SERIE RESEARCH MEMORANDA

LABOUR PRODUCTIVITY SLOWDOWN AND
TECHNICAL PROGRESS:
An empirical analysis for the Netherlands

by F.A.G. den Butter

Research memorandum 1990-9

VRIJE UNIVERSITEIT
FACULTEIT DER ECONOMISCHE WETENSCHAPPEN
EN ECONOMETRIE
AMSTERDAM

LABOUR PRODUCTIVITY SLOWDOWN AND TECHNICAL PROGRESS:

An empirical analysis for the Netherlands

by F.A.G. den Butter

February 1990

Department of Economics
Free University
P.O. Box 7161
1007 MC Amsterdam
The Netherlands

LABOUR PRODUCTIVITY SLOWDOWN AND TECHNICAL PROGRESS: an empirical analysis for the Netherlands.

by F.A.G. den Butter*

1. Introduction.

Like most industrialized countries, the Netherlands experienced a remarkable slowdown of labour productivity growth in the last two decades. In the period 1952-1972 labour productivity growth of enterprises was on average 4.4% per year, whereas labour productivity growth in industry even amounted to a yearly average of 5.8%. The yearly averages of 2.4% and 3.9% respectively for the period 1973-1986 are in sharp contrast with those for the fifties and sixties.

This productivity slowdown is remarkable as it coincided with an increase of industry financed R & D expenditure in the majority of the OECD countries over the late seventies and eighties (see Soete, Verspragen, Patel and Pavitt, 1989). Moreover it defies the notion of rapid technological progress in the field of electronic computing and informational services (see e.g. Baily and Gordon, 1988). Therefore, the problem is sometimes referred to as the productivity (or Solow)-paradox. Numerous causes have been put forward, which may explain this paradox, such as a productivity decline of R & D expenditure -the number of patents per unit of R & D expenditure has fallen-, more government regulation because of environmental demands, a decline in the quality of management and even a decline of intelligence (see e.g. Fase, 1982 and Bishop, 1989). However, the quantitative impact of these various causes is very difficult to assess. Such assessment is often tried by means of growth accounting, i.e. by measuring the impact of the determinants of total factor productivity (see Maddison, 1987, for a survey). Total factor productivity is defined as that part of output growth which, according to a given specification of the production function, cannot be ascribed to the growth of labour and capital as production factors.

Total factor productivity has been associated with, or even identified as, technical progress. In case of a steady state growth and a clay-clay (or Leontief) technology with labour saving technical progress, which has been the centerpiece of modelling the supply side in Dutch macroeconomic policy models, the growth rate of technical progress is identical to labour productivity growth. In that case the determinants of total factor productivity are identified as causes for the decline of labour productivity growth. However, actual economic developments may deviate from steady state growth for quite a long time. This

* Professor of Economics and Head of ALERT (Applied Labour Economics Research Team), Free University, P.O. Box 7161, 1007 MC Amsterdam, The Netherlands. Excellent research assistance by H. Kramer is gratefully acknowledged.

is probably true for the Netherlands where the policy of wage restraint over the last 15 years has led to a lengthening of the life of capital goods and therefore to a (full capacity or structural) labour productivity growth which is below the growth rate of labour saving technical progress. As a matter of fact, the description of this very mechanism in the Dutch policy models has favoured a general consensus on the need for a policy of wage restraint in order to fight unemployment. Moreover, working time reduction, which has been another element of the employment policy, may have added to the discrepancy between the growth rates of technical progress and labour productivity.

This paper investigates the discrepancy mentioned above using a stylized policy model for the Netherlands, which contains, in a general specification, several elements of the Dutch modelling of productive capacity and labour demand by means of the Leontief technology. Within this framework, it gives a step by step analysis of the causes that make labour productivity growth differ from the rate of growth of technical progress. Although we do not test for changes in technical progress (as McHugh and Lane, 1987), we consider both the case of an exogenous 'manna from heaven' technical progress and the case of endogenous technical progress.

The next section gives a stepwise presentation of our modelling of productive capacity and labour demand. It starts with a simple steady state growth model. Successively all elements are added which may explain why the economy deviates from steady state growth. We call this a quasi-vintage approach. In section 3 we calculate how these successive deviations from steady state growth may lead to differences between the growth rates of technical progress and labour productivity. Section 4 looks at how endogenising technical progress affects the working of the model and the calculations on the discrepancy. Whereas sections 3 and 4 refer to a dynamic simulation (<u>ex post</u> prediction) over the period 1973-1986, section 5 looks further into the effects a wage restraint by means of an impulse or 'what if' analysis. A sensitivity analysis shows how the relationship between the labour productivity slowdown and the policy of wage restraint depends on crucial parameter values. Section 6 gives the conclusions of this paper and the scope for future research.

2. Modelling productive capacity and labour demand.

The use of the Vintaf-model by the Dutch Central Planning Bureau about 1975 marks a turning point in model based policy analysis in the Netherlands. The clay-clay vintage approach with embodied labour saving technical progress by Den Hartog and Tjan (1974, 1976) in this model shows that a rise of real wages exceeding the rate of technical progress has caused an increased scrapping of capital goods and hence reduced employment. The Classical policy prescription by this model is a moderation of wages in order to invert the process described above. This modelling of productive capacity and labour demand by a vintage approach has raised much discussion and has led to a ballooning of research on empirical vintage models for the Netherlands (see Den Hartog, 1984, for a survey). In spite of critical comments on the model raised in the discussion, it is nowadays clear that the vintage model and the mechanisms described by it have been instrumental in the general political acceptance of the policy of wage restraint in the Netherlands.

