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STAGFLATIONARY EFFECTS OF MONETARY STABILIZATION POLICIES*

A Quantitative Analysis of South Korea

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We present a quarterly macroeconomic model of South Korea that explicitly incorporates stylized facts about Korea's financial structure (absence of primary securities markets, existence of a curbmarket for credit, etc.). The model focuses on the linkage between financial and real sectors and explicitly incorporates the transmission channel of monetary policy into the supply side of the economy via the real costs of working capital ('Cavallo-effect'). The econometric evidence presented here shows the relevance of this effect. Simulation runs with the model based on the estimated parameter values show strong stagflationary effects of restrictive monetary policy in the short run because of this transmission channel.

1. Introduction

There exists a small but growing body of evidence that the use of some macroeconomic policy instruments (exchange rates, money supply) in LDCs has effects that differ from what one would expect given the predictions of the standard 'North-Atlantic' macro-models. Contractionary effects of a devaluation is a subject with a long history of course, but more recently several authors have started to point to perverse effects of monetary restraint on inflation in LDCs: inflation has often accelerated rather than slowed down as a short-run response on restrictive monetary policy. Empirical evidence is still mainly anecdotal and is to a large extent based on the experience with IMF style stabilization attempts in Latin America. Starting with Cavallo (1977), attempts at solving the puzzle have generally considered the structure of the financial system as the key to the explanation of the

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stagflationary effects of restrictive monetary policy measures. [In addition to Cavallo (1977), see Bruno (1979), van Wijnbergen (1979a), or Taylor (1980).]

In a relatively underdeveloped system of financial intermediation, stock markets play a limited role, if any at all. Accordingly, banks play a much more predominant role than they do in Europe or the United States as a source of funds for firms, both for short-term working capital purposes and for long-term fixed capital formation. For example, debt/equity ratios in countries like Korea range from 5 or 6 to 1 upwards as opposed to 1 or 2 to 1 in the United States or Western Europe. The high leverage, plus the fact that working capital is nearly entirely financed via credit makes the business sector in LDCs very vulnerable to adverse credit conditions.

Bank credit is often severely rationed, with bank lending rates unresponsive to excess demand for credit. This is, of course, one of the main reasons why 'curb markets', Unorganized Money Markets, play such a large role in many countries. Via these markets the public can lend directly to firms, bypassing the banking system. Consumer credit is virtually absent, both in bank loan portfolios and, if Korea is a reliable guide, in the curb market. The last point implies that, to the extent that tight money policies affect (real) aggregate demand at all, they do so by curbing investment rather than consumption.

Much more important in the short run, however, is the transmission channel between monetary instruments and the *supply side* of the economy via credit financing of working capital needs. Working capital is needed to finance stocks of raw materials, semi-finished goods, intermediate imports, advance payments to workers, etc. Typically working capital needs are financed by bank or curb market credit. This in turn implies that the cost of credit (the real interest rate) is a component of input costs. Mark up pricing rules will therefore lead to an immediate cost push effect of high interest rates (the curb market rate is usually the relevant rate to look at) on prices. Also, under monopolistic market structures, a high cost of credit will not only lead to a short-run cost push effect on prices, but lead to a reduction in real output as real input costs have gone up.

This transmission channel, from tight limits on bank credit via the curb market and high costs of financing working capital into the supply side of the economy gives a stagflationary bias to tight monetary policies. Basically, what is going on is that this transmission channel adds an adverse-supply-shock aspect to policies of monetary restraint on top of the more traditional demand reducing effects. Tight money policies lead to expensive credit, which leads to an increase in a component of input costs; this in turn leads to more inflation and less output than would obtain without this transmission mechanism present. Tight money policies pushes firms into the curb market, drives up interest rates there, and so initiates the stagflationary effects mentioned above.

Nearly all bank credit, and certainly all curb market credit, has a very short maturity; a Korean curb market loan typically extends over one or two months. This implies that the stagflationary impact of a credit crunch via the credit-working capital link will work itself through the system quickly, say within one or two quarters. The demand restraining impact, however, typically works only gradually: first aggregate demand (investment) will fall, which over time, will increase unemployment; this in turn will after further lags ease real wage pressure and thus inflation. A typical response to a one shot tightening up of monetary policy would, therefore, be an initial acceleration of the inflation rate, after which demand effects take over, effecting a slow down of the rate. Both effects have a negative impact on output.

Existing macro-models have not incorporated this link between the financial sector and the supply side of the economy via the financing of working capital. The purpose of this paper is to do that, to construct a macro-model that incorporates the financial structure and pricing behavior I just discussed. This model should help in assessing the empirical relevance of these issues.

I have chosen South Korea as the testing ground for this exercise mainly because Korea has come close to conducting a laboratory experiment on this problem over the past 25 years: credit policies with respect to exporters and non-exporters have been markedly different. Exporters have essentially unlimited access to bank credit at subsidized rates, while non-exporters face higher rates and quantity constraints. Accordingly, non-exporters actively borrow in the Unorganized Money Market, something for which exporters have no incentive.

The model, which we present in the next two sections, has a variety of unusual features. An explicit attempt is made to incorporate the financial structure typical for Korea, and we think, for many other LDCs. The role of the commercial banking system providing intermediation between private wealth holders and firms in search for funds, the role of foreign capital inflows (determined endogenously in this model), the important place of the Unorganized Money Markets in the Korean financial system, and the use of credit obtained from those sources and abroad to finance fixed and working capital are all highlighted. The latter link between monetary conditions and the financing of working capital provides a transmission mechanism between monetary policy and the *supply side* of the economy, of crucial importance in many LDCs, but nevertheless usually ignored. Other features are incorporation of intermediate imports as a factor of production and of the implications this has for exchange rate policy. All this is done while imposing the budget and balance sheet constraints faced by the different actors in the economy, thus insuring consistency between the national accounts, flow of funds and end of period asset stocks and composition on the one hand, and

between those and the beginning of period asset stocks on the other. Section 2 focuses on the real sector part of the model; section 3 discusses the financial sector. In section 4 different monetary stabilization packages are simulated using the model presented in sections 2 and 3, and alternative policy measures are discussed; the simulation runs show strong short-run stagflationary effects of tight money policies. Section 5 offers some conclusions.

2. A macro model for Korea

2.1. *The real sector*

The basic structure of the real sector model is as follows. On the supply side, we distinguish between two sectors, exporters and non-exporters. The distinction is made mainly because the government (and the government controlled banking system) follows radically different credit policies with respect to these two sectors. Exporters have basically unlimited access to bank credit at subsidized rates, while non-exporters face higher rates and quantity constraints. The export sector is characterized by monopolistic competition so that firms determine their output and prices simultaneously subject to a downward sloping (foreign) demand curve, input prices and production technology. The domestic sector, which has a much lower degree of concentration as far as firm size is concerned, is assumed to price its products following a simple mark up rule and also faces a downward sloping demand curve (for the market as a whole), describing Korean allocation of their total expenditure over domestic and foreign goods. The output and pricing decisions are based on a model of the firm that starts from the assumption that primary costs (wages and costs of intermediate imports) are financed via credit. The interest rates that are relevant for the cost of credit are *not* exogenous. The *UMM* rate will be discussed in section 3. This production model is also behind the intermediate imports demand equation. The wage price sector is completed by an expectations augmented Phillips curve type relation allowing for catch up wage inflation as a result of last periods inflation surprises.

2.2. *The model equations*

In this section we will present the specific equations of the model; for conciseness of presentation we will also give the corresponding empirical results here rather than collecting them in a separate section.

2.2.1. *The export section*

Assume an exporter faces a downward sloping demand curve describing

foreign demand for Korean goods:

$$E = f(P_{ex}/P_f, Y_f), \quad (1)$$

where P_{ex} is Won price of Korean exports, E is Korean exports (in real terms), P_f is Won price of foreign goods with which Korean exporters compete, and Y_f is real foreign income. Foreign real income and prices are weighted geometric averages of the relevant Japanese and U.S. variables; these two countries received 55.6% of all Korean exports in the base year of all our price indices, 1975, while the third largest recipient was West Germany with less than 5% (in 1975). So approximating trade weighted 'world income' by a weighted average of U.S. and Japanese real income seems reasonable. The weights are 1975 export shares, rescaled to add up to one. The foreign price variable, similarly derived, is based on the Japanese and U.S. WPI. Grossman's conclusion that LDC exports mainly compete with domestic producers in the importing countries provides some support for this choice¹ as does the classic Houthakker-Magee paper on import demand functions [Grossman (1980), Houthakker-Magee (1969)].

After some experimentation with unrestrained lags, we finally opted for a Koyck-lag to get the following result:²

$$\ln E = -2.07 - 0.43 \ln \frac{P_{ex}(-1)}{P_f(-1)} + 0.17 \ln(Y_f^*) + 0.93 \ln(E(-1)), \quad (2)$$

(2.74)	(2.35)	(1.17)	(3.37)
(0.99)	(0.98)	(0.75)	(1.00)

$$R^2 = 0.99, \quad \text{estimation period: 66-II/79-IV.}$$

The estimates confirm the familiar high (world-) income elasticity of Korean exports, the estimates imply a long-run elasticity of slightly below 2.6. They also show a high elasticity with respect to relative prices: a short-run elasticity of 0.43 builds up to not less than 6.1 in the long run. With the strong response of Korean exports to the devaluations in 74 and 80 in mind, this will not come as a surprise either. Let us now turn to export prices. Consider a firm maximizing its profits subject to (1) and a production

¹A caveat is in order here: Grossman's results are obtained for the LDC's as a group and have nothing to say on competition between LDC's, e.g., they do not exclude predominance of competition between say Korean and Taiwanese exporters over competition between Korean exporters and Japanese and U.S. domestic producers.

