DECISIONS OF FIRMS IN A MACRO-ECONOMIC GAME

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Abstract

This paper discusses an experimental macro-economic game. The frame-work of the game is developed from a general equilibrium growth model from which the equilibrium conditions have been removed and the behavioural equations of the production sector have been replaced by players. The game has been played on a computer network where 1 minute playing represents about 1 month in real time. The players had to make decisions about their price, wage, labour demand and investment. The development of six game economies is sketched, while for three of those economies investment, labour demand and real wage equations have been estimated. The conclusion is that although the feedback on decision making to the players was insufficient to enable them to make well-informed decisions, especially the investment equation gives consistent results.

1. Introduction

It is very difficult to test macro-economic theories. This is partly a consequence of the lack of opportunities to do systematic experiments. The development and testing of macro-economic theories can only be done with the help of data of real economies. When the results are not as expected, it is almost always possible to argue that the results are the consequence of special circumstances. And when the results are in agreement with the tested theory, it is almost always possible to find alternative explanations for the data. As a consequence, macro-economic theories are almost never falsified. Hence the controversies between different macro-economic schools of thought can continue.

In experiments this problem can be avoided. But in most experiments the experimental world has to be simplified so much that only a very small part of a macro-economic system can be analyzed. In this paper an experimental world is described that is a model of a complete macro-economic system. The experimental world is a game where the players are running firms for about 15 game years (about one day in real time). The game is played on a computer network with at least 10 to 40 firms at the same time. Each minute the results are computed, so the players can play as if time goes on continuously. The players have to make decisions about pricing, labour demand, labour cost, and investment. The players can produce consumer goods or machines. The behaviour of consumers and workers is modelled by the computer, but the market of machines is determined for a large part by the interaction between the players. At this moment the government and banking sector are managed by the game leader on the central computer. The game generates about 80 time series of data on a monthly base that can be used by the players in their decision making.

In this paper first a sketch will be made of the structure of the game. Second, the development in six game economies will be sketched. Although this sketch shows that the game has not functioned proper enough to use the data for deep theoretical investigations, some first estimations on the investment function and the real wage will be presented. Finally, the use of the game as an experimental world will be discussed.

2. Design of the game

The game has been developed from a aggregate general equilibrium growth model. This growth model has been disaggregated for the behaviour of firms. Those theoretical firms are replaced by real players. The players make all decisions of the theoretical firms, i.e. investment, labour demand, price setting and wage setting. Because the firms are free to do this, the equilibrium conditions have to be replaced by market rationing mechanisms. Furthermore, because of the possibility of errors the putty-putty production function has to be replaced by a putty-clay production function.

First, the description of the growth model. The presentation of the growth model will be a little bit different from the model in the standard textbooks. The reason is that we like to distinguish between the fundamental assumptions about the structure of the economy, and the behavioural assumptions of the firms and the equilibria on the markets. In the game only the fundamental assumptions about the structure of the economy will be modelled, while the behaviour of the firm is a consequence of the behaviour of the players, while there is no a priori reason that equilibrium will emerge in the game. For this reason, we describe first the structure of the economy, and define the fundamental variables. Secondly, the equilibrium conditions on the markets are introduced. Finally we show that the the world is consistent with a profit maximization of the sector of firms under the assumption of price taking behaviour.

a. ~~The restrictions.~~ Technological constraints

Technology is the most important restriction in neoclassical models. In order to have simple aggregation characteristics, a Cobb Douglas production function with constant returns to scale is chosen:

(1) $Q = \alpha K^{ß} L^{1-ß}$

where[1]: Q = Real production in period t
K = Real stock of capital at the beginning of period t
L = Number of labourers in period t

The production function (1) can be written as:

(1a) $g_Y = ß\, g_K + (1-ß)\, g_L$

where: $g_X = \frac{X_{+1} - X}{X}$

$_{+1}$ = Indication of the time lag

The second restriction is the exogenous growth rate of labour supply:

(2) $L^s = g_L\, L^s_{-1}$

where: L^s = Labour supply in period t

The third restriction is the physical deterioration rate of capital δ that is assumed to be a constant percentage of the capital stock:

(3) $D = \delta K$

where: D = Depreciation (deteriation) on capital stock

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[1] For notational convenience the subscript t is omitted when the variable refers to the current period.

b. The definitions

The capital stock is defined as

(4) $K = I_{-1} + K_{-1} - D_{-1}$

where: I = Real investment in capital stock in period t

Hence:

(4a) $K = I_{-1} + (1-\delta)\ K_{-1}$

The national demand is defined as:

(5) $Y^d = C^d + I^d$

where: Y^d = Real national demand of goods
C^d = Demand of goods by consumers
I^d = Demand of goods by the firm sector

While national sales are defined as:

(6) $Y = C + I$

where: Y = Real national sales
C = Real national consumption
I = Real national investment

The savings are defined as:

(7) $S = Y - C$

where: S = Real national savings
Y = Real national sales

While according to definitions (6) and (7) holds by definition:

(7a) $I = Y - C = S$

c. The behavioural assumptions

In the real economy behaviour of firms and consumers is relevant. Because the focus of attention is on firm behaviour, a simple ad hoc consumption function is introduced as a restriction. Consumption is assumed to depend on income[2]:

(8) $C^d = c'\ Y$

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[2] In standard neoclassical equilibrium growth models it is assumed that consumption depends on current income. The reason for this is that a dependence on lagged income assumes that consumers always have incorrect predictions of future income. But in disequilibrium models the use of income without lag implies that the multiplier processes will be finished instantaneously. This implies much more instability than there is in reality. But in an equilibrium model a lag does not influence the theoretical results, because the consumption function with lagged income can always been written as $C = c'\ Y$ where: $c' = c\ (Y_{-1}/Y)$. For simplicity we will use c' instead of a lagged function in the equilibrium model. The ' signals that it is not the same consumption quote as used in the game.

where: C^d = Real consumption demand
Y = Real national income

d. The equilibrium conditions

To complete the model equilibrium on all markets is assumed. Hence, the following equilibrium conditions hold.

First, when a firm maximises its profits, it will have no stocks of products. Hence:

(9) $Y^s = Q$

where: Y^s = Real good supply

Second, equilibrium on the goods market is assumed:

(10) $Y = Y^d = Y^s$

From (9) and (10) follows:

(10a) $Y = Q$

Equilibrium on the market for goods implies:

(11) $C = C^d$

Because investment is determined by savings in this model, equilibrium on the market for investment goods implies that investment demand is determined consistently with equilibrium investment[3]:

(12) $I^d = I$

Finally, equilibrium on the labour market is assumed:

(13) $L = L^s$

With the equations (1)-(13) a complete growth model is of 13 equations and 13 endogenous variables is described.[4] Equations (1)-(8) are equations of the model that will be used in the game. Equations (9)-(13) are equilibrium conditions that will be relevant to define the long term equilibrium growth path of the game.

e. The solution of the model

The set of equations can be solved as follows. From (4), (6) and (8) may be derived[5]:

$S = (1 - c') Y$

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[3] It will be derived later at what interest rate profit maximizing behaviour of firms can generate this result.

[4] These endogenous variables are: $Q, K, L, L^s, D, Y^d, Y^s, Y, C^d, C, I^d, I$, and S.

[5] Notice that $Y_{-1} = \frac{1}{(1+g_{Y,-1})} Y$

From (3) and (4), (7a) and the last equation follows:

$$(14)\quad g_K = \frac{K_{+1} - K}{K} = \frac{I}{K} - \delta = \frac{S}{K} - \delta = \{1 - c'\}\frac{Y}{K} - \delta$$

Because according to (2) and (13) the growth of the stock of labour is exogenous, endogenous variations in the growth rate of national income g_Y are caused only by variations in the growth rate of the capital stock g_K. When the growth rate of the capital stock is greater than the growth rate of labour supply ($g_K > g_L$), then according to (1a):

$$g_Y = g_K + (1-ß)\ (g_L - g_K) < g_K$$

Hence, by definition:

$$d(Y/K) < 0$$

In agreement with (14) it follows:

$$d\ g_K < 0$$

When the growth rate of the capital stock is smaller than the growth rate of labour demand, the complementary story holds.

It may be concluded that the equilibrium growth model described by equations (1)-(13) tends towards a stable equilibrium, where holds:

$$g_K = g_Y = g_L$$

If $g_K > g_L$ then $d\ g_K < 0$
If $g_K < g_L$ then $d\ g_K > 0$

This is the traditional textbook result.[6]

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[6] The growth path can be derived as follows.

