Discussion Paper Series

Credit Market Imperfections and the Monetary Transmission Mechanism Part II: Flexible Exchange Rates

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Abstract

Monetary policy is analyzed in a simple model with credit market imperfections, flexible prices, and a floating exchange rate. Banks' lending rates incorporate a premium, which depends on firms' net worth, over the cost of borrowing from the central bank. In contrast to models in the Kiyotaki-Moore tradition, the supply of bank loans is perfectly elastic at the prevailing lending rate. The central bank sets the refinance rate and provides banks with unlimited access to liquidity at that rate. The model is used to study the macroeconomic effects of changes in the refinance and reserve requirement rates, central bank auctions, shifts in the risk premium and contract enforcement costs, and changes in public spending and world interest rates.

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1 Introduction

Modern central banks conduct monetary policy mostly by setting a key short-term nominal interest rate, which in turn (depending on the behavior of lenders and borrowers) tends to affect market-determined rates. Yet, except for a few exceptions, textbook discussions continue to characterize monetary policy as consisting of controlling some monetary aggregate, with the interest rate adjusting freely to fluctuations in the supply and demand for money. The various open-economy extensions of the standard IS-LM model belong to this tradition. Because these models mischaracterize the process through which monetary policy is implemented, they not only have limited pedagogical value (despite their relative simplicity and tractability) but are also potentially misleading when it comes to conducting policy analysis. Moreover, attempts to extend such models to account for interest rate setting by monetary authorities have met with limited success, because of their failure to account for the complexity of the monetary transmission mechanism—most importantly, interactions between credit market frictions (which remain pervasive in most countries), banks' pricing behavior, and central bank regulations, in the determination of market interest rates.

In a recent paper, we proposed a simple static framework for monetary policy analysis under fixed exchasnge rates (Agénor and Montiel (2006)). A key feature of the model is that it accounts for an important source of imperfection in credit markets, namely, the limited enforceability of loan contracts. This is a particularly relevant consideration for developing countries, where the financial system is dominated by banks and weaknesses in the legal system often make it difficult for lenders to seize collateral in case of default. Specifically, the source of credit market imperfections in the model is default risk, which leads banks to charge a premium over and above the (marginal) cost of funds, taking into account the rate of return on alternative assets. In turn, the premium is taken to depend on borrowers' net worth. At the prevailing lending rate, the supply of loans is perfectly elastic and the actual stock of credit is demand determined. Thus, unlike models in the tradition of Kiyotaki and Moore (1997), or models along the lines proposed by Aghion, Bacchetta, and Banerjee (2000, 2004), or Cooley and Quadrini (2006), borrowing from banks is not strictly constrained by the borrower's initial wealth, current cash flow, or own equity.

This paper extends our previous framework in several directions. As before, we continue to assume that prices are fully flexible and that banks set lending rates as a markup over their marginal cost of funds. In turn, the markup rate is a function of firms' collateralizable net worth.[1] Banks' funding sources are perfect substitutes, and loan supply and the provision of liquidity by the central bank are perfectly elastic at the prevailing lending and refinance rates. Changes in the price of a real asset (which we refer to as land, but could alternatively represent housing) have liquidity and wealth effects, which stimulate private consumption. Private investment is specified as a function of the real lending rate. The key differences are that we now consider the case of a floating exchange rate economy (with possible *ad hoc* central bank intervention), and that we analyze the more realistic case where portfolio reallocations between domestic and foreign assets are not instantaneous. Our view is in the spirit of Krugman (1999) and remains the same as before: because of its relative simplicity, the model proposed in this paper is a useful tool for basic monetary policy analysis. Its main virtues are that its mechanics continue to be relatively straightforward, its intuition can be conveyed easily, and it can be adapted to address a number of issues beyond those discussed in the paper. Given that any economic model is, almost by definition, an *ad hoc* simplification, the ability to derive policy prescriptions that can be conveyed in relatively clear language is a particularly important consideration from the point of view of influencing the way policymakers think about the transmission process of monetary policy. From that perspective, and although the microeconomic foundations of our framework were not fully derived (thereby preventing a rigorous evaluation of welfare effects), our analysis of various experiments suggests that it leads to sensible policy lessons.[2]

The remainder of the paper is organized as follows. Section 2 presents the model. Because we retain essentially the same features as in our previous work, our description is fairly condensed, except for those aspects of the

[1] The use of collateral itself, although unexplained in the model, could be related to standard adverse selection or moral hazard considerations, the nature of the lender-borrower relationship, the degree of competition in the credit market, or the cost of screening borrowers. Moreover, as discussed for instance by Jimenez, Salas, and Saurina (2006), it could also be viewed by borrowers themselves as a signal of credit quality.

[2] In addition, it should be noted that the predictions of micro-based optimizing models are notoriously sensitive to a host of assumptions, such as the degree of (non) separability in household preferences. Using linear approximations to general utility functions—as is often done in the literature—may also create problems for evaluating the welfare properties of these models. See VanHoose (2004) for a critical discussion of the New open-economy macroeconomics along these lines.

model that are specific to the floating exchange rate version. Analytical and graphical solutions are provided in Section 3. In Section 4 the model is used to perform a set of experiments pertaining to changes in the refinance and reserve requirement rates, central bank auctions, shifts in the premium and contract enforcement costs, as well as changes in public spending and in the world interest rate. The last section offers some concluding remarks.

2 The Model

Consider a small open economy producing a single (composite) good that is imperfectly substitutable for a foreign good. The economy is small and the world price of the foreign good is exogenous. Domestic output is fixed within the time frame of the analysis. There are six markets in the economy (for currency, bank deposits, credit, bonds, goods, and foreign exchange), and four categories of agents: households, commercial banks, the government, and the central bank. The nominal exchange rate is flexible, although the central bank retains the discretion to intervene in the market for foreign exchange.

2.1 Household Portfolio Allocation

Households consume both the domestic and foreign goods, and hold four types of financial assets: domestic currency (which bears no interest), domestic currency-denominated deposits with commercial banks, foreign currency-denominated deposits held abroad, and land, the supply of which is fixed and normalized to one. All assets are imperfect substitutes for each other, and foreigners do not hold domestic assets.

Total household financial wealth, A^H, is defined as:

$$A^H = BILL + D + Q \cdot 1 + E \cdot D^*, \tag{1}$$

where $BILL$ is currency holdings, D (D^*) domestic (foreign) bank deposits, and Q the price of land. Because household financial wealth depends on the current-period values of the price of land and the exchange rate, it has both a predetermined as well as an endogenous component. These can be expressed as:

$$A^H = (BILL + D + Q_0 + E_0 \cdot D^*) + (Q - Q_0) + (E - E_0)D^*,$$

that is, using (1),

$$A^H = A_0^H + (Q - Q_0) + (E - E_0)D_0^*, \tag{2}$$

where Q_0 and E_0 are, respectively, the beginning-of-period values of the price of land and the nominal exchange rate, and D_0^* is the beginning-of-period stock of foreign exchange deposits. The term A_0^H represents the predetermined component of household financial wealth and $(Q - Q_0) + (E - E_0)D_0^*$ is the endogenous component.

The allocation of household financial wealth is described as follows. First, the demand for currency is assumed to be related negatively to the opportunity cost of holding cash, as measured by the interest rate on the alternative transactions medium, bank deposits:

$$\frac{BILL}{D} = \nu(i_D), \tag{3}$$

where i_D is the interest rate on bank deposits and $\nu' < 0$.[3]

The real demand for domestic-currency deposits, in turn, is taken to depend positively on the exogenous level of output, $\bar{Y}$, and the bank deposit rate, as well as negatively on the rate of return on alternative assets, that is, the domestic-currency rate of return on foreign deposits and the expected rate of increase in the price of land, $\hat{q}$:

$$\frac{D}{P} = d(i_D, i^* + \varepsilon, \hat{q}, \bar{Y}), \tag{4}$$

where P is the cost-of-living index, i^* the (risk-free) interest rate on deposits held abroad, and ε the expected rate of depreciation of the nominal exchange rate. The derivatives in this equation are such that d_1, $d_4 > 0$ and d_2, $d_3 < 0$.[4]

Using (3) and (4), we will assume that

$$\frac{\eta_D}{\eta_\nu} > \frac{BILL}{BILL + D} = \frac{\nu}{1 + \nu}, \tag{5}$$

[3]The reason why only the interest rate i_D enters in (3) is that currency is viewed only as an alternative to holding domestic deposits and there is no direct return to holding cash.

