Demand-Supply Interactions and Unemployment Dynamics : Can there be Path Dependency?

The case of Belgium, 1955-1994 [1]

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Abstract

The proportion of capacity-constrained firms in European economies remains today fairly small, which suggests that capacity shortages cannot be the direct and single cause of unemployment persistence. Inferring from this observation that low investment rates play no role in explaining the persistence of high unemployment rates may however fail to take into account the relationship between demand expectations, capital accumulation and real rigidities. The objective of this paper is to show how a continuum of excess-supply equilibria can be obtained in models with real rigidities similar to those traditionally used to analyse the determinants of equilibrium unemployment (the NAIRU), provided one takes explicitly into account the effect of a "capital gap" on wage formation, and the relationship between capital accumulation and demand expectations. Such a persistence mechanism might contribute to explain why current unemployment rates seem to depend so much on past history, and why there is no simple explanation that applies equally well to all European countries. The results obtained from an empirical analysis of Belgian post-war data are compatible with such a scenario.
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1 Introduction

The persistence of high unemployment rates in Europe remains by and and large a poorly understood phenomenon (see for instance Bean, 1994, and Blanchard-Katz, 1997). A widely shared view is that "hysteresis" mechanisms are playing a substantial role, on top of labour market rigidities and skill-biased technological change. Such hysteresis mechanisms might in particular explain why current unemployment rates seem to depend so much on past history, and why there is no simple explanation that applies equally well to all European countries. Persistence mechanisms may work through both the demand and the supply side.

Long-term unemployment is usually mentioned as the most important channel of persistence, either through the ranking and selection behaviour of firms when long term unemployment is interpreted -rightly or wrongly- as a negative signal about individual skill characteristics, or through the behaviour of the job-seeker himself when there is "disenfranchisement". In both cases, the "effective" labour force turns out to be much smaller than official statistics may suggest; the actual unemployment rate is then no longer an appropriate measure of the tensions that prevail on the labour market and of the labour constraints that firms are facing. It is difficult though to test to what extent long-term unemployment and disenfranchisement are a cause rather than a consequence of unemployment persistence.

Capital scrapping is another potential source of unemployment persistence. In a standard neo-classical setup with real wage rigidities, lower investment rates reduce the marginal productivity of labour and will generate "classical" unemployment if not compensated by lower real wages and the use of more labour-intensive production techniques (see Giersch, 1981; Malinvaud, 1980, 1982). The combination of adverse real shocks, real wage rigidities and investment dynamics may then generate long-lasting adjustment processes in employment (Burda, 1988; Sneessens, 1987). The existence of such mechanism is not denied (see for instance Bean, 1989, and Layard et al., 1991). Still, it is usually believed that although the return to full-employment may call for substantial investment, the latter would take place spontaneously once the real obstacles to full-employment have disappeared. In the late thirties, the unemployment rate in the United-States fell dramatically from 19% in 1938 to 10% in 1941 without generating inflationary pressures, despite ten years of depressed investment and large initial "capital shortages" (see Blanchard-Summers, 1986, and Gordon, 1988). The proportion of capacity-constrained firms in European economies remains today fairly small, which suggests too that capacity shortages cannot be the direct and single cause of unemployment persistence.

This interpretation of the "capital shortage" story may however be too narrow and fails to take into account the relationship between demand expectations, capital accumulation and real rigidities. Building on earlier works in general equibrium setups (in particular

Roberts, 1987, and Herings, 1996, Dehez-Drèze, 1984, van der Laan, 1982, 1984), Drèze (1997) emphasizes the possibility that, if some relative prices (like the real wage) are downwardly rigid, *unlimited* underutilisation of resources may persist once established, reflecting pure coordination failure rather than price distortions. In other words, there can be a continuum of excess-supply equilibria.

> "The coordination failure could take the form of [...] supply constraints experienced today, as a legacy of the past or as a consequence of a current surprise (like an oil shock or the Gulf war), and accompanied by expectations of future similar constraints, resulting together in current and anticipated underutilisation of resources. [...] The channel of transmission from these expectations to current activity could be investment, or consumption, or both." (Drèze, 1997, p13 and 16)

This view is quite compatible with the example of the fast US economic recovery observed in the late thirties-early fourties, insofar as the starting of the second world-war must have changed expectations and behaviours.

The objective of this paper is to show how a continuum of excess-supply equilibria can be obtained in the type of models used to analyse the determinants of equilibrium unemployment (the NAIRU), provided one takes explicitly into account the effect of large "capital gaps" on wage formation. The basic issues can be illustrated as follows. The standard, stylized representation of a NAIRU model can be summarized in the following log-linear price and wage equations:

$$p - w = \alpha_0 - \alpha_1 (1 - l) + \alpha_{11} \Delta l + \alpha_2 (1 - k) + \alpha_{21} \Delta(1 - k) + \alpha_3 \Delta^2 p$$

$$w - p = \beta_0 - \beta_1 (1 - l) + \beta_{11} \Delta l + \beta_2 (1 - k) + \beta_{21} \Delta(1 - k) - \beta_3 \Delta^2 p$$

where l stands for the observed employment rate (hence the unemployment rate is $u = 1 - l$), k stands for the capacity employment rate, so that the capital gap is measured by $cg = 1 - k$. The constant terms are meant to represent the effect of price- and wage-push variables. The effect of nominal rigidities is introduced in both equations via second differences in the price level p. In the price-setting equation, coefficients α_1 and α_{11} measure the effect of changing market power and marginal costs on the optimal price level, while coefficients α_2 and α_{21} measure the inflationary effects of capacity constraints. In the wage-setting equation, coefficients β_1 and β_{11} measure the effect of insider/outsider behaviours associated to changes in the employment rate. Coefficient β_2 allows an effect of changes in capacity employment on wage behaviours.

Neglecting first- and second-difference terms, one obtains the following expression for the short-term (i.e., at given k) equilibrium employment rate:

$$l = 1 - \frac{\alpha_0 + \beta_0}{\alpha_1 + \beta_1} - \frac{\alpha_2 + \beta_2}{\alpha_1 + \beta_1} + \frac{\alpha_2 + \beta_2}{\alpha_1 + \beta_1}\, k$$

It is usually assumed that capacity employment has no effect on wage formation (i.e., $\beta_2 = 0$). Transitory capital shortages then affect unemployment solely through price formation (α_2); their effect is smaller the larger the sensitivity of wages to unemployment (β_1 large). If in the longer run productive capacities are adjusted so as to maintain a constant degree of capacity utilisation, the long-term NAIRU is then uniquely determined as a function of price- and wage-push variables. To keep the notation as simple as possible, let us assume that the long-run objective is simply $k = l$. The long-run equilibrium employment rate is then equal to:

$$l = 1 - \frac{\alpha_0 + \beta_0}{(\alpha_1 + \beta_1) - (\alpha_2 + \beta_2)}$$

There may however be a considerable asymmetry in the reactions of the economy to positive or negative shocks, especially when the latter are abnormally large. When productive capacities are plentiful ($k > 1$), individual firms are more likely to be constrained by labour shortages rather than capacity shortages. In such circumstances, k would probably have little effect on price formation and on equilibrium unemployment. Proceeding as if coefficients α_2 and β_2 were equal to zero may thus be a workable assumption as long as the economy remains close to full-employment (as it did in most countries until 1974). When large negative (demand or supply) shocks make the excess supply of labour grow larger and larger, one would expect k to become progressively much smaller than 1 and the (log of the) degree of capacity utilisation $l - k$ to provide a better indicator of tensions than the aggregate unemployment rate. [1] Coefficients α_2 and β_2 would then become progressively more and more relevant. Once there is a large capital gap ($k \ll 1$), prices may become much more sensitive to the capacity utilisation rate rather than to the employment rate, that is, the value of coefficient α_2 is equal to α_1. Wage claims may similarly become much more sensitive to the discrepancy between potential job opportunities and actual employment (i.e., $k - l$) rather than to the discrepancy between labour supply and actual employment (i.e., $1 - l$); the value of β_2 is equal to β_1. Under such circumstances, the expression determining the short-term equilibrium employment rate becomes:

$$l = -\frac{\alpha_0 + \beta_0}{\alpha_1 + \beta_1} + k$$

As before, we may assume that k is progressively adjusted to reach a desired degree of capacity utilisation. There is however no well-defined long-term NAIRU anymore. The values of l and k to which the system will converge (assuming it does converge) may depend on initial

[1] The capacity utilisation rate is equal to $\frac{l}{k}$ or $\frac{1-u}{1-cg}$. A Taylor series expansion of $log(\frac{1-u}{1-cg}$ shows that it can be approximated by $l - k$.

conditions and/or sales expectations. Van de Klundert and Van Schaik (1990) have analysed a model of unemployment persistence with similar dynamic properties. The dynamics of prices, wages and productive capacities are described by a system of three dynamic equations with a zero root, implying path dependency. Their specification of the price and wage behaviours is however not obtained from an explicit optimisation programme and remains thus fairly ad hoc.