First, substitute (14) into (1a):

$$g_Y = ß\ g_K + (1-ß)\ g_L = ß\ \{(1- c')\frac{Y}{K} - \delta\} + (1-ß)\ g_L$$

$$Y_{+1} = (1+g_Y)\ Y = [1+ß\ \{(1- c')\frac{Y}{K} - \delta\} + (1-ß)\ g_L]\ Y$$

$$K_{+1} = (1+g_K)\ K = [1+\{(1- c')\frac{Y}{K} - \delta\}]\ K$$

$$\frac{Y_{+1}}{K_{+1}} = [ß + \frac{(1-ß)\ (g_L+1)}{1+\{1-c'\}Y/K - \delta\}}]\ \frac{Y}{K}$$

According to equilibrium condition (12) and definition (7a) planned investment is equal to savings. Hence, according to (6), (8), (11), (4) and (3):

$$Y(1 - c') = (\delta + g_K)\ K$$

$$g_K = (1-c')Y/K - \delta$$

Because in long term equilibrium holds $g_K = g_Y = g_L$:

f. The equilibrium prices

It is possible to derive equilibrium real prices consistent with the growth model. In a good neoclassical tradition, it will be assumed that firms maximise the net present value of the aggregate profits given the production function, and all the prices:

$$(15)\quad \underset{L,I}{\text{Max}}\ NPV = \underset{L,I}{\text{Max}}\ \sum_{t=0}^{\infty} R\pi = \sum_{t=0}^{\infty} R\,[PY - WL - P_I I]$$

subject to:

$$(1)\quad Q = \alpha K^{\beta} L^{1-\beta}$$

$$(4a)\quad K = I_{-1} + (1-\delta) K_{-1}$$

$$(10a)\quad Y = Q$$

$$(16)\quad P_I = P$$

where:

NPV	=	Net present value of profits
P	=	Price level of output in period t
P_I	=	Price of investment goods in period t
W	=	Wage rate in period t
π	=	Profits in period t
R	=	$1 \Big/ \prod_{s=1}^{t} \pi\,(1+r_s)$
i_s	=	Nominal interest rate in period s
r_s	=	Real interest rate in period s: $r_s = i_s - g_P$

Condition (16) follows from the assumption that the output market is homogeneous. Hence the investment good is the same as the consumption good.

From this set of equations the equilibrium real wage rate and real interest rate are determined[7]:

$$(17)\quad \frac{W}{P} = (1-\beta)\,\frac{Q}{L}$$

$$(18)\quad r = \beta\,\frac{Q}{K} - \delta$$

$$(Y/K)^{*} = \frac{(\delta+g_K)}{(1-c')} = (\delta+g_L)/\left(1 - \frac{c}{1+g_L}\right)$$

where * indicates the long term equilibrium level.

[7] The first order conditions for this maximization problem are:

$$\frac{d\,NPV}{d\,L} = P\,\frac{dQ}{dL} - W = P\,(1-\beta)\,\frac{Q}{L} - W = 0$$

$$\frac{d\,NPV}{d\,I_{-1}} = \frac{P}{P_I}\,\frac{dQ}{dK} - r - \delta = \beta\,\frac{Q}{K} - r - \delta = 0$$

From those equations follow the factor demand equations directly.

Hence, it is shown that equilibrium prices consistent with the macro-economic growth model do exist. This finishes the real growth model.[8]

g. The introduction of money

It is easy to introduce a monetary sector into the model. Consistent with the quantity theory of money, the behavioural equation for the demand for money is defined as:

(19) $M^d = P\ Y$

where: M^d = Demand for money

In equation (19) it is implicitly assumed that the velocity of money is equal to 1. This can realised always by defining the length of the period in such a way that the velocity of money is 1.

The growth rate of money supply is determined exogenously by the Central Bank:

(20) $M^s = g_M\ M^s_{-1}$

where: Ms = Money supply

Further, equilibrium on the money market is assumed:

(21) $M^d = M^s$

Finally, we may define the stock of money in circulation as:

(22) $M = M^d$

where: M = Money in circulation

With equations (19)-(22) the price level and the equilibrium inflation rate are determined:

(23a) $P = \frac{M^s}{Y}$

(23b) $g_P = g_M - g_Y$

Hence the equilibrium nominal interest rate is determined, too:

(24) $i = r + g_P = ß\ \frac{Q}{K} - \delta + g_M - g_Y$

where: i = nominal interest rate

In equilibrium condition (21) it is implicitly assumed that the credit market functions appropriately. It is assumed that all subjects can lend as much as they like at the going interest rate. In equilibrium, the banking sector expands its credits till the money stock in the economy is accordance with equations (20) and (21). The supply of (nominal) credit is equal to the (nominal) savings of the private sector (including the net interest payments

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[8] It will be clear that the maximization problem (5.2.15) is not determined with respect to Q. In this section the maximization problem is used to derive the equilibrium prices. In section 5.3 the consequences of this indeterminacy problem will be investigated.

to the banking sector) plus the growth of the stock of money. The demand for credit is equal to the sum of the investments in fixed capital, the investments in finished products[9] and the net investments in cash balances of the private sector. By definition, the growth of the stock of money is equal to the net investments in cash balances of the private sector. Hence, the investment outlays are equal to the savings.

In the foregoing it is not described through which mechanism the expansion of money supply induces inflation. In a general equilibrium model the inflation can only be explained by the assumption of rational expectations. When the Central Bank[10] expands money supply, all the subjects have to expect a rise in prices.[11] Hence, it becomes profitable to demand credits from the Central Bank at the equilibrium real interest rate for the transactions. Implicitly, it is assumed that all subjects have just enough money for transaction purposes. If they do not need the cash money, they lend it to the Central Bank. If they need more money, they can lend it at the Central Bank without limit. Hence, the credit market is perfectly elastic at the going interest rate.

With equations (17) and (18) the equilibrium real wages and interest rates are appended to the model. With equations (19) - (22) the price level and money market were introduced, while with equation (24) the nominal interest rate is determined.[12] With those equations the equilibrium growth model is complete.

3. From equilibrium model to game economy

The general equilibrium model is the framework of the game economy. It remains always one of the possible developments in the game economy. But in the game the equilibrium conditions in the theoretical model are replaced by rationing devices.

In order to disturb the growth model of section 2 as little as possible, the aggregate demand equation (5) will be maintained. Hence, the aggregate demand has to be distributed over the firms. In accordance with standard micro-economic theory, aggregate demand will be distributed over firms according to their relative prices. According to standard price theory, the elasticity of demand is greater in the long run than in the short run. This is formalized by the introduction of the lagged market share in the demand equation:

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[9] Notice that the optimal stock is 0 in the equilibrium model under certainty.

[10] Or the banking sector. In the model it is assumed that there is one exogenous banking sector that gives credits and absorbs loans as much as the private sector likes. The banking sector manipulates its interest rate so that all the money supply is absorbed.

[11] In a non-rational expectations situation, when the Central Bank likes to expand money supply, it can only rise the demand for money by lowering the interest rate. As a consequence of this expansion of credit, aggregate demand will rise. Hence, an inflation process will start. If all subjects expect this rise in prices, the decline in the interest rate will not take place. As long as the public expects that the Central Bank will expand money supply, equilibrium will be reached at the interest rate described in equition (18). Hence, the knowledge of the public about the policy of the bank makes it unnecessary for the bank to create disequilibrium to induce an expansion of the stock of money.

[12] With the seven extra equations seven new endogenous variables were introduced: W, i, r, P, M, M^d and M^s.

$$(25)\quad Y_j^d = \frac{P_j^{\mu}\,(Y_{j,-1}/Y_{-1})}{\sum_j \{P_j^{\mu}\,(Y_{j,-1}/Y_{-1})\}} \cdot Y^d$$

and

$$(26)\quad Y_j = \min(Y_j^d, Y_j^s)$$

where:
Y_j = Quantity sold by firm j
Y_j^d = Quantity demanded from firm j
Y_j^s = Quantity supplied by firm j
P_j = Price set by firm j
μ = Price elasticity of demand (approximately)[13]

The price elasticity of micro-economic demand is approximately equal to μ in this function. The choice of a micro-economic demand function with constant elasticity simplifies the derivation of the equilibrium conditions. By relating the current market share to the lagged market share the market is stabilized. The assumption may be defended by the idea that customers are related with firms, and that most customers stay at the same firm as long as they have no reason to change. But at the moment a firm has been succesful to attract new customers they will stay at this firm so long as they have no price incentive to change.

In the same way aggregate labour supply (that is a function of the real wage) is distributed over the firms:

$$(27)\quad L_j^s = \frac{W_j^{\mu}\,(L_{j,-1}/L_{-1})}{\sum_j \{W_j^{\mu}\,(L_{j,-1}/Y_{-1})\}} \cdot L^s$$

where:
L_j = Labour stock of firm j
L_j^s = Labour supply to firm j
W_j = Wage set by firm j
μ = Wage elasticity of demand (approximately)

Further, the putty-putty production function has to be replaced by a putty-clay production function: the production function after the moment the capital is bought, can be written as:

$$(28)\quad L_j = \min(\alpha\, L_j, L_{max})$$

where:
L_{max} = maximum number of labourers on the capital stock
α = labour productivity of the chosen machines

Finally, many minor restrictions (for example on credits and wages) are introduced to prevent decisions that are irrealistically extreme.

