

# Macroeconomic closings in the Auteta Model

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February 2000

## I. Beyond the classic closing or the dilemma of Amartya Sen

In the AUTA model, as in the AUTETA model, it was assumed that the *value* of a country's total investment,  $IT$ , adjusts to the level of available savings. This is what is expressed by the equilibrium conditions of the AUTA and AUTETA models, according to which  $IT$  takes a value determined by the sum of savings released into the economy, which necessarily satisfies the macroeconomic equilibrium condition of investment and savings. We say that, in this case, the closing of the CGEM is a *classic* closing and we might wish to leave it at that.

In reality, however, it is possible that the economic policy decision makers – and clearly, this is only relevant for a CGEM with government, as in the AUTETA model – want to fix, from the outset, an objective of a certain *volume* of investment to achieve, which could be composed of public works projects, such as infrastructure, over which the government has direct control, but also of firms spending on equipment, and even households, over which it is susceptible of exerting indirect control, by way of consent or other. In this case, when describing the model, the endogenous variable  $IT$  must be substituted with the arithmetical product  $P_I IT_{vo}$ , where  $P_I$  is an endogenous variable corresponding to the cost of investment and where  $IT_{vo}$  is an exogenous variable corresponding to the *volume* of investment, its numeric value giving the sought-after objective.

The equilibrium condition of investment and savings of the AUTETA model can thus be rewritten as :

$$[1] \quad P_I IT_{vo} = SH_{hw} + SH_{hc} + SF + SG$$

We immediately see that for a  $P_I$  whose numeric value is generated by the model, nothing guarantees that total savings available in the economy ( $SH_{hw} + SH_{hc} + SF + SG$ ) allow the objective  $IT_{vo}$  to be reached, while satisfying [1].

More precisely, as shown by the Indian economist and 1998 Nobel Prize winner Amartya Sen almost 40 years ago, it is no longer possible in such a system, other than determining the volume of investment retained, to simultaneously maintain the value of public consumption expenditures at a predetermined level, to compensate the economic agents according to marginal productivity in terms of the value of the factors of production they hold and to satisfy the labour market equilibrium. In other words, for investment and savings equilibrium to be attained, it is necessary to make concessions somewhere and this cannot be done except at the cost of adopting what are called *non-classic* closings (Sen, 1963).

## II. The AUTETA model and non-classic macroeconomic closings

The AUTETA model is a system of 71 independent equations with 79 variables, eight of which are exogenous, making it determined, the number of endogenous variables consequently dropping to 71. In what way is this system of equations and variables changed once the volume of investment becomes an objective of (predetermined) economic policy?

As we have said,  $IT$  must now come from the arithmetic product  $P_I IT_{vo}$  (Cf. [1]). It must also appear in the equation which expresses the demand for investment goods :

$$[2] \quad INV_i = \frac{\mu_i P_I IT_{vo}}{PD_i} \quad (i = 1, 2, 3)$$

where, recall,  $INV_i$  is the volume of product  $i$  entering the composition of investment,  $\mu_i$  is the portion in value of product  $i$  in IT and  $PD_i$  the market price of product  $i$ , with

$$\sum_{i=1}^3 \mu_i = 1.$$

Finally,  $P_I$  must itself be defined. This is accomplished via the new equation :

$$[3] \quad P_I = \prod_{i=1}^3 PD_i^{\mu_i} \quad \text{where } \Pi \text{ corresponds to the sign of multiplication}^1.$$

We now have 72 instead of 71 independent equations, the equation of the cost of investment, [3], having been added to the system. The number of variables has also increased from 79 to 80, IT having been replaced by  $P_I$  and  $IT_{vo}$ . But since  $IT_{vo}$  is predetermined, the number of exogenous variables is no longer 8 but 9, which leaves a number of endogenous variables equal to 71 ( $= 80 - 9$ ) for, as we said, 72 equations. The system is clearly *overdetermined*, and therefore has more than one solution, which is another way of expressing the dilemma of Sen.

The economic literature offers essentially three ways of solving this overdetermination of the system, each of which corresponds to a *non-classic* closing of the CGEM<sup>2</sup> :

- Keynesian closing;
- Kaldorian closing;
- Johansen closing.

These closings are shown below using an AUTETA model, amended as done above, that is, in the case where we are confronted from the outset, with an overdetermination due to an objective of volume of investment<sup>3</sup>.

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<sup>1</sup> In fact, it is possible to show that, once the proportions of the different products stay constant in value in a given aggregate, the price of these products can be obtained using a formula such as equation [3].