This example of course relies very much on an implicit assumption about real wage rigidities. Taking the number of potential jobs as predetermined would not be very realistic if the economy's capital-labour ratio could quickly be changed, when for example workers who lose their job in the manufacturing industry, say, are willing to take jobs in the service sector at substantially lower wage rates (which would correspond in our simple model to a value of coefficient β_1 strictly larger than β_2, whatever the size of the capital gap). It is thus the interactions between demand expectations, investment decisions and wage-price setting behaviours in imperfectly competitive markets that may produce path dependency (or full hysteresis).

The rest of the paper is organised as follows. Section 2 develops a theoretical model with imperfect competition and endogenous sales and/or supply constraints. Prices are set by monopolistically competitive firms; wages are set by local trade-unions so as to maximize the welfare of its members. In the long run, productive capacities are adjusted to maximize expected profits. The conditions needed to obtain path dependency are examined. Section 3 is devoted to an application on Belgian data, over the period 1955-1994. We use Johansen's maximum likelihood method (Johansen, 1988, 1991) to determine the number of cointegrating vectors and test for exogeneity [2]. We impose no a priori restrictions on the parameters of the model. We finally use the results to reexamine the main determinants of equilibrium unemployment in Belgium. We conclude in section 4 with a summary of the main results.

2 Wage-price behaviours, expectations and equilibrium unemployment

We consider an economy with imperfect competition on both the goods and the labour market. There is a large number n of domestic firms or industries, producing each a good that is an imperfect substitute for the others. Each firm sets its price and employment levels so as to maximise expected profits, given expectations about demand and productive capacities, at given input prices (labour and energy), technological constraints and capital stock. The price of energy is exogenous and determined on world markets. The wage rate is determined at

[2] We use the same methodology as in Lubrano, Shadman-Mehta and Sneessens (1996)

the industry level by the local union of workers, so as to maximise the utility of its members, given the price and employment behaviour of the firm (right-to-manage monopoly union setup). To keep the presentation as simple as possible and focus on the effect of demand expectations and investment, we assume constant union membership. We first examine a streamlined model with fixed input-output coefficients, and next discuss extensions.

2.1 A streamlined model

2.1.1 Price-setting and sales expectations

At a given moment of time, the firm is endowed with a given production technology and productive capital stock K. There are two variable inputs, labour and energy. The corresponding input-output coefficients will be denoted a and b respectively. As the focus is on the determinants of equilibrium unemployment, we shall neglect labour hoarding and assume that variable inputs are always used efficiently. At the time prices are set, there is uncertainty about future sales and productive capacity. The firm chooses the price level P_i that maximizes expected profits. The optimisation programme of firm i can be written as follows (see for instance Sneessens, 1987):

$$\max_{P_i} \quad [P_i - (a.W_i + b.Z)]\, E(Y_i) \tag{2.1}$$

$$\begin{aligned} s.t. \quad E(Y_i) &= E\{\min\left[E(Y_i^d), E(Y_i^c), E(Y_i^l)\right]\} \\ &= \{[E(Y_i^d)]^{-\rho} + [E(Y_i^c)]^{-\rho} + [E(Y_i^l)]^{-\rho}\}^{-\frac{1}{\rho}} \qquad (2.2) \\ E(Y_i^d) &= (P_i/P)^{-\epsilon}(Y^d/n) \qquad (2.3) \\ E(Y_i^c) &= (C.K/n) \qquad (2.4) \end{aligned}$$

where Y^d stands for goods demand (a function of the aggregate price level and of exogenous variables), Y^c stands for capacity output and Y^l for labour-supply-determined output. Aggregate variables are represented without a subscript. The costs of one unit of labour and one unit of energy are denoted W and Z respectively. The supply of energy, is assumed to be never binding. Provided the variables are log-normally distributed (see Lambert, 1988), expected output can be approximated by a CES function of expected sales and expected productive capacity (eq. (2.2)). The probability of a sales-constraint is then equal to :

$$\Pi_i^d = \frac{E(Y_i^d)^{-\rho}}{E(Y_i^d)^{-\rho} + E(Y_i^c)^{-\rho} + E(Y_i^l)^{-\rho}} = \frac{E(Y_i)^\rho}{E(Y_i^d)^\rho} \leq 1.$$

Similarly, the probability of a capacity constraint is equal to:

$$\Pi_i^c = \frac{E(Y_i^c)^{-\rho}}{E(Y_i^d)^{-\rho} + E(Y_i^c)^{-\rho} + E(Y_i^l)^{-\rho}} = \frac{E(Y_i)^\rho}{E(Y_i^c)^\rho} \leq 1$$

It will be convenient for later use to recast these expressions in terms of the same variables rescaled by the full-employment ouput level Y^l. Equation (2.2) can then be written in terms of employment rates, as follows:

$$l_i = \{d_i^{-\rho} + k_i^{-\rho} + 1\}^{-1/\rho} \tag{2.5}$$

where l_i represents the employment rate (more precisely, the ratio of expected employment and expected labour supply), while d_i stands for the demand-determined employment rate and k_i for the capacity employment rate (again defined by ratios of expected values) The probabilities of sales- and capacity constraints can be written as:

$$\Pi_i^d = \left\{\frac{E(Y_i)/E(Y_i^l)}{E(Y_i^d)/E(Y_i^l)}\right\}^\rho = \left(\frac{l_i}{d_i}\right)^\rho \tag{2.6a}$$

$$= 1 - \left\{\frac{E(Y_i)/E(Y_i^l)}{E(Y_i^c)/E(Y_i^l)}\right\}^\rho - \left\{E(Y_i)/E(Y_i^l)\right\}^\rho = 1 - \left(\frac{l_i}{k_i}\right)^\rho - (l_i)^\rho \tag{2.6b}$$

$$\Pi_i^c = \left\{\frac{E(Y_i)/E(Y_i^l)}{E(Y_i^c)/E(Y_i^l)}\right\}^\rho = \left(\frac{l_i}{k_i}\right)^\rho \tag{2.7}$$

The probability of a sales or capacity constraint is of course endogenous, and controlled by the firm via its choice of the optimal price level P_i. The latter must satisfy the following first-order optimality condition:

$$P_i = \frac{\epsilon.\Pi_i^d}{\epsilon.\Pi_i^d - 1}(a.W_i + b.Z) \tag{2.8}$$

The markup rate is inversely related to (the absolute value of) the price elasticity of sales. In a setup with quantity constraints, sales may turn out to be smaller than demand; the price elasticity of sales is then the probability of a sales-constraint (Π_i^d) times the price elasticity of demand (ϵ, assumed to be larger than 1). The markup is thus a (non-linear) negative function of the probability of a sales-constraint. Notice that the optimal probability of a sales constraint Π_i^d must be larger than $1/\epsilon$.

2.1.2 Wage-setting and short-run equilibrium

Let us assume that all firms face the same uncertainty and idiosynchratic shocks, and focus on symmetric equilibria. For convenience, we also assume that there is a single economy-wide monopoly union [3]. The union sets the nominal wage rate so as to maximize the welfare of its members. It knows how firms adjust prices in reaction to nominal wage changes, as well as the employment implications thereof.

[3] A similar result holds if there is a monopoly union on each "micro-market".

The feasible real wage constraint

In order to introduce the employment constraint into the union's optimisation programme, we recast the optimal price rule as a feasible real wage equation. By simply rearranging the terms of (2.8) and focusing on symmetric equlibria, we obtain:

$$w = \left(1 - \frac{1}{\epsilon.\Pi^d}\right) - z \tag{2.9}$$

where w and z are respectively the wage and energy shares (i.e., $w \equiv a.(W/P)$ and $z \equiv b.(Z/P)$). At given k, the feasible wage share is a decreasing function of the employment rate l. This function can easily be shown to be concave. At the limit, when the probability of a sales constraint Π^d decreases to $1/\epsilon$ and l goes to its maximum value ($l \rightarrow [\frac{\epsilon-1}{\epsilon}]^{1/\rho}[1+k^{-\rho}]^{-1/\rho} < k$), the profit margin goes to infinity and the feasible real wage to zero. A larger productive capacity k shifts the feasible real wage schedule rightwards; an oil shock ($\Delta z > 0$) shifts it downwards.

The short-run equilibrium employment rate

The union's preferences are represented by the following objective function:

$$\mathcal{U} = U(\bar{w}) + (l)^{\alpha}\left\{U(w) - U(\bar{w})\right\} \tag{2.10}$$

where $\bar{w}$ is the reservation wage (or unemployment benefit). Parameter α measures the weight given to the employment objective compared to purchasing power. For $\alpha = 1$, this objective becomes the usual utilitarian function.