4. Six game economies

The game has been played by six groups of students after their first year at the university. The purpose for the students was to integrate different economic disciplines (for example macro-economics, micro-economics, finance and accounting) in their decision making during the game. Each firm has been played by three students during 4 to 6 hours. The students had to play as if

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[13] μ is only approximately equal to the micro-economic price elasticity of demand, because the denominator changes too when relative prices change. But with a large number of firms this effect is very small compared with the effect of the price change in the numerator. Hence, the influence of changes of the price of a firm on the denominator will be neglected in our derivations.

time was a continuous variable. They could change their wage rate, the price and their labour demand at any moment, just as they could order for investment goods at any moment they like (at the conditions presented at their screen). Each month in the game (about 1 minute real time) the decisions of the players were processed by the central computer and the results of the game economy were send to the computers of the firms. The most recent key data were presented automatically on the decision screens of the players. Although the players did not use it extensively, they could easily present aggregate data as well as data of their own firm on their computers.

The results of the games show that it was very difficult for the players to make adequate decisions. For a proper functioning of the game as an experimental world it is essential that the players get help in making their decisions. Such a help system has not been implemented yet. As a consequence there have been made so many errors that most economies got into big trouble. Nevertheless, the analysis of those games have some interesting results. In this section the dynamics of six game economies will be discussed, while the next section focusses on the explanation of the real wage and investment in those economies.

All the game economies did have an equilibrium growth of 0, and started in equilibrium. Three games were played with firms that produced one output that was divided over consumer goods and machines by the computer, and three firms were played with firms that produced two products: consumer goods and machines. The characteristics of the games are summarized in the following table:

Name	divisions	firms	months
JAN1	1	11	108
JAN2	1	10	122
JAN3	1	12	120
JAN4	2	12	179
JACK4	2	15	147
JACK1	2	12	139

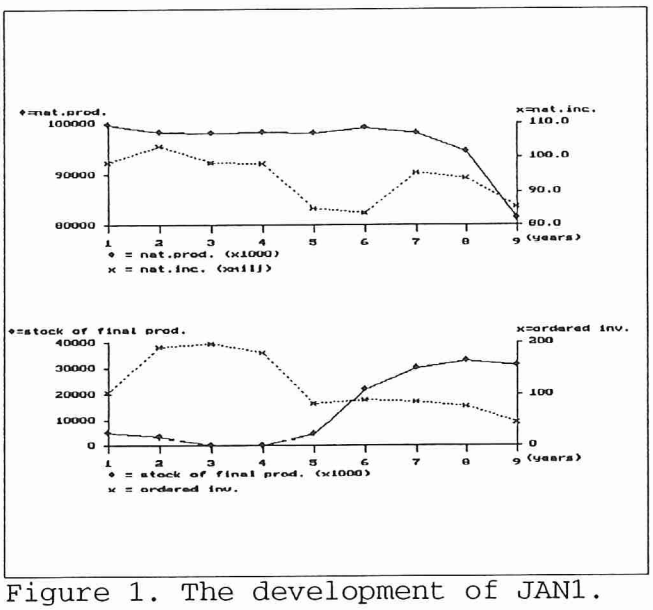

Figure 1. The development of JAN1.

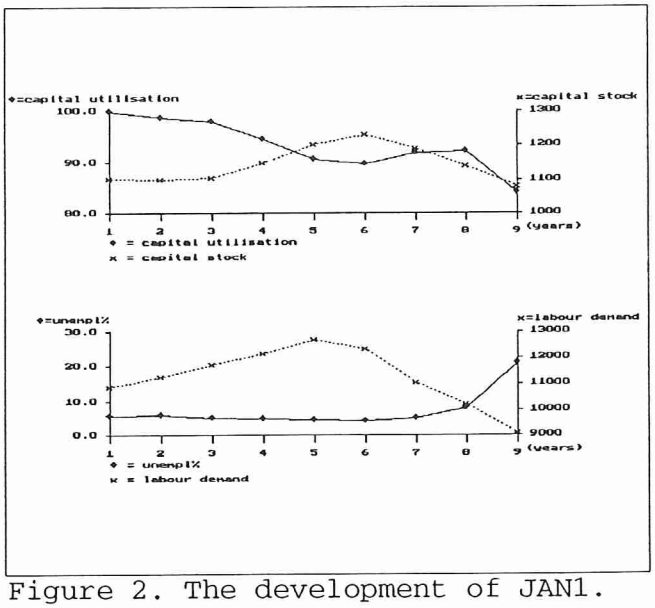

Figure 2. The development of JAN1.

Figure 1 shows for JAN1 a hausse till year 4 that changes in a very deep recession beginning at year 5. In the beginning of the game investment demand was very high resulting in an expansion of the capital stock (see figure 2).

But this expansion did not have much effect on the production level because of a shortage in labour supply. Around year 4 it became clear that no perspectives were available for investment in labour intensive capital. Hence investment demand declined, and a recession started.

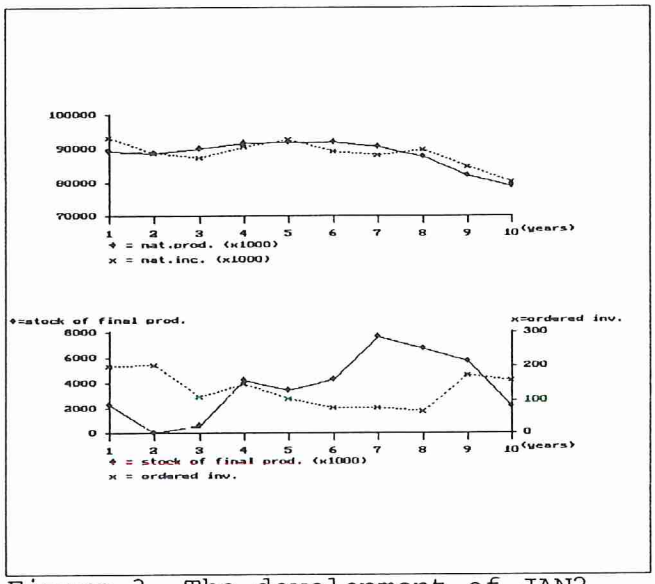

Figure 3. The development of JAN2.

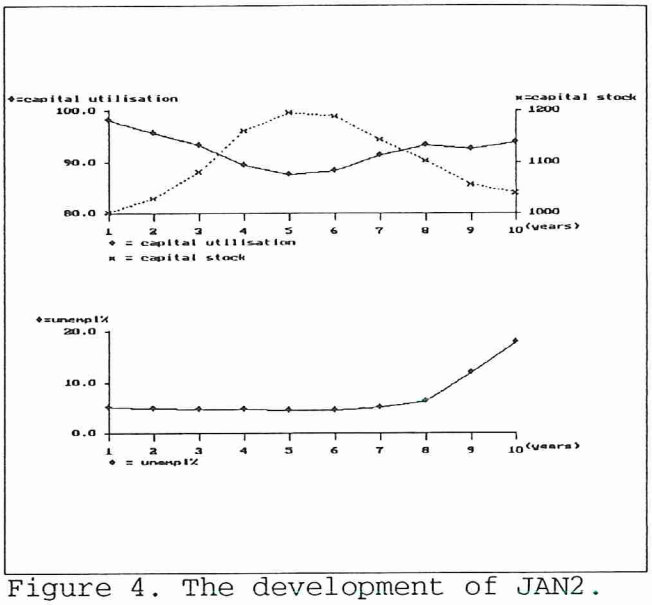

Figure 4. The development of JAN2.

Figure 3 shows that JAN2 is a rather stable economy. The utilisation rate declines till year 5, but then it rises. The stock of products rises till year 7, but then declines. This is caused by a decline in the stock of capital goods starting from year 6 (figure 4). As a consequence there is a small amount of structural unemployment beginning in year 8, that is combined with unemployment caused by a lack in aggregate demand on the output market. But because the stock of final products declines rapidly, while investment demand rises fast (but not too extreme), it may be expected that when this game would have been continued the problems in the output market would have been solved quickly and somewhat later also the structural adjustments would have been made. This economy seems to be the only sound economy that has been played.

Table 1. The development of game economy JAN2

year	nat.inc. (x1000)	nat.stock (x1000)	nat.prod. (x1000)	utilisation rate of cap.	ordered inv.	real wage
1	92916	2217	89130	97.97	197.00	597.41
2	88496	0	88496	95.47	201.00	552.97
3	87075	538	89862	93.30	107.00	484.96
4	90325	4139	91536	89.28	144.00	551.13
5	92383	3323	91789	87.54	101.00	622.51
6	89088	4224	91629	88.22	75.00	631.32
7	87814	7592	90313	91.21	75.00	628.90
8	89563	6671	87390	93.24	65.00	669.49
9	84482	5622	81673	92.48	172.00	555.02
10	80014	2092	78629	93.74	155.00	448.91

Table 1 shows that the real wage rose in the time that the stocks of final products were high. It seems a strange reaction. One explanation may be that in the first period with high demand the players reacted by price, because with the almost full utilisation rate they could not win by attracting more labour. During the recession period the utilisation rate of capital was low; when one expects the recession to be temporary, it is rational to try to get enough labour for the upswing, while there is no reason to rise prices. Finally, when at the end of the game unemployment rose, it was wise to lower the real wage.