²The estimation method used is Fair's variant of 2SLS [Fair (1970)], taking into account first-order serial correlation. All equations are estimated with seasonal dummies, which we do not report here, they seem to be of no interest. The data are on a quarterly basis, obtained from Bank of Korea publications [BoK (n.d.)], the IFS data tape or directly from Korean authorities. An appendix with a detailed description of the data is available on request.

function h giving E as a function of labour input L_e and intermediate inputs M_e (physical capital is kept fixed in the background):³

$$E = h(L_e, M_e)^{1/a}, \quad (3)$$

where a is defined such that h displays constant returns to scale. With capital kept fixed in the background, it is reasonable to assume $a > 1$.

Simple cost minimization given (3) and a fixed output level yields

$$C_e = E^a g(W, P_{im}), \quad (4)$$

where C_e are the total costs of labour and intermediates used to produce E , W is the nominal wage rate, and P_{im} is price of intermediate inputs (taken to be the Won price of intermediate imports in Won).

Now firms will need credit to finance primary costs during the production process. Under the assumption that all or a fixed proportion of primary costs are financed via credit taken out at a cost \bar{r}_e , profits are [using (4)]

$$PR = (1 + t_{subs})P_e E - E^a g(W, P_{im})(1 + \bar{r}_e), \quad (5)$$

where t_{subs} is the export subsidy rate, and profit maximization will lead to

$$(1 + t_{subs}) \left(P_e + E \frac{\partial P_e}{\partial E} \right) - (1 + \bar{r}_e) g(W, P_{im}) a E^{a-1} = 0 \quad (5')$$

which, after substitution of (1) to eliminate E , log differentiation and some reshuffling gives (hats indicate percentage changes)

$$\begin{aligned} \hat{P}_e = & \frac{(a-1)(1+\sigma)}{1+(a-1)(1+\sigma)} \hat{P}_f + \frac{\psi_1}{1+(a-1)(1+\sigma)} \hat{W} \\ & + \frac{\psi_2}{1+(a-1)(1+\sigma)} \hat{P}_{im} + \frac{(a-1)\eta_e}{1+(a-1)(1+\sigma)} \hat{Y}_f \\ & + \frac{1}{1+(a-1)(1+\sigma)} \widehat{(1+\bar{r}_e)} - \frac{1}{1+(a-1)(1+\sigma)} \frac{dt_{subs}}{1+t_{subs}}, \end{aligned} \quad (6)$$

where ψ_1 = wage share in primary costs, $\psi_2 = 1 - \psi_1$. This is the equation we will use in our empirical work. Together with the demand eq. (2), the pricing eq. (6) determines prices and volume of exports.

³The analysis of firm behavior presented here closely follows Bruno (1979).

The empirical results are

$$\begin{aligned} \hat{P}_e = & -0.92 + 0.36 \hat{P}_f + 0.21 \hat{W}(-2) \\ & (0.33) (3.45) (2.82) \\ & (0.26) (1.00) (0.99) \\ & + 0.13 \hat{P}_{im} + 3.63 \left(1 + \frac{\widehat{r_{ex}}}{100} \right) - 0.35 \frac{dt_{subs}}{1+t_{subs}}, \\ & (2.85) (3.73) (1.45) \\ & (0.99) (1.00) (0.85) \end{aligned} \quad (7)$$

$R^2 = 0.70$, estimation period: 66-III/80-II.

The export pricing equation shows, as expected, a strong and immediate impact of prices of imported intermediate goods (including, among other things, oil). Wage increases have a weak impact, and that with a delay only. Similar results have been obtained for Japan, which has a similar labor market structure [Ueda (1980)]. Also, export subsidies do moderate price increases, as shown by the negative coefficient on $dt_{subs}/(1+t_{subs})$. Increases in prices of foreign competitors lead to price increases of Korean exports, but not one for one: The coefficient on $\hat{P}_f = (\widehat{e \cdot P_f^*})$ is significantly smaller than one. This plus the clear importance of domestic cost variables in addition to the importance of foreign prices, confirms our assumption of some market power of Korea in its exports markets. The equation presents us with a few puzzles too, however. Changes in foreign real income show up in our export demand equation and should therefore play a role here too [see eq. (6)]. This is however not the case, \hat{Y}_f invariably got coefficients with the 'wrong' sign and deplorable t -statistics (way below 1). As a consequence the variable was left out altogether. Further, changes in the cost of credit have a dramatic impact. The cost of credit is represented by the special interest rate on export loans. As these are supplied with perfect elasticity at that rate r_e , r_e really measures the cost of credit, unlike the bank lending rate on loans to domestic producers. In fact, the coefficient on interest changes is embarrassingly high [although the reader should keep in mind that we use $(1 + \widehat{r_{e,100}})$, not $\widehat{r_e}$]. In view of the significance of this variable, it is not surprising to learn that the impact of interest rates on the business sector is an issue of major concern for the Korean authorities [see Westphal (1975), especially his description of the turbulent period 1969-1975].

2.2.2. Aggregate demand and output

Government expenditure is considered a policy variable. Private consumption (in real terms) depends on a distributed lag of disposable real

income and the real interest rate. Bank rates are not the relevant rates here, consumers clearly cannot borrow and lend at the going bank rates at will. The curb market does offer this opportunity, so one should expect the real curb market to be the relevant one. This is borne out by empirical evidence (see below). Both real consumption and real after tax income are derived from the corresponding nominal variables by deflation with the *CPI*. The results are

$$C_{pr} = 0.77 - 3.26 \ln \left(\frac{1 + r_{UMM}/100}{1 + CPI/100} \right) + 0.31 \left(\frac{Y - T}{CPI} \right) + 0.57 C_{pr}(-1),$$

(1.08)	(2.41)	(7.28)	(8.79)	(8)
(0.71)	(0.98)	(1.00)	(1.00)	

$$R^2 = 0.99, \text{ estimation period: } 66\text{-I}/79\text{-IV}.$$

Eq. (8) has a number of interesting features. The long-run saving propensity out of after tax income is quite high (0.28), a finding that has surely to do with the high proportion of Korean consumers that derives its income from agriculture (about 35%). The more interesting point is however the strong influence of the real curb market rate. The strong positive impact of this rate on saving (negative impact on consumption) shows the dominance of substitution effects over income effects: when future consumption becomes cheaper in terms of current consumption, both current and future consumption may rise (income effect), but intertemporal substitution away from current towards future consumption dominates, leading to a net decline in current consumption. One of the reasons may be that interest income (and certainly hard to trace interest earnings from the *UMM*) is not part of taxable income. This makes the Korean tax system look more like an expenditure or wage-income tax system than a true income tax system.

Tax revenues themselves are clearly not exogenous. Personal income taxes in Korea are largely wage taxes, which are withheld by employers on a monthly basis; this implies that there is no 'lumpiness' problem, with all of last year's taxes coming in one quarter. The tax revenue equation links tax revenues to nominal GDP and nominal imports:

$$TAXR = -14.6 + 0.05GNPKN(-1)$$

(1.21)	(3.77)	
(0.77)	(1.00)	(9)

$$+ 0.07GNPKN(-2) + 0.29MNWTOT(-1),$$

(6.25)	(5.63)	
(1.00)	(1.00)	

$$R^2 = 0.99, \text{ estimation period: } 67\text{-I}/79\text{-IV}.$$

Investment, in an admittedly ad hoc fashion, is assumed to depend on financial market variables: the cost of credit in the curb market and the flow of real credit forthcoming from the banking system. The idea behind this is that firms will first try to get whatever bank financing they can get, as it is offered at below-market clearing rates. This in turn makes rationing necessary, which explains why the quantity and not the price variable (real bank lending rate) is of relevance. For that part of planned investment not covered by bankloans firms will have to decide whether to go to the curb market or not to undertake the project involved. For this the real curb market rate is of relevance, as the curb-market rate, not hampered by regulations, clears the credit market [for empirical evidence backing up this claim, see van Wijnbergen (1981b)]. Changes in the bank lending rate, under our assumption of rationed bank credit, have no allocative impact, all they do is change a firm's cash flow position and the 'scarcity premium' earned by those who manage to obtain rationed loans. The relevant inflation rate in the definition of the *real* curb market rate is the rate of change of the own product price, which reflects the assumption of putty-clay technology [see Modigliani et al. (1974)]. As at other places in this and the following section expected values are approximated by actual values, using a rational expectations argument. The resulting measurement error is taken into account in the estimation procedure (by using IV on the relevant variables). The investment variable is *total* private fixed capital formation in real terms, where the deflator used is the wholesale price index.

$$\begin{aligned}
 IGRR = & 2.48 - 4.92 \ln \left[\frac{1 + r_{UMM}(-1)/100}{1 + \bar{P}_D(-1)/100} \right] & (10) \\
 & (2.81) \quad (2.72) \\
 & (0.99) \quad (0.99) \\
 & + 0.76 \Delta LSCBR(-1) + 0.62 IGRR(-1), \\
 & (3.28) \qquad (6.02) \\
 & (1.00) \qquad (1.00)
 \end{aligned}$$

$R^2 = 0.81$, estimation period: 66-I/79-IV.

