A MODEL OF THE DUTCH LABOUR MARKET (AMO-K)**

BY

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1 INTRODUCTION

The model of the Dutch labour market (AMO-K) that is presented here is in fact a macro-economic model incorporating the labour market in much more detail than other such models, especially in the aspects to be briefly discussed below.

To understand how the labour market functions, the distinction of sub-markets is an essential condition. The present model is based on a simple dichotomy: a submarket for manual workers (labourers) and a submarket for brain workers (employees); further differentiation is possible. Because of frictions between supply and demand on the labour market, unemployment and vacancies occur side by side. From various investigations we know that the frictions have greatly increased from the mid-1960's onwards; that aspect has been included in the model.

To account for the phenomenon that, in spite of a high unemployment rate, production households sometimes lack the labour required to accomplish the production warranted by sales factors, the inclusion of labour besides capital...

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** This paper summarises an extensive Dutch report on the construction of a model for the Netherlands labour market. The title of the original report is 'AMO-K: Een arbeidsmarktmodel met twee categorieën arbeid; (AMO-K, A labour-market model with two categories of labour); it was published by the Netherlands Economic Institute (NEI) in Rotterdam in the so-called Olive Series, 1982-2, pp. 403 ff. Some details of the model presented in that report were changed after its publication; see G. den Broeder, AMO-K 81-12, Tussenrapport betreffende de verdere ontwikkeling van het arbeidsmarktmodel (Interim report on the further development of the labour-market model), Rotterdam, September 1983. Since then, only minor changes have been carried through. The model reproduced in this paper is the modified version. The model was developed within the National Programme of Labour-Market Research (NPAO) (now defunct), the NPAO organisation having granted a commission to the NEI in Rotterdam.

1. Not only in the Netherlands, but also in Western Germany, the United Kingdom, Belgium and France; see among others Driehuis (1978). Cf. for a systematic determination of the breach year: Heijkoe (1982) and De Koning (1982).
in the production function describing production capacity might be envisaged. Though the capacity function of our model is still essentially based on capital, it does take into account that the labour factor may influence the level of production.

Most macro-economic models treat the supply of labour as almost autonomous in respect of the labour market. For a labour-market model this is unsatisfactory, because important feedbacks from the labour-market situation to supply are very likely. To endogenise the supply of labour, we have divided the population into groups differently related to the labour market, and adapted the model to account for the dependence of the relation between the size of these groups and the supply of labour on labour-market factors.

The labour market being closely associated with the economic system, we have coupled it to a macro-economic model describing production capacity, expenditure, and price formation. Because we had to complete the whole model in a relatively short time and yet give due attention to modelling the labour market, we took an existing medium-term macro-economic model, VINTAF, developed by the Central Planning Bureau,2 adjusted it a great deal, and brought it up to date. Our model resembles VINTAF as to the structure of its production block (vintage concept, economic obsolescence) and its price formation but differs from it, for instance, in the specification of investments and labour demand. All equations have been estimated anew on the basis of more recent data. The social-security block, at first borrowed integrally from VINTAF, has been adjusted since the publication of the research report in 1982.

Most of the data used in the model3 refer to the period 1960–1979, 20 observations in all. The base year for the volume and price indexes is 1970. No account could yet be taken of the latest revision of data from the National Accounts; the figures for years after 1977 have been computed by applying the percentage mutations of the revision to the old figures of 1977. (To estimate the stochastic equations, old figures which were available up to and including 1979 have been used).

The model has been estimated equation by equation, with the exception of the production block, for which a technique of simultaneous estimation has been applied. Such techniques might well enhance the forecasting power of certain blocks of the model, and future research on that score for several model blocks seems to recommend itself. In particular the (labour) supply block, with its closely interwoven sections, seems to lend itself to such treatment.

Equations that are nonlinear with respect to parameters have been estimated, as have linear specifications, by the method of least squares. The values

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3 See for these data the original Dutch report.
of the estimators being determined numerically. The maximum-likelihood estimation method has been applied to nonlinear disturbance structures to correct for autocorrelation or in the simultaneous estimation of equations, the estimates again being determined numerically.

Because AMO-K contains nonlinear equations, numerical methods have also been used for simulation exercises with the model. To solve AMO-K, a procedure of the Gauss/Seidel or Jacobi type has been applied.

For the purpose of judging the estimation results, the estimated equations will be marked by the following statistics:
- the squared correlation coefficient ($R^2$), corrected for degrees of freedom;
- the standard error of the residuals (SE), corrected for degrees of freedom;
- the statistic of Durbin and Watson (DW);
- the r-values of the estimated parameter values.

To each estimation result will be added the number of observations and the period for which the estimation has been estimated.

After the development of the model, this paper judges its forecasting power from simulations of the past.

2 SUPPLY

2.1 Description of Supply

Demographic development can be formulated in the following definition equations.

\[ POP(14-65) = POP(14-65)_{-1} + \triangle POP_{ex} + MI \]  \hspace{1cm} (2.1)

\[ POP = POP(14-65) + POP_{REST} \]  \hspace{1cm} (2.2)

where:

- \( POP \) = population in the Netherlands;
- \( POP(14-65) \) = population in the ages of 14-65;
- \( POP_{REST} \) = population under 14 and 65 and over;
- \( \triangle POP_{ex} \) = change in the population of 14-65-year-olds owing to natural growth and the migration balance excluding Mediterranean people;
- \( MI \) = migration balance of Mediterranean active people.

Equation (2.1) indicates that the population in the ages from 14 to 65 in the current period equals the corresponding population of one period earlier.

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4 See for such numerical methods, among others, Den Broeder (1980). For most linear and some 'simple' nonlinear equations the TSP program has been used (Kurakulaarathy, 1977; the original version of TSP was developed by R.E. Hall at Princeton University).


6 Throughout the report, variables that are exogenous to AMO-K will be underlined.
increased by the natural growth and the net migration balance. The second equation (2.2) indicates that the total population is the sum of the population from 14 to 65 and the remaining population.

The next demographic quantity, potential active population, \( PBB \), is defined as the population from 14 to 65 \( (POP(14-65)) \), less the full-day students \( (OND) \), the unfit-for-work \( (AO) \), and early retirers \( (VUT) \).

\[
PBB = POP(14-65) - OND - AO - VUT
\]  

(2.3)

Three endogenous quantities occurring in the above equations of demographic development will be elaborated in separate equations, namely, the net migration of active persons from Mediterranean countries \( (MI) \), the number of students in the ages of 14 to 65 \( (OND) \), and the number of people unfit for work \( (AO) \). For each of them we shall check whether labour-market factors enter the explanation of their evolution through time.

Only a portion of the potential active population will offer itself on the labour market \( (LS) \), the remaining part \( (PBB-LS) \) consisting mostly of married women who have no paid jobs and are not registered as looking for jobs.

In the model, the supply of labour falls into two groups, namely, the supply of labourers \( (LSA) \) and the supply of employees \( (LSE) \). We assume that both general and profession-specific factors influence supply. Moreover we assume that the general factors mostly determine participation in the labour process, and the specific factors the choice of a labourer’s or an employee’s job. To that end, first an equation is specified and estimated explaining total supply \( (LS) \) from a number of general factors. Subsequently the ratio \( LSA/LSE \) is explained from a number of factors particularly relevant to the choice of a labourer’s or employee’s profession.

### 2.2 Migration of Active Persons from Mediterranean Countries

The migration of workers from Mediterranean countries \( (MI) \) was due in particular to the shortage of certain categories of workers on the labour market in the countries of destination. There were vacancies in particular for labourers to perform the kind of low-skilled work that tends to be done under unpleasant conditions (noise, stench, working in shifts, etc.). The creation of recruitment channels and the spread of information about possible migration encouraged the recruiting of foreign labour. Workers from abroad came to be employed in more and more professions and progressively penetrated them, until after a few years a more or less complete system of facilities for recruitment and reception had been built up. The migration equation to be estimated reproduces the process by the trendwise rise, in the beginning of the period, of the parameter representing the reaction to vacancies of labourers \( (VA) \).

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7 Turkey, Greece, Yugoslavia, Italy, Spain, Portugal, Morocco, Algeria and Tunisia.
Apart from labour-market factors, more autonomous factors tend to influence, and have influenced, the migration balance. Think, for instance, of the spontaneous influx of migrants, growing more or less without regard to the labour-market situation in the Netherlands, the gradually longer stays leading to decreased return migration, and the intensified family reunion, leading to an increased supply of Mediterranean youngsters and women on the labour market.

To represent these processes, a second trend term has been added to the migration equation, with expected positive sign. Because this trend term indicates an autonomous shift accomplished in a certain period, it will have an upper limit. The second trend term comes into play one phase after the first. The workings of the first trend term were probably limited to the beginning of the migration process, in the first half of the 1960's; the second trend term does not enter the picture until after 1965.

The regularisation measure issued at the end of 1975 legalised the stay of about 6,000 foreign workers; we have accordingly corrected the migration equation by adding an autonomous increase of 3,000 persons in 1975 and 1976.

Optimum estimation results were obtained by having the first trend factor run from 1963 to 1966, followed immediately by the second from 1966 to 1976. These estimation results are the following:

\[
MI = (0.256 + 0.0460 \ t_{64,66} \ VA_{-12} + 0.988 \ t_{67,76} - 25.9 + 3 \ d_{75,76}
\]
\[
(7.5) \quad (9.0) \quad (4.1) \quad (7.2)
\]

\[
R^2 = 0.920; \ \overline{SE} = 1.8; \ DW = 1.30; \ N = 18 \quad (1962-1979) \quad (2.4)
\]

where:

\[d_{75,76} = \text{dummy variable adopting a value of 1 in the years 1975 and 1976, and of 0 in the remaining years;}
\]

\[t = \text{trend term} (t_{64,66} = 1, 2, 3; t_{67,76} = 1, 2, \ldots, 10).
\]

The above results are satisfactory. The correlation coefficient is high; all parameter estimates are significant and have the expected sign. The DW statistic is rather low, but closer investigation did not show up a significant autocorrelation.

Information on years after the estimation period has taught us that MI did not turn (strongly) negative when the number of vacancies diminished to almost zero. Therefore, in simulations the migration equation was adjusted by replacing \(VA_{-12}\) with \(max (VA_{-12}, 40)\), on the assumption that the recruitment of foreign labourers does not start until the number of vacancies attains the value of 40,000 (the number of vacancies recorded was never as low as that throughout the estimation period). The indication seems clear that the migration phenomenon is more complex than is now suggested by the model equation.
2.3 Education
To describe school participation, AMO-K starts from the following definition equation:

\[ OND = OND_{-1} + NST - EXST \]  \hspace{1cm} (2.5)

where:

- \( OND \) = number of persons aged 14 to 65 attending full day education;
- \( NST \) = number of people entering education for the 14–65-year-olds;
- \( EXST \) = number of school leavers.

