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THE EFFECTS OF BANK LENDING IN AN OPEN ECONOMY

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The effects of bank lending in an open economy

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Abstract

This paper assesses the effects of bank lending in a small open economy with a floating exchange rate and sticky prices. A theoretical model with costly financial intermediation is developed for New Zealand. The results show that the long-run and business cycle effects of bank lending are small. Whether firms borrow from financial intermediaries or public debt markets is unlikely to affect economic activity. In other words, the financial structure, or degree to which a country's financial system is intermediary based or market based, does not matter.

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1 Introduction

This paper develops a dynamic general equilibrium model to assess the effects of bank lending in an open economy. It is motivated by empirical evidence that credit markets may exacerbate economic fluctuations. For example, following a tightening in monetary policy, borrowing and output by bank dependent firms, which are typically small, often fall more than borrowing and output by large firms with access to public debt markets (Gertler and Gilchrist, 1994). Moreover, the spread between the loan rate paid by bank dependent (small) firms compared to the interest rate paid by (large) firms, with access to public debt markets, tends to increase during monetary contractions (Kashyap, Stein and Wilcox, 1993).

The credit channel literature formally examines the impact of credit markets on economic activity and the implications for monetary policy. There are two main channels through which credit markets are thought to affect the transmission of shocks to the economy. First, a shock to the economy can influence financial intermediaries' willingness to provide loans. This channel is referred to as the bank lending channel. The second channel is the balance sheet channel. It focuses on the potential impact of shocks on firms' financial positions and their ability to borrow. Much of the literature to date has focused on the United States, a large relatively closed economy.[1] Credit markets have yet to be incorporated in a model of an open economy with a floating exchange rate.[2] This paper is a step towards filling that gap.

[1] See Bernanke, Gertler and Gilchrist (1999), Fuerst (1995), Carlstrom and Fuerst (1997) and Fisher (1999) among others.

[2] Edwards and Végh (1997) develop a theoretical model of a small open economy with a predeter-

The model in this paper builds on Edwards and Végh's (1997) small open economy to examine the effects of bank lending. It explicitly models a banking sector and costly financial intermediation. As in Edwards and Végh (1997) there is international debt borrowing and lending. The model is extended to also include exports and imports and slowly adjusting consumption goods prices. Moreover, the economy is assumed to operate under a floating exchange rate, rather than a pre-determined exchange rate as in Edwards and Végh (1997), and the central bank has an explicit inflation target that it achieves by adjusting nominal interest rates.

Incorporating exports and imports and a floating exchange rate has important implications. First, with a floating exchange rate movements in the relative price of currencies affect the supply and demand of final products and factors of production. For example, a real appreciation of the domestic currency increases the price of exports, leading to a decline in foreign demand and domestic output. At the same time, the appreciation lowers the price of imports. All else equal, this leads to an increase in the demand for imports and a substitution from domestic factors of production (final products) to foreign factors (final products), thus exacerbating further the decline in domestic output.[3] Second, exports are a channel through which foreign sector shocks can affect domestic economic activity.

The paper proceeds as follows. Section 2 develops a theoretical model with costly financial intermediation for New Zealand. Section 3 compares the steady states of the

mined exchange rate. In their model, the policy maker sets the exchange rate and stands ready to exchange domestic money for international reserves (or vice versa) at the prevailing exchange rate.

[3]The fall in output is partially offset by lower production costs when imports are a production input.

costly financial intermediation model and the model without financial intermediation costs. Section 4 discusses the adjustment of the economy to shocks and the effects of financial intermediation costs on the business cycle are evaluated in section 5. The last section summarises and concludes.

2 Theoretical model

The theoretical model builds on Edwards and Végh's (1997) small open economy with a predetermined exchange rate. It is extended to include a flexible exchange rate, an inflation targeting monetary authority, sticky prices, imports and exports of goods. There are five agents in the economy: households, firms, financial intermediaries (banks), a government and a monetary authority.

2.1 Firms

Firms are monopolistic competitors and specialise in production. They produce aggregate output of consumption goods, Y_t, under a constant elasticity of substitution (CES) technology by hiring household labour, L_t^h, and using commodity inputs, M_t. Commodity inputs are imported at the beginning of each period.[4] They are material

[4] All imports are treated as material inputs into the production of consumption goods. The assumption simplifies the analysis as it implies that the same price adjustment applies for all consumption goods and no distinction needs to be made between domestically produced and imported consumer goods price inflation.

inputs and last for one period. The aggregate production function is given by

$$Y_t = \left((1-\eta_m)\left(Z_t L_t^h\right)^{\nu} + \eta_m \left(M_t\right)^{\nu}\right)^{\frac{1}{\nu}} \tag{1}$$

where $\eta_m \in (0,1]$ is a parameter and $\nu < 1$; that is, the marginal return to each input is diminishing. Z_t denotes aggregate productivity and the elasticity of substitution in production is given by $\frac{1}{1-\nu}$.

The assumption of monopolistic competition in the consumption goods market allows pricing decisions to be determined explicitly and provides a channel for introducing nominal rigidities. A firm treats the price in domestic currency, $P_t(j)$, of the consumption good j it produces as a choice variable, while taking the domestic aggregate price level, P_t, the nominal exchange rate, S_t, and the foreign price level, P_t^*, as given.[5] Having chosen $P_t(j)$, the firm then produces the quantity of output demanded at that price. Firms may not price discriminate and the price of good j sold to foreign consumers (denominated in foreign currency) is given by $\frac{P_t(j)}{S_t}$.

Firms sell their output of consumption goods, Y_t, to domestic households and the government. They also export to the rest of the world. $C_t^h(j)$, $X_t(j)$ and $G_t(j)$ are the quantity of consumption good j demanded by a typical household and foreign consumer and the government, i.e. $Y_t(j) = C_t^h(j) + X_t(j) + G_t(j)$. The demand functions for good j of the typical household and the government are given by $C_t^h(j) = \left(\frac{P_t(j)}{P_t}\right)^{-\theta} C_t^h$ and $G_t(j) = \left(\frac{P_t(j)}{P_t}\right)^{-\theta} G_t$, where C_t^h and G_t denote total consumption by

[5] The nominal exchange rate, S_t, is measured as the price of foreign currency in units of domestic currency, i.e. an increase in S_t indicates a depreciation of the domestic currency.

the typical household and the government. The aggregate price level, P_t, is an index given by $P_t = \left[\int_0^1 P_t(j)^{1-\theta} dj \right]^{\frac{1}{1-\theta}}$, where θ is the price elasticity of demand faced by each monopolistic competitive firm. Similarly, foreign demand for consumption good j is given by $X_t(j) = \left(\frac{P_t(j)}{P_t} \right)^{-\theta} X_t$, where X_t denotes aggregate exports.[6] Aggregate exports are a function of the real exchange rate, $Q_t \equiv \frac{S_t P_t^*}{P_t}$, and foreign demand, Y_t^*, and given by

$$X_t = \left(\frac{S_t P_t^*}{P_t} \right)^{\kappa} (Y_t^*)^{\varsigma} \tag{2}$$

where $\kappa, \varsigma > 0$ are the price and foreign demand elasticities of exports. In a symmetric equilibrium, all firms charge the same price, produce the same output, employ the same labour and use the same commodity inputs.

To pay for commodity imports, firms must borrow from financial intermediaries, i.e.

$$\hat{L}_t = Q_t M_t \tag{3}$$

where $\hat{L}_t$ denotes firms' loans in real terms.[7] Firms may also hold (issue) bonds, $\hat{B}_t^f$, i.e. they can lend (borrow) internationally at rate I_t.[8] Firms' financial net wealth in real terms at the beginning of period t, $\hat{A}_t^f$, is thus given by

$$\hat{A}_t^f = \hat{B}_t^f - \hat{L}_t \tag{4}$$

[6] The exchange rate cancels out in the relative price term.

[7] Variables with a "ˆ" denote real values of nominal variables. A change in variables is introduced as inflation is positive in steady state (discussed further below) and nominal variables are trending.

[8] Uncovered interest rate parity is assumed to hold.

Since firms must pay the lending rate, I_t^l, for bank credit, their flow constraint is given by

$$Y_t + \frac{(1+I_t)\hat{A}_t^f}{1+\Pi_t} - \hat{W}_t^h L_t^h - Q_t M_t - \frac{\left(I_t^l - I_t\right)\hat{L}_t}{1+\Pi_t} - \hat{\Omega}_t^f - \hat{A}_{t+1}^f = 0 \tag{5}$$

$\frac{\left(I_t^l - I_t\right)\hat{L}_t}{1+\Pi_t}$ represents firms' financial cost, in real terms, for having to use bank credit to pay for commodity inputs, where Π_t is the inflation rate. $\hat{W}_t^h$ is households' wage rate, $\hat{\Omega}_t^f$ denotes firms' dividend payments and $\hat{A}_{t+1}^f$ is firms' financial net wealth at the end of period t or beginning of period $t+1$.

The present discounted real value of firms' dividends can be written as

$$\begin{aligned} E_t \sum_{k=0}^{\infty} \frac{1}{\left(\frac{1+I_t}{1+\Pi_t}\right)^k} \hat{\Omega}_{t+k}^f = \hat{A}_0^f + E_t \sum_{k=0}^{\infty} \frac{1}{\left(\frac{1+I_t}{1+\Pi_t}\right)^k} \{Y_{t+k} \\ -\hat{W}_{t+k}^h L_{t+k}^h - \left(1 + \frac{I_{t+k}^l - I_{t+k}}{1+\Pi_{t+k}}\right) Q_{t+k} M_{t+k}\} \end{aligned} \tag{6}$$

where E_t is the conditional expectations operator with respect to information available at time t. Firms' objective is to choose $\left\{L_t^h,\ M_t\right\}$ to maximise the present discounted value of dividends for given paths of $\hat{W}_t^h$, Q_t, I_t^l, I_t and Π_t and an initial stock of real net assets, $\hat{A}_0^f$. Their first-order conditions are given by

$$\hat{W}_t^h = \frac{(1-\eta_m)(Z_t)^{\nu}\left(\frac{Y_t}{L_t^h}\right)^{1-\nu}}{\xi_t} \tag{7}$$

and

$$\left(1 + \frac{I_t^l - I_t}{1+\Pi_t}\right) Q_t = \frac{\eta_m\left(\frac{Y_t}{M_t}\right)^{1-\nu}}{\xi_t} \tag{8}$$

The first-order conditions show that firms sell their output at a mark-up, ξ_t, over production costs and factor prices are below their marginal products. The mark-up, ξ_t, is the ratio of the price level to aggregate marginal cost. Under price flexibility, it is constant and equal to $\frac{\theta}{\theta-1}$.

Equations (7) and (8) also show that the real allocation of resources is independent of the time path of dividends. Dividends are paid at the end of the period and households only care about the present discounted value of dividends.

