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A macroeconometric disequilibrium model of product market and labour market for The Netherlands

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I. INTRODUCTION

For years empirical macroeconomic models have contained disequilibrium elements, but their theoretical foundation is usually elaborated poorly. Conventional macroeconomic theory lacks the refinement to deal with (short-term) constraints to adjustment. The new disequilibrium macro theory, in principle, offers the theoretical base for the required differentiation between planned variables and realized variables, but up till now this differentiation is hardly implemented in overall empirical model building. This is not surprising. Conventional macro theory mainly deals with planned variables. The explanation of observed variables additionally requires macroeconomic theories to describe dynamic adjustment in different markets to price and nonprice constraints. Such theories are not well developed. Moreover, the econometrics of disequilibrium are rather complicated. This sets practical limits to the size and the structure of the disequilibrium model to be estimated. Consequently there is room for relatively simple disequilibrium approaches that link up with the empirical macroeconomic tradition as a first step towards a full integration of disequilibrium analysis in macroeconometric model building.

This article describes such an approach, focussing on the interaction between the goods market and the labour market. The full description of the decision processes, governed by prices as well as by nonprice constraints in both markets, may call for numerous stages, but for practical reasons our model concentrates on a limited number of these. The first stage describes notional variables, linking up with theories that explain plans when mainly price constraints are relevant. The second (*ex ante*) stage describes spillovers between both markets and effective supplies and demands. Finally, the realized or *ex post* stage refers to actual observations.

A crucial simplification is that *ex ante* shortages in the product market are supposed to lead to such spillovers in foreign trade that domestic product demand is fully met. Domestic product demand is therefore treated as exogenously determined. Demand for domestically produced goods then follows from the specified export and import demand relations. Notional domestic product supply and labour demand are determined by profit-maximizing producers that are subject to labour adjustment costs and short-run diminishing returns to scale. Effective labour demand follows by taking into account possible constraints on the goods market and effective

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product supply follows from the production function because of the quasi-fixed nature of the labour stock. Demand pressure then partly translates into decreased exports and partly into increased imports. Since consumers are not rationed on the goods market by assumption, the labour supply equation contains no spillover effect.

In line with other empirical disequilibrium studies basically we assume that the link between effective supply and demand and actual transactions is provided by the voluntary trade condition stating that transactions are equal to the minimum of supply and demand. The stochastic specification of the model follows the Ginsburgh–Tishler–Zang (GTZ) approach to add a disturbance term to the transactions function, schematically as follows:

$$x = \min(x_s, x_d) + u \tag{1}$$

where x_s and x_d are (deterministic) effective supply and demand and u is a random variable (Tishler and Zang, 1979; Ginsburgh *et al.*, 1980). Equation 1 is a special case of the Maddala–Nelson (MN) specification

$$x = \min(x_s + u_s, x_d + u_d)$$

where the disturbances u_s and u_d of supply and demand are incorporated in the transactions function. The likelihood function in the MN specification is, however, much more complicated, which hinders its application especially to multimarket disequilibrium models (for a discussion of some of these problems, see Kooiman and Kloek, 1980). The GTZ approach also poses some problems, however. Because the specification of Equation 1 results in a likelihood function that is nondifferentiable in the parameters of the equations determining x_s and x_d, Tishler and Zang (1979) propose to smooth the minimum function in Equation 1 on a (small) strip $(x_s - x_d) < \varepsilon$ to be able to use a computationally efficient optimization technique (see also Sneessens, 1981). Ginsburgh *et al.* (1980) suggest as an alternative smoothing method the approximation

$$\min(x_s, x_d) \simeq (x_s^{-\rho} + x_d^{-\rho})^{-1/\rho}$$

for large ρ, which method has also been used by Vilares (1982). In our study we employ a variant of the second method, of the form:

$$x = [\delta x_s^{-\rho} + (1-\delta) x_d^{-\rho}]^{-1/\rho} \tag{2}$$

which is the generalized harmonic mean (or CES function), for a suitable value of ρ.

Apart from its computational convenience, our choice of the CES approximation can be based on a second consideration concerning the occurrence of market-tension related unobservable variables. If nonprice trade conditions fluctuate with the tension in the market we may expect the effective price of the commodity or service traded to be higher than the observed price if sellers are on the short side of the market and lower if sellers are on the long side. This will tend to diminish the gap between supply and demand and cause a smoother transition between regimes than would occur on the basis of the notional demand curves. The minimum of the resulting 'actual' supply and demand curves will thus resemble the CES specification in Equation 2 (see Fig. 1 below).

