSGE literature. The standard deviation of the noise shock is such that the annualized volatility of the return on shares is close to its empirical values. In the baseline calibration STT was set so that the implicit tax rate (the ratio of the tax revenue to the tax base) was around 20 basis points (see the header of the 'STT' part of Table 1). This corresponds to revenue raised with the tax of 0.16% of GDP on average. These values are close to historical tax rates and revenues raised in G-20 countries over the last two decades; see Matheson, 2010.

Two main effects of the STT can be pointed out:

First, in the long run (see the 'mean' columns in table 1), the introduction of an STT leads to a reduction of the share price and an increase in share returns. The return on capital also increases, which implies higher financing costs for firms. As a result, investment and the stock of productive capital fall. Correspondingly, output, consumption and employment all decline in the long-run as well. Moreover, the size of this restrictive impact of the STT is sizeable according to our model.

Table 1: Stochastic simulation results without and with STT

	NO STT			STT (implicit tax rate: 20 bp)		CHANGE	
variable	***mean***	***std/mean (%)***		***mean***	***std/mean (%)***	***mean (%)***	***std/mean (pp)***
		total	of which noise				
output	1.00	2.77	0.29	0.97	2.75	-3.43	-0.03
capital	8.18	1.75	0.01	7.47	1.74	-8.67	-0.01
investment	0.20	3.62	1.10	0.19	3.60	-8.68	-0.02
consumption	0.70	3.76	0.98	0.69	3.65	-2.26	-0.11
employment	0.61	1.94	1.60	0.61	1.86	-0.34	-0.08
wage	3.60	2.83	0.08	3.49	2.82	-3.09	0.00
share price	4.13	3.86	1.33	3.77	3.81	-8.67	-0.05
return on share	3.01	3.10	2.50	3.41	3.04	0.40	-0.06
risk-free return	1.01	4.25	3.94	1.01	4.06	0.00	-0.19
return on capital	4.02	1.81	0.01	4.22	1.80	0.20	-0.02
STT revenues/GDP	0.00			0.16		0.16	
transactions costs/GDP	0.83	3.85	2.99	0.78	3.76	-0.04	-0.09

Note: Output in the benchmark (no STT) version is normalised to one. Other real aggregates are shares (or multipliers) of the benchmark output. Returns are reported in quarterly percentage points. STT revenues and transaction costs are shown as % of GDP. The volatility (standard deviation / mean) is expressed as % of the given variable with the exception of the returns as well as the revenue and transaction cost ratios, where it is expressed in percentage points. Similarly, changes in mean are % changes with respect to no-STT levels, except for returns as well as revenues and transaction costs (expressed in percentage points). Changes in volatility are all in percentage points.

Second, the STT reduces the profitability of buying shares when expected returns increase and selling them afterwards. Therefore, it helps containing noise-traders' activity and thereby also the standard deviation of the share price driven by short-term noise trading. Since the volatility of the share price matters for firms via the financing constraint, the volatility of investment and the overall output volatility can also be reduced. However, the order of magnitude of changes in volatility implied in the model is found to be fairly small. Therefore, the long-run negative impact of the STT seems to outweigh the gain in terms of volatilities.

Sensitivity analysis

In this subsection, we check the robustness of the above results to different tax rates and to different shares of noise traders.

Tax rates

In the benchmark version STT is calibrated so as to raise a revenue of 0.1 – 0.2% of GDP in line with historical values. If instead tax rates are given and tax revenue is calculated within the model, STT rates of 1 and 10bp, would not raise more than 0.1% of GDP tax revenues in the model; such rates would also be insufficient to contain the negative impact of short-term noise trading, while already leading to non-negligible real losses (see Tables A.1 and A.2 in the Appendix).

The share of noise traders

The above results were produced under the assumption that half the share of all the traders are noise traders, sn=0.5. In the Appendix results for sn=0.75 (only a quarter of traders are informed, see Table A.3) and sn=0.25 (see Table A.4) are reported. As is clearly visible from comparison of the tables, the effects of the introduction of an STT in the economy remain qualitatively similar regardless of the assumed share of noise traders. Moreover, the long-run behaviour of macroeconomic and financial variables is quantitatively identical independent of the number of noise traders. On the other hand, an increase in the number of noise traders leads to an increased volatility of most variables, and in some cases (investment) this effect is sizeable. With more numerous noise traders, the attenuating effect of the introduction of the STT on the volatility in the economy tends to be larger as well.