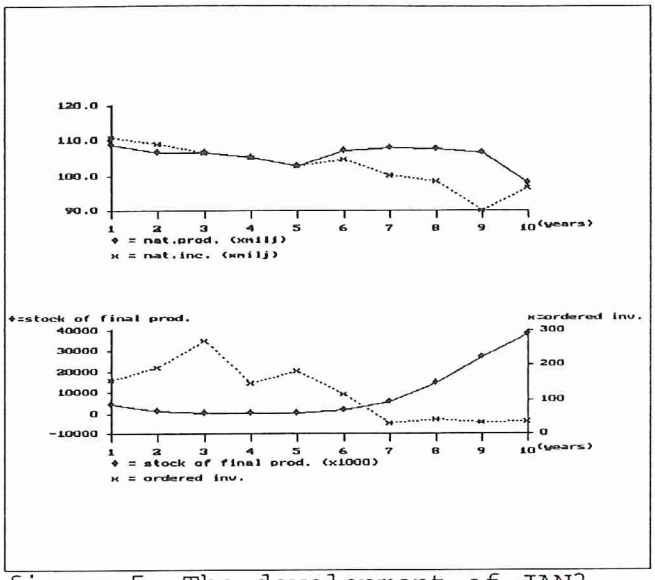

figure 5. The development of JAN3.

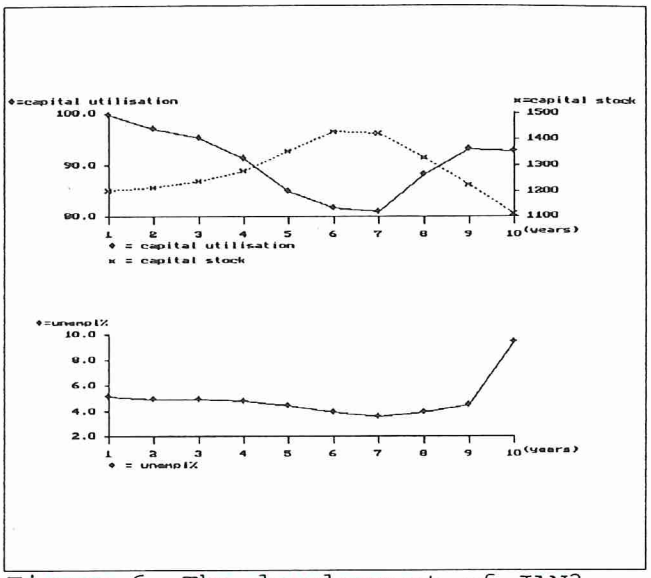

Figure 6. The development of JAN3.

Figure 5 shows that in JAN3 national income is slightly higher than production. As a consequence stocks are 0 starting between year 3 and 5. Because of underinvestment (figure 6) production decreases during that period. Investment during period 3 to 5 induces an expansion of the stock of capital that cannot be met by labour supply. Hence, the utilisation rate of capital declines. As a consequence of this investment demand declines, and hence sales for the firms decline. The stock of finished products rises as well as the unemployment rate. The game ends in this recession period.

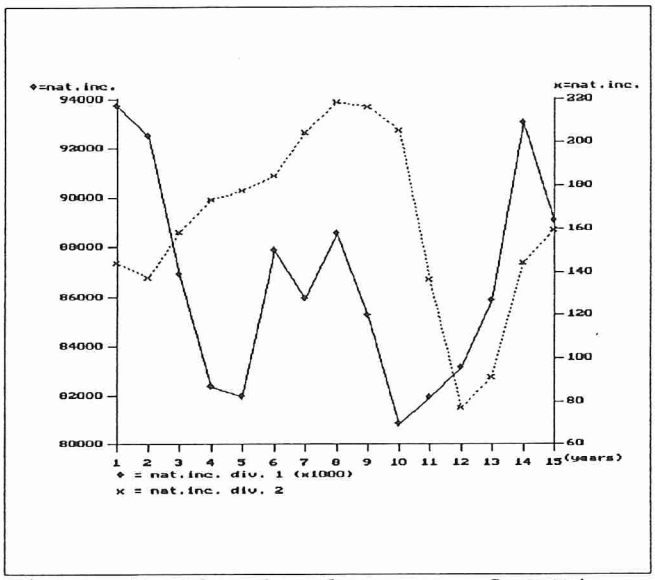

Figure 7. The development of JAN4.

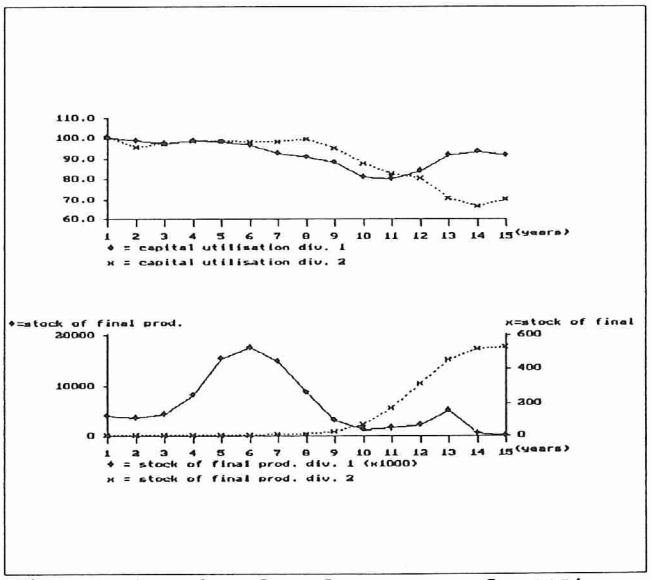

Figure 8. The development of JAN4.

AN4 is a game with two divisions. The results will be discussed a little bit more at length. In the first 5 years the investment sector expanded at the cost of the sector of consumer goods. Then a general expansion began, which ended in a sharp crisis starting in the consumer products in year 8. Around year 12 the situation became better. But figure 8 shows that a fundamental disequilibrium emerged: very high stocks of investment goods. This is a consequence of irrational behaviour of the players; they did fire labour; as

a consequence they produced for stock, while there was no perspective in selling the stock. As a consequence those firms would have been bankrupt in reality, but in this game this was not the case, the firms did only get a owners' negative capital, and the stocks of investment goods remained on the market.

Table 2. The market of consumer goods in JAN4.

year	nat.inc. (x1000)	nat.stock (x1000)	nat.prod. (x1000)	utilisation of cap.	ordered investment	real wage
1	93676	3971	93674	100.00	172.00	608.01
2	92464	3602	91757	98.55	242.00	594.69
3	86853	4218	89162	97.20	213.00	529.73
4	82309	8035	88763	98.25	124.00	477.67
5	81931	15109	88043	97.73	102.00	466.71
6	87817	17266	85945	96.07	85.00	517.91
7	85870	14693	82022	92.34	90.00	510.77
8	88506	8611	80945	90.45	108.00	528.79
9	85170	2979	81666	87.48	92.00	495.70
10	80816	1231	81169	80.49	95.00	464.25
11	81856	1553	82140	79.46	80.00	491.93
12	83080	2083	84051	83.63	58.00	509.73
13	85781	5039	87771	91.43	88.00	509.47
14	92973	622	88099	93.01	127.00	481.12
15	88998	0	88998	91.26	165.00	419.45

The market for consumer goods (table 2) starts good in the first year, but then a long recession starts that goes on until year 10. Till year 6 the recession shows itself in rising stocks of final products, and afterwards in a low utilisation rate of capital. The expectation that the situation will improve results in continuous expansion of the stock of capital in the consumer sector. But the fundamental cause of the problems is the extremely low real wage in the country.

Although the recession reached its deepest point in year 10, the only government intervention in the game resulted in a sharp rise in demand in year 14. The market for machines shows a very long boom after a short recession in the first year. The cause of this boom is over-investment (table 3). The table shows that investment orders in the first year are about 60 % higher than replacement investment for division 1, and more than 3 times as high for division 2. The consequence of this is a shortage in production capacity in the investment goods sector resulting in a long delivery time for investment goods (almost 4 years in year 4). This was an incentive for new orders of machines.

