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Macroclosures in Open Economy CGE Models : A Numerical Reappraisal

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ABSTRACT

It has been argued that in the construction and simulation process of computable general equilibrium (CGE) models, the choice of the proper macroclosure remains a fundamental problem. In this study, with a standard CGE model, we simulate disturbances stemming from the supply or demand side of the economy, under alternative macroclosures. According to our results, the choice of a particular closure rule, for a given disturbance, may have different quantitative and qualitative impacts. This seems to confirm the importance of simulating CGE models under alternative closure rules and eventually choosing the closure which best applies to the economy under study.

Key-words: computable general equilibrium, macroclosures.

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RÉSUMÉ

Le choix de la fermeture macroéconomique d'un modèle calculable d'équilibre général (M.C.E.G.) a souvent été présenté comme un problème fondamental. A l'aide d'un M.C.E.G. simplifié, nous simulons l'introduction de chocs émanant soit de l'offre, soit de la demande, dans des conditions alternatives de fermeture. D'après nos résultats, le choix de la fermeture, pour un type donné de choc, peut avoir un impact différent à la fois quantitatif et qualitatif. Ceci semble confirmer l'importance de simuler les M.C.E.G. avec des fermetures alternatives et éventuellement de choisir la fermeture qui s'applique le mieux au fonctionnement de l'économie étudiée.

Mots-clés: équilibre général calculable, fermetures macroéconomiques.

1. INTRODUCTION

More than 20 years ago, Sen (1963) showed that, in a closed economy with neoclassical production, it is impossible to achieve predetermined levels of real investment and public consumption, to pay production factors the value of their marginal product and to maintain factor full-employment at the same time. The system is simply overdetermined. Sen himself suggested various ways of getting rid of that overdeterminacy or, more fashionably, different possible macro-closures of the model.

These last 10 years, there has been a renewed interest in Sen's original dilemma, with the proliferation of computable general equilibrium (CGE) models applied to developed and developing economies.[1] Indeed, the CGE modeller, having chosen the technological and behavioral specifications which apply to the different agents, institutions, and markets distinguished in the model, finds himself in a quandary similar to Sen's. If neoclassical income distribution and factor full-employment are the rule and if real investment and public consumption levels are predetermined, the CGE model has more equations than unknowns. As such, the modeller has to find some way of closing the system, i.e. rendering it mathematically determined.

Borrowing much from Sen's 1963 contribution and terminology, CGE modellers have become accustomed to distinguishing between four possible macroclosures, at least in the case of a closed economy: the Keynesian, the Johansen, the Classical and the Kaldorian.[2] To choose one

1 For surveys of these applications, see Shoven and Whalley (1984), Manne (1985), Decaluwé and Martens (1986), Devarajan, Lewis and Robinson (1986).

2 See, e.g., Lysy (1982).

macroclosure among the four means to drop one specific assumption of the original model. In the case of the Keynesian macroclosure, labor full-employment is no longer mandatory; employment becomes endogeneous. In the Johansen closure, it is the turn of the public consumption volume to become endogeneous; as such, given the level of government revenue, it is up to public savings to fill the gap between the exogeneous investment volume and the other sources of savings. With the Classical closure, the real investment target is abandoned; the volume of investment, which is now endogeneous, adjusts itself to the total available savings. Finally, with the Kaldorian closure, production factors are not necessarily paid according to their marginal-value productivity; a mechanism, in general determined outside the model, forces, through a change in income distribution, real savings to adjust to the total investment target, considering that different income groups have different propensities to save. It has been said that the choice of a particular macroclosure depends crucially on how the CGE modeller views the functioning of the economy at hand. If he leans toward a structuralist interpretation, he will favor the Keynesian or Kaldorian closures. If he does not believe in the notion of a planned investment level or in the existence of "animal spirits", he will adopt a Classical closure; etc. In short, the choice of the proper macroclosure seems to bring an important qualitative dimension to the CGE model construction and simulation process.[3]

3 It is clear from the above that the use of the labels "Keynesian", "Johansen", "Classical" and "Kaldorian" by CGE modellers is no claim that the corresponding closing procedures can exactly be traced to the original work of the authors involved (Keynes, Johansen, etc.). Moreover, each closure can have its own variants (see, e.g. Rattso (1982), in the case of the Johansen closure). Finally, "Kaldorian" became a generic name for any closure where the neoclassical income distribution rule is ignored in view of generating enough savings given the total investment target, whether the modeller calls his closure neo-Keynesian, neo-Ricardian, Marxian, neo-Marxian, Cambridge or Kaldorian itself. (For further reading on the possible distinction between various "Kaldorian" closures, see, e.g. Taylor (1979, 1983), Taylor and Lysy (1979), Gibson, Lustig and Taylor (1982), and Marglin (1984)).