For simplicity firms are assumed not to accumulate or decumulate net assets or issue new equity and their initial net assets, $\hat{A}_0^f$, are zero.[9] Equation (4) then implies

$$\hat{B}_t^f - \hat{L}_t = 0 \tag{9}$$

and firms' dividend payments are given by

$$\hat{\Omega}_t^f = Y_t - \hat{W}_t^h L_t^h - \left(1 + \frac{I_t^l - I_t}{1+\Pi_t}\right) Q_t M_t \tag{10}$$

Equation (9) can be interpreted as follows. Firms take out loans from financial intermediaries, which they use to purchase bonds to pay for commodity imports. Because uncovered interest rate parity holds, firms are indifferent between holding domestic and foreign bonds and so to pay for commodity imports they purchase foreign currency denominated bonds.

[9]The assumption is likely to affect the dynamic properties of the model but not the overall conclusion of small bank lending effects.

2.2 Households

Households are infinitely lived and a typical household values streams of consumption and leisure according to

$$E_t \sum_{k=0}^{\infty} \beta^k \left\{ \ln \left(C_{t+k}^h \right) + \gamma \left(1 - N_{t+k} \right) \right\} \tag{11}$$

where $\gamma > 0$ is a parameter and $\beta \in (0,1)$ denotes the household's discount factor. C_t^h is an index of household consumption in period t.[10] The time endowment is normalised to one. The household's labour supply is thus given by N_t and $(1 - N_t)$ is leisure.

Following Cooley and Hansen (1989), households face a deposit-in-advance constraint on a proportion of their purchases of consumption. Or, in the terminology of Lucas and Stokey (1983; 1987) consumption is a "cash good" and leisure is a "credit good". Households hold positive demand deposits, $\hat{D}_t$, because of transaction costs and the deposit-in-advance constraint is given by

$$\vartheta C_t^h \leq \hat{D}_t \tag{12}$$

for $\vartheta \in [0,1]$.

At the end of each period, households divide their assets into demand deposits, domestic and foreign bonds. Households' financial gross wealth in real terms, $\hat{A}_t^h$, is

[10] Each household consumes many goods, all of which are domestically produced. C_t^h is the quantity consumed in period t of an index of these goods with $C_t^h = \left[\int_0^1 C_t^h(j)^{\frac{\theta-1}{\theta}} dj \right]^{\frac{\theta}{\theta-1}}$, where $C_t^h(j)$ denotes the household's period t consumption of good j and $\theta > 0$ (see Dixit and Stiglitz, 1977). The government's consumption index (discussed below) is given accordingly.

given by

$$\hat{A}_t^h = \hat{D}_t + \hat{B}_t^h + Q_t \hat{B}_t^{h*} \tag{13}$$

where $\hat{D}_t$, $\hat{B}_t^h$ and $\hat{B}_t^{h*}$ denote the real stock of demand deposits, domestic and foreign bonds and Q_t is the real exchange rate.

Households derive income from three sources. First, they earn wage income, $\hat{W}_t^h N_t$, from supplying labour, N_t, to firms, where $\hat{W}_t^h$ is households' real wage rate. Second, households receive interest from holding financial assets. Demand deposits and domestic bonds earn a nominal return (in terms of domestic currency) of I_t^d and I_t. The nominal rate of interest paid on foreign bonds is given by I_t^*. Third, households receive dividends from firms and financial intermediaries, $\hat{\Omega}_t^f$ and $\hat{\Omega}_t^{fi}$.[11] Households pay taxes on their wage, interest and dividend income. For simplicity it is assumed that households' capital gains from exchange rate movements are not taxed. The tax rate imposed by the government is given by τ.

Households' flow constraint in real terms is given by

$$\begin{aligned} &(1-\tau)\left(\hat{W}_t^h N_t + \hat{\Omega}_t^f + \hat{\Omega}_t^{fi}\right) + \tfrac{(1+(1-\tau)I_t)\left(\hat{D}_t + \hat{B}_t^h\right)}{1+\Pi_t} + \tfrac{(1+(1-\tau)I_t^*) Q_t \hat{B}_t^{h*}}{1+\Pi_t^*} \\ &-C_t^h - \tfrac{(1-\tau)\left(I_t - I_t^d\right)\hat{D}_t}{1+\Pi_t} - \hat{D}_{t+1} - \hat{B}_{t+1}^h - Q_t \hat{B}_{t+1}^{h*} = 0 \end{aligned} \tag{14}$$

where $\frac{(1-\tau)\left(I_t - I_t^d\right)\hat{D}_t}{1+\Pi_t}$ denotes the opportunity cost of having to hold demand deposits to purchase consumption goods. Households' flow constraint can be interpreted as follows. Each period, households receive income from supplying labour. They also earn a real

[11] For simplicity, equities are assumed non-tradeable. The assumption does not affect the conclusions in this paper because firms are identical.

return on their financial assets (demand deposits, domestic and foreign bonds) and receive dividend payments from firms and financial intermediaries. Households then sell all their financial assets to purchase consumption goods and new financial assets. The flow constraint is binding and households' expenditure is equal to their income.

Households' lifetime budget constraint can be written as follows

$$\begin{aligned}&\hat{A}_0^h + E_t \sum_{k=0}^{\infty} \frac{1}{\left(\frac{1+I_t}{1+\Pi_t}\right)^k} \{(1-\tau)\left(\hat{W}_{t+k}^h N_{t+k} + \hat{\Omega}_{t+k}^f + \hat{\Omega}_{t+k}^{fi}\right) \\ &- \left(1 + \frac{\vartheta(1-\tau)\left(I_{t+k} - I_{t+k}^d\right)}{1+\Pi_{t+k}}\right) C_{t+k}^h\} = 0\end{aligned} \tag{15}$$

as the deposit-in-advance constraint holds as an equality at an optimum if $I_t^d < I_t$. Households' optimisation problem consists of choosing $\left\{C_t^h,\ N_t\right\}$ for all $t \in [0, \infty)$ to maximise lifetime utility (equation 11) subject to equation (15), given their initial financial wealth, $\hat{A}_0^h$, and the time paths of $\hat{W}_t^h$, $\hat{\Omega}_t^f$, $\hat{\Omega}_t^{fi}$, I_t, I_t^d and Π_t. Households' first-order conditions are given by

$$\frac{1}{\gamma C_t^h} - \frac{\left(1 + \frac{\vartheta(1-\tau)\left(I_t - I_t^d\right)}{1+\Pi_t}\right)}{(1-\tau)\hat{W}_t^h} = 0 \tag{16}$$

and

$$\frac{1}{C_t^h} - E_t\left[\frac{\beta(1+(1-\tau)I_t)}{(1+\Pi_t)C_{t+1}^h}\right] = 0 \tag{17}$$

Equation (16) indicates that at an optimum the marginal rate of substitution between consumption and leisure is equal to the relative price of consumption; that is, the ratio of the effective price of consumption and the after-tax real wage rate. The effective price of consumption is the sum of its market price (equal to unity) and the opportunity cost of having to hold demand deposits to purchase consumption goods $\frac{\vartheta(1-\tau)\left(I_t-I_t^d\right)}{1+\Pi_t}$. Equation (17) implies that the marginal rate of substitution between consumption today and next period is equal to the after-tax, real rate of interest.

2.3 Financial intermediaries

Financial intermediaries are perfectly competitive and owned by households. They provide loans, $\hat{L}_t$, to firms to pay for commodity imports. Financial intermediaries finance the loans with households' demand deposits, $\hat{D}_t$, and by issuing domestic bonds, $\hat{B}_t^h$. They can also issue (purchase) internationally traded, foreign bonds, $\hat{B}_t^{fi}$. Financial intermediaries thus exist because of households' demand for deposit liabilities as a medium of exchange and to provide loans to firms.

Financial intermediaries' financial net wealth in real terms, $\hat{A}_t^{fi}$, is given by

$$\hat{A}_t^{fi} = \hat{B}_t^{fi} + \hat{L}_t - \hat{D}_t - \hat{B}_t^h \tag{18}$$

Their assets consist of internationally traded bonds, $\hat{B}_t^{fi}$, and loans to firms, $\hat{L}_t$. Their liabilities comprise households' demand deposits, $\hat{D}_t$, and domestically issued bonds, $\hat{B}_t^h$.

As in Edwards and Végh (1997), the provision of demand deposits and loans is costly and financial intermediaries use tradeable resources to produce demand deposits and loans. The cost function is assumed to be strictly increasing, convex and linearly homogenous and is given by the generalised Leontief function

$$h\left(\hat{L}_t, \hat{D}_t\right) = \upsilon_l \hat{L}_t + \upsilon_d \hat{D}_t - \upsilon_{ld}\left(\hat{L}_t\right)^{\frac{1}{2}}\left(\hat{D}_t\right)^{\frac{1}{2}} \tag{19}$$

where υ_l, υ_d and $\upsilon_{ld} > 0$. The parameters in $h(.)$ are chosen so that for $\hat{L}_t > 0$ and $\hat{D}_t > 0$ the cost function satisfies:

$$h(.) > 0,\ \frac{\partial h}{\partial \hat{L}} > 0,\ \frac{\partial h}{\partial \hat{D}} > 0,\ \frac{\partial^2 h}{\partial^2 \hat{L}} > 0,\ \frac{\partial^2 h}{\partial^2 \hat{D}} > 0 \text{ and } \frac{\partial^2 h}{\partial \hat{L} \partial \hat{D}} < 0$$

This means that υ_{ld} must be less than υ_l and υ_d to ensure that $\frac{\partial h}{\partial \hat{L}} > 0$ and $\frac{\partial h}{\partial \hat{D}} > 0$.

Financial intermediaries' flow budget constraint is given by

$$\begin{aligned} &\tfrac{(1+I_t)\hat{A}_t^{fi}}{1+\Pi_t} + \tfrac{\left(I_t^l - I_t\right)\hat{L}_t}{1+\Pi_t} + \tfrac{\left(I_t - I_t^d\right)\hat{D}_t}{1+\Pi_t} - \left(\upsilon_l \hat{L}_t + \upsilon_d \hat{D}_t - \upsilon_{ld}\left(\hat{L}_t\right)^{\frac{1}{2}}\left(\hat{D}_t\right)^{\frac{1}{2}}\right) \\ &-\hat{\Omega}_t^{fi} - \hat{A}_{t+1}^{fi} = 0 \end{aligned} \tag{20}$$

Since financial intermediaries could always lend by buying bonds at rate I_t, $I_t^l - I_t$ is the spread earned from lending to firms and $I_t - I_t^d$ is the spread earned from borrowing in the form of demand deposits rather than issuing bonds at rate I_t.