These results show a strong impact of financial market variables on private fixed capital formation, with quantity signals (change in real credit to the private sector outstanding) of relevance in the regulated markets, and price signals (real interest rate in the curb market) in the unregulated curb market. These results also point to the importance of crowding out of private investment by additional government expenditure given tax revenues and money growth rules enforced via credit ceilings and capital controls [as are now (81) in operation in Korea]. Under those circumstances, additional

government expenditures will be financed by increases in credit to the government, which, given overall credit ceilings, will reduce credit to the private sector. Eq. (10) demonstrates that such a reduction has an immediate impact on private investment.

Not all demand for investment goods translates into demand for domestic goods, substantial parts of it (mainly machinery, etc.) leads to a demand for capital goods imports. This is captured by a demand equation for imports of capital goods linking the *volume* of imports of capital goods to the *volume* of private fixed capital formation:

$$\ln(M_{\text{cap}}) = 6.65 + 1.16 \ln(IGPRR), \quad (11)$$

(25.6) (11.2)

(1.00) (1.00)

$$R^2 = 0.89, \text{ estimation period: 65-III/79-IV.}$$

The elasticity with respect to real investment expenditure is about 1, the difference with 1 is not significant using a 5% two-tailed test (the relevant *t*-statistic is 1.56). No influence was found of relative price variables (in this case the relative price of foreign capital goods). The domestic component of private fixed capital formation is dominated by construction, while imports of capital goods completely consist of machinery and the like, so this evidence of complementarity should not come as a surprise.

The same holds of course for consumption, part of that falls on foreign goods too. However, imports of consumer goods are small in proportion to total consumption, and are dominated by rice imports. Rice imports moreover are entirely government controlled and sold domestically at prices that do not reflect the price at which they are bought in the world-market. Accordingly, we take the imports of consumer goods as a control variable of the government.

The equation describing the remaining category of imports, intermediate imports, is derived from the same model of firm behaviour used in the derivation of the pricing equations. There is one complication: we do not have separate data on intermediate imports used by exporters and by nonexporters. Accordingly, we have to aggregate the demand functions for intermediate imports into one demand function. The production model presented above leads to a demand function for intermediate imports depending on output, the real price of intermediate imports and the real interest rate. This can be obtained by simple differentiation of the cost function. If the production function underlying the unit cost function *g* is CES, the resulting demand function will depend on $P_{\text{im}}(1 + \bar{r}_i)$, P_i and Y_i only (where *i* is *E* or *D* referring to Exporters or producers for the Domestic

Market):⁴

$$\hat{M}_{I_i} = -\sigma_i(\widehat{P}_{im} + (1 + \widehat{r}_i) - \widehat{P}_i)a_i \widehat{Y}_i. \quad (12)$$

Now total intermediate imports M_I equal $M_{I,E} + M_{I,D}$, so

$$\hat{M}_I = \phi_1 \hat{M}_{I,E} + \phi_2 \hat{M}_{I,D} \quad \text{with} \quad \phi_i = M_{I,i}/M_I,$$

so using (12) we get

$$\begin{aligned} \hat{M}_I = & \phi_1 \sigma_E (\widehat{P}_{im} + (1 + \widehat{r}_E) - \widehat{P}_E) - \phi_2 \sigma_D (\widehat{P}_{im} + (1 + \widehat{r}_{UMM}) - \widehat{P}_D) \\ & + \phi_1 a_1 \widehat{Y}_D + \phi_2 a_2 \widehat{E}. \end{aligned} \quad (13)$$

In our empirical work we made the further simplification of replacing the two output components by gross output, $GOR = (GDP + M_I P_{im})/P_D$,⁵ which is right if $a_1 = a_2$ and the shares ϕ_i are equal to the corresponding shares in gross output. The impossibility of splitting up M_I over intermediates used for export production and those used for production for the domestic market prevented inclusion of disaggregated gross output concepts. The results (in log-linear form rather than percentage changes) are

$$\begin{aligned} \ln(M_{iml}) = & 10.9 + 1.35 \ln(GOR) - 0.85 \ln\left(\frac{P_{int}^* \cdot e}{P_{ex}}\right) \\ & (12.0) \quad (11.7) \quad (1.90) \\ & (1.00) \quad (1.00) \quad (0.94) \\ & - 0.21 \ln\left(\frac{P_{int}^* \cdot e}{P_D}\right) - 0.12 \ln\left(\frac{1 + r_{ex}/100}{1 + \widehat{P}_{ex}/100}\right) \\ & (0.49) \quad (1.15) \\ & (0.38) \quad (0.74) \\ & - 0.34 \ln\left(\frac{1 + r_{UMM}(-1)/100}{1 + \widehat{P}_D(-1)/100}\right), \\ & (2.67) \\ & (0.99) \end{aligned} \quad (14)$$

$$R^2 = 0.84, \rho = 0.8, \quad \text{estimation period: 66-I/79-IV.}$$

⁴A reminder may be useful: the bar on \widehat{r}_i indicates we are talking about a *real* interest rate.

⁵GDP *Nominal* gross domestic product.

The equation shows a strong impact of gross output, but relative prices and the cost of credit play a significant role too. For exporters relative prices seem to be more important, and the cost of credit less than they are for producers for the domestic markets.

2.2.3. Wages and prices

The pricing equation explaining prices of Korean products sold to the domestic market is a simple mark up on prime costs, wages and intermediate inputs, with the added novelty of the assumption that these costs are financed by credit taken out at the curb market and commercial bank credit:

$$\hat{P}_d = a_0 + a_1 \hat{W} + a_2 \hat{P}_{im} + a_3 (\widehat{1 + \bar{r}_{UMM}}), \quad (15)$$

where the constant term is supposed to capture 'trend' productivity growth due to capital accumulation and technological progress. The relevant interest rate is the *real* curb market rate, the rationale behind this is similar to the argument presented when we discussed the investment function. Like in most pricing equations estimated for DC's [see the well known Eckstein (1972) volume, Nordhaus (1972) and numerous other papers in BPEA], aggregate demand does not play a significant role in this mark-up. As a result, the model essentially is a sticky price model (producers just pass through cost factors), with output demand determined. Over time however, demand side pressure comes in via the effect of unemployment on real wages. In analyzing price setting for Korean products sold on the domestic market, we distinguish between the price of rice (taken to be a policy variable) and the price of other goods. Other implications of the distinction between agriculture and the rest of the economy are not yet taken into account [a version of this model that incorporates the agricultural sector explicitly is presented in van Wijnbergen (1981b)]. The pricing equation for P_D comes out as follows:

$$\begin{aligned} \hat{P}_d = & -7.94 + 0.54(\widehat{1 + r_{UMM}/100}) - 0.014(\widehat{1 + \hat{P}_d(-1)})/100 \\ & (1.81) (3.50) \qquad\qquad\qquad (0.66) \\ & (0.92) (1.00) \qquad\qquad\qquad (0.49) \\ & -0.057(\widehat{1 + \hat{P}_D(-2)})/100 + 0.15(\widehat{P_{int}^* \cdot e}) + 0.33(\widehat{P_{int}(-1) \cdot e(-1)}) \\ & (3.18) \qquad\qquad\qquad (1.75) \qquad (11.2) \qquad\qquad\qquad (16) \\ & (1.00) \qquad\qquad\qquad (0.91) \qquad (1.00) \\ & + 0.10(\widehat{P_{int}^*(-2)e(-2)}) + 0.22\hat{W}(-1) - 0.07\hat{W}(-2) + 0.15\hat{W}(-3), \\ & (3.09) \qquad\qquad\qquad (2.98) \qquad (1.03) \qquad (2.27) \\ & (1.00) \qquad\qquad\qquad (1.00) \qquad (0.69) \qquad (0.97) \end{aligned}$$

$$R^2 = 0.90, \quad \hat{\rho} = 0.2, \quad \text{estimation period: 66-II/80-II.}$$

As in the export pricing equation, wages come in with a delay only. There is also a strong and much quicker (when compared with the impact of wage changes) response to changes in the Won-price of intermediate imports, $e \cdot P_{int}^*$. This considerably complicates exchange rate management, because the exchange rate is a component of the Won-price of intermediate imports.⁶ Turning to the cost of credit variables, we found that the commercial bank lending rate had no impact on \hat{P}_d whatsoever. The curb market rate r_{UMM} does show up strongly however, a result that is compatible with our story of rationed bank credit and spillover of excess demand into the *UMM*. P_d then is added to the price index of rice (after suitable weighting, of course) to give the wholesale price index *WPIK* (the weights refer to the base year of the series, 1975):

$$WPIK = 0.9804P_d + 0.0696P_{rice}. \quad (17)$$

The consumer price index is also a weighted average of the price of rice and P_d (domestic price of non-rice goods produced in Korea),⁷ but the timing and weights are different. The timing of the non-rice component is based on regression analysis

$$CPIK = 4.52 + 0.64P_d + 0.11P_d(-1) + 0.27CPI_{rice},$$

(4.50)	(4.68)	(0.69)	(4.78)	
(1.00)	(1.00)	(0.51)	(1.00)	(18)

$$R^2 = 0.99, \quad \text{estimation period: 65-II/80-III.}$$

The third endogenous price in this model, the price of Korean exports, has been dealt with in section 2.2.1.

Now wages. The wage equation is a traditional expectation augmented Phillips curve, with one special twist: we do allow for catch-up wage demands when last period's inflation was higher than anticipated. The relevant inflation rate is of course the *CPI* inflation rate. The catch-up effect is modeled in a particularly simple way: assume workers have a target real wage W^* . At the end of the period, workers will set their nominal wage demands based on their current nominal wage and the anticipated *CPI* inflation rate over the coming period; if however an inflation surprise has eroded their real wage below W^* , there will be pressure for additional

⁶In the presence of intermediate imports, a devaluation has an unambiguously stagflationary impact. See van Wijnbergen (1980) for this point.