The outflow from education (\( EXST \)) is represented as a fraction of the number of students of the previous year:

\[ EXST = (1 - \gamma_t) \cdot OND_{-1} \]  \hspace{1cm} (2.6)

The continuous rise in prosperity has contributed much to the increased school participation, not only because the educational provisions were extended and improved, but also because parents were able to keep their children at school longer. As measure of prosperity we have chosen the gross value added of the private sector (\( y \)) (at factor cost and in constant prices) including the natural-gas sector (\( y_{ag} \)) by head of population (\( POP \)). Moreover, the government has stimulated school participation by lengthening the compulsory period, to be represented in the model by dummy variables. In the period considered the number of compulsory school years was increased twice. On August 1, 1971, one year was added to the period of eight years hitherto prevailing; four years later another year was added, and the duration of lower professional education lengthened from three to four years. Probably both additions to the period of compulsory schooling simply formalized the development that had already taken place.

Some labour-market factors may also have influenced school participation. The loss of job opportunities in the 1970’s diminished the chances of work, which has possibly induced people to put off their entrance into the labour market and continue their education in the hope of improving their future position on it. The factor features in the outflow equation as the ratio between employment (\( L \)) and labour supply (\( LS \)).

Another relevant labour-market factor may have been the income advantages associated with a higher education, advantages which probably have decreased along with the wage differences. An approximate indicator is the ratio between the average net disposable income (\( l_x \)) and the net disposable minimum wage (\( l_{min}^{net} \)). This ratio has decreased fast, especially in the 1970’s. Perhaps the decline in the income advantages of higher education has somewhat slowed down the increase in school participation.

Educational decisions mean commitment for a longer or shorter period, and therefore, changes in the variables explaining educational choices do not
express themselves immediately and fully in an increased or decreased school participation. The reaction to such changes will come with a certain delay, and a relatively large portion of the numbers continuing or leaving school will be determined by the number of stayers or leavers of the previous period.

The specification of the outflow fraction, in which the above considerations have been taken into account, produced the following estimation results:

\[
\ln(1 - \gamma) = -0.174 - 0.325 \ln\left(\frac{(y + y_{se})}{POP}\right)_{-12} + \\
(2.9) \quad (8.3) \\
+ 1.527 \ln \left(\frac{L}{LS}\right)_{1} + \\
(2.2) \\
- 0.121 \ln \left(\frac{L}{L^{\text{norm}}}\right)_{-2} - 0.025 \ d_{31,72} - 0.103 \ d_{45,76} + \\
(1.8) \quad (3.6) \quad (17.9) \\
+ 0.451 \ln (1 - \gamma)_{-1} \\
(6.8) \\
\]

\[R^2 = 0.998; \bar{SE} = 0.0062; DW = 1.97; N = 15 (1965-1979)^8\]

where \(d_{i, i+1}\) denote dummy variables adopting the value 1 for the years \(i\) and \(i+1\) and in the remaining years the value 0.

A log-linear specification has been chosen to satisfy the constraint for the computed value of \(\gamma\): \((1-\gamma)>0\). That constraint is not unimportant, the value of \(\gamma\) approaching 1.

Because stock data such as OND, \(U\) and \(LS\) do not refer to the end of the year but represent annual averages, a transformation of the flow data into data centred around the beginning of the year has been effected by taking mean values; in the same way the values of explanatory variables have to be backdated to that moment, the various lags thus being at least half a year. By this transformation, the effects of both dummy variables in (2.7) have also been spread over two years. The estimation results can be called very satisfactory: the fit is excellent and all parameter estimates are significant and have the sign expected \(a\ priori\). In simulations of the future, however, the influence of the work-chance variable has been levelled off at an unemployment rate of 5 percent.

The complete inflow into day schools from 14 years onwards consists of two groups of persons, the important group of the 14-year-olds in day schools, and the very small group of persons entering, or returning to, full-time education later in life. The latter group, being negligible, will not be explicitly included in the model. So, \(NST\) exclusively refers to the group of 14-year-olds, the inflow of adults being subtracted from the outflow.

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8 Exact figures with respect to education are not always available for the early 1960's.
AMO-K explains the volume of NST as a fraction of the total group of 14-year-olds (VTJ). In the 1960’s and 1970’s this fraction increased steadily, although its growth levelled off in the course of time. The prolongation of the period of compulsive schooling from eight to nine years carried out in 1971 caused some additional growth of school participation by 14-year-olds, but since then participation has hardly changed, a percentage of practically 100 being attained in 1978.

The development of school participation by 14-year-olds can be described by a logistic function of time, a dummy variable being added from 1971 (with lag 1/2) to take care of the stimulating effect of the longer school period then introduced. The estimation results are:

\[
NST = \frac{1}{1 + 0.323 \exp \left( -0.150 t_{60} - 1.44 d_{71-72} \right)} \quad \text{(2.8)}
\]

\[
R^2 = 0.991; \quad SE = 2.08; \quad DW = 1.57; \quad N = 19 \text{ (1961–1979)}
\]

where:
\( d_{71} \) = dummy variable adopting the value of 1 from 1971, and 0 previously;
\( t_{60} \) = time variable, running from 1960 (0, 1, 2, 3, ...).

These results are satisfactory. All parameters estimated differ significantly from 0 and have the sign expected a priori; the correlation coefficient is very high.

2.4 Unfitness for Work

There is no reason to believe that the steep rise in unfitness for work is due to a serious deterioration of working conditions or health care. A more acceptable explanation is the dramatic worsening of the situation on the labour market, owing to which unfitness for work is more readily recognised as such.\(^9\) Moreover the granting of unfitness benefit is related to the chance of finding suitable work, a chance that will have progressively dwindled in the course of the 1970’s. Indeed, Douwen and Herweijer (1979) found a positive relation between the inflow into unfitness benefit and unemployment.\(^10\)

Unfitness for work \((AO, \text{ measured in working years})\), like school participation, can be considered a transitory process; the following definition equation can therefore serve as point of departure:

\[
AO = AO_{-1} + \text{INA} - \text{UITAO} \quad \text{(2.9)}
\]

\(^9\) L. Aarts et al. (1981) found that entering the ranks of those drawing an unfitness benefit is somewhat arbitrary: they identified a relation between long absence on account of sickness or unfitness for work on the one hand and such factors as working conditions, economic strength of the company, and job security on the other.

\(^10\) See also: F.A.J. van den Bosch and C. Petersen (1980).
No separate inflow (INAQ) and outflow (UITAO) series are available for the entire estimation period. As far as the outflow is concerned some information can be taken from the Central Bureau of Statistics labour-force surveys; apparently it amounts to about 8 percent of the stock of unfit-for-work and consists largely of retirement (4 percent) and deaths (1 percent). So, the outflow is relatively small and probably hardly influenced by labour-market factors. We assume, therefore, that annually a constant fraction of 8 percent leaves the stock of unfit-for-work.

\[ \text{UITAO} = \delta_1 \text{AO}_{-1} = 0.08 \text{ AO}_{-1} \quad (2.10) \]

To calculate the inflow of unfit-for-work we also start from a certain fraction of the qualifying groups, making the portion of the professional population that joins the ranks of unfit-for-work dependent on the situation on the labour market. Two institutional factors have to be taken into account. The first is the rule that only after a year's sickness does a person qualify for unfitness benefit; for that reason we include the stocks from which the inflow derives with a year's lag. The second is the introduction of the AAW (General Unfitness Act) in 1976; before the introduction of this national insurance only those employed in private companies (a) (excluding self-employed, \(a_s\)), unemployed (U), or occupied in complementary works (AW) and social work projects (SWP) could claim unfitness benefit, the inflow equation reading as follows:

\[ \text{INAQ} = (\delta_2 + \delta_3) \left( (a - a_s) + U + \text{SWP} + \text{AW} \right)_{-1} \quad (2.11) \]

\[ \delta_3 = f(U/LS) \quad (2.12) \]

The AAW provides for benefits also to persons from other groups of the population in the ages of 14 to 65. After the introduction of the AAW the inflow equation therefore reads:

\[ \text{INAQ} = \delta_2 \left( \text{POP}(14-65) - \text{AO} - \text{LS} - \text{UT} \right)_{-1} + (\delta_2 + \delta_3) \text{LS}_{-1} \quad (2.13) \]

At the moment of transition from the old to the new regime, a group of latent unfit-for-work became suddenly visible because they now qualified for AAW benefit. To account for this group, we have assumed a regular inflow in the past at the same rate as after the introduction of the AAW, except for the labour-market effect (which could not apply to a nonexistent benefit). So, the supposed inflow (X) is equal to:

\[ \text{In the estimation no significant difference could be recognised between the autonomous inflow fraction } \delta_1 \text{ of LS and that of the other group.} \]
\[ X = \delta_2 \{ POP(14-65) - AO - LS - VUT + a_z + (a_m - SWP - AW) \} \]

where \( a_m \) = government employment. Given the chance of continuation \((1-\delta_1)\) the size of the group of the latently unfit \((AOX)\) then is:

\[ AOX = X + (1-\delta_1)X + (1-\delta_1)^2X + (1-\delta_1)^3X + \ldots = \frac{1}{\delta_1}X = 12.5X \]  

(2.15)

The inflow \( X \) has been approximated by applying \( \delta_2 \) to the group given in (2.14) as present in the year previous to the introduction of the AAW: 1975. As the AAW was introduced on the first of October, 1976, 25 percent has been allocated to 1976 and 75 percent to 1977.

To make it more readable, we will rewrite the inflow equation as follows:

\[ INAO = \delta_2 (PBB + OND)_{t-1}^* + \delta_3 LS_{t-1}^* \]  

(2.16)

in which the superscript * indicates both the effect of the addition of new groups and the shock effect on the autonomous inflow, and \( PBB + OND \) is equal to \( POP(14-65) - AO - VUT \) (including \( LS \)), thus comprising all groups qualifying for AAW.

For the parameter \( \delta_3 \), dependent on the labour-market situation, we take a function of the root of the unemployment rate, to account for a declining influence of this factor on the inflow of unfit-for-work as unemployment increases. After all, we can hardly assume that the criteria for granting an unfitness benefit are unlimitedly flexible.\(^{12}\) So, for \( \delta_3 \) we choose the following specification:

\[ \delta_3 = \delta_4 \frac{U}{LS}^{1/2} \]  

(2.17)

Estimation of the equation produced by substituting (2.10), (2.16) and (2.17) into definition equation (2.9), gives the following results:

\[ AO = 0.92 \ A_{O-1} + 0.00133 \ (PBB + OND)_{t-1}^* + 0.0645 \ (U/LS)^{1/2} LS_{t-1}^* \]  

(12.3)  

(25.3)

\[ R^2 = 0.992; \overline{SE} = 4.9; DW = 1.85; N = 20 \ (1961-1980)\]  

(2.18)

\(^{12}\) For the simulations we have indeed assumed a ceiling corresponding to an unemployment rate of 5 per cent.