5. DISCUSSION

To the best of our knowledge, very little theoretical work has been done to assess the impact of the introduction of an STT on the real economy. The few existing models studying STT in the presence of noise traders apply only partial equilibrium analysis (see Kupiec, 1996 or Song & Zhang, 2005). Xu (2009) studies the impact of financial transaction tax in a general equilibrium model with noise traders; however, she focuses on foreign currency transaction tax as opposed to the securities transaction tax which is the focus of this note.

Also, earlier theoretical assessments of the impact of the STT on the share price and on the cost of capital are rather scarce. The few notable examples are Matheson, 2010 and Rene M. Stulz's Discussion of Campbell and Froot, 1994. Matheson uses a simple formula for the assessment of the effect of STT on the share price which allows a partial equilibrium assessment of the long-run impact of the STT on the share price, given assumptions about the interest rate and the average holding period and assuming that dividends (and hence everything else in the real economy, incl. the cost of capital) remain constant; see p. 14 and the Appendix in Matheson (2011).

Since this formula does not allow the author to create a link between the STT and firms' decision making, or put differently between the STT and the cost of capital, Matheson develops a formula for the cost of capital for which he assumes an ad-hoc link noting that the 'STT acts like a permanently increasing dividend tax rate' (p. 40, Appendix, Matheson, 2011). He thus assumes that the STT directly enters firms' decision problem and hence directly influences the cost of capital. This approach has two shortcomings. First, in reality, there is no reason to assume that firms directly take the STT into consideration, since in most countries where STT exists it is not introduced on the primary asset market. Second, this approach is not sufficient to capture the link between the price of shares traded in the secondary market and the value of capital, i.e. firms' decisions. In particular, it is not useful in capturing the impact on firms of share price volatility caused by non-fundamental factors like noise trading considered in this model.

In contrast to Matheson's two loosely linked formulas for the share price and the cost of capital, respectively, the model we presented explains the impact of the STT on share prices in a coherent general equilibrium model and, in addition, it explicitly introduces a plausible link between the share price and firms' decisions via the financing constraint of firms. This allows us to capture the long-run impact of an STT on the share price and economic aggregates and thereby it also creates a – less than proportional - link between variations in the share returns and variations in the cost of capital.

<u>Long-run negative effect of STT:</u>

Our model predicts a sizeable long-run negative impact of an STT on the real economy via firms' financing channel. The change in the share price generated by our model is fairly close to, though somewhat below the one implied by the Matheson formula for the share price under similar assumptions about the tax rate and the holding period. The difference is likely to be explained by endogenous changes in other variables predicted by our general equilibrium model, which are not captured in the Matheson formula.

As regards our predictions for the cost of capital, the impact of the STT implied by our model is somewhat smaller than the Matheson-type formula for the cost of capital would show for the same tax rates and holding periods. This difference should be to a large extent attributable to the less direct link between the STT and the cost of capital in our general equilibrium model.

<u>Impact on Volatility:</u>

We find a rather modest impact of the STT on the volatility of the share price and on the volatility of real economic aggregates. This result is similar to the one reported by Xu (2009) for the effect of the introduction of a Tobin's tax in foreign exchange markets. It should be mentioned that our model does not capture the effect of falling liquidity on share price volatility; this is likely to decrease the volatility gains of the STT even further.

Caveats and possible future extensions:

Due to the complexity of modelling trade in financial assets in DSGE models, a number of features could not be addressed in the model which would be relevant for the debate.

First, there is no derivatives market in the model and it is assumed that STT is effectively implementable and enforceable. Therefore, the model cannot be used to answer questions about the taxation of derivatives; it cannot be used either to study changes in the market structure (spot vs. derivatives markets) if only the spot market transactions were taxed. A potential extension could however introduce various spot market assets to assess the elasticity of the tax base if only one of the instruments were taxed.

Second, we use a closed-economy model. This does not allow us to assess cross-border capital mobility and the relocation effects of the STT neither. It could be in principle possible to consider an open economy version of the model to address this issue. However, such a project would involve new technical challenges implying modelling tasks well beyond the current state-of-the-art frameworks.

Overall, the more possibilities financial markets have to avoid the tax, the lower the revenues that can be raised by the tax and the lower the direct impact on the economy would be. At the same time, the STT itself may lead to non-trivial changes in the structure of financial markets with potential economic consequences which are difficult to foresee.