When the economy is open to trade, the necessity of choosing one of the above four macroclosures remains if we are in a floating foreign exchange regime or if the exchange rate is kept at a fixed level in real terms. In both cases the supply of foreign savings is not perfectly elastic and, as such, does not necessarily fill the gap between the real investment target and available national savings. It is only when the exchange rate is fixed in nominal terms that the necessity to look for a macroclosure disappears. In such a case, the model is initially fully determined. If there is fixed exchange parity, supply of foreign savings is perfectly elastic and automatically fills the savings-gap. As pointed out by Dewatripont and Michel (1983), who were the first to systematically analyze the closure problem under alternative exchange-rate regimes, there is a possible cost attached to a policy of fixed parity: long-term and permanent external indebtedness.

With the help of a simple CGE model built for an open economy with a floating exchange rate, we look hereafter at the impact of choosing alternative closure rules when the system is affected by disturbances stemming from the supply side or the demand side of the economy. Our preliminary experiments suggest that the choice of the macroclosure "matters".

2. THE MODEL

The model's features are highly standard.[4] There are three activities, two producing tradables (agriculture and manufacturing) and one non-tradables (services). The production functions are of the nested Cobb-Douglas type with constant returns to scale. The two production factors (labour and capital) are perfectly mobile between activities. There are two groups of income earners (wage earners and capitalists) with different propensities to save and Cobb-Douglas private consumption-expenditure systems. The choice between domestically produced and imported commodities is based upon the existence of a

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[4] See appendix I, for the model's complete set of equations.

constant trade elasticity of substitution relationship, also known as Armington function. There is a finite price-elasticity of demand for exports. Government levies direct and indirect taxes, including import duties. There is no money. The wage-earners' consumption price-index is chosen as numéraire, i.e. all other price indices reflect real changes in prices relative to the price of the wage earners' consumption basket. The model is static; as such, current investment does not increase production capacity, the latter being determined only by the initial factor endowment.

3. THE SIMULATION PLAN

In a first step, we constructed a set of 4 reference solutions, one for each type of macroclosure. In the case of the macroclosures where total real investment is set exogeneously - i.e. the Keynesian, Johansen and Kaldorian - it was assumed that the latter would grow by 5 % from its initial base value. In the case of the Classical closure, where total real investment is not predetermined, the reference solution was taken as the set of initial base values.[5]

In a second step, we introduced two types of disturbances as possible sources of simulations: a 1 % increase in the initial capital endowment (or supply disturbance); a 1 % increase in the autonomous component of agricultural exports (or demand disturbance). This gave us 8 simulations, considering that, for each of the 2 disturbances, the model can be closed in 4 different manners.

Table 3.1 gives, in terms of the model's equations, the mode of implementation of each of the macroclosures. For the Keynesian, Classical and Johansen closures, Table 3.1 is self-explanatory. The implementation of the Kaldorian closure calls for a few comments.

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5 See appendix II, Table II.1. These values correspond roughly to the ex post equilibrium of a typical semi-industrialized developing economy.

Table 3.1
Modes of implementation of the macroclosures

Type of closure / To be considered	Keynesian	Classical	Johansen	Kaldorian
Investment volume ($\bar{I}$)	exogeneous[1]	endogeneous (adjusts to total savings in eq. 48)	exogeneous[1]	exogeneously set[1], but reached by approximations
Public consumption volume ($\overline{GE}$)	exogeneous[2]	exogeneous[2]	endogeneous (adjusts in eq. 44, for a given p_g to GR-S_g, S_g having filled in eq. 47 the gap between investment and other savings)	exogeneous[2]
Labor-market clearing equation ($\bar{L}$)	deleted	holds	holds	holds
Forced personal income transfer from wage earners to capitalists (TR_k)	zero value	zero value	zero value	calculated through model-solving as to generate increase in personal savings required by investment target[3]

Equations and symbols refer to appendix I.

1 5 % increase relatively to the initial base value.
2 kept at the level of the initial base value.
3 for explanations, see the text.