Financial intermediaries choose $\left\{\hat{D}_t, \hat{L}_t\right\}$ to maximise the present discounted value of dividends

$$\begin{aligned} &E_t \sum_{k=0}^{\infty} \tfrac{1}{\left(\frac{1+I_t}{1+\Pi_t}\right)^k} \hat{\Omega}_{t+k}^{fi} = \hat{A}_0^{fi} + E_t \sum_{k=0}^{\infty} \tfrac{1}{\left(\frac{1+I_t}{1+\Pi_t}\right)^k} \{ \tfrac{\left(I_{t+k}^l - I_{t+k}\right)\hat{L}_{t+k}}{1+\Pi_{t+k}} + \tfrac{\left(I_{t+k} - I_{t+k}^d\right)\hat{D}_{t+k}}{1+\Pi_{t+k}} \\ &-\upsilon_l \hat{L}_{t+k} - \upsilon_d \hat{D}_{t+k} + \upsilon_{ld}\left(\hat{L}_{t+k}\right)^{\frac{1}{2}}\left(\hat{D}_{t+k}\right)^{\frac{1}{2}} \} \end{aligned} \tag{21}$$

taking as given the time path of I_t, I_t^d, I_t^l and Π_t and the cost function, $h\left(\hat{L}_t, \hat{D}_t\right)$. Financial intermediaries' first-order conditions are given by

$$\frac{I_t - I_t^d}{1+\Pi_t} - \frac{2\upsilon_d\left(\hat{D}_t\right)^{\frac{1}{2}} - \upsilon_{ld}\left(\hat{L}_t\right)^{\frac{1}{2}}}{2\left(\hat{D}_t\right)^{\frac{1}{2}}} = 0 \tag{22}$$

and

$$\frac{I_t^l - I_t}{1+\Pi_t} - \frac{2\upsilon_l\left(\hat{L}_t\right)^{\frac{1}{2}} - \upsilon_{ld}\left(\hat{D}_t\right)^{\frac{1}{2}}}{2\left(\hat{L}_t\right)^{\frac{1}{2}}} = 0 \tag{23}$$

In the case of costless banking, $h\left(\hat{L}_t, \hat{D}_t\right) = 0$ and equations (22) and (23) reduce to

$$I_t - I_t^d = 0 \tag{24}$$

and

$$I_t^l - I_t = 0 \tag{25}$$

Equations (24) and (25) indicate that in a competitive equilibrium with costless banking, financial intermediaries would charge borrowers the opportunity cost of funds (and pay depositors the cost of funds), i.e. firms' cost of borrowing from banks would be the same as accessing public debt markets directly for external finance. In the case of costly banking, the level of deposits and loans affects the cost of extending credit. For example, negative shocks that affect deposits are transmitted to the supply-side through a rise in lending rates, $\frac{\partial^2 h}{\partial \hat{L} \partial \hat{D}} < 0$, and a decline in the demand for loans.

As in the case of firms, the time path of financial intermediaries' dividend payments is irrelevant as dividends are paid at the end of the period and households only care about the present discounted value of dividends. For simplicity, financial intermediaries, as firms, are assumed not to accumulate or decumulate net assets or issue new equity and their initial net assets, $\hat{A}_0^{fi}$, are zero. Loan market clearing (equation 18) then implies

$$\hat{L}_t = \hat{D}_t + \hat{B}_t^h - \hat{B}_t^{fi} \tag{26}$$

and dividends are zero

$$\hat{\Omega}_t^{fi} = \frac{\left(I_t^l - I_t\right)\hat{L}_t}{1+\Pi_t} + \frac{\left(I_t - I_t^d\right)\hat{D}_t}{1+\Pi_t} - \upsilon_l \hat{L}_t - \upsilon_d \hat{D}_t + \upsilon_{ld}\left(\hat{L}_t\right)^{\frac{1}{2}}\left(\hat{D}_t\right)^{\frac{1}{2}} = 0 \tag{27}$$

Equation (26) shows that in an open economy with access to foreign capital, economic activity is not constrained by domestic saving. For example, if firms' demand for loans exceeds domestic saving, i.e. $\hat{L}_t > \hat{D}_t + \hat{B}_t^h$, then $\hat{B}_t^{fi} < 0$ and financial intermediaries borrow both domestically and in international capital markets to provide funding to firms.

2.4 Government

The government's budget constraint is given by

$$\begin{aligned} &\tau\left(\hat{W}_t^h L_t^h + \hat{\Omega}_t^f + \hat{\Omega}_t^{fi} + \frac{I_t^d \hat{D}_t}{1+\Pi_t} + \frac{I_t \hat{B}_t^h}{1+\Pi_t} + \frac{I_t^* Q_t \hat{B}_t^{h*}}{1+\Pi_t^*}\right) \\ &+\upsilon_l \hat{L}_t + \upsilon_d \hat{D}_t - \upsilon_{ld}\left(\hat{L}_t\right)^{\frac{1}{2}}\left(\hat{D}_t\right)^{\frac{1}{2}} - G_t = 0 \end{aligned} \tag{28}$$

The government collects taxes on households' wage, dividend and interest incomes, $\tau(\hat{W}_t^h L_t^h + \hat{\Omega}_t^f + \hat{\Omega}_t^{fi} + \frac{I_t^d \hat{D}_t}{1+\Pi_t} + \frac{I_t \hat{B}_t^h}{1+\Pi_t} + \frac{I_t^* Q_t \hat{B}_t^{h*}}{1+\Pi_t^*})$. Capital gains from exchange rate movements are not taxed. As in Edwards and Végh (1997) the financial intermediation cost, $v_l\hat{L}_t + v_d\hat{D}_t - v_{ld}\left(\hat{L}_t\right)^{\frac{1}{2}}\left(\hat{D}_t\right)^{\frac{1}{2}}$, appears in the government's budget constraint. This is because financial intermediation costs are assumed to be a private cost (for financial intermediaries) and not a social cost. The government can be thought of as providing the monitoring and administrative services needed to operate banks. If financial intermediation costs were a social cost, the economy's real resources would be affected by the size of the banking system.[12]

The government uses its revenue to purchase an index of consumption goods, G_t, from firms. For simplicity, the government's budget constraint is assumed to balance in each period, i.e. there is no debt financing.

2.5 Monetary authority

The monetary authority has an explicit consumer price inflation target, Π^T. To maintain this target following a shock to the economy the central bank adjusts the nominal rate of interest paid on domestic bonds. A change in monetary policy is transmitted to the real economy through its impact on lending and demand deposit rates. Moreover, a change in policy affects the exchange rate.

The central bank's reaction function is based on a variant of the Taylor rule (Taylor, 1993) and depends on deviations of inflation from target and deviations of output from full capacity, flexible price output as in a Taylor rule, and last period's interest rate. Full

[12] The assumption is made for simplicity and does not change the overall conclusions. This is because financial intermediation costs are relatively small.

capacity, flexible price output and the central bank's reaction function are discussed further in section 4.

2.6 Market clearing and equilibrium conditions

The clearing conditions for the labour and goods markets are given by

$$N_t = L_t^h \tag{29}$$

$$Y_t = C_t^h + G_t + X_t \tag{30}$$

Firms' and financial intermediaries' bond holdings, $\hat{B}_t^f$ and $\hat{B}_t^{fi}$, are assumed to be in the form of foreign securities and the foreign sector clearing condition is determined by

$$\tfrac{(1+I_t^*)Q_t\left(\hat{B}_t^{h*}+\hat{B}_t^f+\hat{B}_t^{fi}\right)}{1+\Pi_t^*} + X_t - Q_t M_t - Q_t\left(\hat{B}_{t+1}^{h*} + \hat{B}_{t+1}^f + \hat{B}_{t+1}^{fi}\right) = 0 \tag{31}$$

Uncovered interest rate parity holds

$$1 + (1-\tau)\, I_t = E_t\left[\left(1 + (1-\tau)\, I_t^*\right)\tfrac{S_{t+1}}{S_t}\right] \tag{32}$$

and the sequences of foreign interest rates, prices, inflation and foreign demand $\{I_t^*$, P_t^*, Π_t^*, $Y_t^*\}$ are given to the small open economy. Uncovered interest rate parity implies that agents are indifferent between holding domestic and foreign bonds. For simplicity, it is also assumed that all households' bond holdings are in foreign securities, i.e. $\hat{B}_t^h = 0$ for all t.[13]

The real exchange rate is given by $Q_t = \frac{S_t P_t^*}{P_t}$ and evolves according to

$$E_t \left[\frac{Q_{t+1}}{Q_t} \right] = E_t \left[\frac{\frac{S_{t+1}}{S_t} \frac{P_{t+1}^*}{P_t^*}}{\frac{P_{t+1}}{P_t}} \right] \tag{33}$$

3 Parameter values and steady state

The steady states of the model with and without financial intermediation costs are discussed next. Parameter values are chosen so that the steady state of the model with financial intermediation costs is broadly consistent with New Zealand data and/or assumptions made in the literature. A period in the model is assumed to correspond to one quarter and the following parameters are chosen.

Households' discount rate, β, equals 0.9902 and leads to an annual steady state, pre-tax real domestic interest rate of 4 percent. The coefficient on leisure, γ, in households' utility function is set to 2.4, such that work effort accounts for approximately a third of the time endowment in steady state. The ratio of demand deposits to consumption, ϑ, is 0.3. This is in line with the current ratio of advances outstanding on personal credit cards to retail sales in New Zealand.

Labour-augmenting productivity, $\bar{Z}$, is normalised to 1 in steady state. The elasticity of substitution between labour and commodity inputs, $\frac{1}{1-\nu}$, is set to $\frac{1}{1.1}$ to approximate a Cobb-Douglas production technology. The coefficients on commodity inputs,

[13] The assumption does not change the conclusions.

η_m, in firms' production function is 0.36 and leads to a labour income share of output of about 0.64. Firms' mark-up in steady state is 20 percent ($\frac{\theta}{\theta-1} = 1.2$), i.e. $\theta = 6$, the same as in McCallum and Nelson (1999).

The parameters in financial intermediaries' cost function are $\upsilon_l = 0.01$, $\upsilon_d = 0.006$ and $\upsilon_{ld} = 0.001$. This leads to a spread between the demand deposit rate and the domestic bond rate of around 2 percent per annum, which is about the average (1991 to 2004) spread between the call deposit rate and the New Zealand overnight interbank cash rate.[14] The spread between the loan rate and domestic bond rate is approximately 4 percent per annum, which is about the average (1991 to 2004) spread between the base lending rate and overnight interbank cash rate. The spreads are intentionally chosen to be high. As the analysis will show even with these large spreads the effects of bank lending are small.

The annual domestic steady state inflation rate is equal to the Reserve Bank of New Zealand's inflation target rate, Π^T, of 2 percent, the mid-point of the 1 to 3 percent target band for consumer price inflation. The tax rate, τ, equals 17 percent in line with the income tax assumption in the Reserve Bank's model (Black, Cassino, Drew, Hansen, Hunt, Rose and Scott, 1997).

For simplicity, the steady state foreign inflation rate, $\bar{\Pi}^*$, and nominal bond rate, $\bar{I}^*$, are assumed to be the same as for the domestic economy and the steady state real exchange rate, $\bar{Q}$, is normalised to 1. The price and foreign demand elasticities of exports, κ and ς, are equal to unity as in McCallum and Nelson (2001). Foreign

[14] The overnight interbank cash rate is the interest rate used by the Reserve Bank of New Zealand since March 1999 to change the stance of monetary policy.

demand is chosen to yield a steady state ratio of exports to output of 30.5 percent, which leads to a ratio of net exports to output similar to that in the Reserve Bank of New Zealand's model.

The steady state of the model can be solved for numerically.[15] A residual is calculated to ensure that the model "nearly" solves. The steady state values for the variables in the model are summarised in Table 1. Column (1) shows the results for the model with costly financial intermediation. The ratios of household and government consumption to output, at 57.2 and 12.3 percent, are lower than those in the Reserve Bank of New Zealand's model. This is because in this model all imports are intermediate goods whereas in the Reserve Bank's model a proportion of imports are for final demand. The steady state ratio of demand deposits to output at 17.2 percent is slightly less than half the current ratio of households' assets with deposit-taking institutions to output. The ratios of exports and imports to output are 30.5 and 33.2 percent. They are slightly lower than the assumptions in the Reserve Bank's model but lead to a similar ratio of net exports to output. The cost of financial intermediation makes up approximately 0.4 percent of output.