Table 3. Investment in JAN4.

year	ordered investment div. 1	ordered investment div. 2	stock of capital div. 1	stock of capital div. 2	delivery time of machines	labour intensity of machines div.1	labour intensity of machines div. 2
1	172.00	63.00	1031	167.08	12.42	10.00	10.03
2	242.00	60.00	1029	176.67	22.50	9.96	9.78
3	213.00	62.00	1022	199.50	33.67	9.85	9.72
4	124.00	35.00	1015	213.50	35.92	9.76	9.71
5	102.00	33.00	1022	220.17	33.75	9.64	9.66
6	85.00	29.00	1025	233.33	29.08	9.56	9.60
7	90.00	39.00	1023	256.58	22.33	9.52	9.58
8	108.00	28.00	1036	275.92	15.92	9.49	9.62
9	92.00	43.00	1090	323.58	10.17	9.46	9.73
10	95.00	32.00	1171	371.42	3.92	9.53	9.95
11	80.00	25.00	1186	380.08	3.00	9.72	10.10
12	58.00	3.00	1143	361.92	3.00	9.78	10.20
13	88.00	6.00	1082	336.25	3.00	9.83	10.24
14	127.00	18.00	1061	317.08	3.00	9.81	10.23
15	165.00	27.00	1102	294.42	3.00	9.76	10.22

Because of the high level of investment in machines with normal labour intensity, it could be expected that problems on the labour market would arise. But because of the long delivery time this problem became severe only around year 8. Investment demand declined sharply at a moment that production

capacity in the investment goods sector had doubled compared to the start of the game. There was only one firm that ended with a positive owner's capital for the machine division: firm number 5. This firm had the correct reaction on the problems: a low price and firing the useless labour (partly transferring it to division 1, where it could have been used at a profit).

The market for labour developed correctly during the first ten years, but shows a rather strange development at the end of the game. During the first recession in the consumer goods sector, unemployment rises. That is okay. But in the second recession the unemployment rate remains very low. The fundamental explanation is the creation of an enormous amount of rather labour intensive capital compared with the labour supply. Hence, the first years were characterized as years of over-investment. Because of the high demand for final products during the hausse in the first five years, the firms increased their prices. But they did not increase their wages during this period. Hence, real wages declined. During the recession for the consumer sector, unemployment rose from 5 till 9 % while wages declined slightly. In the upswing that followed unemployment declined and wages rose. This is all okay.

When the general crisis started in year 10 unemployment did not decline. The wage rate continued to rise, while for the investment sector the prices declined to less than 20 % of the prices in the hausse. With this expensive labour the firms produced for stock; consequently, this resulted in very high costs to store those stocks. The firm with the best results at the end of the reacted fast on the slack in the investment good sector by setting a relatively low price to get as many sales as possible, in combination with a quick ending of the production.(table 4).

Table 4. The decisions of firms 5 and 6 related to the aggregate in JAN4

year	production			price (x 1000)		
	div. 2	firm 5.2	firm 6.2	div. 2	firm 5.2	firm 6.2
1	140.35	11.69	11.69	271	274	267
2	139.95	11.76	10.92	314	334	294
3	159.68	14.77	14.83	399	445	354
4	172.24	15.05	14.49	497	567	414
5	177.07	15.12	14.05	604	734	538
6	185.96	17.08	14.79	673	805	599
7	204.26	18.83	17.29	629	730	586
8	223.94	18.69	18.21	569	675	518
9	253.47	21.91	19.68	509	580	460
10	265.75	20.37	21.46	443	474	420
11	256.54	20.72	18.09	378	341	358
12	238.43	6.51	13.46	270	245	268
13	192.45	4.20	5.72	172	151	148
14	171.10	9.38	4.27	143	150	124
15	167.03	10.92	2.38	121	121	121

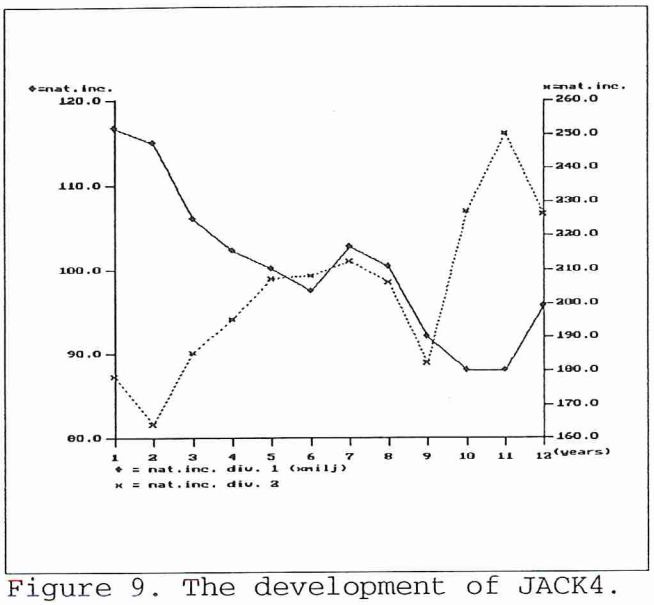

Figure 9. The development of JACK4.

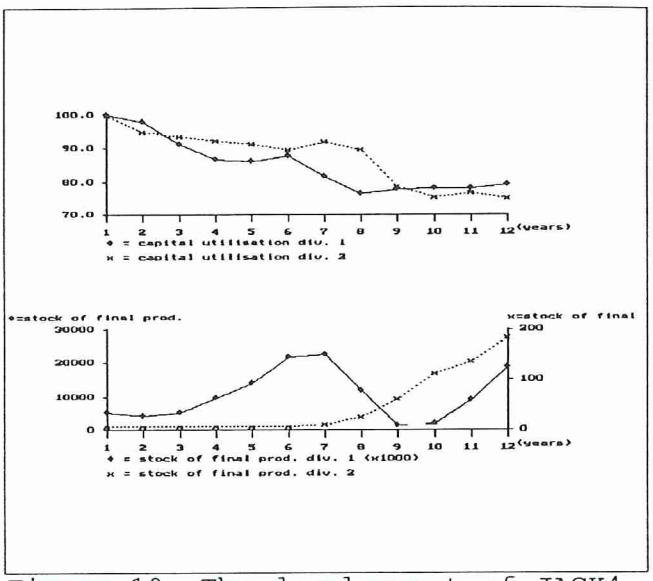

Figure 10. The development of JACK4.

After a very short recession the investment sector in JACK4 expands at the cost of the consumption sector. In year 7 a recession starts that continuous till year 9. But just as in the game JAN4 a fundamental overcapacity develops at the end of the game with the consequence that the utilisation rate of capital declines (because of a shortage in labour supply). The reaction on the problems is just the same as in JAN4: most players try to maximise their utilisation rate and forget to adjust labour demand to aggregate demand of output. Therefore, the stocks of final products rise extremely at the end of the game.

Table 5. The market of consumer goods in JACK4.

year	nat.inc. (mill)	nat.stock (mill)	nat.prod. (mill)	utilisation of cap.	ordered investment	real wage
1	117	4969	117	99.63	190.00	605.06
2	115	4077	113	97.62	379.00	594.58
3	106	5180	110	90.79	231.00	517.91
4	102	9496	107	86.35	225.00	479.53
5	100	13710	105	85.69	99.00	452.14
6	97	21371	104	87.51	37.00	422.80
7	103	22347	96	81.29	62.00	446.17
8	100	11650	87	76.03	57.00	426.46
9	92	1267	87	77.53	86.00	407.96
10	88	1873	92	77.68	168.00	349.62
11	88	8744	98	77.84	173.00	336.84
12	95	18390	101	78.71	170.00	407.73

The market for consumer goods declines almost continuously. This is the consequence of the decline in the real wage (that only rises in year 7 and 12). Because of the over-investment compared to aggregate demand and the usefulness of labour in the other sector, the utilization rate declines. But this is especially a problem for the firms with bad results:

Table 6. The utilisation rate of capital in JACK4

year	utilisation rate of capital for the best six firms					
	firm 8	firm 4	firm 15	firm 12	firm 10	firm 5
1	99.98	99.98	99.98	99.73	100.00	99.98
2	93.38	88.61	100.00	95.88	99.57	100.00
3	64.15	75.74	100.00	82.24	84.07	95.02
4	63.69	82.93	100.00	91.83	72.81	82.87
5	64.22	82.12	98.67	99.33	80.12	78.08
6	68.48	86.02	91.05	99.42	82.21	90.48
7	93.91	81.91	87.86	99.01	84.57	90.38
8	99.65	82.30	73.27	95.18	93.05	88.53
9	94.76	89.82	84.53	83.32	91.04	87.27
10	93.96	89.42	90.33	89.50	91.94	94.94
11	95.16	72.33	84.67	95.04	86.90	99.80
12	96.23	73.68	78.40	91.77	93.12	97.46

Table 7. The market of investment goods in JACK4.

