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Learning by Devaluating:
A Supply-Side Effect of
Competitive Devaluation

Aboa Centre for Economics

Discussion Paper No. 67
Turku 2011

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ABSTRACT

This study shows that the learning by doing (LBD) effect has substantial, both quantitative and qualitative, consequences for the international transmission of monetary policy. LDB implies that a country can increase its productivity-increasing skill level, at the expense of the neighbour, by competitive devaluation engineered through low interest rates. If measured by the cumulative change in output after 12 quarters, LBD increases the harmful effect of competitive devaluation on foreign output by 85–125%, when compared to the case without it. If LBD is sufficiently strong and the cross-country substitutability is high (low), it reverses the effect of monetary policy on foreign (domestic) welfare into negative (positive). Moreover, a combination of a high cross-country substitutability and a sufficiently strong LDB effect implies that competitive devaluation increases both domestic output and welfare, at the expense of foreign output and welfare.

JEL Classification: E52, F30, F41, F44

Keywords: Beggar-thyself, beggar-thy-neighbour, competitive devaluation, learning by doing, open economy macroeconomics

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1 Introduction

During the recent global financial crisis, the U.S. Federal Reserve implemented expansionary monetary policy by lowering the short-term nominal interest rate to the zero-lower bound. Some economists have accused the Federal Reserve of competitive devaluation, which aims to depreciate the dollar and thereby boost U.S. exports and the economy at the expense of the rest of the world. For example, Stiglitz (2008) argues that U.S. interest rate reductions have contributed to a weaker dollar, thus helping export the problems of the U.S. economy to other countries. He also argues that, from a global perspective, this is simply a new version of a beggar-thy-neighbour policy. Later Stiglitz (2010) argues that "[c]ompetitive devaluation engineered through low interest rates has become the preferred form of beggar-thy-neighbor policies in the 21st century."

The traditional Mundell-Fleming model supports the view that competitive devaluation is harmful to the rest of the world. However, the new open economy macroeconomics (NOEM) literature does not unambiguously support this view. In two-country NOEM models based on local currency pricing (LCP), the increase in demand caused by a lower interest rate is split between the countries, and output increases in both countries. This has a beggar-thy-neighbour welfare effect, because the home country can improve its terms of trade at the neighbour's expense. However, LCP implies that an exchange rate depreciation causes an improvement in the terms of trade. This is inconsistent with the empirical evidence of Obstfeld and Rogoff (2000), which shows the opposite. In addition, the LCP assumption violates the traditional view, whereby an exchange rate depreciation causes a fall in the relative price of the country's exports, and consequently world demand shifts towards its products.

In NOEM models based on producer currency pricing (PCP), an interest rate reduction depreciates the currency and boosts the country's output at the neighbour's expense (if the Marshall-Lerner condition is satisfied). The reason is that the country experiences a fall in the relative price of its exports and world demand shifts towards its products. A crucial parameter that governs the welfare effects of monetary policy is the elasticity of substitution between domestic and foreign goods (the cross-country substitutability, for short). If it is high, an interest rate reduction increases utility in both countries. This is because an improvement in the foreign terms of trade implies that foreign consumption increases despite a fall in output. If the cross-country substitutability is low, an interest rate reduction has a beggar-thyself effect. This is because the welfare benefits from higher output are dominated by the welfare losses from a deterioration of the terms of trade. In summary, in the basic NOEM models, based on PCP, a monetary expansion does not have a beggar-thy-neighbour welfare implication, despite that fact that it increases domestic output at the neighbour's expense.

Open economy models typically treat productivity exogenously and independent of the exchange rate, and focus on the demand-side effects of exchange rate changes. It has been known, however, that exchange rate changes can also affect productivity and the supply side of the economy. Boltho (1996) discusses the possible supply-side effects of devaluations and emphasises that some models have suggested that exchange rate depreciations could have beneficial effects that go beyond a short-term boost to exports. Higher output could stimulate investment and cause a positive supply response in the form of more rapid productivity growth, which would increase the competitive advantage. Moreover, Bean (1988) emphasises supply-side effects that come from the presence of technical progress through learning by doing (LBD).[1] He argues that "[i]f the level of total factor productivity depends on past levels of output, then a fall in output today, due to, say, a loss in competitiveness, will lower productivity in the future and reduce supply" (Bean 1988, 59).[2]

Not everybody shares the view that it might be beneficial to have undervalued currency. Porter (1990) argues that depreciations can be harmful, because an overvalued exchange rate can be better for productivity growth, by forcing higher productivity growth in the traded-goods sector. However, Matsuyama (1992) uses a two-sector open economy growth model to show that a combination of LBD in the traded goods sector and a depreciation of the exchange rate can cause a temporary increase in productivity growth. The evidence of McLeod and Mileva (2011) supports this idea. They find a robust and causal relationship between a weak exchange rate and faster productivity growth. Moreover, they find that faster productivity growth is partly driven by the LBD effect.

The importance of LBD is highlighted by Chang et al. (2002). They emphasise that the empirical labour economics literature has shown the following results: Past work experience has a significant effect on current wage earnings; displaced workers suffer considerable wage losses; and wage profile is strongly affected by job tenure. According to Chang et al., these findings suggest that the aggregate economy experiences systematic changes in labour productivity, as business cycles are associated with strongly pro-cyclical hiring of new workers and counter-cyclical layoffs. Motivated by these observations, they assume an LBD mechanism in which worked hours increase workers' skill, which increases productivity in subsequent periods. The authors show that the LBD mechanism improves the ability of real

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[1] The idea of learning by doing dates back at least to Arrow (1962) and Kaldor (1957).

[2] Many empirical studies support the view that it might be beneficial to have undervalued currency. Dollar (1992) finds that an overvalued exchange rate harms growth. Razin and Collins (1997) find that mild undervaluation enhances economic growth, but large undervaluation is harmful. Hausmann, Pritchett and Rodrik (2005) find that growth accelerations often coincide with exchange rate depreciations.

business cycle models to match the empirically observed output and employment fluctuations.[3]

Empirical evidence shows that exchange rate depreciations may have beneficial effects on the supply side of the economy, and the economy may experience systematic changes in productivity associated with pro-cyclical hiring of new workers and counter-cyclical layoffs. This leads me to study the consequences of LBD for the international transmission of monetary policy, which includes carrying out an analysis of the welfare consequences of LBD. A limitation of the above-mentioned studies that use LBD is that only the positive effects are analysed. In addition, I am not aware of any paper that analyses the implications of LBD in a two-country model, featuring imperfect competition and nominal rigidities. In this paper, I fill in this gap by studying the positive and normative consequences of LBD in the context of a two-country NOEM model. Based on the idea of Chang et al. (2002), I assume that the productivity-increasing skill level of the firm accumulates over time, according to hours worked in the past. Therefore, competitive devaluation has supply-side consequences for both countries.

This paper shows that the introduction of an LBD mechanism into an open economy model has substantial, quantitative implications for the effectiveness of monetary policy to stimulate domestic exports and output. LBD implies that a domestic country can raise its productivity-increasing skill level, at the neighbour's expense, by competitive devaluation. The expenditure-switching effect of an exchange rate depreciation increases domestic employment. This causes productivity-increasing skill level accumulation. In the short term, this lowers the relative price of domestic goods, and appears to be a positive, temporary productivity shock that increases the supply of domestic goods. The opposite happens abroad. The LBD mechanism increases the cumulative change in domestic output over 12 quarters by 34–52%, when compared to the case without LBD. However, this occurs at the neighbour's expense, as the mechanism strengthens the harmful effect of competitive devaluation on foreign output by 85–125%, depending on parameterisation.

One of the main findings of this paper is that LBD has qualitative implications for the welfare effects of monetary policy. As mentioned earlier, if LBD is absent and the cross-country substitutability is equal to the elasticity of substitution between two goods produced in the same country, the two countries gain in equal measure from the overall utility changes. If the LBD effect is sufficiently strong, it reverses the effect on foreign welfare into negative,

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[3] Johri and Lahiri (2008) use the idea of Chang et al. (2002) to show that a combination of LBD in production and habit formation in leisure can enhance the ability of flexible price models to account for the observed high volatility and persistence of real exchange rates. The same question cannot be addressed in the context of the present model because the real exchange rate is always constant as preferences are identical across regions and the law of one price holds for all goods.

so that competitive devaluation becomes a beggar-thy-neighbour policy. Global demand shifts away from foreign goods and employment falls. This induces a fall in the foreign skill level, which corresponds to a negative productivity shock. Foreign households have to work more to achieve a given level of consumption. Therefore, a fall in the skill level reduces foreign consumption and welfare. In fact, the effect is so strong that it dominates the positive welfare effect caused by a terms of trade improvement.