To assess the long-run real effects of costly financial intermediation, the steady state model is solved without financial intermediation costs, i.e. $h\left(\bar{Q}\bar{M}, \bar{D}\right) = 0$. The results are reported in column (2) of Table 1. Column (3) reports the percent (percentage point) differences between the model without financial intermediation costs and the costly financial intermediation model.

[15] The steady state equations are contained in appendix A.

Table 1: Numerical steady state

		costly financial intermediation	no financial intermediation costs	difference
		(1)	(2)	(3)
$\bar{D}$	demand deposits	0.0262	0.0264	0.8 %
$\bar{B}^{h*}$	households' foreign bonds	0.2915	0.3265	12.0 %
$\bar{B}^{f}$	firms' bonds	0.0507	0.0512	1.1 %
$\bar{B}^{fi}$	financial intermediaries' bonds	-0.0245	-0.0248	1.4 %
$\bar{C}^{h}$	household consumption	0.0873	0.0880	0.8 %
$\bar{G}$	government consumption	0.0188	0.0184	-2.4 %
$\bar{X}$	exports	0.0466	0.0467	0.2 %
$\bar{Y}$	output	0.1527	0.1531	0.2 %
$\bar{M}$	imports	0.0507	0.0512	1.1 %
$\bar{L}^{h}$	labour	0.3011	0.2999	-0.4 %
$\bar{W}^{h}$	wage rate	0.2528	0.2545	0.6 %
$\bar{\Omega}^{f}$	firms' dividend payments	0.0255	0.0255	0.2 %
$\bar{I}$	domestic bond rate	7.36 %	7.36 %	0.00 p.p.
$\bar{I}^{l}$	lending rate	11.50 %	7.36 %	-4.14 p.p.
$\bar{I}^{d}$	demand deposit rate	5.13 %	7.36 %	2.23 p.p.
$\bar{\Delta S}$	change in exchange rate	0.00 %	0.00 %	0.00 p.p.
	residual	$7.6 \cdot 10^{-17}$	$1.4 \cdot 10^{-17}$	
$\bar{D}/\bar{Y}$		17.2 %	17.2 %	0.1 p.p.
$\bar{C}^{h}/\bar{Y}$		57.2 %	57.5 %	0.3 p.p.
$\bar{G}/\bar{Y}$		12.3 %	12.0 %	-0.3 p.p.
$\bar{X}/\bar{Y}$		30.5 %	30.5 %	0.0 p.p.
$\bar{M}/\bar{Y}$		33.2 %	33.5 %	0.3 p.p.
$h\left(\bar{Q}\bar{M}, \bar{D}\right)/\bar{Y}$		0.4 %	0.0 %	-0.4 p.p.

Note: All variables are reported at quarterly rates, except for interest rates, which are at annual rates. Differences between the model without financial intermediation costs and the costly financial intermediation model in column (3) are in percent (%) or percentage points (p.p.).

With no financial intermediation costs the lending rate that financial intermediaries charge is the same as the rate of interest firms would pay if borrowing directly in public debt markets, i.e. $\bar{I}^l = \bar{I}$. Moreover, the demand deposit rate is equal to the domestic bond rate, i.e. $\bar{I}^d = \bar{I}$, and the opportunity cost of having to hold demand deposits to purchase consumption goods is zero.

With zero financial intermediation costs the lending rate and cost of borrowing fall, raising firms' demand for loans. This leads to an increase in the long-run level of steady state output, firms' dividend payments and the wage rate. Moreover, the decline in the lending rate lowers the cost of imports, leading to a substitution from labour to imports. As a result, household labour falls and imports rise. Firms' foreign bond holdings increase with higher imports. Exports are also higher, but net exports deteriorate slightly as the increase in steady state exports is more than offset by higher imports.

Households' savings in the form of foreign bonds rise.[16] Households' demand deposits also increase as the decline in financial intermediation costs lowers the opportunity cost of having to hold demand deposits and consumption rises. But the increase in demand deposits is insufficient to meet firms' higher demand for loans and financial intermediaries' borrowings in international capital markets increase. Government consumption falls because of lost revenue from financial intermediation.

In summary, a reduction in financial intermediation costs lowers the lending rate and raises firms' demand for loans, leading to an increase in the long-run level of steady

[16] The increase in households' foreign bond holdings is determined residually to ensure that the foreign sector clearing condition holds.

state output. Households' wage rate and consumption are also higher. However, overall the effects are small. This is because the financial intermediation costs are relatively small. Larger financial intermediation costs would lead to larger real effects, but the spreads between the domestic bond rate and the demand deposit and lending rates would have to be even more unrealistically large.[17]

4 Adjustment of the economy to shocks

To evaluate the effects of financial intermediation costs on the business cycle, the economy is subjected to a range of exogenous shocks and the adjustment paths of the costly financial intermediation model back to steady state are compared to those of the model without financial intermediation costs. The dynamic responses are derived in terms of logarithmic deviations from steady state (denoted by lower case letters). Analysing the dynamic properties of the model (with and without financial intermediation costs) requires specifying the shock processes, firms' price adjustment, full capacity, flexible price output and the monetary authority's reaction function. Following a shock to the economy firms change prices, inflation deviates from target and the economy operates below or above full capacity. To return the economy to steady state the central bank adjusts interest rates.

[17] The results are robust to different specifications of the model. For example, changing the ratio of demand deposits to consumption or relaxing the assumption of zero household domestic bond holdings affect households' and financial intermediaries' steady state net asset positions, but do not change the overall conclusions. Relaxing the assumption that firms and financial intermediaries can borrow or lend internationally also does not change the results because financial intermediation costs are small. Moreover, the overall results hold for different specifications of households' utility function, the financial intermediation cost function, different steady state inflation rates or if firms, instead of borrowing to pay for commodity inputs, must take out loans to pay for wages.

4.1 Exogenous shocks

To assess the effects of financial intermediation costs on the business cycle three types of shock are considered: to monetary policy, aggregate productivity and foreign demand. The shocks illustrate how lending and deposit rates and the exchange rate affect the adjustment of the economy and are discussed in the next section.

All shocks are assumed normally distributed. Productivity, z_t, and foreign demand, y_t^*, are univariate exogenous processes and evolve according to

$$z_t = \rho_z z_{t-1} + \epsilon_{z,t}, \quad \text{where} \quad \epsilon_{z,t} \sim i.i.d.\ N\left(0; \sigma_z^2\right) \tag{34}$$

$$y_t^* = \rho_{y^*} y_{t-1}^* + \epsilon_{y^*,t}, \quad \text{where} \quad \epsilon_{y^*,t} \sim i.i.d.\ N\left(0; \sigma_{y^*}^2\right) \tag{35}$$

The choice of shock parameters follows McCallum and Nelson (2001), except for the foreign demand shock. McCallum and Nelson (2001) assume that the foreign demand shock is a random walk. Here, the shock is temporary and the autocorrelation coefficient is the same as for McCallum and Nelson's (2001) risk premium shock, i.e. $\rho_{y^*} = 0.5$.[18] The autocorrelation coefficient of the productivity shock, ρ_z, is 0.95 and the innovation variances are assumed to be given by $\sigma_z^2 = (0.007)^2$ and $\sigma_{y^*}^2 = (0.02)^2$. The standard deviation of the monetary policy shock is 0.8 percent per annum.

[18] It is possible to consider a random walk shock but it would alter the derivation of impulse responses. For consistency a temporary shock is assessed instead. The choice of a temporary rather than a more persistent shock is arbitrary.

4.2 Inflation adjustment

Firms' price adjustment follows Calvo (1983) and is assumed to be sluggish. Each period there is a constant probability, φ, that firms can adjust their prices. This leads to the following inflation adjustment equation

$$\pi_t = \beta E_t \left[\pi_{t+1}\right] + \varrho \left(y_t - \bar{y}_t\right) \tag{36}$$

where $\varrho = \frac{\varphi(1-(1-\varphi)\beta)}{(1-\varphi)\theta}$ and $\bar{y}_t$ is the log level of aggregate flexible price output of consumption goods.[19] Equation (36) states that inflation is a function of expected future inflation and deviations of output from full capacity, flexible price output, i.e. the output gap. In the dynamic analysis the probability that firms can adjust prices is set to 0.33, i.e. prices remain unchanged on average for three quarters.

4.3 Full capacity, flexible price output

Full capacity, flexible price output is the total domestic output of consumption goods that would be produced under price flexibility, i.e. in the absence of any restrictions of adjusting prices. Under price flexibility, the log level of aggregate output, $\bar{y}_t$, is given by

$$\bar{y}_t = (1-\eta_m)\left(\frac{\bar{Z}\bar{L}^h}{\bar{Y}}\right)^{\nu} z_t + (1-\eta_m)\left(\frac{\bar{Z}\bar{L}^h}{\bar{Y}}\right)^{\nu} \bar{l}_t^h + \eta_m \left(\frac{\bar{M}}{\bar{Y}}\right)^{\nu} \bar{m}_t \tag{37}$$

where $\bar{l}_t^h$ and $\bar{m}_t$ denote the log levels of flexible price household labour and imports. Under price flexibility, the mark-up ξ_t is constant and equal to $\frac{\theta}{\theta-1}$. Flexible price

[19] Firms' discount factor, β, is assumed to be the same as for households.

household labour, $\bar{l}_t^h$, can then be derived from households' first-order condition that the marginal utility of leisure is equal to the after-tax real wage rate and firms' first-order condition determining labour demand (equation 7). It is given by $\bar{l}_t^h = \bar{y}_t + \frac{\nu}{1-\nu} z_t$. The log level of flexible price commodity imports, $\bar{m}_t$, is derived from firms' first-order condition (8), with ξ_t equal to the constant mark-up $\frac{\theta}{\theta-1}$, and given by $\bar{m}_t = \bar{y}_t - \frac{1}{1-\nu} q_t - \frac{1+\bar{I}^l}{(1-\nu)\left(1+\bar{\Pi}+\bar{I}^l-\bar{I}\right)} i_t^l + \frac{1+\bar{I}}{(1-\nu)\left(1+\bar{\Pi}+\bar{I}^l-\bar{I}\right)} i_t + \frac{\bar{I}^l-\bar{I}}{(1-\nu)\left(1+\bar{\Pi}+\bar{I}^l-\bar{I}\right)} \pi_t$. Equation (37) can then be re-written as

$$\begin{aligned} &\bar{y}_t - \frac{1}{1-\nu} z_t + \frac{\eta_m \left(\frac{\bar{M}}{\bar{Y}}\right)^\nu}{(1-\nu)(1-\eta_m)\left(\frac{\bar{Z}\bar{L}^h}{\bar{Y}}\right)^\nu} q_t + \frac{\eta_m \left(\frac{\bar{M}}{\bar{Y}}\right)^\nu \left(1+\bar{I}^l\right)}{(1-\nu)(1-\eta_m)\left(\frac{\bar{Z}\bar{L}^h}{\bar{Y}}\right)^\nu \left(1+\bar{\Pi}+\bar{I}^l-\bar{I}\right)} i_t^l \\ &- \frac{\eta_m \left(\frac{\bar{M}}{\bar{Y}}\right)^\nu \left(1+\bar{I}\right)}{(1-\nu)(1-\eta_m)\left(\frac{\bar{Z}\bar{L}^h}{\bar{Y}}\right)^\nu \left(1+\bar{\Pi}+\bar{I}^l-\bar{I}\right)} i_t - \frac{\eta_m \left(\frac{\bar{M}}{\bar{Y}}\right)^\nu \left(\bar{I}^l-\bar{I}\right)}{(1-\nu)(1-\eta_m)\left(\frac{\bar{Z}\bar{L}^h}{\bar{Y}}\right)^\nu \left(1+\bar{\Pi}+\bar{I}^l-\bar{I}\right)} \pi_t = 0 \end{aligned} \tag{38}$$

The flexible price level of log output is thus a function of labour-augmenting productivity, the real exchange rate and the financial cost in real terms of having to use bank credit.