⁷Imports of non-rice consumer goods are negligible in Korea. Rice imports are handled by the government and sold at prices unrelated to the worldmarket prices at which they were bought.

nominal wage increases to catch up with this erosion,⁸

$$\hat{W} = c_0 + c_1 \widehat{CPI^e} + c_2 U(-1)^{-1} + c_3 \left(W^* - \frac{W(-1)}{CPI(-1)} \right). \quad (19)$$

If W^* is a declining function of U , say $W^* = f_0 + f_1 U(-1)^{-1}$, we get

$$\hat{W} = a_0 + a_1 \widehat{CPI^e} + a_2 U(-1) + a_3 \frac{W(-1)}{CPI(-1)}. \quad (19')$$

If being off target counts last period, a_3 should be significantly less than zero. (19') can be used to define a target wage given the beginning of period wage, unemployment and expected CPI inflation. Gradual adjustment towards that target wage gives rise to the following wage equation:

$$\begin{aligned} \ln(W) = & -0.68 + 0.20(\ln(CPIK) - \ln(CPIK(-1))) \\ & (3.40) \quad (0.72) \\ & (1.00) \quad (0.52) \\ & -0.38(\ln(W(-1)) - \ln(CPIK(-1))) \\ & (3.57) \\ & (1.00) \\ & + 1.14 \ln(W(-1)) + 0.52 U_{SA}(-1)^{-1}, \\ & (2.66) \quad (2.54) \\ & (1.00) \quad (0.99) \end{aligned} \quad (20)$$

$$R^2 = 0.99, \quad \text{estimation period: } 66\text{--}I/79\text{--}I.$$

The results show the importance of catch-up wage demands, the term capturing that effect has a strongly negative coefficient (a t -statistic of 3.57). Further the moderating impact of unemployment (adjusted for seasonal variation) on wage demands is clear, the inverse of the beginning of period unemployment rate adjusted for seasonal variation, $U_{SA}(-1)$, shows up with a significantly positive term.

2.2.4. Closing the real sector model

Two more equations are needed to close the real sector part of the model. The first concerns employment, the second potential output.

In line with the putty-clay assumption used elsewhere in this model, we do not use a neoclassical labor demand function linking labor demand to real

⁸ U is measured as end of period unemployment, so we want $U(-1)$ in eqs. (19) and (19').

main features of this model are the assumption of imperfect substitution between different assets and the attention paid to the impact of balance sheet constraints on the specification of behavioural equations and the structure of the model. Further salient features are an explicit incorporation of the curb market and financial intermediaries and the attention paid to the role played by firms and banks (rather than private wealth holders, as is usually done) in determining foreign capital inflows.

3.1. Deposit Money Banks (DMB's)

DMB's can be subdivided into domestic commercial banks and branch offices of foreign banks.⁹ Although the size of the loan portfolio of foreign banks is relatively small, there is an important difference between them and Korean banks that warrants special attention: their liability structure is entirely different, with inter-office loans from abroad making up roughly 60% of their sources of funds (in 1980). Foreign sources provide only 2% of the total of funds available to domestic banks. These inter-office loans skyrocketed after the creation of special swap arrangements, available to foreign banks only, under which foreign banks sell foreign currency to the BoK under repurchase contracts. In the model presented here we will treat inter-office loans from abroad separately from other foreign borrowing by DMB's.

Table 1
DMB borrowing at foreign capital markets (in billion Won).

	Inter-office loans to foreign offices	Other DMB borrowing abroad
Dec. 74	43	238
Dec. 75	114	305
Dec. 80	1,875	1,055

Inter-office loans to Korean branch offices by their parent banks are determined in the portfolio allocation process of these parent banks. This leads to an equation linking the volume of inter-office loans LNIO to the total volume of loans made by foreign (mainly Japanese and U.S.) banks, Korean, Japanese and U.S. interest rates and, in general, the expected rate of

⁹These two groups make up what are called 'commercial banks' in Korean statistics. A third category of DMB's, so-called 'Special Banks' (banks for agriculture, housing, fishery and the Korean Exchange Bank), are small (roughly 10% of the DMB's loan volume is theirs), so we lumped them together with domestic commercial banks.

devaluation of the Won versus the U.S. dollar and the Yen. Due to the exchange rate regime over the estimation period (pegging to the U.S. dollar), only expectations with respect to the Yen are relevant. Preliminary estimations showed a total irrelevance of U.S. variables, inter-office loans are apparently dominated by those from Japan. The results (after exclusion of U.S. variables) are

$$\ln \left[\frac{LNIO}{ERWY} \right] = -35.8 + 5.98 \ln \left[\frac{1 + RLD/100}{1 + RLCBJ/100} \right] \\
\begin{array}{ccc}
(18.6) & (6.45) & \\
(1.00) & (1.00) & \\
+ 3.31 \ln \left[\frac{LSCBJ}{ERWY} \right] + 0.50DSWAP, & & \\
(19.9) & (3.83) & \\
(1.00) & (1.00) & (23)
\end{array}$$

$$R^2 = 0.98, \quad \text{estimation period: 70-II/80-II,}$$

where *LSCBJ* is the Total Loan Supply Japanese Banks in Won, *LNIO* are Inter Office loans (Won), *ERWY* is the Won-Yen exchange rate, *RLCBJ* is the Japanese call money rate, *RLD* is the Korean Bank lending rate, and *DSWAP* is the Dummy for swap arrangements; 0 before 75, 1 from there on.

Interest rate differentials between Korean lending rates (which foreign branch offices can charge on their loans) and the rate on comparable short-run bank assets in Japan (call money) come in very significantly (a *t*-statistic of 6.45), as does the total of all loans and discounts by Japanese banks. The dummy accounting for the introduction of swap arrangements with the BoK also has a significant coefficient and the 'right' sign. Expected exchange rate changes did not have a significant effect. This could be due to discrepancies between the premium implied by the swap arrangement and actual expectations. No information is available on the terms of these arrangements, so this is impossible to verify.

Borrowing abroad by domestic banks depends on domestic lending rates and the costs of obtaining funds abroad: as long as the marginal cost of borrowing abroad is less than the lending rate, the stock of foreign liabilities should be increased. The costs of borrowing abroad depend on the relevant Eurodollar rate, a country-specific mark-up factor, and the cost of obtaining government guarantees. In the model analyzed in appendix A,¹⁰ these latter costs are assumed to be an increasing function of the banks total foreign

¹⁰Available upon request.

liabilities. Further, there is evidence [Kim (1976)], that the BoK encourages private banks and firms to borrow abroad when the BoK's Net Foreign Assets (*NFA*) is considered tight. We tried to capture this by including the number of months of imports that could be financed from current *NFA* stock of the BoK as a proxy for this effect. The appropriate scale variable in the equation would have been net worth of the *DMB*'s, which we approximate by a time trend. Finally we borrowed from finance theory the notion that a firm should maximize its value in terms of the goods its shareholders consume, which leads to the *CPI* as the appropriate deflator. All this leads to

$$\begin{aligned} \frac{L_f}{CPI} = & -0.67 + 0.10(RLD - REUR) + 0.02 TIME \\ & (1.08) (2.34) \qquad (1.59) \\ & (0.71) (0.97) \qquad (0.88) \qquad (24) \\ & -1.85 \frac{NFA(-1)}{MNWTOT(-1)} + 0.62 \frac{L_f(-1)}{CPI(-1)}, \\ & (3.18) \qquad (5.06) \\ & (1.00) \qquad (1.00) \end{aligned}$$

$R^2 = 0.79$, estimation period: 70-I/80-III.

As in the previous equation, the relevant interest rate differentials (here between the Eurodollar rate and the Korean bank *lending* rate) strongly influence the foreign liabilities banks choose to incur. Not surprisingly, the data did not contain sufficient information to capture the effect of exchange rate expectations: the relevant rate is the Won-dollar rate, which was fixed over most of the sample period. The proxy for BoK manipulation of cost and availability of loan guarantees, last periods Net Foreign Assets of the BoK (end of period value) over last periods total imports, is highly significant and has the right sign. This lends support to Kim's (1976) claim that the BoK encourages the private sector to borrow abroad whenever reserves are tight and vice versa.

Other sources of funds are dominated by time and saving deposits and, to a lesser extent, demand deposits. These are covered in the section on private portfolio allocation. Finally the BoK is an important source of funds (about 10% of total *DMB* liabilities is with respect to the BoK). BoK to *DMB* lending is considered a policy instrument.

Then the assets side. The model underlying bank behavior is spelled out in the appendix, but let us repeat the results for the loan supply function. Loans extended to non-exporters will depend positively on the lending rate and beginning of period availability of funds from depositors and the BoK. They

will further depend negatively on the BoK discount rate and reserve requirements, all standard results. Via a mechanism we discuss in the appendix one expects a negative correlation with the volume of export loans, but this effect turned out to be very weak and was therefore omitted. Finally, as shown in the appendix, the loan supply to non-exporters will, in the absence of reserve requirements against foreign liabilities, depend one for one on current foreign liabilities, the other policy instrument in the hands of the *DMB's* here considered. All this leads to a loan supply function for loans to non-exporters:

$$\begin{aligned}
 L_{nc} = & 29.9 + 10.5(RL_D - R_{DISC}) + 0.93 DEP(-1) \\
 & (1.23) (2.73) \quad (50.9) \\
 & (0.77) (0.99) \quad (1.00) \\
 & + 0.60 NDCCB(-1) + 0.999(L_f + LNIO), \\
 & (7.18) \quad (6.67) \\
 & (1.00) \quad (1.00)
 \end{aligned}
 \tag{25}$$

$$R^2 = 0.99, \text{ estimation period: } 66\text{--}I/79\text{--}I,$$

where *DEP* is the end of period sum of demand, time and savings deposits. *NDCCB* is end of period *net* borrowing from the BoK. The 'net' refers to the fact that we netted out the item 'securities' against borrowing from the BoK. This item consists mainly of government bonds, stock in government-run enterprises, etc. [Kim (1976)]. *DMB's* are really captive buyers for all these things, so we netted them out against BoK credit to *DMB's*.