The union chooses the value w that maximizes this function subject to the feasible real wage constraint (2.9). The first-order optimality condition can be written:

$$\frac{U'_w}{U(w) - U(\bar{w})} = \alpha \, \frac{(\epsilon\Pi^d)^2}{\rho\epsilon(1 - \Pi^d)} \tag{2.11}$$

The left-hand-side is decreasing in w; by (2.9), the right-hand side is increasing in w. The usual assumptions on the curvature of $U(.)$ (i.e., $U'(0) = \infty$; $U'(\infty) = 0$) then suffice to ensure the existence of a solution with $\bar{w} < w < w_{max}$, where $w_{max} = \frac{\epsilon-1}{\epsilon} - z$ is the maximum feasible wage rate at a symmetric equilibrium. The equilibrium wage and employment rates correspond to a tangency point between the feasible real wage curve and one of the union's indifference curves. The equilibrium wage rate is decreasing in $\bar{w}$ and z. Equations (2.9) and (2.11) jointly determine the equilibrium probability of a sales-constraint (or proportion of sales-constrained firms) Π^d and the equilibrium real wage rate. It is worth stressing that a change in the capacity employment rate k leaves the equilibrium values of Π^d and w unaffected; it only changes the short-run equilibrium employment rate l. The short-run equilibrium relationship between l and k is given by (2.6b), at fixed Π^d. Solving (2.6b) for l and rearranging yields:

$$l = \left\{\frac{1 - \Pi^d}{1 + k^{\rho}}\right\} k \tag{2.12}$$

where Π^d is fixed at its equilibrium value. It is worth noting that once k has become sufficiently small, the denominator on the right-hand side is almost equal to unity (for example, with $\rho = 30$, $(1 + k^\rho) = 1,04$ for $k = 0.9$). In other words, once the capital gap has become large, the short-run equilibrium employment rate l becomes (almost) strictly proportional to the capacity employment rate k. At the other extreme, when there is no capital gap ($k \geq 1$), the short-run equilibrium value of l is almost independent of k.

2.1.3 Capacity adjustment and long-run equilibrium

The firm's optimization programme (2.1) can easily be extended in an intertemporal infinite-horizon setup to allow the derivation of the optimal productive capacity, and the corresponding capacity employment rate k and capacity utilisation rate l/k. We assume that installed capacities become productive with a one period lag. To start with, we neglect the effects of adjustment costs or irreversibility. The choice of the optimal productive capacity can then be represented by the following static optimization programme:

$$\max_{k_i, P_i} \quad \left[\frac{P_i}{P} - (w + z)\right] l_i \quad - \quad v.k_i \tag{2.13a}$$

subject to:

$$l_i = \{d_i^{-\rho} + k_i^{-\rho} + 1\}^{-1/\rho} \tag{2.13b}$$

$$d_i = \left(\frac{P_i}{P}\right)^{-\epsilon} d \tag{2.13c}$$

where v stands for the capital usage cost. The investment decision takes into account the wage-price interactions that will take place after the productive capacity has been changed, as discussed in the previous subsection (i.e., the value of w remains unaffected). The first-order optimality on k can then be shown to imply:

$$\Pi^c \, \frac{w + z}{\epsilon \Pi^d - 1} \, \frac{l}{k} \; = \; v \tag{2.14a}$$

where:

$$\Pi^c = \left(\frac{l}{k}\right)^\rho \tag{2.14b}$$

The right-hand side of (2.14a) is the marginal cost of capital; the left-hand side is the expected marginal revenue, equal to the probability that the installed productive capacity will be used times the value of the profit margin on variable costs.

Equations (2.14a)-(2.14b) provide a long-run relationship between l and k. Because Π^d is unaffectd by k, l and k remain strictly proportional. This relationship, together with the short-run one (2.12), determines the long-run equilibrium values of k and l, denoted respectively $k^\star$ and $l^\star$. The short-run and long-run relationships are illustrated in figure 1. The intersection between the two determines the long-run equilibrium values of unemployment and capacity utilisation.

This of course does not take into account the effects of uncertainty and irreversibility. It is now well-known that, because of irreversibility, the expected discounted profit needed to stimulate investment may become quite large in an uncertain environment, even for realistic values of the parameters and with risk-neutral firms (see e.g. Dixit, 1988, and Bertola-Caballero, 1990). Bean (1989) gives numerical examples suggesting that, for reasonable levels of uncertainty, profitability (the wedge between the expected return to investment and the cost of capital) may well have to be larger than 15% before firms start investing in new projects! There can then be a wide range of profit rates over which neither investment nor disinvestment would occur. In other words, if there is uncertainty about the future, there is on the short-run equilibrium schedule of figure 1 a range of values of k and l around the long run equilibrium ($k^\star$, $l^\star$) for which firms would choose neither to invest nor to disinvest. The interval around $k^\star$ and $l^\star$ for which such a situation may obtain is typically asymmetric around $l^\star$, as figure 1 suggests. In this numerical example, the long-run equilibrium unemployment $(1-l)$ and capacity utilisation (l/k) rates are respectively 2.63% and 97.2%. If we shift down along the short-run schedule to an unemployment rate equal to 10%, the capacity utilisation rate increases slightly (to 98.4%); total profits are about 8% lower. Both the wage share and the proportion of sales-constrained firms remain unchanged, at 79% and 61% respectively. Once the economy has reached such a point and if there is much uncertainty about future sales prospects, firms may choose not to invest despite the fact that the average profit rate is (slightly) above normal. The equilibrium unemployment rate is then no longer uniquely defined; its value is proportional to k and path dependent. In such a scenario, pessimistic expectations become self-fulfilling. With pessimistic expectations about the longer run, a demand expansion would leave production capacities unchanged and merely serve to generate inflation. This suggests too that, although there is path dependency, these (un-)employment equilibria may be locally very stable [4].

[4] The "disenfranchisement" hypothesis is a similar story, which might also produce path dependency. There is one substantial difference though. In the "disenfranchisement" model, the labour market is actually much tighter than it looks; it is the shortage of motivated workers (i.e., a purely supply-side problem) which explains the persistence of unemployment. In the "capital gap" model, there is a genuine excess supply of labour (of which disenfranchisement may be a consequence) that became a locally stable unemployment equilibrium as a result of capital scrapping *and* pessimistic expectations. Demand- and supply-side influences interact to yield the result. Many European countries are characterized by large "capital gaps". See the "capital gap" estimates reported in Drèze et al. (1990) and Bean (1989).

2.2 Changes in labour intensity

We now generalise the initial setup to introduce the possibility of changes in labour intensity. We distinguish two types of jobs, one with high productivity, one with low productivity. This is the simplest way to introduce the distinction between high-productivity jobs in the manufacturing sector and low-productivity jobs in the service sector. There are also two types of workers, high- and low-skilled workers. The former can be used on both high- and low-productivity jobs; the latter can only be used on low-productivity jobs. We further assume that these productivities are given (so that the average labour productivity can only be changed by changing the proportion of high- and low-skilled jobs), and that the wage rate paid on low productivity jobs is fixed, while wages paid on high-productivity jobs are set by the firms so as to attract the desired amount of high-skilled worker (efficiency wage hypothesis). These specifications provide a fairly reasonable stylised representation of the working of labour markets in many European economies. Low-skilled wage rates are much less flexible downwards than high-skilled wage rates are, as a result of explicit minimum wage laws and/or of the unemployment benefit system; although the aggregate unemployment rate is large, the high-skilled unemployment rate is typically much lower than the low-skilled one, so that firms may be constrained by high-skilled labour shortages, especially during expansions, which motivates them to offer appopriate wages.

In this setup, the optimisation programme of the firm remains essentially unchanged, except for two differences: (i) the high-skilled wage rate is now a decision variable of the firm; (ii) the effects of quantity constraints should be written in terms of high-skilled labour (rather than total labour). The relevant aggregate relationships corresponding to a symmetric equilibrium can then be written as follows:

$$\Pi^d = 1 - \left[1 + (k^h)^{-\rho}\right] (l^h)^\rho \tag{2.15}$$

$$w^h = \left(\frac{\epsilon.\Pi^d - 1}{\epsilon.\Pi^d}\right) - w^l - z \tag{2.16}$$

where k^h stands for hig-skilled capacity employment and l^h for high-skilled employment. Equation (2.15) corresponds to (2.6b); equation (2.16) is the optimal price condition, corresponding to (2.9), with a distinction between low- and high-productivity wages (w^l and w^h respectively). The optimal high-productivity wage can be shown to imply [5]:

$$w^h = \frac{\eta\Pi^h}{1+\eta\Pi^h}(1 - w^l - z) \tag{2.17}$$

where $\Pi^h \equiv (l^h)^\rho$ is the probability of (or the proportion of firms constrained by) a high-skilled labour shortage, and η is the wage elasticity of the high-skilled labour supply to an individual

[5] See for instance Sneessens and Shadman-Mehta (1994)

firm. In order to introduce the so-called "ladder effect" (high-skilled workers taking the job of low-skilled ones when the probability of finding a job on the high-productivity segment of the labour market is low), let us assume that high-skilled workers switch to the low-productivity segment as soon as the following inequality is *not* satisfied:

$$l^h \;\geq\; \lambda \,\frac{w^l}{w^h} \tag{2.18}$$

Once this constraint becomes binding, unemployed high-skilled workers move to the low-productivity segment and get a job there, so that (2.18) is satisfied with strict equality. It can be shown then the two equations (2.17)-(2.18) determine unique values of l^h and w^h; the value of Π^d and k^h are then determined by (2.15)-(2.16). The *aggregate* unemployment rate and capital gap remain however undetermined. This comes from the downward rigidity of the low-productivity wage rate.