References

Campbell, John Y., Kenneth A. Froot (1994): 'International Experience with Securities Transaction Taxes', in Jeffrey Frankel ed. *The Internationalization of Equity Markets*, University of Chicago Press: Chicago, IL, 277–303.

Honohan, Patrick; Sean Yoder (2010): 'Financial Transaction Tax: Panacea, Threat or Damp Squib?', Policy Research Working Paper 2530, World Bank.

Kupiec, Paul H. (1996): 'Noise Traders, Excess Volatility and a Securities Transaction Tax', Journal of Financial Services Research 10:115-129.

Matheson, Thornton (2011): 'Taxing Financial Transactions: Issues and Evidence', IMF Working Paper / 11 / 54.

Song, Frank M., Junxi Zhang (2005): 'Securities Transaction Tax and Market Volatility', *The Economic Journal*, 115, pp. 1103-1120,.

Xu, Juanyi (2010): 'Noise Traders, Exchange Rate Disconnect Puzzle, and the Tobin Tax'**,** *Journal of International Money and Finance*, volume 29, issue 2, pp. 336-357.

Appendix

Table A.1. Stochastic simulation without and with STT – implicit tax rate: 1bp

	NO STT		STT (implicit tax rate: 1bp)		CHANGE	
variable	***mean***	***std/mean (%)***	***mean***	***std/mean (%)***	***mean %***	***std/mean (pp)***
output	1.00	2.77	1.00	2.78	-0.17	0.00
capital	8.18	1.75	8.14	1.75	-0.47	0.00
investment	0.20	3.62	0.20	3.64	-0.51	0.02
consumption	0.70	3.76	0.70	3.77	-0.12	0.00
employment	0.61	1.94	0.61	1.94	-0.03	0.00
wage	3.60	2.83	3.59	2.83	-0.16	0.00
share price	4.13	3.86	4.11	3.86	-0.47	0.00
return on share	3.01	3.10	3.03	3.09	0.02	-0.01
risk-free return	1.01	4.25	1.01	4.24	0.00	-0.01
return on capital	4.02	0.07	4.03	0.07	0.01	0.00
STT revenues/GDP	0.00		0.01		0.01	
transactions costs/GDP	0.83	3.85	0.82	3.85	0.00	0.00

Table A.2. Stochastic simulation without and with STT – implicit tax rate: 10bps

	NO STT		STT (implicit tax rate: 10 bp)		CHANGE	
variable	***mean***	***std/mean (%)***	***mean***	***std/mean (%)***	***mean %***	***std/mean (pp)***
output	1.00	2.77	0.98	2.75	-1.76	-0.02
capital	8.18	1.75	7.81	1.75	-4.50	-0.01
investment	0.20	3.62	0.20	3.62	-4.55	0.00
consumption	0.70	3.76	0.69	3.71	-1.16	-0.06
employment	0.61	1.94	0.61	1.89	-0.20	-0.05

wage	3.60	2.83	3.54	2.82	-1.58	0.00
share price	4.13	3.86	3.95	3.83	-4.50	-0.03
return on share	3.01	3.10	3.21	3.06	0.20	-0.04
risk-free return	1.01	4.25	1.01	4.15	0.00	-0.10
return on capital	4.02	0.07	4.12	0.07	0.10	0.00
STT revenues/GDP	0.00		0.08		0.08	
transactions costs/GDP	0.83	3.85	0.80	3.80	-0.02	-0.05

Note: Output in the benchmark (no STT) version is normalised to one. Other real aggregates are shares (or multipliers) of the benchmark output. Returns are reported in quarterly percentage points. STT revenues and transaction costs are shown as % of GDP. The volatility (standard deviation / mean) is expressed as % of the given variable with the exception of the returns as well as the revenue and transaction cost ratios, where it is expressed in percentage points. Similarly, changes in mean are % changes with respect to no-STT levels, except for returns as well as revenues and transaction costs (expressed in percentage points). Changes in volatility are all in percentage points.