<sup>2</sup> Refer not only to Sen (1963), but also Taylor (1979, 1983), Taylor and Lysy (1979), Gibson, Lustig and Taylor (1982), Lysy (1982) as well as Dewatripont and Michel (1983).

a) Keynesian Closing

The first non-classic, or Keynesian closing, assumes that labour market equilibrium does not necessarily exist. Equation [4], which expresses this equilibrium :

$$[4] \quad LS = \sum_{j=1}^4 LD_j$$

disappears from the system, as does the exogenous labour supply variable LS. The system is thus determined once again : the number of equations goes from 72 to 71, and the number of variables from 80 to 79, of which 8 are exogenous and 71 endogenous. As a result of such a closing, the demand for labour which stays an increasing function of production and decreasing function of real wages, brings household income to a level such that enough savings are freed so that the objective volume of investment is achieved and, as a result, the condition for macroeconomic equilibrium of investment and savings is satisfied.

The results of the Keynesian closing of the AUTETA model, under the hypothesis that the volume of investment of the country ( $IT_{v_0}$ ) is 10 % above its reference level, are given in columns 3 and 4 of Table 1 and in column 2 of Tables 2 to 5.

We see right away, with respect to the reference situation, that there is an increase in the quantity of labour demanded by the different sectors of activity, this increase being particularly high in the case of the sector where the product is a major part of the composition of the investment. This increases the relative shortage of capital, for which the return increases in consequence, this increase being reflected in agricultural and industrial prices as well as on the price of commercial services. As for the price of non commercial services, they decrease under the impact of a drop in the relative cost of labour, which, we know, is the main input in the production of services offered by the government.

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<sup>3</sup> Our illustration is adapted, for an autarchic economy, from Decaluwé, Martens and Monette (1988).

Enough supplementary wages are distributed in the economy for the income of salaried households to increase, which brings about an increase in their consumption and savings, as in the case of capitalist households. The increase in savings of the two categories of household, as well as the savings of firms, is such that, in spite of the objective of the increase of investment, the current account deficit of the government is able to decline, given the increase in direct and indirect fiscal receipts. The generalized augmentation of the production translates into an increase of 2.89% of the real GDP.

Keynesian closing, as has just been described, however, raises a question. We now have a volume of labour demand equal to  $30\,250 (= \sum_{j=1}^4 LD_j)$ , whereas the volume supplied is, at the reference situation, 28 860. From where does the additional labour of 1 390 originate? Is there not a contradiction?

Of course not! Remember that the equality of labour demanded and supplied, that is 28 860, as given in the AUTETA matrix, is an *accounting identity* which only expresses a sort of tautology, namely that the volume of distributed wages is equal to wages received. It does not however, guarantee that there is full employment of labour at that very reference point and, is therefore, possible.

**Table 1**  
**Non-classic closings of the AUTETA model: Selection of results**

Variables		Reference Situation <sup>(1)</sup>		Hypothesis : 10 % increase in the volume of investment (IT <sub>vo</sub> )					
				Keynesian Closing <sup>(2)</sup>		Kaldorian Closing <sup>(2)</sup>		Johansen Closing <sup>(2)</sup>	
		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Definition	Symbol	Volume	Value	Volume	Value	Volume	Value	Volume	Value
<b>PRICE :</b>									
Wage	s	-	1,000	-	0,985 (-1,53)	-	1,007 (-0,71)	-	0,995 (-0,51)
<b>RETURN ON CAPITAL :</b>									
• agriculture	r <sub>1</sub>	-	1,000	-	1,034 (3,40)	-	0,958 (-4,18)	-	1,009 (0,872)
• industrial	r <sub>2</sub>	-	1,000	-	1,067 (6,75)	-	1,017 (1,65)	-	1,029 (2,90)
• commercial services	r <sub>3</sub>	-	1,000	-	1,032 (3,19)	-	1,038 (3,81)	-	1,001 (0,10)
<b>COST OF PRODUCTION AT FACTOR COST :</b>									
• agriculture	P <sub>1</sub>	-	1,000	-	1,000 (0,00)	-	1,000 (1,00)	-	1,000 (0,00)
• industrial	P <sub>2</sub>	-	1,000	-	1,025 (2,53)	-	1,012 (1,20)	-	1,011 (1,09)
• commercial services	P <sub>3</sub>	-	1,000	-	1,009 (0,94)	-	1,017 (1,72)	-	1,001 (0,10)
• non-commercial services	P <sub>4</sub>	-	1,000	-	0,992 (-0,80)	-	1,008 (0,81)	-	0,998 (-0,24)
<b>MARKET PRICE :</b>									
• agriculture	PD <sub>1</sub>	-	1,020	-	1,020 (0,00)	-	1,020 (0,00)	-	1,020 (0,00)
• industrial	PD <sub>2</sub>	-	1,050	-	1,076 (2,53)	-	1,062 (1,20)	-	1,061 (1,10)
• commercial services	PD <sub>3</sub>	-	1,030	-	1,040 (0,94)	-	1,048 (1,72)	-	1,031 (0,10)
• investment	P <sub>I</sub>	-	1,047 (see text)	-	1,070 (2,28)	-	1,058 (1,08)	-	1,057 (0,98)