This paper uses a generalised version of a vintage approach for modelling productive capacity and labour demand. It is based on quarterly data. This approach incorporates various elements of the different specifications of the vintage model, but it does not explicitly model the vintages for each quarter separately. The advantages of this approach as compared to the usual vintage models are that its specification is much more flexible and that scrapping is not dependent on investment data over 60 quarters or more ago. Hence we do not need such long time series on investment. The main differences compared with the usual vintage models are that the present approach makes no explicit distinction between technical and economic obsolescence and that the distinction between embodied and disembodied technical progress depends on parameter values (see De Nederlandsche Bank, 1985, and Den Butter, 1987).

2.1 Simple growth model

We start with a simple growth model with Leontief technology and labour saving technical progress, which generates steady state growth. The model is given by equations (1-5) below.

(1) $$k = k_{-1} + i - k_a$$

(2) $$k_a = 0.015\ k_{-1}$$

(3) $$y^{nb} = (1/\kappa)\ k$$

(4) $$a^* = 0.018\ k\ e^{-\Sigma\mu/100}$$

(5) $$a = a^*$$

Equation (1) defines the capital stock as the capital stock in the previous period plus investment minus scrapping (the Annex contains a list of symbols). Equation (2) implies that in each quarter 1.5% of the capital stock of the previous quarter is scrapped. The value of this coefficient is, like all other coefficient values of this study, based on the empirical literature. In determining these values the outcomes of the Dutch policy models have played a prominent part. The selected scrapping percentage of 1.5 implies an average life of the capital stock of over 15 years. Equation (3) describes the proportionality between the capital stock and productive capacity of enterprises. The capital output ratio κ is set equal to 5. This relatively high value of κ is selected in order to let the data used in this study on production match with the data on cumulated investment. Equation (4) describes the fixed relationship between capital stock and full capacity labour demand. The amount of labour associated with the capital stock decreases in each quarter due to labour saving technical progress. In the basis variant of the model this percentage μ is set equal to 1.25, implying a yearly growth of technical progress of 5%. Instead of multiplication by a time trend we use the summation of μ in this equation so as to allow us to change the value of μ in the course of time. The coefficient value of 0.018 in equation (4) represents the reciprocal of investment costs per employee in the base year, which is 1970. The value of 0.018 assumes that in the base year an investment of about 55.000 guilders (prices of 1977) leads to an extra labour demand of one labour year. Finally, for the time being, equation (5) equates actual labour demand to full capacity labour demand.

2.2 Capital saving technical progress

The first step towards a more realistic modelling of productive capacity and labour demand is relaxing the assumption of a fixed capital output ratio by allowing for capital saving technical progress in equation (3').

$$(3') \qquad y^{nb} = (1/\kappa)\, k \; e^{\Sigma\mu'/100}$$

We have set μ' equal to -0.225, which implies a negative capital saving technical progress (or capital using technical progress) of 0.9 % per year.

2.3 Working time

Next we assume that the amount of working time influences the relationship between the capital stock and full capacity labour demand. (working time index h is 1 in base year 1970). The coefficient value of 0.5 in equation (4') assumes that working time reduction leads to an extra labour demand of 50% of that reduction.

$$(4') \qquad a^{*} = 0.018\,\{\, 1 + 0.5\,(1-h)\}\; k\; e^{-\Sigma\mu/100}$$

2.4 Real wages

Now we introduce the essential feature of the Dutch vintage models, namely the influence of real wage costs on scrapping and hence on labour demand. In equation (2') the percentage of scrapping is determined by the scrapping term c_{af}, which is defined in equation (6).

$$(2') \qquad k_a = 0.015\,(1 + 0.25\,[\mu - 1.25])\; c_{af}\; k_{-1}$$

with

$$(6) \qquad c_{af} = \{ 1 + 0.4 [\frac{(\dot{w}-\dot{p})_{av} - 4\mu}{4\mu}]\}$$

$$\text{where} \qquad (\dot{w}-\dot{p})_{av} = \tfrac{1}{4} \sum_{j=0}^{3} (\dot{w}-\dot{p})_{-j}$$

The scrapping term c_{af} is equal to 1 in case the growth rate of real wage costs is equal to the growth rate of labour saving technical progress. In that case we have steady state growth with a constant life of capital goods. However, in case real wage costs surpass the growth rate of technical progress, the scrapping term becomes larger than 1. Then more than 1.5 percent of the capital stock is scrapped in each quarter. This results in a shortening of the average life of the capital stock. When in periods of wage moderation the growth rate of real wage costs is lower than that of technical progress the model describes the opposite mechanism. Whereas in models with explicit vintages the influence of real wage costs on scrapping is determined by the specification of the vintage model and by the scrapping criterion, the present model describes this relation by a coefficient which has been set to the value of 0.4. This value implies a real wage elasticity of labour demand in the quasi-vintage block of about -0.5. Section 5 discusses a sensitivity analysis on the value of this coefficient.

In clay-clay vintage models with embodied technical progress a lower rate of technical progress leads to a longer economic life of capital goods in steady state growth. In order to take this mechanism into account equation (2') also contains a term which alters the percentage of scrapping if μ differs from its value of 1.25% of the basis variant. Calculations in Den Butter (1977, 1978) show that a decrease of μ with 1 %-point on a yearly basis leads to a lengthening of the life of capital goods of between ½ and 2 years. For that reason the relevant coefficient value in equation (2') is set equal to 0.25.