\(^{13}\) To include as many as possible of the years in which the AAW has been applicable, we have, by way of exception, added the year 1980 to the estimation period, because for that year quite a reliable \( AO \) figure was already available.
These outcomes are most satisfactory, both estimated parameters being highly significant (conditional on part of the specification being fixed \textit{a priori}) and of acceptable size.

2.5 \textit{Supply of Labour}

In an approach similar to the one followed for migration, education and unfitness for work, to describe the supply of labour ($LS$) we shall start from a (quasi-) flow equation:

$$\left( LS - GP + VUT \right) = \left( LS - GP + VUT \right)_{-1} + INLS - UITLS \quad (2.19)$$

The above flow equation refers only to domestic labour supply plus the early retirers ($VUT$). Domestic supply was derived from total supply by detracting from the latter (exogenous) frontier commuting ($GP$). The early retirers were added to domestic supply to make the observations of the professional population referring to the period after the introduction of early retirement with pay as consistent as possible with earlier observations.

The inflow ($INLS$) derives from various data stocks, such as:

- the potential professional population. Annually a small portion of PBB not already included in the supply of labour will offer itself with a year's lag on the labour market; we denote that portion by $\alpha (PBB - LS + GP)_{-1}$;
- the unfit-for-work. A small portion of those unfit for work will have recovered and be ready to resume work one period later; we denote that portion by $\beta AO_{-1}$;
- the school leavers. Most school leavers will offer themselves on the labour market in the current year; we denote that group by $\eta EXST$;
- the migrants. All workers from Mediterranean and other countries migrating to the Netherlands offer themselves on the labour market; that inflow into $LS$ is equal to $MI + MI^m$.

The outflow ($UITLS$) also refers to several groups:

- the (fit) professional population. Annually a portion of the domestic professional population will leave the labour market; we denote this portion by $\delta (LS - GP + VUT)_{-1}$;
- the unfit-for-work. Annually a portion of the labour supply will drop out of the professional population because of unfitness for work; this portion can be estimated with the help of equation (2.18): $(0.00133 + 0.0645 (U/LS)^{0.2}) LS_{-1}$.

Substituting these flows into (2.19) we find, after some rewriting, the following supply equation:

\[ N.B.: \] we are considering only the migration balance.
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\[ LS = (1 - \delta) (LS - GP + VUT)_{-1} + a_s (PBB - LS + GP)_{-1} + \beta_A \theta_{-1} + \eta_E \chi_{-1} + M1 + M1' + GP - VUT + \]
\[ - (0.00133 - 0.0645 (U/LS)^{0.5}) LS_{-1} \]  

(2.20)

We assume that the factors \((1 - \delta)\), \(a_s\), \(\beta\), and \(\eta\) are not constant but determined by autonomous as well as labour-market factors. Labour-market factors can have both encouraging and discouraging effects. More persons are likely to give up looking for a job as the situation on the labour market deteriorates. The discouraging effect will be particularly manifest among married women, but also among school leavers (see the education equation) and people recovering from unfitness. The effects of unemployment need not all be discouraging; indeed, if one member of a family loses his or her job, the partner or other family members will make efforts to find employment to keep up the family income as much as possible. Therefore, the sign of the influence of the unemployment rate \((U/LS)\) cannot be known a priori.

With the encouraging and discouraging effects, the income factor will always be present in the background. But income may also have a direct influence on the participation in the labour market. Indeed, the higher the income of families or other forms of cohabitation becomes, the less other members need to look for a job. On the other hand, the lure of a potentially high income may induce members of a family to trade valuable leisure time for work time. Whether average income as an explanatory variable has a clear influence on the supply of labour, and if so, in which direction, cannot be said a priori. However, we may expect the negative sign for the minimum wage as explanatory variable, because in particular families with a minimum income will be induced to try to keep the income at par by offering more labour. Because the role of the minimum wage is clearer than that of average income, we shall confine ourselves to the former and assume that the additional labour offered when the minimum wage is reduced will be more if the original minimum wage was low already. For that reason we shall take as wage variable the logarithm of real net minimum wage:

\[ \ln \left( \frac{l_n}{l_{n-1}} \right) \]

By the same reasoning, working hours can also have a direct effect on the supply of labour. In particular, shorter weekly working hours \((H = (HA \cdot LSA + HE \cdot LSE) / LS)\) increase the chance of more members of a family (or other forms of cohabitation) offering themselves on the labour market.

School leavers and those recovered from unfitness for work, when deciding whether or not to enter the labour market (again), will take the level of relevant variables into account. In subsequent years these persons, whether belonging to the professional population or to the potential professional population refraining from entering the labour market, will revise their choice.
only on the ground of changes in these variables. Our assumption that the three labour-market variables mentioned will always be weighed up with the same intensity by the in- and outflowing groups can be concretely expressed as follows:

\[(1 - \delta) = \delta(1 - \Delta \varepsilon)\]
\[\alpha_i = \alpha_0(1 - \Delta \varepsilon)\]
\[\beta_i = \beta_0(1 - \varepsilon)\]
\[\eta_i = \eta_0(1 - \varepsilon)\]
\[\varepsilon = \varepsilon_1(U/LS)_{-1/2} + \varepsilon_2 H^*_{-1/2} + \varepsilon_3 \ln(l^*_{min})_{-1/2}, \quad \varepsilon_1, \varepsilon_2, \varepsilon_3 > 0 (2.21)\]

In order not to let the value of \(1 - \varepsilon\) differ too much from 1, the variables referring to work time and minimum wage have been normalised as follows:

\[H^* = H - 40\]
\[\ln(l^*_{min}) = \ln(l^*_{min})_{-1/2}/p_i\]

Moreover we have assumed, on the strength of data from the labour-force surveys of the CBS: \(\alpha_0 = 0.02; \beta_0 = 0.03\) and \(\eta_0 = 1\).

The estimation results of the supply equation thus developed read:

\[LS = (1 - \Delta \varepsilon)(0.968 (LS - GP + VUT)_{-1} +
+ 0.02 (PBB - LS_{-1} + GP)) +
+ (1 - \varepsilon)(0.03 AO_{-1} + EXST^*) + MI + MP^* + GP - VUT +
- (0.0013 + 0.06447 (U/LS)^{1/2}) LS_{-1}
\]

\[\varepsilon = 1 - 0.388 \Delta (U/LS)_{-1/2} - 0.0057 \Delta H^*_{-1/2} - 0.056 \Delta \ln(l^*_{min})_{-1/2}
(2.1) \quad (1.9) \quad (1.3)
\]

\[R^2 = 0.994; DW = 1.32; SE = 9.3; N = 15 (1965–1979) (2.22)\]

Note that the variables in \(\varepsilon\) have been delayed by six months because the labour stocks represent annual averages; the change then happens around the turning of the year. The * added to \(EXST\) indicates a three-month lag for the years before 1975, because school leavers did not immediately qualify for social benefit at the time, so that registration with a labour exchange was then less urgent. The 'shock effect' of the new measure, amounting to one-fourth of the number of school leavers in 1974, has been divided equally between 1975 and 1976.

The fit of (2.22) is highly satisfactory. All parameters estimated have the expected sign and – with the exception of \(\varepsilon_3\) – differ significantly from 0. The
rather low value of the \( DW \) statistic, even if not quite reliable because of the lagged dependent variable in the right-hand term of (2.22), points to some autocorrelation in the disturbances; evidently, the specification can still be improved.

2.6 Division of the Supply into Labourers and Employees

Because the current version of AMO-K does not yet allow for a division of education by level and direction, we cannot make a direct connection between schooling and the choice of a manual (LSA) or intellectual (LSE) profession. We have tried to overcome that deficiency somewhat by taking gross production \((y + y_{ag})\) per head (POP) as an indicator of prosperity, which, as we have seen, is one explanatory factor of school participation. Welfare, for that matter, may also affect the professional orientation of those who at an advanced age want to take up work (again) or change their profession. Increased prosperity could induce people to look for jobs with pleasant working conditions or a higher status; such jobs will mostly be found among the white-collar professions.

Besides schooling and working conditions, labour-market factors may affect professional choices. A higher wage rate and less chance of unemployment (UA, UE) may enhance a profession's attractiveness.

Our final remark is that professional migration is a marginal phenomenon. Only a relatively minor portion of the professional population will in any one year change from manual to intellectual jobs, or the other way round. Changes in the professional structure are attributable mostly to young people, in particular those entering the labour market for the first time. The professional structure of labour supply will indeed be determined largely by that of the previous period.

In addition, the response to factors determining professional choice may be delayed, in particular the response to changes in the ratio of labourers' and employees' wages (WA/WE). For that reason the professional-choice equation contains the three-year progressive mean of the variable concerned, the average lag thus being put at one year. Estimation of the professional-choice equation thus composed produces the following results:

\[
\begin{align*}
\ln(\text{LSA}/\text{LSE}) &= 0.433 + 0.860 \ln(\text{LSA}/\text{LSE})_{-1} + \\
&\quad - 0.180 \ln(y + y_{ag})/\text{POP} + \\
&\quad + 0.554 \frac{1}{3} \sum_{i=2}^{3} \ln(\text{WA}/\text{WE}) - \\
&\quad - 0.0096 \ln((\text{UA}/\text{LSA})(\text{UE}/\text{LSE})) \\
\end{align*}
\]
\[ R^2 = 0.9995; \; DW = 2.02; \; \bar{SE} = 0.0055; \; N = 17 \; (1963-1979) \]

The fit of this equation is excellent; all parameters except one are significant and all have the expected sign. As was to be expected, the one-year-lagged ratio \( LSA/LSE \) accounts for the greater part of the explanation. Although the unemployment variable is not significant, we will maintain it in the equation, because it does contribute to some degree to the explanation of \( LSA/LSE \).

3 PRODUCTION CAPACITY, JOB OPPORTUNITIES, AND DEMAND FOR LABOUR

3.1 Introduction and Definitions

For labourers as well as employees a demand function has been specified and estimated. By 'demand' we understand the sum of employment (fulfilled demand) and the number of vacancies.\(^1\)

To develop the demand functions for labourers and employees, we have started from the level of employment in both categories needed for the production when the workload on the employed is normal. That level of employment for both categories equals the product of the number of job opportunities and the degree of utilisation of the equipment available. By the number of job opportunities we understand the level of employment under full utilisation of the available equipment.

To attain the desired level of employment, firms will have to take into account the time lapse before a vacancy is filled. The level of demand required to obtain the desired volume of staff will therefore be equal to the latter quantity multiplied by a factor related to the vacancy duration. On that basis, the demand functions of labourers and employees have been elaborated.

Unfortunately, there are no figures available of the number of job opportunities and the rate of utilisation, so, to construct the relevant series ourselves, we specified and estimated a macro production function, generating the series required. First let us consider the form of the production function.