Variables		Reference Situation <sup>(1)</sup>		Hypothesis : 10 % increase in the volume of investment (IT <sub>vo</sub> )					
				Keynesian Closing <sup>(2)</sup>		Kaldorian Closing <sup>(2)</sup>		Johansen Closing <sup>(2)</sup>	
		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Definition	Symbol	Volume	Value	Volume	Value	Volume	Value	Volume	Value
<b>AGGREGATES : <sup>(1)</sup></b>									
<b>PRODUCTION AT FACTOR COST :</b>									
• agriculture	XS <sub>1</sub>	9 000,00	9 000,00	9 358,09	9 358,09	8 648,82	8 648,82	9 099,92	9 099,92
			total col. 7	(3,98)	(3,98)	(-3,90)	(-3,90)	(1,11)	(1,11)
• industrial	XS <sub>2</sub>	54 400,00	54 400,00	56 183,74	57 605,47	54 603,49	55 257,43	55 137,56	55 737,96
			total col. 8	(3,28)	(5,89)	(0,37)	(1,58)	(1,36)	(2,46)
• commercial services	XS <sub>3</sub>	22 000,00	22 000,00	22 625,86	22 837,32	22 404,22	22 789,35	22 076,40	22 098,11
			total col. 9	(2,84)	(3,81)	(1,84)	(1,58)	(0,35)	(0,45)
• non-commercial services	XS <sub>4</sub>	8 700,00	8 700,0	8 770,26	8 700,00	8 630,38	8 700,00	8 214,22	<b>8 194,68</b>
			total col. 10	(0,81)	(0,00)	(-0,80)	(0,00)	(-5,58)	(-5,81)
<b>VALUE-ADDED AT FACTOR COST :</b>									
• agriculture	VA <sub>1</sub>	7 200,00	7 200,00	7 486,48	7 444,53	6 919,06	6 899,04	7 279,94	7 262,80
			t <sub>1,7</sub> + t <sub>2,7</sub>	(3,98)	(3,40)	(-3,90)	(-4,18)	(1,11)	(0,87)
• industrial	VA <sub>2</sub>	18 900,00	18 900,00	19 519,72	20 175,05	18 970,70	19 212,27	19 156,25	19 447,38
			t <sub>1,8</sub> + t <sub>2,8</sub>	(3,28)	(6,75)	(0,37)	(1,65)	(1,36)	(2,89)
• commercial services	VA <sub>3</sub>	14 300,00	14 300,00	14 706,81	14 755,83	14 562,70	14 844,92	14 349,66	14 309,46
			t <sub>1,9</sub> + t <sub>2,9</sub>	(2,85)	(3,19)	(1,84)	(3,81)	(0,35)	(0,07)
• non-commercial services	VA <sub>4</sub>	6 960,0	6 960,00	7 016,21	6 909,18	6 904,31	6 953,18	6 571,38	6 537,84
			t <sub>1,10</sub>	(0,81)	(-0,73)	(-0,80)	(-0,10)	(-5,58)	(-6,07)
<b>LABOUR :</b>									
• agriculture	LD <sub>1</sub>	5 760,00	5 760,00	6 047,89	5 955,62	5 480,44	5 519,23	5 840,05	5 810,24
			t <sub>1,7</sub>	(5,00)	(3,40)	(-4,85)	(-4,18)	(1,39)	(0,87)
• industrial	LD <sub>2</sub>	7 560,00	7 560,00	8 195,04	8 070,02	7 630,90	7 684,91	7 818,86	7 778,95
			t <sub>1,8</sub>	(8,40)	(6,75)	(0,94)	(1,65)	(3,42)	(2,90)
• commercial services	LD <sub>3</sub>	8 580,00	8 580,00	8 990,66	8 853,50	8 844,35	8 906,95	8 629,72	8 585,68
			t <sub>1,9</sub>	(4,79)	(3,19)	(3,08)	(3,81)	(0,58)	(0,07)
• non-commercial services	LD <sub>4</sub>	6 960,00	6 960,00	7 016,21	6 909,18	6 904,31	6 953,18	6 571,38	6 537,84
			t <sub>1,10</sub>	(0,81)	(3,19)	(-0,80)	(-0,10)	(-5,58)	(-6,07)
• total	LS	28 860,00	28 860,00	Not relevant (see text)		28 860,00	29 064,28	28 860,00	28 712,71
			total line			(0,00)	(0,71)	(0,00)	(-0,51)
<b>CAPITAL :</b>									
• agriculture	KD <sub>1</sub>	1 440,00	1 440,00	1 440,00	1 488,91	1 440,00	1 379,81	1 440,00	1 452,56
			t <sub>2,7</sub>	(0,00)	(3,40)	(0,00)	(-4,18)	(0,00)	(0,87)
• industrial	KD <sub>2</sub>	11 340,00	11 340,00	11 340,00	12 105,03	11 340,00	11 527,36	11 340,00	11 668,43
			t <sub>2,8</sub>	(0,00)	(6,75)	(0,00)	(1,65)	(0,00)	(2,90)
• commercial services	KD <sub>3</sub>	5 720,00	5 720,00	5 720,00	5 902,33	5 720,00	5 937,97	5 720,00	5 723,78
			t <sub>2,9</sub>	(0,00)	(3,19)	(0,00)	(3,81)	(0,00)	(0,07)