year	nat.inc.	nat.stock	nat.prod.	utilisation of cap.	ordered investment	delivery time machines
1	178.00	6.33	174.44	99.44	46.00	10.75
2	164.00	6.99	166.92	94.71	89.00	18.50
3	185.00	7.64	184.42	93.42	74.00	30.50
4	195.00	6.91	197.54	92.05	70.00	41.92
5	207.00	7.24	206.22	90.88	23.00	42.92
6	208.00	7.70	206.92	89.35	26.00	36.67
7	212.00	9.91	227.01	91.75	38.00	26.83
8	206.00	25.46	230.65	89.15	12.00	19.50
9	182.00	60.52	225.08	78.20	20.00	10.92
10	227.00	111.27	259.10	75.03	43.00	5.67
11	250.00	134.36	281.57	76.53	52.00	3.58
12	226.00	181.99	286.77	74.94	38.00	3.00

Table 8. The position of three firms in the sector of investment goods in JACK4.

year	Stock of final products			utilisation rate of capital		
	firm 8	firm 4	firm 15	firm 8	firm 4	firm 15
1	0.39	0.39	0.39	100.00	100.00	100.00
2	0.48	0.63	0.44	90.05	97.40	100.00
3	0.49	0.49	0.46	95.23	97.31	100.00
4	0.49	0.48	0.22	98.77	97.04	93.41
5	0.56	0.51	0.47	99.01	98.41	97.72
6	0.48	0.59	0.57	95.25	98.78	100.00
7	0.54	0.50	0.46	92.18	98.00	99.10
8	0.50	0.53	1.36	98.89	94.98	95.26
9	0.43	0.69	2.02	97.33	77.32	86.86
10	2.45	0.48	1.84	97.32	83.39	99.27
11	9.71	0.52	2.52	96.66	86.74	86.91
12	10.70	5.16	0.39	97.87	82.87	88.70

Table 9. The position of three firms in the sector of investment goods in JACK4.

year	profit on production (x 1000)			ordered investment		
	firm 8	firm 4	firm 15	firm 8	firm 4	firm 15
1	131	79	98	4.00	4.00	0.00
2	-276	324	-313	5.00	7.00	8.00
3	911	930	464	4.00	7.00	3.00
4	1200	1902	683	3.00	5.00	2.00
5	635	3543	586	3.00	3.00	1.00
6	-1131	6192	3004	0.00	2.00	1.00
7	-2779	11198	2924	2.00	1.00	0.00
8	-124	13939	9219	1.00	0.00	0.00
9	5957	20024	7362	2.00	0.00	4.00
10	17253	20101	9264	4.00	13.00	3.00
11	7857	28042	10956	6.00	10.00	3.00
12	10568	6978	8991	2.00	4.00	8.00

The market for machines shows a very quick expansion in production capacity. Although demand rises, around year 7 a fundamental overcapacity emerges. But this overcapacity does not hold for all firms. The winning firms 8, 4, and 15 remained on acceptable levels of stock or had an acceptable utilisation rate of capital, while the level of profits remained good. This explains why some firms continue with investment despite of the bad aggregate situation. This aggregate situation would have been much better if bankruptcy would have been

allowed: 140 machines of the total stock of 180 unsold machines have been produced by the two worst firms (6 and 13).

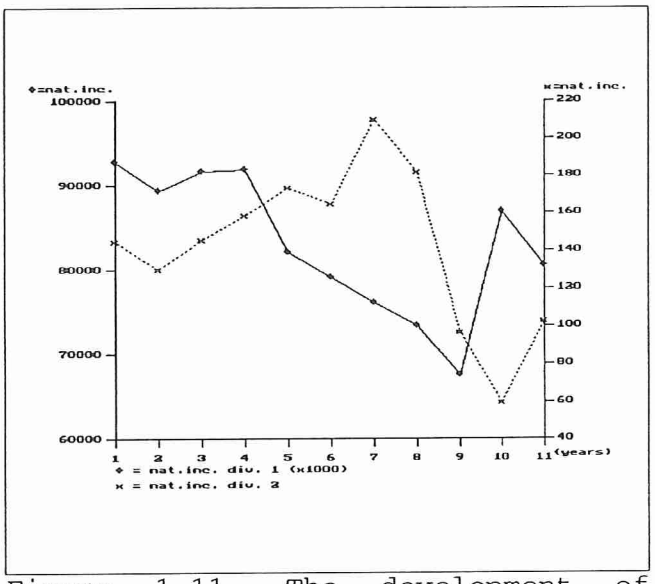

Figure 1.11. The development of JACK1.

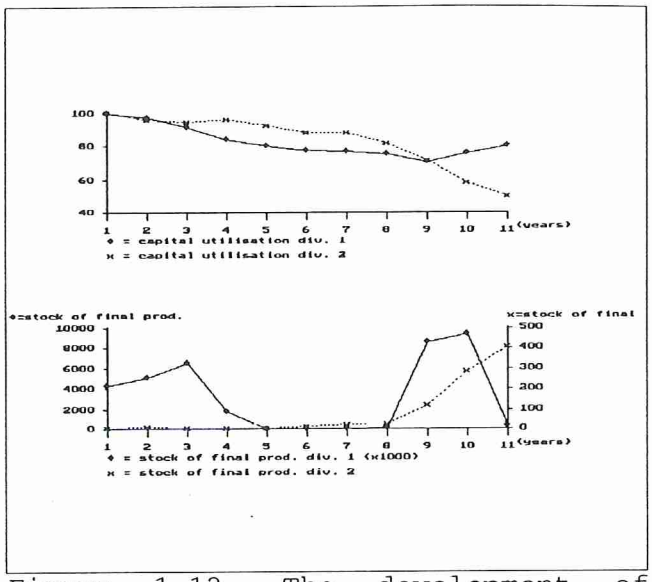

Figure 1.12. The development of JACK1.

Figure 11 shows that during the first 4 years of JACK1 the investment goods sector expands lightly, while the consumer goods sector remains constant. Starting with year 5 the consumer goods sector declines , but until year 8 the investment sector grows. Till year 10 there is a general decline that has been stopped by a fiscal impulse by government. Figure 12 shows that just as in JAN4 and JACK4, over-investment in combination with a fast growing stock of unsold machines caused a severe problem around year 10.

Table 10. The market of consumer goods in JACK1.

year	nat.inc. (x1000)	nat.stock (x1000)	nat.prod. (x1000)	utilisation of cap.	ordered investment	real wage
1	92544	4217	93011	99.29	179.00	591.42
2	89225	5014	91225	96.93	317.00	523.04
3	91501	6413	90524	90.86	199.00	415.51
4	91664	1723	86280	83.34	93.00	281.17
5	81897	0	81897	79.80	56.00	171.01
6	78883	0	78883	77.11	36.00	103.98
7	75932	0	75932	76.42	59.00	62.27
8	73185	69	74648	74.57	53.00	37.82
9	67430	8497	76069	70.25	15.00	33.01
10	86678	9247	79333	75.11	18.00	42.46
11	80241	230	77484	79.55	83.00	44.13

The market for consumer goods (table 10) shows a restriction by a lack production capacity starting in year 5. The cause is insufficient labour supply. Because of declining real wages consumer demand declined more than consumer production; this explains the rising stock of finished products. A government impulse stops this lack in demand for the sector of consumer goods. But the labour supply remains insufficient to improve the situation.

Table 11. The market of investment goods in JACK1.

year	nat.inc.	nat.stock	nat.prod.	utilisation of cap.	ordered investment	delivery time machines
1	144.00	4.63	140.21	99.90	36.00	10.83
2	129.00	6.93	133.63	95.01	54.00	19.50
3	145.00	6.11	143.73	94.21	50.00	31.50
4	158.00	5.89	158.41	95.93	51.00	41.42
5	173.00	6.02	171.47	91.83	49.00	37.75
6	164.00	12.83	185.15	87.66	21.00	29.25
7	209.00	21.95	200.81	87.90	19.00	18.92
8	181.00	26.99	218.58	81.44	28.00	10.92
9	96.00	116.61	244.80	70.92	16.00	2.67
10	59.00	280.77	212.21	57.41	3.00	-9.42
11	102.00	401.74	180.88	49.75	23.00	-21.67

The market for investment goods (table 11) shows an expansionary policy during the first five years resulting in a long delivery time for investment goods. Then investment demand declines rather fast. This results in high stocks of finished products in combination with a low utilisation rate of capital; only 50 % in the last year.

In year 11 only two firms did have a rise in their owner's capital: firm 5 and firm 12. Table 12 shows that firm 12 remained at a utilisation rate of capital of almost 100 %, while firm 5 had an acceptable utilisation rate of capital with no unsold machines in stock. Table 13 shows that firm 5 obtained this result by a very low price policy at the deepest point of the crisis; firm 12 obtained it by restricting excess production capacity in the depression through low prices in the beginning of the crisis in combination with a very careful expansionary policy.