3.2 A Vintage Model with Two Categories of Labour

The production function used, a clay-clay vintage model,\(^2\) reads as follows:

\[
\begin{align*}
CAP(t, \tau) &= \kappa_0 (1 + \kappa_1) t \; (HA)^t \; i(t, \tau) \\
LRA(t, \tau) &= \alpha_0 (1 + \alpha_1)^{-\tau} (1 + \alpha_2)^{-\tau} \; i(t, \tau) \\
LRE(t, \tau) &= \beta_0 (1 + \beta_1)^{-\tau} (1 + \beta_2)^{-\tau} \; i(t, \tau)
\end{align*}
\]

\(^1\) The variables mentioned as well as the supply of labour and unemployment are measured in full-time equivalents.

where:
\[ i(t, \tau) \] = what remains in period \( t \) of the capital goods installed in period \( \tau \);
\[ CAP(t, \tau) \] = corresponding production capacity;
\[ LRA(t, \tau) \] = corresponding job opportunities for labourers;
\[ LRE(t, \tau) \] = corresponding job opportunities for employees;
\[ HA_t \] = work time of labourers in period \( t \);
\[ e \] = superscript indicating that the quantities have been measured at the end of each period.

Den Hartog and Tjan (1974, 1976) have applied clay-clay vintage models to the Netherlands without distinguishing between kinds of labour as we have done. At first they considered only embodied labour-saving technical innovation. In a later version of their model they distinguished disembodied as well as embodied labour-saving technical innovation, and by including a constant term attempted to take account of a rising capital coefficient.\(^{17}\)

We assume that the capital coefficient can differ among vintages, but remains constant during the period a vintage is utilised. Another assumption is that the recruitment of manual labour is subject to both embodied and disembodied technical innovation. As far as intellectual labour is concerned the assumption is that the productivity of this type of labour is not influenced by the age composition of the equipment available, but evolves in a fully autonomous manner. The production capacity has been made dependent on the work time of labourers rather than that of employees. The last two assumptions have been inspired by the idea that intellectual work is less bound up with capital goods than is manual labour.

The specification of (3.1) does not account for possible changes in the rotation rate of labour shifts. A fixed ratio is assumed between operating time and work time.\(^{18}\) Following Den Hartog and Tjan (1974, 1976) we have set the elasticity \( e \) of work time at 0.75, which means that production by man-hours increases as work time is shortened.

Capital goods are subject to wear and tear. Indicating by the symbol \( \Omega(t, \tau) \) the fraction of the capital goods of building year \( \tau \) remaining in period \( t \), we write:

\[ i(t, \tau) = \Omega(t, \tau)i_r \]  

with \( i_r \) denoting investments by firms in equipment and means of transportation in period \( \tau \).

\(^{17}\) Den Hartog and Tjan (1980). In the original model, the capital coefficient was still assumed constant, but that assumption proved untenable. See De Klerk et al., (1975).

\(^{18}\) That assumption finds some empirical support in the fact that the proportion of industrial workers working in shifts changed little in the past period (see CBS (1976) and CPB (1979)).
According to the series of survival fractions \( \Omega(t, \tau) \) borrowed from Den Hartog and Tjan (1976), capital goods begin to show wear and tear only from the sixth year after their installation, after which the survival fractions diminish in the course of time according to the bell-shaped curve of the normal distribution. After 45 years capital goods are completely worn. The economic lifetime of capital goods may be shorter, however, ending at the latest when their use no longer makes good the labour costs associated with them.\(^{19}\) For the vintage \( v_i \) that can just be kept in exploitation, the following equation then holds:

\[
P_n \text{CAP}^c(t, v_i) = W_A \text{LRA}^c(t, v_i) + W_E \text{LRE}^c(t, v_i)
\]

(3.5)

where:

- \( p_r \) = price index of the value added of the private sector;
- \( W_A \) = wage costs of one labourer, employee in the private sector.

With the help of equations (3.1) through (3.3), \( v_i \) can now be solved:

\[
v_i = \frac{\ln \{ \alpha_0 H A_0 - \beta_0 (1 + \beta_2)^{-\eta} (W_E / p_n) \} - \ln \{ \alpha_0 (1 + \alpha_2)^{-\eta} (W_A / p_n) \}}{\ln \{ (1 + \alpha_2)(1 + \alpha_3) \}}
\]

(3.6)

If according to (3.6), \( t - v_i > 45 \), then \( v_i \) is, of course, set at \( t-45 \).

On the assumption that \( (1 + \alpha_2)(1 + \alpha_3) > 1 \), for both kinds of labour an increase in the real wage costs will shorten the economic lifetime of capital goods, and lead (if \( v_i < t-45 \)) to additional discarding of older vintages and the corresponding job opportunities. Even if the loss of capacity were fully compensated by new investments, the net number of job opportunities of labourers will still decline, because new capital goods require less manual labour than older ones; the number of jobs for employees will then remain the same. Presumably, entrepreneurs will belatedly adjust their discarding behaviour to changes in \( P_n, W_A \) and \( W_E \); therefore, the current values of \( P_n, W_A \) and \( W_E \) in the discarding equation have been replaced with the average of the last three years.

Given the building year of the oldest vintage in exploitation, we can develop equations for the production capacity (\( \text{CAP}^c \)) and the total number of job opportunities for labourers and employees (respectively, \( \text{LRA}^c \) and \( \text{LRE}^c \)):

\[
\text{CAP}^c = \sum_{\tau=1}^{t} \sum_{v} \text{CAP}^c(t, \tau)
\]

(3.7)

\[
\text{LRA}^c = \sum_{\tau=1}^{t} \sum_{v} \text{LRA}^c(t, \tau)
\]

(3.8)

\(^{19}\) With restricted sales prospects, economic discarding could even happen earlier, if in spite of the purchase costs working with new capital goods were considered more advantageous. See in that connection Malcolmson (1975) and Den Broeder (1981).
\[ LRE'_{i} = \sum_{t=1}^{T} LRE'(t, \tau) \]  \hspace{1cm} (3.9)

3.3 *Estimation Method and Estimation Results*

We have already stated that there are no data available of the production capacity and the number of job opportunities. For that reason we made assumptions about the way these quantities are related to some others of which we do have information, namely, production volume and employment of labourers and employees in the private sector.

The production capacity \((CAP)\) represents the largest production volume possible:

\[ y_{t} \leq CAP_{t} \]  \hspace{1cm} (3.10)

where \(y\) = value added of the private sector. Our estimation method, which follows the literature about ‘frontier’ production functions,\(^{20}\) is based on the assumption of a disturbance structure such that the capacity restriction is always satisfied. We use the following specification:

\[ y_{t} = CAP_{t} \left( 1/2 + \frac{\arctan(\xi_{t})}{\pi} \right)^{1/\theta}, \quad \theta > 0 \]  \hspace{1cm} (3.11)

where \(\xi_{t}\) is a normally distributed disturbance term with mean 0 and variance \(\sigma^{2}\).

The utilisation rate \(q\) is defined as:

\[ q_{t} = y_{t}/CAP_{t} = \left( 1/2 + \frac{\arctan(\xi_{t})}{\pi} \right)^{1/\theta} \]  \hspace{1cm} (3.12)

By putting \(\xi_{t}\) equal to zero in (3.12), an ‘average’ utilisation rate \(\bar{q}\) can be derived:

\[ \bar{q} = \left( \frac{1}{2} \right)^{1/\theta} \]  \hspace{1cm} (3.13)

If the workload on the employed is normal, the level of employment of labourers and employees required for production is equal to the number of jobs available for either category multiplied by the utilisation rate. As a result of unforeseen developments of the sales situation and/or the situation on the labour market, firms may be confronted by a shortage or surplus of staff. We assume that the past average utilisation rate of job opportunities was the same as that of capital, viz. \(\bar{q}\). That leads to the following equations for the

employment of labourers (\(LA^b\)) and employees (\(LE^b\)) in the private sector:

\[
LA^b = \dot{q} \cdot LRA_i
\]

\[
LE^b = \dot{q} \cdot LRE_i
\]

(3.14)

(3.15)

In the same way the following equation holds (apart from a disturbance term):

\[
y_i = \dot{q} \cdot CAP_i
\]

(3.16)

The symbols \(LRA\) and \(LRE\) denote the number of job opportunities for labourers and employees, respectively, but this time (like \(CAP\)) pinpointed halfway the year. The theoretical quantities \(LRA^r\), \(LRE^r\) and \(CAP^r\), however, relate to the end of the year. To relate the two groups of variables to each other, the following interpolation procedure has been applied. From (3.14) follows that

\[
LA^b_i = \frac{1}{2} \dot{q} \cdot LRA_i^r + \frac{1}{2} \dot{q} \cdot LRA_{i-1}^r
\]

\[
LRA_{i-1}^r = \frac{1}{2} LA^b_i / \dot{q} + \frac{1}{2} LA^b_{i-1} / \dot{q}
\]

Therefore:

\[
LA^b_i = 2/3 \dot{q} \cdot LRA_i^r + 1/3 LA^b_{i-1}
\]

(3.17)

The same procedure has been followed with respect to \(LE^b\) and \(y_i\). Adding disturbance terms to the equations of \(LA^b\) and \(LE^b\), we obtain the following model for estimation:

\[
y_i = (2/3 \ CAP^x + 1/3 \ y_{i-1} / \dot{q}) \left\{ 1/2 + \frac{\text{arctg}(\xi_1^i)}{\pi} \right\}^{\mu \theta}
\]

(3.18)

\[
LA^b_i = 2/3 \dot{q} \cdot LRA_i^r + 1/3 LA^b_{i-1} + \xi^2_i
\]

(3.19)

\[
LE^b_i = 2/3 \dot{q} \cdot LRE_i^r + 1/3 LE^b_{i-1} + \xi^3_i
\]

(3.20)

with \(\xi^2_i\) and \(\xi^3_i\), like \(\xi^1_i\), representing normally distributed disturbance terms with the usual properties.

The model consisting of the equations (3.18) through (3.20) has been estimated simultaneously by the method of maximum likelihood, on the basis
of data from the period 1962–1979. Our assumption as to the pace of technical progress before 1948 and war damage have been the same as made by Den Hartog and Tjan (1976). It should be emphasized that we do not intend to explain \( y \), \( LA^t \) and \( LE^t \) by means of the equations (3.18) through (3.20). We only use these equation to obtain estimates of the parameters of the vintage production function, and estimates of the unknown series \( CAP^t \), \( LRA^t \) and \( LRE^t \) as well.

The first estimation of the equation for the employment of labourers left large positive residuals at the end of the estimation period. That is probably due to a phenomenon observed in other countries as well, namely, that in the 1970's labour productivity increased markedly less rapidly than in the 1960's. The literature mentions many possible causes of this phenomenon, but what the real causes are is still unclear. We have decided to solve the problem for the time being by adjusting the parameter of the disembodied labour-saving technical innovation \( \alpha_i \), assuming that it declines after 1972 to reach the level of \( \beta \) in 1979. Table 3.1 presents the estimation results (\( \alpha_i \) being adjusted).