Table A.3. Stochastic simulation without and with STT – high share of noise traders

	NO STT		STT (implicit tax rate: 20 bp)		CHANGE	
variable	***mean***	***std/mean (%)***	***mean***	***std/mean (%)***	***mean %***	***std/mean (pp)***
output	1.00	3.10	0.97	3.03	-3.43	-0.07
capital	8.18	1.76	7.47	1.75	-8.67	-0.01
investment	0.20	4.72	0.19	4.52	-8.68	-0.20
consumption	0.70	4.72	0.69	4.50	-2.26	-0.22
employment	0.61	2.89	0.61	2.76	-0.34	-0.13
wage	3.60	2.93	3.49	2.92	-3.09	-0.01
share price	4.13	5.05	3.77	4.97	-8.67	-0.09
return on share	3.01	4.61	3.41	4.52	0.40	-0.09
risk-free return	1.01	6.37	1.01	6.08	0.00	-0.29
return on capital	4.02	2.08	4.22	0.09	0.16	-1.99
STT revenues/GDP	0.00		0.16		0.16	
transactions costs/GDP	0.83	5.69	0.78	5.57	-0.04	-0.12

Table A.4. Stochastic simulation without and with STT – low share of noise traders

	NO STT		STT (implicit tax rate: 20 bp)		CHANGE	
variable	***mean***	***std/mean (%)***	***mean***	***std/mean (%)***	***mean %***	***std/mean (pp)***
output	1.00	2.57	0.97	2.55	-3.43	-0.02
capital	8.18	1.75	7.47	1.74	-8.67	-0.01
investment	0.20	2.86	0.19	2.86	-8.68	0.00
consumption	0.70	3.07	0.69	3.02	-2.26	-0.05
employment	0.61	1.01	0.61	0.96	-0.34	-0.05
wage	3.60	2.76	3.49	2.77	-3.09	0.00
share price	4.13	2.92	3.77	2.90	-8.67	-0.02

return on share	1.03	1.61	3.41	1.59	2.38	-0.02
risk-free return	1.01	2.14	1.01	2.04	0.00	-0.10
return on capital	4.02	0.07	4.22	0.07	-3.86	0.00
STT revenues/GDP	0.00		0.16		0.16	
transactions costs/GDP	0.83	2.06	0.78	2.02	-0.04	-0.04

Note: Output in the benchmark (no STT) version is normalised to one. Other real aggregates are shares (or multipliers) of the benchmark output. Returns are reported in quarterly percentage points. STT revenues and transaction costs are shown as % of GDP. The volatility (standard deviation / mean) is expressed as % of the given variable with the exception of the returns as well as the revenue and transaction cost ratios, where it is expressed in percentage points. Similarly, changes in mean are % changes with respect to no-STT levels, except for returns as well as revenues and transaction costs (expressed in percentage points). Changes in volatility are all in percentage points.

C. Securities Transaction Tax Model Description

1 Model Description

1.1 Households

There are two types of households. A share s_l are the standard infinitely-living households: they consume, work and own a fixed fraction of firms' shares on which they earn dividends. The remaining $1 - s_l$ fraction are short-horizon financial traders. They borrow from the long-lived households at the riskfree interest rate and invest the money borrowed in the risky asset. In the following period, they earn the dividends and sell their assets from which they reimburse their debt including the interest payment and consume the rest. In addition, it is assumed that a share s_n of traders are so-called 'noise-traders': their expectations about the future share return are noisy in the sense that they may deviate from the rational expectations by a noise shock.

Variables in the model description are all in per capita terms.

1.1.1 Long-lived households:

$$\max_{C_t^l, L_t, B_t^l} E_0 \sum_{t=0}^{\infty} \beta^t \left[\log C_t^l - \frac{\omega}{1+\kappa} L_t^{1+\kappa} \right]$$

subject to:

$$C_t^l + B_t^l = \left(1 - \tau^l\right) W_t L_t + R_{t-1} B_{t-1}^l + DIV_t a_{t-1}^l - T_t^{ls},$$

where C_t^l is the long-lived households' (per capita) consumption, B_t^l their risk-free asset holding and a_t^l their stock holding which is constant: $a_t^l = \frac{\theta}{s_l}$. DIV_t denotes dividends paid in period t, R_{t-1} the gross risk-free interest rate fixed in $t-1$ and paid in t. L_t is hours worked per person in the household, W_t denotes the wage and τ^l the labour income tax. T_t^{ls} stands for lump-sum taxes.