[4]Here and below, $g_i(\cdot)$ represents the partial derivative of function $g_i(\cdot)$ with respect to its ith argument.

where $\eta_D = Pd_{i_D}i_D/D = d_{i_D}i_D/d > 0$ and $\eta_\nu = -\nu' i_D/\nu > 0$. That is, the ratio of the interest elasticity of demand for deposits to that of the currency-deposit ratio exceeds the share of currency in the total money stock, given by $BILL/(BILL + D)$. When this condition is satisfied, an increase in the deposit interest rate will increase the total demand for money (that is, $\partial(BILL + D)/\partial i_D > 0$).

Turning to the nonmonetary assets, land and foreign-currency deposits are taken to be imperfect substitutes. Accordingly, the household's desired allocation of its nonmonetary financial wealth between the two assets depends on their expected rates of return:

$$\frac{E \cdot D^*}{Q + E \cdot D^*} = f(i^* + \varepsilon, \hat{q}),$$

or,

$$E \cdot D^* = \frac{f(i^* + \varepsilon, \hat{q})}{1 - f(i^* + \varepsilon, \hat{q})} Q = h(i^* + \varepsilon, \hat{q})Q, \tag{6}$$

where $f_1 > 0$, $f_2 < 0$, and $h = f/(1 - f)$, so $h_1 > 0$, $h_2 < 0$.

We will assume, however, that households face costs in adjusting their stocks of foreign-currency deposits. While these costs could be motivated in a variety of ways, a simple assumption is that the country in question maintains (imperfect) restrictions over capital outflows, which have the effect of throwing "sand in the wheels" of the mechanism through which households adjust their stocks of foreign-currency deposits. As a result, these adjustments are not instantaneous. Specifically, we will assume that they occur gradually over time, in such a way that capital outflows during each period, denoted ΔD^*, are proportional to the gap between households' desired stock of foreign exchange deposits and the actual stock they inherit from the previous period:

$$\Delta D^* = \lambda(D^* - D_0^*),$$

that is, using (6),

$$\Delta D^* = \lambda[h(i^* + \varepsilon, \hat{q})Q/E - D_0^*]. \tag{7}$$

The parameter $\lambda > 0$ is an indicator of the severity of adjustment costs, with $\lambda = 1$ indicating the absence of such costs, and $\lambda = 0$ a situation where such costs are prohibitive, eliminating private capital movements altogether.

Under these conditions, the *effective* demand for foreign-currency deposits becomes:

$$E \cdot D^* = \lambda h(i^* + \varepsilon, \hat{q})Q + (1 - \lambda)E \cdot D_0^*. \tag{8}$$

In turn, the effective demand for land can be derived residually from equation (1) as

$$Q = A^H - BILL - D - E \cdot D^*,$$

that is, using (3), (4), and (8),

$$Q = A_0^H + (Q - Q_0) + (E - E_0)D_0^* - (1+\nu)Pd(\cdot) - \lambda h(\cdot)Q - (1-\lambda)E \cdot D_0^*.$$

Rearranging terms yields

$$Q = \frac{A_0^H - Q_0 - [1 + \nu(i_D)]Pd(i_D, i^* + \varepsilon, \hat{q}, \bar{Y}) + (\lambda E - E_0)D_0^*}{\lambda h(i^* + \varepsilon, \hat{q})},$$

or equivalently

$$Q = Q(i_D, i^* + \varepsilon, \hat{q}, \bar{Y}, E; A_0^H). \tag{9}$$

Because the supply of land is exogenous, this equation also represents the equilibrium condition in the market for land. It therefore determines the equilibrium value of Q. It has the following properties:

$$Q_1 = -\frac{Pd\eta_\nu(1+\nu)}{i_D \lambda h}\left(\frac{\eta_D}{\eta_\nu} - \frac{\nu}{1+\nu}\right) < 0,$$

$$Q_2 = -\frac{Q\lambda h_1 + (1+\nu)Pd_2}{\lambda h} < 0,$$

$$Q_3 = -\frac{Q\lambda h_2 + (1+\nu)Pd_3}{\lambda h} > 0,$$

$$Q_4 = -\frac{(1+\nu)Pd_4}{\lambda h} < 0,$$

$$Q_5 = D_0^*/h > 0,$$

$$Q_6 = 1/\lambda h > 0.$$

The intuition for these results is as follows. An increase in the deposit rate shifts households into money (bills and domestic bank deposits), with no effect on their choice between land and foreign deposits; it must therefore result, other things equal, in a decline in their demand for land and a decrease in the equilibrium price of land. An increase in the rate of return on foreign deposits, by contrast, has two effects on the demand for land: first, by causing the demand for money to contract, it increases demand for all non-monetary assets, including land; second, it reduces the demand for land by causing households to switch from land into foreign-currency deposits. The net effect on the demand for land is thus ambiguous in principle. However, if land is a closer substitute for foreign deposits than for money, the second effect must dominate. Because this assumption is plausible, we assign a negative sign to Q_2.

Next, an increase in the expected rate of increase in land prices unambiguously raises the demand for land, drawing resources out of both money holdings and foreign-currency deposits. Thus, an expected future increase in the price of land raises its current price. Higher domestic income, by contrast, induces households to hold more money for transactions purposes, reducing the demand for land as an asset and lowering its price. A depreciation of the exchange rate creates a capital gain on foreign-currency deposits, which increases household wealth and therefore also the demand for, and equilibrium price of, land. The magnitude of this effect depends on the initial composition of household portfolios. If households initially hold their desired ratio of foreign-currency deposits to land, so that $E_0 D_0^*/Q_0 = h$, then $Q_5 E_0/Q_0 = 1$, that is, the equilibrium land price and the nominal exchange rate change in the same proportion. Finally, an increase in initial household wealth raises the demand for land, because in the absence of wealth effects on the demand for money, the additional resources are devoted to holding land and foreign-currency deposits. The result is an increase in the equilibrium price of land.

2.2 Commercial Banks

Banks allocate their investable assets (that is, assets net of required reserves) between loans to firms and holdings of government bonds. They can borrow reserves from the central bank in order to match their assets and liabilities, but cannot borrow abroad. Banks' assets therefore consist of credit extended to firms, L^F, reserves held at the central bank, RR, and government bonds, B^B, whereas their liabilities consist of deposits held by households, D, and borrowing from the central bank, L^B.[5] Banks' balance sheet can therefore be written as:

$$L^F + RR + B^B = D + L^B. \tag{10}$$

Reserves held at the central bank do not pay interest. They are deter-

[5] All these variables are measured in nominal terms.

mined by:

$$RR = \mu D, \tag{11}$$

where $\mu \in (0, 1)$ is the reserve requirement ratio.