Variables		Reference Situation <sup>(1)</sup>		Hypothesis : 10 % increase in the volume of investment (IT <sub>vo</sub> )					
				Keynesian Closing <sup>(2)</sup>		Kaldorian Closing <sup>(2)</sup>		Johansen Closing <sup>(2)</sup>	
		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Definition	Symbol	Volume	Value	Volume	Value	Volume	Value	Volume	Value
<b>PERSONAL INCOME OF :</b>									
• salaried households	YM <sub>hs</sub>	-	29 000,00	-	29 928,31	-	29 204,28	-	28 852,71
			total line 3		(3,20)		(0,70)		(-0,51)
• capitalist households	YM <sub>hk</sub>	-	13 000,00	-	13 597,76	-	13 207,08	-	13 206,86
			total line 4		(4,60)		(1,59)		(1,59)
Transfer of salaried to capitalist households	Tsk	Not relevant (see text)		Not relevant (see text)		-	<b>4 830,15</b>	Not relevant (see text)	
<b>DISPOSABLE INCOME OF :</b>									
• salaried households	YDM <sub>hs</sub>	-	28 420	-	29 329,75	-	23 790,04	-	28 275,65
			total col. 3 – t <sub>6,3</sub>		(3,20)		(-16,29)		(-0,51)
• capitalist households	YDM <sub>hk</sub>	-	12 350,00	-	18 917,87	-	17 376,88	-	12 546,52
			total col. 4 – t <sub>6,4</sub>		(4,60)		(40,70)		(1,59)
<b>CONSUMPTION OF SALARIED HOUSEHOLDS IN :</b>									
• agricultural products	C <sub>1hs</sub>	4 179,41	4 263,00	4 313,20	4 399,46	3 498,54	3 568,51	4 158,18	4 241,35
		t <sub>11,3</sub> / PD <sub>1</sub>	t <sub>11,3</sub>	(3,20)	(3,20)	(-16,29)	(-16,29)	(-0,51)	(-0,51)
• industrial products	C <sub>2hs</sub>	10 830,46	11 368,00	10 901,29	11 731,90	8 958,75	9 516,02	10 659,34	11 310,26
		t <sub>12,3</sub> / PD <sub>2</sub>	t <sub>12,3</sub>	(0,65)	(3,20)	(-17,28)	(-16,29)	(-1,58)	(-0,51)
• marketable services	C <sub>3hs</sub>	9 657,28	9 947,00	9 874,14	10 265,41	7 947,38	8 326,51	9 598,79	9 896,45
		t <sub>13,3</sub> / PD <sub>3</sub>	t <sub>13,3</sub>	(2,25)	(3,20)	(-17,71)	(-16,29)	(-0,61)	(-0,51)
<b>CONSUMPTION OF CAPITALIST HOUSEHOLDS IN :</b>									
• agricultural products	C <sub>1hk</sub>	605,88	618,00	633,74	646,42	852,50	869,55	615,52	627,83
		t <sub>11,4</sub> / PD <sub>1</sub>	t <sub>11,4</sub>	(4,60)	(4,60)	(40,70)	(40,70)	(1,59)	(1,59)
• industrial products	C <sub>2hk</sub>	3 529,81	3 705,00	3 600,99	3 875,36	4 907,79	5 213,06	3 545,35	3 763,96
		t <sub>12,4</sub> / PD <sub>2</sub>	t <sub>12,4</sub>	(2,07)	(4,60)	(39,04)	(40,70)	(0,50)	(1,59)
• marketable services	C <sub>3hk</sub>	4 785,29	5 557,00	5 590,97	5 812,52	7 462,87	7 818,89	5 475,61	5 645,43
		t <sub>13,4</sub> / PD <sub>3</sub>	t <sub>13,4</sub>	(3,63)	(4,60)	(38,33)	(40,70)	(1,49)	(1,59)
Income of firms	YE	-	7 400,00	-	7 798,51	-	7 538,06	-	5 737,91
			total line 5		(5,39)		(1,87)		(1,86)
Total current account receipts of the government	YG	-	6 250,00	-	6 569,53	-	6 351,26	-	6 356,33
			total line 6		(5,11)		(1,62)		(1,70)
<b>INDIRECT TAXES ON :</b>									
• agricultural products	TI <sub>1</sub>	-	180,00	-	187,16	-	171,93	-	182,00
			t <sub>6,11</sub>		(3,98)		(-4,48)		(1,11)
• industrial products	TI <sub>2</sub>	-	2 700,00	-	2 859,10	-	2 743,98	-	2 766,41
			t <sub>6,12</sub>		(5,89)		(1,63)		(2,46)
• marketable services	TI <sub>3</sub>	-	660,00	-	685,12	-	688,50	-	662,94
			t <sub>6,13</sub>		(3,81)		(4,32)		(0,45)