The estimation period was confined to (66-I/79-I) because the Korean authorities switched towards direct limits on total bank lending as an instrument of monetary policy in the second quarter of 1979. The equation shows a strong impact of the difference between the lending rate and the discount rate.¹¹ Beginning of period deposits and net credit from the BoK have a significant impact on end of period loans, as expected. An earlier version contained the rate of reserve requirements *RR* and loans to exporters (see below) to capture the crowding out effect of the preferential credit policy with respect to exporters, but the relevant coefficients were insignificantly different from zero although they did have the right sign (negative). Finally the prediction of a one for one pass-through of funds borrowed abroad into loans extended domestically is clearly confirmed.

¹¹ Apart from their sign the coefficients when estimated separately were not significantly different from each other, so we imposed equality.

The final component of domestic credit is credit to exporters. Commercial bank extend loans to exporters at subsidized rates, but can rediscount 80% of them at the BoK, also at subsidized rates. There is no quantity constraint on that rediscounting facility. Accordingly loans to exporters are demand-determined and will be dealt with in the subsection of firm behavior.

The remaining two items on the asset side are required and free reserves. Required reserves clearly follow from the liability structure. Free reserves then become the residual item, dictated by the behavioral equations specified above and the balance sheet constraint stating that total liabilities are equal to total assets.

3.2. Firm behavior

For our analysis of the financial sector, we are mainly interested in the liability management of firms. There is a clear dichotomy here between exporters and non-exporters; exporters have essentially unlimited access to bank credit and therefore have no incentive to enter the Unofficial Money Market as borrowers. Their demand for loans is simply based on the model presented in van Wijnbergen (1979a), where demand for loans depends on the level of output, the costs of inputs and the real cost of credit. This leads to the following result:

$$\begin{aligned} \ln\left(\frac{L_{EX}}{P_{ex}}\right) &= -5.60 - 0.49 \ln\left(\frac{1 + RL_{EX}/100}{1 + \hat{P}_{ex}/100}\right) \\ &\quad (2.55) \quad (1.25) \\ &\quad (0.99) \quad (0.79) \\ &+ 0.84 \ln \frac{PMINT \times ERWD}{P_{ex}} \quad (26) \\ &\quad (2.22) \\ &\quad (0.97) \\ &+ 0.57 \ln(E) + 0.38 \ln\left(\frac{L_{EX}(-1)}{P_{ex}(-1)}\right), \\ &\quad (3.47) \quad (2.64) \\ &\quad (1.00) \quad (0.99) \end{aligned}$$

$$R^2 = 0.96, \quad \text{estimation period: 66-I/79-IV,}$$

where L_{EX} are loans to exporters (billion Won), RL_{EX} is lending rate charged on L_{EX} , P_{ex} are Won price of exports, $PMINT$ is the Dollar price of intermediate imports, $ERWD$ is the Won-dollar exchange rate, and E are real exports.

Somewhat surprisingly, the cost of intermediate inputs is the only input cost factor to show up significantly, wage costs do not seem to play a role here. The real cost of credit parameter has the right sign and a plausible magnitude, but is estimated very imprecisely, the *t*-statistic on its parameter is only 0.79. The other parameters present no surprises.

Non-exporting firms face a different situation. Bank loans are rationed, they face a quantity constraint. For the rest of their credit needs they have to either enter the curb market or the Eurodollar market.¹² Given their balance sheet constraint, a behavioral equation for one of the two will imply one for the other. We are choosing the foreign liability part; so we now turn to foreign sources of credit and the capital account of the BoK.

Unfortunately there is no way to separate foreign liabilities incurred by the export sector from those incurred by the non-export sector, so we are forced to estimate an aggregate function explaining total foreign liabilities as a share of all liabilities incurred by firms as a function of the Eurodollar market rate, the curb market rate (the alternative source of funds for non-exporters), and the rate on export loans (the alternative source of funds for exporters). The result is eq. (8):

$$\begin{aligned}
 \ln\left(\frac{FLPSW}{WPIK}\right) &= 0.41 - 1.28 \ln\left(1 + \frac{REUR}{100}\right) + 0.15 \ln\left(1 + \frac{RUMM}{100}\right) \\
 &\quad (2.15) \quad (1.96) \qquad\qquad\qquad (0.91) \\
 &\quad (0.96) \quad (0.94) \qquad\qquad\qquad (0.63) \\
 &\quad - 0.04 \times \ln\left(1 + \hat{e}_d^w \frac{(-1)}{100}\right) - 0.05 \ln\left(1 + \hat{e}_s^w \frac{(-2)}{100}\right) \\
 &\quad (0.55) \qquad\qquad\qquad (0.88) \\
 &\quad (0.42) \qquad\qquad\qquad (0.57) \\
 &\quad - 0.16 NFA(-1) / MNWTOT(-1) \qquad\qquad\qquad (27) \\
 &\quad (3.64) \\
 &\quad (1.00) \\
 &\quad + 0.18 \ln\left(\frac{FLPSW + LSDMBNE + L_{EX} + LSUMM}{WPIK}\right) \\
 &\quad (3.07) \\
 &\quad (1.00) \\
 &\quad + 0.69 \ln\left(\frac{FLPSW(-1)}{WPIK(-1)}\right), \\
 &\quad (19.5) \\
 &\quad (1.00)
 \end{aligned}$$

$$R^2 = 0.99, \quad \text{estimation period: 69-II/79-I,}$$

¹²Retained earnings are modeled as a loan from the firm owner to the firm and are lumped together with loans from the curb market.

where *FLPSW* are total net foreign liabilities of the non-bank/non-government sector (billion Won), *REUR* is the Eurodollar rate in London (3 months), *RUMM* is the curb market rate, and *LSUMM* is the volume of *UMM* loans outstanding.

The domestic lending rate did not play any role at all which should not come as a surprise after what was said in the previous sections on disequilibrium in the market for bank credit. The curb market rate does come in with the right sign and a coefficient that seems to have a reasonable magnitude, but the standard error is quite large. The 3-month Eurodollar rate has the expected negative sign, as do the proxies for expected exchange rate changes. Also our proxy for BoK encouragement to borrow abroad in periods of 'tight' reserves shows up significantly and with the right sign. Finally the equation can degenerate into a 'flow-' approach equation if the coefficient of the lagged endogenous variable (which came in via a stock-adjustment scheme) is not significantly different from one, thus allowing for a test of the two approaches (stock versus flow approach to the capital account of the BoK) against each other. The flow version is definitely rejected, with a *t*-statistic on the difference between the coefficient of the lagged left-hand side variable and one of 8.86, thus confirming our 'stock-' approach to the capital account.

Eq. (27), together with the CA-deficit that comes out of the part of the model presented in Chapter 8, plus some accounting identities allow us to derive the Net Foreign Assets position of the consolidated banking system, the second component of the money supply. More on that in section 5. For the determination of money demand, we have to consider the private sector's portfolio allocation. This we will do in the next section.

3.3. The private sector

The analysis of the commercial banking system and a part of the non-bank business sector presented in the two previous sections allow us to build up the components of the supply of *M2*. The demand for *M2* and its components comes out of the public's allocation of its wealth over *M2* and other assets. Private individuals can hold their wealth either as currency, demand or time deposits at *DMB*'s or as loans outstanding at the *UMM*. The latter option comes down to direct lending to firms, bypassing the banking system (disintermediation).

Contrary to what is usually assumed in the (scarce) literature on this subject, the *UMM* is largely an urban phenomenon in Korea. In a survey done by the Sogang University of Seoul, it was found that 79% of *UMM*

lending was to the urban business sector, 7% to urban consumers and the remaining 14% to rural households (the survey was undertaken in 1969). Kim (1976), from whom this information is taken, does not provide information on sample design etc., so one should be careful in interpreting these data. Moreover Kim (1976) reports that urban and rural credit markets are entirely separated. In what follows we will confine our attention to the urban business sector.

In the same survey it was found that 75% of all firms responding had some debts outstanding at the *UMM*, while 10% had more than 50% of their debts at the *UMM*. The importance of the *UMM* has been declining over time however, since the interest rate reform in 1965 improved the functioning of financial intermediaries, and with increasingly easy access to foreign capital markets. Nevertheless the *UMM* continues to play an important role. For many small firms the *UMM* is the only place to go when turned down by commercial banks (which, as mentioned earlier, only happens to non-exporters, exporters have automatic access to credit). In the same survey, 93% of the firms with *UMM* debts gave as the reason for operating in the *UMM* the unavailability of (sufficient amounts of) bank credit. It seems clear that, from the demand side, the *UMM* is largely a spillover phenomenon kept alive by the occurrence of credit rationing by commercial banks, which have no control over their lending rates.