4.4 Monetary authority's reaction function

The monetary authority's reaction function is assumed to be given by

$$i_t = \mu_1 \pi_t + \mu_2 \left(y_t - \bar{y}_t\right) + \mu_3 i_{t-1} + \epsilon_{i,t} = 0 \tag{39}$$

where $\epsilon_{i,t} \sim i.i.d.\ N\left(0; \sigma_i^2\right)$ is an exogenous shock that can be interpreted as a policy error. The coefficients on inflation, the output gap and past interest rate are given by $\mu_1 = 1.5$, $\mu_2 = 0.5$ and $\mu_3 = 0.8$. The choice for μ_1 and μ_2 is based on the parameter values in a Taylor rule (Taylor, 1993).[20] The coefficient on the lagged interest rate, μ_3, is the same as in McCallum and Nelson (1999) and in line with estimates for New Zealand by Huang, Margaritis and Mayes (2001), who find strong evidence of interest rate smoothing.

5 Business cycle effects

Next, the effects of financial intermediation costs on the business cycle are assessed. The log-linearised model can be solved with the method of undetermined coefficients.[21] The solution is used to evaluate the dynamic properties of the models with and without financial intermediation costs via impulse response analysis. The impulse responses of the variables in the models with and without financial intermediation costs to a shock in monetary policy, productivity and foreign demand are plotted in Figures 1 to 3 as percent deviations from steady state together with the respective shock.[22] The solid line shows the responses of the costly financial intermediation model and the dotted line is the economy without financial intermediation costs (in most graphs the two lines are indistinguishable).

The main results can be summarised as follows. Following a shock to the economy lending and deposit rates and the exchange rate are important channels for the

[20] The original Taylor rule does not include the lagged interest rate.

[21] Uhlig's (1997) procedures for MATLAB are used. The log-linearised equations of the costly financial intermediation model are given in appendix B.

[22] Household consumption and demand deposits are plotted in one panel. This is because the deposit-in-advance constraint implies the same percent deviation from steady state for these two variables. Firms' bonds and imports also deviate by the same amount following a shock to the economy and are hence also plotted in one panel.

economy to adjust. But the effects of financial intermediation costs are negligible.[23] The adjustment paths of the variables in the costly financial intermediation model and the model without financial intermediation costs are almost identical. This is because following a shock to the economy, the lending rate and demand deposit rate increase (decrease) virtually by the same amount as the domestic bond rate.

The result that financial intermediation costs do not affect business cycle fluctuations suggests that whether firms borrow from financial intermediaries or public debt markets directly does not affect economic activity. The finding of small effects of bank lending is in line with Fisher's (1999) closed economy results for the United States. It also supports empirical evidence that the degree to which a country's financial system is intermediary based or market based does not affect economic growth (Levine, 2002).

5.1 Monetary policy shock

An unanticipated tightening in monetary policy (Figure 1) that increases domestic interest rates raises firms' cost of borrowing, leading to a fall in output, imports, employment and the wage rate. Household and government consumption fall and exports are also lower. The unexpected tightening in monetary policy causes an appreciation of the nominal and real exchange rates. The real appreciation increases the price of exports, leading to lower foreign demand and exports. It also puts downward pressure on the cost of imports. The decline in the cost of production inputs (both labour and

[23] Claus (2004), however, shows that the effectiveness of the financial system in allocating resources to best uses can have important effects on economic activity.

imports) increases firms' profits and dividend payments.

Following the unanticipated monetary tightening inflation declines as output temporarily falls below capacity, i.e. the output gap becomes negative. The output gap widens because output declines and because the real appreciation of the domestic currency leads to an increase in full capacity, flexible price output.

Households' savings in the form of demand deposits and foreign bonds fall. Demand deposits decrease by more than firms' demand for loans and financial intermediaries' borrowings from abroad decline.

5.2 Productivity shock

A positive labour-augmenting productivity shock (Figure 2) leads to an increase in output, the wage rate and firms' dividend payments. Labour falls slightly and firms' imports are somewhat higher. Imports are higher and employment is lower because the monetary authority accommodates the productivity shock and eases monetary policy. Domestic interest rates fall, lowering firms' cost of borrowing to purchase commodity imports and increasing their demand for loans. Financial intermediaries are able to increase lending to firms as households' demand deposits and financial intermediaries' borrowings from abroad rise. Households' savings in the form of foreign bonds also increase.

The central bank is able to lower the interest rate as the positive productivity shock leads to an increase in full capacity, flexible price output and a negative output gap, which puts downward pressure on inflation. The decline in interest rates leads to

Figure 1: Impulse responses to a monetary policy shock (in percent deviations from steady state)

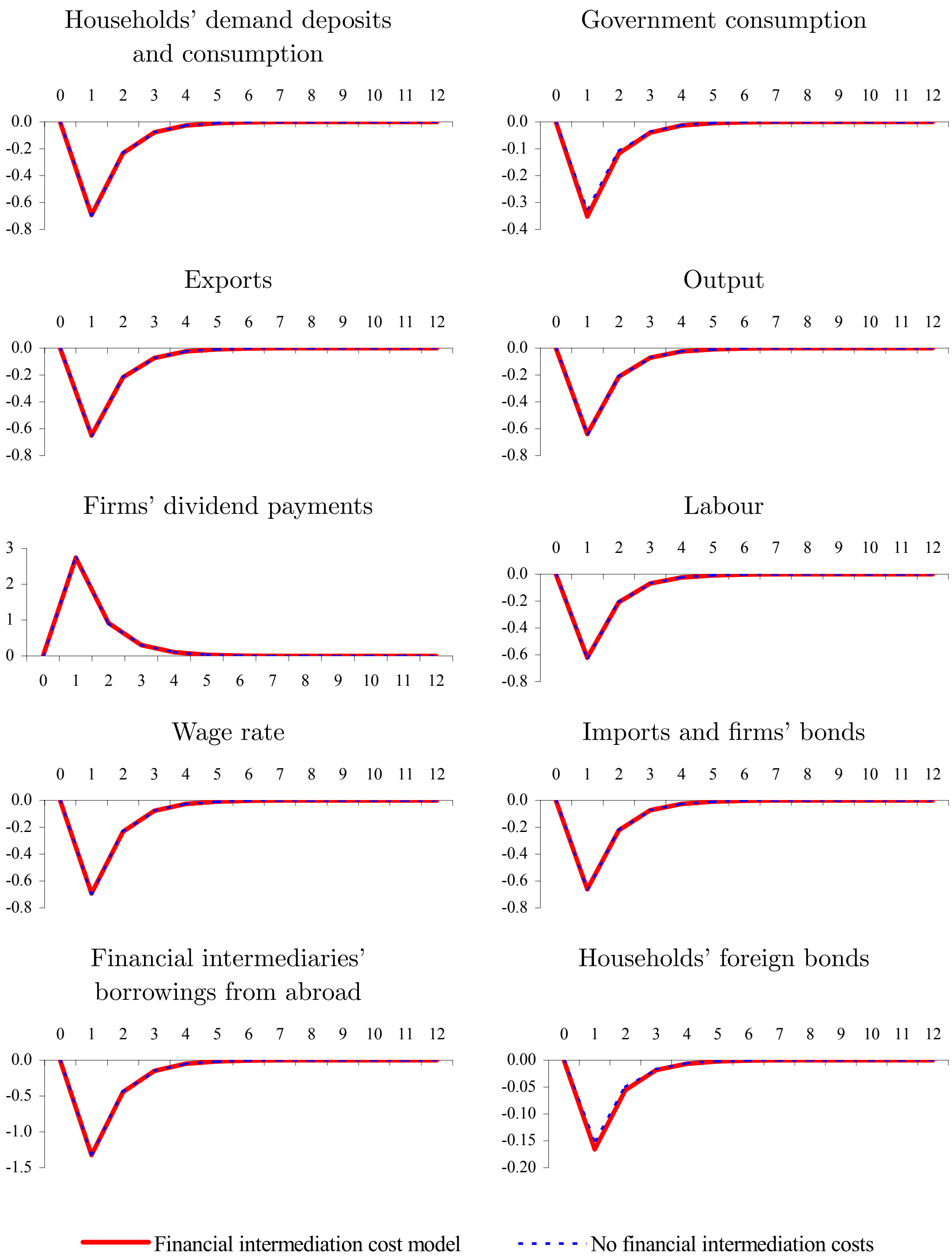
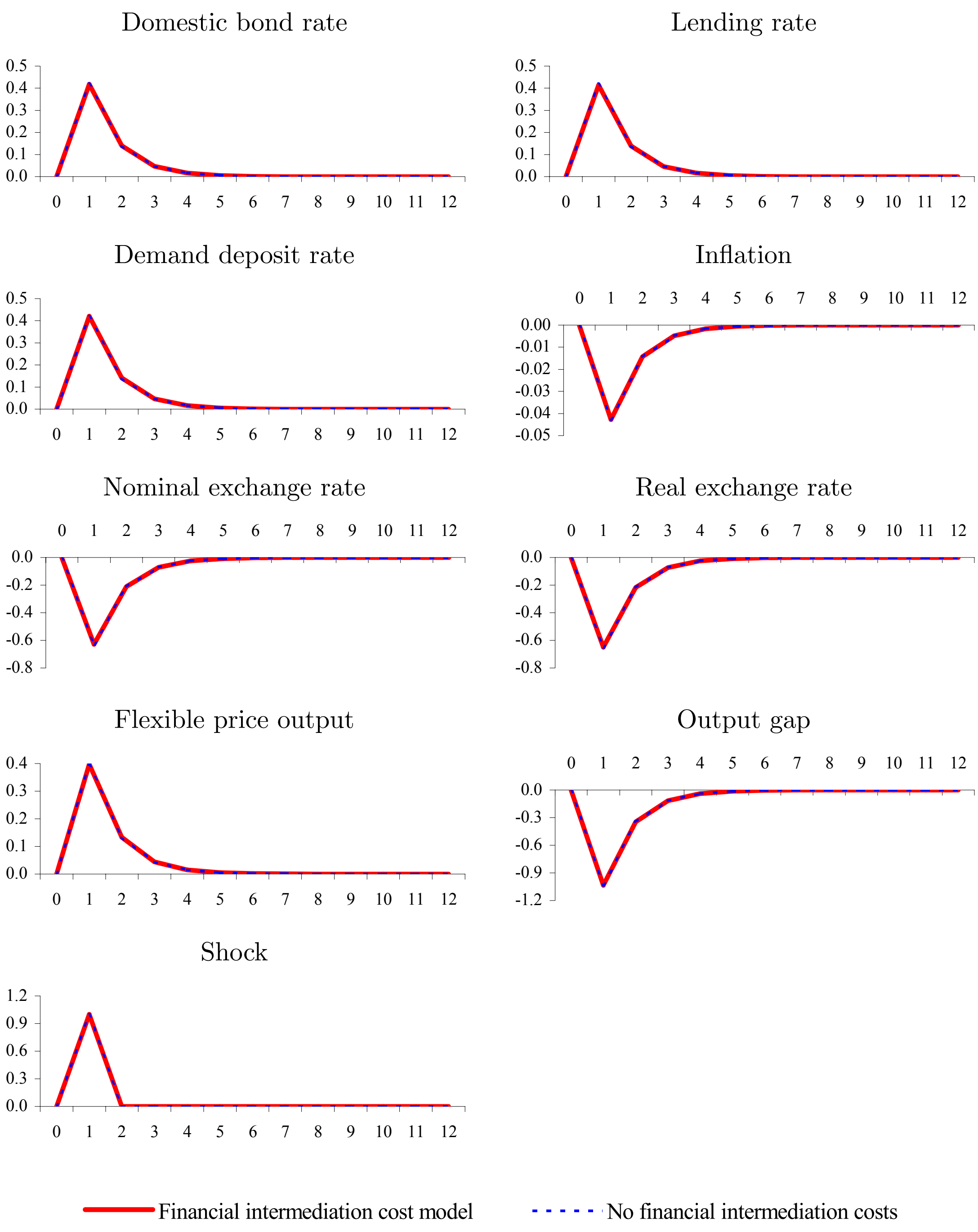