Banks set both deposit and lending rates. As noted earlier, from their perspective domestic-currency deposits and central bank liquidity are perfect substitutes at the margin. Accordingly, the deposit rate on domestic-currency deposits, i_D, is set equal to the cost of funds provided by the central bank, i_R, with a downward correction that accounts for the (implicit) cost of holding reserve requirements:

$$1 + i_D = (1 + i_R)(1 - \mu). \tag{12}$$

Apart from the central bank, commercial banks are the only holders of domestic government debt. The interest rate that banks demand to be paid on government bonds, i_B, is set as a premium over their marginal cost of funds, which is given by the cost of borrowing from the central bank, i_R:

$$1 + i_B = (1 + \theta_B)(1 + i_R), \tag{13}$$

and θ_B is the risk premium on government bonds, which is assumed to be increasing in the ratio of the stock of these bonds held by banks, B^B, to the maximum debt that the government's fiscal plans can support, $B^{\max}$. Thus:

$$\theta_B = \theta_B(B^B/B^{\max}), \quad \theta'_B > 0. \tag{14}$$

The domestic loan rate is set at a premium over the prevailing interest rate on government bonds:

$$1 + i_L = (1 + \theta_L)(1 + i_B), \tag{15}$$

where the risk premium θ_L on lending to firms is inversely related to the ratio of firms' assets (the value of their beginning-of-period physical capital stock, K_0, which is taken as given, times P_D, the price of the domestic good) over their liabilities, which consist of beginning-of-period loans, L_0^F:

$$\theta_L = \theta_L(\frac{\kappa P_D K_0}{L_0^F}; x_P), \tag{16}$$

where x_P is a shift parameter, whereas $\theta_{L_1} < 0$ and $\theta_{L_2} > 0$. The coefficient $\kappa \in (0, 1)$ in (16) measures the proportion of firms' assets that can effectively be used or pledged as collateral; $\kappa P_D K_0$ therefore measures firms' "collateralizable" wealth.[6]

Using equations (14), (15), and (16), the banks' loan rate can be written as:

$$i_L = [1 + \theta_L(\frac{\kappa P_D K_0}{L_0^F}; x_P)][1 + \theta_B(B^B/B^{\max})](1 + i_R) - 1,$$

or equivalently

$$i_L = i_L(P_D; B^B, i_R, x_P, ..), \tag{17}$$

with $i_{L1} < 0, i_{L2} > 0, i_{L3} > 0$,and $i_{L4} > 0$. That is, the loan rate is decreasing in the domestic price level, because it raises the value of the firms' collateralizable net worth; and it is increasing in the stock of bonds held by banks (because that increases the interest rate on government bonds, which provides the benchmark for pricing private debt). It is also increasing in the marginal cost of funds to banks and in the shift parameter x_P.

Because commercial banks are the only private holders of government bonds, their total holdings are determined by central bank policies. Specifically, banks' holdings of government bonds are determined by the difference between the total stock of bonds outstanding, $\bar{B}$, which is predetermined, and bonds held by the central bank, B^C:

$$B^B = \bar{B} - B^C. \tag{18}$$

Given the commercial banks' interest rate-setting behavior, the actual stock of credit outstanding is determined by firms' demand for loans, to be described below. With B^B, L^F, RR and D being determined by either the central bank or private agents, the balance sheet constraint (10) requires that borrowing from the central bank be determined as

$$L^B = L^F + RR + B^B - D.$$

Using (4) and (11), this equation becomes:

$$L^B = L^F + B^B - (1 - \mu)d(i_D, i^* + \varepsilon, \hat{q}, \bar{Y})P. \tag{19}$$

[6]See Agénor and Montiel (2006) for a more detailed discussion. Although we treat κ as constant, it is worth noting that in a more general setting it could be made counter-cyclical, to reflect the fact that banks are more willing to lend when firms' cash flows are high or, equivalently, that banks are prone to excessive lending during booms. Thus, counter-cyclical movements in κ could also result from proyclical changes in the intensity of competition among banks.

2.3 Central Bank

In addition to selling bonds to commercial banks, the central bank supplies reserves elastically to them at the fixed official (or refinance) rate, i_R. Because banks set their deposit rate on the basis of this official rate, monetary policy operates largely through the effects of the refinance rate on the banking system's cost of funds. And because the supply of liquidity is perfectly elastic at rate i_R, base money is endogenous. Although the exchange rate is flexible, we will also allow scope for the central bank to intervene in the foreign exchange market on an *ad hoc* (or discretionary) basis.

The central bank's balance sheet consists, on the asset side, of loans to commercial banks, L^B, foreign exchange reserves, R^* (measured in foreign-currency terms), and government bonds, B^C. On the liability side, it consists of the monetary base, MB, plus capital, which is comprised solely of capital gains or losses on foreign exchange reserves arising from fluctuations in the market exchange rate relative to the reference rate, E_0:

$$E \cdot R^* + (B^C + L^B) = MB + (E - E_0)R^*. \tag{20}$$

The monetary base is the sum of currency in circulation and required reserves:

$$MB = BILL + RR, \tag{21}$$

which implies, using (11), that the supply of cash is

$$BILL^s = MB - \mu D. \tag{22}$$

In this framework, the central bank can manipulate three instruments to conduct monetary policy: the refinance rate, i_R, holdings of government bonds, B^C, and the required reserve ratio, μ. It also has an exchange rate policy instrument in the form of its holdings of foreign exchange, R^*.

2.4 Price Level and the Real Sector

The cost of living, P, is a geometric weighted average of the price of the domestic good, P_D, and the price of the imported good, EP_M^* (where P_M^* is the foreign-currency price of the imported good, assumed exogenous):

$$P = P_D^{1-\delta}(E \cdot P_M^*)^{\delta}, \tag{23}$$

where $\delta \in (0, 1)$ is the share of spending by domestic households on imported goods, derived from a Cobb-Douglas utility function (so that expenditure shares are constant). Setting $P_M^* = 1$, this equation becomes

$$P = P_D z^{\delta}, \tag{24}$$

where $z = E/P_D$ is the real exchange rate.

Real consumption expenditure by households, C, measured in units of the domestic good, is assumed to depend on the resources available to them in the form of human as well as physical capital and financial wealth, and on intertemporal relative prices. Because our model is not explicitly intertemporal, we capture the contribution of human and physical capital by allowing consumption to depend positively on disposable income and on the real value of financial wealth. To capture the effects of intertemporal relative prices we allow it to depend negatively on real rates of return on the assets held by households (domestic- and foreign-currency deposits, and land). We treat the partial effects of each of these rates of return on present consumption as being identical. Thus, consumption spending can be written as:

$$C = C_0 + \alpha_1(\bar{Y} - T) - \alpha_2[(i_D - \pi^a) + (i^* + \varepsilon - \pi^a) + (\hat{q} - \pi^a)] + \alpha_3(A^H/P_D), \tag{25}$$

where T denotes lump-sum taxes, π^a is the expected inflation rate, $\alpha_1 \in (0, 1)$ is the marginal propensity to consume out of disposable income, and $\alpha_2, \alpha_3 > 0$.

We model investment demand in a simple fashion. On the assumption that domestic investment is financed by bank loans, the real loan interest rate represents the opportunity cost of physical capital. Thus the capital stock desired by firms, K^d, is inversely related to the real lending rate, $i_L - \pi^a$. Adjustment costs in changing the physical capital stock cause real investment spending by domestic firms I to be a linear function of the difference between the desired stock and the actual stock, K_0:

$$I = K^d(i_L - \pi^a) - K_0 = I(i_L - \pi^a; K_0), \tag{26}$$

where $I_1 < 0$. Thus, with the beginning-of-period stock of loans given by L_0^F, new loan demand from commercial banks is equal to

$$L^F = L_0^F + P_D I. \tag{27}$$

As noted earlier, as long as firms are willing to pay the interest rate defined in (15), the supply of credit is perfectly elastic. Thus, the actual stock of credit is demand-determined and firms do not face credit constraints.

Letting $X(z)$ denote exports, which are positively related to the real exchange rate (so that $X' > 0$), the supply of domestic goods to the domestic market is $\bar{Y} - X(z)$. The equilibrium condition of the market for domestic goods is given by:

$$\bar{Y} - X(z) = (1 - \delta)C + I + G, \tag{28}$$

where G is government spending on domestic goods, taken to be exogenous.