If the scrapping term c_{af} is greater than one and economic life of capital goods shortens, the capital stock becomes more efficient as compared to steady state growth in case of embodied labour saving technical progress. Therefore the relationship between the capital stock and full capacity labour demand in equation (4'') is modelled to be influenced by the cumulated differences of the scrapping term from unity.

$$(4'') \qquad a^{*} = 0.018 \{ 1 + 0.5 (1-h)\} k\, e^{-\Sigma\mu/100} . e^{-0.01\Sigma(c_{af}-1)}$$

The corresponding coefficient, which is set to the value of-0.01, describes the indirect substitution between capital and labour under a Leontief technology, in case the growth of real labour costs is too high or too low as compared to technical progress. Hence this coefficient value determines the extent to which labour saving technical progress is embodied or not

2.5 Real interest rate

Up to now only real labour cost determine the indirect substitution between capital and labour in this model. However, capital costs, represented by the real interest rate, may also be of importance in this respect. Therefore equation (6') adds a factor to the scrapping term which is greater than 1 when the real interest rate is below average and capital becomes relatively inexpensive, and lower than 1 in case of a relatively high real interest rate.

$$(6') \qquad c_{af} = \{ 1 + 0.4 [\frac{(\dot{w}-\dot{p})_{av} - 4\mu}{4\mu}]\}\{ 1- 0.015[(r-\dot{p}^{e})_{av} - (r-\dot{p}^{e})_{0}]\}$$

with $(r-\dot{p}^{e})_{av} = ¼ \sum_{j=0}^{3} (r-\dot{p}^{e})_{-j}$

and $(r-\dot{p}^{e})_{0}$ the average real interest rate over the reference period

Inclusion of the real interest rate in the scrapping criterion can be derived from microeconomic theory for profit maximizing producers under imperfect competition (see Malcomson, 1975, and Den Butter, 1976). According to this scrapping condition the economic life of capital goods increases with increasing real capital costs. This is because investment costs are made at the moment of instalment of equipment and carry a larger weight the higher is the discount rate for calculating the present value of future revenues. Calculations with a simple version of a clay-clay vintage model with embodied technical progress show that an increase of the real interest rate of 2 %-points leads to an increase of the life of capital goods of a about half a year. This rather small influence implies the coefficient value in equation (6') of 0.015.

2.6 Cyclical labour demand

According to equation (5') actual labour demand is set equal to full capacity labour demand minus that part of full capacity labour demand which is not employed due to underutilization of the capital stock.

$$(5') \qquad a = const + a^{*} - 0.5 (1 - ¼ \sum_{j=0}^{3} [y/y^{nt}]_{-j}) a^{*}$$

with $y^{nt} = y^{nb} . (y/y_{bn})$

The coefficient value of 0.5 assumes that, as compared to full capacity utilization, half of the labour associated with underutilization is laid off while the other half remains employed as cyclical labour reserve. In order to link the data on production by enterprises with national product, we define total productive capacity as productive capacity of enterprises multiplied by the exogenous ratio of national income and production by enterprises. The constant term in equation (5') is set equal to its mean value in the reference period, given the selected values of the coefficients in the quasi-vintage block. This makes labour demand as calculated by the vintage block on average equal to measured labour demand in the reference period. However, the calibration of the coefficient values and the validation of this block has been performed in such a way, that this constant term obtains a small value only.

2.7 Modelling the rest of the economy

We continue by endogenising the main explanatory variables of the quasi-vintage model introduced above (with the exception of technical progress, which will be made endogenous in section 4). Hereto we build the quasi-vintage model into a simple model of the Dutch economy which comprises all main characteristics of the macroeconomic models actually used in policy analysis in the Netherlands. Our model consists of the usual expenditure equations, wage and price equations, demand for money function, a labour supply equation, equations determining the supply of financial assets and an interest rate equation. Financial flows and stocks are modelled in a consistent way by means of the balance of payments identity, the budget restriction of the government and the macroeconomic budget restriction. For more details we refer to Den Butter (1990).

3. Discrepancy between technical progress and labour productivity.

This section describes how the productivity slowdown, or to be more precise, the discrepancy between the growth rates of technical progress and labour productivity in the reference period 1973-1986, can be explained by the consecutive steps of extending the model. To start with, table 1 and chart 1 give the actual data on labour productivity growth in the post war period. As mentioned in the introduction, labour productivity growth of enterprises has been much higher before the first oil crisis than thereafter. In the period 1980-1986 the average yearly growth rate has even fallen below 2%. Labour productivity growth in industry has traditionally been somewhat higher than that in enterprises, but the productivity slowdown also clearly appears from the data for industry.

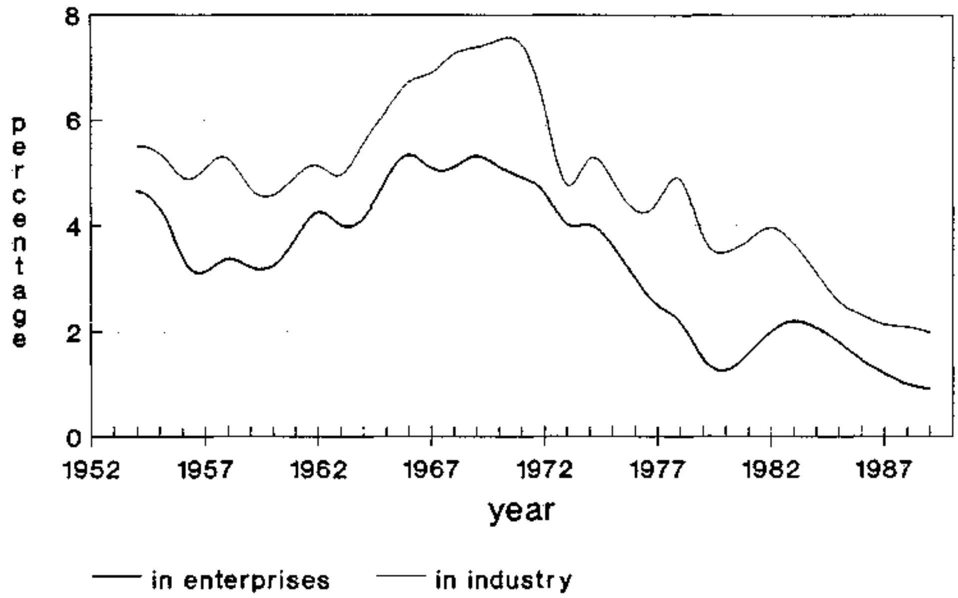
Table 1. Average labour productivity growth

in	period 1952-1988	1952-1972	1973-1986	1973-1979	1980-1986
enterprises	3.4	4.4	2.4	3.1	1.7
industry	4.9	5.8	3.9	4.8	3.0