To implement the Kaldorian closure, the prerequisite is that different income groups have different propensities to save. Such a prerequisite exists in the case of our model which assumes, whatever the type of simulation performed, the capitalists' propensity to save (s_k in eq. 27) is always larger than that of the wage earners (s_w in eq. 20).[6] One can then, through model-solving and by successive approximations, calculate the "forced" transfer of personal income from wage earners to capitalists (TR_k in eq. 18 and 25), which will generate the net increase in personal savings ($\Delta S_k - \Delta S_w$) required by the financing of total real investment ($\bar{I}$). When the required TR_k is found, the corresponding model's solution is called Kaldorian. Needless to say that this is a purely mechanical procedure: it does not tell us <u>how</u> TR_k is transferred from wage earners to capitalists. One could also imagine other implementation modes of the Kaldorian closure where there is not necessarily a conflict between capital formation and equity, as it is the case here.

In all cases, the foreign exchange rate (variable e), defined as the amount of domestic currency needed for the purchase of one unit of foreign currency, is assumed to be floating in order to clear the foreign exchange market (eq. 38). Since, in all simulations, the numéraire (the wage earners' private consumption price or p_c^w) was kept equal to 1 ("no inflation"), increases in e, in the model's solutions, correspond to real depreciations of the domestic currency, whereas decreases in e correspond to real appreciations.[7]

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6 See appendix II, Table 2.1, for the model parameters values.

7 In our working-sheets, we also simulated for fixed real echange rate regimes. In such cases, clearly the $\frac{e}{p_c^w}$ or real exchange rate is predetermined. E.g., a 5 % real devaluation can be built into the system by exogeneously setting e at 1,155 and p_c^w at 1,1, which corresponds to a 15,5 % nominal devaluation when inflation is 10 %. We then have to find the level of foreign savings (in foreign currency) which clears, at that e value, the foreign exchange market. We did not report the corresponding results to the extent that they did not substantially alter the conclusions derived from simulations in a floating regime. This is hardly surprising: real devaluations (revaluations) and depreciations (appreciations) are very close reallocation mechanisms.

4. RESULTS[8]

The reference solutions (Table 4.1)

In the Keynesian case, the 5 % increase in real investment provides a clear multiplier effect: output and employment are expanded.[9] But this is not the only effect. There is a change in relative factor prices which makes labor-intensive activities relatively more attractive. As a result, agriculture expands more than industry (and services), though, somewhat paradoxically, investment, whose increase triggered the expansion process, has a high component of capital-intensive industrial goods.

In the Johansen and Kaldorian cases, overall expansion is not permitted, factor endowment being fixed. As such, the increase of the industrial output calls for some resource reallocation. In the Johansen case, since public consumption is endogeneous and allowed to decrease in order to satisfy the overall investment target, the bulk of resources going to industry comes from services, some agricultural growth being maintained. In the Kaldorian case, the "forced" personal income transfer from wage earners to capitalists (roughly .... one half of the initial wage earners' personal income) has altered the overall consumption pattern "against" agricultural products; as such the input needs of the industrial sector are met with resources coming from both agriculture and services.

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8 The complete set of results is available from the authors on request. The model was constructed and solved on an IBM-AT microcomputer, using the GAMS-HERCULES package. The latter implements the TV ("transaction value") method of construction and simulation of CGE models, which was designed at the World Bank Development Research Department by Drud, Grais and Pyatt (1983).

9 The deletion of the model's labor-market clearing equation 7 allows of course to have, according to the simulation performed, labor unemployment or an endogeneous increase in labor supply, which will permit the output growth. This is evidently a simple interpretation of the Keynesian closure, which is however, consistent with that of Lluch (1979) but different from Taylor and Lysy's (1979).

Table 4.1

Reference solutions: selected results
(% changes from initial base values)

Variables	Keynesian	Classical	Johansen	Kaldorian
Volumes				
GDP at factor cost	6,01	—	0,00	0,00
Labor	8,56	—	0,00	0,00
Capital	0,00	—	0,00	0,00
Agricultural output	7,64	—	1,05	-0,30
Industrial output	5,46	—	1,06	0,61
Output of services	4,88	—	-1,82	-0,27
Imports of goods and services	6,11	—	0,11	0,07
Exports of goods and services	10,77	—	1,96	1,11
Investment	5,00	—	5,00	5,00
Private consumption	2,38	—	-0,64	-2,78
Wage earners' private consumption	2,40	—	-0,65	-6,41
Capitalists' private consumption	2,34		-0,63	13,85
Public consumption	0,00	—	-12,77	0,00
Values				
Investment	6,57	—	5,26	5,15
Private savings	2,38	—	-0,64	-2,78
Wage earners' private savings	2,40	—	-0,65	-6,41
Capitalists' private savings	2,34	—	-0,63	13,85
Forced personal income transfer	—	—	—	65,09[2]
Public savings	88,49	—	208,20	19,06
Foreign savings[1] (≡ current external deficit)	7,80	—	1,40	0,80