2.5 Balance of Payments

Assume for now that official foreign reserves are constant at $R_0^* = 0$. We close the model by specifying the economy's balance-of-payments equilibrium condition as:

$$E^{-1}P_D[X(z) - \delta C] + i^* D_0^* - (D^* - D_0^*) = 0,$$

where D_0^* is the beginning-of-period stock of household deposits held abroad. Given that $E/P_D = z$, this condition becomes

$$z^{-1}[X(z) - \delta C] + i^* D_0^* - \Delta D^* = 0. \tag{29}$$

3 Model Solution

In solving the model, and as in our previous paper, we will take the expected rate of change in land prices, the expected rate of inflation, and the expected rate of depreciation all to be exogenous. There are three key endogenous variables in the model: the banks' lending rate, i_L, the price of domestic goods, P_D, and the real exchange rate, z. To solve it we will express the domestic goods market clearing condition (28) and the balance-of-payments equilibrium condition (29) as functions of these three variables, and then use equation (17) to eliminate the lending rate from these equations. The model thus collapses to two equations—an *internal balance* condition describing equilibrium in the domestic goods market, and an *external balance* condition describing balance-of-payments equilibrium—which can be solved for the two unknowns, z and P_D.

Consider first the internal balance condition. Substituting the consumption function (25) and the investment function (26) in equation (28), and setting $C_0 = 0$, the goods market equilibrium condition can be written as the requirement that the excess demand for domestic goods be equal to zero:

$$(1-\delta)\left\{\alpha_1(\bar{Y}-T)-\alpha_2[(i_D-\pi^a)+(i^*+\varepsilon-\pi^a)+(\hat{q}-\pi^a)]\right.$$
$$\left.+\,\alpha_3(A^H/P_D)\right\}+I(i_L-\pi^a;K_0)+G+X(z)-\bar{Y}=0.$$

Using equations (2), (9), (12), (14), and (15), this condition becomes:

$$(1-\delta)\left\{\alpha_1(\bar{Y}-T)-\alpha_2[((1+i_R)(1-\mu)-1-\pi^a)+(i^*+\varepsilon-\pi^a)+(\hat{q}-\pi^a)]\right.$$
$$\left.+\,(\alpha_3/P_D)[A_0^H+Q(i_D,i^*+\varepsilon,\hat{q},Y,zP_D;A_0^H)-Q_0+(zP_D-E_0)D_0^*\right\}$$
$$+I\left\{[1+\theta_L(\frac{\kappa P_D K_0}{L_0^F};x_P)][1+\theta_B(\frac{B^B}{B^{\max}})](1+i_R)-1-\pi^a;K_0\right\}$$
$$+G+X(z)-\bar{Y}=0.$$

This equation expresses the internal balance condition as a function of the endogenous variables z and P_D. Notice that the effect of a change in the real exchange rate, z, on the excess demand for domestic goods is given by

$$\alpha_3(1-\delta)(Q_5+D_0^*)+X'>0.$$

This expression consists of two parts: a wealth effect on consumption of domestic goods, given by $\alpha_3(1-\delta)(Q_5+D_0^*)$, and a competitiveness effect, given by X'. The wealth effect arises from the fact that, given the price of domestic goods, a real exchange rate depreciation is the equivalent of a depreciation in the *nominal* exchange rate. This nominal depreciation both creates a capital gain on foreign-currency deposits and results in an increase in the price of land (see equation 7)). The total effect on household wealth is given by $Q_5 + D_0^*$, and the resulting increase in consumption demand for domestic goods is $\alpha_3(1-\delta)(Q_5+D_0^*)$. As indicated earlier, the sum of the wealth and competitiveness effects is positive: a real exchange rate depreciation, holding the price of domestic goods constant, is expansionary.

The effect of an increase in the price of domestic goods on the excess demand for such goods, holding the real exchange rate constant, is somewhat more complicated. It is given by:

$$\frac{\alpha_3(1-\delta)}{P_D}[(Q_5+D_0^*)z-(\frac{A_0^H}{P_D})]\;+I_1\theta_{L_1}(\frac{\kappa K_0}{L_0^F})(1+\theta_B)(1+i_R).$$

The first term in this expression is negative: it captures the wealth effects on consumption of an increase in the price of domestic goods, holding the real exchange rate constant. When the price of domestic goods rises at an unchanged value of the real exchange rate, the nominal exchange rate must depreciate in the exact same proportion as the increase in the price of domestic goods. As we have just seen, this gives rise to a capital gain on foreign deposits and land. On the assumption that households initially hold their desired foreign-currency deposits-land ratio, the increase in the price of land is proportional to the exchange rate depreciation. This implies that the real value of land and foreign-currency deposits remains unchanged. Thus, the net effect on the real value of household financial wealth, given by $[(Q_5 + D_0^*)z - A_0^H/P_D]/P_D$, is determined by the effects of the price level increase on total real money balances, which are negative.[7]

The second term is the "financial accelerator" effect. Recalling that $I_1 < 0$ and $\theta_{L_1} < 0$, this term is positive: an increase in the domestic price level increases the collateralizable net worth of domestic firms, thus lowering their external finance premium, reducing banks' lending rate, and increasing investment. This, in turn, raises the excess demand for domestic goods. We will assume for now that the role of this effect is to ameliorate, but not reverse, the negative effects on the excess demand for domestic goods of an increase in the price of such goods that operate through wealth effects. In what follows, however, we will highlight how the properties of the model are affected by this financial accelerator effect.

Putting together the effects on the excess demand for domestic goods of changes in the real exchange rate and of the price of domestic goods, we can derive an internal balance locus drawn in z-P_D space. On the assumption just made that wealth effects on consumption dominate financial accelerator effects on investment, the internal balance locus must have a positive slope, as in the curve labeled IB in Figure 1: the positive effects on the excess demand for domestic goods arising from a real depreciation must be offset by negative effects arising from an increase in the domestic price level. The slope of IB is given by

$$\left.\frac{dz}{dP_D}\right|_{IB} = -\frac{\alpha_3(1-\delta)[(Q_5 + D_0^*)z - A_0^H/P_D]/P_D \;\; + I_1\theta_{L_1}(1+\theta_B)(1+i_R)}{\alpha_3(1-\delta)(Q_5 + D_0^*) + X'} > 0.$$

[7] To see this, recall that if $h = E_0 D_0^*/Q_0$, $Q_5 = D_0^*/h = Q_0/E_0$. Substituting in the first term above yields $(Q_5 + D_0^*)z - A_0^H/P_D = (Q_0 + ED_0^* - A_0^H)/P_D = -(BILL + D)/P_D$.

Notice that, because financial accelerator effects weaken the effects of increases in P_D on the excess demand for domestic goods, these effects make the internal balance locus flatter than it would otherwise be—that is, a larger increase in the domestic price level is required to restore internal balance after a real depreciation than would be required if financial accelerator effects were absent.

Next, consider the external balance condition. Substituting the consumption function (25) and capital flows equation (7) into the balance-of-payments equilibrium condition (29), the external balance condition can be written as:

$$z^{-1}[X(z) - \delta\{\alpha_1(\bar{Y} - T) - \alpha_2[(i_D - \pi^a) + (i^* + \varepsilon - \pi^a) + (\hat{q} - \pi^a)]$$
$$+\alpha_3(A^H/P_D)\}] + i^* D_0^* - \lambda[h(i^* + \varepsilon, \hat{q})Q/E - D_0^*] = 0.$$

Substituting for the deposit interest rate from (12), for household financial wealth from (2), and for the price of land from (9), and replacing the nominal exchange rate E by zP_D, the external balance condition becomes:

$$z^{-1}\{X(z) - \delta[\alpha_1(\bar{Y} - T) - \alpha_2[\{(1+i_R)(1-\mu) - 1 - \pi\} + (i^* + \varepsilon - \pi^a) + (\hat{q} - \pi^a)]$$
$$+\frac{\alpha_3}{P_D}[A_0^H + (Q((1+i_R)(1-\mu) - 1, i^* + \varepsilon, \hat{q}, Y, zP_D; A_0^H) - Q_0) + (zP_D - E_0)D_0^*]\}$$
$$+i^* D_0^* - \lambda[\frac{h(i^* + \varepsilon, \hat{q})}{zP_D} Q\{(1+i_R)(1-\mu) - 1, i^* + \varepsilon, \hat{q}, Y, zP_D; A_0^H\} - D_0^*] = 0.$$

Again, this condition can de described as an equation in the two endogenous variables z and P_D.

