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CAPITAL ACCUMULATION AND UNEMPLOYMENT: A TALE OF TWO "CONTINENTS"

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Abstract

In contrast to much recent work regarding the causes of European unemployment, in this paper, we emphasise the importance of capital accumulation. But unlike the few previous studies which have examined the relationship between capital accumulation and unemployment, we argue that what matters for the evolution of employment [and the unemployment rate] is not the absolute growth rate of a country's capital stock, but its evolution relative to other countries' capital stock. The empirical validity of the above statement is demonstrated for almost all OECD countries using quarterly time-series data from 1961-1995. More detailed evidence is also presented for Germany, Japan and the United Kingdom.

Keywords: Unemployment, capital accumulation, international competition

JEL Classification: E22, E24, J21

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I. Introduction

The received wisdom regarding the causes of the historically high un-employment rates in Europe during the last twenty years has recently been reaffirmed: "…generous unemployment benefits that are allowed to run on indefinitely…; high unionization with wages bargained collectively and no coordination between either unions or employers in wage bargaining; high overall taxes impinging on labour…; poor educational standards at the bottom end of the labour market" [Nickell, 1997, p.72]. Accordingly, it is suggested that to fight unemployment, the European

(b) erode the relative value of the minimum wage (c) restructure the payroll tax system (d) foster competition in product and labour markets (e) improve training and (f) offer the unemployed the option of turning their benefits into employment vouchers [Alogoskoufis *et al*., 1995, p.129-130]. Others are even more emphatic about the roots of the evil: "…the specter of unemployment that is haunting Europe will not be exorcised unless governments are prepared to undertake major reforms of the institutional setup of the labour market" [Siebert, 1997, p.53].

What the above mentioned studies and many others [*c.f.* Nickell, 1998, Phelps and Zoega, 1998 and Ljungqvist and Sargent, 1998] have in common is the absence of any role for the capital stock as a determinant of unemployment. In their influential treatise on unemployment, Layard, Nickell and Jackman, 1991 - LNJ [1991] hereafter - provide a justification for this omission based on a "stylized fact": the unemploy-ment rate is untrended over the very long-term. They interpret this as suggesting that in the long-term, a country's capital stock and productivity have no impact on its unemployment rate. Otherwise unemployment should be negatively trended given the large increases in capital stock and

productivity during the last century. Additionally, they show that in the context of a union model [p. 107], equilibrium unemployment is independent of the amount of capital *per capita* in the economy if the production function is Cobb-Douglas and the benefit replacement ratio is constant[1].

The relationship between the capital stock and the unemployment rate has attracted the attention of a small number of economists [the earliest one being Malinvaud, 1980][2]. Bean [1994] provides a summary of the earlier work in this area which is mainly based on the idea of limited *ex-post* substitutability between capital and labour. In this work, employment is constrained by the amount of the existing capital stock. Survey evidence on capacity utilization has been used by Sneessens and Drèze [1986] to support the idea that capital shortages create a technological constraint on employment. Nevertheless, later studies [see, Drèze and Bean, 1990], have questioned the assumption of limited *ex-post* factor substitutability and Bean [1994] concludes that capital shortages cannot be the main explanation for the rise in European unemployment. This conclusion has been challenged by two recent studies.

First, Rowthorn [1996] uses a "battle of the mark-ups" or a "competing claims" model [see Rowthorn, 1977, Blanchard, 1986, Layard and Nickell, 1986 and Carlin and Soskice, 1990] type model to argue that an increase in the capital stock reduces the ability of firms to raise prices since it creates - *ceteris paribus* - excess capacity. It also leads to better trade performance, which allows the real exchange rate to appreciate and real

[1] Phelps (1968) was the first to demonstrate that the natural rate of unemployment is not affected by proportional increases in the capital stock and productivity.
[2] More recent studies containing general equilibrium models in which the capital stock is a fundamental determinant of unemployment include Sneessens (1987), Phelps (1994), de la Croix and Licandro (1995), de la Croix and Fagnart (1995), Benassy (1997) and Caballero and Hammour (1998a, 1998b).

domestic income to increase. The conflict over income distribution is thus lessened and a stable rate of inflation can be achieved at a lower unemployment rate. Rowthorn's empirical analysis provides some support for this thesis. Second, Gordon [1997] finds that the countries which experienced the largest slowdowns in the growth rate of capital per potential labour hour faced the greatest increases in the unemployment rate. He also concluded that the European countries in the 1990s do not have enough capital to equip all the employees who would have had a job if unemployment rates in Europe had remained at the level of the late 1970s. The basic mechanism which Gordon uses to explain these findings is a version of the "battle-of-the-mark-ups". Within this framework Gordon shows that in response to a wage-setting shock, the new full equilibrium position will involve the original level of labour productivity and even lower employment. Consequently, the traditionally expected [positive] trade-off between unemployment and productivity would not be observed.