Figure 1 continued



a (real) depreciation of the exchange rate and increased foreign demand for exports. Household and government consumption also rise.

5.3 Foreign demand shock

A positive shock to foreign demand (Figure 3) raises exports, leading to an increase in output, imports, employment and firms' dividend payments. The increase in output opens a positive output gap and puts upward pressure on inflation. As a result, the central bank tightens monetary policy, domestic interest rates rise and output, imports, employment and inflation start returning to steady state. Full capacity, flexible price output increases due to a real appreciation of the domestic currency following the tightening. But the rise in full capacity output is insufficient to meet increased foreign demand, leading to the positive output gap and inflationary pressures.

The wage rate falls following the foreign demand shock. This is because imports are a production input and because the real exchange rate appreciates following the tightening in monetary policy. The real appreciation lowers the cost of imports relative to labour and induces firms to substitute labour for imports, putting downward pressure on the wage rate. The decline in wages leads to lower household consumption. Households' savings in the form of demand deposits and foreign bonds also decline. To meet firms' increased demand for loans financial intermediaries' borrowings from abroad rise. The positive foreign demand shock and increase in exports and output raise the government's tax revenue and consumption.

Figure 2: Impulse responses to a productivity shock (in percent deviations from steady state)

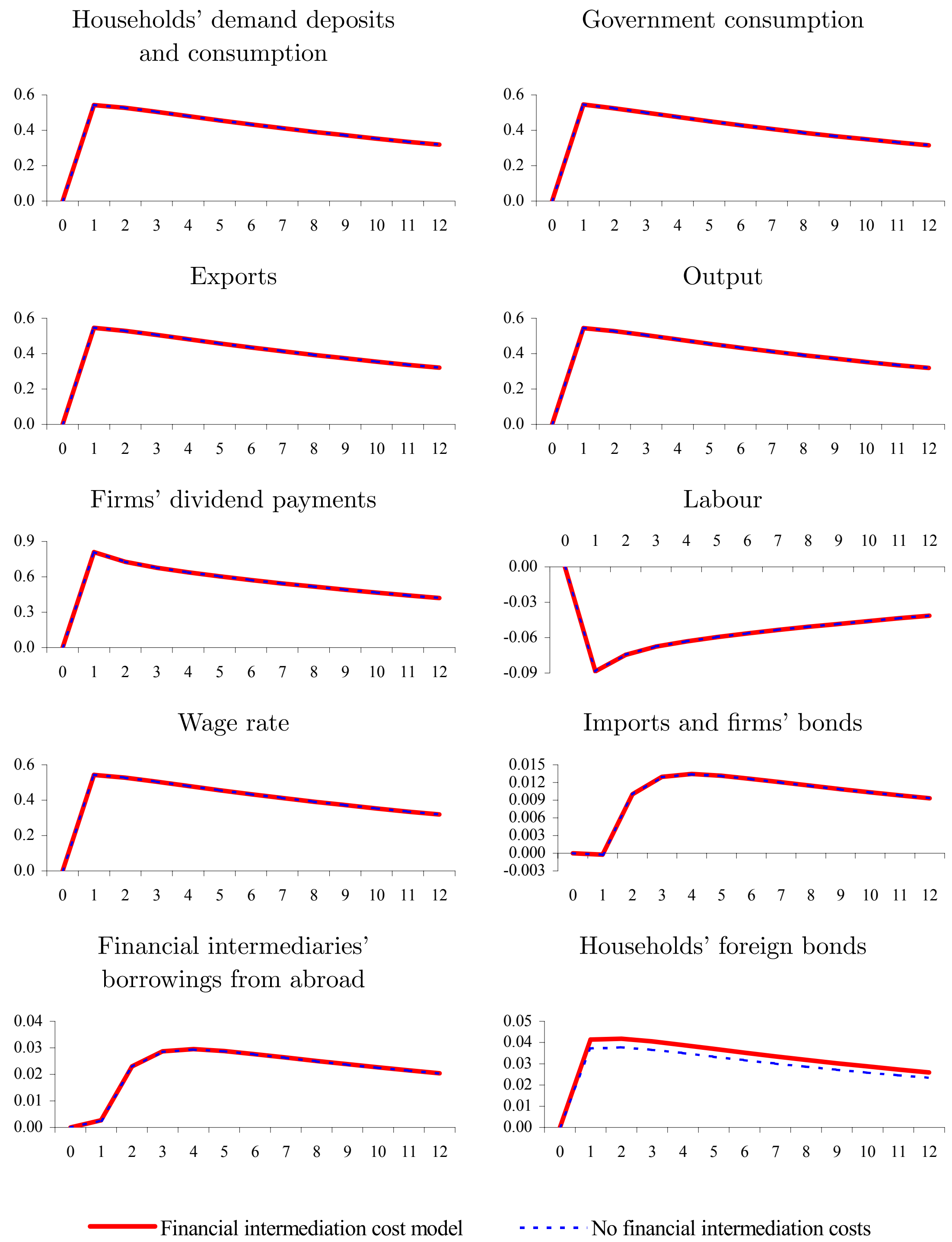


Figure 2 continued

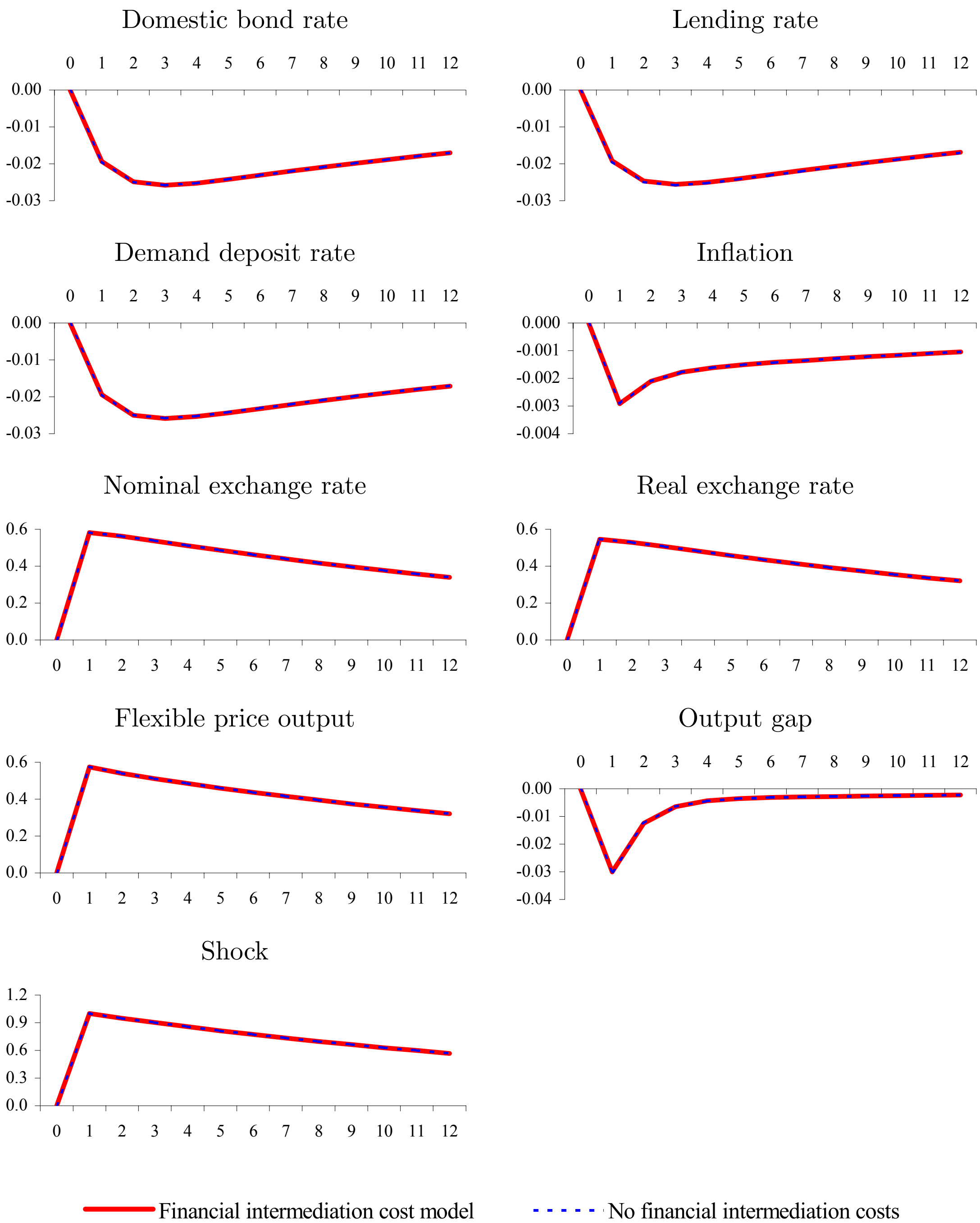


Figure 3: Impulse responses to a foreign demand shock (in percent deviations from steady state)