To derive the external balance locus, consider first the effects of a real exchange rate depreciation on the country's external balance. This effect is given by:

$$z^{-1}(X' - \frac{TB}{z}) - z^{-1}\delta\alpha_3(Q_5 + D_0^*) - (\frac{\lambda h}{z^2 P_D})(Q_5 z P_D - Q), \qquad (30)$$

where $TB = X - \delta C$ is the initial trade balance. This expression can be decomposed into three parts, corresponding to the three terms above. The first term captures the conventional Marshall-Lerner expenditure-switching effect. This term will be positive unless the country runs a large initial trade surplus ($TB > zX'$) and the elasticity of substitution in demand for the country's exports is relatively small. We assume the conventional positive sign here.

The second term captures an expenditure-increasing effect arising from the wealth effects created by depreciation-induced capital gains on foreign-currency deposits and land. The negative sign on this term arises because the increase in spending induced by these capital gains results in an increase in imports, and thus causes the trade balance to deteriorate.

The third term arises from the effect of exchange rate depreciation on capital outflows. A depreciation of the nominal exchange rate simultaneously increases households' demand and supply of foreign-currency deposits. The latter effect arises because an exchange rate depreciation increases the domestic-currency value of deposits held abroad proportionately. The former arises because the increase in the domestic-currency value of foreign-currency deposits increases the price of land, which in turn raises the demand for foreign-currency deposits. However, if households initially hold their desired composition of land and foreign-currency deposits, as we have been assuming (that is, if $E_0 D_0^*/Q_0 = h$), then it is easy to show that these effects exactly offset each other, so $Q_5 z P_D - Q = 0$ and the third term vanishes. In what follows we will consider the reference case to be one in which expenditure-switching effects are dominant, giving the expression in (30) a positive sign. However, as before, we will consider the implications of this condition failing to hold for the experiments to be conducted later.

Finally, consider the effects on the balance of payments of an increase in the price of domestic goods, P_D. The total effect is given by:

$$-\frac{\delta\alpha_3}{zP_D}[(Q_5 + D_0^*)z - \frac{A_0^H}{P_D}] - (\frac{\lambda h}{zP_D^2})(Q_5 z P_D - Q).$$

The first term captures the expenditure-reducing effects of an increase in the price of domestic goods, operating through a negative real balance effect, on the country's trade balance. This effect is the same as that described in the derivation of the IB curve. In this case, the reduction in domestic consumption implies a reduced demand for imports and thus an improvement in the balance of payments, giving the first term a positive sign.

The second term is similar to that discussed immediately above in deriving the effects of a real exchange rate depreciation. It vanishes under the maintained assumption that $E_0 D_0^*/Q_0 = h$. The upshot is that an increase in the price of domestic goods, at a given value of the real exchange rate, must improve the balance of payments, essentially because of adverse real-balance effects on the demand for imports.

Putting together the effects on the external balance condition of changes in z and P_D, it follows that an increase in the price of domestic goods must be offset by an appreciation in the real exchange rate for the balance of payments to remain in equilibrium. That is, the external balance locus, labeled EB in Figure 1, must have a negative slope. This slope is given by:

$$\left.\frac{dz}{dP_D}\right|_{EB} = \frac{\delta\alpha_3[(Q_5 + D_0^*)z - A_0^H/P_D]/P_D}{(X' - TB/z) - \delta\alpha_3(Q_5 + D_0^*)} < 0.$$

Putting together the internal and external balance loci, as in Figure 1, the model can be solved for the equilibrium values of the real exchange rate and the price of domestic goods. To understand how the model works, the next section analyzes the effects on this equilibrium of a variety of policy and exogenous shocks.

4 Policy and Exogenous Shocks

In this section we undertake several experiments designed to illustrate the functioning of our framework. The first set of experiments involves changes in monetary policy variables and variables describing structural characteristics of the domestic financial system. These include an increase in the official refinance rate, i_R; a central bank auction of government bonds that results in a change in B^B; an increase in the required reserve ratio, μ; an exogenous increase in the risk premium on bank lending, x_P; an increase in contract enforcement costs, κ. Our second set of experiments involves exogenous shocks in the form of changes in public spending G, and in the world interest rate i^*.

4.1 Changes in the Refinance Rate

As indicated earlier, changes in the refinance rate are intermediated through the banking system to the bond rate as well as to the loan interest rate. Because it is passed on directly by banks to the deposit rate, an increase in the refinance rate exerts both interest rate and wealth effects on consumption.

An increase in the deposit interest rate directly induces consumers to increase saving and thus reduce spending on domestic goods. It also induces them to switch away from nonmonetary assets—including land—and into deposits, thereby depressing land prices. The lower price of land represents a reduction in household wealth, which reinforces the adverse effect of higher deposit rates on private consumption. In addition, the higher refinance rate is passed on by banks to the loan rate (given the fixed markup on government bonds), which reduces investment by domestic firms. The upshot is that to maintain internal balance at an unchanged value of P_D, the real exchange rate rate would have to depreciate. Thus the IB curve shifts upward, as illustrated in Figure 2.

An increase in the refinance rate has three effects on the external balance condition. First, through its effect on the deposit rate, it directly reduces consumption spending, thus lowering the demand for imports and improving the trade balance. Second, by exerting downward pressure on the price of land, it reduces household wealth, with negative indirect effects on consumption; these effects, as we have just seen, reinforce the direct effect. These two effects together cause an increase in the refinance rate to improve the trade balance, for given values of z and P_D. At the same time, the reduction in the price of land caused by the increase in the refinance rate reduces household demand for foreign-currency deposits, so households are led to repatriate capital. The resulting capital inflow reinforces the positive effects of the increase in the refinance rate on the trade balance, with the result that the three channels all combine to improve the balance of payments. Consequently, to restore external balance, the real exchange rate has to appreciate, that is, the EB curve shifts down. The upshot is that the price of the domestic good must fall—the increase in the refinance rate is contractionary—but the effect of this policy on the real exchange rate is ambiguous. As shown in Figure 2, depending on the magnitude of the shift in the IB curve relative to the EB curve, the economy may move from the initial position E to a point such as E' (corresponding to a depreciation) or E'' (corresponding to an appreciation).[8]

Because the effect of the financial accelerator mechanism is to flatten out the IB curve, it is easy to show that the stronger the financial accelerator effect is, the more powerful will be the contractionary effect of the increase in the refinance rate on the domestic economy—that is, the larger the drop in the price of the domestic good. A stronger financial accelerator effect, everything else equal, also makes it more likely that the real exchange rate

[8] A similar graph could be drawn to show that whether the real exchange rate appreciates or depreciates depends on the magnitude of the shift in the EB curve relative to the IB curve.

will depreciate in response to an increase in the refinance rate.

4.2 Central Bank Auctions

Another common monetary policy tool used by central banks in industrial and middle-income developing countries alike is the auctioning of government bonds to commercial banks. Such an auction increases the stock of government bonds B^B that must be held by these banks. Because this measure has no effect on bank deposit rates, it does not affect the rates of return faced by domestic households on the assets they hold in their portfolios. Consequently, there is no incentive for households to reallocate assets, and no impact effect on household demand for land. The implication is that, unlike in the case of a change in the refinance rate, land prices are not a vehicle for monetary transmission in the case of central bank auctions.