Variables		Reference Situation <sup>(1)</sup>		Hypothesis : 10 % increase in the volume of investment (IT <sub>vo</sub> )					
				Keynesian Closing <sup>(2)</sup>		Kaldorian Closing <sup>(2)</sup>		Johansen Closing <sup>(2)</sup>	
		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Definition	Symbol	Volume	Value	Volume	Value	Volume	Value	Volume	Value
<b>DIRECT TAXES ON :</b>									
• salaried households	TD <sub>hs</sub>	-	580,00	-	598,57	-	584,09	-	577,05
			t <sub>6,3</sub>		(3,20)		(0,70)		(-0,51)
• capitalist households	TD <sub>hk</sub>	-	650,00	-	679,89	-	660,35	-	660,34
			t <sub>6,4</sub>		(4,60)		(1,59)		(1,59)
• firms	TDE	-	1 480,00	-	1 559,70	-	1 502,46	-	1 507,51
			t <sub>6,5</sub>		(5,39)		(1,51)		(1,86)
Government transfers to salaried households	TG <sub>hs</sub>	-	140,00	-	140,00	-	140,00	-	140,00
			t <sub>3,6</sub>		(0,00)		(0,00)		(0,00)
Public consumption (= XS <sub>4</sub> )	G	8 700,00	8 700,0	8 770,33	8 700,00	8 630,39	8 700,00	8 214,22	<b>8 194,68</b>
			t <sub>14,6</sub>		(0,81)		(0,00)		(-5,81)
<b>SAVINGS OF :</b>									
• salaried households	SM <sub>hs</sub>	-	2 842,00	-	2 932,98	-	2 379,00	-	2 827,57
			t <sub>15,3</sub>		(3,20)		(-16,29)		(-0,51)
• capitalist households	SM <sub>hk</sub>	-	2 470,00	-	2 583,58	-	3 475,38	-	2 509,30
			t <sub>15,4</sub>		(4,60)		(40,70)		(1,59)
• firms	SE	-	4 020,00	-	4 338,81	-	4 130,45	-	4 130,33
			t <sub>15,5</sub>		(7,93)		(2,75)		(2,74)
• government	SG	-	-2 590,00	-	-2 270,46	-	-2 488,74	-	-1 978,36
			t <sub>15,6</sub>		(12,34)		(3,91)		(23,62)
<b>INVESTMENT IN :<sup>(3)</sup></b>									
• agricultural products	INV <sub>1</sub>	660,98	674,20	743,62	758,49	734,91	749,61	734,20	748,88
		t <sub>11,15</sub> / PD <sub>1</sub>	t <sub>11,15</sub>	(12,50)	(12,50)	(11,19)	(11,19)	(11,08)	(11,08)
• industrial products	INV <sub>2</sub>	5 780,88	6 067,80	6 343,10	6 826,40	6 351,40	6 746,48	6 352,09	6 739,96
		t <sub>12,15</sub> / PD <sub>2</sub>	t <sub>12,15</sub>	(9,73)	(12,50)	(9,87)	(11,19)	(9,88)	(11,08)
• total	IT	6 441,39	6 742,00	7 085,53	7 584,89	7 085,53	7 496,09	7 085,53	7 488,84
		total col. 15	total col. 15	(10,00)	(12,50)	(10,00)	(11,19)	(10,00)	(11,08)
		/ P <sub>I</sub> or IT <sub>vo</sub>							

(1) : The totals and the t<sub>ij</sub> which appear in columns 1 and 2, correspond to the totals and to the cells of the AUTETA matrix, from which the numeric values of the reference situation are taken.

(2) : The volumes and the values of the aggregates were rounded to two decimal places. The numbers in parentheses are relative variations (%) with respect to the reference situation. For the aggregates, these percentages were calculated on the basis of numeric values to three decimal places and were rounded to two decimal places. The same procedure of percentage rounding was used for the price variations.

(3) : Given the procedure for arriving at a solution, INV<sub>1</sub> + INV<sub>2</sub> in volume is not exactly equal to IT<sub>vo</sub> calculated as IT / P<sub>I</sub>.