As mentioned earlier, in typical NOEM models, monetary policy does not have both a positive effect on domestic output and welfare and negative effect on foreign output and welfare at the same time. A combination of a high cross-country substitutability and a sufficiently strong LDB effect, however, implies that domestic monetary policy can increase both domestic output and welfare at the expense of foreign output and welfare.[4] The LDB effect, therefore, substantially increases incentives to implement competitive devaluation.

The LBD mechanism also has a qualitative implication for the welfare effects of monetary policy where the cross-country substitutability is low. As already mentioned, if it is low and the LBD effect is absent, the benefits from higher output are dominated by the losses from a terms of trade deterioration. When the LBD effect is at play, an increase in the domestic skill level enables higher domestic consumption at the given level of employment. The increase in domestic consumption is higher, when compared to LBD being absent. This effect is strong enough to reverse the effect of competitive devaluation on domestic welfare into positive. The LDB effect, therefore, implies that the domestic country has an incentive to implement competitive devaluation. However, it also increases foreign welfare.

The rest of this paper is organised as follows: Section 2 introduces the model. Section 3 discusses the parameterization of the model. Section 4 analyses the international transmission of monetary policy. I also implement a sensitivity analysis to study the extent to which the effects of monetary policy may be sensitive to the parameter values that govern the strength of the LBD effect. Section 5 concludes the paper.

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[4] An identical result is found by Novy (2010) and Tervala (2010). Novy (2010) finds that the introduction of trade costs into the Obstfeld-Rogoff model implies that an increase in the domestic money supply increases both domestic output and welfare, at the expense of foreign output and welfare. Tervala (2010) finds that a combination of a high cross-country substitutability and asymmetric price setting (PCP by domestic firms and LCP by foreign firms) implies the same result.

2 Model

In this section, I lay out a two-country open economy model. Its innovation is the introduction of LBD into the production function, following the idea of Chang et al. (2002).[5] The world consists of two countries: home and foreign. There is a continuum of households and firms that are indexed by $z \in [0,1]$. The size of the domestic country is denoted by n, and the fraction of domestic (foreign) firms and household is $n(1-n)$. In the presentation of the model, I discuss only domestic equations, if the equations are symmetric across countries.

2.1 Households
2.1.1 Preferences

The intertemporal utility function of the representative domestic household is

$$U_t = E_0 \sum_{s=t}^{\infty} \beta^{s-t} \left[\log C_s - \frac{(\ell_s(z))^2}{2} \right], \tag{1}$$

where E_t is the expectations operator; $0 < \beta < 1$ is the discount factor; C_t denotes consumption; and $l_t(z)$ is the household's supply of labour. The consumption index is given by

$$C_t = \left[n^{\frac{1}{\rho}} (C_t^h)^{\frac{\rho-1}{\rho}} + (1-n)^{\frac{1}{\rho}} (C_t^f)^{\frac{\rho-1}{\rho}} \right]^{\frac{\rho}{\rho-1}}, \tag{2}$$

where C_t^h and C_t^f denote an index of domestic and foreign goods, respectively. The term ρ is the elasticity of substitution between domestic and foreign goods, which is referred to as the cross-country substitutability. These consumption indexes are aggregates of the different types of domestic and foreign goods

$$C_t^h = [n^{-\frac{1}{\theta}} \int_0^n (c_t^h(z))^{\frac{\theta-1}{\theta}} dz]^{\frac{\theta}{\theta-1}}, \quad \text{and} \tag{3}$$

$$C_t^f = [(1-n)^{-\frac{1}{\theta}} \int_n^1 (c_t^f(z))^{\frac{\theta-1}{\theta}} dz]^{\frac{\theta}{\theta-1}}, \tag{4}$$

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[5] The model is based on Tervala (2011).

where $c_t^h(z)$ ($c_t^f(z)$) is the consumption of the differentiated domestic (foreign) good z by the representative domestic household, The term $\theta > 1$ is the elasticity of substitution between goods produced in the same country, which is referred to as the within-country substitutability.

The consumption indexes (2), (3) and (4) imply that households allocate their consumption according to the following equations:

$$c_t^h(z) = \left[\frac{p_t^h(z)}{P_t^h}\right]^{-\theta}\left[\frac{P_t^h}{P_t}\right]^{-\rho}C_t \ , c_t^f(z) = \left[\frac{p_t^f(z)}{P_t^f}\right]^{-\theta}\left[\frac{P_t^f}{P_t}\right]^{-\rho}C_t \text{ and}$$

$$c_t^{*h}(z) = \left[\frac{p_t^{*h}(z)}{P_t^{*h}}\right]^{-\theta}\left[\frac{P_t^{*h}}{P_t^*}\right]^{-\rho}C_t^* \ , c_t^{*f}(z) = \left[\frac{p_t^{*f}(z)}{P_t^{*f}}\right]^{-\theta}\left[\frac{P_t^{*f}}{P_t^*}\right]^{-\rho}C_t^* \ ,$$

where foreign variables are denoted by asterisks. This means that $c_t^{*h}(z)$ ($c_t^{*f}(z)$) denotes the consumption of the domestic (foreign) good by the representative foreign household. These equations show that households allocate their total consumption between domestic and foreign goods, taking into account their relative prices and the cross-country substitutability. In addition, households allocate their consumption of, say, domestic goods between differentiated domestic goods, taking into account the relative price of differentiated domestic goods and their elasticity of substitution (θ).

All prices are expressed in local currency terms, although firms set their prices in the producer's currency. The domestic currency price of domestic (foreign) goods is denoted by $p_t^h(z)$ ($p_t^f(z)$), and P_t^h (P_t^f) is the price index corresponding to the domestic (foreign) consumption basket C_t^h (C_t^f). Corresponding foreign indexes, expressed in foreign currency terms, are denoted by an asterisk. For instance, $p_t^{*h}(z)$ ($p_t^{*f}(z)$) is the price of a domestic (foreign) good. The domestic price indexes are defined as follows:

$$P_t^h = [n^{-1}\int_0^n (p_t^h(z))^{1-\theta}dz]^{\frac{1}{1-\theta}},$$

$$P_t^f = [(1-n)^{-1}\int_0^n (p_t^f(z))^{1-\theta}dz]^{\frac{1}{1-\theta}}, \text{ and}$$

$$P_t = \left[n(P_t^h)^{1-\rho} + (1-n)(P_t^f)^{1-\rho}\right]^{\frac{1}{1-\rho}}. \tag{5}$$

The corresponding foreign indexes are defined in a similar way.

The law of one price holds for each good: $p_t^h(z) = S_t p_t^{*h}(z)$, where S_t is the nominal exchange rate, defined as the domestic currency price of foreign currency (i.e., an increase in S_t is a depreciation of the domestic currency). Consequently, the purchasing power parity holds: $P_t = S_t P_t^*$.

2.1.2 Budget Constraints

Consider a cashless economy, where money is only a unit of account. The budget constraint of the domestic household, expressed in nominal terms, is given by

$$D_t = (1 + i_t)D_{t-1} + w_t \ell_t(z) - P_t C_t + \pi_t, \tag{6}$$

where: D_t denotes nominal domestic bonds, denominated in the domestic currency, held in the beginning of period t; i_t denotes the nominal interest rate on bonds between t-1 and t; w_t is the nominal wage paid to the household; and π_t is the household's share of the dividends (that are equal to profits) of domestic firms. All domestic households own an equal share or all domestic firms.

The foreign economy is identical to the domestic economy, with one notable exception: Foreign households can hold both domestic and foreign bonds; whereas domestic households can only hold domestic bond. Therefore, the foreign bond, denominated in foreign currency and denoted by F_t^*, is not internationally traded, unlike the domestic bond. However, the net supply of the foreign bond is zero in equilibrium, since there is one representative household in the foreign country.

The budget constraint of the representative foreign household is given by

$$\frac{D_t^*}{S_t} + F_t^* = (1 + i_t)\frac{D_t^*}{S_t} + (1 + i_t)F_{t-1}^* + w_t^* \ell_t^*(z) - P_t^* C_t^* + \pi_t^*. \tag{7}$$

The global asset-market clearing condition for domestic bonds requires $nD_t + (1-n)D_t^* = 0$.

The use of the Taylor rule implies that the model must be stationary. To render the present model stationary, uncovered interest rate parity (UIP) is extended by the introduction of a term that is a function of the level of net foreign debt, as in Bergin (2006), for example. This implies that wealth allocations, in the long term, will return to their initial levels. As

emphasised by Bergin (2006), this term can be interpreted as a risk premium, because the setup implies that lenders demand a higher rate of return from a country with a large debt, to compensate for perceived default risk.[6]

Foreign households must be indifferent between holding domestic and foreign bonds. The log-linear version of UIP with a risk premium (ψ) can be written as

$$(1-\beta)\hat{i}_t = (1-\beta)\hat{i}_t^* + E_t\hat{S}_{t+1} - \hat{S}_t - \psi\hat{D}_t,$$ (8)

where percentage changes from the initial steady state (denoted by the subscript zero) are denoted by hats (e.g., $\hat{i} = di_t/i_0$). Equation (8) shows that the household has to pay a small cost if its bond holdings are not equal to their initial steady-state level (i.e., zero).