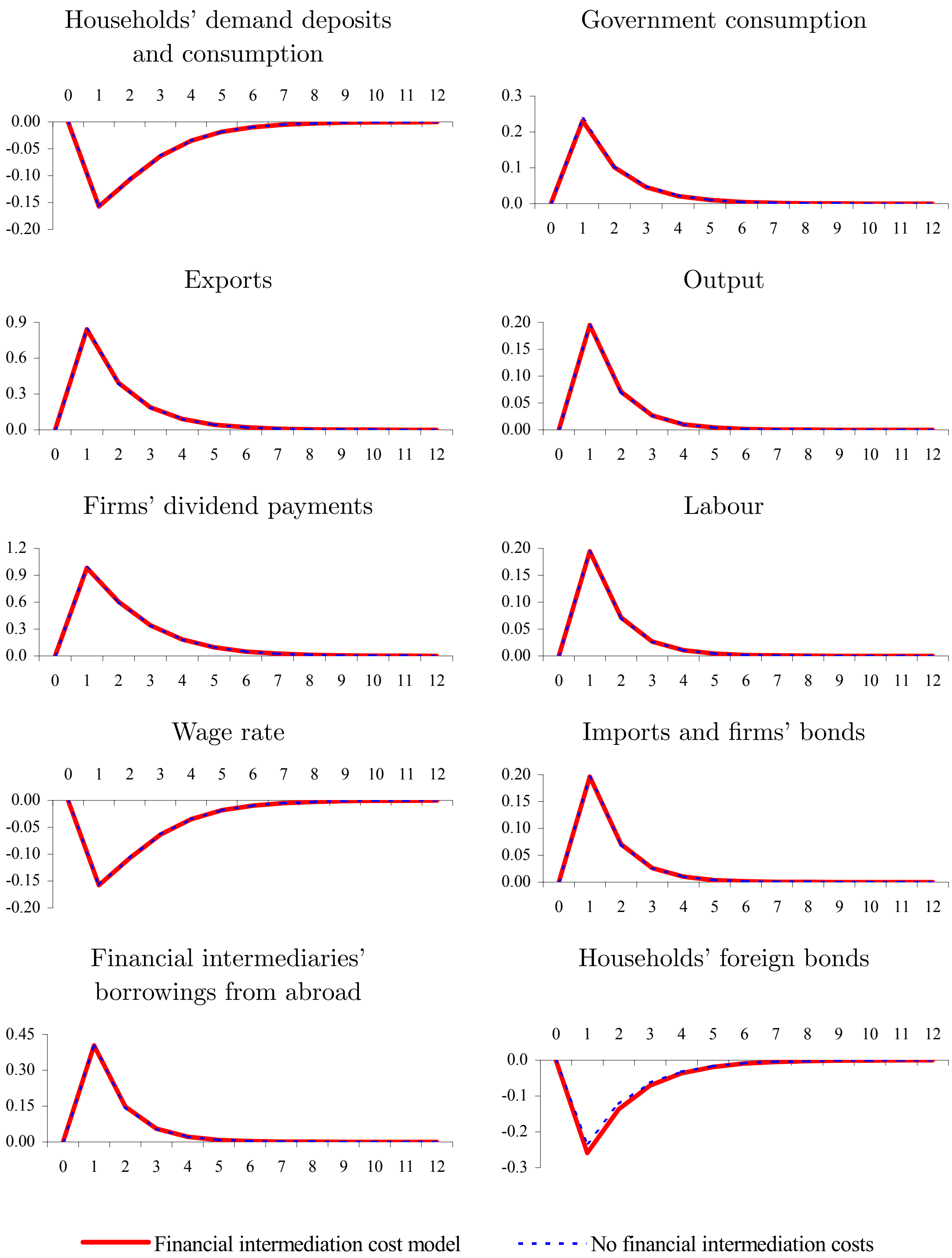
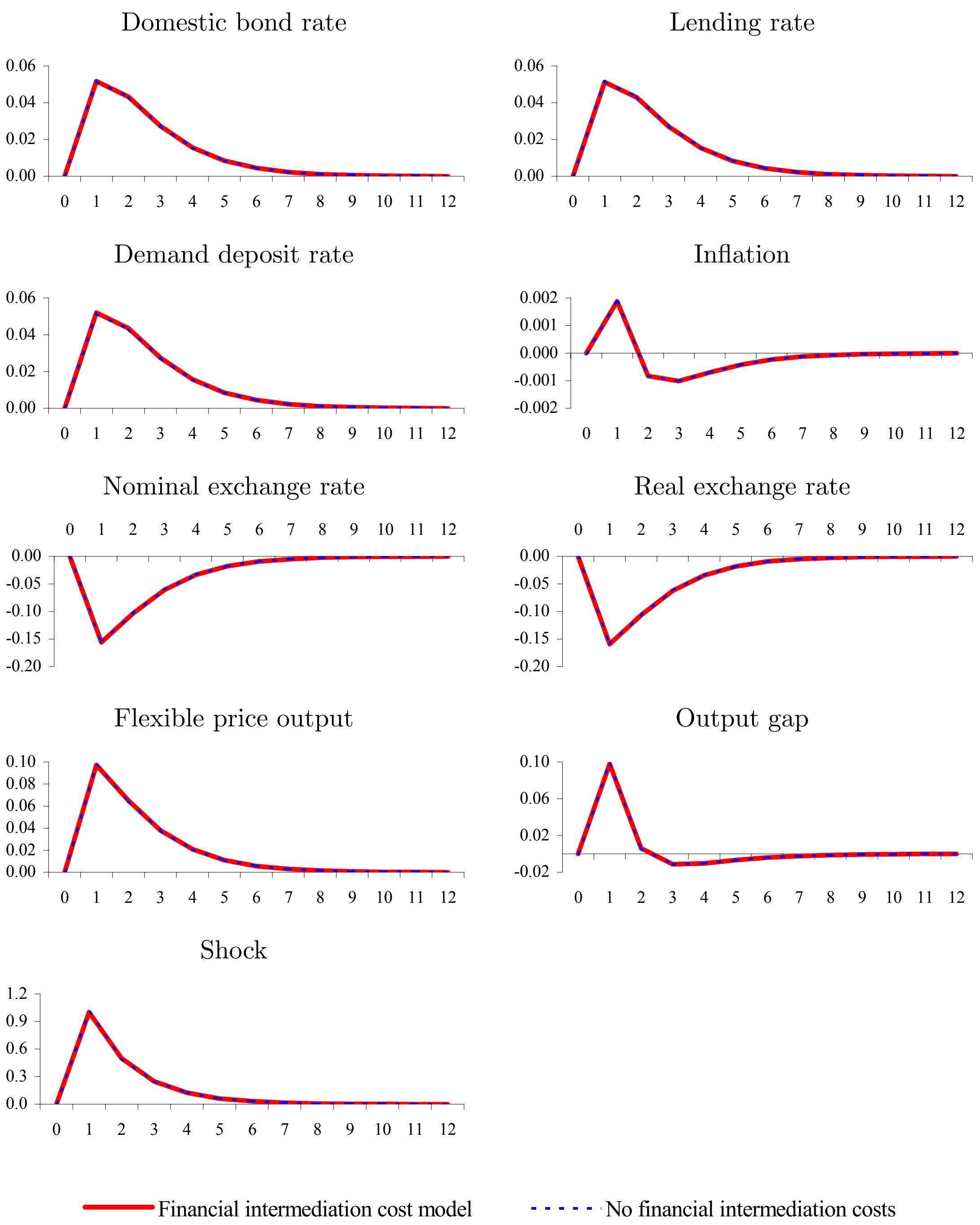


Figure 3 continued



6 Concluding remarks

This paper developed a theoretical model of a small open economy to assess the effects of bank lending. The model built on Edwards and Végh's (1997) small open economy with a pre-determined exchange rate. It was extended to incorporate imports and exports of goods, a floating exchange rate, slowly adjusting consumption goods prices and an inflation targeting monetary authority. The model was parameterised for New Zealand.

The results showed that dependence on bank credit for external finance increases firms' cost of borrowing. Issuing debt in public debt markets directly would lower the cost of borrowing, increase firms' demand for loans and lead to a small increase in the long-run level of steady state output. However, following a shock to the economy, the adjustment paths of the models with and without financial intermediation costs are virtually identical. This is because the lending rate and demand deposit rate increase/decrease by the same amount as the domestic bond rate. It is therefore unlikely that financial intermediation costs per se "dramatically alter the real effects of macroeconomic disturbances" as projected by Edwards and Végh (1997), who actually do not solve their model. The findings suggest that whether firms borrow from financial intermediaries or public debt markets directly does not affect economic activity. In other words, the financial structure, or degree to which a country's financial system is intermediary based or market based, does not matter.

A Steady state

The steady state model is solved with "FindRoot" in Mathematica, which uses Newton's method. The system of equations is given by

$$\bar{D} - \vartheta \bar{C}^h = 0 \tag{40}$$

$$\frac{\gamma}{(1-\tau)\bar{W}^h} - \frac{1}{\left(1+\frac{\vartheta(1-\tau)(\bar{I}-\bar{I}^d)}{1+\bar{\Pi}}\right)\bar{C}^h} = 0 \tag{41}$$

$$\frac{1+(1-\tau)\bar{I}}{1+\bar{\Pi}} - \frac{1}{\beta} = 0 \tag{42}$$

$$\left((1-\eta_m)\left(\bar{Z}\bar{L}^h\right)^{\nu} + \eta_m \bar{M}^{\nu}\right)^{\frac{1}{\nu}} - \bar{Y} - = 0 \tag{43}$$

$$\bar{Y} - \bar{W}^h\bar{L}^h - \left(1 + \frac{\bar{I}^l - \bar{I}}{1+\bar{\Pi}}\right)\bar{Q}\bar{M} - \bar{\Omega}^f = 0 \tag{44}$$

$$\frac{\left(\bar{W}^h\right)^{\frac{1}{1-\nu}}\bar{L}^h}{\bar{Z}^{\frac{\nu}{1-\nu}}(1-\eta_m)^{\frac{1}{1-\nu}}} - \frac{\left(\left(1+\frac{\bar{I}^l-\bar{I}}{1+\bar{\Pi}}\right)\bar{Q}\right)^{\frac{1}{1-\nu}}\bar{M}}{(\eta_m)^{\frac{1}{1-\nu}}} = 0 \tag{45}$$

$$\bar{W}^h - \frac{(1-\eta_m)\bar{Z}^{\nu}\left(\frac{\bar{Y}}{\bar{L}^h}\right)^{1-\nu}}{\frac{\theta}{\theta-1}} = 0 \tag{46}$$

$$\bar{M} - \bar{B}^f = 0 \tag{47}$$

$$\frac{\bar{I}-\bar{I}^d}{1+\bar{\Pi}} - \frac{2\upsilon_d\bar{D}^{\frac{1}{2}} - \upsilon_{ld}\left(\bar{Q}\bar{M}\right)^{\frac{1}{2}}}{2\bar{D}^{\frac{1}{2}}} = 0 \tag{48}$$

$$\frac{\bar{I}^l-\bar{I}}{1+\bar{\Pi}} - \frac{2\upsilon_l\left(\bar{Q}\bar{M}\right)^{\frac{1}{2}} - \upsilon_{ld}\bar{D}^{\frac{1}{2}}}{2\left(\bar{Q}\bar{M}\right)^{\frac{1}{2}}} = 0 \tag{49}$$