Another approach to the modelling of disequilibrium transactions, which results in a smooth transactions function at the macrolevel, has been proposed by Hansen (1970) and Muellbauer (1978). In these theories a macromarket consists of a large number of micromarkets in each of

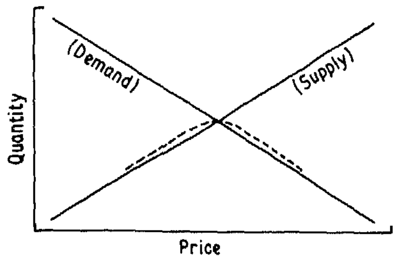

Fig. 1. Transactions curve (CES-approximation).

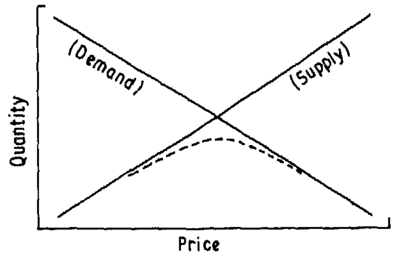

Fig. 2. Transactions curve (aggregated).

which transactions are equal to the minimum of supply and demand. This implies that aggregate transactions will lie below the minimum of aggregate supply and demand with the largest difference occurring if the proportion of markets on either side is equal (Fig. 2). Muellbauer (*op. cit.*) has shown that for an appropriate distribution of supply and demand over micromarkets the resulting expression for aggregate transactions is the same as the expression for expected transactions in the MN model, which can therefore also be read from Fig. 2.

In this study the smoothed minimum transactions function (Equation 2) is applied to the labour market and the goods market. Similar two-market empirical disequilibrium models have been estimated by Vilares (1982) for the Portuguese economy and by Sneessens (1983) for the Belgian economy. A two-market study for the Netherlands using the MN approach is presented in Kooiman and Kloek (1980). Batchelor (1977) uses the aggregation approach to incorporate demand pressure variables in a model of UK exports and export pricing. Muellbauer and Winter (1980) extend this approach to the labour market.

II. THE MODEL

The first 21 equations of this section describe the model. The following general notation conventions are used:

$X_{-i} \equiv X(t-i)$ (i-period lag)

$\hat{X} \equiv (X - X_{-1})/X_{-1}$ (relative change)

$$\mathring{y}_d = \omega_1 \mathring{g}_d + \omega_2 \mathring{b}_d - \omega_3 \mathring{m}_d \tag{3}$$

$$\mathring{g}_d = \mathring{g} \tag{4}$$

$$\mathring{b}_d = (1-\theta_b)(\beta \mathring{m}_w + \varepsilon(\mathring{p}_b - \mathring{p}'_b)_{-\theta}) + \theta_b(\mathring{b}_d)_{-1} \tag{5}$$

$$\mathring{m}_d = \mathring{y}_d + \alpha_m n_{b_{-1}} + \eta \mathring{p}_{F_{-\theta}} + \lambda_y \mathring{y}_{la} \tag{6a}$$

$$\ln p_F = \rho \tanh\left[\frac{1}{\rho} \ln\left(\frac{p_m/p_y}{p_E}\right)\right] + \ln p_E \tag{6b}$$

$$\mathring{p}_E = \pi(\mathring{p}_m - \mathring{p}_y) + (1-\pi)(\mathring{p}_E)_{-1} \tag{6c}$$

$$(\mathring{p}_m - \mathring{p}_y) = (\mathring{p}_E)_{-1} + u_5 \tag{6d}$$

$$\mathring{b} = \mathring{b}_d + \gamma_b u_y(\mathring{y}_d - \mathring{y}_s) + u_2 \tag{7}$$

$$u_y = \left[1 + \left(\frac{y_s}{y_d}\right)_{-1}^{\rho_y}\right]^{-1} \tag{8}$$

$$\mathring{m} = \mathring{m}_d + \gamma_m u_y(\mathring{y}_d - \mathring{y}_s) + \lambda_y \mathring{y}_{la} + u_1 \tag{9}$$

$$\mathring{y} = \omega_1 \mathring{g} + \omega_2 \mathring{b} - \omega_3 \mathring{m} \tag{10}$$

$$y_t^* = \frac{1}{\kappa_t} \sum_{\tau=v_t}^{t-1} e^{-\delta(t-1-\tau)} I_\tau \tag{11}$$

$$L_t^* = \frac{1}{\kappa_t} \sum_{\tau=v_t}^{t-1} \lambda_{t,\tau} e^{-\delta(t-1-\tau)} I_\tau \tag{12}$$