Table 4.1 (continued)

Variables	Keynesian	Classical	Johansen	Kaldorian
Prices				
Unit wage	-5,70	—	-0,60	-0,40
Unit rental capital value	2,30	—	-0,60	-0,40
Agricultural output price	-2,90	—	-0,50	-0,30
Industrial output price	-0,60	—	-0,20	-0,10
Services output price	-2,60	—	-0,50	-0,30
Exchange rate	7,80	—	1,40	0,80

[1] % change in national currency.

[2] in monetary units.

In all three cases, there is depreciation of the national currency. It is especially large with the Keynesian closure. This is hardly surprising. In the Keynesian case, public consumption is not allowed to decrease in order to increase national savings (as with the Johansen closure) and "forced" personal income transfers, also meant to boost national savings (as with the Kaldorian closure), are ruled out. Thus arises the need for especially large amounts of foreign capital in view of closing the savings-gap measured in domestic currency (and this, despite a non-negligible increase in public savings which is explained by a growth-induced jump in tax revenues). Foreign savings being exogeneously fixed in foreign currency, only a substantial depreciation of the domestic currency can then bring external savings to a level sufficient to finance the gap.

Also, in all three cases, the economy increases its external competitiveness, output prices having decreased. Quantities demanded for exports thus increase. As far as the demand for imports is concerned, the combination of exogeneously fixed international import prices in foreign currency (small-country assumption) and domestic currency depreciation means higher domestic import prices. Import volumes, as seen from Table 4.1, are however, not reduced. Clearly the income (or production) - effect has dominated the price-effect. This dominance is especially obvious with the closure which permits overall growth, i.e. the Keynesian one.

<u>The simulation results</u> (Table 4.2)

Recall that the simulation results are % changes from the reference solution results given in Table 4.1. As such, in the three closures where the real investment target is fixed (i.e. in the Keynesian, Johansen and Kaldorian cases), the relative variations found in Table 4.2 correspond, according to the case, to a dampening of or an increase in the changes which were induced by a 5 % increase in the investment volume. With the Classical closure, where investment is

Table 4.2

Simulations: selected results (% changes from reference solutions)

Variables	1 % increase in initial capital endowment (supply)				1% increase in autonomous agricultural exports (demand)			
	Keynesian	Classical	Johansen	Kaldorian	Keynesian	Classical	Johansen	Kaldorian
<u>Volumes</u>								
GDP at factor cost	-0,05	0,30	0,30	0,30	-0,03	0,00	0,00	0,00
Labor	-0,45	0,00	0,00	0,00	-0,04	0,00	0,00	0,00
Capital	1,00	1,00	1,00	1,00	0,00	0,00	0,00	0,00
Agricultural output	-0,08	0,33	0,27	0,35	0,04	0,07	0,06	0,07
Industrial output	0,02	0,32	0,26	0,28	-0,10	-0,07	-0,07	-0,07
Output of services	-0,01	0,25	0,36	0,26	-0,02	0,00	0,01	0,00
Imports of goods and services	0,00	0,03	0,02	0,03	0,28	0,28	0,28	0,23
Exports of goods and services	-0,03	0,54	0,43	0,48	-0,20	-0,15	-0,16	-0,15
Investment	0,00	0,28	0,00	0,00	0,00	0,02	0,00	[illegible]
Private consumption	-0,02	0,11	0,15	0,27	0,22	0,22	0,22	0,24
Wage-earners' private consump.	-0,02	0,12	0,15	0,50	0,22	0,22	0,23	0,25
Capitalits' private consump.	-0,04	0,09	0,12	-0,59	0,20	0,20	0,20	0,13
Public consumption	0,00	0,00	0,80	0,00	0,00	0,00	0,07	0,00
<u>Values</u>								
Investment	-0,03	0,33	0,04	0,04	-0,09	-0,07	-0,09	-0,08
Private savings	-0,02	0,11	0,15	0,27	0,22	0,22	0,22	0,24
Wage-earners' private savings	-0,02	0,12	0,15	0,50	0,22	0,22	0,23	0,26
Capitalists' private savings	-0,04	0,09	0,12	-0,59	0,20	0,20	0,20	0,13
Forced person. income transfer	—	—	—	-5,51	—	—	—	-0,40
Public savings	-1,24	4,71	6,25	4,54	-15,45	-1,32	2,00	-1,75
Foreign savings[1] (≡ current external deficit)	0,00	0,40	0,39	0,40	-0,52	-0,50	-0,49	-0,50
<u>Prices</u>								
Unit wage	0,42	0,10	0,10	0,10	0,32	0,20	0,20	0,20
Unit rental capital value	-0,98	-0,90	-0,90	-0,90	0,19	0,20	[illegible]	[illegible]
Agricultural output price	0,10	-0,10	0,00	0,00	0,21	0,20	0,20	0,20
Industrial output price	0,00	-0,10	-0,10	-0,10	0,10	0,10	0,10	0,10
Services output price	0,00	-0,10	-0,10	-0,10	0,20	0,20	0,20	0,20
Exchange rate	0,00	0,40	0,39	0,40	-0,52	-0,50	-0,49	-0,50