$$\bar{Q}\bar{M} - \bar{D} + \bar{Q}\bar{B}^{fi} = 0 \tag{50}$$

$$\bar{X} - \bar{Q}\bar{Y}^* = 0 \tag{51}$$

$$\begin{aligned} &\tau \left(\bar{W}^h \bar{L}^h + \bar{\Omega}^f + \tfrac{\bar{I}^d \bar{D}}{1+\bar{\Pi}} + \tfrac{\bar{I}^* \bar{Q} \bar{B}^{h*}}{1+\bar{\Pi}^*} \right) + \upsilon_l \bar{Q}\bar{M} \\ &+ \upsilon_d \bar{D} - \upsilon_{ld} \left(\bar{Q}\bar{M} \right)^{\frac{1}{2}} \bar{D}^{\frac{1}{2}} - \bar{G} = 0 \end{aligned} \tag{52}$$

$$\bar{Y} - \bar{C}^h - \bar{G} - \bar{X} = 0 \tag{53}$$

$$\tfrac{\bar{Q}\left(1+\bar{I}^*\right)\left(\bar{B}^{h*}+\bar{B}^f+\bar{B}^{fi}\right)}{1+\bar{\Pi}^*} + \bar{X} - \bar{Q}\bar{M} - \bar{Q}\left(\bar{B}^{h*} + \bar{B}^f + \bar{B}^{fi}\right) = 0 \tag{54}$$

$$1 + (1-\tau)\,\bar{I} - \left(1 + (1-\tau)\,\bar{I}^*\right)\left(1 + \bar{\Delta S}\right) = 0 \tag{55}$$

$$\begin{aligned} &(1-\tau)\left(\bar{W}^h \bar{L}^h + \bar{\Omega}^f\right) + \tfrac{\left(1+(1-\tau)\bar{I}\right)\bar{D}}{1+\bar{\Pi}} + \tfrac{\left(1+(1-\tau)\bar{I}^*\right)\bar{Q}\bar{B}^{h*}}{1+\bar{\Pi}^*} \\ &-\bar{C}^h - \tfrac{(1-\tau)\left(\bar{I}-\bar{I}^d\right)\bar{D}}{1+\bar{\Pi}} - \bar{D} - \bar{Q}\bar{B}^{h*} + residual = 0 \end{aligned} \tag{56}$$

B Dynamic model

The dynamic costly financial intermediation model is described by (36), (38) and (39) and the following equations:

$$y_t - (1-\eta_m)\left(\frac{\bar{Z}\bar{L}^h}{\bar{Y}}\right)^{\nu} z_t - (1-\eta_m)\left(\frac{\bar{Z}\bar{L}^h}{\bar{Y}}\right)^{\nu} l_t^h - \eta_m\left(\frac{\bar{M}}{\bar{Y}}\right)^{\nu} m_t = 0 \tag{57}$$

$$\begin{aligned}&\bar{Y}y_t - \bar{W}^h\bar{L}^h w_t^h - \bar{W}^h\bar{L}^h l_t^h - \left(1+\tfrac{\bar{I}^l-\bar{I}}{1+\bar{\Pi}}\right)\bar{Q}\bar{M}q_t - \left(1+\tfrac{\bar{I}^l-\bar{I}}{1+\bar{\Pi}}\right)\bar{Q}\bar{M}m_t\\ &-\left(\tfrac{1+\bar{I}^l}{1+\bar{\Pi}}\right)\bar{Q}\bar{M}i_t^l + \left(\tfrac{1+\bar{I}}{1+\bar{\Pi}}\right)\bar{Q}\bar{M}i_t + \left(\tfrac{\bar{I}^l-\bar{I}}{1+\bar{\Pi}}\right)\bar{Q}\bar{M}\pi_t - \bar{\Omega}^f\omega_t^f = 0\end{aligned} \tag{58}$$

$$\begin{aligned}&(1-\nu)\,m_t + q_t + \tfrac{1+\bar{I}^l}{1+\bar{\Pi}+\bar{I}^l-\bar{I}} i_t^l - \tfrac{1+\bar{I}}{1+\bar{\Pi}+\bar{I}^l-\bar{I}} i_t\\ &-\tfrac{\bar{I}^l-\bar{I}}{1+\bar{\Pi}+\bar{I}^l-\bar{I}}\pi_t - (1-\nu)\,l_t^h - w_t^h + \nu z_t = 0\end{aligned} \tag{59}$$

$$m_t - b_t^f = 0 \tag{60}$$

$$d_t - c_t^h = 0 \tag{61}$$

$$c_t^h + \tfrac{\vartheta(1-\tau)\left(1+\bar{I}\right)}{1+\bar{\Pi}+\vartheta(1-\tau)\left(\bar{I}-\bar{I}^d\right)} i_t - \tfrac{\vartheta(1-\tau)\left(1+\bar{I}^d\right)}{1+\bar{\Pi}+\vartheta(1-\tau)\left(\bar{I}-\bar{I}^d\right)} i_t^d - \tfrac{\vartheta(1-\tau)\left(\bar{I}-\bar{I}^d\right)}{1+\bar{\Pi}+\vartheta(1-\tau)\left(\bar{I}-\bar{I}^d\right)}\pi_t - w_t^h = 0 \tag{62}$$

$$\begin{aligned}&\tau\bar{W}^h\bar{L}^h w_t^h + \tau\bar{W}^h\bar{L}^h l_t^h + \tau\bar{\Omega}^f\omega_t^f + \tfrac{\tau\bar{I}^d\bar{D}}{1+\bar{\Pi}} i_t^d - \tfrac{\tau\bar{I}^d\bar{D}}{1+\bar{\Pi}}\pi_t\\ &+\left(\left(\upsilon_d + \tfrac{\tau\bar{I}^d}{1+\bar{\Pi}}\right)\bar{D} - \tfrac{\upsilon_{ld}\left(\bar{Q}\bar{M}\right)^{\frac{1}{2}}\left(\bar{D}\right)^{\frac{1}{2}}}{2}\right) d_t\\ &+\left(\left(\upsilon_l\bar{M} + \tfrac{\tau\bar{I}^*\bar{B}^{h*}}{1+\bar{\Pi}^*}\right)\bar{Q} - \tfrac{\upsilon_{ld}\left(\bar{Q}\bar{M}\right)^{\frac{1}{2}}\left(\bar{D}\right)^{\frac{1}{2}}}{2}\right) q_t\\ &+\tfrac{\tau\bar{I}^*\bar{Q}\bar{B}^{h*}}{1+\bar{\Pi}^*} b_t^{h*} + \tfrac{\tau\bar{I}^*\bar{Q}\bar{B}^{h*}}{1+\bar{\Pi}^*} i_t^* - \tfrac{\tau\bar{I}^*\bar{Q}\bar{B}^{h*}}{1+\bar{\Pi}^*}\pi_t^*\\ &+\left(\upsilon_l\bar{Q}\bar{M} - \tfrac{\upsilon_{ld}\left(\bar{Q}\bar{M}\right)^{\frac{1}{2}}\left(\bar{D}\right)^{\frac{1}{2}}}{2}\right) m_t - \bar{G}g_t = 0\end{aligned} \tag{63}$$

$$x_t - q_t - y_t^* = 0 \tag{64}$$

$$\begin{aligned}&\tfrac{1+\bar{I}^d}{1+\bar{\Pi}} i_t^d - \tfrac{1+\bar{I}}{1+\bar{\Pi}} i_t + \tfrac{\bar{I}-\bar{I}^d}{1+\bar{\Pi}} \pi_t + \tfrac{\upsilon_{ld}}{4} \left(\tfrac{\bar{Q}\bar{M}}{\bar{D}}\right)^{\frac{1}{2}} d_t \\ &-\tfrac{\upsilon_{ld}}{4} \left(\tfrac{\bar{Q}\bar{M}}{\bar{D}}\right)^{\frac{1}{2}} q_t - \tfrac{\upsilon_{ld}}{4} \left(\tfrac{\bar{Q}\bar{M}}{\bar{D}}\right)^{\frac{1}{2}} m_t = 0\end{aligned} \tag{65}$$

$$\begin{aligned}&\tfrac{1+\bar{I}^l}{1+\bar{\Pi}} i_t^l - \tfrac{1+\bar{I}}{1+\bar{\Pi}} i_t - \tfrac{\bar{I}^l-\bar{I}}{1+\bar{\Pi}} \pi_t + \tfrac{\upsilon_{ld}}{4} \left(\tfrac{\bar{D}}{\bar{Q}\bar{M}}\right)^{\frac{1}{2}} d_t \\ &-\tfrac{\upsilon_{ld}}{4} \left(\tfrac{\bar{D}}{\bar{Q}\bar{M}}\right)^{\frac{1}{2}} q_t - \tfrac{\upsilon_{ld}}{4} \left(\tfrac{\bar{D}}{\bar{Q}\bar{M}}\right)^{\frac{1}{2}} m_t = 0\end{aligned} \tag{66}$$

$$\bar{Q}\bar{M}m_t - \bar{D}d_t + \bar{Q}\bar{B}^{fi}b_t^{fi} + \left(\bar{M} + \bar{B}^{fi}\right)\bar{Q}q_t = 0 \tag{67}$$

$$\bar{Y}y_t - \bar{C}^h c_t^h - \bar{G}g_t - \bar{X}x_t = 0 \tag{68}$$

$$E_t\left[c_{t+1}^h\right] - c_t^h - i_t + \pi_t = 0 \tag{69}$$

$$\begin{aligned}&\tfrac{\left(1+\bar{I}^*\right)\bar{B}^{h*}}{1+\bar{\Pi}^*} b_t^{h*} + \tfrac{\left(1+\bar{I}^*\right)\bar{B}^{f}}{1+\bar{\Pi}^*} b_t^{f} + \tfrac{\left(1+\bar{I}^*\right)\bar{B}^{fi}}{1+\bar{\Pi}^*} b_t^{fi} + \tfrac{\left(1+\bar{I}^*\right)\left(\bar{B}^{h*}+\bar{B}^f+\bar{B}^{fi}\right)}{1+\bar{\Pi}^*} i_t^* \\ &-\tfrac{\left(1+\bar{I}^*\right)\left(\bar{B}^{h*}+\bar{B}^f+\bar{B}^{fi}\right)}{1+\bar{\Pi}^*} \pi_t^* + \tfrac{\bar{X}}{\bar{Q}} x_t - \tfrac{\bar{X}}{\bar{Q}} q_t - \bar{M}m_t - \bar{B}_t^{h*} E_t\left[b_{t+1}^{h*}\right] \\ &-\bar{B}^f E_t\left[b_{t+1}^f\right] - \bar{B}^{fi} E_t\left[b_{t+1}^{fi}\right] = 0\end{aligned} \tag{70}$$

$$i_t - i_t^* - E_t\left[s_{t+1}\right] + s_t = 0 \tag{71}$$

$$E_t\left[q_{t+1}\right] - q_t - E_t\left[s_{t+1}\right] + s_t + E_t\left[\pi_{t+1}\right] - E_t\left[\pi_{t+1}^*\right] = 0 \tag{72}$$

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