The domestic household maximizes (1) subject to (6). The optimal behaviour of households is governed by the following first-order conditions:

$$P_{t+1}C_{t+1} = (1+i_{t+1})\beta P_t C_t,$$ (9)

$$P_{t+1}^* C_{t+1}^* = (1+i_{t+1}^*)P_t^* C_t^*,$$ (10)

$$\ell_t(z) = \frac{w_t}{C_t P_t}, \text{ and}$$ (11)

$$\ell_t^*(z) = \frac{w_t^*}{C_t^* P_t^*}.$$ (12)

Equations (9) and (10) are the Euler equations for optimal domestic and foreign consumption, respectively. Equations (11) and (12) show that the optimal labour supply is an increasing function of the real wage and a decreasing function of consumption.

2.2 Monetary Policy

The central banks in both countries follow the log-linear Taylor rule with interest rate smoothing, as follows:

$$\hat{i}_t = (1-\mu_1)(\mu_2\Delta P_t + \mu_3\hat{y}_t) + \mu_1\hat{i}_{t-1} + \varepsilon_{i,t},$$ (13)

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[6] The empirical evidence supports the view that monetary policy shocks cause deviations from UIP (e.g., Faust and Roger, 2003; and Bluedorn and Bowdler, 2011).

where μ_1, μ_2 and μ_3 are non-negative coefficients, Δ is the first difference operator and $\varepsilon_{i,t}$ is an unpredictable shift in monetary policy (a zero mean white noise process). The monetary policy rule shows that the inflation target is zero. In this paper, I analyse the effects of monetary policy, and the only friction is caused by the staggered price setting. Therefore, the deviation of output from the initial steady state measures the output gap. Consequently, the central bank responds directly to the deviations of output from the initial level.

2.3 The Supply Side: Firms
2.3.1 Skill Level, Demand and Profits

Chang et al. (2002) assume that the skill level of the *household* depends on hours worked in the past, and that the skill level raises the effective unit of labour supplied by the household. I assume that the skill level of the *firm*, denoted by x_t, accumulates over time according to past employment. The stock of the skill level evolves according to the following log-linear equation:

$$\hat{x}_t = \phi\hat{x}_{t-1} + \mu\hat{\ell}_t(z),$$ (14)

where $0 \leq \phi < 1$ and $\mu \geq 0$ are parameters. This equation shows that an increase in the number of hours worked in the current period increases skill level in the next period, with an elasticity of μ. An increase in the skill level is not permanent, since it depreciates over time at the rate of $1 - \phi$.

All firms produce a differentiated good. The production function of the representative firm is

$$y_t(z) = x_t\ell_t(z),$$ (15)

where $y_t(z)$ denotes the output of firm z and $\ell_t(z)$ is the labour input used by the firm. Equations (14) and (15) show that, in this setup, a demand-driven expansion can affect the supply side of the economy: A rise in employment causes an increase in future productivity through the accumulation of the skill level, which in turn increases future output. On the other hand, counter-cyclical reductions in employment reduce the skill level and future productivity.

The firm minimises its costs, $w_t\ell_t(z)$, subject to the production function (15). Therefore, the marginal cost is given by

$$mc_t(z) = \frac{w_t}{x_t}.$$
(16)

The firm maximizes its profits

$$\pi_t(z) = p_t(z)y_t(z) - w_t\ell_t(z),$$
(17)

taking into account the production function (14) and the demand curve for its products

$$y_t^d(z) = \left[\frac{p_t^h(z)}{P_t^h}\right]^{-\theta}\left[\frac{P_t^h}{P_t}\right]^{-\rho} C_t^W,$$

where C_t^W denotes world demand ($C_t^W = nC_t + (1-n)C_t^*$). The profits of the firm can therefore be written as

$$\pi_t(z) = \left[\frac{p_t^h(z)}{P_t^h}\right]^{-\theta}\left[\frac{P_t^h}{P_t}\right]^{-\rho} C_t^W (p_t^h(z) - mc_t(z)).$$
(18)

2.3.2 Price Setting

Under flexible prices, the firm would maximize it profits, specified in equation (17), with respect to $p_t^h(z)$, so that

$$p_t^h(z) = \frac{\theta}{\theta-1}mc_t(z).$$
(19)

Under flexible prices, the price is simply a mark-up over the marginal cost. Equations (16) and (19) demonstrate that an increase in the skill level is like a productivity shock that reduces the price of the domestic good.

Following Calvo (1983), I introduce nominal rigidities by assuming that each firm may reset its price with a probability of $1-\gamma$ in each period, independently of other firms and time passed since the last price adjustment. When setting the price, each firm has to take into account that in every subsequent period there is a probability of $0 < \gamma < 1$ that it will not be able to change it again. When setting a new price in period t, each firm seeks to maximize the expected value of real profits, weighing future profits by the probability that the price will still be effective in that period. Therefore, the domestic firm seeks to maximize

$$\max_{p_t^h(z)} V_t(z) = E_0 \sum_{s=t}^{\infty} \gamma^{s-t} Q_{t,s} \frac{\pi_s(z)}{P_s} , \tag{20}$$

where $Q_{t,s} = \beta^{s-t} \dfrac{P_t}{P_s} \dfrac{C_t}{C_s}$ is the stochastic discount factor for nominal payoffs between periods

t and s ($s>t$). The optimization problem results in the following equation

$$p_t^h(z) = (\frac{\theta}{\theta-1}) \frac{\sum_{s=t}^{\infty} \gamma^{s-t} Q_{t,s} \left(\frac{C_s^W}{P_s}\right) \left(\frac{1}{P_s}\right)^{-\theta} \left(\frac{P_s^h}{P_s}\right)^{-\rho} mc_s}{\sum_{s=t}^{\infty} \gamma^{s-t} Q_{t,s} \left(\frac{C_s^W}{P_s}\right) \left(\frac{1}{P_s}\right)^{-\theta} \left(\frac{P_s^h}{P_s}\right)^{-\rho}} . \tag{21}$$

The log-linear version of equation (21) can be written as

$$\hat{p}_t^h(z) = \beta\gamma E_t \hat{p}_{t+1}^h(z) + (1-\beta\gamma) m\hat{c}_t , \tag{22}$$

so that the optimal price is simply the weighted average of the current and future marginal costs.

2.4 Symmetric Equilibrium

All firms in a country are symmetric. Every firm that changes its price in any given period chooses the same price and output. The price setting framework means that each period, a fraction of $1-\gamma$ of firms sets a new price, while the remaining firms keep their price unchanged. This implies that the evolution of the domestic price index, equation (5), is

$$\hat{P}_t = n\hat{b}_t(z) + (1-n)(\hat{S}_t + \hat{b}_t^*) ,$$

where

$$\hat{b}_t(z) = (1-\gamma) \sum_{s=t}^{\infty} \gamma^{s-t} \hat{p}_s(z) \Rightarrow \hat{b}_t = \gamma\hat{b}_{t-1} + (1-\gamma)\hat{p}_t^h(z) , \text{ and} \tag{23}$$

$$\hat{b}_t^*(z) = \gamma\hat{b}_{t-1}^* + (1-\gamma)\hat{p}_t^{*f}(z) . \tag{24}$$

Equation (23) is the Calvo-weighted price index of domestic goods. Equation (24) is the Calvo-weighted price index of foreign goods.

Equations (6) and (17) can be used to derive the consolidated budget constraint of the home country[7], as follows:

$$P_t C_t = p_t^h(z) y_t(z) + (1+i_t) D_{t-1} - D_t.$$

The model is log-linearized around a symmetric steady state, where initial net foreign assets are zero ($D_0 = 0$) and the initial skill level is normalized to one ($x_0 = 0$). The consolidated budget constraint, in the case of a symmetric equilibrium, implies that $C_0 = y_0(z)$. This equation, as well as equations (11), (15) and (19), all imply that the initial level of employment and output is given by

$$y_0(z) = \ell_0(z) = \left(\frac{\theta-1}{\theta}\right)^{\frac{1}{2}}. \tag{25}$$

Equilibrium is defined as sequences of variables that clear the labour and goods markets in each country in each period, and satisfies intertemporal budget constraints and pricing rules.

3 Choice of Parameter Values

The rationale for the choice of parameter values is as follows: Periods are defined as quarters, therefore $\beta = 0.99$. The countries are assumed to be of equal size, implying that $n = 0.5$. Based on Rotemberg and Woodford (1992), the within-country substitutability (θ) is set to 6. The interest rate smoothing parameter (μ_1) in the Taylor rule is set to 0.8, which is roughly consistent with Clarida et al. (2000). Based on Taylor (1993), μ_2 is set to 1.5, and μ_3 is set to 0.5/4. Based on the estimates of Bergin (2006), the risk premium in UIP (ψ) is set to 0.0004.