In this setup, once the economy has reached a sufficiently deteriorated situation such that (2.18) becomes binding, one again has path dependency. This results comes from the interaction between real rigidities, capital accumulation and demand expectations. The most efficient way to eliminate unemployment is to act on all these factors simultaneously.

3 The Empirical Model

Our objective in this section is to examine empirically the short-run and long-run determinants of the equilibrium unemployment rate $ur = 1 - l$, in the light of the previous discussion regarding the possibility of path dependency and multiple equilibria. To this end, we estimate the model using Johansen's maximum-likelihood procedure (Johansen, 1988, 1991). The advantage of this method is that we need impose as few *a priori* assumptions as possible, for example on the number of "long-run" or cointegrating relations, or the exogeneity of variables.

The list of explanatory variables included in our analysis is suggested by the theoretical analysis of the previous section. It includes the real price of energy z, the real interest rate r, the replacement ratio rr, the tax wedge tx, public consumption g and world trade y_w (see appendix for definition of variables). Henceforth, all the variables will be in logarithms, except for the unemployment rate ($ur = 1 - l$), the capital gap ($cg = 1 - k$) and the real interest rate r.

We pay due attention to the fact that most series are non-stationary. The order of integration of the variables of interest have already been studied in Lubrano et al.(1996) which covered the period only to 1988. We estimate The final subsection discusses the economic interpretation of these results.

3.1 Structural breaks

Estimation of econometric equations is basically aimed at explaining one set of variables, given another set. The assumption of the constancy of the parameters of these equations is an essential reduction for progress to be possible. However regime shifts do occur and they need to be modelled. The Belgian economy experienced a structural break with the income stabilisation imposed after 1981. This policy essentially implemented three kinds of wage controls: (i) suspension of real wage negotiations after 1981; (ii) cancellation of wage indexation for the 12 months following the 8.5% devaluation of February 1982, and smoothing of the indexation procedure afterwards; (iii) increases in social security contributions equal in size to the nominal wage increases due to automatic indexation (in 1984, 85, 87), which implied net real wage cuts.

The effect of the last two measures is captured by two dummy variables ($dum1$ and $dum2$ respectively), which are equal to zero till 1981, then related to the cumulated effects on net real wages of the corresponding wage controls (see also Figure 6). These values have been computed at the Belgian Planning Bureau (see Bogaert et al., 1991).

	dum1	dum2
1982	-.0204	0.0
1983	-.0594	0.0
1984	-.0712	-.0148
1985	-.0665	-.0389
1986	-.0635	-.0388
1987	-.0665	-.0499
1988	-.0665	-.0577
1989	-.0666	-.0577
1990	-.0666	-.0577
1991	-.0666	-.0577
1992	-.0666	-.0577
1993	-.0666	-.0577
1994	-.0666	-.0577

3.2 Estimates of the unrestricted cointegration space, and Identification of the long-run structure

Our first step consists of exploring the existence of cointegration between the variables of the model. Using the method proposed by Johansen(1988,1991) and Johansen and Juselius(1990), we estimate the following model:

$$\Delta x_t = \Pi \tilde{x}_{t-1} + \psi D_t + \epsilon_t$$

where $x_t^{'} = (w, ur, cg, tx, z, g, y_w, r, rr)$, and $\tilde{x}_t$ is the same as x_t plus a trend. The program PcFiml 9 (Doornik and Hendry (1996))was used to obtain the following results. $dum1$ and $dum2$ were included as predetermined (i.e. dummy) variables in D_t. A trend was included in the cointegration space. The sample period used was 1955 to 1994. Due to the large number of variables in the system and the size of the sample, we could only allow for a lag of 1 in the VAR-model. Table 1 reports some statistics that help to evaluate this system.

* and ** refer to significance at the 5% and 1% levels respectively. The standard deviations of the residuals provide a useful measure of the goodness of fit, as they are invariant under linear transformations of the variables and can act as the baseline innovation standard errors. The correlations between the residuals, help guide the direction of modelling. We observe a large negative correlation between the residuals of w and z as well as y_w and ur, and some correlation between the residuals of w and ur, w and cg, cg and z and r and z.

	w	ur	cg	tx	z	g	y_w	r	rr
ur	0.45	.	.	.	.	.	.	.	
cg	0.53	0.29	.	.	.	.	.	.	
tx	−0.24	−0.14	−0.39	.	.	.	.	.	
z	−0.75	−0.06	−0.47	0.27	.	.	.	.	
g	0.20	0.09	−0.16	0.02	−0.12	.	.	.	
y_w	−0.24	−0.70	−0.13	−0.01	−0.11	0.41	.	.	
r	0.25	0.21	0.23	−0.29	−0.43	0.19	0.18	.	
rr	−0.01	0.08	−0.21	−0.03	−0.05	0.19	−0.04	−0.15	.

(a): Residual Correlations

	w	ur	cg	tx	z	g	y_w	r	rr
$F_{s=1}(9,19)$	1.27	6.62**	5.66**	2.71*	1.43	5.88**	0.79	1.85	3.90**
$\lvert\lambda_{(\pi(1)-I)}\rvert$	0.91	0.91	0.61	0.61	0.12	0.79	0.23	0.23	0.60
$\lvert\lambda_{Comp}\rvert$	0.41	0.41	0.65	0.65	1.12	0.21	0.78	0.78	0.40

(b): Dynamics

Statistic	w	ur	cg	tx	z	g	y_w	r	rr
$\hat{\sigma}$	0.018	0.007	0.008	0.009	0.153	0.021	0.040	0.016	0.062
$F_{ar}(2,25)$	4.01*	0.75	2.38	9.54**	2.68	0.54	0.59	0.29	0.40
$F_{arch}(1,25)$	0.69	5.88*	0.17	5.11*	0.06	0.23	1.17	0.	0.42
$\chi^2_{nd}(2)$	5.35	1.54	3.76	0.93	17.55**	2.38	0.20	11.35**	5.27

(c): Evaluation

Table 1: Goodness of fit and misspecification tests.

Panel (b) in table 1 examines the dynamics of the system. The statistic $F_{s=1}$ tests the hypothesis of a 1-period lag. Surprisingly, a few are insignificant. $|\lambda_{(\pi(1)-I)}|$'s are the moduli of the eigenvalues of the long-run matrix $\hat{\Pi}$, and the $|\lambda_{Comp}|'s$ those of its companion matrix. The values of the $|\lambda_{(\pi(1)-I)}|$'s suggest that the rank of $\hat{Pi}$ is less than nine but greater than 0. As for the eigenvalues of the companion matrix, one is greater than one, which would imply an explosive system, but this anomaly may be due to the large size of the system relative to the number of available observations.

Finally, panel (c) reports tests of misspecification. A satisfactory model should have constant parameters and residuals that are homoscedastic innovations. $F_{ar}()$ is the Lagrange-Multiplier test for autocorrelated residuals (here of the second-order). $F_{arch}()$ is the $ARCH$ test for autoregressive conditional heteroscedasticity, or autocorrelated squared residuals (here of order 1) (see Engle(1982)). $\chi^2_{nd}(2)$ is a chi-square test for normality. The corresponding test applied to the system is reported under the column VAR (see Doornik J.A. and Hendry, D.F. (1996)). Other than some autocorrelation in the residuals of tx, heteroscedasticity in those of ur and tx, and non-normality of the residuals of z and r, the remaining results are satisfactory. As for the constancy of the parameters, one can only look at the recursive estimates from 1984 onwards because of the sample size, but there is no rejection of the hypothesis over this period.

Next we investigate cointegration in the system. Table 2 gives the eigenvalues (μ), the associated maximal eigenvalue statistic (Max), as well as the trace statistic (Tr). The latter two statistics are given both as calculated normally and adjusted for degrees of freedom, by multiplying by $(T - nk)/T$, where T is the sample size, n is the number of variables in the VAR, and k is the lag length (see Reimers(1992)). The critical values are from Osterwald-Lenum(1992, table 2*). Although the unadjusted statistics lead to the conclusion that the rank of the Π matrix is 2 or even 3, the adjusted statistics suggest that the rank is only 1. When we try with the two dummy variables restricted to lie in the cointegration space, then the rank is 2. We therefore continue the analysis with the hypothesis that there are two cointegrating relations between these variables. We prefer not to take the rank equal to 3 for the added reason that the third and fourth roots are complex conjugates and there is little sense in taking one root without the other and the hypothesis of the rank being equal to 2 rather than 4 is clearly accepted. Panel (b) in table 2 gives the stationary eigenvectors and their corresponding adjustment factors.