$$\kappa_t = \kappa_0 h_t^{\chi_1} \tag{13}$$

$$\lambda_{t,\tau} = h_t^{\chi_2} \lambda_0 e^{\alpha_0(\tau-1950)} \qquad \tau \leqslant 1950 \tag{14a}$$

$$\lambda_{t,\tau} = h_t^{\chi_2} \lambda_0 e^{\alpha_1(\tau-1950)} \qquad \tau \geqslant 1950 \tag{14b}$$

$$\lambda_{t,v_t^*} = \frac{p_{y_t}}{w_t h_t^{\chi_2}} \tag{15}$$

$$\Delta v = \zeta(v^* - v_{-1}) \tag{16}$$

$$L_n = L_{-1}(L^*/L_{-1})^{\theta_l} \tag{17a}$$

$$y_n = y^*(L_n/L^*)^{\xi_l} \tag{17b}$$

$$L_d^* = L^*(\min(y^*, y_d)/y^*)^{1/\xi_l} \tag{18a}$$

$$L_d = L_{-1}\left(\frac{L_d^*}{L_{-1}}\right)^{\theta_l} \tag{18b}$$

$$L = [0.5 L_d^{-\rho_l} + 0.5(vL_s)^{-\rho_l}]^{-1/\rho_l} \cdot e^{u_3} \tag{19}$$

$$y_s = y^*\left(\frac{L}{L^*}\right)^{\xi_l} \tag{20}$$

$$L_s = aN - L_g \tag{21}$$

$$\ln\left[-\ln\left(\frac{a}{a_{\max}}\right)\right] = \varepsilon_2 \ln\left[-\ln\left(\frac{a_{-1}}{a_{\max}}\right)\right] + (1-\varepsilon_2)\left[\varepsilon_0 + \varepsilon_1 \ln\left(\frac{w}{p_c h}\right)\right] \tag{22}$$

$$\hat{L}_r = \nu L_s \delta_s \left((L_d/\nu L_s)^{\rho_s} - 1\right) / \left((L_d/\nu L_s)^{\rho_s} + 1\right) \tag{23a}$$

$$\ln L_r - \ln(L_r)_{-1} = \ln \hat{L}_r - \ln(\hat{L}_r)_{-1} + u_4 \tag{23b}$$

Equations 3–10 determine notional product demand (y_d) and actual transactions (y) in the product market if notional supply (y_s) is–for the time being–considered as given. A major simplification is that *ex post* domestic demand, including the net exports of services, (g), equals notional domestic demand (g_d) (Equation 4), an assumption which may not be unrealistic for a very open economy. It implies that domestic pressure effects are limited to exports (b) and imports (m) of goods. The *ex ante* shares ω_1, ω_2 and ω_3 in Equation 3 are taken to be equal to their *ex post* values used in Equation 10. The simplification concerning domestic demand also implies that notional product demand is equal to effective product demand, since spillovers from the labour market are excluded.

Notional exports of goods are determined by a geometric lag on their normal level; the latter is related to conventional demand variables: world imports (m_w) and the ratio of Dutch export prices (p_b) to foreign export prices (p_b'), with a distributed lag, denoted by $-\theta$ (Equation 5). After some experimentation we decided on the following form:

$$p_{-\theta} = 0.4\,p + 0.3\,p_{-1} + 0.2\,p_{-2} + 0.1\,p_{-3}.$$

Similarly, notional imports of goods (m) depend on notional (= effective) product demand (y_d), agricultural production, which represents largely weather-determined harvest fluctuations that affect domestic supply, and the ratio of import prices (p_m) to the price of domestic output (p_y) (Equation 6a), using the same lag structure. Additionally, we took account of stock fluctuations and included one year lagged inventory formation as a percentage of last year's sales (n_b) in deviation from its average value because stocks constitute a short-term substitute for imports. We assume that the substitution effects caused by extreme unexpected (oil) price changes take a relatively long time. This assumption is implemented in two steps. The first implies a (geometrically) lagged adjustment of the expected price ratio (p_E) to the actual ratio (p_m/p_y) (Equation 6c). Next, because we assume short-term substitution possibilities to be bounded, the effective ratio p_F is taken to vary between about $1 \pm \rho$ times the expected ratio (Equation 6b); both ratios are nearly equal if the actual ratio is close to the expected ratio, but the effective ratio is bigger (smaller) if the actual ratio is bigger (smaller) than the expected ratio. In the long-run the effective price ratio is equal to the actual price ratio, because expectations converge. By demanding that these expectations minimize the prediction error one period ahead we obtain Equation 6d, where u_5 is an uncorrelated random variable.