[1] % change in national currency.

endogeneous, the simulation results are mere relative changes from the initial base values which, in this case, constitute the reference solution.[10] Let us now look at the results.

In the case of the **supply** disturbance (1% increase in the initial capital endowment), there is, as expected, for all closures, an increase of the wage-rental ratio, labor having become scarcer. The impact of this increase of the relative wage is, however, different for the Keynesian closure, where employment is endogeneous, when compared to the three other closures where employment remains fixed.

With the Keynesian closure, the expansion, which was observed in the reference solution, is simply dampened: less increase in employment, thus less output augmentation. On the financing side, the savings-gap (i.e. foreign savings expressed in domestic currency) remains unaltered. Consequently, depreciation which increases external financing in domestic currency, is not called for. Finally, the variation in the wage-rental ratio has determined an increase in agricultural output prices, which makes the economy less competitive on world markets, hence the relative decrease in the volume of exports.

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We can then write, in general, if x_0, x_1 and x_2, are, respectively, the initial numerical value, the value corresponding to the reference solution and the value corresponding to the simulation solution, that:

$$x_1 = x_0 \; [1 + \theta]$$

$$x_2 = x_1 \; [1 + \theta']$$

or $x_2 = x_0 \; [1 + \theta] \; [1 + \theta']$

with θ and θ' the percentage variations (divided by 100) found, respectively, in Table 4.1 and Table 4.2.

With the Classical, Johansen and Kaldorian closures, the increase in the capital stock determines an increase of output as well as of the savings-gap. As far as the Johansen and Kaldorian closures are concerned, this widening of the savings-gap was already observed in the reference solution: national savings needed to be supplemented with additional external savings in order to reach the fixed real investment target and, since the net foreign-exchange inflow is exogeneously set, depreciation had to take place. With the Classical closure, however, there is no fixed investment target. Here, national and foreign savings add up to determine the investment level, which is not very different from the initial value. Contrary to what was observed with the Keynesian closure, the higher wage-rental ratio or more relevantly, the lower rental-wage ratio, brings with all three closures increased competitiveness on world markets, which explains larger sales to the rest of the world. The fact that domestic prices are more attractive does not translate itself into lower import volumes. On the contrary, the latter increase. Clearly, the income or production-effect has again dominated the price-effect, as far as imports are concerned.

In the case of the **demand** disturbance (1 % increase in autonomous agricultural exports), strikingly similar results emerge from all closures.

First, the additional pull on available resources, induced by the autonomous increase in agricultural exports, raises all output prices. This, in turn, reduces external competitiveness to the point where, despite the initial shock, exports are eventually diminished. Since no overall expansion takes place, the relative increase in imports is entirely due to price changes, foreign products having become cheaper when compared to domestic goods. These undesirable price changes have an especially strong impact with the Keynesian closure: output and employment show a relative decline. This again illustrates that, when there is no initial unused production capacity, the multiplier effect does not work: on the contrary.

The second general result is the relative decrease in the savings-gap, to which corresponds an appreciation of the national currency on the foreign-exchange market. How to explain this reduction in the savings-gap?

For all closures, we have an increase in the wage rate and the rental value of capital. We also have a given volume of production factors.[11] Since production takes place according to Cobb-Douglas relationships with constant returns to scale, the exhaustivity rule applies to factor-income distribution and it is normal to find a relative increase in the GDP value defined as the sum of the production factor rewards. Finally, wage earners and capitalists saving a constant value share of their income, personal savings are bound to increase, thus the smaller savings-gap.