Source: Central Planning Bureau

The yearly data of table 1 and chart 1 are constructed by the Central Planning Bureau (CPB), whereas our model is based on quarterly data derived from the National Accounts of the Central Bureau of Statistics (CBS). In spite of some differences due to definitions and sources, our data show the same pattern as regard to labour productivity growth as those of table 1 and chart 1. Therefore these differences are of no importance to our conclusions.

Chart 1. Labour productivity growth
(5 years moving averages)



Source: Central Planning Bureau

In table 2 we consider two measures of labour productivity growth which summarize the results of the simulations made with the various versions of our model. Firstly the table gives the average growth rates with respect to full capacity output (or structural growth rate) defined as

lpgfc = average growth rate of a/y^{nb}

Secondly the table presents the average labour productivity growth rate with respect to actual output:

$$\text{lpgao} = \text{average growth rate of } a/y^b \quad \text{with } y^b = y/(y/y_{bn})$$

Of course calculation of the labour productivity growth rates with respect to actual output only makes sense in case actual output plays a role in the models.

The first line of table 2 illustrates that the simple model generates steady state growth so that labour productivity growth is equal to the rate of labour saving technical progress which is, as mentioned in section 2, set equal to 5% per year over the whole reference period. When a negative capital saving technical progress of 0.9 % per year is introduced in the model, there still is steady state growth, with a yearly labour productivity growth rate of 4.1 %. The third line of table 2 shows the effects of the introduction of working time into the model. As working time reduction has been quite gradual over the reference period, the negative effects of working time reduction on labour productivity growth are about equal in both subperiods distinguished in table 2. Because of labour time reduction the average labour productivity growth, as measured by the model, has fallen to 3.8 %.

Table 2. Average labour productivity growth according to quasi-vintage models

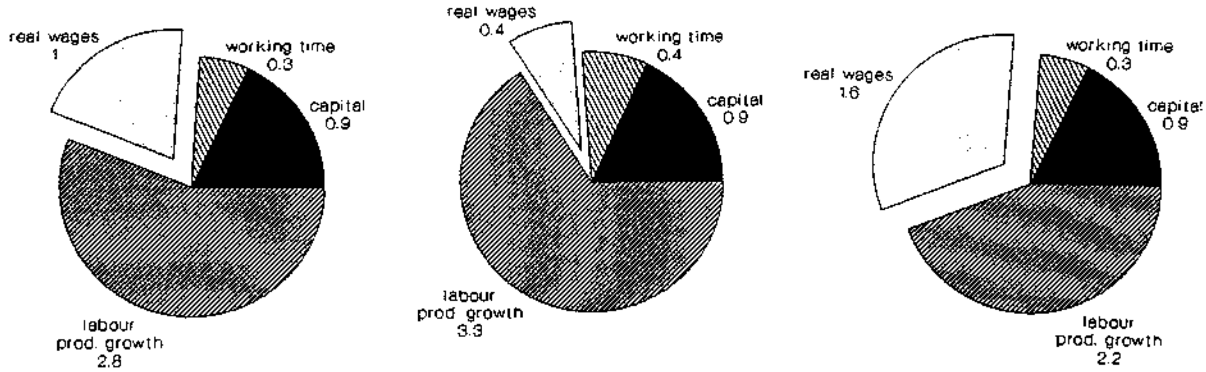
model	period 1973-1986 lpgfc	lpgao	1973-1979 lpgfc	lpgao	1980-1986 lpgfc	lpgao
1. simple growth	5.0	-	5.0	-	5.0	-
2. capital saving tech. progress	4.1	-	4.1	-	4.1	-
3. working time	3.8	-	3.7	-	3.8	-
4. real wages	2.8	-	3.3	-	2.2	-
5. real interest rate	2.7	-	3.2	-	2.3	-
6. cyclical labour demand	3.2	2.1	3.1	3.0	3.2	1.2
7. demand and monetary sector	3.1	3.1	2.7	4.1	3.5	2.3

Explanatory note: lpgfc: labour productivity growth with respect to full capacity output
lpgao: labour productivity growth with respect to actual output

Next table 2 looks at the effects of real wages on labour productivity growth. Line 4 of the table shows that over the whole reference period 1973-1986 the development of real labour costs accounts for about 1 %-point decline in average labour productivity growth. This effect appears to be considerably larger in the second subperiod 1980-1986. It indicates that wage moderation did, according to the model, indeed account for an important part of the productivity slowdown. It therefore shows that the productivity slowdown should not necessarily be associated with a decline of technical progress.

The results in line 5 of table 2 indicate that interest rate developments lead, on average, to no further decline of calculated productivity growth. Accordingly, a shortage of credit cannot be designated as an important argument for the productivity slowdown. From lines 6 and 7 of table 2 we see that the introduction of cyclical labour demand into the model as well as incorporating the quasi-vintage block into a full model does not lead to less labour productivity growth with respect to full capacity output either. However, it is remarkable that the average labour productivity growth with respect to actual output is much lower in the second subperiod than in the first subperiod. This can be ascribed to the cyclical slowdown at the beginning of the eighties and to the fact that the model does not reckon with scrapping because of excess capacity that took place in that period (see Gelauff <u>et al.</u>, 1985).

Chart 2. Causes of the discrepancy between the growth rates of labour saving technical progress and labour productivity.