In earlier literature, Tille (2001) and Tervala (2011) have shown that the cross-country substitutability (ρ) is a key variable in determining the welfare effects of monetary policy. In the first exercise, I set it to 6, so that it is equal to the within-country substitutability, as in the Obstfeld-Rogoff model. The empirical literature shows a wide range of estimates for the cross-country substitutability, and some estimates are very low. For example, Chari et al.

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[7] The corresponding foreign equation takes into account the global asset-market clearing condition for domestic bonds, and the fact that the net supply of foreign bonds is zero:

$$P_t^* C_t^* = p_t^{*f}(z) y_t^*(z) - (1+i_t) \frac{n}{1-n} \frac{D_{t-1}}{S_t} + \frac{n}{1-n} \frac{D_t}{S_t}.$$

(2002) argue that studies found the U.S. cross-country substitutability at between 1 and 2.[8] Following their work, in the second exercise, I use the value of 1.5.

An important parameter that governs the strength and duration of the expenditure-switching effect is the price rigidity parameter (γ). It is often set to 0.5, so that the average time until a new price is reset, which is $1/(1-\gamma)$, is six months (2 periods). This is consistent with the estimates of Bils and Klenow (2004), which are based on U.S. retail prices. For the question at hand, however, it is more important to set the parameter value to match the empirical evidence on the price rigidities of internationally traded goods. Gopinath and Rigobon (2008) find that the trade weighted median price duration is 10.6 months for U.S. imports and 12.8 months for U.S. exports. Therefore, γ is set to 0.75. This implies that the average time until a new price is set is one year.

Finally, and most importantly, the values for LBD parameters have to be defined. Chang et al. (2002) use a Bayesian approach and micro level data to estimate these parameters. They find that $\phi = 0.8$ and $\mu = 0.11$. I use these values. Therefore, a unit increase in the number of hours worked today increases the skill level in the next period by 0.11 units, and the depreciation rate of the skill level is 20%.[9]

4 Learning By Doing and the International Transmission of Monetary Policy
4.1 Method of Welfare Analysis

The method used for welfare analysis is as follows: I first analyse the change in period-by-period utility. Then, I calculate the discounted present value (PDV) of the change in utility. A first-order Taylor expansion of the utility function implies that the change in utility in period t is given by

$$dU_t = \hat{C}_t - \ell_0^2 \hat{\ell}_t.$$

Figures 2, 3 and 4 illustrate the changes in the period's utility. The PDV value of the change in utility is calculated as

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[8] On the other hand, Sutherland (2006) argues that typical estimates for the average elasticity across all traded goods are in the range of 5 to 6.

[9] I simulate the model using the algorithm developed by Klein (2000) and McCallum (2001).

$$dU_{DPV} = \sum_{s=t}^{\infty} \beta^{s-t} dU_s .$$

Tables 2, 4, 6 and 8 show the DPV of the change in utility.[10]

4.2 Consequences of Learning By Doing When the Cross-Country Substitutability Is High

I this section, I analyse the effects of a 1% negative shock ($\varepsilon_{i,1} = -1$) to the domestic monetary policy rule on key variables, in the case where the cross-country substitutability is equal to the within-country substitutability ($\theta = \rho = 6$). In Figures 1 and 2, the solid lines plot the impulse responses without LBD ($\phi = \mu = 0$), and the dashed lines with LBD. In all figures, the vertical axes show percentage changes from the initial steady state. An exception is the change in bond holdings of domestic household (of which initial value is zero), which is expressed as a deviation from initial consumption. The domestic terms of trade are defined as the ratio of domestic export prices to import prices. Therefore, the domestic terms of trade worsen when this index falls.

First, I briefly discuss the effects of monetary policy in the absence of LBD. Then, I analyse the consequences of the LBD. Panel (f) of Figure 1 illustrates that a reduction in the domestic interest rate depreciates the nominal exchange rate. In the short and medium term, the domestic interest rate is low, relative to the foreign rate. UIP then implies that the exchange rate is expected to appreciate. Therefore, it must initially depreciate to a point where it will appreciate, until it reaches the steady-state level.[11]

An exchange rate depreciation lowers the relative price of domestic goods. This shifts global demand toward domestic goods and away from foreign goods. This expenditure-switching effect increases domestic output and decreases foreign output, as long as prices are sticky, as shown in panel (a) of Figure 1. In the absence of LBD, these changes are quite short-lived as

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[10] The DPV of welfare is calculated using 1,000 periods.

[11] Bluedorn and Bowdler (2011) use the VAR method to estimate the consequences of a contractionary U.S. monetary policy shock on the United States and on non-U.S. G7 countries. They find that this induces an impact appreciation of the dollar that is followed by a gradual return roughly to the initial level. In addition, there is positive interest rate pass-through from the United States to non-U.S. G7 countries. Monetary policy, however, creates deviations from UIP. The exchange rate implications of the present model are fully consistent with these empirical findings, because the effects of a contractionary monetary policy would mirror those reported in this paper.

the expenditure-switching effect peters out quite rapidly. An increase in domestic output raises wages and the optimal price of the domestic good increases, as we saw in equation (21). This is shown in panel (c) of Figure 2. The opposite happens in foreign countries. Staggered price setting, however, implies that the Calvo-weighted price index of domestic goods is the more relevant index. It takes into account that only a fraction of firms each period can set a new price. This is shown in Panel (f) of Figure 2.

When domestic firms have an opportunity to reset their prices, the price advantage of domestic goods disappears, and the expenditure-switching effect gradually peters out. In the medium term, a rise in the price of domestic goods, a fall in the price of foreign goods and the behaviour of the exchange rate imply that the relative price of domestic goods increases. Consequently, domestic (foreign) output falls (increases) relative to the initial steady state. The duration of a positive (negative) effect of monetary expansion on domestic (foreign) output is four (three) quarters. In the long term, all prices have adjusted and the world economy has reverted back to the initial equilibrium.

Panels (a) and (c) in Figure 1 show that in the LBD case, an increase (decline) in domestic (foreign) output is more persistent. An increase in domestic employment implies that domestic firms experience the LBD effect, and their skill level increases, as shown in panel (h) of Figure 1. On one hand, an increase in output raises wages and, consequently, the optimal price of the domestic good. On the other hand, an increase in the skill level lowers the marginal cost of domestic firms—as we saw in equation (16)—and they can produce goods more cheaply, when compared to LBD being absent. In addition, an increase in the domestic skill level is like a positive productivity shock that increases the supply of domestic goods in the short term. However, a rise in the skill level is temporary, as it depreciates over time.

The LBD effect implies that foreign firms suffer from a fall of the skill level, which increases the optimal price of foreign goods. Therefore, their price competitiveness falls, when compared to LBD being absent, as shown in Panel (f) of Figure 2. In addition, a fall in the foreign skill level is like a negative, temporary productivity shock that reduces the supply of foreign goods.

As Figure 1 illustrates, the LBD mechanism strengthens the positive effect of monetary policy on domestic output. As mentioned earlier, the mechanism increases the supply of domestic goods and lowers their relative price in the short and medium term, while the opposite happens abroad. Therefore, domestic firms, with a temporarily high skill level and competitiveness, steal the market from foreign firms. The LBD effect doubles the duration of the positive effect on domestic output from four to eight quarters. This, however, comes at

the expense of its neighbour, as the duration of the harmful effect on foreign output increases to from three to eight quarters.

After eight periods, domestic output falls relative to the initial steady state. This is because inflation has decreased the real wage, and with higher medium-term wealth, domestic households choose to decrease their labour supply. Consequently, domestic output falls below the initial level. The LBD process is reversed, and a reduction in employment reduces the domestic skill level and productivity. After 14 periods, domestic output falls by more than it does in the absence of LBD (for some time). Foreign households, with lower medium-term wealth, are willing to supply more labour, consequently increasing foreign output. In addition, an increase in hours worked raises the future productivity of foreign firms, and output increases by more than it does in the absence of LBD after 13 periods (for some time).