The main point of this paper is that in an international context, what matters for the evolution of employment [and the unemployment rate] is not the absolute growth rate of a country's capital stock, but its evolution relative to other countries' capital stock. In other words, this paper explains the medium- to long-term variations [caused by differential rates of capital accumulation] around the untrended very long-term unemployment rate brought to the attention of the profession by LNJ [1991]. To understand the intuition generating such a conclusion, consider an oligopolistic setting in which domestic firms are competing with foreign firms. If firms compete in quantities [the Cournot-Nash solution], then increases in the domestic capital stock [which increase labour productivity] will - by reducing the marginal cost of domestic firms - increase domestic output and reduce foreign output and employment. However the effect on domestic employment is ambiguous since it depends on

the net result of the employment gains associated with higher domestic output and the employment loses [at the same level of output] due to increased productivity. By contrast, increases in the foreign capital stock, would result in decreases in the marginal cost of foreign firms and in reductions of domestic output and employment. In this sense the trade-off between unemployment and productivity [or the capital stock] may even be negative. A country may need high growth rates in its capital stock to avoid the loss of market share which would be a result of increases in foreign capital stock [and productivity][3].

Figure 1. Unemployment Rate & Difference in Growth Rates of Capital Stocks

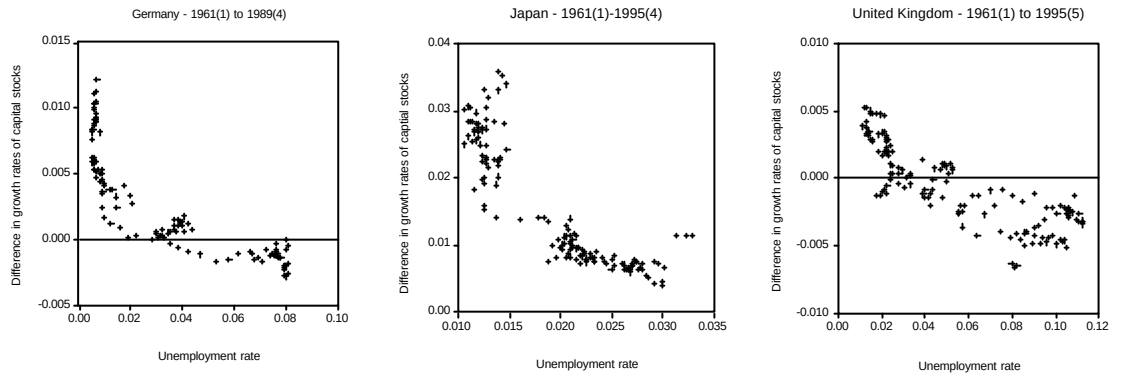


Figure 1 illustrates the empirical importance of the above statement very clearly. Given the widely differing experience between Europe and Japan over unemployment on the one hand, and the growth rate of the capital stock, on the other, it is illuminating - at this moment - to look at three countries: Germany, United Kingdom [as representatives of the European experience] and Japan. For each of the above countries, the horizontal axis in Figure 1 measures the unemployment rate whereas the difference in the growth rate between each country's capital stock and the weighted average of the rest of the OECD's capital

[3] A different (but complementary) interpretation for why fast growth rates in a country's capital stock are conducive to lower unemployment rates can be based on the idea that more recent additions to a country's capital stock improve its technological capabilities relative to its competitors and allow it to capture a larger market share.

stock is displayed on the vertical axis[4]. We term this variable "difference in growth rates of the capital stock"[5]. For each of the three countries there is a clear negative non-linear relationship between the unemployment rate and the difference in growth rates of the capital stock. We demonstrate later in Section III that this relationship holds for almost all OECD countries for which data are available[6].