$Rank$	1	2	3	4	5	6	7	8	9
μ	0.90	0.80	0.74	0.56	0.48	0.38	0.31	0.15	0.06
Max	91.37**	64.5**	53.66*	32.68	26.41	19.01	15.13	6.61	2.40
Max_{adj}	70.81**	49.99	41.58	25.32	20.47	14.73	11.72	5.12	1.86
$Trace$	311.8**	220.4**	155.9*	102.2	69.56	43.15	24.14	9.00	2.39
$Trace_{adj}$	241.6**	170.8	120.8	79.23	53.91	33.44	18.7	6.98	1.86

(a): Eigenvalues, Johansen's Maximal and Trace Statistics

Variable	$\hat{\beta}_1$	$\hat{\beta}_2$	$\hat{\alpha}_1$	$\hat{\alpha}_2$
w	1.	.432	-.325	-.672
ur	-.577	1.	.221	-.227
cg	-.611	-.216	.184	.588
tx	-.388	-.065	.040	.008
z	.071	.015	.373	-.971
g	-.208	-.063	-.135	-.166
y_w	-.309	.245	.199	-.158
r	.442	-.188	-.055	.337
rr	-.009	-.009	-.403	-.790
t	.020	-.011		

(b): The stationary eigenvectors, $\hat{\beta}_i$, and their weights, $\hat{\alpha}_i$.

Table 2: Cointegration Analysis.

Given the large number of variables involved, it is difficult to interprete the two vectors as a wage or employment equation. Any linear combination of these vectors is also stationary, and in that sense only the cointegration space is identified. In order to formally identify these long-run relations, some restrictions need to be imposed on each. Johansen and Juselius (1994) set out the conditions for a set of restrictions to be identifying. Once the system is checked to be identified, further overidentifying restrictions can be tested for, using likelihood ratio statistics which are asymptotically distributed as χ^2.Thus, various hypotheses were tested, after setting the rank of the long-run response matrix to two[6]. The most interesting identification restrictions are reported below, as particular forms for the β and α matrices, where $\Pi = \alpha\beta'$:

$$H_0^1 : \beta' = \begin{pmatrix} 1 & \beta_{21} & 0 & 0 & 0 & 0 & \beta_{71} & \beta_{81} & 0 & \beta_{t1} \\ \beta_{12} & 1 & -1 & \beta_{42} & \beta_{52} & \beta_{62} & 0 & 0 & 0 & \beta_{t2} \end{pmatrix} \in Sp(\beta)$$

$$H_0^2 : \beta' = \begin{pmatrix} 1 & \beta_{21} & 0 & 0 & 0 & 0 & \beta_{71} & \beta_{81} & 0 & \beta_{t1} \\ \beta_{12} & 1 & -1 & \beta_{42} & \beta_{52} & \beta_{62} & 0 & 0 & 0 & \beta_{t2} \end{pmatrix} \in Sp(\beta)$$

together with

$$\alpha' = \begin{pmatrix} 0 & \alpha_{21} & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ \alpha_{12} & \alpha_{22} & \alpha_{32} & 0 & 0 & 0 & 0 & 0 & 0 \end{pmatrix}$$

The test statistics related to each of these hypotheses is $\chi^2(7) = 2.14[0.95]$ and $\chi^2(21) = 21.55[0.43]$ respectively. H_0^2 clearly supports the hypothesis that the variables tx, z, g, y_w, r, rr may be treated as weakly exogenous for the long-run parameters of the equations for w, ur, cg. The former set of variables need therefore not be modelled. Moreover, we use the vectors identified under H_0^1 to reduce the estimated model to the $I(0)$ space, and in later estimation

[6]There is a widely held view that the degree of capacity utilisation - c in equation (3.9.a) - is stationary. This would imply cointegration between ur and cg. However, an ADF test on the variable c cannot reject the hypothesis of a unit root: $ADF = -1.211$. The system analysis of our variables also gives no indication that there exists a cointegrating relationship between ur and cg alone.

we will once again test the pertinence of the insignificance of the first cointegrating vector in the equations for w and cg.

These restricted vectors are as follows:

$$\begin{aligned} Vec1 &= w + 6.53ur + 1.90y_w - 1.85r - .093t \\ Vec2 &= ur - cg + 1.44w - .60tx + .08z - .22g + .008t \end{aligned}$$

These two vectors are formally identified (in the sense of Johansen and Juselius (1994)), but their economic interpretation and hence their identification as a wage or unemployment relationship is far from obvious[7].

The wage share has a positive trend but decreases with higher unemployment. The unemployment rate is essentially the capital gap adjusted by adverse effects from the tax wedge and surprisingly from higher government expenditure. But the latter variable can be removed without changing the results significantly. Energy costs seem to have a favourable effect on the differential between ur and cg. The replacement ratio has no long-run effect at all.

3.3 Estimating the Short-run structure

Our analysis so far indicates that we need to consider the three variables w, ur and cg as the endogenous variables being jointly determined by this system. We will now use the information deduced from the cointegration analysis of the data to identify and estimate the structural form of the wage, unemployment and capital gap equations, conditional on the two cointegrating relations $Vec1$ and $Vec2$, both adjusted for their sample means. The data are thus mapped to $I(0)$ linear combinations. The new system is more parsimonious ($PVAR$) and determines five variables $(\Delta w_t, \Delta ur_t, \Delta cg_t, Vec1_{1t}, Vec2_{2t})$, where $Vec1_t$ and $Vec2_t$ are defined as identities. After estimating the $PVAR$, modelling can be pursued further to reduce high dimensionality. The $FIML$ estimates of our final equations, incorporating overidentifying restrictions are as follows:

[7] An alternative approach would be to argue that in this case, where a large number of variables are present, some of which can be considered as weakly exogenous, it is better to estimate a submodel directly and identify the long-run vectors in that framework. We find however that the sample size is too small to allow adequate testing, given that the lag length is already restricted to a minimum.

$$\Delta w_t = \underset{(5.14)}{1.}\ \Delta ur_t + \underset{(1.91)}{0.334}\,\Delta tx_t - \underset{(7.38)}{0.085}\,\Delta z_t - \underset{(7.06)}{0.468}\,Vec2_{t-1} + \underset{(2.45)}{0.347}\,dum1 - \underset{(1.56)}{0.287}\,dum2 \tag{3.3.a}$$

$$\Delta ur_t = \underset{(5.62)}{.157}\,\Delta g_t - \underset{(13.83)}{.171}\ \Delta y_{wt} + \underset{(4.09)}{0.139}\,\Delta r_t - \underset{(9.69)}{0.085}\,Vec1_{t-1} + \underset{(7.11)}{0.146}\,Vec2_{t-1} + \underset{(2.07)}{0.10}\,dum1 - \underset{(5.88)}{0.417}\,dum2 + \underset{(12.90)}{0.015}\,Const \tag{3.3.b}$$

$$\Delta cg_t = \underset{(2.62)}{.163}\,\Delta w_t + \underset{(2.54)}{0.039}\,Vec1_{t-1} + \underset{(7.32)}{0.301}\,Vec2_{t-1} - \underset{(1.55)}{0.191}\,dum2 \tag{3.3.c}$$

The Likelihood Ratio statistic of the overidentifying restrictions for the above system is $\chi^2(9) = 12.11[0.2073]$. The restrictions are easily accepted at the 5% significance level, and the test can be interpreted as providing evidence that this structural model parsimoniously encompasses the VAR. Furthermore, almost all the coefficients are significant at the 5% level, thus supporting the view that the above structure is empirically identified.

Recursive estimation, although covering only a small period, due to the size of the sample, shows no evidence of outliers in the residuals. The breakpoint CHOW statistic remains insignificant thus supporting parameter constancy, and the recursive encompassing test statistic is also displayed (see figure 7). Finally, figure 8 shows the actual and fitted values of the three endogenous variables together with a plot of the scaled residuals for each equation.

Dynamic simulation of the model, conditional on their initial values produces simulated values for Δw, Δur and Δcg which are shown plotted against the corresponding actual values. These are shown in figure 9, and the post-1973 years are well simulated. The changes in cg are not simulated as well as the other two series.

3.4 Economic Interpretation

The economic interpretation of these empirical results is not easy. The difficulty arises not only from the fact that there are both stochastic and deterministic trends in the DGP, but also from the existence of only two cointegrating relations where there are three endogenous variables. The cointegrating relations are furthemore not immediately interpretable as a long-run wage or unemployment or capital gap relations.