<table>
<thead>
<tr>
<th>Production capacity</th>
<th>Labourers</th>
<th>Employees</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \kappa_0 ) = 0.0403 (53.8)</td>
<td>( \alpha_0 = 0.0292 ) (86.3)</td>
<td>( \beta_0 = 0.0165 ) (116.1)</td>
</tr>
<tr>
<td>( \kappa_1 = -0.0067 ) (38.4)</td>
<td>( \alpha_1 = 0.0450 ) (73.5)</td>
<td>( \beta_2 = 0.0214 ) (45.5)</td>
</tr>
<tr>
<td>( \bar{q} = 0.9831 ) (153.2)</td>
<td>( \alpha_2 = 0.0415 ) (40.9)</td>
<td></td>
</tr>
<tr>
<td>( SE = 1813 )</td>
<td>( SE = 15.6 )</td>
<td>( SE = 10.3 )</td>
</tr>
<tr>
<td>( R^2 = 0.9916 )</td>
<td>( R^2 = 0.9955 )</td>
<td>( R^2 = 0.9935 )</td>
</tr>
<tr>
<td>( DW = 1.20 )</td>
<td>( DW = 1.06 )</td>
<td>( DW = 0.45 )</td>
</tr>
</tbody>
</table>

The negative value of \( \kappa_1 \) is striking; it implies that the capital coefficient has risen through time. That result is in accordance with the re-estimated version of the Den Hartog and Tjan model. On the other hand, the condition \((1 + \kappa_1)(1 + \alpha_1) > 1\) is clearly satisfied, so that the real wage costs have a negative effect on the economic lifetime of capital goods. Capital goods do not really

21 For an extensive description, see our research report: Heijne, De Koning, Maas and Den Broeder (1982).
23 In the simulations to be discussed later, the parameter of embodied labour-saving technical innovation has also been adjusted for the future.
24 The rising capital coefficient should be interpreted with caution; indeed it is not necessarily due to capital-using technical innovation, but may also result from ex ante substitution of capital for labour (Kuipers and Van Zon (1982)) or sector shifts (Den Hartog and Tjan (1980)); it may even be attributed to the way the investment volume has been measured.
begin to be economically obsolescent until the 1970's. In 1975 the economic lifetime has dropped to 25.8 years, to increase again to 28.9 years in 1979.

From Table 3.1, the fit of the three equations of the production block appears adequate. The t-values given in brackets behind the estimations are very high, but have to be looked upon with caution, also given the low DW values.

Fig. 3.1 reproduces a number of constructed series, concerned first of all with production capacity and the number of job opportunities for labourers and employees.

The following remarks are in order:

- the capacity is only slightly above the actual production, as was already apparent from the high value of $\hat{q}$ (0.9831) in Table 3.1;

![Figure 3.1 - Utilisation of production factors](image-url)
the estimated number of job opportunities is above the level of employment for both categories;
- the number of job opportunities for labourers is structurally declining, while those for employees are steadily growing in number. Two explanations can be offered; with labourers there is more disembodied labour saving than with employees, and the renewal of capital equipment affects only the number of labourers' jobs.

The workload of labourers, or work-intensity rate, is defined as the ratio between the level of employment of labourers required for production at normal work intensity \((q \cdot LRA)\) and the actual level of employment of labourers \((LAp)\). It appears in the expenditure block of the model as a measure of the degree to which the labour supply is the bottleneck in the production process, next to the utilisation rate, which serves, among other things, as a measure of bottlenecks related to the production factor capital.

3.4 Demand

As has been said before, by demand we understand the sum of employment and the number of vacancies. The demand functions in AMO-K indicate that in the long run the demand for labour in the private sector adjusts to the employment needed for production at normal work intensity, account being taken of the 'average' proportion of vacancies to be expected. That average proportion is derived from the number of vacancies in an equilibrium situation, when the number of vacancies is equal to (friction) unemployment (see section 4).

Adjustment of the staff, contraction as well as expansion, can entail costs. When workers have to be laid off, there are the costs of redundancy schemes; new recruits may have to receive professional training to become skilled workers in the production process. Such costs may delay the response of demand for labour to changes in the quantity of labour needed for production. Uncertainty as to the development of the sales market will also delay the evolution of demand for labour.

On the above considerations, and a logarithmic form of the demand functions for labourers and employees being adopted, the estimation procedure produced the following results:

\[
\Delta \ln(LDA^a) = 0.0038 + 0.5118 \ln(q(1 + \frac{UAFRIC}{LAv}) \cdot LRA) + 0.0067 \ln(LDA_{2}^e) - 0.5185 \ln(LDA_{1}^e)
\]

\(R^2 = 0.4594; DW = 1.79; SE = 0.01; N = 16 (1964–1979)\)  
(3.21)
\[ \Delta \ln(LDE^p) = 0.0033 + 0.2178 \ln\left(1 + \frac{UEFRIC}{LE^p} \right) LRE + \]
\[ 0.4607 \ln(LDE_{t-1}) - 0.6785 \ln(LDE_{t-2}) \]
\[ R^2 = 0.7580; \; DW = 1.89; \; SE = 0.01; \; N = 16 \; (1964-1979) \]  

(3.22)

where:
\( LDA^p, LDE^p \) = demand for labourers, employees in the private sector;
\( UAFRIC, UEFRIC \) = equilibrium friction unemployment of labourers, employees.

The direct effects of the term containing the utilisation rate are smaller, and the lags longer, for employees than for labourers; that confirms the hypothesis that the delays are due, among other things, to the costs of changing the volume of the staff, costs which as a rule will be higher for employees than for labourers.

4 EMPLOYMENT, VACANCIES, AND UNEMPLOYMENT

4.1 Disequilibrium on the Labour Market

Employment is the resultant of the interaction of supply and demand on the labour market. Should the labour market perform perfectly, then employment would equal the smaller of supply and demand, and unemployment and vacancies would not occur at the same time. In reality the labour market's performance is far from perfect, and there are always vacancies side by side with unemployment.

In the past, macro-econometric models have ignored the phenomenon of simultaneous unemployment and vacancies. They made no distinction between the demand for labour and employment, and thus failed to recognise the existence of vacancies. As a result, these models left out of account the increasing discrepancies on the labour market from the mid-1960's onward, an important phenomenon both in the Netherlands and in many other developed countries.

AMO-K describes the employment on the submarkets of labourers and employees by means of so-called employment functions. These functions explain the employment of labourers and employees from the demand for and the supply of labour on the submarket concerned.

4.2 Theoretical Backgrounds of the Employment Function

As pointed out above, discrepancies occur on the labour market between the demand and supply sides. A major explanation is that the labour market is divided into many submarkets, more or less strictly separated by, for instance,
geographical or professional gaps. On some submarkets demand may surpass supply, while on others the opposite is true. Even if unemployment and vacancies did not occur side by side on the micro level, they still would on the macro level.

That thought is at the basis of the model developed by Kooiman and Kloek (1979) after an idea of Muellbauer (1978). Starting from a probability distribution of micro markets ranked by the levels of demand for and supply of labour, and on the assumption that on each micro market employment equals either supply or demand, whichever is the smaller, they compute macro employment \( L \) as a function of the macro levels of supply \( (LS) \) and demand \( (LD) \). Apart from the disturbance term, their employment function has the general form:

\[
L = f(LS, LD)
\]  
(4.1)

Function \( f \) is determined by the shape of the distribution chosen. Applying their model to the Netherlands labour market as a whole, Kooiman and Kloek used two different distribution specifications, a normal one and a log-normal one. Other specifications can be thought of, but they will not all be equally operational.

Besides choosing a different distribution one can also try directly to develop a macro employment function satisfying the relevant theoretical demands, which are the following:

1. \( L < \min \{ LS, LD \} \): employment is smaller than the smaller of supply and demand;
2. \( \lim L = \min \{ LS, LD \} \): if either demand or supply adopts extreme values, employment tends to the smaller of supply and demand;
   \( LS \to \infty \)
   or \( LD \to \infty \)
3. \( \eta L = f(\eta LS, \eta LD) \): the scale of the labour-market process does not affect the frictions between supply and demand;
4. \( \frac{\delta f}{\delta LS} > 0, \frac{\delta f}{\delta LD} > 0 \): increased supply and/or increased demand leads to increased employment;
5. \( \frac{\delta^2 f}{\delta LS \delta LD} < 0, \frac{\delta^2 f}{\delta LD^2} < 0 \): at a given demand (supply), the effect of increasing supply (demand) will be progressively less.

One specification satisfying the above requirements is the following CES function\(^{25} \):

\[
L = (LS^{-\lambda} + LD^{-\lambda})^{-\frac{1}{\lambda}}, \lambda > 0
\]  
(4.2)

\(^{25}\) CES functions to describe disequilibrium on markets are also found in Siebrand (1979).
The employment function developed by Kooiman and Kloek also satisfies the requirements; moreover, as Den Broeder (1983) has shown, the CES function can be derived from a certain probability distribution.

Parameter $\lambda$ in (4.2) can be looked upon as an indicator of the efficiency of the labour market. As this parameter becomes larger, the minimum points at increasing frictions on the labour market. Although we are aware that a qualitative explanation of the phenomenon is called for, we have contented ourselves with representing the decline of $\lambda$ by simple time trends.

4.3 Applying the CES Employment Function to the Submarkets of Labour and Employees

Application of the CES function to the submarket of labourers, with correction for autocorrelation, produced the following results:

$$LA = [(LSA)^{-\lambda A} + (LDA)^{-\lambda A}]^{-1/\lambda A}$$ (4.3)

with $\lambda_A = 41.392 \exp \{-0.0491 \ t_{62}\}$

$$25.7 \ (20.7)$$

$\varrho_A = 0.4555; \ R^2 = 0.9999; \ SE = 1.9; \ DW = 1.71; \ N = 19 \ (1961-1979)$. (2.3)

With respect to employees the results were as follows:

$$LE = [(LSE)^{-\lambda E} + (LDE)^{-\lambda E}]^{-1/\lambda E}$$ (4.4)

with $\lambda_E = 138.022 \exp \{-0.0750 \ t_{64}\}$

$$20.3 \ (16.3)$$

$\varrho_E = 0.4644; \ R^2 = 1.0000; \ SE = 0.9; \ DW = 1.30; \ N = 19 \ (1961-1979)$. (1.7)

Up to 1962 the variable $t_{62}$ adopts the value of zero, and from 1963 onwards increases linearly with time; $t_{64}$ is a linear trend starting in 1965. The estimates of (4.3) and (4.4) are based on additive disturbance terms.

For both equations, the agreement between the calculated values and the actual values can be called excellent. On both submarkets, supply and demand are increasingly mismatched. In both cases the trend started before 1967, the year often mentioned in the literature as the breaking point (see Hart

26 To that end one could use research already carried out in the Netherlands, in particular by Siddrée and Theeuwes (1977), Kooiman and Kloek (1979), Den Broeder (1981), Heijke (1982), and Den Broeder, Hekije and De Koning (1984).
For the employees deterioration sets in later than for the labourers; on the other hand, the decline, in terms of \( \lambda \), is faster with employees. Nevertheless, at the end of the period \( \lambda_E \) is still higher than \( \lambda_A \).