**Table 2 : Non-classic closings and real GDP,  
Increase of private consumption and investment in the AUTETA model : volume flows**

Aggregates	Reference Situation	Keynesian Closing	Kaldorian Closing	Johansen Closing
	(1)	(2)	(3)	(4)
GDP at factor cost $\left(\sum_{j=1}^4 VA_j\right)$	47 360,0	48 729,2 (2,89)	47 356,8 (0,00)	47 357,2 (0,00)
Private consumption,	33 588,2	34 914,3 (3,95)	33 627,9 (0,12)	34 052,8 (1,38)
<i>of which :</i>				
• salaried households $\left(\sum_{i=1}^3 CH_{ihw}\right)$	24 667,2	25 088,6 (1,71)	20 404,7 (-17,30)	24 416,3 (-1,10)
• capitalist households $\left(\sum_{i=1}^3 CH_{ihc}\right)$	8 921,0	9 825,7 (10,14)	13 223,2 (48,23)	9 636,5 (8,02)
investment (IT <sub>vo</sub> )	6 441,9	7 085,5 (10,00)	7 085,5 (10,00)	7 085,5 (10,00)

**Table 3 : Non-classic closings and macroeconomic equilibrium the AUTETA model: value flows**

Aggregates	Reference Situation	Keynesian Closing	Kaldorian Closing	Johansen Closing
	(1)	(2)	(3)	(4)
Domestic Raw Production at market prices,	50 900,0	53 016,0	51 513,8	51 168,9
<i>of which :</i>				
• domestic raw prod. at factor cost $\left(\sum_{j=1}^4 VA_j\right)$	47 360,0	49 284,6	47 909,4	47 557,5
• indirect taxes $\left(\sum_{i=1}^3 TI_j\right)$	3 540,0	3 731,4	3 604,4	3 611,4
= private consumption,	= 35 458,0	= 36 731,1	= 35 317,2	= 35 485,3
<i>of which :</i>				
• salaried households $\left(\sum_{i=1}^3 CH_{ihw}\right)$	25 578,0	26 396,8	21 416,3	25 448,1
• capitalist households $\left(\sum_{i=1}^3 CH_{ihc}\right)$	9 880,0	10 334,3	13 901,5	10 037,2
+ public consumption (G)	+ 8 700,0	+ 8 700,0	+ 8 700,0	+ 8 194,7
+ investment (IT)	+ 6 742,0	+ 7 584,9	+ 7 496,1	+ 7 488,8

**Table 4 : Non-classic closings and the government current account  
in the AUTETA model: values flows**

Aggregates	Reference Situation	Keynesian Closing	Kaldorian Closing	Johansen Closing
	(1)	(2)	(3)	(4)
Receipts (YG),	6 250,0	6 569,6 (5,11)	6 351,3 (1,62)	6 356,3 (1,70)
<i>of which :</i>				
• direct taxes $\left(\sum_{h=hw}^{hc} TDH_h\right)$	2 710,0	2 838,2 (4,73)	2 746,9 (1,36)	2 744,9 (1,29)
• indirect taxes $\left(\sum_{i=1}^3 TI_i\right)$	3 540,0	3 731,4 (5,41)	3 604,4 (1,82)	3 611,4 (2,02)
= public consumption (G)	= 8 700,0	= 8 700,0 (0,00)	= 8 700,0 (0,00)	= 8 194,7 (-5,81)
+ transfers to salaried households (TG)	+ 140,0	+ 140,0 (0,00)	+ 140,0 (0,00)	+ 140,0 (0,00)
+ savings (SG)	-2 590,0	-2 270,5 (12,34)	-2 488,7 (3,91)	-1 978,4 (23,62)

( ) : Variation in percentage with respect to the reference situation.

**Table 5 : Non-classic closings and aggregate prices in the AUTETA model**

Price	Reference Situation	Keynesian Closing	Kaldorian Closing	Johansen Closing
	(1)	(2)	(3)	(4)
Price of raw domestic products at factor cost	1,000	1,011	1,012	1,004
Price of private consumption	1,056	1,052	1,050	1,043
Price of public consumption (= P <sub>4</sub> )	1,000	0,992	1,008	0,998
Price of investment (P <sub>1</sub> )	1,047	1,070	1,058	1,057

Source : Tables 2 and 3. Prices were obtained by dividing the value flows by corresponding volume flows, except for P<sub>4</sub> and P<sub>1</sub> which are given directly in Table 1.

b) Kaldorian Closing

*Kaldorian* closing assumes that the income of households is no longer equal to the income generated by the factor of production paid at their marginal productivity. More precisely, even though this rule prevails, a mechanism is introduced into the system such that, if the objective volume of investment is greater than that at the reference situation, a transfer of income from households having a weak propensity to save towards those whose propensity is high takes place so as to meet the macroeconomic equilibrium condition of investment and savings. Obviously, if the objective volume of investment is below that of the reference situation, the transfer takes place in the opposite direction.