1973-1986 1973-1979 1980-1986

Explanatory note: all simulations assume a constant growth rate of labour saving technical progress of 5%.

Chart 2 summarizes the main results on the productivity slowdown. It illustrates that the model ascribes a considerable part of the discrepancy between the growth rates of labour saving technical progress and labour productivity to three causes, namely negative capital saving technical progress, working time reduction, and real wage moderation. We recall that all calculations above are based on the assumption of a fixed labour saving technical progress of 5% per year. It is noticeable that the simulated average labour productivity growth according to chart 2 (and hence according to line 4 of table 2) appears to be quite in conformity with actual labour productivity growth of enterprises presented in table 1. It corroborates our conclusion that the three causes mentioned above are the main determinants of the productivity slowdown, and that is not necessarily a decline of technical progress growth which is at the root of the productivity slowdown.

4. Endogenous technical progress.

4.1 Modelling endogenous technical progress

The full quasi-vintage block of section 2 incorporates the main mechanisms which are at work when the economy moves from one steady state growth path to another. Such move will, for instance, occur in case of a change of the growth rate of labour saving technical progress, μ. This section investigates the consequences of changes in μ. Firstly we calculate the effects of a simple exogenous change of μ, which, in the period 1973-1976, is assumed to decrease gradually from a yearly average of 5% to 4%.

Next we endogenise the growth of labour saving technical progress μ in a similar way as in the FREIA-KOMPAS model of the Central Planning Bureau, which is at present used for policy analysis in the Netherlands (see Van den Berg et al., 1988). As a first step in our step by step analysis we consider equation (7) where the average growth rate of real income acts as the sole determinant of labour saving technical progress growth.

(7) $\mu = \text{const} + 0.3\ \dot{y}_{av}$

where $\dot{y}_{av}$: average growth rate of y over the past 5 years

In equation (7) the constant term const is set equal to the value which, over the reference period, makes the mean value of μ calculated by (7) equal to 5% on a yearly basis. The coefficient, which represents the influence of income growth, is given the value of 0.3, like in FREIA-KOMPAS (see Gelauff, 1986). The reason for making labour productivity growth dependent upon income growth is that income growth may lead to more R & D expenditure which, on its turn, enhances technical progress. The modelling of technical progress according to (7) is reminiscent of Verdoorn's Law which links output growth to labour productivity growth. Although Fase and Van den Heuvel (1988) find no causal relationship between these two growth rates and therefore conclude that endogenizing technical progress seems not to be necessarily warranted, the lack of causality in Verdoorn's Law can be due to the fact described in this paper: the growth rate of labour productivity may differ quite markedly from the growth rate of technical progress.

Secondly we consider equation (7') for endogenizing μ, where technical progress is determined both by income growth and by the growth rate of real wages corrected for working time.

(7') $\mu = const + 0.3\ \dot{y}_{av} + 0.3\ (\dot{w}_{av} - \dot{p}_{av} - 0.8\ \dot{h}_{av} - const')$

where $\dot{w}_{av}$: average growth rate of nominal wages over past 3 years

$\dot{p}_{av}$: average growth rate of prices over past 3 years

$\dot{h}_{av}$: average growth rate of working hours over past 3 years

The reason for including the latter determinant in the technical progress equation is that, in addition to direct or indirect capital-labour substitution, high real wage rates may induce extra efforts for introducing new labour saving techniques. The coefficient value of 0.3 has again been taken from the FREIA-KOMPAS-model; const' is set to the value that makes the mean of the term within parentheses in equation (7') equal to zero in the reference period.

4.2 Effects on the discrepancy, 1973-1986

Table 3. Average labour productivity growth with endogenous labour saving technical progress

model	period 1973-1986			1973-1979			1980-1986		
	μ	lpgfc	lpgao	μ	lpgfc	lpgao	μ	lpgfc	lpgao
7. exogenous μ (μ=5%)	5.0	3.1	3.1	5.0	2.7	4.1	5.0	3.5	2.3
8. declining μ (μ:5%->4%)	4.2	2.4	2.0	4.4	2.2	3.9	4.0	2.5	0.4
9. μ depends on income growth	5.2	3.3	3.3	5.2	2.9	4.3	5.2	3.6	1.6
10. μ depends on income growth and real wages	5.5	3.5	3.5	5.6	3.1	4.5	5.4	3.8	2.8

Explanatory note: μ: growth rate of labour saving technical progress
lpgfc: labour productivity growth with respect to full capacity output
lpgao: labour productivity growth with respect to actual output

Table 3 shows the effects of endogenizing technical progress on the growth rates of labour productivity as calculated by the models. Starting point is the full model of the last line of table 2 with a constant exogenous growth rate of technical progress of 5% per year. The second line in table 3 gives the outcomes when this growth rate is gradually reduced from 5 to 4 %. It is no surprise that this reduction of technical progress leads to a decline of labour productivity. However, the model generates second order effects with respect to actual labour productivity as the respective differences with the previous model are not consistently equal to 1%-point but vary over the subperiods.

The last two lines of table 3 illustrate that endogenizing technical progress has no systematic influence on the calculated value of labour productivity growth. This result suggests that the labour productivity slowdown in the Netherlands cannot be ascribed to an endogenous decrease of technical progress with income growth and real wages as determinants.

5. Effects of a wage restraint.

The outcomes in the previous sections are based on dynamic simulations of labour productivity growth, given the actual values of the explanatory exogenous variables in the reference period. In order to isolate the effects of the policy of wage restraint, this section looks at the impulse effects of a simulated wage restraint. To that end we simulate a permanent and autonomous 2 % reduction of the wage rate over the period of 24 quarters (6 years). The baseline projection is based on the values of the exogenous variables in the 4th quarter of 1986. The autonomous reduction of the wage rate starts in the first quarter of the simulation period. The effects of the reduction of wages are measured as differences from the baseline projection.