5. CONCLUSION

In this paper we looked with the help of a standard open economy CGE model at the relationship between 4 types of macroclosures and 2 types of disturbances, one stemming from supply, the other from demand.

In all simulations, i.e. whatever closures or disturbances were considered, changes in the factor-price ratio and the foreign exchange rate played a dominant explanatory role. The changes in these two prices were quite comparable for all four closures in the realm of each disturbance. The final impact was however, not always comparable as it is illustrated in the case of the supply disturbance where a higher relative wage decreases competitiveness with flexible employment (Keynesian closure) but increases it with fixed employment (Classical, Johansen and Kaldorian closures). The latter result which is not merely quantitative but qualitative, since it corresponds to a change in sign, is enough, we believe, to support the view that more applied and complex

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11 Except with the Keynesian closure where there is, as it has been said, employment reduction. However, the latter is not significant enough to affect the general result.

CGE models should be simulated under alternative closure rules and that eventually, if the results underpin a policy program, the modeller will have to take a stand on what is the closure rule which best applies to the functioning of the economy under study.

Finally let us remember that all the above simulations are static in nature, whereas the macroclosure problem refers to the **ex ante** equilibrium on three different markets: labor, foreign-exchange, investment-savings. The last market is clearly linked to some concept of inter-period or dynamic (versus intra-period or static) equilibrium. As such it is not sure that our simulation results even show all the importance which should be attached to the choice of closure rules in CGE model-building.[12]

12 Another possible line of investigation is that suggested in a recent article by Whalley and Yeung (1984) where they look at the sensitivity of the CGE model's results to alternative closure rules, taking into account different model's specifications, in this case, for imports and exports.

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APPENDIX I

The model's complete set of equations

All economic variables are expressed in value terms, except if upper-barred, in which case they are volumes. Prices are price indices divided by 100. «0» refers to base year values. i,j = 1,2,3 refer to activities or commodities (1: agriculture, 2: manufacturing, 3: services).

Categories	Interpretation	Formulation	No	Symbols
Factor services	demand derived from Cobb-Douglas production functions with constant returns to scale	$\bar{L}^d_j = \alpha_j \frac{\hat{p}_j}{w} \overline{VA}$ $\bar{K}^d_j = (1 - \alpha_j) \frac{\hat{p}_j}{r} \overline{VA}_j$	1-3	L^d_j, $\bar{K}^d_j$, demands for labor and capital services; $\overline{VA}$, value added; α_j, labor value added production elasticity; $\hat{p}_j$, price of value added; w, unit wage; r, unit capital rental value.
	factor-market clearing	$\sum_j \bar{L}^d_j = \bar{L}^s$ $\sum_j \bar{K}^d_j = \bar{K}^s$	7	$\bar{L}^s$, $\bar{K}^s$, supplies of labor and capital services.
Intermediate inputs	Leontief type demand	$DI_{ij} = a_{ij} \frac{\dot{p}_i}{p_j} X_j$	9-17	DI_{ij}, sectoral intermediate demand; a_{ij}, physical input-output ratio, $\dot{p}_i$, input composite market price; $\dot{p}_j$, output price at factor cost.
Wage earners	sources of income	$Y_w = w(\sum_j \bar{L}^d_i) - TR_k$	18	Y_w, wage earners' personal income; TR_k, «forced» income transfers from wage earners to capitalists (= 0, except in the Kaldorian macroclosure; for explanation, see text)
	allocation of income	$TD_w = t_w Y_w$ $S_w = s_w Y_w$ $C_w = c_w Y_w$	19 20 21	TD_w, S_w, C_w, wage earners' income taxes, savings and consumption; t_w, s_w, c_w, fixed value shares with $t_w + s_w + c_w = 1$
	consumption-expenditure system derived from Cobb-Douglas utility function	$C_{iw} = c_{iw} C_w$	22-24	C_{iw}, commodity consumption by wage earners; c_{iw}, fixed value shares with $\sum_i c_{iw} = 1$
Capitalists	sources of income	$Y_k = r(\sum_i \bar{K}^d_i) + TR_k$	25	Y_k, capitalists' personal income.
	allocation of income	$TD_k = t_k Y_k$ $S_k = s_k Y_k$ $C_K = c_k Y_k$	26 27 28	TD_k, S_k, C_k, capitalits' income taxes, savings and consumption; t_k, s_k, c_k, fixed value shares with $t_k + s_k + c_k = 1$
	consumption-expenditure system derived from Cobb-Douglas utility function	$C_{ik} = c_{ik} C_k$	29-31	C_{ik}, commodity i consumption by capitalists; c_{ik}, fixed value shares with $\sum_i c_{ik} = 1$
Imports	demand valued at landed prices (i.e. including import and other indirect taxes) derived from a CES function of domestically produced and imported commodities	$M^l_i = (1 - \delta_i)(\frac{p^l_i}{\dot{p}_i})^{1-\gamma_i} D_i$	32-33	M^l_i, commodity i imports at landed prices; D_i, commodity i domestic demand at composite market prices; δ_i, distributive parameter with $0 < \delta_i < 1$; γ_i, trade (or Armington) substitution elasticity with $0 < \gamma_i < +\infty$, p^l_i, import landed price; $\dot{p}_i$, composite market price.
	demand value at CIF prices in domestic currency	$M_i = \mu_i \frac{p^m_i e}{p^l_i} M^l_i$ (i = 1,2)	34-35	M_i, commodity i imports at CIF prices in domestic currency; p^m_i, commodity i import CIF price in foreign currency; e, foreign exchange rate; μ_i, parameter with $\sum_i \mu_i = 1$.