There are many ways of introducing Kaldorian closing. In the case of the AUTETA model, we did it in the most direct way possible. We simply created a new *endogenous* Tsk, defined as an income transfer from salaried households, having a weak propensity to save ( $\varphi_{hs} = 0, 1$ ), towards capitalist households, whose propensity to save is higher ( $\varphi_{hk} = 0, 2$ ). The disposable income equations for the two categories of household have thus been rewritten as follows :

$$[5] \quad YDH_{hw} = YH_{hw} - TD_{hw} - Tsk \quad \text{for salaried households}$$

$$[6] \quad YDH_{hc} = YH_{hc} - TD_{hc} + Tsk \quad \text{for capitalist households}$$

The idea here is that the transfer Tsk allows, through adjustments, disposable income of capitalist households ( $YDH_{hc}$ ) to sufficiently increase, to the detriment of that of salaried households ( $YH_{hw}$ ), so that this induced redistribution frees savings such that, simultaneously, the objective investment volume is reached and the equilibrium condition of investment and savings is satisfied.

A way of visually translating the mechanism into reality would be to say that there exists, alongside the government, a public bank whose administration costs are nil - and therefore, it doesn't pay salaries or purchase intermediate inputs - and whose only responsibility is to make the kind of transfer mentioned.

If we return to the model, the number of equations is still 72. On the other hand, with the addition of Tsk, the number of variables has gone from 80 to 81. But since the new variable is endogenous, the number of variables of this type is 72 instead of 71, with the number of exogenous variables remaining at 9. The overdetermination of the system has thus disappeared.

The results of the Kaldorian closing appear in columns 5 and 6 of Table 1 and in column 3 of Tables 2 to 5, with the objective of an increase of investment volume, with respect to the reference situation, remaining at 10 %.

The induced transfer of the income of salaried households to capitalist households required for the realization of the objective (Tsk) is far from insignificant, the amount 4 830 corresponding to a reduction by 16,29 % of the disposable income of salaried households and an increase by 40,3 % of that of capitalist households. The basket of consumption of the latter being composed, above all, of marketable services, it is thus not surprising that the production of such services rises the most, whereas industrial production practically does not change and agricultural production decreases, since agricultural products are the principal product consumed by salaried households.

This reallocation of the demand for products especially in favour of marketable services, explained by a redistribution of income, has the expected impact on the price of products and the costs of the factors of production : it is the price of marketable services and the return to capital specific to that production which experience the strongest augmentation. The cost of labour, of which the use is greater in agriculture than in industrial production or marketable services, increases slightly, and, under the effect of a decrease in agricultural production, the return to capital specific to it, decreases.

Total production of the economy remains determined by initial endowments in factors of production. The rate of variation of real GDP is thus negligible.

### c) Johansen Closing

The last non-classic closing, *Johansen closing*, is a little more simple. It assumes, in one of many possible variations, that the value of public consumption, our G, which is exogenous, becomes endogenous, making the system determined, with the number of endogenous variables going from 71 to 72, for a number of equations which stays at 72, and the number of exogenous variables now being 8 instead of 9. This allows government savings (SG), also variable and endogenous, to adjust in such a way so that the investment and savings equilibrium are satisfied, given the objective of investment.

We find these results of the Johansen closing in columns 7 and 8 of Table 1 and in column 4 of Tables 2 to 5.

With respect to the reference situation, the realization of the objective of a 10% increase in the volume of investment requires a decrease of 5,81% in the value of public consumption, which corresponds to a decrease of 5,58% in volume. This decrease, which equals a slowdown in the production of labour-intensive non-marketable services, makes the latter cheaper for the economy as a whole. Under the effect of a decrease in wages, the income of salaried households and, as a result, their consumption and savings, decreases. Under the effect of this same salary decrease, the price of agricultural products also falls, which, for both household categories brings about a reallocation of their consumption in favour of agricultural products.

With respect to government savings, they certainly remain negative. But the strong reduction in public consumption causes a decrease in the government current account deficit of 23,62%. It is this decrease in the government deficit, combined with an increase in the savings of capital owners, that is, capitalist households and firms, the beneficiaries of accrued returns, which allows the realization of the objective investment.

To conclude this section, it would be interesting to compare the results of Johansen closing with those of Simulation 2 of the AUTETA model.