At a given capital gap cg, the (short-run) equilibrium wage and unemployment rates are uniquely determined. A linear combination of the cointegrating vectors can then written:

$$\begin{aligned} w &= .78cg + 0.47tx - .06z + 0.18g + 0.23y_w - .22r - 0.02t \\ ur &= -.12cg - .07tx + 0.06z - .03g - .33y_w + 0.32r + .02t \end{aligned}$$

Once the dynamics of capital accumulation are taken into account, the equilibrium wage share and unemployment rate are no longer uniquely defined. There is thus path dependency, that is different starting values may imply permanently different histories, temporary shocks can have permanent effects. The dynamics of the system is however such that the equilibria are locally very stable, so that not all shocks will make the economy switch paths. A one-period 10% decrease in world activity has for example no permanent effect. But a temporary wage control might have permanent effects and help put the economy on a lower unemployment rate path. To get more insight on the dynamics of the model, let us rearrange the terms in the two cointegrating relations so as to write each dynamic equation of table 4 with its corresponding error correction term. We obtain the following dynamic equations:

$$\begin{aligned}
\Delta w &= \{.34dum1 - .29dum2\} + \Delta ur - .08\Delta z + .33\Delta tx - .67\Big(w_{-1} + .70(ur_{-1} - cg_{-1}) \\
&\quad -.42tx_{-1} - .16g_{-1} + .06z_{-1} + .006t_{-1} + .21\Big) + \text{error} \\
\Delta ur &= \{.015 + .1dum1 + .42dum2\} + .16\Delta g - .17\Delta y_w + .14\Delta r - .41\Big(ur + .36cg_{-1} \\
&\quad -.31w_{-1} + .22tx_{-1} - .03z + .40y_{w_{-1}} + .08g_{-1} - .38r - .004t_{-1} + .175\Big) + \text{error} \\
\Delta cg &= \{-.19dum2\} + .16\Delta w - .30\Big(cg_{-1} - 1.85ur_{-1} - 1.57w_{-1} + .60tx_{-1} - .08z_{-1} \\
&\quad -.25y_{w_{-1}} + .23g_{-1} + .24r_{-1} - .007t_{-1} - 1.02\Big) + \text{error}
\end{aligned}$$

The coefficients associated with the error correction terms are .67, .41 and .30 for the wage, unemployment and capital gap equations respectively, suggesting fairly slow adjustment speeds for the unemployment rate and the capital gap.

One clear implication of these equations is that capital accumulation plays a substantial role in the dynamics of unemployment, and should be taken into account. To shed further light on the properties of the model and obtain an interpretation of past history, we conducted a few simulation experiments. Before presenting the results, it is necessary to consider the exogeneity status of the variables upon which the system is conditioned. The important issue here is to ascertain whether or not the parameters of the conditional model have changed in response to changes in regime during the historical period under study. For a simulation exercise to be valid, it is necessary not only that the conditioning variables be weakly exogenous, but also that the parameters of the conditional model be invariant to the potential changes in the parameters of the marginal densities. The conjunction of weak exogeneity and invariance of parameters ensures the *superexogeneity* of the conditioning variables.

We follow the procedures developed in Engle and Hendry (1993) to test for superexogeneity. The tests they propose are based on the idea that one must be able to discern whether there has been a shift in regime as far as the conditioning variables are concerned and if so, how big a change in parameters would thereby be expected. Thus, to test for superexogeneity, the procedure is to develop the marginal distribution of the conditioning variables and show the existence of regime shifts. The next step is to construct measures of the first two moments of these marginal distributions. These measures will clearly reflect those regime changes. Finally, introduce these measures into the conditional model. If the added variables turn out to be insignificant, there is evidence that the parameters of the conditional model are invariant to those regime changes and therefore that the conditioning variables may be treated as superexogenous.

We estimated the marginal distribution of each of the conditioning variables in our system, using an $AR(2)$ process. The recursive $CHOW$ statistics of parameter constancy showed clear evidence of the presence of regime shifts in all variables except for g. In all cases, the shift occurs either in 1974 or 1975. From these models we calculated the residuals of each regression $\hat{\eta}_t(.)$. We also estimated a two-period $ARCH$ model with the latter and calculated the deviations $Dev(.)$ of $\hat{\eta_t^2}(.)$ from the $ARCH$ error. We then reestimated equations (3.3.a) and (3.3.b) with OLS to get the following results:

$$\begin{aligned}
\Delta w_t \;=\;& \underset{(5.20)}{1.04}\,\Delta ur_t + \underset{(1.48)}{0.284}\,\Delta tx_t - \underset{(5.30)}{0.081}\,\Delta z_t - \underset{(7.19)}{0.493}\,Vec2_{t-1} \qquad (3.3.a')\\
& + \underset{(2.61)}{0.380}\,dum1 - \underset{(1.68)}{0.316}\,dum2\\
& - \underset{(0.69)}{0.798}\,\eta_t(\hat{dtx}) - \underset{(1.48)}{775}\;Dev_t(dtx) - \underset{(0.014)}{0.0003}\,\eta_t(\hat{dz}) - \underset{(1.39)}{0.218}\,Dev_t(dz)\\
\Delta ur_t \;=\;& \underset{(2.51)}{.289}\,\Delta g_t - \underset{(5.27)}{.219}\,\Delta y_{wt} + \underset{(1.88)}{0.125}\,\Delta r_t - \underset{(8.10)}{0.083}\,Vec1_{t-1} + \underset{(6.23)}{0.142}\,Vec2_{t-1} \qquad (3.3.b')\\
& + \underset{(1.36)}{0.07}\,dum1 - \underset{(6.33)}{0.413}\,dum2 + \underset{(11.52)}{0.017}\,Const\\
& + \underset{(0.93)}{0.045}\,\eta_t(\hat{dyw}) + \underset{(0.41)}{0.132}\,Dev_t(dyw) - \underset{(0.38)}{0.034}\,\eta_t(\hat{dr}) + \underset{(0.64)}{1.73}\,Dev_t(dr)\\
& - \underset{(1.43)}{0.170}\,\eta_t(\hat{dg}) - \underset{(0.64)}{0.659}\,Dev_t(dg)
\end{aligned}$$

Clearly, none of the additional variables are significant, thus reinforcing the view that the conditioning variables may be treated as superexogenous. The only odd result here is the large value for the coefficient of $Dev_t(dtx)$, suggesting the presence of some form of non-linearity in the marginal distribution of tx. This remains to be investigated in future research.

Our simulation results are illustrated in figures 10 and 11. The solid line in all these figures shows the simulated values of ur and w using the estimated model of table 4. We first constructed a reference scenario as follows: Before 1973, all the exogenous variables keep their actual values; from 1973 onwards, we assume that world trade (y_w) continues to grow at the same average rate as before (i.e. 4.63% per annum), the tax wedge (tx) and the deterministic trend take their actual values; all other exogenous variables keep their 1973 values. With this economic environment, the wage share and the unemployment rate remain more or less constant (the stochastic and deterministic trends compensate the trend in world trade and in the tax wedge); this is shown as the dashed-dotted line in figure 10.1 (for the unemployment rate) and figure 10.2 (for the wage share). We next give to world trade its actual value. This produces a huge increase in unemployment and a moderate decrease in wages (dotted line in figures 10.1 and 10.2).

The next step is to introduce public expenditure (g) and the wage control dummies ($dum1$ and $dum2$). This is shown as the dashed-dotted line in figure 11.1 and 11.2. The result is a much lower unemployment rate (mainly due to wage controls) and lower wage share (mainly due to public expenditure cuts; this variable probably plays the role of a proxy for policy changes not accounted for by $dum1$ and $dum2$). The difference between the dashed-dotted line and the solid line represents the effect of the remaining exogenous varibles, namely z, r and rr.

These simulation experiments thus suggest at least two points:

— Firstly, variables traditionally regarded as supply side variables, such as the replacement ratio rr, the tax wedge tx, the real interest rate r, or the real price (here share) of energy z do not seem to be responsible for the observed increase in unemployment.

— Secondly, the slowdown in the growth of world trade seems to have been the main cause of rising unemployment in Belgium; without the wage controls of the early eighties, employment losses would have been much larger. These findings corroborate those of Mehta-Sneessens (1990), based on a different econometric methodology.

4 Conclusions

The theoretical models presented in this paper suggest that by introducing explicitly and rigorously the effects of sales and capacity constraints in otherwise standard $NAIRU$ models, one can obtain path dependency. The result comes from a combination of both demand and supply-side effects (demand expectations, capital accumulation, real rigidities). This remains true if we enlarge the model to distinguish two types of labour and skills.

We estimated an econometric model on Belgian post-war data, with special emphasis on the effects of the 1982-1987 wage controls. The list of variables included in the analysis is fairly standard. The model was estimated by using Johansen's maximum likelihood approach, thus imposing as few *a priori* restrictions as possible on the structure of the model. The results obtained suggest path dependency and are thus compatible with the implications of our theoretical model.

This of course does not "prove" path dependency. Still, it is worth considering the economic policy implications of such a scenario. The most important being that an economic policy aimed at reducing unemployment should, in order to be efficient, use both demand and supply-side policy instruments (the so-called "two-handed growth strategy").

APPENDIX . List of variables

P	=GNP price index
Y	= GNP
Y/L	= Observed labour productivity
A	= Technical productivity of labour, corrected for labour hoarding
B	=Technical productivity of energy
C	= Technical productivity of capital
w_y	= share of labour in GNP defined as $[log(W/P) - log(Y/L)]$
z_y	= share of imported energy in GNP defined as $[log(Z/P) - log(Y/N)]$ where Y/N represents the observed productivity of imported energy
W	= firm's wage cost (per head)
WN	= Net wages (per head)
rr	$= log(UB/WN)$, where UB is unemployment benefits per head (obtained from the Belgian Planning Bureau 1953-1994)
tx	= tax wedge $= log(W/WN)$
r	= real long-run interest rate
YL	= Full-employment output. It is calculated as labour productivity (corrected for labour hoarding) multiplied by labour supply
g	$= log(G/YL)$, where G = government expenditure
y_w	$= log(Y_w/YL)$, where Y_w is the index of world trade
ur	= unemployment rate $= 1 - l = 1 - (L/LS)$ where L is actual employment and LS labour supply
cg	= capital gap $= 1 - k = 1 - (LP/LS)$ where LP is full-capacity employment and LS labour supply

Variables LP, full-capacity employment and YL, full employment output are estimated variables based on annual data (1955-1990) as in Mehta-Sneessens (1990). LP is proportional to the stock of capital, with the proportionality factor being equal to the ratio of technical coefficients. In a Cobb-Douglas production function this ratio is equal to the ratio of the optimal values of production factors $\frac{W^*}{V^*}$; With partial adjustment:

$$log(\frac{W^*}{V^*})_t = \theta log(\frac{W}{V})_t + (1-\theta) log(\frac{W^*}{V^*})_{t-1}$$

$\frac{W}{V}$ was approximated by $\frac{W}{P}$, and θ, the only parameter involved in the calculation of LP, was estimated to be .75.