4.4 Friction Unemployment

To specify the demand functions in the previous section, we have used the concept of equilibrium friction unemployment, a concept defined as the unemployment that would exist if for a given value of realised employment supply and demand on the labour market would be found equal. With application of the CES function (4.2) this equilibrium friction unemployment (\( UFRIC \)) can be derived as follows:

\[
L = \left( (L + UFRIC)^{-\alpha} + (L + UFRIC)^{-1} \right)^{-\frac{\alpha}{1-\alpha}}, \quad \text{so} \quad UFRIC = L \left( 2^{\frac{\alpha}{1-\alpha}} - 1 \right)
\]

(4.5)

Table 4.1 presents the equilibrium friction unemployment calculated for various years as percentages of the labour supply of the categories involved.

**TABLE 4.1 - EQUILIBRIUM FRICTION UNEMPLOYMENT AMONG LABOURERS AND EMPLOYEES, IN PERCENTAGES OF LABOUR SUPPLY**

<table>
<thead>
<tr>
<th>Year</th>
<th>Labourers</th>
<th>Employees</th>
</tr>
</thead>
<tbody>
<tr>
<td>1961</td>
<td>1.7</td>
<td>0.5</td>
</tr>
<tr>
<td>1965</td>
<td>1.9</td>
<td>0.5</td>
</tr>
<tr>
<td>1970</td>
<td>2.5</td>
<td>0.8</td>
</tr>
<tr>
<td>1975</td>
<td>3.0</td>
<td>1.1</td>
</tr>
<tr>
<td>1979</td>
<td>3.7</td>
<td>1.5</td>
</tr>
</tbody>
</table>

The equilibrium friction unemployment is 2.5 to 3.5 times higher among labourers than among employees. It did increase faster among the employees, however: while among labourers the friction unemployment doubled, among employees it tripled. The absolute increase was nevertheless higher among labourers.

5 WAGES

AMO–K also distinguishes, and explains separately, the wages of labourers and employees. The reason is that, while the wages of both groups of employed people have continuously increased since 1960 – if at a slower rate since the oil crisis of 1973/1974 –, their ratio has been far from constant. The ratio between the variables to be explained, \( WE \) and \( WA \), that is, the ratio between the gross wages of employees and labourers in the private sector, including all
taxes and premiums as well as periodical and incidental benefits, fluctuated around 1.20 in the period 1960–1979, with a slight but not negligible tendency towards levelling.

In the economic literature, the development of wages is explained by several factors, mostly based on scarcity and on the relative power of the negotiating partners. Thus Phillips (1958) took wage mutations to be negatively dependent on the volume of unemployment: when there is much unemployment, the employed will have to moderate their demands, whereas in a tight labour market employers will try to recruit staff by increasing the wages. In collective wage negotiations between employers and workers, growing labour productivity, the passing-on of increased taxes and premiums, and compensation for higher prices often play a role along with the tension on the labour market. All these aspects are accounted for in the following derivation, which is based on Brandsma and Van der Windt (1980). The assumption is that workers will try to acquire a real disposable income \((L_d)\) representing a certain fraction of real production value \((\gamma)\), a fraction that will be larger as the tension on the labour market is higher.

\[
L_d = p_q \cdot y \quad 0 < q < 1
\]

(5.1)

in which \(p_q\) denotes consumption price.

The gross income to be explained \((L_b)\) consists, apart from disposable income, of wage tax \((T_{wb})\) and social premiums paid by workers \((P_{wv})\) and employers \((P^b_{wv})\):

\[
L_b = L_d + (T_{wb} + P_{wv}) + P^b_{wv}
\]

(5.2)

Division of (5.2) by employment in the private sector \((a)\) and introduction of percentage mutations produces the equation explaining the development of individual gross (weekly) wage \(l\), which equation, after some rearranging of elements, reads as follows:

\[
l = \dot{p}_q + (\dot{y} - \dot{a}) + \gamma_b [(T_{wb} + P^b_{wv}) - \dot{y} - \dot{p}_q] + \gamma_s [(P_{wv}) - \dot{y} - \dot{p}_q] + (1 - \gamma_b - \gamma_s)\phi
\]

(5.3)

in which \(\gamma_b = (P^b_{wv}/L_b)_{-1}\) and \(\gamma_s = ((T_{wb} + P_{wv})/L_b)_{-1}\).

The above equation indicates only which factors have to be passed on to achieve a share of exactly \(\phi\). In reality, however, negotiations are carried on, and there is no saying to what extent the various factors will eventually be passed on. Therefore, to all factors distinguished in the estimation equations for \(WA\) and \(WE\) a parameter is added, which could adopt values between 0 and 1 and which has to be estimated. Apart from that, a possible lag in the responses is reckoned with.

In the original specification of the Phillips curve, only the unemployment
rate as such figures as tension variable. We prefer the following form, however:

\[ \dot{q} = (1 + \frac{U}{L})^{-\gamma} - (1 + \frac{V}{L})^{-\gamma} \]  

(5.4)

a tension variable which derives directly from the employment function, for which \((1 + U/L)^{-\gamma} + (1 + V/L)^{-\gamma} = 1\). This specification has the advantage of weighing up the negotiation positions of employers and workers, while 'correcting' at the same time for shifts in \(U\) and \(V\) that are due exclusively to the increasing market imperfection and do not influence power relations. In that way the phenomenon of 'stagflation,' a term to denote progressive unemployment combined with wage and price increases, can be accounted for.

The estimation procedure produces the following results:

\[
WA - \dot{p}^* = 0.809 (\dot{y} - \dot{a})_{t+1} + 3.839 \{ (1 + \frac{UA}{LA})^{-\gamma} + \frac{VA}{LA} \}^* + 0.478 SG + 0.848 SB \\
\]

(9.8) \hspace{2cm} (3.7)

\[
- (1 + \frac{VA}{LA})^{-\gamma} \}^* + 0.478 SG + 0.848 SB \\
\]

(2.2) \hspace{2cm} (2.8)

\[ R^2 = 0.889; \; \bar{SE} = 0.817; \; DW = 1.68; \; N = 17 \; (1963-1979) \]

\[ WE - \dot{p}^* = 0.690 (\dot{y} - \dot{a})_{t+1} + 2.654 \{ (1 + \frac{UE}{LE})^{-\gamma} + \frac{VE}{LE} \}^* + \]

(7.1) \hspace{2cm} (2.1)

\[
- (1 + \frac{VE}{LE})^{-\gamma} \}^* + 0.743 SG + 0.713 SB \\
\]

(2.9) \hspace{2cm} (2.0)

\[ R^2 = 0.812; \; \bar{SE} = 0.963; \; DW = 2.08; \; N = 18 \; (1963-1979) \]

Here \(SG\) and \(SB\) represent the taxes and social premiums of employed persons (families) and employers (firms) weighing on the wages; regrettably, these are not known by category of labour. We multiplied the Phillips-curve terms by \((1 - \gamma_s - \gamma_a)\). From the introduction of the automatic price compensation in 1970 onwards, \(\dot{p}\) was delayed by one quarter.

The estimation showed that the price compensation was complete. Therefore, the corresponding parameters were put at 1, so that (5.5) and (5.6) indeed explain the real wages.

The estimated parameter values appear clearly divergent from 1, which, though not overwhelmingly significant, is remarkable, indicating among other things that taxes and social premiums are not fully passed on. The differences between the two equations are also considerable: the wages of labourers
appear to respond stronger than those of employees to mutations in labour productivity and to the situation on the labour market.

With standard errors below 1 percent, the explanatory power of the equations estimated can be called satisfactory.

6 GOODS MARKET

To complete the economic circuit, this section explains expenditure and prices on the goods market. While the components distinguished are the same as in the VINTAF-II model of the Central Planning Bureau (1977), now superseded, the explanation of the various variables has been adjusted to new theoretical insights and econometric methods. One adaptation has been to take the effect of the labour-market situation on the satisfaction of the demand for products into account: in some equations the work intensity of labourers plays a role, a variable which was defined in section 3. A value of more than 1 of this quantity indicates that the firms have difficulty in recruiting enough labourers to satisfy the demand for their products. Apart from that, AMO-K explains expenditure mostly from demand factors, though in price equations discrepancies between demand and (short-term) supply are expressed in the level of the utilisation rate \( q \).

In our model, the volume of private consumption \( C_l(p_c \cdot POP) \) by head of population \( (POP) \) is dependent on the level of the various sources of income by head, apart from an autonomous portion. The marginal consumption quotas of disposable wage income \( (L_y) \), the disposable income from benefits \( (O_a) \), and disposable other income (profits and the attributed wage of self-employed people) \( (Z_p) \) can vary. The autonomous part of consumption is fully attributed to the workers. As a result, the average consumption quota of workers is close to one. The satisfaction of demand for consumption goods, thus composed, will correlate negatively with the work intensity of labourers \( (q \cdot LRA/LA^c) \), the limited availability of labourers having a negative influence on production prospects.

The estimation results (autocorrelation being corrected for) are:

\[
C_l(p_c \cdot POP) = \left[ 1.848 \left( a + a_{or} - (SWP + AW) \right) / POP + 0.698 L_y(p_c \cdot POP) + 0.486 Z_p(p_c \cdot POP) + 1.005 O_a(p_c \cdot POP) \right] \frac{LRA}{LA^c} - 0.260
\]

\( q = 0.593; R^2 = 0.9984; SE = 0.0388; DW = 1.34; N = 18 \) (1962–1979)
The high marginal consumption quota of $O$, is striking; that of $L$ seems rather low. That the quota for $Z$ is not above 0.5 is plausible, because $Z$ also serves to finance investments. The influence of work intensity appears to be far from negligible. The explanatory power of (6.1) is satisfactory, but the $DW$ statistic remains rather low in spite of correction for autocorrelation.

Private investments in equipment and means of transportation ($i_{ew}$) play an important role in AMO–K. They serve not only for building up and maintaining the production capacity of industries, but also boost labourers’ productivity by the introduction of corresponding new technologies.

Technological innovation being already included in the obsolescence condition, the investment equation is based on the function of investments as a means to adjust capacity. The first aspect to be considered is the capacity desired by the end of the year, which is the resultant of the production expected by the end of the year ($y_{n+1}^*$) and the utilisation rate desired by then ($q^*$).

In view of the estimation results, we have extrapolated the most recent production results to find the expected production for the final investment equation: $y_{n+1}^* = y(y/y_n)^{1/2}$. As to the desired utilisation rate, we have assumed that it is a weighted average of the ‘neutral’ value $\bar{q}$ and the one-year lagged value of $q$: $q^* = \frac{q^0 + \bar{q}}{2}$. The desired investments ($i^*$) can now be determined directly, given their productivity and the remaining capital goods (standardised as to productivity differences) of older vintages, the latter being equal to:

$$K_0 = \sum_{t=1}^{T} (1 + x_t) (1 + \xi_t) \Omega(t, \tau) r_t.$$  

The equation of desired investments then reads:

$$i^* = \frac{y_{n+1}^*}{q^*} J^H A (1 + x_t) Y^{0.75} - K_0$$  (6.2)

These are the investments ‘desired’ from a macro-economic point of view. However, we are concerned with the investment plans of numerous individual firms, which, though anxious to enlarge their market shares, will not invest unless the investment promises a satisfactory profit. As an indicator of average profit we have chosen the previous year’s disposable profits ($Z_n$), deflated by the price of investments in equipment and transportation means ($p$). Because these profits refer also to the sector of natural gas, we have deducted the exogenous investments on behalf of this sector ($i_{ew}$).