Table 4. The effects of an autonomous reduction of the wage rate of 2%.
(in % of the baseline projection)

on	according to 4.: growth model with real wages				6.: model with full quasi-vintage block				7.: full model with exogenous μ			
after	1qu	1yr	3yr	6yr	1qu	1yr	3yr	6yr	1qu	1yr	3yr	6yr
Income of enterprises (y^b)	-	-	-	-	-	-	-	-	-0.5	1.2	2.2	2.4
Labour demand (a)	0.1	1.0	1.5	1.3	0.1	0.9	1.1	1.0	0.0	1.4	2.6	2.4
Technical progress (μ)	-	-	-	-	-	-	-	-	-	-	-	-
Labour prod. full cap. (a/y^{nb})	-0.0	-0.4	-0.6	-0.6	-0.0	-0.3	-0.3	-0.4	0.0	-0.5	-1.1	-1.1
Labour prod. act. outp. (a/y^b)	(-0.1	-1.0	-1.5	-1.3)	(-0.1	-0.9	-1.1	-1.0)	-0.5	-0.2	-0.4	0.0

Table 4 reports the effects calculated with the version of the quasi-vintage model with real wages, the full quasi-vintage block and the full policy model with exogenous technical progress, respectively. The table shows that the 2% wage restraint induces a long run increase of labour demand of about 1% in the quasi-vintage block, whereas, due to multiplier effects, this increase amounts to about 2.5% in the full model. According to the indirect substitution mechanism described by the vintage model, structural labour productivity declines in case of a wage restraint. This decline appears to be larger when the impulse response is calculated by the full model than by the vintage block only. However, the wage restraint has, mainly because of the improvement of the competitive position, such a favourable cyclical effect on economic activity, that the decline of structural productivity is, at the end of the simulation period, fully matched by an increase of capacity utilization. Therefore there is no decline of actual labour productivity after 6 years. It should be noted that in the vintage block income of enterprises is exogenous so that in the left and middle parts of table 4 the decline of 'actual' labour productivity equals the growth of labour demand.

Table 5 gives a sensitivity analysis of the coefficient of scrapping with respect to real wage costs in equation (6') in the full policy model. This coefficient is set equal to the value of 0.4 in the basis version of the model. In the two alternatives this coefficient is given a value of 0.6 and 0.2 respectively. From the table it appears that the model's response to a wage impulse depends much on the value of this coefficient. When scrapping depends strongly on wage costs, a wage restraint causes the capital stock to be highly labour intensive as compared to the baseline. Therefore we see a huge increase of labour demand and, consequently, a decrease of structural labour productivity. On the other hand, the impulse response of economic activity does not depend much on the value of this coefficient as the labour intensity of production is not connected with the competitive position. For that reason the middle block of columns of table 5 also shows a large decline of actual labour productivity. When there is little scrapping associated with wage costs, the increase of capacity utilization due to the rise in demand outweighs the decline of structural labour productivity so that actual labour productivity increases in the long run. This is shown in the third block of columns of table 5.

Table 5. The effects of an autonomous reduction of the wage rate of 2%. (in % of the baseline projection)

on	according to 7.: full model with exogenous μ				7.: full model, coef. of scrapping 0.6				7.: full model, coef. of scrapping 0.2			
after	1qu	1yr	3yr	6yr	1qu	1yr	3yr	6yr	1qu	1yr	3yr	6yr
Income of enterprises (y^b)	-0.5	1.2	2.2	2.4	-0.5	1.2	2.3	2.3	-0.4	1.2	2.0	2.5
Labour demand (a)	0.0	1.4	2.6	2.4	0.1	2.0	4.4	4.0	-0.0	0.8	1.5	1.8
Technical progress (μ)	-	-	-	-	-	-	-	-	-	-	-	-
Labour prod. full cap. (a/y^{nb})	0.0	-0.5	-1.1	-1.1	0.0	-0.8	-1.7	-1.8	0.0	-0.3	-0.7	-0.8
Labour prod. act. outp. (a/y^b)	-0.5	-0.2	-0.4	0.0	-0.5	-0.8	-2.0	-1.7	-0.4	0.4	0.5	0.7

Table 6 gives the results of the impulse analysis in the versions of the models where technical progress is made endogenous. The first block of columns relates to the case, where technical progress depends on income growth only. In the second block of columns of table 6 the influence of income growth on technical progress is doubled as compared to the previous version of the model. Hence the respective coefficient is set to a value of 0.6. The third block of columns of table 6 relates to the version of the model were technical progress depends both on income growth and on real wage growth. In the last block of columns of table 6 the influence of real wages on technical progress is doubled as compared to the basis version of this model. Its coefficient is given the value of 0.6.

Table 6. The effects of an autonomous reduction of the wage rate of 2%.
(in % of the baseline projection)

on	according to 9.: μ depends on income				9.: idem, coef. of income 0.6				10.: μ depends on income and real wages				10.: idem, coef. of real wages 0.6			
after	1qu	1yr	3yr	6yr	1qu	1yr	3yr	6yr	1qu	1yr	3yr	6yr	1qu	1yr	3yr	6yr
Income of enterprises (y^b)	-0.5	1.2	2.2	2.6	-0.5	1.1	2.2	2.7	-0.5	1.1	2.1	2.3	-0.4	1.1	1.9	1.9
Labour demand (a)	0.0	1.4	2.4	1.9	0.0	1.3	2.1	1.2	0.1	1.7	3.4	3.0	0.2	2.0	5.0	5.5
Technical progress (μ)	-0.5	1.4	2.4	1.6	-1.0	2.7	4.7	3.5	-4.5	-5.1	-3.4	2.9	-8.9	-13.1	-12.8	0.3
Labour prod. full cap. (a/y^{nb})	0.0	-0.5	-0.9	-0.6	0.0	-0.4	-0.7	-0.1	-0.0	-0.7	-1.6	-1.4	-0.1	-0.9	-2.6	-3.0
Labour prod. act. outp. (a/y^b)	-0.5	-0.2	-0.2	0.7	-0.5	-0.2	0.1	1.5	-0.5	-0.5	-1.3	-0.7	-0.6	-0.8	-2.9	-3.4