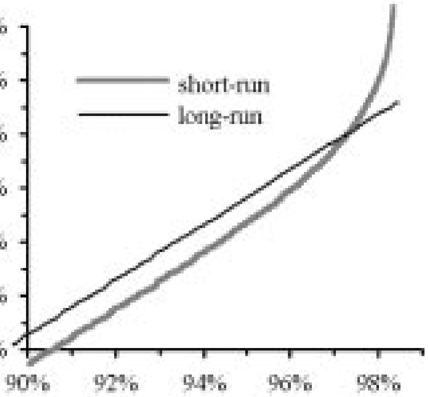


Figure 1: Determination of the Long-run Equilibrium
(k is measured along the vertical axis, l along the horizontal)

Figure 2: Unemployment and Capital Gap

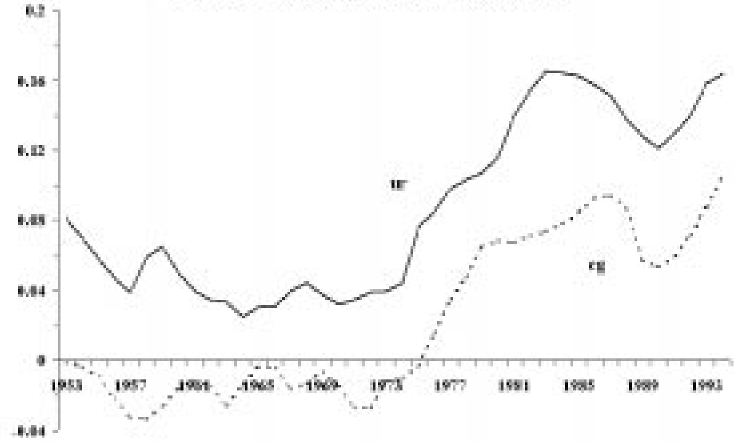


Figure 3: Investment and Government Expenditure

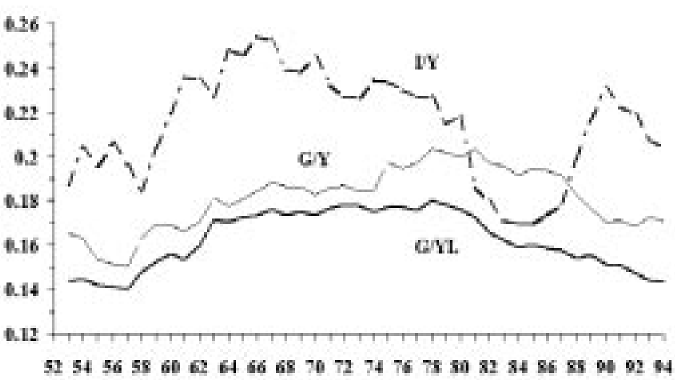


Figure 4: The wage, energy and profit shares in total output

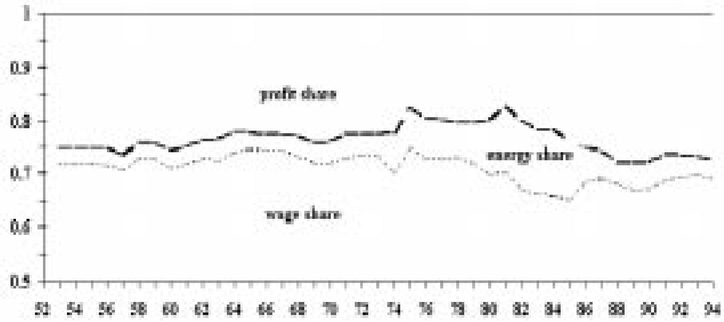


Figure 5: Real Interest Rate, Replacement Ratio and the rate of growth of World Trade.

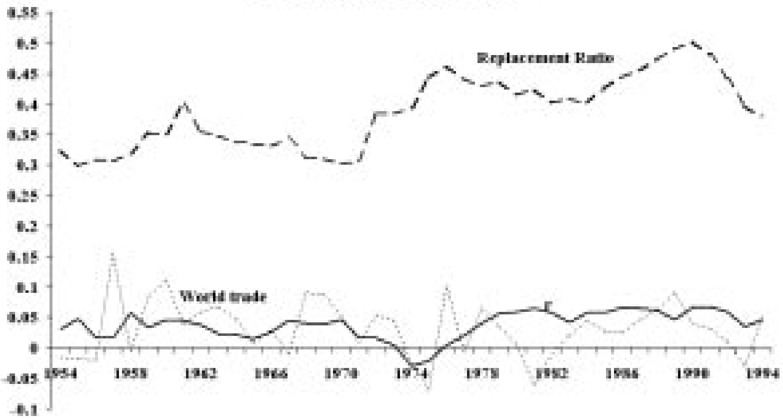


Figure 6: Tax Wedge and Wage control.

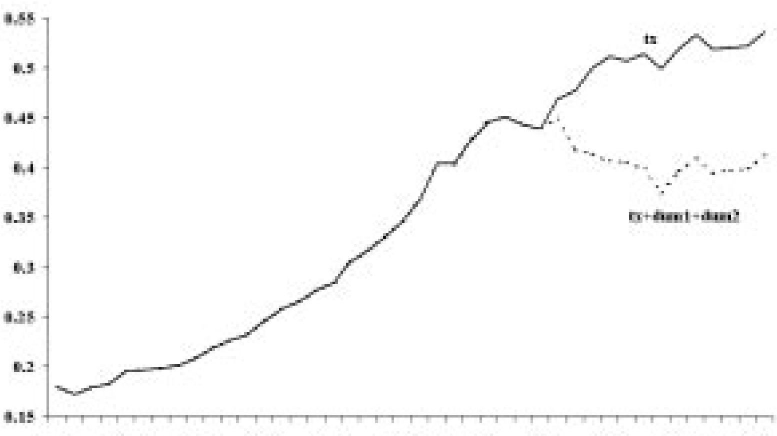


Figure 7: Recursive Evaluation of the Model.

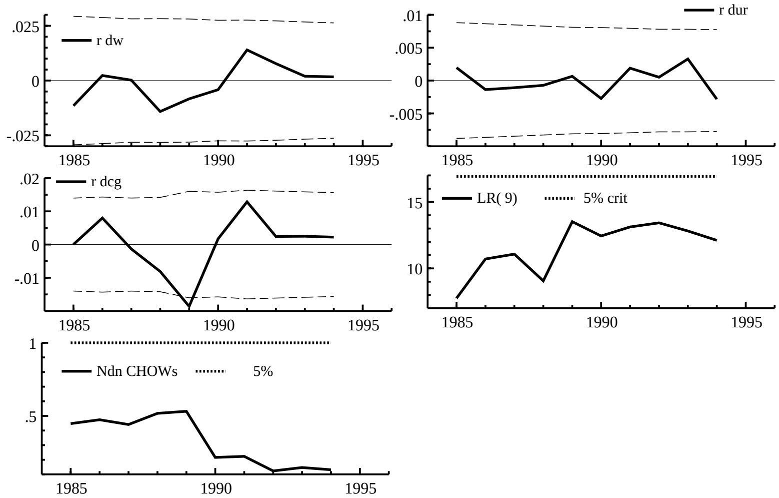


Figure 8: Actual and Fitted Values and Scaled Residuals.

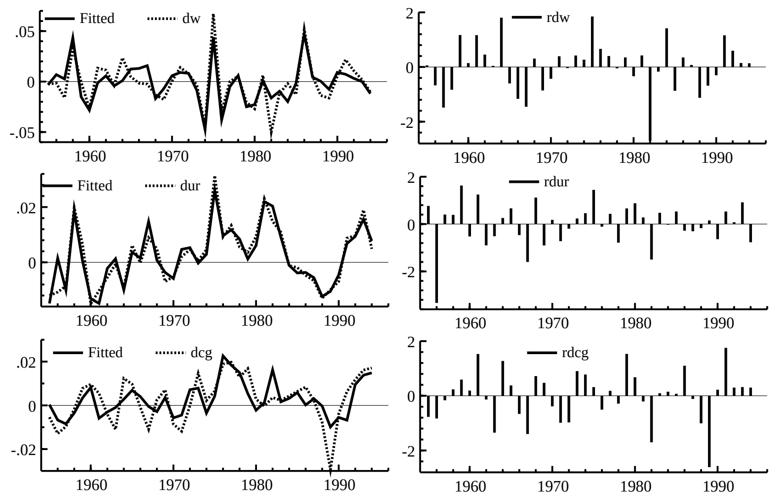


Figure 9: Actual and Simulated Values of the changes in w, ur and cg.