Table 1: Cumulative Change in Output at Time Horizon k When $\rho = 6$

	Domestic Output					Foreign Output				
Quarters (k)	4	8	12	100	DPV	4	8	12	100	DPV
Without LBD	0.15	0.13	0.12	0.085	0.093	-0.068	-0.050	-0.040	-0.015	-0.023
With LBD	0.17	0.19	0.19	0.11	0.13	-0.083	-0.092	-0.089	-0.018	-0.035
Change (%)	17.8	46.2	60.7	29.1	35.2	23.8	83.0	125	17.8	53.1

Table 1 measures the consequences of LBD on the ability of monetary policy to stimulate output. The table shows cumulative changes in output after k quarters ($\sum_{s=t}^{k} \hat{y}_s$), the DPV of the change in output ($\sum_{s=t}^{\infty} \beta^{s-t} \hat{y}_s$) and the percentage of change caused by LBD, relative to the case without LBD. For example, in the case without LBD, the cumulative increase in domestic output after 12 quarters is 0.12%. As the table shows, LBD has substantial consequences on the effectiveness of monetary policy to stimulate domestic output. With LBD, the cumulative increase in domestic output after 12 quarters is 0.19%. This means that LBD increases the cumulative change in output after 12 periods by 60.7%. LBD would also increase output in the closed economy, but the table shows that the positive effect of LBD on domestic output happens partly at the expense of the neighbour. The cumulative fall in the foreign output after 12 quarters is no less than 125% higher, when compared to the case without LBD.

Table 1 also shows that the DPV of the change in domestic output is 0.093 % without LBD and 0.13% with LBD. Therefore, LBD increases the overall effect of monetary policy on domestic output by 35.2%. In addition, the table shows that LBD has even stronger effect on foreign output. It increases the negative effect of domestic monetary policy on foreign output by no less than 53.1%.

A topic that has received attention in the NOEM literature is the welfare effects of monetary policy. One main finding by Obstfeld and Rogoff (1995) is that a domestic money supply shock increases the DPV of utility by the same amount in both countries, in the case where the cross-country substitutability is equal to the within-country substitutability. Tervala (2011) shows that the result does not change, if monetary policy is modelled in terms of the Taylor rule with interest rate smoothing. An interest rate rule, however, renders the evolution of welfare richer: Monetary policy is a beggar-thyself policy in the short term and beggar-thy-neighbour policy in the medium term, even though the DPV of utility increases by an equal amount in both countries.

The results shown in Figure 2 and Table 2 (in the case without LBD) are consistent with the earlier studies. The current account channel, which affects the evolution of welfare over time, does not affect overall welfare due to intertemporally optimizing households. The deterioration of the domestic terms of trade, caused by the exchange rate depreciation, implies that domestic consumption increases less than proportionately to employment and output. The improvement in the foreign terms of trade implies that foreign consumption increases despite a fall in output. The behaviour of the terms of trade provides the channel through which the countries share the benefits of monetary policy equally.

Table 2: Discounted Present Value of the Changes in Utility When $\rho = 6$

	dU_{DPV}	dU_{DPV}^{*}
Without LBD	0.0059	0.0059
With LBD	0.044	-0.0023

Table 2 shows that the introduction of LBD into the model has two significant implications on the welfare effects of monetary policy. First, the LBD effect substantially increases incentives to implement competitive devaluation. A rise in the domestic skill level is like a productivity shock that enables higher domestic output and consumption at the given level of employment. This makes it possible to have a much higher level of consumption, when compared to without LBD, despite little change in employment (see panel (g) of Figure 2). This has a positive effect on domestic welfare. Therefore, the increase in domestic welfare is much higher than in the case without LBD.

Second, as we see in Table 2, the introduction of LBD implies that competitive devaluation is a beggar-thy-neighbour policy. A fall in the foreign skill level corresponds to a negative productivity shock, and foreign households have to work more to achieve a given level of consumption. This implies that a demand-driven fall in foreign output tends to reduce foreign welfare.

There are positive effects on welfare: In the medium term, foreign employment is smaller and the improvement in foreign terms of trade in stronger than in than in the absence of LDB. These effects, however, are dominated by the negative effect mentioned above: A fall in the foreign skill level implies a fall in consumption that reduces foreign welfare, when compared to the case without LBD. In fact, the effect is so strong that overall foreign welfare is reduced.

Based on their results that monetary expansion increases utility in both countries, Obstfeld and Rogoff (1995) argue that the traditional Mundell-Fleming may have overstated the importance of the beggar-thy-neighbour effects, which a country inflicts on trading partners when it depreciates its currency. The introduction of LBD, however, implies that competitive devaluation increases both domestic output and welfare at the expense of foreign output and welfare. An identical result is found by Novy (2010) and Tervala (2010). According to Novy (2006), the introduction of trade costs into the Obstfeld-Rogoff model implies that an increase in the domestic money supply increases both domestic output and welfare, at the expense of foreign output and welfare. Tervala (2010) shows that a combination of high cross-country substitutability and asymmetric price setting (PCP by domestic firms and LCP by foreign firms) implies the same result.

4.3 Consequences of Learning By Doing When the Cross-Country Substitutability Is Low

In this section, I analyse how the key results depend on the cross-country substitutability. This is important for two reasons. First, the cross-country substitutability is a key variable in determining the strength of the expenditure-switching effect. If it is low, domestic and foreign goods are poor substitutes, and a given change in the relative price of domestic goods leads to a smaller shift in demand. Therefore, the results regarding the cumulative increase in output might be sensitive to changes in this parameter value. Second, as shown by Corsetti and Pesenti (2001), Tille (2001) and Tervala (2011), if the cross-country substitutability is sufficiently low, monetary policy becomes a beggar-thyself policy.

Figure 3 and Table 3 illustrate that the consequences of LBD for the positive effects of monetary policy are in line with the case where the cross-country substitutability is equal to the within-country substitutability. Table 3 shows a noteworthy result: On one hand, if the cross-country substitutability is low, LBD has a weaker effect on the cumulative change in output in both countries, at least for the first 12 quarters. On the other hand, the DPV of the change in output is higher when the cross-country substitutability is low.

When the cross-country substitutability is 1.5 (6), the percentage increase in the cumulative increase in domestic output after 12 quarters is 41.1% (60.7%) higher than in the absence of

LBD. When goods produced in different countries are poorer substitutes, a given change in the relative price of domestic goods, caused by LBD, leads to a weaker shift in demand. Consequently, an increase (fall) in domestic (foreign) output caused by LBD becomes weaker in the short term.

Table 3: Cumulative Change in Output at Time Horizon *k* When $\rho = 1.5$

	Domestic Output					Foreign Output				
Quarters (k)	4	8	12	100	DPV	4	8	12	100	DPV
Without LBD	0.091	0.091	0.084	0.072	0.074	-0.012	-0.010	-0.0081	-0.0022	-0.0039
With LBD	0.10	0.12	0.12	0.10	0.10	-0.015	-0.016	-0.016	-0.0026	-0.0060
Change (%)	13.3	30.3	41.1	39.4	38.6	19.3	61.3	94.0	16.2	53.5

As noted above, the DPV of the change in output is only a little higher, somewhat surprisingly, when the cross-country substitutability is low. The reason is as follows: When the cross-country substitutability is high, the international shift in wealth is high, as illustrated in panels (e) of Figures 1 and 3. In this case, a strong positive (negative) wealth effect on domestic (foreign) labour supply reduces (increases) domestic (foreign) output after the initial positive (negative) response. When a change in wealth is strong, a fall in the domestic skill level is strong. This, in turn, limits an increase in the DPV of the increase in domestic output.

When the cross-country substitutability is low, the wealth effect in weaker. Therefore, a fall in the domestic skill level after the initial positive response is much weaker. In fact, when cross-country substitutability is high, the output loss caused by a decrease in the domestic skill level is so strong that the percentage change caused by LBD is smaller, compared to low cross-country substitutability.

Tille (2001) analyses the effects of money supply shocks and finds that if cross-country substitutability is sufficiently low, the gains in domestic output are more than offset by deteriorating terms of trade. A terms of trade deterioration implies domestic output increases without an equivalent increase in consumption. Therefore, monetary policy is a beggar-thyself policy. Tervala (2011) shows that the same result applies in a case of an interest rate shock. The welfare result in Table 4 replicates this result.

However, Table 4 reveals a noteworthy result: With LBD, a monetary expansion increases domestic welfare, instead of being a beggar-thyself policy. The reason for the positive impact of LBD on domestic welfare is the same as in the previous exercise. A rise in the domestic skill level enables higher domestic consumption at the given level of employment. Therefore,

the increase in domestic consumption is higher, when compared to without LBD. This effect is strong enough to reverse the domestic welfare effect into positive.

Table 4: Discounted Present Value of the Changes in Utility When $\rho = 1.5$

	dU_{DPV}	dU^{*}_{DPV}
Without LBD	-0.014	0.025
With LBD	0.010	0.034

4.4 Sensitivity Analysis

The next step is to assess how responsive the international effects of monetary policy are to changes in parameter values, which govern the strength (μ) and duration (ϕ) of LBD. Using different priors, Chang et al. (2002) find the posterior estimates of $\phi = 0.66$ and $\mu = 0.15$. These imply a stronger effect of employment on the skill level, and a faster depreciation rate of the skill level.