All simulations of a wage restraint of this paper show that according to the full model the Keynesian fall in demand because of lower wages has a dominant influence on economic activity in the first quarter of the simulation period only. Thereafter the positive influence of the improvement of the competitive position and of the rise in labour demand on economic activity is much stronger so that total income rises. It implies that an income dependent technical progress also rises. This rise causes the capital stock to become less labour intensive than in case of exogenous technical progress. For that reason the long run increase of labour demand due to the policy of wage restraint is somewhat lower according to the model with income dependent technical progress than according to the model with exogenous technical progress. This is shown by comparison of the results in the first block of columns of table 6 with those in table 4 or 5. Now the negative effect of the wage restraint on structural labour productivity is smaller than with exogenous technical progress and the effect on actual labour productivity becomes positive after 6 years.

These effects are magnified when the dependence of technical progress on income growth becomes stronger. The results in the second block of columns of table 6 show that the effects of labour saving and less scrapping in case of a wage restraint almost compensate each other at the end of the simulation period, so that the decline of structural labour productivity is about nil as compared to the baseline. According to this version of the model actual labour productivity rises considerably on the long run because of the favourable demand effects of the wage restraint.

Things are somewhat more complicated when technical progress also depends on real wages. In that case a wage restraint leads to a decline of technical progress as compared to the baseline in the first part of the simulation period. This is illustrated by the third and fourth blocks of columns in table 6. As production is now much more labour intensive, the positive effects of a wage restraint on labour demand are larger than in case of exogenous technical progress. Accordingly, labour productivity is lower than with exogenous technical progress and even actual labour productivity now stays under baseline level. At the end of the simulation period, when technology has been fully adapted to the new level of wages, the positive influence of enhanced economic activity on technical progress again becomes of importance. That is why technical progress ends up above baseline level when it depends both on real wages and on income.

The results of table 6 show that endogenisation of technical progress has a substantial influence on the working of the model with respect to a policy of wage restraint. Whereas the effects on economic activity and on labour demand remain positive throughout, the relationship between wages and labour productivity fully depends on the modelling of technical progress.

6. Conclusions.

This paper shows that wage policy may partly explain the labour productivity slowdown in the Netherlands. More specifically, in the context of a vintage model with indirect and gradual substitution between labour and capital, a policy of wage restraint leads to a discrepancy between the rate of labour saving technical progress and labour productivity growth. We have calculated that in the reference period 1973-1986 wage moderation has accounted for a structural labour productivity growth which is on average 1%-point below the rate of labour saving technical progress. Moreover about 0.3%-points of the discrepancy mentioned above can be ascribed to working time reduction and another 0.9%-points to negative capital saving technical progress. Admittedly, the latter outcome follows immediately from our assumption on this type of technical progress. These calculations indicate that the labour productivity slowdown should not necessarily be associated with a decline of the growth of technical progress.

The main aim of this paper is to illustrate how the relationship between technical progress and labour productivity depends on the modelling of labour demand and productive capacity. We use a general specification which includes a number of mechanisms at work in various types of vintage models. The relative importance of these mechanisms can, in our specification, be steered by coefficient values. Hence, it allows us to perform a sensitivity analysis on the specification of the vintage model and on the assumptions on e.g. technical progress and scrapping implicit in the model. Impulse simulations show that assumptions on the following aspects are of crucial importance for measuring the effects of a policy of wage restraint on labour productivity:

- the type of technical progress (labour saving versus capital saving; embodied versus disembodied)
- the influence of real wage costs on scrapping (the scrapping criterion)
- endogenisation of technical progress

In spite of many different types of vintage models that have been constructed for the Netherlands, little reliable empirical knowledge is available on these assumptions. This is most probably due to the fact that the information content of macroeconomic data is to poor as to allow us to discriminate between these assumptions. To that end we would need more microeconomic information on production, technological development and labour demand.

References.

Baily, M.N. and R.J. Gordon, 1988, The productivity slowdown, measurement issues and the explosion of computer power, Brookings Papers on Economic Activity, Nr. 2, pp. 347-420.

Berg, P.J.C.M. van den, G.M.M. Gelauf and V.R. Okker, 1988, The FREIA-KOMPAS model for the Netherlands: a quarterly macroeconomic model for the short and medium term, Economic Modelling, 5, pp. 170-236.

Bishop, J.H., 1989, Is the test score decline responsible for the productivity growth decline?, American Economic Review, 79, pp. 178-197.

Butter, F.A.G. den, 1976, De optimale economische levensduur in een jaargangenmodel met een vaste kapitaalcoëfficiënt, Maandschrift Economie, 40, pp. 396-405.

Butter, F.A.G. den, 1977, De economische levensduur van kapitaalgoederen in een clay-clay jaargangenmodel, Maandschrift Economie, 41, pp. 205-231.

Butter, F.A.G. den, 1978, Toekomstscenario's voor meer werkgelegenheid, Maandschrift Economie, 42, pp. 433-451.

Butter, F.A.G. den, 1987, Model en Theorie in de Macro-economie (Stenfert Kroese, Leiden).

Butter, F.A.G. den, 1990, Macroeconomic Modelling and the Policy of Restraint in the Netherlands (Free University ,Amsterdam), mimeo.