Table 12. Performance of firms 2 and 5 in the machine sector.

year	change of owners' capital (mln)			stock of unsold machines		utilisation rate of capital	
	firm 12	firm 5	average	firm 12	firm 5	firm 12	firm 5
2	4	4	5	0.39	0.5675	100.00	100.00
3	14	14	16	0.52	0.5605	100.00	99.34
4	44	30	42	0.39	0.8165	99.86	99.67
5	97	54	102	0.22	0.7899	99.50	100.00
6	159	83	206	0.55	0.4130	99.11	100.00
7	39	-99	80	0.63	0.5096	98.71	100.00
8	98	-7	203	0.48	0.6279	99.48	100.00
9	-187	-233	-394	0.48	0.4673	99.26	78.68
10	-13	-173	-616	0.81	0.4516	100.00	64.37
11	157	70	-205	10.17	0.5741	98.87	90.25

Table 13. Decisions of firms 2 and 5 in the machine sector.

Year	Price (x 1000)			Production		
	firm 5	firm 12	average	firm 5	firm 12	aggregate
1	275	273	287	11.69	11.69	140.21
2	355	347	397	11.13	10.78	133.63
3	626	621	736	11.37	10.74	143.73
4	1727	1337	1673	12.08	11.39	158.41
5	4864	3008	4095	12.45	12.41	171.47
6	12724	8585	9826	13.51	13.31	185.15
7	21596	12792	15512	15.25	14.29	200.81
8	21085	20667	22566	26.68	15.03	218.58
9	7437	16500	15365	26.37	14.86	244.80
10	3632	9944	7143	20.48	15.58	212.21
11	1378	3155	2284	28.84	14.76	180.88

It is clear that the low pricing policy of firm 5 could not work if all firms would do that. It would create more trouble. The same holds for firm 12: after year 11 its stock of orders would have been ended. As a consequence it would have been necessary to decline production. Hence, the only adequate policy in the aggregate would have been to stop production. Firms 1, 4, 9, and 10 did this, but much too late, with as a consequence that their situation became very bad: a combination of a low utilisation rate of capital and a high stock of unsold machines.

Let us do a small thought experiment. Is it more profitable for a firm to stop production or to create stocks? It is very clear that the cost of stocks are very high (interest rate + 5 % storing cost), while as long as they are not sold the labour costs will add to it. As long as the stocks cannot be sold, no benefits are available. Hence, it is clear that the decisions of the players not to lay off people are wrong.

How stable is the market for machines? In the situation where there is no firm with a significant delivery time, the cheapest builder supplier sells its machine. This will be profitable as long as the price of the machine is higher than the variable costs, i.e. the labour costs. Hence, in the machine market the prices will decline till about the variable costs. For a machine with 10 persons per machine and a wage of f 2000,- labour costs per machine is f 20000,- per month. It requires 1/0.07 months to produce a machine. Hence total variable costs are about f 300.000,- per machine. Hence, the price of more than f 2 mln,- could decline to 15 %, before underbidding by price would not be profitable any more.

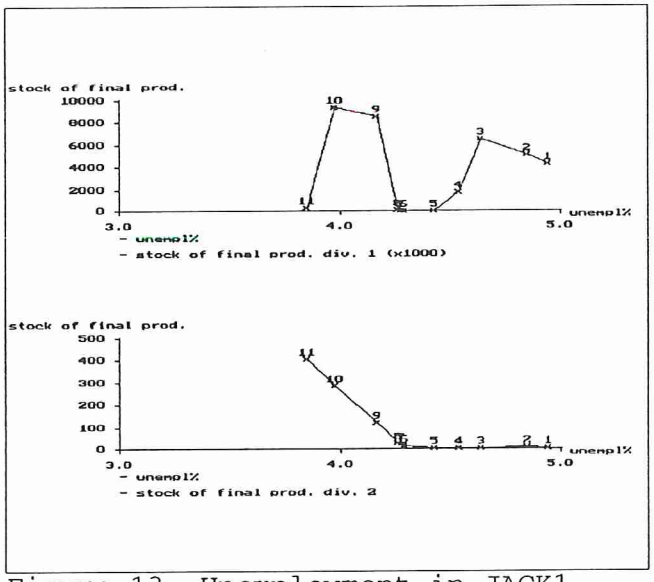

Figure 13. Unemployment in JACK1.

Figure 13 shows that during this game the unemployment rate declined continuously, indepedent of the situation of the output markets. The reason is simple: many players were focussed more on the utilisation rate of capital than on the stock of finished products, while over-investment caused a very low average utilisation rate. The solution of this problem seems to be in better (and on-line) instruction of the players when obvious errors are made, in combination with restrictions on stocks and the introduction of bankruptcy.

4. The explanation of investment and real wages

During the games it was clear that the behaviour of the players was far from rational. The players did not understand enough what they were doing. The feedback to the players about their decisions has to be improved. But despite the poor behaviour of the players already some consistent estimations can be made. It is obvious that it is senseless to test on rational expectations, but it may be interesting to test equations based on static expectations. With the data of the games a simple investment function, real wage function and employment function have been estimated. The results will be presented in this section.

a. <u>The investment function.</u>

With the help of the results of the game a simple investment function has been estimated. The variable to be explained is ordered investment, because the moment of ordering investment is the moment the investment decision is made. The first explanatory variable is the utilisation rate of capital. In the beginning of the games the utilisation rate of capital was about 100 %. Because of over-investment the labour market became too restrictive, so the utilisation rate declined because of restrictions on the labour market. This implies that it would have been wise to decline investment. In the last part of most games aggregate demand for final products was lower than aggregate supply. Also in this situation it would have been wise to restrict investment demand. Hence, a positive relation between the utilisation rate of capital and investment demand may be expected.

The second explanatory variable is profits on production. When the rate of profits is low, it is not wise to expand too much. The variable may be correlated with the other two variables, because in a recession it may be expected that all variables are influenced. The expected sign is positive.

The last explanatory variable is the stock of final products. A high stock of final products implies that aggregate supply is higher than aggregate demand, while the firms did not adjust labour demand in order to adapt production towards demand. Hence, high stocks of final products represent aggregate excess supply in combination with a lack of short run accomodating policy of the firms. This relation has to be negative.

The results are as follows:

Explanation of ordered investment (standard errors between brackets):

Game	Period	utilisation rate of capital		profits on production (mln)		stock of final products		R^2
JAN1	jan 1 - jan 10	0.61	(0.09)	0.274	(0.104)			0.43
	jan 1 - nov 6	0.68	(0.15)	0.228	(0.194)			0.23
	jan 6 - jan 10	0.32	(0.10)	0.338	(0.191)			0.31
JAN2	jan 1 - may 10	0.57	(0.18)	0.299	(0.328)			0.11
JAN3	jan 1 - nov 10	0.15	(0.12)	1.2	(0.3)			0.20
JAN1	jan 1 - jan 10	0.38	(0.10)			-0.164	(0.038)	0.48
JAN2	jan 1 - may 10	0.16	(0.06)			-0.739	(0.227)	0.15
JAN3	jan 1 - nov 10	0.44	(0.09)			-0.499	(0.065)	0.39
JAN1	jan 1 - jan 10	0.30	(0.12)	-0.292	(0.180)	-0.256	(0.068)	0.50
JAN2	jan 1 - may 10	0.63	(0.19)	0.131	(0.360)	-0.069	(0.041)	0.13
JAN3	jan 1 - nov 10	0.39	(0.11)	0.285	(0.299)	-0.463	(0.076)	0.40
JAN1	jan 1 - jan 10	0.69	(0.08)					0.39
JAN2	jan 1 - may 6	0.62	(0.17)					0.10
JAN3	jan 1 - nov 10	0.38	(0.11)					0.09

Game	Period	utilisation rate of capital		profits on production (mln)		stock of final products		R^2
JAN1	1-I - 9-IV	1.80	(0.40)	0.287	(0.160)			0.50
JAN2	1-I - 10-I	1.93	(0.77)	0.249	(0.467)			0.19
JAN3	1-I - 10-IV	0.30	(0.50)	1.6	(0.4)			0.35
JAN1	1-I - 9-IV	1.10	(0.47)			-0.498	(0.166)	0.57
JAN2	1-I - 10-I	1.65	(0.74)			-1.8	(1.0)	0.26
JAN3	1-I - 10-IV	1.40	(0.37)			-1.5	(0.3)	0.54
JAN1	1-I - 9-IV	0.69	(0.55)	-0.404	(0.294)	-0.889	(0.328)	0.60
JAN2	1-I - 10-I	1.78	(0.74)	0.880	(0.675)	-3.2	(1.5)	0.30
JAN3	1-I - 10-IV	1.05	(0.40)	0.566	(0.441)	-1.2	(0.3)	0.56
JAN1	1-I - 9-IV	2.04	(0.38)					0.45
JAN2	1-I - 10-I	2.06	(0.73)					0.19
JAN3	1-I - 10-IV	1.17	(0.50)					0.12

The first set of estimations is based on monthly data, the second is based on quaterly data. The added estimation results on sub-periods in the monthly estimates of JAN1 show that even over time the estimated relations seem to be rather stable. The estimation results between the monthly data and the quaterly data seem to be rather consistent[14]. Because it may be expected that serial correlation is a less important problem in the second set of estimates, we will use in first instance the quaterly results. All games with one sector gave similar results for the utilisation rate of capital as long as the results were significant. The addition of 'profits on production' in JAN3 seems to mess up the results, but further expansion of the equation with the stock of final products overrules this effect, and seems to clean up the estimates. JAN1 is sensible for adding the profits on production to an

[14] Remind that ordered investments on a quaterly basis have to be three times as high as on a monthly basis

estimation of the equation with quantity data. The best results are with a set of equations with only the utilisation rate of capital and the stock of final products.