The impact of pressure of demand on exports (Equation 7) and imports (Equation 9) is controlled by the pressure parameter u_y (Equation 8). Because $u_y \simeq 1$ for $y_s < y_d$ and $u_y \simeq 0$ for $y_s > y_d$, we see that the demand pressure terms are only operative in excess demand situations, in which case export demand is rationed and imports are increased to meet domestic demand. Actual production follows from the accounting identity (Equation 10). The goods market transactions function implicit in the foreign trade equations can be derived as follows. Using

Equations 3, 4 and 10 we obtain

$$\mathring{y} - \mathring{y}_d = \omega_2(\mathring{b} - \mathring{b}_d) - \omega_3(\mathring{m} - \mathring{m}_d)$$

Inserting Equations 7 and 9 gives

$$\mathring{y} = (\omega_3\gamma_m - \omega_2\gamma_b)u_y\mathring{y}_s + (1 - (\omega_3\gamma_m - \omega_2\gamma_b))u_y\mathring{y}_d + \omega_2 u_2 - \omega_3 u_3$$

which is approximately the logarithmically differentiated form of Equation 2 with $\delta = \omega_3\gamma_m - \omega_2\gamma_b$. Effective product supply (y_s) entering these trade relations is determined in the producers' model discussed below (Equations 11–18).

Capacity employment and capacity production are determined by the available capital stock in a clay–clay technology. This technology is based on labour saving embodied technical progress, at a yearly rate α_1 from 1950 onwards and a (smaller) rate α_0 before 1950, combined with exponential technical deterioration (at a rate δ). The current capital–output ratio κ and the labour–output ratio of vintage t at year t, $\lambda_{t,t}$ follow from the basic assumptions, supplemented by corrections for changes in contractual working hours (h) in Equations 13 and 14 (the index 0 refers to a base year). A decrease in contractual working hours is assumed to cause some increase in labour productivity per hour. The labour–output ratio in terms of man years (λ) therefore increases less than proportionally with a reduction in contractual working hours. Such reductions will also increase the capital stock per unit of output, κ, as both capital operating time and capital efficiency are affected.

The factor–output ratios applied to investment in enterprises, (I), and summed over vintages τ starting from the oldest vintage in use in year t, (v_t), determine the long run target values of notional product supply and labour demand or, for short, capacity output (y^*) and capacity employment (L^*) in Equations 11 and 12 respectively. Investment is an exogenous variable in the model, but the capital stock is not, because economic obsolescence is endogenous. Using a standard short-run profit maximization criterion we obtain the familiar result that capital goods are scrapped if the relevant labour costs are equal to the associated gross revenue, or in symbols:

$$L^*_{t,v_t^*} \cdot w_t = y^*_{t,v_t^*} \cdot p_{y_t}$$

where v_t^* is the marginal vintage at time t, w the wage rate and p_y the output price. The implied equality of the real wage rate and labour productivity at the oldest vintage, and the evaluation of the latter by means of Equation 14, lead to an expression from which v_t^* can be solved (Equation 15). We assume a gradual adjustment of the actual scrap decision to that value (Equation 16).

If labour availability differs from capacity employment, not all capital goods can be manned according to the above criterion. This consideration determines the basic form of our short-run production function:

$$y/y^* = (L/L^*)^{\xi_t} \tag{24}$$

Different assumptions can be made with respect to the elasticity ξ_t. One alternative is that all vintages are utilized proportionally. In that case ξ_t is 1 for all t. Another alternative, which was adopted here, is an optimal distribution of production over vintages, also in the short run. Then the marginal labourer will just produce the value of his wage. In this case the elasticity can be approximated by the ratio between marginal and average labour productivity at capacity employment:

$$\xi_t = \left(\frac{w \cdot L^*}{p_y y^*} \cdot h^{\chi_2} \right)_t \tag{25}$$

This capital-utilization assumption applies both in the derivation of notional labour demand and product supply (Equations 17a, b) and the target level of effective labour demand (L_d^*) (Equation 18a). The former equations arise from the gradual adjustment of the optimal employment level towards its long-run target, whereas the latter equation implies that firms try to man their capital goods in such a way that the effective output supply is equal to notional product demand if the latter is lower than capacity output, and equal to capacity output otherwise. Effective labour demand itself (L_d) adjusts again gradually to its target level (Equation 18b). Actual employment follows from the confrontation of effective labour demand (L_d) and effective labour supply (L_s) in Equation 19, the form of which was discussed in the preceding section; an error term $\exp(u_3)$ is added. Effective product supply is found by inserting actual employment in the short-run production function (Equation 24), which gives Equation 20.