1.1.2 Traders:

$$\max_{C_t^{T,j}, a_t^{T,j}} \beta E_t^j \log C_{t+1}^{T,j}$$

subject to:

$$E_t^j C_{t+1}^{T,j} = \bar{w} + E_t^j \left(P_{t+1}^{sh} + DIV_{t+1}\right) a_t^{T,j} - R_t P_t^{sh} a_t^{T,j} - \frac{c + \tau^{FTT}}{2} P_t^{sh} \left(a_t^{T,j}\right)^2 - T_t^{ls,T}$$

where $j = I, N$ is standing for informed traders and noise traders, respectively. $C_{t+1}^{T,j}$ is traders' consumption, $a_t^{T,j}$ is their asset holding. P_t^{sh} stands for the share price. In addition, traders are assumed to earn a fixed $\bar{w}$ on their wealth which they consume immediately (this is just to avoid zero consumption of traders and does not change anything in the model). Traders may also pay lump-sum taxes $T_t^{ls,T}$.

The share return will be defined as $R_t^{sh} \equiv \frac{P_t^{sh} + DIV_t}{P_{t-1}^{sh}}$.

The expectations of informed traders are rational: $E_t^I R_{t+1}^{sh} = E_t R_{t+1}^{sh}$. The expectations of noise traders only deviate from rational expectations by a random noise shock: $E_t^N R_{t+1}^{sh} = E_t R_{t+1}^{sh} + \nu_t$, $\nu_t \sim N\left(\nu^*, \sigma_\nu\right)$.

The cost c is standing for transaction costs unrelated to taxes. It is treated as waste in the model. The financial transaction tax increases costs related to trading. The only difference compared to the 'wasted' transaction costs is that the tax raises revenue for the government budget.

Total traders' consumption is $C_t^T = (1 - s_n) C_t^{T,I} + s_n C_t^{T,N}$.
Total traders' stock holding is: $a_t^T = (1 - s_n) a_t^{T,I} + s_n a_t^{T,N}$.

1.2 Firms:

Firms maximise the future discounted flow of dividends by taking optimal decisions about employment, capital stock K_t and investment I_t. They may face employment and investment adjustment costs. They take into account the discount factor of long-lived households (who own the majority of the firms' stocks). Formally:

$$\max_{L_t, K_t, I_t} \sum_{t=0}^{\infty} \beta \frac{\lambda_t^l}{\lambda_0^l} DIV_t$$

subject to:

$$DIV_t = (1-\tau^c)\left(Y_t - W_t s_l L_t - \frac{\gamma_l}{2}\left(L_t - L_{t-1}\right)^2 - \frac{\gamma_i}{2}\left(\frac{I_t}{K_{t-1}} - \delta\right)^2 K_{t-1}\right) + \tau^c \delta K_{t-1} - I_t,$$

where τ^c stands for the corporate income tax. λ_t^l is the Lagrange multiplier of the long-lived households' budget constraint.

The production technology:

$$Y_t = A_t \left(K_{t-1}\right)^{1-\alpha}\left(s_l L_t\right)^{\alpha}.$$

The capital accumulation equation:

$$K_t = (1-\delta) K_{t-1} + I_t.$$

The financing constraint for investment:

$$I_t \leqslant \phi \beta E_t \left[\frac{\lambda_{t+1}^l}{\lambda_t^l} P_{t+1}^{sh}\right].$$

The Lagrange multiplier of the collateral constraint (in terms of consumption utils) is denoted by μ_t. The same for the capital accumulation equation is denoted by Q_t.

Note: For the optimisation problem, P_{t+1}^{sh} is considered to be exogenous for the firm [I don't know how innocuous this assumption is].

1.3 Government:

Budget constraint (debt accumulation equation):

$$\begin{aligned}\frac{B_t^G}{R_t} \quad &= \quad B_{t-1}^G + G_t - \tau^l s_l W_t L_t - s_l T_t^{ls} - (1-s_l)\, T_t^{ls,T} - \tau^c \left(Y_t - W_t s_l L_t\right) + \tau^c \delta K_{t-1} - \\ &\quad - (1-s_l)\frac{\tau^{FTT}}{2} P_{t-1}^{sh}\left((1-s_n)\left(a_{t-1}^{T,I}\right)^2 + s_n\left(a_{t-1}^{T,N}\right)^2\right)\end{aligned}$$

where B_t^G denotes the public debt and G_t is (exogenous) government consumption.

The debt rule:

$$T_t^{ls} = T_{t-1}^{ls} + \alpha^{Tls}\left(\frac{B_t^G}{Y_t} - \overline{BY}\right)$$

where $\overline{BY}$ denotes the target debt-to-GDP ratio.