What can be learned from these results? First, in all three games, the players were more focussed on quantities than on profits. This is quite consistent with the intuition we had when the games were going on. It was rather difficult for students to have a good indication of the real profit rate. An indicator of the profit rate at the decision screen signaled only profits at full capacity. Furthermore, the profit rate as used in these estimations was correlated with the utilisation rate of capital, because a lower utilisation rate of capital implied lower profits on production. Second, in all three games investment was influenced both by the utilisation rate of capital and the stock of final products. It should be mentioned that in a rational expectations economy this relation can be expected not te be so strong.

b. The real wage equation.

The real wage is the consequence of decisions on prices and wages. First, when the stock of final products rises, it is wise to lower the price. Hence, there will be a positive relation between the stock of final products and the real wages. Second, it may be expected that the wage rate rises in periods with very low unemployment rates; hence there is a negative relation between the real wage and the unemployment rate. Last, the utilisation rate of capital may be low. When this is caused by restrictions on the labour market, then the real wage will rise and consequently the relation between the real wage and the utilisation rate of capital will be negative. When it is caused by restrictions on the output market the prices will decline, and the relation will be negative, too. Because the stock of final products is 0 in periods of excess demand, the level excess demand can be measured by the delivery time. Hence, both variables are complementary to a large extent.

The results are as follows:

Explanation of real wages (standard errors between brackets):

Game	Period	utilisation rate of capital		unemployment rate		stock of final products		delivery time		R^2
JAN1	1-I - 9-IV	20.67	(1.15)	14.40	(0.90)	0.0045	(0.0004)			0.94
	1-I - 5-III	22.15	(1.76)	17.10	(9.08)	-0.0014	(0.0025)			0.95
	5-III - 9-IV	14.63	(4.36)	11.35	(2.23)	0.0051	(0.0009)			0.96
JAN2	1-I - 10-I	0.12	(2.18)	-8.88	(1.50)	0.0165	(0.0028)			0.70
JAN3	1-I - 10-IV	8.05	(1.74)	-96.84	(20.91)	-0.0023	(0.0006)			0.43
JAN1	1-I - 9-IV	19.63	(1.07)	13.65	(0.83)	0.0058	(0.0005)	8.92	(2.84)	0.95
JAN2	1-I - 10-I	6.01	(0.54)	-9.01	(1.69)	0.0172	(0.0049)	-2.10	(4.21)	0.87
JAN3	1-I - 10-IV	7.96	(1.76)	-89.16	(25.22)	0.0027	(0.0009)	-1.86	(3.33)	0.43

The strong positive coefficients for the utilisation rate of capital rejects the hypothesis that the relation between the utilisation rate of capital and the real wage is negative. The explanation is straightforward. In the beginning of the game over-investment resulted in a high demand for investment goods, and hence a rise in prices. Because the stock of capital cannot expand very fast (restrictions on the supply side of machines), labour demand did not rise in the beginning of the game, and wages remained rather constant. As a consequence, real wages declined (see figure 14). When later in the game the over-investment resulted in a low utilisation rate of capital, real wages were very low. Later on, when the stock of final products and the unemployment rate rose, there was excess demand on both the labour market and the output market, so both wages and prices declined. Only the stock of final products has the correct sign in all games. The addition of the delivery time as an additional variable did only influence the results of the equation in JAN2 significantly, although the effect itself was not significant.

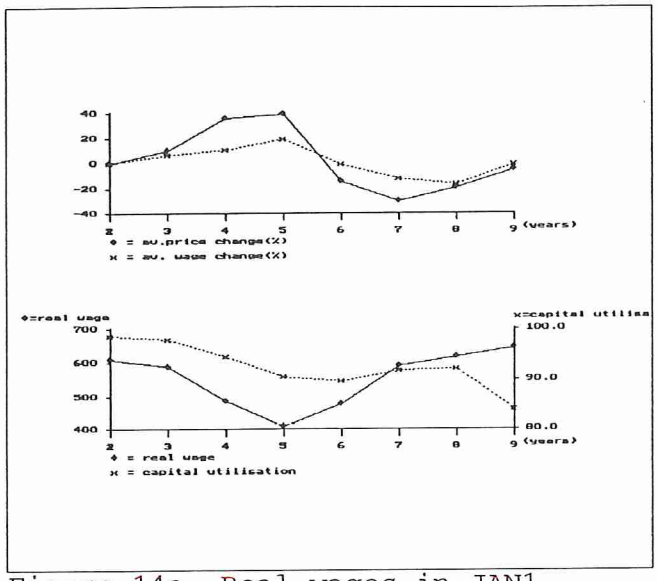

Figure 14a. Real wages in JAN1.

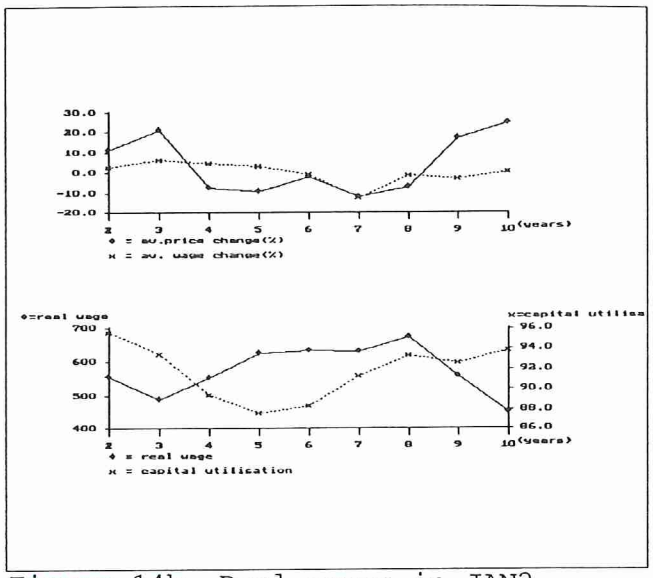

Figure 14b. Real wages in JAN2.

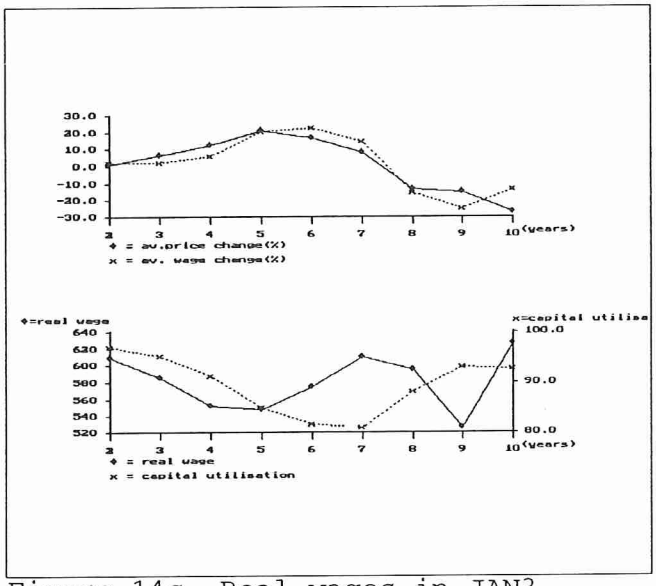

Figure 14c. Real wages in JAN3.

What can be learned from these results? First, it is clear that the wage and price decisions were only focussed on the very short run. Especially the players were not conscious of the fact that the high investment caused a shortage of labour in the future. As a consequence, they only rose prices and not wages in the beginning of the game. Second, the players did not react on a decline of the delivery time of investment goods, a good indicator of an approaching recession. Third, the restriction on the output market was more effective in reducing investment then the problems in the labour market (indicated by the utilisation rate of capital).

c. <u>The employment function.</u>

It may be expected that the change in employment depends on the stock of final products and the utilisation rate of capital. Furthermore, when the unemployment rate is low, it is not possible to expand employment, so the employment rate will not react on the situation.

The results are as follows:

Explanation of the change in employment (standard errors between brackets):

Game	Period	utilisation rate of capital		unemployment rate		stock of final products		R^2
JAN1	1-I - 9-IV	-0.0259	(0.0504)	-0.21	(0.04)	-0.030	(0.015)	0.69
JAN2	1-I - 10-I	0.0161	(0.0605)	-0.17	(0.09)	0.016	(0.060)	0.39
JAN3	1-I - 10-IV	-0.0061	(0.0083)	0.022	(0.097)	-0.0078	(0.0026)	0.30

The effect of the utilisation rate of capital is never significant. This can be explained by the fact that the first time that the utilisation rate of