So much for the demand for *UMM* loans, but who supplies them? In the Sogang University survey, 73% of the loans made to the urban business sector came from 'relatives and friends and professional money lenders' with the latter taking up 33%. 7.3% came from 'men of same trade' and the remaining 19.3% from 'miscellaneous', including merchants. So only about 20% represents trade credit. According to Kim (1976), professional money lenders are usually middlemen acting for wealthy businessmen. These results seem to lend support to the approach taken in van Wijnbergen (1979a). There I assumed that, in the absence of significant securities markets and an open market in interest-bearing government debt, individuals can hold their wealth as currency, savings and demand deposits at the banks, or engage in direct lending to the business sector via the *UMM* (financial disintermediation). This leads to traditional portfolio allocation equations for the different *M2*-components, with *RUMM*, *RTD*, \widehat{CPI} , income and wealth ($M2 + LSUMM$) as arguments.^{13,14} The loan supply at the *UMM* can then be derived via the wealth constraint a private individual faces,

¹³ *RUMM* is the curb market rate, *RTD* is the time deposit rate, \widehat{CPI} is *CPI* inflation (= minus the real rate of return on cash balances), *LSUMM* is the volume of loans outstanding at the curb market.

¹⁴ Simple accounting shows that within the financial structure assumed here, $M2 + LSUMM$ equals the monetary base plus the value of the capital stock; accordingly this is an appropriate definition of wealth.

$$\begin{aligned}
 \ln\left(\frac{TD}{CPIK}\right) &= 0.36 - 0.89 \ln\left(1 + \frac{RUMM}{100}\right) + 1.63 \ln\left(1 + \frac{RTD}{100}\right) \\
 &\quad (1.71) \quad (2.42) \qquad\qquad\qquad (4.08) \\
 &\quad (0.91) \quad (0.98) \qquad\qquad\qquad (1.00) \\
 &\quad - 0.38 \ln\left(1 + \frac{\widehat{CPIK}}{100}\right) + 0.02 \ln\left(\frac{GNPKN}{CPIK}\right) \\
 &\quad (3.51) \qquad\qquad\qquad (0.53) \qquad\qquad\qquad (28) \\
 &\quad (1.00) \qquad\qquad\qquad (0.40) \\
 &\quad + 0.93 \ln\left(\frac{TD(-1)}{CPIK(-1)}\right), \\
 &\quad (42.4) \\
 &\quad (1.00)
 \end{aligned}$$

$R^2 = 0.997$, $\rho = 0.3$, estimation period: 64-I/79-IV.

Reshuffling the variables to derive dependence on real rates of return of course leaves the coefficients on the two interest rates unchanged, but results in a negative coefficient for the real rate of return on currency (*minus* the CPI inflation rate); the coefficient on $\ln(1 + \widehat{CPIK}/100)$ becomes +0.36. See table 2.

Table 2

Elasticity with respect to the real rate of return on:

Alternative asset 1:	the curb market	$\left(\ln\left(1 + \frac{RUMM}{100}\right) - \ln\left(1 + \frac{\widehat{CPIK}}{100}\right)\right)$:	-0.89
Alternative asset 2:	currency	$\left(-\ln\left(1 + \frac{\widehat{CPIK}}{100}\right)\right)$:	-0.36
Itself:	time deposits	$\left(\ln\left(1 + \frac{RTD}{100}\right) - \ln\left(1 + \frac{\widehat{CPIK}}{100}\right)\right)$:	+1.63

Clearly, substitution between the curb market and time deposits is of more importance than substitution between currency and time deposits. This is of crucial importance for the analysis of the effect of time deposit rate changes on inflation and economic activity. The fact that TD's are closer substitutes to curb market loans than to MI, together with the absence of wealth effects on the demand for time deposits (via which increased savings could have

been channeled into *TD*'s over time), is a strong indication that the phenomenal increase in time deposits after the interest rate reform in 1965 was caused by a switch from lending at the *UMM* to time deposits at *DMB*'s by private asset holders, and not by additional savings as is usually claimed.

The equation for *MI* showed no significant wealth or interest rate effects, but a strong dependence on the own rate of return, minus the *CPI* inflation rate:

$$\ln\left(\frac{MI}{CPIK}\right) = 0.08 - 0.40 \ln\left(1 + \frac{\widehat{CPIK}}{100}\right) + 0.03 \ln\left(\frac{GNPKN}{CPIK}\right) \\ (0.81) \quad (4.50) \quad (0.50) \\ (0.58) \quad (1.00) \quad (0.38) \quad (29)$$

$$+ 0.97 \ln\left(\frac{MI(-1)}{CPIK(-1)}\right); \\ (21.6) \\ (1.00)$$

$$R^2 = 0.998, \quad \text{estimation period: 64-I/79-IV.}$$

Eqs. (28) and (29) imply a reasonable supply equation for loans on the curb market via the wealth constraint, with positive dependence on its own real rate of return, negative dependence on the real rate of return on the two alternative assets (*MI* and Time Deposits) and a unit wealth elasticity.

Finally we have to describe the allocation of *MI* over demand deposits and currency because we need total deposits (*TD* and *DD*) in the loan supply equation of *DMB*'s. For simplicity, we choose a variant on the fixed currency-*DD* ratio:

$$DD = 2.81 + 0.18M + 0.69DD(-1), \\ (0.19) \quad (2.70) \quad (5.37) \\ (0.15) \quad (0.99) \quad (1.00) \quad (30)$$

$$R^2 = 0.99, \quad \text{estimation period: 66-I/80-IV,}$$

which represents a gradual adjustment to a fixed share of demand deposits in *MI*.

3.4. Pulling the threads together

The building blocks outlined in the preceding sections allow us to construct money (*M2*) supply and demand.

The money supply simply equals

$$M2^s = NDCG + L_{nc} + L_{EX} + NFA - OL, \quad (31)$$

NDCG, Net Domestic Credit to the Government, equals last period's *NDCG* plus the fraction of the budget the government chooses to finance via recourse to the BoK. Credit to the private sector [to non-exporters (L_{nc}) and to exporters (L_{EX})] is explained by eqs. (25) and (36). All this is fairly straightforward. One has to be careful however in setting up *NFA*, Net Foreign Assets of the consolidated banking system (the BoK and the *DMB's*). Clearly foreign borrowing by the banking system does not affect their *net* assets position,¹⁵ this changes only via an unbalanced current account and foreign capital inflows into the non-bank sector. A further wrinkle is added by exchange rate changes: capital gains (losses) on beginning of period Net Foreign Assets because of intra period exchange rate changes *do* increase end of period Net Foreign Assets, but do *not* automatically lead to changes in the money supply. The capital gain (loss) on the asset side is offset by a matching entry in a revaluation account on the liability side, leaving *M2* unchanged. We have 'submerged' this revaluation account into the residual category Other Liabilities, *OL*, which therefore follows eq. (32).¹⁶

$$OL(t) = OL^*(t) + NFA(t-1) \times \frac{ERWD(t) - ERWD(t-1)}{ERWD(t-1)}. \quad (32)$$

The demand side of the money market is simply the sum of the demand for currency, demand and time deposits by the public:

$$M2^D = MI + TD \quad (33)$$

with *MI* and *TD* determined in eqs. (29) and (30).

The final equilibrium condition, implicitly determining the curb market rate, is simply

$$M2^s = M2^D. \quad (34)$$

It is easy to show by appropriate use of accounting identities, the balance sheet constraints imposed on all the actors in this model and the assumption that demand and time deposits are demand determined, that (34) translates into a demand equals supply condition for monetary base (the 'inside' component of *M2*) with demand coming from the public (currency) and

¹⁵We endogenized these capital inflows via the banking system nevertheless [eqs. (23) and (24)] because of the role they play in determining the *DMB's* loan supply.

¹⁶Note that all variables refer to end of period values.

banks (reserves) and supply determined by accumulated credit to the government and Net Foreign Assets.

A final accounting identity incorporated in the model, and needed to close it, is worth mentioning explicitly here. We have explicitly linked saving by private individuals to private asset accumulation. As said before, private assets are either held as loans on the curb market (*LSUMM*), currency or demand and time deposits at *DMB*'s.

The savings/asset accumulation implies that nominal private saving should equal nominal increases in total wealth:¹⁷

$$\begin{aligned} LSUMM(t) + M2(t) = & LSUMM(t-1) + M2(t-1) + GNPKN(t) \\ & - TAXR(t) - CPRN(t) \end{aligned} \quad (35)$$

or disposable income minus private consumption equals wealth accumulation. Although this is of course standard in theoretical growth models, we are not aware of applied models that display this consistency between beginning of period asset stocks, savings decision determined in the real sector and the end of period asset stocks whose composition is determined in the financial sector. The model presented here seems to be the first applied model that integrates the real and financial sector in an internally consistent way. It can generate the national accounts, flow of funds and end of period asset stocks and composition that are internally consistent with each other and with the beginning of period asset stocks carried over from the previous period.

4. Some simulation exercises

To indicate the empirical relevance of short-run stagflationary effects of tight money policies, I present some simulation runs set up with the model presented in the previous two sections. The variables singled out for presentation are first of all the inflation rate and real output; then the current account to see whether expenditure adjustment has also taken place; and finally, real investment, as we would like to know whether, given a certain downward adjustment in expenditure, it comes from consumption or investment. This issue is clearly of relevance when analyzing potential medium-term costs of short-run stabilization attempts.