We assume that labour-force participation depends on past and present real wages. In addition we include a 'saturation' level of labour-force participation, $a_{\max}$, to represent the idea that physical and sociological factors constitute an upper boundary to the participation rate a. The form we have chosen is:

$$\frac{a}{a_{\max}} = \exp\left[-e^{\varepsilon_0} \left\{ \prod_0^{\infty} (x_{t-i})^{\varepsilon_1 \varepsilon_2^i} \right\}^{(1-\varepsilon_2)} \right]$$

in which $x = w/(p_c h)$ (the real wage per hour). We take logarithms twice and apply a Koyck-transformation to obtain Equation 22. The participation rate is multiplied by the working age population (N) and the result is diminished by government employment L_g to get labour supply available to firms (L_s) in Equation 21, which in view of the spillovers from the product market to labour supply equals effective labour supply. Registered labour supply (L_r) in Equation 23 is basically a fraction of employable notional labour supply. This fraction is governed by the ratio between notional labour demand (L_d) and the employable notional supply (νL_s); the maximum possible discouraged-worker effect is equal to $\delta_s \nu L_s$, as can be seen by letting $L_d/\nu L_s \to 0$; the discouraged-worker effect at labour market equilibrium is $\frac{1}{2}\delta_s \rho_s L_d$.

Our model contains two spillovers between product market and labour market, the effects of a difference between product demand and capacity output on labour demand (Equation 18a) and the effects of relative labour availability on product supply (Equation 8). The spillover from labour demand to product demand does not occur since domestic demand is exogenous and the spillover from the goods market to labour supply is absent since the small-economy assumption ensures that consumers are never rationed in the goods market. The specification of the business sector in this model implies that firms are off their production function if $y_d < y_s$, since then actual production is equal to demand, which does not conform to Equation 20. This implies necessarily that the labour stock is not fully utilized and, consequently, in addition to the standard regimes – Keynesian ($y_s > y_d$, $L_d < L_s$), repressed inflation ($y_s < y_d$, $L_d > L_s$), and classical ($y_s < y_d$, $L_d < L_s$) – also the underconsumption regime ($y_s > y_d$, $L_d > L_s$) may occur.

The excess supply of goods implies however that employment is larger than desired and this regime is therefore necessarily transitory since the adjustment of the labour stock by the firms will bring the economy either into a situation of repressed inflation or into a situation of Keynesian unemployment, depending on the relative magnitudes of the disequilibria in both markets.

III. ESTIMATION

The present model is estimated by means of full-information maximum likelihood, in contrast to earlier submodels it integrates (Siebrand, 1972; Lenderink and Siebrand, 1976) that were estimated by an iterative OLS method.

The model yields in total four equations to be estimated, marked by a disturbance term (u_i, $i = 1, \ldots, 4$). Exports (b) and imports (m) were estimated in log differences, according to Equations 7 and 9 respectively. Employment (L) and effective labour supply (L_r) were estimated in logarithms according to Equations 18 and 22 respectively, the last of which is based on a generalized difference scheme. The other observable variable, production (y), is implicitly determined by the accounting identity (Equation 10).

The error terms $u_i(t)$ are assumed to be normally distributed with the following covariance structure

$$E\{u_i(t)u_j(\tau)\} = \sigma_i^2 \qquad t = \tau,\ i = j$$
$$= 0 \qquad \text{otherwise} \tag{26}$$

Because the model is recursive the concentrated likelihood function of the model is proportional to:

$$L \propto \left\{ \prod_{i=1}^{4} \sum_{t=1}^{T} u_i^2(t) \right\}^{-T/2} \tag{27}$$

The parameter estimates given below are maximum-likelihood estimates with respect to Equation 27; the (asymptotic) covariance matrix Ω of these estimates is computed from

$$\hat{\Omega} = \sum_{i=1}^{4} \{G_i' G_i / \hat{\sigma}_i^2\}^{-1}$$

where $\hat{\sigma}_i^2 = \frac{1}{T} \sum_{t=1}^{\hat{T}} u_i^2(t)$

and G_i is the jacobian of $(u_i(1), \ldots, u_i(T))'$ with respect to the parameter vector.