1.4 Equilibrium:

In equilibrium, all markets clear. This implies the following conditions:

1.4.1 Stock market:

$$a_t = s_l a_t^l + (1 - s_l)\, a_t^T = 1$$

from which:

$$a_t^T = \frac{1 - \theta}{1 - s_l}.$$

1.4.2 Bond market:

$$B_t^l = \frac{1}{s_l}\left(\frac{B_t^G}{R_t} + (1 - s_l)\, P_t^{sh} a_t^T\right).$$

1.4.3 Goods market:

Total traders' consumption is $C_t^T = (1 - s_n)\, C_t^{T,I} + s_n C_t^{T,N}$.
Total households' consumption is: $C_t = s_l C_t^l + (1 - s_l)\, C_t^T$.

The goods market equilibrium condition is:

$$\begin{aligned} Y_t &= C_t + G_t + I_t + \frac{\gamma_l}{2}\left(L_t - L_{t-1}\right)^2 + \frac{\gamma_i}{2}\left(\frac{I_t}{K_{t-1}} - \delta\right)^2 K_{t-1} + \\ & \quad + (1 - s_l)\, \frac{c}{2} P_{t-1}^{sh}\left((1 - s_n)\left(a_{t-1}^{T,I}\right)^2 + s_n\left(a_{t-1}^{T,N}\right)^2\right) - (1 - s_l)\, \bar{w}. \end{aligned}$$

2 First-order conditions:

2.1 Households:

2.1.1 Long-lived households:

$$\frac{-U_t^L}{U_t^{C,l}} = \left(1-\tau^l\right) W_t$$

$$\lambda_t^l = \beta R_t E_t \lambda_{t+1}^l$$

$$U_t^L = \omega L_t^\kappa$$

$$U_t^{C,l} = \frac{1}{C_t^l}$$

$$\lambda_t^l = U_t^{C,l}$$

2.1.2 Trader households:

$$E_t \frac{1}{C_{t+1}^{T,I}} a_t^{T,I} \left(c+\tau^{FTT}\right) = E_t \left[\frac{1}{C_{t+1}^{T,I}} \left(R_{t+1}^{sh} - R_t\right)\right]$$

$$E_t^N \frac{1}{C_{t+1}^{T,N}} a_t^{T,I} \left(c+\tau^{FTT}\right) = E_t^N \left[\frac{1}{C_{t+1}^{T,N}} \left(R_{t+1}^{sh} - R_t\right)\right]$$

$$R_t^{sh} = \frac{P_t^{sh} + DIV_t}{P_{t-1}^{sh}}$$

$$C_t^{T,I} = \bar{w} + \left(P_t^{sh} + DIV_t\right) a_{t-1}^{T,I} - R_{t-1} P_{t-1}^{sh} a_{t-1}^{T,I} - \frac{c+\tau^{FTT}}{2} P_{t-1}^{sh} \left(a_{t-1}^{T,I}\right)^2 - T_{t-1}^{ls,T}$$

$$C_t^{T,N} = \bar{w} + \left(P_t^{sh} + DIV_t\right) a_{t-1}^{T,N} - R_{t-1} P_{t-1}^{sh} a_{t-1}^{T,N} - \frac{c+\tau^{FTT}}{2} P_{t-1}^{sh} \left(a_{t-1}^{T,N}\right)^2 - T_{t-1}^{ls,T}$$

$$E_t^N R_{t+1}^{sh} = E_t R_{t+1}^{sh} + \nu_t$$

$$E_t^N C_{t+1}^{T,N} = E_t C_{t+1}^{T,N} + \nu_t P_t^{sh} a_t^{T,N}$$

2.1.3 Aggregations:

$$a_t^T = (1 - s_n)\, a_t^{T,I} + s_n a_t^{T,N}$$

$$a_t^T = \frac{1-\theta}{1-s_l}$$

$$B_t^l = \frac{1}{s_l}\left(\frac{B_t^G}{R_t} + (1-s_l)\, P_t^{sh} a_t^T\right)$$

$$B_t^T = P_t^{sh} a_t^T$$

$$C_t^T = (1 - s_n)\, C_t^{T,I} + s_n C_t^{T,N}$$

$$C_t = s_l C_t^l + (1-s_l)\, C_t^T$$

2.2 Firms:

$$Y_t = A_t \left(K_{t-1}\right)^{1-\alpha} \left(s_l L_t\right)^{\alpha}$$

$$DIV_t = (1-\tau^c)\left(Y_t - W_t s_l L_t - \frac{\gamma_l}{2}\left(L_t - L_{t-1}\right)^2 - \frac{\gamma_i}{2}\left(\frac{I_t}{K_{t-1}} - \delta\right)^2 K_{t-1}\right) + \tau^c \delta K_{t-1} - I_t,$$