Categories	Interpretation	Formulation	No	Symbols
Exports	constant price-elasticity foreign demand	$E_i = E_i^0 A_i (p_i^I e)^{\eta_i} (p_i^f)^{(1-\eta_i)}$	36-37	E_i, commodity i exports at FOB prices in domestic currency; p_i^f, commodity i FOB export price in domestic currency; p_i^I commodity i international price in foreign currency; η_i, foreign demand price elasticity with $0 < \eta_i < +\infty$; A_i, coefficient of autonomous change in commodity i exports (if $A_i = 1$, no change).
Balance of payments	foreign-exchange market clearing	$\sum_i M_i - \sum_i E_i - e\, TR_g = eF^*$	38	TR_g, net current transfers to the government from abroad in foreign currency; F^* foreign savings supply in foreign currency
Government	current revenues	$GR = TD_w + TD_k + \sum_i t_i XD_i + \sum_i t_i^m M_i + e\, TR_g - \sum_i t_i^f E_i$	39	GR, government total current revenues; t_i, t_i^m, ad valorem tax rates on domestic output sold domestically and on imports; XD_i, commodity i domestic output sold domestically; t_i^f, ad valorem subsidy rate on exports.
	total current expenditures	$GE = p_g \overline{GE}$	40	GE, total government current expenditures; p_g, price of government consumption.
	commodity current expenditures	$GE_i = g_i \frac{\dot{p}_i}{p_g} GE$	41-43	g_i, fixed volume shares with $\sum_i g_i = 1$.
	residual savings	$S_g = GR - GE$	44	S_g, government savings
Investment-savings	sectoral investment allocation	$I_i = v_i (p_v \bar{I})$	45-47	I_i, gross capital formation in commodity i, with i = sector of origin; $\bar{I}$, total gross capital formation; p_v, price of investment; v_i fixed value shares with $\sum_i v_i = 1$.
	capital market equilibrium	$p_v \bar{I} = S_w + S_k + S_g + e\, F^*$	48	
Other definitions of economic variables	sectoral value added at factor cost	$\hat{p}_j \overline{VA}_j = X_j - \sum_i DI_{ij}$	49-51	
	commodity total domestic demand at market prices	$D_i = C_{iw} + C_{ik} + G_i + I_i + \sum_i DI_{ij}$	52-54	
	domestic output sold domestically at factor cost	$XD_i = X_i - (1 + t_i^f) E_i$	55-57	
Prices	value-added price	$\hat{p}_j = w^{\frac{L_j^{d0}}{VA_j^0}} r^{\frac{K_j^{d0}}{VA_j^0}}$	58-60	
	output price at factor cost	$p_j = \sum \dot{p}_i a_{ij} + \hat{p}_j$	61-63	
	output market prices of domestic production sold domestically	$p_j = \dot{p}_j (1 + t_j)$	64-66	
	landed import price	$p_i^l = (1 + t_i^m) e p_i^m$ (i = 1,2)	67-68	
	FOB export price	$p_i^f = \frac{p_i}{(1 + t_i^f)}$ (i = 1,2)	69-70	

APPENDIX I (continued)