However, the additional bonds held by commercial banks increase the risk associated with this asset from the banks' perspective, because the government's debt-servicing capacity (as measured by $B^{\max}$) remains unchanged. Consequently, banks increase the premium θ_B that they demand for holding government bonds. Because the loan interest rate is determined as a markup over the interest rate on government bonds, the lending rate demanded by banks in order to continue to hold the amount of loans outstanding increases as well. Because this reduces the investment demand for domestic goods, the IB curve shifts upward, as shown in Figure 3. However, on our maintained assumption that investment demand is wholly devoted to the purchase of domestic goods, this shock has no effect on the external balance locus. The domestic price level must fall—making this a contractionary shock—and the real exchange rate must depreciate. It is easy to show that a stronger financial accelerator effect will tend to magnify both of these results.

4.3 Increase in the Reserve Requirement Rate

An increase in the required reserve ratio, μ, makes deposits less attractive to banks as a source of funding and causes them to lower the deposit interest rate. This affects the goods market both directly, because the lower deposit rate discourages saving and stimulates consumption, as well as indirectly, as the lower deposit rate causes household to reallocate their portfolios away from deposits and into real assets such as land. The result is that land prices rise and household consumption is stimulated through a wealth effect.

Because both effects tend to increase demand for domestic goods, a more appreciated real exchange rate is required to clear the goods market. Unlike in the case of a change in the refinance rate, this policy has no effect on the loan rate or investment spending, because under the monetary policy regime under consideration, it does not change commercial banks' marginal cost of funds. The positive effects on consumption cause the IB curve to shift downward (see Figure 4). Because changes in the required reserve ratio affect the external balance condition only through the term $(1+i_R)(1-\mu)-1$, the effects of an increase in that ratio on the EB curve are exactly the opposite of those of an increase in the refinance rate considered above: the external balance locus shifts upward. The net result is that the price of domestic goods increases, but effects on the real exchange rate are ambiguous, with possibly a real appreciation in the new equilibrium (a move from point E to point E'') if the shift in EB is large enough. In short, increases in the required reserve ratio are expansionary.

The explanation for this seemingly counterintuitive result is that, as previously mentioned, changes in reserve requirements have no effect on banks' cost of funds under our assumed monetary policy regime. Because the central bank stands ready to provide the funds desired by banks at the given policy rate i_R, increases in reserve requirements leave banks' cost of funds—and therefore their lending rates—unaffected, while at the same time *lowering* the interest rate that represents the opportunity cost both of current versus future consumption, as well as of holding real assets as opposed to financial ones. The induced substitution of current for future consumption and the higher level of consumption induced by capital gains on real assets are the mechanisms through which expansionary effects are transmitted to the real economy.

4.4 Shifts in the Risk Premium and Contract Enforcement Costs

An increase in banks' perceived risk of lending to private firms, as captured by an upward shift in the parameter x_P, induces banks to demand a higher risk premium. Just as in the case of central bank auctions, this would increase banks' lending rate, cause domestic investment to contract, and shift the IB curve upward. Again, the macroeconomic results are as depicted in Figure 3: the real exchange rate depreciates, and the price of domestic goods falls. The presence of a financial accelerator once again magnifies these effects: the increase in the loan interest rate is larger than that required to offset the initial shift in perceived risk, because the rise in the real value of loans outstanding lowers the collateral offered by firms, increasing banks' intermediation costs.

An increase in κ, resulting from a reduction in contract enforcement costs, raises the proportion of firms' real assets that can be pledged as collateral. In turn, the improved quality of collateral reduces banks' intermediation costs and allows them to charge a lower premium. Thus the markup on lending to firms, θ_L, is reduced, and the IB curve shifts downward, as in Figure 5. This is clearly expansionary, as the domestic price level rises and the real exchange rate appreciates. Notice that in this case the financial accelerator magnifies the reduction in the loan rate, because the increase in the domestic price level reduces the real value of firms' loans, and thus increases the effective value of their collateral over and above what is achieved through the reduction in contract enforcement costs *per se*.

4.5 Changes in Public Expenditure and World Interest Rates

An increase in government spending on domestic goods shifts the IB curve downward while leaving the EB curve unchanged, increasing the domestic price level and causing the real exchange rate to appreciate. It is straightforward to show that, contrary to what standard "crowding out" considerations might suggest, the loan interest rate would actually *fall* in this case. The reason is that the central bank follows an accommodative monetary policy under our assumptions, keeping the refinance rate i_R fixed and rediscounting freely to meet banks' demands for funds. Thus, the supply of funds to banks is perfectly elastic, and in the absence of financial accelerator effects the loan interest rate would remain unchanged. The effect on the loan rate thus arises purely from the financial accelerator effect, which in this case acts to reduce the loan rate because the higher domestic price level reduces the real value of firms' outstanding debt to banks.

Changes in world interest rates have more complicated effects. An increase in i^*, for instance, has no direct effect on commercial banks or the government, because neither financial intermediaries nor the government are assumed to borrow or lend abroad. Households, however, do have access to foreign assets in the form of deposits, and the higher foreign deposit rate induces them to shift their portfolios out of domestic and into foreign assets. This implies a reduced demand for land, with a concomitant fall in its price. Together with a direct negative effect on consumption spending arising from the substitution of future for present consumption, the result is that the demand for domestic goods contracts, causing the IB curve to shift upward. The shift in the external balance locus, however, is ambiguous. The reduction in domestic absorption caused by the effects just described, together with an increase in interest earnings on (beginning-of-period) foreign-currency deposits, cause the current account to improve. However, the increased returns available on foreign-currency deposits induce a capital outflow, leaving the overall effect on the balance of payments ambiguous. If impediments to capital outflows (as measured by λ) are sufficiently strong, such inflows will be muted and the net effect on the balance of payments will be positive, causing the EB curve to shift downward. In this case the effect on the domestic economy must be contractionary (the price of the domestic good must fall), but effects on the real exchange rate are ambiguous, as illustrated in Figure 6 (move from E to either E' or E'').

However, if capital outflows are sufficiently large, this result could be reversed. Indeed, if these outflows are strong enough to cause the increase in the world interest rate to induce an incipient *deficit* in the balance of payments, the EB curve would shift upward. If so, the real exchange rate always depreciates; and if the shift in EB is sufficiently large, the shock could be expansionary (move from E to E'''', as opposed to E''', in Figure 6). The expansion would be driven in this case by a depreciation of the real exchange rate that improves the competitiveness of domestic producers and creates positive wealth effects on consumption.

5 Concluding Remarks

Building on a previous contribution (Agénor and Montiel (2006)), we developed in this paper a simple open-economy macroeconomic model with credit market imperfections, flexible prices, and a floating exchange rate. A key assumption of the model is that banks must incur a cost to monitor the activity of borrowers, as a result of information asymmetries. Thus, lenders must be compensated in the form of a premium, above and beyond their "normal" profit margin and the cost of borrowing from the central bank. The premium, in turn, depends on borrowers' net worth, which gives rise to the financial accelerator. In contrast to models in the Kiyotaki-Moore tradition, the supply of bank loans is perfectly elastic at the prevailing rate and there is no explicit credit rationing. The central bank sets the refinance rate and provides banks with unlimited access to liquidity at that rate. The model was used to study the macroeconomic effects of changes in the refinance and reserve requirement rates, central bank auctions, shifts in the premium and contract enforcement costs, and changes in public spending and world interest rates.

As argued by Krugman (1999), the type of simple, relatively *ad hoc* model that we develop here can actually be a powerful tool for clarifying thought, given its inherent general equilibrium nature. More rigorous, micro-based models may not be demonstrably better from that perspective, particularly when it comes to discussing real-world policy issues.