The first series of figures (figs. 2a-5a) compares the base-run results using actual data for money growth with a simulation run where we enacted a once and for all reduction in the level of *M2* in the first quarter of 1979 of 5%.¹⁸ The second

¹⁷This is compatible with real savings equals real wealth accumulation if real income is defined properly (i.e., includes capital gains, etc.). See for example Levhari and Patinkin (1968).

¹⁸The runs are derived with a version of the model in which capital controls and direct credit limits are used to directly control *M2*.

series of pictures (figs. 2b–5b) compares the base level run with a simulation run where we chopped 10% off the $M2$ growth rate in all the three years considered. In the discrete time framework considered here the reduction in $M2$ growth is really equivalent to a repeated series of reductions in the level, with the shocks increasing in absolute size. The actual ($M21$) and simulated $M2$ -path ($M22$ for the one-shot level change, $M23$ for the reduced growth rate) are given in fig. 1.

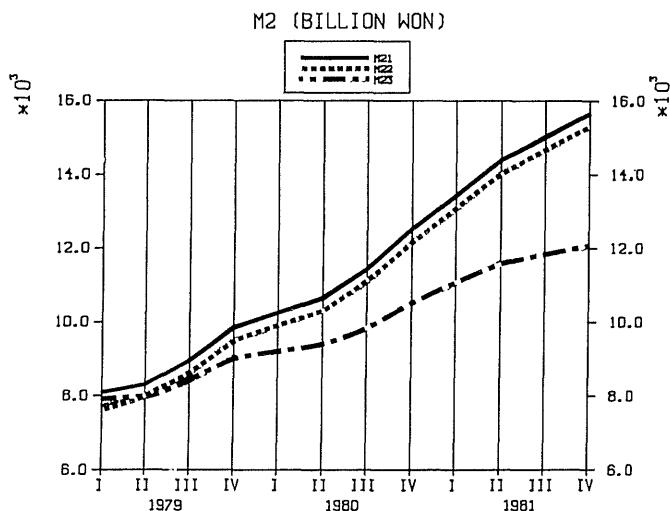


Fig. 1

Let us consider the effects of a one-shot monetary contraction, figs. 2a–5a.

The impact on inflation is exactly as predicted. The 5% reduction in $M2$ with respect to the base level value in the same period (not with respect to the previous period!) has a dramatic impact on inflation in the first quarter. In judging the size of the jump one should of course keep in mind that the contraction enacted here is larger than anything that could qualify as a feasible policy measure. Demand effects take over later on: inflation is actually reduced below base level values for the next 2 quarters. After that we are back to normal again, as one would expect after a once and for all reduction in the level of $M2$. The drop in output starts immediately, becomes more severe in the second quarter when restrictive demand effects are added, and then fades away in the 3rd and 4th quarter. Over the first year, the real output loss caused by the 5% cut in $M2$ is about 2% of real GNP . Expenditure however also adjusts, as can be seen from the results from the current account data presented in fig. 4a: after a slight deterioration in the first quarter, restrictive demand effects take over and the current account deficit improves considerably (with about 1 billion US\$). However, as can be seen from fig. 5a, the adjustment falls on investment. After the first year, all variables return to base-run levels.