Categories	Interpretation	Formulation	No	Symbols
<u>Prices</u>	composite commodity market price of tradables	$\dot{p}_i = (\delta_i \tilde{p}_i^{1-\gamma_i} + (1 - \delta_i) (p_i^1)^{1-\gamma_i})^{\frac{1}{1-\gamma_i}}$ (i = 1,2)	71-72	
	«composite» commodity market price for non-tradables	$\dot{p}_i = \tilde{p}_i$ (i = 3)	73	
	price of public consumption	$p_g = \sum_i g_i \dot{p}_i$	74	
	price of investment	$p_v = \prod_i \dot{p}_i^{v_i}$	75	
	price of capitalists' private consumption	$p_k^c = \prod_i \dot{p}_i^{c_{ik}}$	76	
	price of wage earners' private consumption or <u>numériaire</u>	$p_W^c = \prod_i \dot{p}_i^{c_{iw}}$	77	$p_w^c = 1$, if «no inflation»

APPENDIX II

VARIABLE INITIAL BASE VALUES AND PARAMETERS VALUES

Table II.1

Variables

Equation number[1]	Values (in monetary units)
1-3	L_1 = 390, L_2 = 294, L_3 = 400; V_A = 489, V_A = 489, V_3 = 567
4-6	K_1 = 99, K_2 = 195, K_3 = 167
7	L = 1084
8	K = 461
9-17	DI_{11} = 58, DI_{12} = 147, DI_{13} = 26
	DI_{21} = 108, DI_{22} = 717, DI_{23} = 95
	DI_{31} = 175, DI_{32} = 277, DI_{33} = 232
	X_1 = 830; X_2 = 1630; X_3 = 920
18	Y_w = 1084, TR_k = 0
19	TD_w = 4
20	S_w = 135
21	C_w = 945
22-24	C_{1w} = 287, C_{2w} = 555, C_{3w} = 103
25	Y_k = 461
26	TD_k = 14
27	S_k = 241
28	C_k = 206
29-31	C_{1k} = 121, C_{2k} = 62, C_{3k} = 23
32-33	M_1^1 = 7, M_2^1 = 678, D_1 = 636, D_2 = 2184
34-35	M_1 = 6, M_2 = 605
36-37	E_1 = 198, E_2 = 202
38	TR_g = 9, F^* = 202

Table II.1 (continued)

Equation number[1]	Values (in monetary units)
39	$GR = 204$, $TD_w = 4$, $TD_k = 14$, $XD_1 = 623$
	$XD_2 = 1421$, $XD_3 = 920$
40	$GE = 218$
41-43	$GE_1 = 0$, $GE_2 = 80$, $GE_3 = 138$
44	$S_g = -14$
45-47	$I_1 = 56$, $I_2 = 508$, $I_3 = 0$, $I = 564$
52-54	$D_3 = 948$

[1] Each initial value is listed in front of the first equation it enters. Upper-script «0» is omitted for the reader's convenience.

Table II.2

Parameters

Equation number[1]	Values
1-3	$\alpha_2 = 0{,}80$, $\alpha_2 = 0{,}60$, $\alpha_3 = 0{,}70$
9-17	$a_{11} = 0{,}07$, $a_{12} = 0{,}09$, $a_{13} = 0{,}03$; $a_{21} = 0{,}13$, $a_{22} = 0{,}44$, $a_{23} = 0{,}10$; $a_{31} = 0{,}21$, $a_{32} = 0{,}17$, $a_{33} = 0{,}25$
19	$t_w = 0{,}004$
20	$s_w = 0{,}12$
21	$c_w = 0{,}87$
22-24	$c_{1w} = 0{,}59$, $c_{2w} = 0{,}11$, $c_{3w} = 0{,}30$
26	$t_k = 0{,}03$
27	$s_k = 0{,}52$
28	$c_k = 0{,}45$
29-31	$c_{1k} = 0{,}59$, $c_{2k} = 0{,}11$, $c_{3k} = 0{,}30$
32-33	$\delta_1 = 0{,}99$, $\delta_2 = 0{,}69$ $\gamma_1 = 1{,}5$, $\gamma_2 = 0{,}5$
36-37	$\eta_1 = 1{,}1$, $\eta_2 = 1{,}1$
39	$t_1 = 0{,}01$, $t_2 = 0{,}06$, $t_3 = 0{,}03$ $t_1^m = 0{,}17$, $t_2^m = 0{,}12$ $t_1^f = 0{,}04$, $t_2^f = 0{,}03$
40	$g_1 = 0{,}00$, $g_2 = 0{,}63$, $g_3 = 0{,}37$
45-47	$v_1 = 0{,}10$, $v_2 = 0{,}90$, $v_3 = 0{,}00$

[1] Each parameter is listed in front of the first equation it enters.