To explain the demand for investments, two factors appear essential: the desired capacity, multiplied by a ‘competition parameter’ $\beta > 1$ to account for the individual companies’ attempts at enlarging their market shares, and a
profitability factor. Some firms will give more weight to the former, others to the latter factor. Therefore, on the macro level a high average profitability and low sales prospects may produce the same demand for investment goods as low profitability and excellent sales prospects. A Cobb-Douglas function represents that adequately.

The degree of realisation is once more made dependent on the work intensity of labourers. In the estimation, the corresponding elasticity tended towards the limit of $-1$. The investment equation of AMO-K thus results in the following specification:

$$i_{ow} = 0.324 \left( \frac{Y_{y_{-1}^{12}}}{Y_{y_{-1}^{12}}} \right) - K_0^{1-0.527}$$

$$(4.4) \quad (8.8) \quad \frac{q^{0.25}}{q^{0.75}} \times a^{0.85} H A^{0.75}$$

$$\times \left( \frac{Z_h}{p_{t-1}} - i_{eq} \right)^{0.527} \frac{q \cdot L R A}{L A^h} \left[ 1 + i_{eq} \right] (6.3)$$

$$q = 0.471 \quad (2.3)$$

$$R^2 = 0.953; \; SE = 527; \; DW = 1.7; \; N = 18(1962-1979)$$

The statistic quality is acceptable and the parameters that have still been estimated freely have plausible values.

On the assumption of a relation between accommodation and equipment, investments in company buildings ($i_{geb}$) depend on the investment in new equipment ($i_{eq} = i + i_{eq}^2$) and the discarding of obsolete equipment ($s = KAP_{eq} - (KAP - i)$, where $KAP = \sum_{t=1}^T Q_{t} r_{t}^2$). The variable $i_{geb-1}$ has been included to account for building activities left over from the previous year. Because entrepreneurs will try the next year to compensate for any losses of time suffered through frost ($WW_{frost}$), the mutation of the variable has been included in the equation. The amount of unused capital at the beginning of the year has been taken as indicator of the loss of (usable) accommodation on account of reorganisations: a lower utilisation rate spells trouble to the companies. We presume that the buildings coming available after the closing down of factories are not generally suitable for new activities, which, given the level of investments in new equipment, makes new investments in buildings necessary. In the simulations, the effect of reduced utilisation has been taken not to exceed 5 per cent of $KAP_{eq}$. The

$$i_{geb} = -290 + 0.383 i_{ow} - 0.684 s + 0.124 (1-q_{-1:2}) KAP_{eq} +$$

$$(2.2) \quad (14.3) \quad (15.0) \quad (10.6)$$

$$-55.2 \Delta WW_{frost} + 0.573 i_{geb-1}$$

$$(11.9) \quad (16.1)$$

$$R^2 = 0.9910; \; SE = 80; \; DW = 2.60; \; N = 18(1962-1979)$$
The great explanatory power and the high significance of the estimated parameter values are to be noted: the DW statistic is somewhat high.

The greater part of the goods imports are raw materials and manufactured goods not available in the Netherlands. Hence, the volume of the imports \( m \) will depend largely on the volume of total expenditures \( v \). As far as there is competition, the ratio between the import price \( P_m \) and the price of domestic goods \( P_r \) will play a part as well. A high utilisation rate \( q \) of domestic capacity may indicate that imports are necessary to overcome capacity shortages.

\[
\begin{align*}
\ln m &= -3.903 + 1.228 \ln v - 0.330 \ln P_m - 0.0181(1-q)_{-13} \\
&\quad (-19.5) \quad (72.2) \quad (4.3) \quad P_r \quad (3.9) \\
R^2 &= 0.9986; \quad \bar{SE} = 0.012; \quad DW = 1.69; \quad N = 16 \ (1964-1979) \quad (6.5)
\end{align*}
\]

In the analogous goods-export \( b \) equation (the index of) world trade \( m_r \) act as the motor. The estimation results point at a structural relative decline of Netherlands exports. Foreign competition here is far more important than with imports, which is due, of course, to the nature of the products exported. Long-term elasticity with respect to the ratio between the price of the Dutch product \( P_r \) and that of the competitors \( P_r^* \) even rises considerably above 1. The influence of the price ratio is delayed according to a truncated Pascal distribution. In the export equation, unlike the import one, the (Netherlands) utilisation rate does not enter.

\[
\begin{align*}
\ln b &= 0.948 \ln m_r - 1.282 \sum_{i=0}^{\infty} \frac{0.387^{i}(t-r + 1)\ln (P_r)}{P_r} + 10.720 \\
&\quad (34.0) \quad (8.2) \quad (6.4) \\
R^2 &= 0.9989; \quad DW = 1.62; \quad \bar{SE} = 0.013; \quad N = 16 \ (1964-1979) \quad (6.6)
\end{align*}
\]

Gross value added in the private sector is assessed from stock building, government consumption (exogenous), depreciation, indirect taxes and the balance of imports and exports of services.

The price equations express the market mechanism in two ways. First, by assuming that prices do not only follow the development of cost \( k \), but take account as well of the development of the prices quoted by foreign competitors. Second, the utilisation rate \( q \) is taken as an indicator of differences between demand and (short-term) supply on the commodity market, occurring either as level (‘Phillips-curve’ effect) in the equation concerning the price of investments in equipment and transportation means \( P_r \), as well as in that concerning the export price \( P_e \), or as a cost-increasing factor, as mutation, in the equation referring to the price of private consumption \( P_r \). A portion of consumption and investments \((\varepsilon_c, \varepsilon_i)\) is imported; of that portion the prices \( P_{mc, P_{mi}} \) are exogenous.
\[
\hat{p}_e = (1 - \epsilon_e) \left( \hat{k}_e - 0.281(\hat{k}_e - \hat{p}_{mc-2}) + 37.9 \Delta q \right) + \epsilon_e \hat{p}_{mc} + 0.456 \hat{p}_{ee} \\
(4.5) (2.3) (1.8)
\]

\[
\hat{\rho}_i = (1 - \epsilon_i) \left[ k_i - 0.569(k_i - \hat{p}_{mt-12}) + 1.163 \ln \left( \frac{1 - \hat{q}}{1 - q} \right) - 1.283 \right] + \\
(4.0) (2.5) (-2.6)
\]

\[
+ \epsilon_i \hat{p}_{mai} + \hat{p}_{ei}^{ee} \\
\hat{R}^2 = 0.937; \hat{SE} = 0.901; DW = 2.64; N = 18 (1962–1979) 
(6.8)
\]

\[
\hat{p}_s = k_s - 0.713(k_s - \hat{p}_{s}^{ee}) + 0.398 \ln \left( \frac{1 - \hat{q}}{1 - q} \right) - 0.863 \\
(5.3) (1.0) (2.3)
\]

\[
\hat{R}^2 = 0.929; \hat{SE} = 1.543; DW = 2.14; N = 18 (1962–1979) 
(6.9)
\]

The explanatory power of the price equations is acceptable. As could be expected, the export price is most sensitive to competition. A striking result is that from the sign of the constant, the utilisation rate in the exporting and investment sectors appears to be structurally higher than the national average.

7 SOCIAL SECURITY AND GOVERNMENT FINANCE

The collective sector – which AMO–K divides into the sectors ‘social security’ and ‘government finances in the strict sense’ – is described by a number of (semi-) definition equations. Benefit payments according to the social-security scheme are calculated by multiplying the number of benefit drawers by the benefit rates, which are coupled to wage development. The total sum of social-security premiums to be paid equals the total sum of benefits, abstracting from fund formation and state transfers. Various kinds of benefits have been distinguished: demographically-determined benefits such as old-age pensions, child benefits, payments to widows and orphans; sickness and unfitness benefits, benefits according to insurance schemes for the costs of sickness and unemployment benefits. The number of benefit drawers, other than unemployed and unfit, is mostly independent of the economic development and the situation on the labour market; it can be explained from demographic development or the number of insured people (for instance, absence because of sickness and costs of sickness).

AMO–K makes a distinction between unemployed people enjoying a benefit by virtue of the Unemployment Act (WW) and those receiving benefits according to the Unemployment Provisions Act and the State Scheme for
Unemployed Workers (WWV/RWW). The category of 'fully unemployed' has a flow character: WW benefits are paid only during the first half year of unemployment. In conditions of rising unemployment (\(\Delta U > 0\)) the theoretical minimum number of WW payees is \(\frac{1}{2} \Delta U\); moreover, a deteriorating labour market is likely to slow down the flow back to employment. So, a rise in total unemployment will result in an increasing proportion of long-term unemployed, that is, of people drawing WWV/RWW benefits. In addition, a rise in the equilibrium friction unemployment in relation to the labour supply will probably also increase the larger share of long-term unemployed in total unemployment.

The estimated equation with respect to the number of fully unemployed \((WW, i)\) reads as follows:

\[
WW_{it} = WW_{it}^{min} + (U - WW_{it}^{min}) / \left[1 + \exp \left\{6.749 + 0.00271 U + \right. \right.
\]

\[
+ 1.729 \ln(UFRIC/LS) - 0.617 \ln \left(\frac{WW_{it} - WW_{it}^{min}}{U - WW_{it}^{min}} \right) \right] \right] \quad (3.4)
\]

\[
R^2 = 0.9302; \ SE = 0.152; \ DW = 1.93; \ N = 17 (1963–1979) \quad (1.9)
\]

with: \(WW_{it}^{min} = \max (0, \frac{1}{2} \Delta U)\).

The social-security system can be approximated by the following equations:

\[U_i = u_i \cdot l_{wi} \cdot KW_i\]

(7.2)

in which:

\(u\) = normalised number of benefit drawers;

\(l_{wi}\) = the wage rate to which the benefit is coupled;

\(KW\) = exogenous quality factor determining the actual level of the benefit rate;

\[U_i = \sum U_i\]

(7.3)

---

27 Those entitled to WW payments are mostly fully unemployed workers and people redundant because of weather conditions.

28 Statistics of \(\ln(\frac{U - WW_{it}^{min}}{U - WW_{it}^{min}} - 1)\)

The standard error for \(WW_{it}\) is 2.7.

29 Gross wage, collectively bargained wage, or net minimum wage.
The quality of benefit sum and premium sum ($P_s$):

$$P_s = U_s - P_{su}$$

(7.4)

in which $P_{su}$ represents in particular the contributions of the state.