Nevertheless, the model presented in this paper could be fruitfully extended in a number of directions. In the framework described above, firms borrow only from domestic banks. While this is appropriate for many lower middle-income countries, we could also account for foreign borrowing by firms, as for instance in Gertler, Gilchrist, and Natalucci (2003), Céspedes, Chang, and Velasco (2003, 2004), Elekdag, Justiniano, and Tchakarov (2006), and Tovar (2005, 2006). By endogenizing the foreign interest rate through a mark-up equation similar to the one used earlier, one could examine the net worth effects associated with changes in the domestic-currency value of foreign debt, in the presence of currency mismatches. A nominal depreciation, in this context, could trigger a vicious cycle: by increasing the domestic-currency value of foreign liabilities, it may lead to a deterioration in borrowers' net worth. The resulting increase in the premium on foreign borrowing, by raising the domestic cost of borrowing, may in turn exacerbate fluctuations in investment, activity, and capital flows. Most of the existing models in this area, however, abstract from domestic banks and focus exclusively on external financial intermediation. An important direction for future research would be therefore to consider the case where domestic firms have access to both types of financing.

Alternatively, it could be assumed that firms borrow directly only from domestic financial intermediaries, with these intermediaries in turn borrowing at a premium on world capital markets, as for instance in Agénor and Aizenman (1998). Although there is evidence suggesting that financial accelerator effects operating through a foreign finance premium may be significant for some countries,[9] this two-level financial structure may actually provide a better characterization of borrowing opportunities for some middle-income developing countries, where direct access to international capital markets is typically available to only a small group of large firms.

Some of the other extensions identified in Agénor and Montiel (2006) are also relevant here, of course. For instance, one could endogenize the supply side and introduce a cost channel for monetary policy, by accounting for a direct effect of lending rates on firms' marginal production costs. This is a common feature of developing economies (as discussed in Agénor (2006) and Cheng and Ma (2005)), and there is some evidence that this effect may be important also in industrial countries.[10] By contrast, New Keynesian models of monetary policy either disregard this channel (as in Clarida, Galí, and Gertler (1999)) or, when they do account for it, continue to assume that the central bank controls the growth rate of money (as in Christiano, Eichenbaum, and Evans (2005)). A possible starting point could be the closed-economy, staggered-price framework proposed by Bruckner and Schabert (2003), whose financial component would need to be thoroughly reworked.

Equally important is the need to extend the model to a dynamic setting, with an explicit account of financial asset and physical capital accumulation. This would allow not only to endogenize price and exchange rate expectations (with possibly both forward- and backward-looking components) but also to consider the possibility that banks may price differently short-term loans aimed at financing working capital needs (as in the "cost channel" literature alluded to earlier), and longer-term investment loans. As suggested by the results in Das (2004), the real effects of monetary policy could then be quite different, depending on the factors that affect these pricing decisions.

[9] See, for instance, Elekdag, Justiniano, and Tchakarov (2006) for the case of Korea, and Tovar (2006) for Chile, Colombia, and Mexico.

[10] Among recent studies, see for instance Ravenna and Walsh (2006) for the United States, Gaiotti and Secchi (2006) for Italy, Kato (2006) for Japan, and Chowdhury, Hoffmann, and Schabert (2006) for a larger group of countries. Cooley and Quadrini (2006) present also some useful simulation results.

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Figure 1
Goods and Financial Market Equilibrium