Figure 4 depicts the effects of varying key parameters when cross-country substitutability is 6. The solid lines show the baseline case, which was analysed in the previous section, and the dashed lines illustrate the case where $\phi = 0.66$ and $\mu = 0.15$. Table 5 shows the cumulative change in output. Table 6 shows the DPV of the change in utility.

Panel (h) in Figure 4 depicts a somewhat stronger initial impact on the domestic skill level and a faster depreciation. Table 5 and panel (a) in Figure 4 both show that a stronger initial impact implies a stronger increase in domestic output, in short time horizons. A faster depreciation rate of the skill level implies a smaller increase in output, in longer time horizons. Therefore, the DPV of the increase in domestic output is reduced from 35.2 % to 26.0 %.

Table 5: The Percentage Change in the Cumulative Change in Output Compared to the Case Without LDB When $\rho = 6$

	Domestic Output					Foreign Output				
Quarters (k)	4	8	12	100	DPV	4	8	12	100	DPV
Change (%) $\phi = 0.8$ $\mu = 0.11$	17.8	46.2	60.7	29.1	35.2	23.8	83.0	125	17.8	53.1
Change (%) $\phi = 0.66$ $\mu = 0.15$	22.8	46.7	51.9	20.0	26.0	35.4	93.1	113	23.2	49.3

Table 6 shows that the new parameterisation causes a qualitative change: Foreign welfare increases when a decrease in the foreign skill level is more short-lived. On one hand, the improvement in the foreign terms of trade implies that foreign consumption increases despite a fall in output. On the other hand, a fall in the foreign skill level corresponds to a negative productivity shock and foreign households have to work more to achieve a given level of consumption. When the depreciation rate of the skill level is sufficiently high, the terms of trade effect dominates the skill level effect. This means that the welfare benefit of higher consumption is larger than the welfare losses caused by a smaller skill level.

Table 6: Varying the Key Parameters: The Discounted Present Value of the Change in Utility When $\rho = 6$

	dU_{DPV}	dU^*_{DPV}
Without LBD	0.0059	0.0059
With LBD, $\phi = 0.8$, $\mu = 0.11$	0.044	-0.0023
With LBD, $\phi = 0.66, \mu = 0.15$	0.036	0.0015

Table 7 shows the effects of the new parameterisation on output when cross-country substitutability is 1.5. The results are consistent with the high cross-country substitutability case. The new parameterisation implies that the LBD effect has a weaker effect on output. Table 8 demonstrates that, unlike in the case of a high cross-country substitutability, the new parameterisation does not affect welfare results. Monetary policy increases utility in both countries.

Table 7: The Percentage Change in the Cumulative Change in Output Compared to the Case Without LDB When $\rho = 1.5$

	Domestic output					Foreign output				
Quarters (k)	4	8	12	100	DPV	4	8	12	100	DPV
Change (%) $\phi = 0.8$, $\mu = 0.11$	13.3	30.3	41.1	39.4	38.6	19.3	61.3	94.0	16.2	53.5
Change (%) $\phi = 0.66$, $\mu = 0.15$	14.5	28.1	34.0	28.3	28.5	25.2	64.2	85.1	17.8	45.6

Table 8: Varying the Key Parameters: Discounted Present Value of the Change in Utility When $\rho = 1.5$

	dU_{DPV}	dU^*_{DPV}
Without LBD	-0.014	0.025
With LBD, $\phi = 0.8$, $\mu = 0.11$	0.010	0.034
With LBD, $\phi = 0.66$, $\mu = 0.15$	0.006	0.031

5 Conclusions

This paper analyses the consequences of LBD for the international transmission of monetary policy. LBD here means that the skill level of the country accumulates over time, according to past employment. This mechanism implies that demand-driven business cycles affect the supply side of the economy. Therefore, a country can raise its productivity-increasing skill level, at the neighbour's expense, by competitive devaluation.

Some economists have argued that the recent loose monetary policy of the U.S. Federal Reserve is competitive devaluation intended to depreciate the dollar, thereby boosting the U.S. economy, and its exports in particular, at the expense of the rest of the world. This paper sheds some light on the question of whether U.S. interest rate reductions are a beggar-thy-neighbour policy, and the LBD mechanism has at least two implications for the question at hand.

First, the LBD effect increases the ability of U.S. interest rate reductions to stimulate the U.S. economy at the expense of the rest of the world. The reductions lead to a weaker dollar, which induces a global expenditure-switching effect towards U.S. goods. LBD implies that this, in turn, leads to an increase in the U.S. skill level, which not only lowers the relative price of U.S. goods even further, but also increases the supply of U.S. goods. Therefore, with the help of LBD, U.S. firms should be able to gain a bigger share of the world market. However, this happens at the expense of the rest of the world's output.

Second, LBD substantially increases the welfare benefits of U.S. interest rate reductions. An increase in the U.S. skill level acts like a productivity shock to enable higher U.S. consumption, at the given level of employment. If the elasticity of substitution between U.S. and foreign goods is low, LBD reverses to positive the effect of U.S. interest rate reductions on U.S. welfare. If the cross-country substitutability is high and the LDB effect is sufficiently strong, the beggar-thy-neighbour effects that the United States inflicts on the rest of the world are real. The United States can increase not only its output, but also its welfare at the expense of the rest of the world.

References

Arrow, Kenneth (1962): "The Economic Implications of Learning by Doing," *Review of Economic Studies* 29: 155-173.

Bean, Charles Richard (1988): "Sterling Misalignment and British Trade Performance," In Richard C. Marston (ed), *Misalignment of Exchange Rates*, Chicago: University of Chicago Press: 39-76.

Bergin, Paul R. (2006): "How Well Can the New Open Economy Macroeconomics Explain the Exchange Rate and Current Account?" *Journal of International Money and Finance* 25: 675-701.

Bils, Mark and Peter J. Klenow (2004): "Some Evidence on the Importance of Sticky Prices," *Journal of Political Economy* 112: 947-985.

Bluedorn, John C. and Christopher Bowdler (2011): "The Open Economy Consequences of U.S. Monetary Policy," *Journal of International Money and Finance* 30: 309-336.

Boltho, Andrea (1996): "Convergence, Competitiveness and the Exchange Rate" In Nicholas Crafts and Gianni Toniolo (eds), *Economic Growth in Europe Since 1945*, Cambridge, Cambridge University Press: 107-130.

Calvo, Guillermo A. (1983): "Staggered Prices in a Utility Maximizing Framework," *Journal of Monetary Economics* 12: 383–398.

Chang, Yongsung, Joao F. Gomes and Frank Schorfheide (2002): "Learning-by-Doing as a Propagation Mechanism," *American Economic Review* 92: 1498-1520.

Chari, V. V., Patrick J. Kehoe and and Ellen R. McGrattan (2002): "Can Sticky Price Models Generate Volatile and Persistent Real Exchange Rates?" *Review of Economic Studies* 69: 533–563.

Clarida, Richard, Jordi Galí and Mark Gertler (2000): "Monetary Policy Rules and Macroeconomic Stability: Evidence and Some Theory," *Quarterly Journal of Economics* 115: 147-180.

Corsetti, Giancarlo and Paolo Pesenti (2001): "Welfare and Macroeconomic Interdependence," *Quarterly Journal of Economics* 116: 421.455.

Dollar, David (1992): "Outward-Oriented Developing Economies Really Do Grow More Rapidly: Evidence from 95 Ldcs, 1976–1985," *Economic Development and Cultural Change* 40: 523–544.

Faust, Jon and John H. Rogers (2003): "Monetary Policy's Role in Exchange Rate Behavior," *Journal of Monetary Economics* 50: 1403-1423.

Gopinath, Gita and Roberto Rigobon (2008): "Sticky Borders," *Quarterly Journal of Economics* 123: 531–575.

Hausmann, Ricardo, Lant Pritchett and Dani Rodrik (2005): "Growth Accelerations," *Journal of Economic Growth* 10: 303-329.

Johri, Alok and Amartya Lahiri (2008): "Persistent Real Exchange Rates," *Journal of International Economics* 76: 226-236.

Kaldor, Nicholas (1957): "A Model of Economic Growth," *Economic Journal* 67: 591-624.

Klein, Paul (2000): "Using the Generalized Schur Form to Solve a Multivariate Linear Rational Expectations Model," *Journal of Economic Dynamics and Control* 24: 1405-1423.

Matsuyama, Kiminori (1992): "Agricultural productivity, comparative advantage and economic growth," *Journal of Economic Theory* 58: 317-334.

McCallum, Bennett (2001): Software for RE Analysis. Computer software available at http://wpweb2.tepper.cmu.edu/faculty/mccallum/research.html.

Novy, Dennis (2010): "Trade Costs and the Open Economy," *Scandinavian Journal of Economics* 112: 514-545.

McLeod, Darryl and Elitza Mileva (2011): "Real Exchange Rate and Productivity Growth," Fordham University, Department of Economics Discussion Paper 2011-04.