The initial value of the (unobservable) notional participation rate $a(0)$ was set at 0.4475, compared to an (observed) *ex post* value of 0.4425. The constant ε_0 in the labour supply proved to be badly determined locally, and for computational reasons was fixed *a priori* at the value at which the notional participation ratio in period 0 coincides with its long-run equilibrium value, i.e.

$$\varepsilon_0 = \ln(-\ln(a(0)/a_{\max})) - \varepsilon_1 \ln(w(0)h(0)/p_c(0))$$

The maximum value a_{max} also turned out to be weakly determined in preliminary estimations; therefore it was fixed at 0.70, about the value of its preliminary estimates. The required starting value for p_E was taken to be equal to that of p_m/p_y.

Next to these initial values, some parameter values were fixed *a priori*. These values are followed by a bar (–) in Table 1. The parameters ρ_y and ρ_l were set at a high value to give a satisfactory approximation to the minimum-transactions hypothesis. The *a priori* value for v amounts to a 'frictional' unemployment rate of 1.5 %. The values for χ_1 and χ_2 were fixed as in den Hartog and Tjan (1976); that for χ_1 can be interpreted as implying a minor increase in shift work as a result of a reduction in contractual working hours, that for χ_2 implies that such a reduction in working hours induces some increase in labour efficiency.

The sample period is 1954–1976. The parameter estimates and their asymptotic standard errors are presented in Table 1. Table 2 presents the corresponding error statistics.

Judged by the error statistics in Table 2, the explanation of the data offered by the model is satisfactory. Regarding the parameter estimates in Table 1, most parameters are highly significant and of plausible magnitude. Note in particular the pronounced effects of demand pressure on imports (γ_m) and exports (γ_b). In the production block estimated we may note the low value of δ. This value assigns only a small part of total capacity decay to technical deterioration, leaving the larger part to economic scrap, which is implemented with a mean lag

Table 1. *Parameter estimates*

Demand block			Production block			Labour market		
α_m	−2.34	(0.68)	χ_1	−0.75	(–)	ε_1	−0.076	(0.055)
η	−1.21	(0.16)	χ_2	−0.75	(–)	ε_2	0.518	(2.8)
λ_y	−0.068	(0.05)	δ	0.044	(0.01)	α_{max}	0.7	(–)
ρ	0.267	(0.21)	α_0	0.0047	(0.003)	δ_s	0.058	(0.025)
γ_m	0.490	(0.15)	α_1	0.056	(0.003)	ρ_s	7	(–)
π	0.127	(0.09)	λ_o	0.097	(0.006)	v_s	0.985	(–)
β	1.044	(0.06)	κ_o	0.809	(0.09)	θ_l	0.299	(0.14)
ε	−0.729	(0.32)	ζ	0.277	(0.06)	ρ_l	30.	(–)
θ_b	0.339	(0.17)						
ρ_y	30.	(–)						
γ_b	−0.495	(0.22)						

Table 2. *Error statistics*

Equation (number)	Durbin–Watson	$\hat{\sigma}_u$	R^2
Price forecast (6d)	1.83	0.0601	0.94
Exports (7)	1.70	0.0223	0.77
Imports (9)	1.88	0.0172	0.93
Employment (19)	1.41	0.0047	0.999
Labour Supply (23b)	2.24	0.0032	0.67

of three years, according to the estimated value of ζ. The adjustment speed θ_l of the labour stock is also fairly low, with a mean lag of five years. The estimate of δ_s implies that, starting from labour market equilibrium, a one per cent decrease in labour demand will lead to $\frac{1}{2}\delta_s \rho_s = 0.20\%$ decrease in labour supply.

A further test on the model is provided by considering the model forecast errors one year ahead, over the post-sample period 1977–1981.

The forecast error of the exports, imports, and labour supply equation are well in line with the estimates within the sample period, but those of the employment equation are less satisfactory. The slowdown in productivity growth that began in these years is not completely tracked by the

Table 3. *Model forecast errors over 1977–1981*

	Mean error	Root mean square error
Price forecast	0.051	0.088
Exports	−0.009	0.025
Imports	−0.001	0.026
Employment	0.010	0.012
Labour Supply	−0.003	0.007