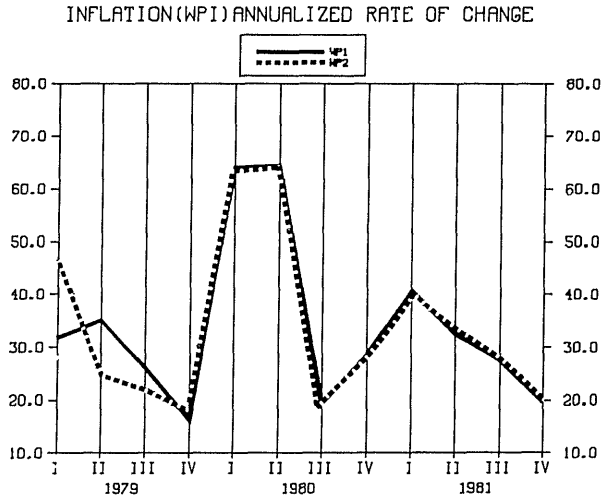


Fig. 2a

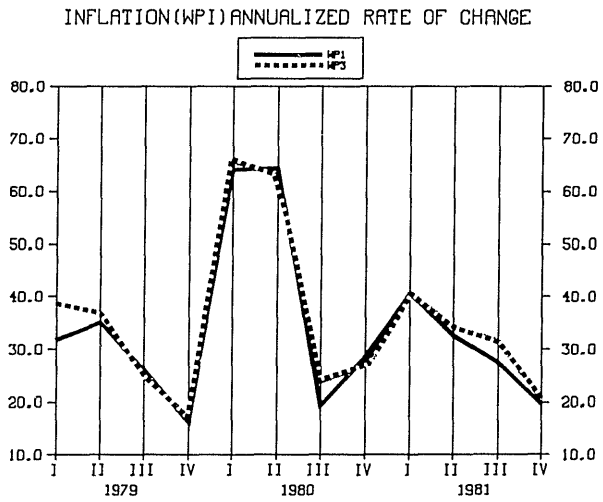


Fig. 2b

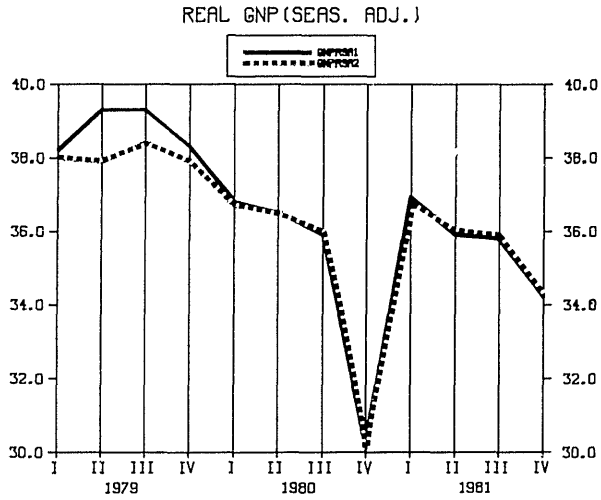


Fig. 3a

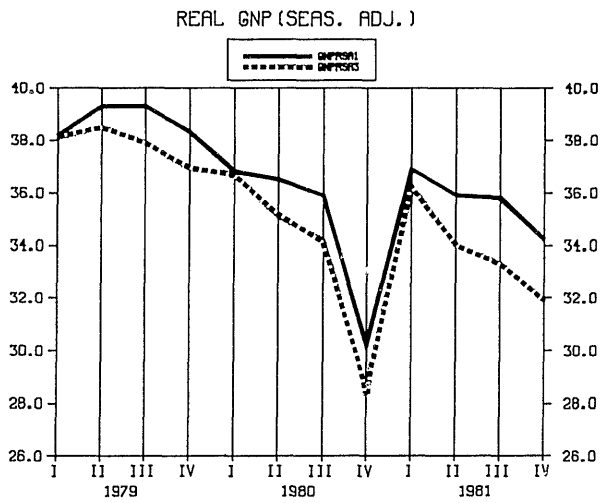


Fig. 3b

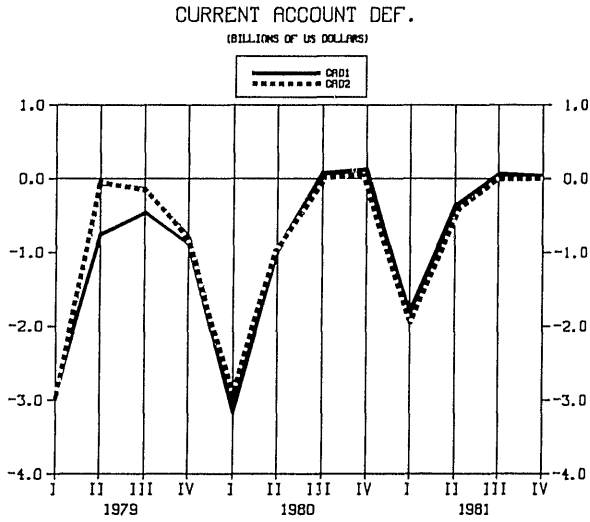


Fig. 4a

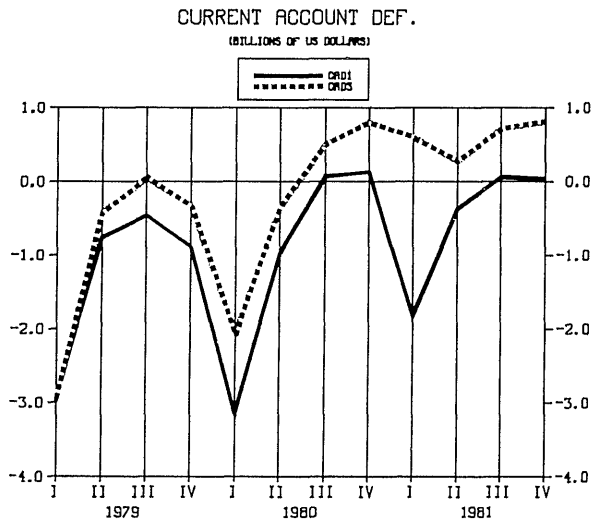


Fig. 4b

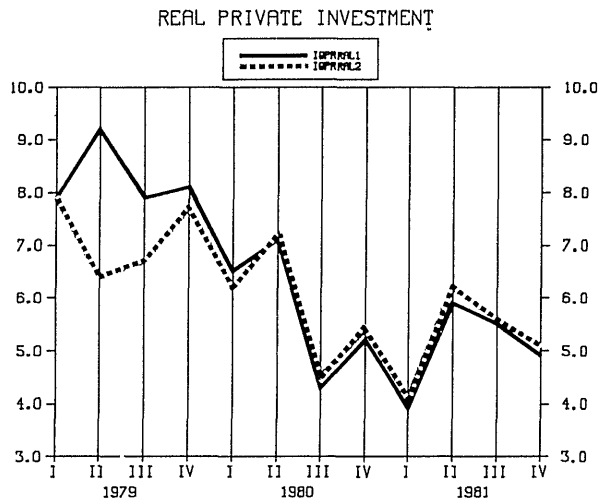


Fig. 5a

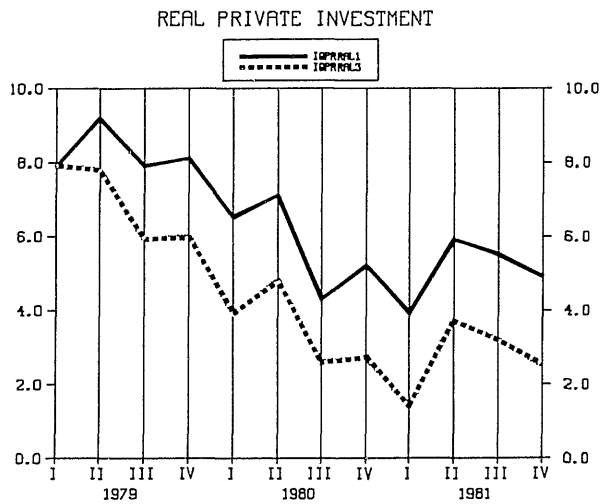


Fig. 5b

If instead of a once and for all reduction in $M2$, we enact a series of such shocks via a reduction in the $M2$ -growth rate, the results become quite dramatic. The policy measure enacted is rather drastic, the 10% chopped off the $M2$ growth rate cuts it roughly in half. Again, we see the initial perverse impact on inflation (fig. 2b), but now the inflation-reducing effect in later quarters is more or less kept in check by the inflationary impulses emanating from the new shocks coming in. In the long run of course demand effects will win, when output and employment fall enough to break the inflationary inertia via the wage-price spiral. As this simulation shows, the long-run may be very long indeed. Anybody who has followed the Chilean experiences after Pinochet took over in the early seventies, will not be surprised by the extreme sluggishness of inflation with respect to monetary restraint; it may come as a healthy reminder to monetarists who see cuts in $M2$ growth as the cure to all ills, however. The other results will not come as a surprise: the loss in output (see fig. 2b) increases as inflation keeps hovering at the base level values, indicating an increasingly tight monetary situation. Consumption does respond to the loss in real income and the high real rate, but the more dramatic expenditure adjustment once again, comes from investment (fig. 5b). All this adds up to a significant improvement in the current account. The sluggishness of inflation may be more of a problem in Korea than in other countries because the particular labour market structure causes considerable lags before real wage pressure can be reduced by unemployment; the basic message is clear however in both simulation runs: Monetary restraint has serious costs in terms of lost output and investment, causes an initially perverse response of the inflation rate due to the credit-supply side link peculiar to *LDC*'s and may take considerable time before it brings inflation down. The initial effect actually comes as an adverse supply shock, increasing inflation and reducing output; later on traditional demand shock effects take over, with the main expenditure adjustment coming from investment rather than consumption.

What are the conclusions to be drawn from this? That monetary restraint is always bad? Clearly not. This analysis warns however that initial results may be perverse and the good results slow in arriving, with high costs in terms of lost output and investment.

If reduction in the money growth rate is a costly way of bringing inflation down, what are the alternatives? One set of policy measures would combine the absence of *LR* effects of one-shot changes in the level with the long-run effectiveness of changes in the *growth rate* of money. An initial *increase* in the *level* of $M2$, coupled with a subsequent reduction in the growth rate, if 'tuned' correctly, will reduce inflation over time and avoid the perverse impact effects: the perverse impact effects of the lower growth rate are offset by the beneficial effects of the increase in the level. In the long-run only the growth rate matters, so this way one gets the best of both worlds. There is a snag of course: any anti-inflation package relying on lower money growth rates, but starting out with an increase in the level of the money-stock will run into serious credibility problems. Similar

packages could be worked out however with the increase in the level of $M2$ replaced by a *decrease* in time deposit rates; instead of increasing the money supply one would then reduce (the level of) money demand. Such a policy package would also meet a more orthodox objection brought up by Robert Mundell: assume a lower growth rate of money succeeds in slowing down the inflation rate. This means that the return on holding money, minus the inflation rate, will have gone up. Accordingly real money demand will be higher than before in the new equilibrium. So somewhere along the adjustment path, the real money stock will have to increase to accommodate this. Stringently enforced money growth rate rules do this by causing a prolonged recession, leading to an inflation rate lower than money growth somewhere along the adjustment path, thus increasing the real money stock. Our policy package would solve this problem (known as the velocity problem or the Mundell-effect) painlessly via the one shot increase in the money supply 'up front'.

Still to be solved however is the problem that lower $M2$ growth takes so much time to slow down inflation, even if we solve the perverse impact effects via either the one-shot increase in the level of $M2$ or a lower time deposit rate early on in the program. One alternative can be constructed that would solve this problem too: I have a variant of the crawling peg experiment tried out by Argentina and Chile recently, in mind: a slow down in the rate of devaluation. If implemented correctly, perverse impact effects (a real appreciation in this case) can probably be avoided, while a slow-down in the rate of devaluation would have a much faster impact on inflation than slower money growth because of its impact on local currency prices of intermediate imports such as oil. Further discussion of this policy is outside the scope of this paper; I have discussed this policy elsewhere [van Wijnbergen (1979b)].

5. Conclusions

In the previous sections of this paper we have presented a macro-model of the Korean economy that focuses on short-run macro-economic adjustment and, more in particular, on the transmission channels of monetary policy between the financial and the real sector of the economy. Apart from the usual link between monetary policy and aggregate demand via investment, we have incorporated the link between monetary policy and the *supply side* of the economy via the financing of working capital with borrowed funds. This link can potentially reverse the short-run impact of tight money on inflation and aggregate the impact on output. The results I think are quite strong. Both export prices and domestic prices show a significant sensitivity to cost of financing working capital (the special rate on export loans in the case of export prices and the *UMM* rate in the case of domestic prices). This credit-supply side link gives a stagflationary bias to restrictive credit policies.

The empirical relevance of this phenomenon is strongly supported by the simulation results derived with the model. The stagflationary effects on a one-shot reduction in $M2$ (effected via credit limits and capital controls) dominate strongly in the first quarter, causing inflation to accelerate; traditional demand effects via an investment slump take over in the third and fourth quarter, after which neutrality with respect to level-changes in the money stock is restored. Changes in the growth rate of money are shown to have stagflationary effects that persist much longer than that. An alternative set of policy measures would combine the absence of long-run effects of one-shot changes in the level with the long-run effectiveness of changes in the growth rate of money. An initial *increase* in the *level* of $M2$, coupled with a subsequent reduction in the growth rate, will reduce inflation over time and avoid perverse impact effects: the perverse impact effects of the slower growth rate are offset by the beneficial effects of the level increase. If an increase in the level 'up front' will cause credibility problems with respect to future cut-backs in $M2$ -growth, one might consider a cut in the time deposit rate (which would reduce money demand) as an alternative to the level increase up front.

Here the information on the asset market structure presented in this paper is important. The financial sector part of the model focuses on the role the curb market and foreign capital markets play in satisfying the business' sector demand for financing, on the private sector's portfolio allocation and on the role of the commercial banks in all this. The role of the curb market is quite persuasive: time deposits are shown to be a closer substitute to curb market loans than to $M1$, indicating that a decrease of time deposit rates would moderate stagflationary impact effects of low $M2$ growth rules by increasing the availability of funds to the business sector as people shift out of time deposits (with high reserve requirements) to curb market loans (which can be passed on completely, no required reserves at all). This would lower curb market rates and, via the cost-of-credit/supply-side line, have a favorable impact effect on inflation.

We also found that the demand equations for $M2$ components do not show significant wealth effects, indicating that increased savings are mainly channeled into the curb market over time. This plus the result that time deposits are closer substitutes to curb market loans than to $M1$ indicates that the phenomenal increase in time deposits in 1965 after the financial reform was caused by a switch from lending at the curb market into time deposits by private asset holders and not by an increase in savings as is usually claimed.

Further structural information of relevance for policy increases and presented here is the strong evidence of Korean market power in their export markets. Domestic cost factors (wages, local currency price of intermediate imports) do influence Korean competitiveness. Wage changes feed through with a delay only, while our wage equation shows an incomplete first period adjustment to changes in the CPI inflation rate, so a devaluation can in fact change relative prices in the short-run. The importance of intermediate import prices (whose local currency

value responds one for one to a devaluation) gives this policy instrument a stagflationary impact effect too however.

A final feature of the financial sector model presented here is that it incorporates all the accounting identities and balance sheet constraints constraining the different actors in the economy, and their implications for behavioral equations. The incorporation of the link between private saving (determined, loosely speaking, in the real sector) and the increase of end of period asset stocks (over their beginning of period magnitude) whose allocation is determined in the financial sector, make the real and financial parts of the model internally consistent. This seems to be a novelty in applied models, although this is of course standard in modern theoretical macroeconomics. The model presented here can generate the national accounts, flow of funds and end of period asset stocks that are internally consistent with each other and with the asset stocks carried over from the previous period.

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