Recently, Blanchard [1998] argued that the failure of unemployment to decrease in Continental Europe since the mid 1980s - despite the substantial decreases in wages relative to underlying factor productivity - must be due to a downward movement of the labour demand curve. Blanchard suggests two explanations [and provides some evidence, see, Blanchard, 1997] for the drop in labour demand. The first rests on a shift in the distribution of rents. Tighter corporate governance and weaker unions may have allowed firms which suffered from feather bedding and excess employment to shed labour. The second explanation is based on technological bias: firms in Continental Europe have adopted more capital intensive methods of production. Our explanation for the drop in labour demand by European firms as a result of faster capital accumulation in other countries is supportive of Blanchard's emphasis on adverse shifts in the labour demand curve.

The rest of this paper is organised as follows. In the next Section we first construct a simple two-country model to show the partial equilibrium effects of changes in the

[4] The data employed in this study are on a quarterly basis and are from the OECD Business Sector [BSD], Quarterly Labour Force Statistics [QLF] and Economic Outlook [EO] databases. Further details on data definitions and sources can be found in the Data Appendix. Lack of reliable capital stock data constrains us to use the rest of OECD as a proxy for the rest of the world. The sample period for the German data has been truncated to 1989(4) due to reunification.

[5] This measure is defined as $\hat{k}_t = \Delta \ln k_t - \sum \omega_{j,t} \Delta \ln k_{j,t}$, where $\Delta \ln k_t$ is a country's own rate of capital stock growth and $\sum \omega_{j,t} \Delta \ln k_{j,t}$ is the GDP weighted sum of the growth rates in the rest of the OECD.

[6] Full sample data are not available for Iceland, Luxembourg, Mexico, New Zealand and Turkey.

domestic and foreign capital stocks. Then we discuss the macroeconomic implications arising from relaxing some of the partial equilibrium assumptions. In Section III, we estimate the relationship between the unemployment rate and the difference in growth rates of the capital stock for 20 OECD economies. In Section IV, we further test for Germany, Japan and the United Kingdom whether the strong and statistically significant negative relationship that we find between the two variables is an artifact of either missing variables and/or of high correlation of the relative capital stock variable with aggregate demand measures. Finally, Section V contains concluding comments.

II. Theoretical Considerations

In this Section we present an imperfectly competitive model which is a variant of the partial equilibrium models used in the strategic trade policy literature [see, for example, Brander and Spencer, 1985, Helpman and Krugman, 1989][7]. We then use the results of this model to draw some implications regarding the effects of domestic and foreign capital accumulation in a macroeconomic framework.

II.1 CAPITAL STOCKS AND EMPLOYMENT IN PARTIAL EQUILIBRIUM

Consider a two country model with each economy consisting of many sectors[8]. We first examine one sector in isolation. We assume that there is a unified world market for the product of this sector in which n [identical] domestic and n [identical] foreign firms behave as Cournot oligopolists. The market demand curve facing domestic and foreign firms in this sector is

[7] Needless to say that other partial equilibrium models with different assumptions about market structure would yield the same conclusions.
[8] Presenting a two-country instead of an n-country model saves on notation without losing anything in substance.

(1) $$P = \alpha - \beta(nX_1 + nX_2)$$

where P is the price of the product and X_i; i=1,2 is the output [and sales] of each of the n domestic and n foreign firms, respectively. The capital stock K_i, which each firm uses is taken as exogenous. We assume further that both sets of firms have similar cost structures. In particular, we assume that there are economies of scale which arise from the existence of a fixed cost in terms of labour which must be incurred to start producing.

This is expressed as

(2) $$N_i = \gamma_i + \delta_i(K_i)X_i, \quad \delta_i'(K_i) < 0, \quad i = 1,2$$

where N_i is the amount of labour required to produce X_i units of output by each firm in country i, γ_i is the fixed cost of labour input in country i, and $\delta_i(K_i)$ is the marginal input-output coefficient which depends [negatively] on the capital stock used by each firm. For any given level of the capital stock, equation (2) implies that the marginal cost is constant but the average cost is declining[9]. The term $\delta_i(K_i)$ captures the extent to which a higher capital stock succeeds in increasing the productivity of labour.