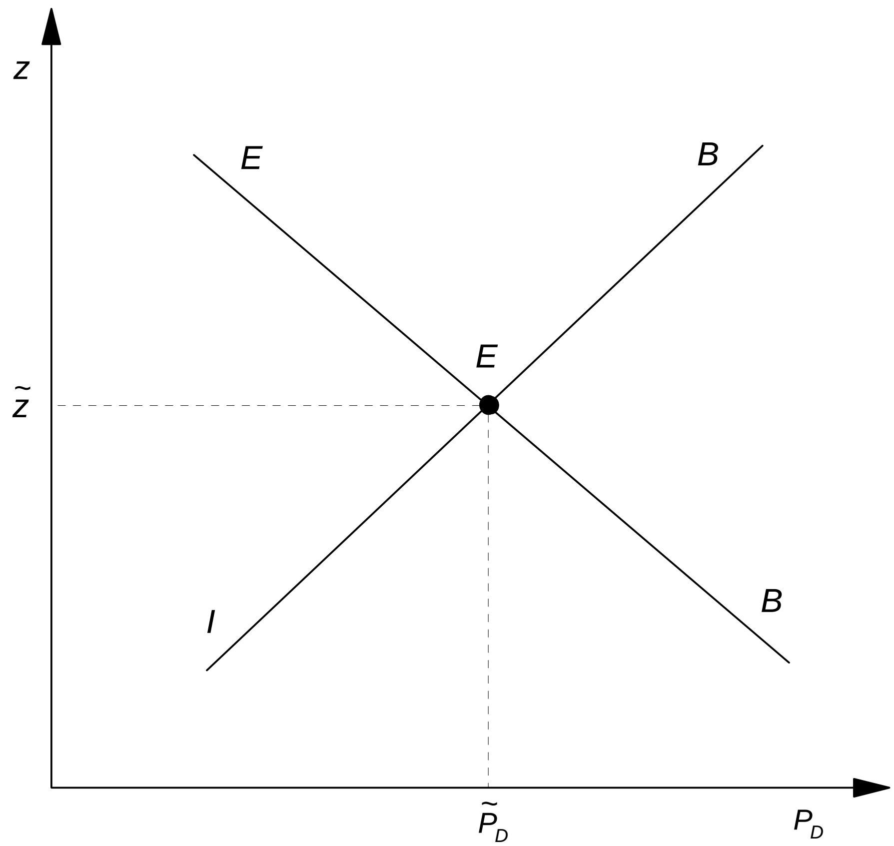

Figure 2
Increase in the Central Bank Refinance Rate

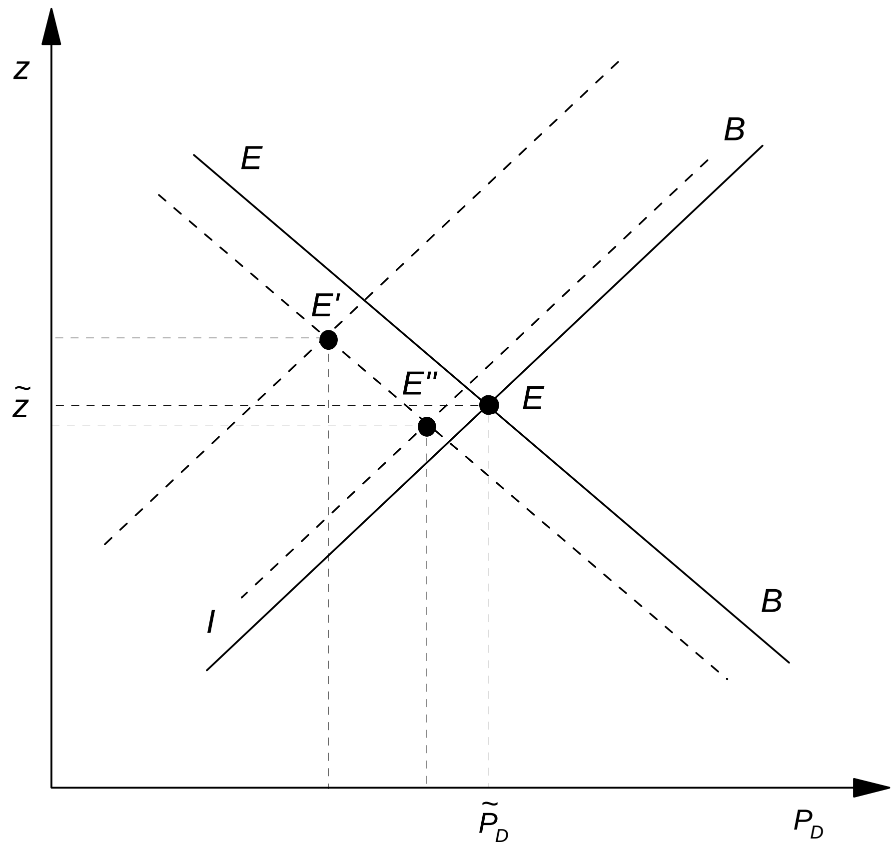

Figure 3
Bond Auction by the Central Bank

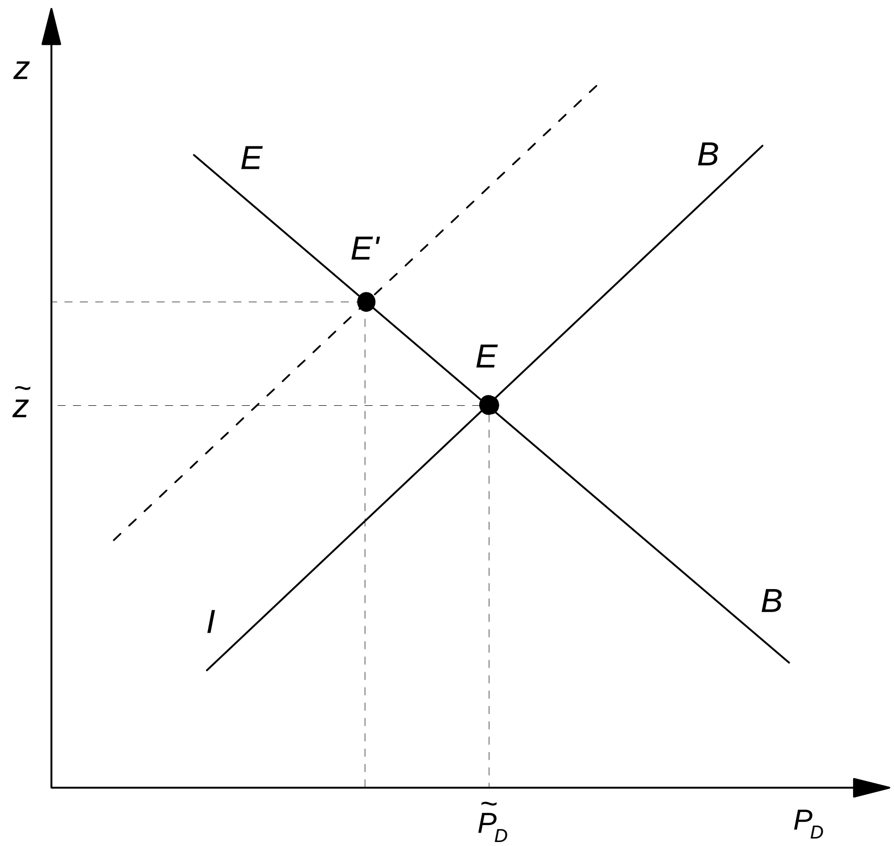

Figure 4
Increase in the Required Reserve Ratio

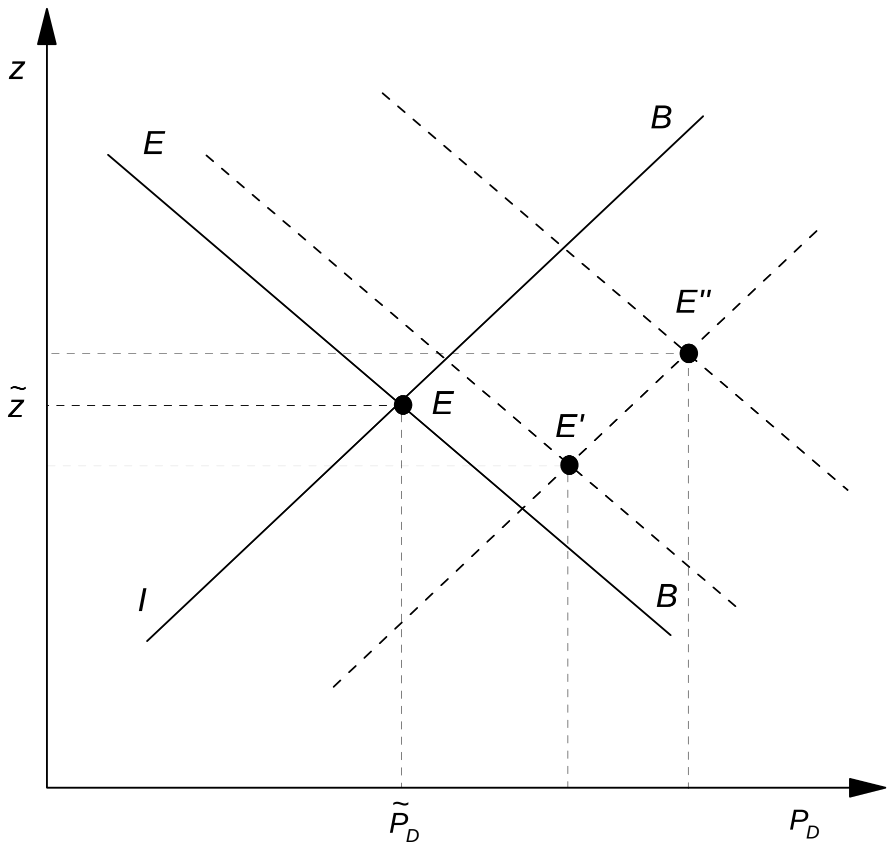

Figure 5
Reduction in Contract Enforcement Costs

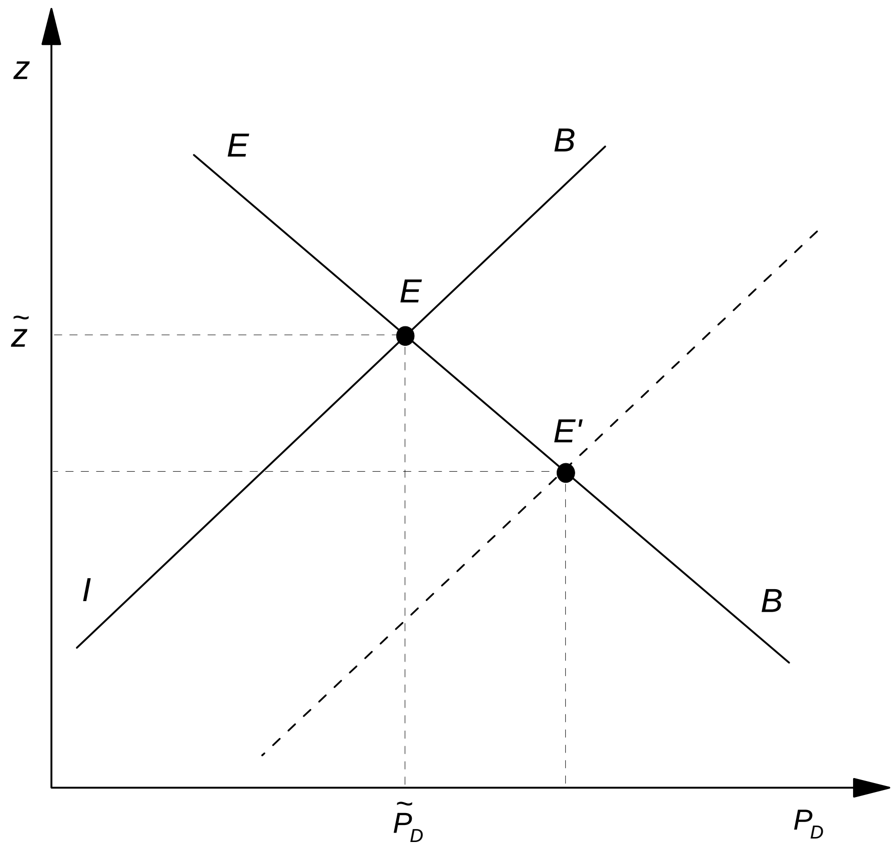

Figure 6
Increase in the World Interest Rate