This simulation used a reduction of 10% in the value of public consumption, for a classic closing of the model,  $G$  remaining exogenous and investment in volume implicitly endogenous. This decrease of 10% in public consumption brought about an increase in the volume of investment by 17,12%, whereas, in the Johansen closing the increase of 10% in the volume of investment induced a reduction, as we have just seen, of 5,81% in public consumption expenditures. In consequence, for the economy with which we are concerned, a reduction in public consumption of 4,19 percentage points ( $= 10\% - 5,81\%$ ) corresponds to an increase in the volume invested of 7,12 percentage points ( $= 17,12\% - 10\%$ ) or, stated another way, if public consumption decreases by one percentage point, the volume invested grows by 1,70 percentage points ( $= 7,12 / 4,19$ ).

### **III. How Does One Choose?**

The choice between classic and non-classic closing clearly rests on the vision that the modeler has of how the economy behaves. If investment is left mainly to private initiative, classic closing is better at translating what happens in reality. If, however, investment is, above all, centrally “planned” by the government, a non-classic closing proves to be more appropriate.

The choice among one of the three non-classic closings is undoubtedly made more difficult because several different considerations can be made. Keynesians closing assumes that, if the objective corresponds to a level of investment that is higher than that at the reference situation, there exists unused labour that will likely be used. This, incidentally signifies that labour and capital can be used in variable proportions. As for Kaldorian closing, it can't be used unless the income transfer, which it implies, is socially and politically realizable. Johansen closing is invariably unfavourable to wage earners given their importance in the production of non-marketable services, in all probability not bringing about as severe a redistribution of income from salaried households to capitalist households as in the case of Kaldorian closing. Johansen closing, however, requires that particular attention be paid to the impact on the well-being of individuals of a reduction in services offered by the government. This, however, can be difficult to evaluate using the AUTETA model, at least in its current form where no distinction is made between



private and public goods, and where no room is given to other possible failings in the market which the government could be called upon to correct<sup>4</sup>.

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<sup>4</sup> In the absence of a clear choice of closing, Abdelkhalek and Martens (1996) propose a “probabilistic” treatment of CGEM closings, with an application to Morocco.

## BIBLIOGRAPHY

- Abdelkhalek, T. and A. Martens (1996), *Macroclosures in Computable General Equilibrium Models with an Application to Morocco*, Cahier de recherche no 2596, C.R.D.E., Université de Montréal, Montréal.
- Decaluwé, B., A. Martens and M. Monette (1988), “Macroclosures in Open Economy CGE Models : A Numerical Appraisal ” *International Journal of Development Planning Literature* 3(2), pp. 69-90.
- Dewatripont, M. and G. Michel (1983), *On Closure Rule and Micro-Foundations of Applied General Equilibrium Models*, World Bank, unnumbered Working Paper, Washington, D.C.
- Gibson, B., N. Lustig and L. Taylor (1982), *Terms of Trade and Class Conflict in a Computable General Equilibrium for Mexico*, El Centro de Estudios Economicos, El Colegio de Mexico, Working Paper no. 1982-VI, Mexico.
- Johansen, L. (1960), *A Multi-Sectoral Study of Economic Growth*, North-Holland, Amsterdam.
- Kaldor, N. (1956), “Alternative Theories of Distribution”, *Review of Economic Studies* 23, pp. 83-100.
- Keynes, J.M. (1936), *The General Theory of Employment, Interest and Money*, MacMillan, London.
- Lysy, F.J. (1982) : *The Character of General Equilibrium Models under Alternative Closures*, World Bank, unnumbered Working Paper, Washington, D.C.
- Marglin, S.A. (1984), *Growth, Distribution and Prices*, Harvard University Press, Cambridge, Mass.
- Rao, V.K.R.V (1958), “Investment, Income and the Multiplier in an Underdeveloped Economy”, in *The Economics of Underdevelopment*, under the direction of A.N. Agarwala and S.P. Singh, Oxford University Press, New York, N.Y., pp. 205-218. Originally published in the February 1952 edition of the *Indian Economic Review*.
- Rattso, J. (1982), “Different Macroclosures of the Original Johansen Model and their Impact on Policy Evaluation ”, *Journal of Policy Modeling* 4, pp. 85-97.
- Sen, A (1963), “Neo-Classical and Neo-Keynesian Theories of Distribution ”, *The Economic Record* 39, pp. 53-64.
- Sen, A (1981), *Poverty and Famines*, Clarendon University Press, Oxford, G.-B.

Taylor, L. (1979), *Macro Models for Developing Countries*, McGraw-Hill Book Co., New York, N.Y.

Taylor, L. (1983), *Structural Macroeconomics*, Basic Books Inc., New York, N.Y.

Taylor, L and F.J. Lysy (1979), “ Vanishing Income Distributions : Keynesian Clues about Model Surprises in the Short Run ”, *Journal of Development Economics* 16, pp. 123-138.

Wood, A. (1987), “ Kaldor, Nicholas ”, in *The New Palgrave, A Dictionary of Economics*, under the direction of J. Eatwell, M. Milgate and P. Newman, The MacMillan Press Limited, London, Vol. 3, pp. 3-8.