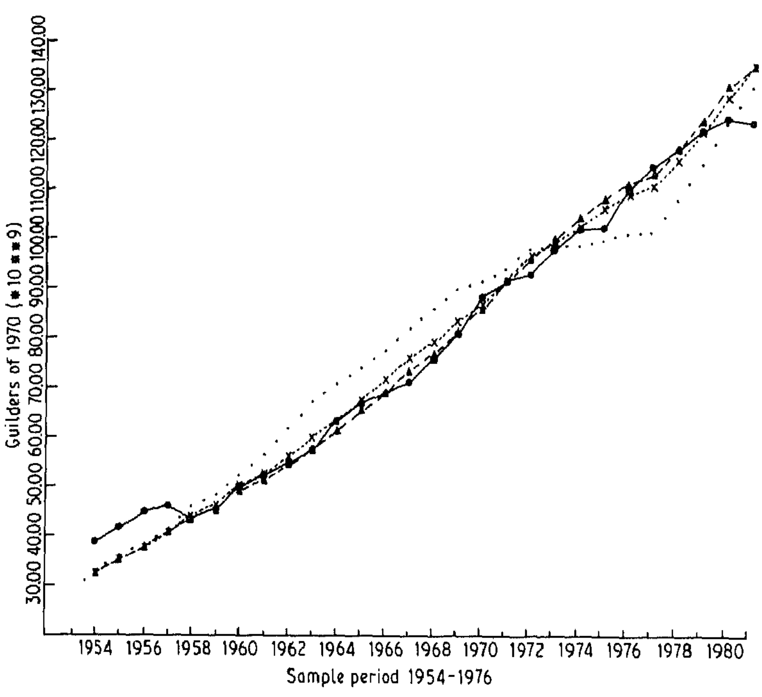

Fig. 3. Goods market *ex ante*. ⊙ Effective demand, ▲ effective supply, ∗ notional supply, • capacity output.

model. Instead the continuing real wage pressure leads to a continuing substitution from labour to capital in the model by way of the induced scrap of old vintages with a relatively high labour intensity, causing an increase in aggregate labour productivity.

An important advantage of empirical disequilibrium models over conventional macromodels is that the endogenous sample separation into different regimes of the former reveals much clearer the nature and magnitude of the macroeconomic imbalances that existed in the various periods. The following picture emerges from our results, if we look at the structural development of the Dutch economy in terms of these *ex ante* variables (see Figs. 3 and 4 below). In the early fifties the lack of productive capacity resulting from war damage caused some classical unemployment of a technical nature because all existing capital goods were fully manned. The rapid expansion of the economy resolved this regime into one of repressed inflation in the mid-fifties. The restraints on expenditure issued by the government in 1957 together with the international recession resulted in a sharp downfall of demand in 1958, which led to some Keynesian unemployment in 1959. By 1961 demand had recovered, however, and labour supply became the bottleneck again. The sixties were characterized by alternating periods of repressed inflation and Keynesian unemployment, with a very strong development of capacity output, that remained well above product demand for the entire period, so that unemployment did not in fact carry a residual classical component. This situation changed in the seventies, because the strong pressure of real wages from about 1964 caused a stagnation in

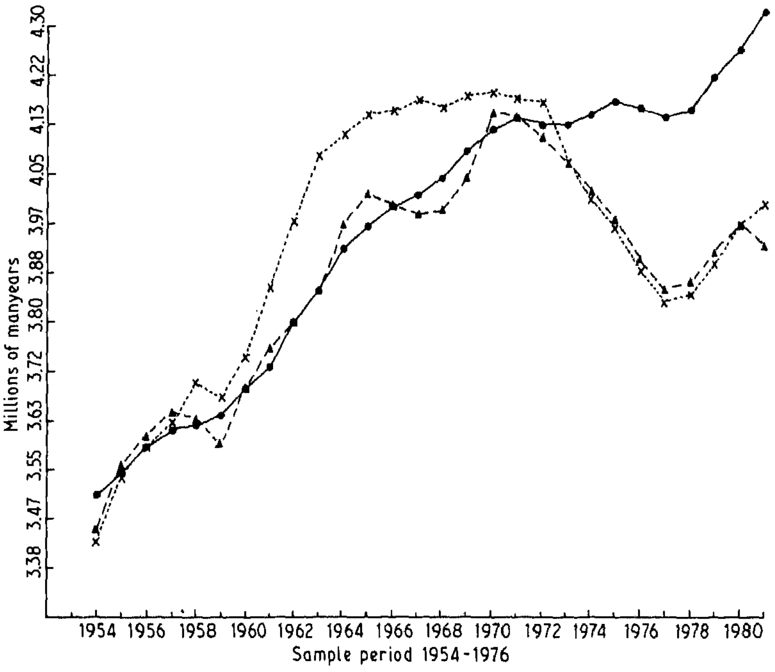

Fig. 4. Labour market *ex ante*. ⊕ Effective supply, ∗ notional demand, ▲ effective demand.

capacity growth, that turned below demand in 1973. The Keynesian unemployment regime that started in 1972 and was reinforced by the world energy crises, therefore from the beginning carried a strong classical component and capacity became a bottleneck with unemployment being largely of a classical nature. The deceleration in real wage growth after 1976 then resulted in a recovery of capacity growth, so that the retardation in product demand growth, as a result of the declining world trade activity, led again to a switch to the Keynesian unemployment regime.