The system of social security is completed by equations representing the benefits and premiums of life-insurance companies and pension funds (institutions which build up considerable capital funds to cover future payments) and the division of social premiums among employers (companies) ($P_{e}$) and employed (families) ($P_{f}$).

Government income and expenditure are partly endogenous in AMO–K. The returns of income tax and profit tax are coupled, through the (exogenous) tax rate, to the development of the wage sum, the benefit payment, and the profits. The indirect taxes are similarly coupled to the consumption outlays. The wage sum of civil servants has been calculated by multiplying the (exogenous) number of civil servants (in working years) by their average wage rate, which is linked to the wage development in the private sector. The volumes of material government consumption, government investments and the building of houses are exogenous. The corresponding price development is linked to the prices for firms and consumers. Both the volume and the price components of the transfers to families (WWV, RWW, public assistance, scholarships, rent subsidies, etc.) are endogenous. The relevant equation reads as follows:

$$T_R = l_{min} (U - WW_u) + Y_{-1/2}KW_{TR}$$

(7.5)

in which:

$T_R$ = transfers to families;

$KW_{TR}$ = (exogenous) quality factor coupling the remaining transfers (other than WWV and RWW) to national income.

The transfers to social funds, private companies, and foreign countries are exogenous, as are the government's depreciations, interest payments, and income from natural gas. The financing balance is defined as the difference between government income and expenditure, the latter including consumptive credits.

8 STRUCTURE OF THE MODEL AND SIMULATION OF THE PAST

8.1 The Structure of AMO–K

Central to the AMO–K model are the income variables. The model allows for interaction between wages and profits on the one hand and on the other prices, social benefits and premiums, government outlay and income, and expenditure. Wages and profits lead to consumption and investments; total expenditure determines the total of incomes.
Through the economic obsolescence of capital goods, the (real) wages costs work out on the production capacity and demand for labour. The real net (minimum) wages influence the number of school leavers and the supply of labour. The development of the wages is also influenced by the tension on the labour market. That so-called Phillips mechanism constitutes an important link in the model, because it largely determines the stability of its results.

The Phillips mechanism is not the only stabilising element in the model. There are also feedbacks from the disequilibrium of the labour market to the inflow into unfitness-for-work, foreign labour, labour supply and demand for labour. Moreover, the (short-term) disequilibrium of the commodity and service markets, expressed in the utilisation rate of production capacity, affects price building and imports. As the utilisation rate tends towards 1 with increasing tension on the labour market, the price rises generated by the relevant equations become so high and the imports generated so voluminous as to slow down expenditure and domestic production. Thus production is guaranteed to remain below capacity and the utilisation rate thus below 1.

AMO–K registers discrepancies, not only on the external labour market but also within companies, between the number of workers actually employed and the number needed to realise the production volume required. Such discrepancies can make workers redundant (forming a labour reserve within the companies) or cause them to be more than normally burdened. The work intensity of labourers limits expenditure on consumption and investments. That feedback prevents the production volume determined by the spending side of the economy from becoming much larger than can be produced at a normal work intensity by the number of persons actually working, a number that results from the interaction process between supply and demand on the external labour market.

The nonlinearity of the model makes understanding its dynamic properties by means of analytic methods very difficult; therefore, in spite of the stabilising mechanisms mentioned above, we cannot a priori be sure of its stability and the duration of the adjustment processes. Simulations may give us a better insight.

AMO–K has been used for many and varied long-term explorations of the future,\textsuperscript{30} during which the model has shown no instabilities, but on the contrary has proved suitable for policy-relevant analysis. Because of constraints on the length of this paper, policy simulations are not presented here. These can be obtained from the authors on request. To give an impression of the forecasting quality of the model, simulations of the past have been carried out; their results will be shown in the next section.

\textsuperscript{30} Cf. Den Broeder, Heijke and Den Koning (1983), and Den Broeder and Heijke (1984).
8.2 Simulation of the Past
To evaluate the results obtained with the model, fictitious 'forecasts' for the past have been compared with the observations of real developments. Two methods have been applied: first the year-to-year method or static simulation, with the realised exogenous and lagged endogenous variables forming each year's input values, and next the continuous method or dynamic simulation, which starts from realised exogenes and the lagged endogenes calculated for the previous period(s). These simulations have been carried out for the whole estimation period (1965–1979). The forecasting errors were expressed in Theil's inequality coefficient (THEIL), which makes the standard error less sensitive to level of the variable concerned by scaling it.

\[
THEIL = \frac{1/n \sum (\hat{y}_t - y_t)^2}{(1/n \sum y_t^2)^{1/2}}
\]

in which:
\(\hat{y}_t, y_t\) = forecast, realised value in year \(t\);
\(n\) = number of observations.
The Theil coefficient is always larger than or equal to 0, the value 0 indicating a perfect forecast.

Table 8.1 represents the forecasting qualities of some core variables of AMO-K by this criterion. As could be expected, the Theil coefficients are lower for the static than for the dynamic simulation. Just as obviously, they are much lower for level quantities than for balances and percentage mutations. The percentage development of employment and investments is forecast relatively poorly, as are the balance of the current account, migration and the vacancies for employees. For some important variables, the results of the dynamic simulation over the estimation period are illustrated in Fig. 8.1.
Figure 8.1 – Dynamic simulation over the estimation period
Figure 8.1 – Dynamic simulation over the estimation period – continued
<table>
<thead>
<tr>
<th>Level variables</th>
<th>Static simulation</th>
<th>Dynamic simulation</th>
</tr>
</thead>
<tbody>
<tr>
<td>employment with companies</td>
<td>0.008</td>
<td>0.018</td>
</tr>
<tr>
<td>employment of labourers</td>
<td>0.010</td>
<td>0.018</td>
</tr>
<tr>
<td>employment of employees</td>
<td>0.007</td>
<td>0.028</td>
</tr>
<tr>
<td>demand for labourers</td>
<td>0.014</td>
<td>0.022</td>
</tr>
<tr>
<td>demand for employees</td>
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<td>0.024</td>
</tr>
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<td>labour supply</td>
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</tr>
<tr>
<td>supply of labourers</td>
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<td>0.012</td>
</tr>
<tr>
<td>supply of employees</td>
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<td>0.019</td>
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<tr>
<td>students and trainees</td>
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<td>0.011</td>
</tr>
<tr>
<td>unfit for work</td>
<td>0.016</td>
<td>0.076</td>
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<td>Balance variables</td>
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<td>balance current account</td>
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<td>financing balance</td>
<td>0.121</td>
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</tr>
<tr>
<td>additions to stock</td>
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<td>0.168</td>
</tr>
<tr>
<td>migration balance</td>
<td>0.345</td>
<td>0.745</td>
</tr>
<tr>
<td>unemployment</td>
<td>0.131</td>
<td>0.191</td>
</tr>
<tr>
<td>unemployment among labourers</td>
<td>0.144</td>
<td>0.161</td>
</tr>
<tr>
<td>unemployment among employees</td>
<td>0.123</td>
<td>0.326</td>
</tr>
<tr>
<td>vacancies</td>
<td>0.193</td>
<td>0.296</td>
</tr>
<tr>
<td>vacancies for labourers</td>
<td>0.195</td>
<td>0.252</td>
</tr>
<tr>
<td>vacancies for employees</td>
<td>0.247</td>
<td>0.623</td>
</tr>
<tr>
<td>Percentage mutations</td>
<td></td>
<td></td>
</tr>
<tr>
<td>production cost</td>
<td>0.245</td>
<td>0.292</td>
</tr>
<tr>
<td>price of investment goods</td>
<td>0.128</td>
<td>0.151</td>
</tr>
<tr>
<td>consumption price</td>
<td>0.298</td>
<td>0.338</td>
</tr>
<tr>
<td>export price</td>
<td>0.152</td>
<td>0.157</td>
</tr>
<tr>
<td>price of buildings</td>
<td>0.188</td>
<td>0.237</td>
</tr>
<tr>
<td>price of government consumption</td>
<td>0.196</td>
<td>0.239</td>
</tr>
<tr>
<td>average wage of employed</td>
<td>0.176</td>
<td>0.230</td>
</tr>
<tr>
<td>wage of labourers</td>
<td>0.178</td>
<td>0.228</td>
</tr>
<tr>
<td>wage of employees</td>
<td>0.187</td>
<td>0.240</td>
</tr>
<tr>
<td>average disposable wage</td>
<td>0.219</td>
<td>0.283</td>
</tr>
<tr>
<td>minimum wage</td>
<td>0.161</td>
<td>0.207</td>
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<tr>
<td>labour productivity</td>
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<tr>
<td>employment</td>
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<td>1.023</td>
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<tr>
<td>production volume</td>
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<td>investment volume</td>
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<td>0.667</td>
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<tr>
<td>consumption volume</td>
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<tr>
<td>export volume</td>
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<td>0.234</td>
</tr>
<tr>
<td>import volume</td>
<td>0.237</td>
<td>0.289</td>
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</table>

a For some of the variables, data corrections made after the equation involved had been estimated, have led to a (slight) deterioration of the fit over the estimation period. More often, however, specification improvements resulted in lower Theil coefficients, especially for the dynamic simulation.
9 CONCLUSION

From exercises carried out with AMO-K it is clear that this model, though certainly amenable to improvements on many points, is operational for medium-term (and possibly long-term) simulations; indeed, even under extreme conditions the model remains stable and produces plausible results.

Because at this stage AMO-K contains no monetary sector, a special device must be used to reproduce adequately the effects of important changes in the government's financing balance of expenditures; clearly, therefore, extending AMO-K with a monetary sector, describing these effects, and endogenising the exchange rates in the process, is recommendable.

Another improvement would be to extend the distinction between labourers and employees to other variables in the model, to start with education and unfitness for work. In that way the potential supply of labour could also be split into the two groups, which would permit a far better description of the supply of labourers and employees.

The production block, too, can be much improved. A better description of the capacity-limiting role of labour and the substitution between labourers and employees are among the aspects to be envisaged. Moreover, the economic obsolescence condition could be upgraded, among other things by taking the price of new capital goods into account.

The development of frictions on the labour market has so far been described by simple time trends; however, research outcomes obtained meanwhile offer adequate handles for replacing these trends with explanatory factors.

Finally, the use of simultaneous estimation techniques for strongly interwoven parts of the model could bring about a marked improvement.

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31 For details we refer to Den Broeder and Heijke (1984).
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**Summary**

**A MODEL OF THE DUTCH LABOUR MARKET (AMO-K)**

So far, the labour market has not received any special attention from macro-econometric model builders. In this article an attempt has been made to describe the labour market in detail, paying attention to such important phenomena as the friction between labour supply and demand, the heterogeneity of labour, the dependence of labour supply on the labour-market situation, the Phillips mechanism and the impact of real wages on labour demand. To make it suitable for policy simulations, the model has been extended to a complete macro-econometric model, taking account of the fact that both labour and capital limit the production possibilities.