Obstfeld, Maurice and Kenneth Rogoff (1995): "Exchange Rate Dynamics Redux," *Journal of Political Economy* 103: 624–660.

Obstfeld, Maurice and Kenneth Rogoff (2000): "New Directions for Stochastic Open Economy Models," *Journal of International Economics* 50: 117-153.

Porter, Michael E. (1990): *The Competitive Advantage of Nations*. New York: Free Press.

Razin, Ofair and Susan M. Collins (1999): "Real Exchange Rate Misalignments and Growth," in Assaf Razin and Efraim Sadka (eds), *The Economics of Globalization: Policy Perspectives from Public Economics*, Cambridge: Cambridge University Press: 59-82.

Rotemberg, Julio J. and Michael Woodford (1992): "Oligopolistic pricing and the Effects of Aggregate Demand on Economic Activity," *Journal of Political Economy* 100: 1153-1207.

Sutherland, Alan (2006): "The Expenditure Switching Effect, Welfare and Monetary Policy in a Small Open Economy," *Journal of Economic Dynamics and Control* 30: 1159-1182.

Stiglitz, Joseph (2008): "Responding to the Crisis," presentation, Financial Regulation by the Initiative for Policy Dialogue and Brooks World Poverty Institute, Manchester, July, 2008.

Stiglitz, Joseph (2010): "Why Easier Money Won't Work," Wall Street Journal, October 23, 2010.

Taylor, John B. (1993): "Discretion versus Policy Rules in Practice," *Carnegie-Rochester Conference Series on Public Policy* 39: 195-214.

Tervala, Juha (2010): "The International Transmission of Monetary Policy in a Dollar Pricing Model," *Open Economies Review* 21: 629-654.

Tervala, Juha (2011): "International Welfare Effects of Monetary Policy," Aboa Centre for Economics Discussion Paper 66.

Tille, Cedrik (2001): "The Role of Consumption Substitutability in the International Transmission of Monetary Shocks," *Journal of International Economics* 53: 421–444.

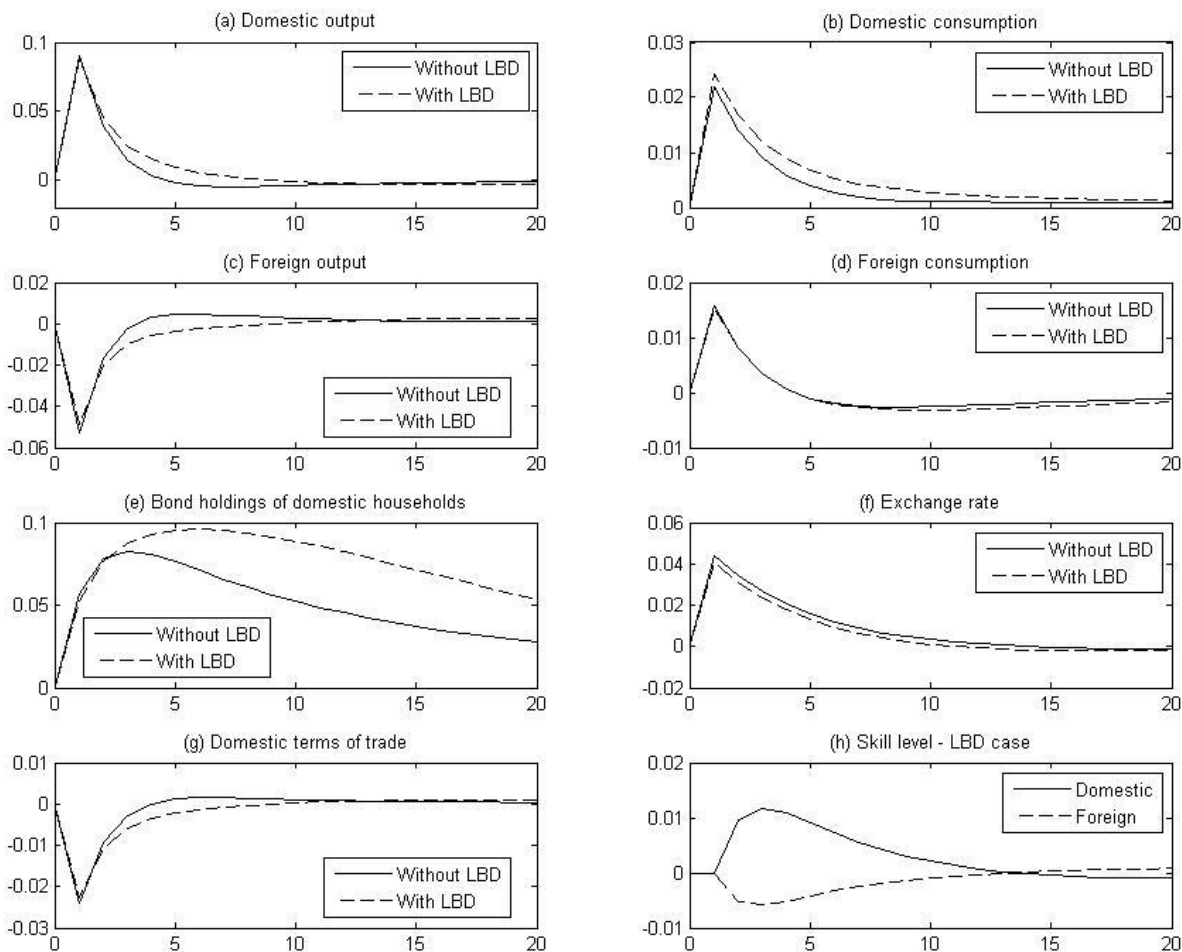**Figure 1: Dynamic Effects of a Domestic Interest Rate Shock When** $\rho = 6$