IV. CONCLUDING REMARKS

Linking up with the empirical macroeconomic tradition our relatively simple approach generates an interesting picture of the spillovers between domestic and foreign trade and between product market and labour market in the last decades in the Netherlands. To some extent it provides an *ex post* justification for *ad hoc* introduction of disequilibrium elements in earlier empirical models. When compared with these models, the differentiation between realized and *ex ante* (planned) variables in our models pays off in terms of a stronger separation between long-term intentions and short-term adjustment. The explicit introduction of nonprice constraints thus stresses rather than obscures the role of adjustment to prices.

Nevertheless, the model is only partial. Important parts of the behaviour of firms and households are left out. The choice-theoretic foundation of the model could also be improved. Moreover, experiments not reported above have shown that some empirical results are rather sensitive to changes in the specification. This holds, in particular, for the *ex ante* part of the model. Of course, approximative functions constitute only an imperfect substitute for direct statistical information on plans and expectations. Still, models like ours may help to bridge the wide gap between empirical macroeconomic model building and the theory of decision-making under nonprice constraints, especially by focussing on the possibly important but poorly analysed spillovers between markets. Perhaps they will also be instrumental in identifying long-term adjustment processes behind short-term developments and thereby cure our undoubtedly biased view of the adjustment capabilities of our economies.

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APPENDIX

Definitions of variables

1. Exogenous variables.

g : sales of domestic products plus net exports of services (milliards of guilders at 1970 prices)

h : index of contractual working hours ($h(1951) = 1$).
I : investment in fixed assets by enterprises, exclusive of plant, housing and natural gas (milliards of guilders at 1970 prices).
L_g : government employment, millions of manyears.
m_w : index of world trade.
N : working age population (15–64 years old), millions of persons.
n_b : ratio of total inventory formation to previous year's sales.
p_y : implicit deflator of value-added, index ($p_y(1970) = 1$).
p_b : export goods price, index ($p_b(1970) = 1$).
p'_b : competitors prices on export markets in guilders, index, double weighted ($p'_b(1970) = 1$).
p_c : consumer price index ($p_c(1970) = 1$).
p_m : import goods price index ($p_m(1970) = 1$).
w : total wage sum per manyear.
y_{la} : agricultural production, divided by its trend level.

2. Observable endogenous variables.

b : exports of goods exclusive of natural gas (milliards of guilders at 1970 prices).
L : employment in enterprises (including self-employed), (millions of manyears).
L_r : registered labour supply exclusive of government (private employment plus registered unemployment), millions of manyears.
m : imports of goods (milliards of guilders at 1970 prices).
y : value-added of enterprises at factor costs exclusive of natural gas (milliards of guilders at 1970 prices).

3. Unobservable endogenous variables.
(Dimensions are as of corresponding observables).

a : notional participation rate of working age population in labour force
b_d : demand for exports of goods
g_d : demand for domestic products and services
L^* : capacity employment (= target notional labour demand)
L_d : effective labour demand
L_d^* : target effective labour demand
L_n : notional labour demand
L_s : effective labour supply (= notional labour supply)
m_d : demand for imported goods
p_E : expected relative price of imported versus domestic goods
p_F : effective relative price of imported and domestic goods
u_y : demand pressure index, $0 < u_y < 1$
v : vintage of oldest capital in use
v^* : target vintage of oldest capital to be used
y_d : effective demand for goods and services (= notional demand)
y^* : capacity output (= target notional product supply)
y_n : notional product supply
y_s : effective product supply

Data sources

$b, g, I, L, L_g, L_r, m, n_b, p_b, p_c, p_m, p_Y, w, y, y_{la}$:
Nationale Rekeningen (national accounts), Centraal Bureau voor de Statistiek, Staatsuitgeverij, Den Haag, various issues.

m_w, p'_b: Centraal Economisch Plan (Central Economic Plan), Centraal Planbureau, Staatsuitgeverij, Den Haag, various issues.

N: Maandstatistiek van de bevolking (monthly population statistics), Centraal Bureau voor de Statistiek, Staatsuitgeverij, Den Haag, various issues.

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