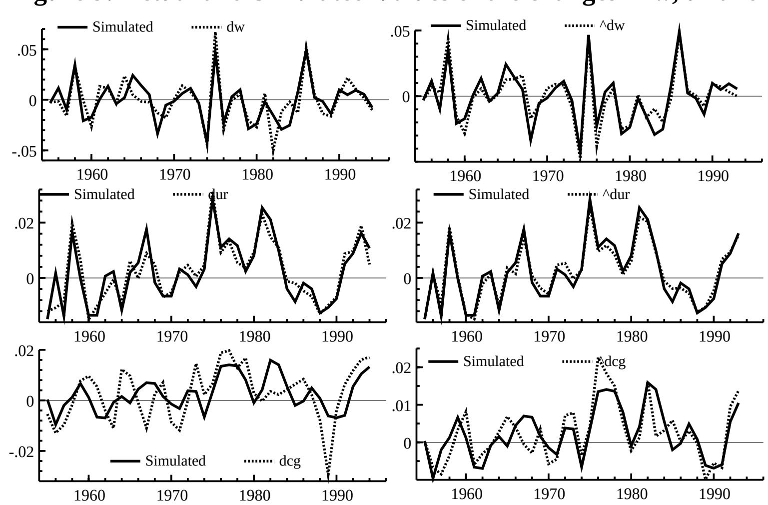


Fig10.1: Comparing the effect of actual and adjusted Yw on the unemployment rate ur.

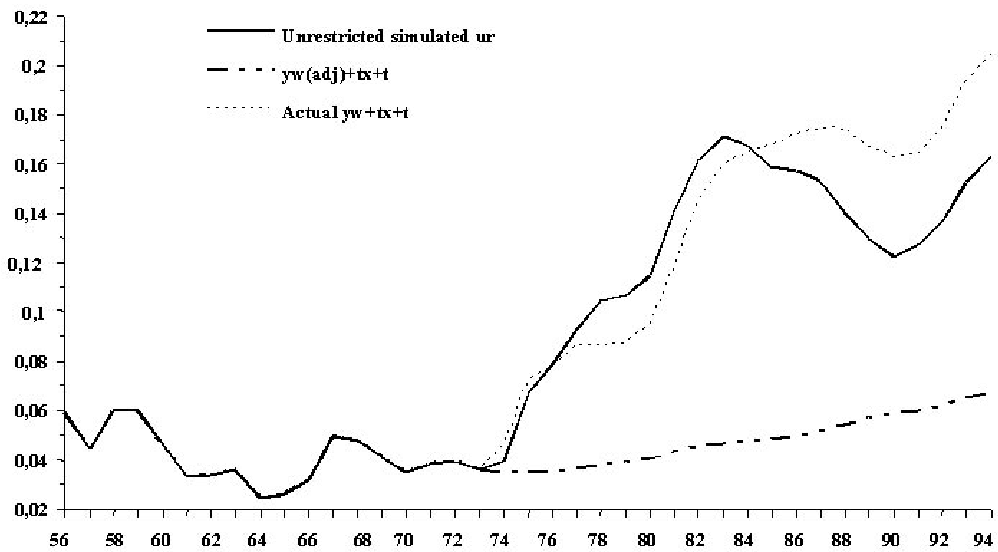


FIG10.2: Comparing the effect of actual and adjusted Yw on the wage share w.

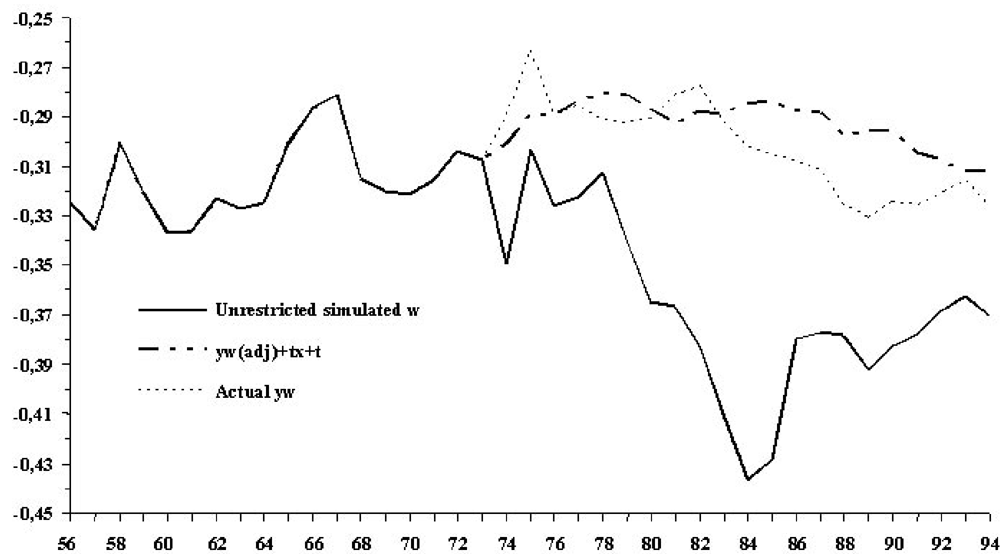


FIG11.1: Adding the effect of g and wage control dummies on the unemployment rate ur.

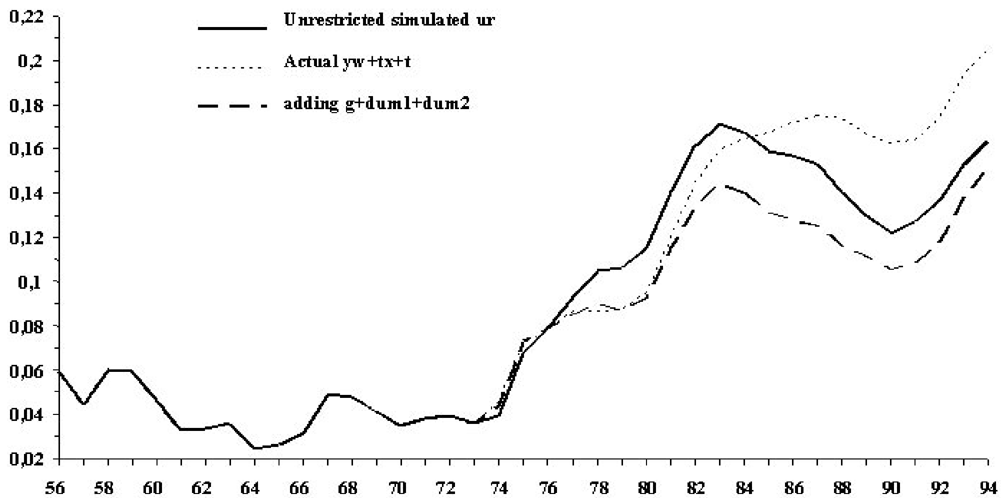
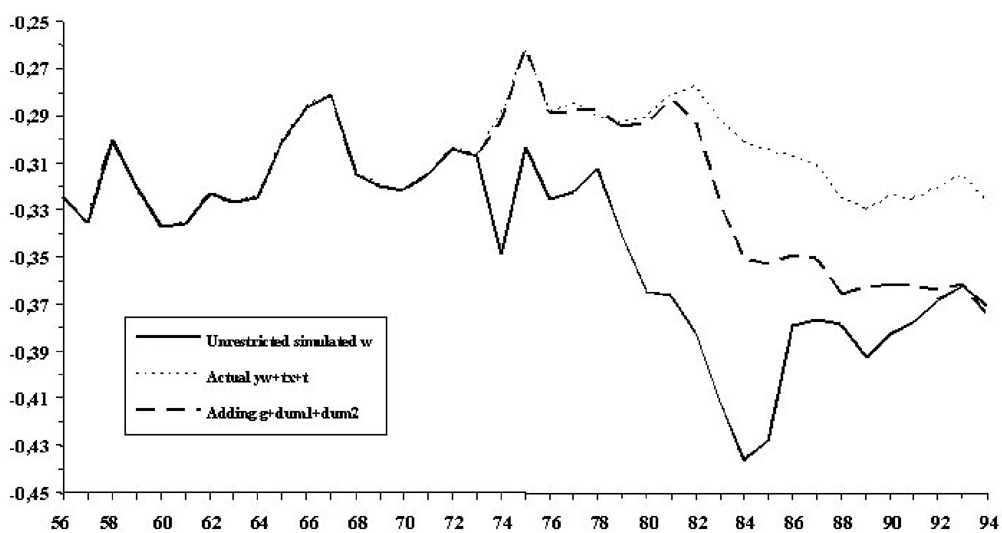


FIG 11.2: Adding the effect of g and wage control dummies on the wage share w.



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