Figure 2: Dynamic Effects of a Domestic Interest Rate Shock When $\rho = 6$
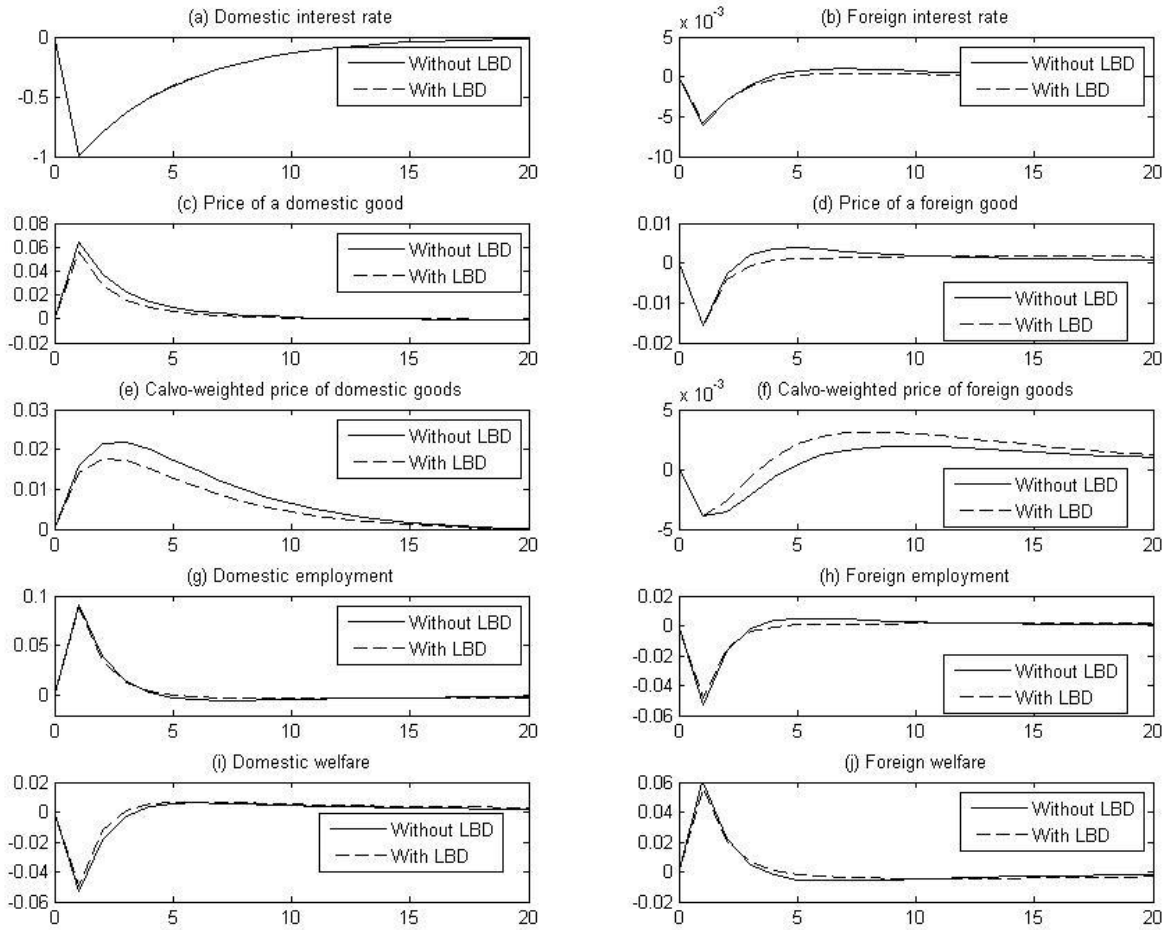
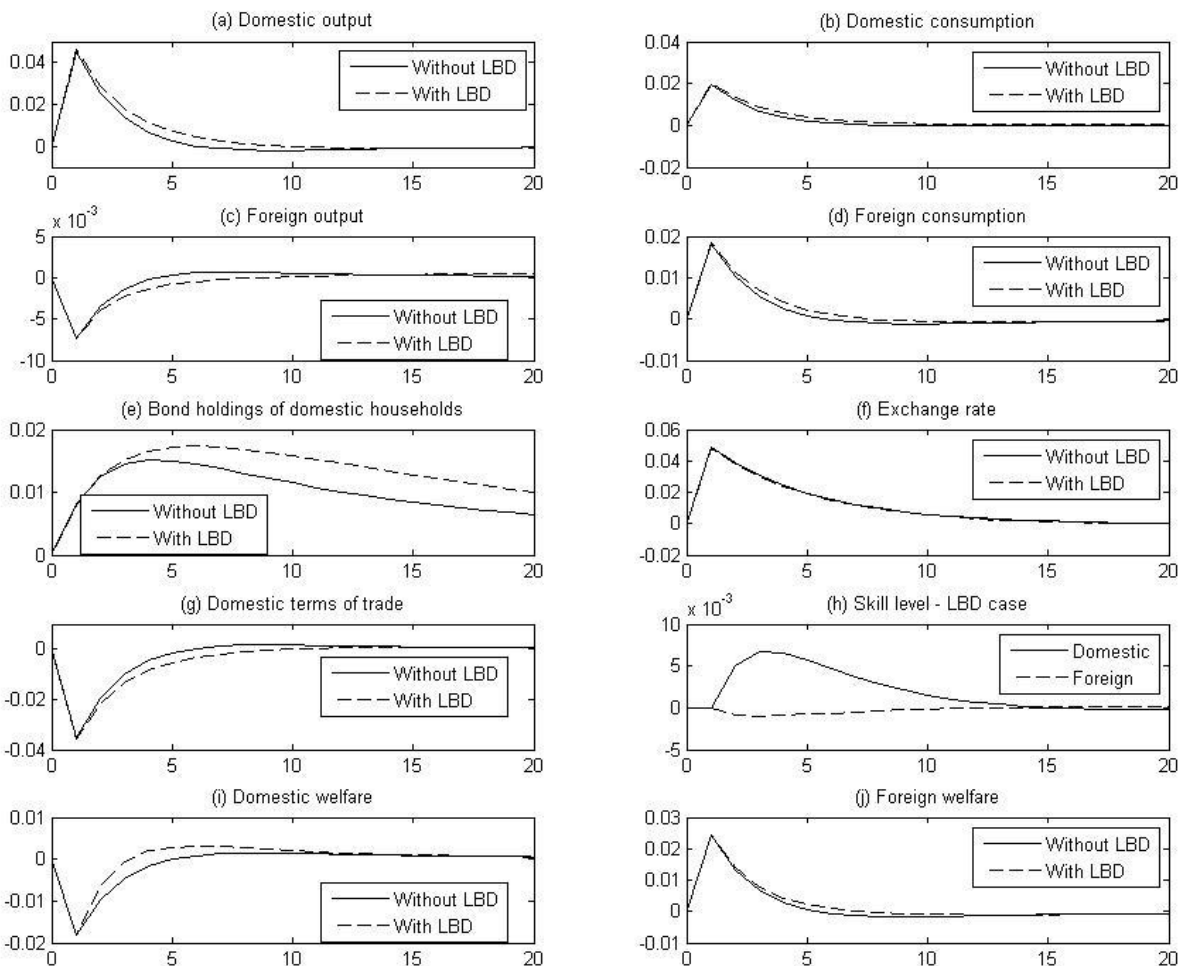**Figure 3: Dynamic Effects of a Domestic Interest Rate Shock When** $\rho = 1.5$
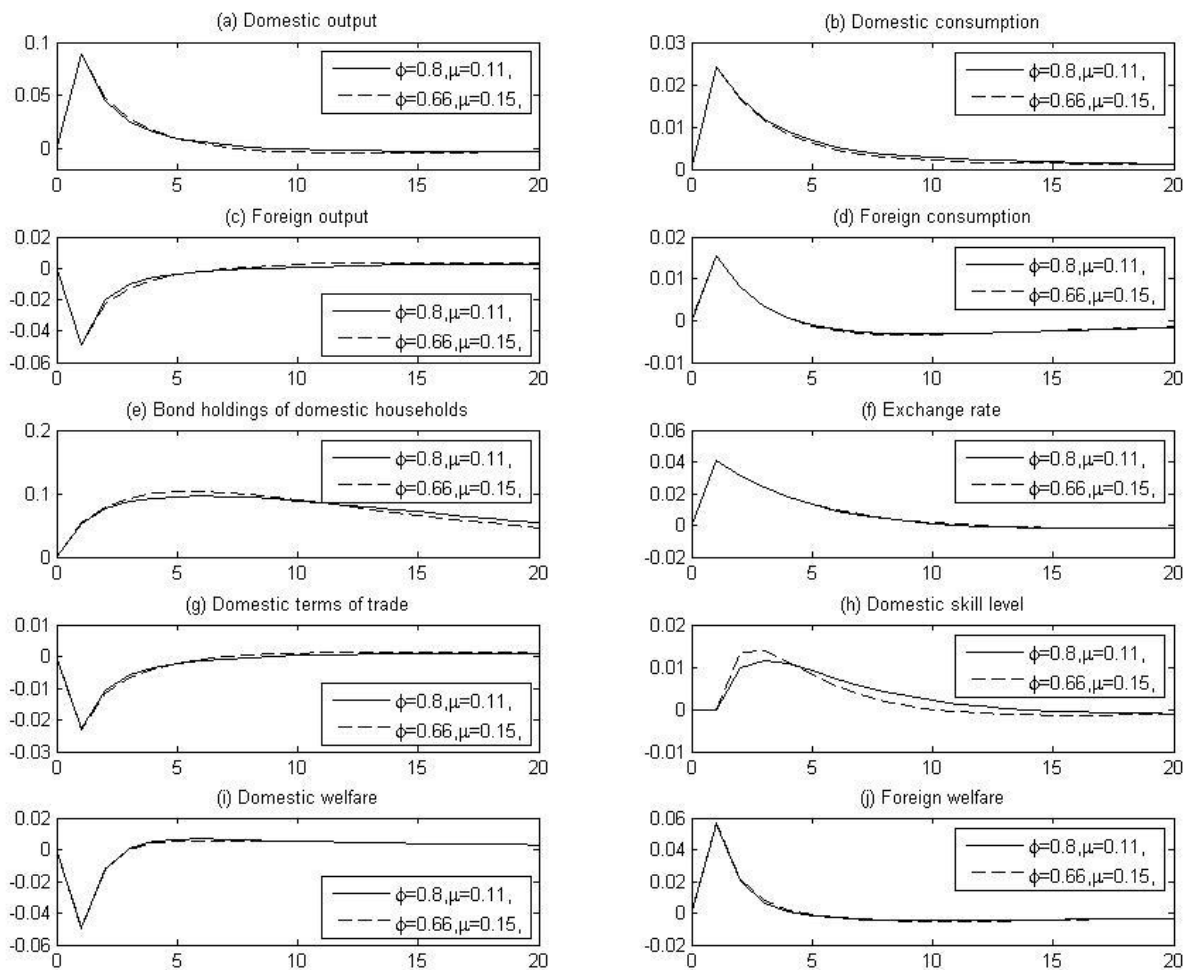
Figure 4: Effects of Varying Key Parameter Values When $\rho = 6$

(a) Domestic output

(b) Domestic consumption

(c) Foreign output

(d) Foreign consumption

(e) Bond holdings of domestic households

(f) Exchange rate

(g) Domestic terms of trade

(h) Domestic skill level

(i) Domestic welfare

(j) Foreign welfare

$\phi=0.8, \mu=0.11,$

$\phi=0.66, \mu=0.15,$

Aboa Centre for Economics (ACE) was founded in 1998 by the departments of economics at the Turku School of Economics, Åbo Akademi University and University of Turku. The aim of the Centre is to coordinate research and education related to economics in the three universities.

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ISSN 1796-3133