$$K_t = (1-\delta)\, K_{t-1} + I_t$$

$$I_t = \phi\beta E_t\left[\frac{\lambda_{t+1}^l}{\lambda_t^l} P_{t+1}^{sh}\right]$$

$$\alpha\frac{Y_t}{s_l L_t} = W_t + \gamma_l\left(L_t - L_{t-1}\right) - \beta E_t\left[\frac{\lambda_{t+1}^l}{\lambda_t^l}\gamma_l\left(L_{t+1} - L_t\right)\right]$$

$$Q_t = \beta E_t \frac{\lambda_{t+1}^l}{\lambda_t^l}\left[(1-\tau^c)\,(1-\alpha)\,\frac{Y_{t+1}}{K_t} + \tau^c\delta + (1-\delta)\, Q_{t+1}\right]$$

$$Q_t = 1 + \gamma_i\left(\frac{I_t}{K_{t-1}} - \delta\right) + \mu_t$$

2.3 Government:

$$\frac{B_t^G}{R_t} = B_{t-1}^G + G_t - \tau^l s_l W_t L_t - s_l T_t^{ls} - (1-s_l)\, T_t^{ls,T} - \tau^c \left(Y_t - W_t s_l L_t\right) + \tau^c \delta K_{t-1} -$$
$$- (1-s_l) \frac{\tau^{FTT}}{2} P_{t-1}^{sh} \left((1-s_n) \left(a_{t-1}^{T,I}\right)^2 + s_n \left(a_{t-1}^{T,N}\right)^2 \right)$$

$$T_t^{ls} = T_{t-1}^{ls} + \alpha^{Tls} \left(\frac{B_t^G}{Y_t} - \overline{BY} \right)$$

$$T_t^{ls,T} = -s^T \left[\frac{\tau^{FTT}}{2} P_{t-1}^{sh} \left((1-s_n) \left(a_{t-1}^{T,I}\right)^2 + s_n \left(a_{t-1}^{T,N}\right)^2 \right) \right]$$

2.4 Goods market equilibrium:

$$Y_t = C_t + G_t + I_t + \frac{\gamma_l}{2} \left(L_t - L_{t-1}\right)^2 + \frac{\gamma_i}{2} \left(\frac{I_t}{K_{t-1}} - \delta \right)^2 K_{t-1} +$$
$$+ (1-s_l) \frac{c}{2} P_{t-1}^{sh} \left((1-s_n) \left(a_{t-1}^{T,I}\right)^2 + s_n \left(a_{t-1}^{T,N}\right)^2 \right) - (1-s_l)\, \bar{w}.$$

2.4.1 Exogenous processes:

$$\nu_t = (1-\rho_\nu)\, \nu^* + \rho_\nu \nu_{t-1} + \varepsilon_t^\nu$$

$$\log(A_t) = (1-\rho_a) \log\left(\bar{A}\right) + \rho \log(A_{t-1}) + \varepsilon_t^a$$

$$\log(G_t) = \left(1-\rho_g\right) \log\left(\bar{G}\right) + \rho \log(G_{t-1}) + \varepsilon_t^g$$

3 Relation between various returns:

The model has four Euler equations:

$$\lambda_t^l = \beta R_t E_t \lambda_{t+1}^l$$

$$E_t \frac{1}{C_{t+1}^{T,I}} a_t^{T,I} \left(c + \tau^{FTT}\right) = E_t \left[\frac{1}{C_{t+1}^{T,I}} \left(R_{t+1}^{sh} - R_t\right) \right]$$

$$E_t^N \frac{1}{C_{t+1}^{T,N}} a_t^{T,I} \left(c + \tau^{FTT}\right) = E_t^N \left[\frac{1}{C_{t+1}^{T,N}} \left(R_{t+1}^{sh} - R_t\right) \right]$$

and

$$Q_t = \beta E_t \left\{ \frac{\lambda^l_{t+1}}{\lambda^l_t} \left[(1-\tau^c)(1-\alpha) \frac{Y_{t+1}}{K_t} + \tau^c \delta + (1-\delta) Q_{t+1} \right] \right\}.$$