Fase, M.M.G., 1982, Stagnerende groei: oorzaken en remedies, in Kiezen en Delen, Bedrijfskundige Opstellen over Desinvesteren, Herinvesteren en het Ombouwen van Organisaties (Kluwer, Deventer), pp. 9-20.

Fase, M.M.G. and P.J. van den Heuvel, 1988, Productivity and growth; Verdoorn's law revisited, Economics Letters, 28, pp. 135-139.

Gelauff, G.M.M., 1986, Het Capaciteitsblok van FK'85, CPB Onderzoeksmemorandum No. 16 (CPB, 's-Gravenhage).

Gelauff, G.M.M., A.R.M. Wennekers and A.H.M de Jong, 1985, A putty-clay model with three factors of production and partly endogenous technical progress, De Economist, 133, pp. 327-351.

Hartog, H. den, 1984, Empirical vintage models for the Netherlands: a review in outline, De Economist, 132, pp. 326-349.

Hartog, H. den and H.S. Tjan, 1974, Investeringen, Lonen, Prijzen en Arbeidsplaatsen, Occasional Paper No. 2, Central Planning Bureau, The Hague.

Hartog, H. den and H.S. Tjan, 1976, Investment, wages, prices and demand for labour (a clay-clay vintage model for the Netherlands), De Economist, 124, pp. 32-55.

Maddison, A., 1987, Growth and slowdown in advanced capitalist economies: techniques of quantitative assessment, Journal of Economic Literature, 25, blz. 649-689.

Malcomson, J.M., 1975, Replacement and the rental value of capital equipment subject to obsolescence, Journal of Economic Theory, 10, 24-41.

McHugh, R. en J. Lane, 1987, The role of embodied technological change in the decline of labor productivity, Southern Economic Journal, 53, pp. 915-924.

De Nederlandsche Bank N.V., 1985, MORKMON, A Quarterly Model of the Netherlands Economy for Macro-economic Policy Analysis, Monetary Monographs No. 2 (De Nederlandsche Bank N.V./ Martinus Nijhoff, Dordrecht).

Oulton, N., 1989, Productivity growth in manufacturing, 1963-85: the roles of new investments and scrapping, National Institute Economic Review, 127, pp. 64-75.

Soete, L., B. Verspragen, P. Patel and K. Pavitt, 1989, Recent Comparative Trends in Technology in the OECD Area (MERIT Research Paper, Maastricht).

ANNEX

C. List of symbols.

a	labour demand by enterprises
a^*	full capacity labour demand by enterprises
h	index number of hours worked in enterprises (1970=1) #
i	volume of gross fixed investments (enterprises)
k	volume of capital stock
k_a	scrapping of capital stock
p	price index of gross national product (1977=1)
$\dot{p}$	rate of inflation
$\dot{p}^e$	inflationary expectations
r	(long term) interest rate
w	wage level

$\dot{w}$ wage inflation

$\dot{w}^e$ expected wage inflation

y volume of (gross) national product

y/y_{bn} ratio of national product and production by enterprises #

y^b production of enterprises

y^{nb} productive capacity of enterprises

y^{nt} total productive capacity

κ capital output ratio #

μ labour saving technical progress #

μ' capital saving technical progress #

Summary

A step by step vintage modelling of productive capacity and labour demand, and a dynamic simulation over the period 1973-1986, indicate that the labour productivity slowdown in the Netherlands can for a large part be ascribed to various aspects of wage policy. Therefore, it is not necessarily true that a decline of technical progress growth has been at the root of this labour productivity slowdown. An impulse analysis shows that these conclusions depend on a number of crucial assumptions and parameter values of the vintage model. The influence of real wage costs on scrapping of old capital goods appears to be of major importance in this respect. The same holds for the question whether technical progress is endogenous or not.

1988-1	H. Visser	Austrian thinking on international economics
1988-2	A.H.Q.M. Merkies T. van der Meer	Theoretical foundations for the 3-C model
1988-3	H.J. Bierens J. Hartog	Nonlinear regression with discrete explanatory variables, with an application to the earnings function
1988-4	N.M. van Dijk	On Jackson's product form with 'jump-over' blocking
1988-5	N.M. van Dijk M. Rumsewicz	Networks of queues with service anticipating routing
1988-6	H. Linneman C.P. van Beers	Commodity Composition of Trade in Manufactures and South-South Trade Potential
1988-7	N.M. van Dijk	A LCFS finite buffer model with batch input and non-exponential sevices
1988-8	J.C.W. van Ommeren	Simple approximations for the batch-arrival $M^X/G/1$ queue
1988-9	H.C. Tijms	Algorithms and approximations for bath-arrival queues
1988-10	J.P. de Groot H. Clemens	Export Agriculture and Labour Market in Nicaragua
1988-11	H. Verbruggen J. Wuijts	Patterns of South-South trade in manufactures
1988-12	H.C. Tijms J.C.W. van Ommeren	Asymptotic analysis for buffer behaviour in communication systems
1988-13	N.M. van Dijk E. Smeitink	A non-exponential queueing system with batch servicing
1988-14	J. Rouwendal	Existence and uniqueness of stochastic price equilibria in heterogeneous markets
1988-15	H. Verbruggen	GSTP, the structure of protection and South-South trade in manufactures
1988-16	Mevr. H. Weijland Mevr. R. Herweijer J. de Groot	Female participation in agriculture in the Dominican Republic
1988-17	N.M. van Dijk	Product Forms for Random Access Schemes
1988-18	A.H.Q.M. Merkies I.J. Steyn	Adaptive Forecasting with Hyperfilters
1988-19	J. Rouwendal	Specification and Estimation of a Logit Model for Housing Choice in the Netherlands
1988-20	J.C.W. van Ommeren R.D. Nobel	An elementary proof of a basic result for the GI/G/1 queue