Rearranging and using $a^T_t = \frac{1-\theta}{1-s_l}$ as well as the expression for Q_t (without capital adjustment costs):

$$\frac{1}{R_t} = \beta E_t \frac{\lambda_{t+1}}{\lambda_t}$$

$$E_t R^{sh}_{t+1} = R_t + \left(c + \tau^{FTT}\right) \frac{1-\theta}{1-s_l} - s_n \nu_t$$

$$E_t R^k_{t+1} \equiv (1-\tau^c)(1-\alpha) \frac{Y_{t+1}}{K_t} + \tau^c \delta \simeq R_t (1+\mu_t) - (1-\delta) \left(1 + E_t \mu_{t+1}\right)$$

from which it is possible to establish an approximate relationship between the expected return on capital $E_t R^k_{t+1}$ and the expected return on shares $E_t R^{sh}_{t+1}$:

$$E_t R^k_{t+1} \simeq \left[E_t R^{sh}_{t+1} - \left(c + \tau^{FTT}\right) \frac{1-\theta}{1-s_l} + s_n \nu_t \right] (1+\mu_t) - (1-\delta) \left(1 + E_t \mu_{t+1}\right)$$

C. Additional considerations

Three important additional aspects in the current FTT debate, not covered by the previous model are (a) the effect of mobility of economic factors on the macroeconomic outcomes, (b) the incidence of the tax and (c) a possible redistribution effect across sectors. To consider these additional elements, Chisari, Estache and Nicodème (2011) develop a Computable General Equilibrium Model to assess the impact of imposing a VAT or tax on intermediate and final sales of the financial sector. The model is calibrated for Belgium in 2007. The choice of 2007 is guided by the desire to avoid the effects of the 2008 crisis while the choice of Belgium is guided by both the choice of a small open and developed economy and pure practicalities of data availability.

The financial sector is defined as financial intermediation services, except insurance and pension funding services as well as services auxiliary to financial services. It therefore excludes insurance and pension funding services. It represents 4.33% of total value-added in the model. The model contains 16 sectors (7 for goods and 9 for services) of the economy, a public sector and an external sector as well as details on their use of labour and capital inputs, as well as the input-output relationships between the sectors. Finally, the model includes information on the household consumption composition and can split consumers between 'riches' and the 'poor' (respectively the top and bottom two quartiles).

The model looks at the effects over 5 periods of introducing taxes and is defined as the differential between the simulation and the baseline dynamic and incremental scenario of a 3% GDP growth per year. Each year, prices are such that all markets are cleared, except the labour market to generate unemployment. In this framework, real wages increase by 1.5% in the first year[13]. Labour is however fully mobile across sectors while only 20% of capital input is mobile across domestic sectors (the remaining 80% is assumed to be sector-specific). Two scenarios of international mobility are proposed and compared: a closed-economy scenario for which capital is immobile internationally, and a scenario of mild capital international mobility under which 10% of the capital of households can be shifted abroad and avoid taxation.

Two main taxes are simulated: a 15% VAT on the financial sector and a 10% tax on the sales of the financial sector to other sectors and to households[14]. This latter scenario implies a cascading effect that proxies the qualitative effects of a Financial Transactions Tax.

In the closed-economy scenario, both taxes impact negatively on GDP and international trade. The negative effect of the FTT on GDP is twice as large as the one for VAT. Unemployment increases because of the tax in both cases during the first two periods before that the real wage adjusts. The fiscal result, expressed in welfare of the government, is 5 times larger with a FTT than with VAT. Interestingly, the VAT starts hitting the poor more than the riches in the short-run but this is inversed after 3 periods. The FTT is seen to be mildly progressive. Finally, almost all sectors of the economy suffer in about the same way

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[13] Then the real wage adjusts to ensure full employment.

[14] In the paper, a simulation of a 10% sales tax to intermediate sales to other sectors only is also proposed.

when any of the tax is introduced but the negative effects are larger with a FTT than with VAT, because of the cascading effect. This shows that none of these taxes 'targets' the financial sector in practice.

The mild international mobility of capital scenario offers a good point of comparison. The effects of VAT on GDP are similar to the ones under the closed-economy scenario. For the FTT, even a mild international mobility dramatically amplifies the negative effects, which almost triple. For VAT, most of the results are qualitatively similar. Openness slightly decreases the regressive effect of the tax. For the FTT, the fiscal effects are negative in the short-run as capital escapes. The progressivity of the tax is by and large maintained. The impact on the sectors changes depending on their degree of openness. The financial sector is however hit hardly in both the short and long-run.

Reference: Chisari, Estache and Nicodème (2011), mimeo.