The profit function of each firm can be written as

(3) $$\pi_i = PX_i - [\gamma_i + \delta_i(K_i)X_i]w_i - r_iK_i, \quad i = 1,2$$

where w_i and r_i stand for the given wage rate and the rental cost of capital (respectively). The Cournot-Nash solution to this oligopoly game predicts that the output level of each domestic and foreign firm will be equal to

(4) $$X_1 = [\alpha + nw_2\delta_2(K_2) - (n+1)w_1\delta_1(K_1)] / \beta(2n+1)$$

(5) $$X_2 = [a + nw_1d_1(K_1) - (n+1)w_2d_2(K_2)] / b(2n+1).$$

[9] This assumption is by no means necessary for the rest of the analysis.

From equations (4) and (5) we observe that an increase in the domestic firms' capital stock will increase their output and reduce the output of their foreign rivals. The effects of changes in the capital stock on employment are not so clear-cut however. We find that

(6) $$dN_1 / dK_1 = \{d_1'(K_1)[a + nw_2 d_2(K_2) - 2(n+1)w_1 d_1(K_1)]\} / b(2n+1) \gtrless 0$$

(7) $$dN_2 / dK_2 = \{d_2'(K_2)[a + nw_1 d_1(K_1) - 2(n+1)w_2 d_2(K_2)]\} / b(2n+1) \gtrless 0$$

(8) $$dN_1 / dK_2 = [nw_2 d_2'(K_2) d_1(K_1)] / b(2n+1) < 0$$

(9) $$dN_2 / dK_1 = [nw_1 d_1'(K_1) d_2(K_2)] / b(2n+1) < 0 .$$

We observe that an increase in the capital stock of each domestic firm will result - *ceteris paribus* - in a reduction in employment for every foreign firm, whereas it has an ambiguous effect on domestic employment. This ambiguity stems from the fact that fewer workers are now needed to produce the old level of output. The increase in domestic output may thus not be large enough to provide employment for those that would lose their jobs if domestic output had remained constant.

On the basis of the above partial equilibrium results one may conclude that equivalent increases in the capital stock of both domestic and foreign firms are not likely to result in increases in either domestic or foreign employment. Consider, for example, a symmetric case in which domestic and foreign firms are identical [i.e. $w_1=w_2=w$, $r_1=r_2=r$, $K_1=K_2=K$, $d_1(K_1)= d_2(K_2)= d(K)$]. Then we find that

(10) $$(dN_1 / dK_1) + (dN_1 / dK_2) = \{d'(K)[a - 2wd(K)]\} / b(2n+1) \gtrless 0 .$$

Even though this expression appears to be ambiguous, note that a denotes the [almost] maximum price which can be set in the market without sales [of all firms] dropping

to zero whereas $wd(K)$ denotes the marginal cost. Since we can think of many people who would be willing to pay twice the going price for a box of matches rather than go without them and [we suspect] that Mercedes would be able to sell some cars even if it doubled its prices, it is very likely that $a > 2wd(K)$. Consequently, we would expect that in this particular partial equilibrium setting equiproportional increases in K_1 and K_2 would result in a fall in employment in the sector producing this good in both countries.

II.2 MACROECONOMIC IMPLICATIONS

The first thing that must be taken into account with respect to the previous analysis in a macroeconomic setting is the assumed constancy of the market demand curve [equation (1)]. If, following from the previous symmetric example, K_1 and K_2 increase by the same proportion, from equations (4) and (5) we can deduce that X_1 and X_2 will increase. If the increase in output [and of the capital stock] is not restricted to a particular sector, the resulting increase in aggregate [real] income would affect at least the position [i.e. it would increase the value of parameter a] of the market demand curve. Nevertheless it can be shown that the net effect on employment would still be [even within the confines of the particular example] ambiguous. This ambiguity becomes, however, less pronounced if we do not consider equiproportional increases in the capital stocks of the two countries. Let, for example, an increase in the world capital stock be unequally distributed between the domestic and the foreign country [$dK_2 > dK_1$]. It is then obvious from equations (6) and (8) that - *ceteris paribus* - it becomes more likely that domestic employment will fall [equivalently, it becomes more likely that foreign employment will rise]. We therefore conclude that countries which enjoy faster growth rates in their capital stock than their trade partners are more likely - *ceteris paribus* - to experience employment increases.

We now relax the assumption of constant wages at home and abroad [i.e. the assumption of constant competitiveness]. Following LNJ [1991] we assume that there exists an upward sloping wage setting [WS] function which relates aggregate employment to the real wage [for a given labour supply][10]. The position of this schedule depends - amongst other things - on labour productivity. A higher level of the capital stock is expected to shift the WS schedule upwards. LNJ [1991] argue that it is such increases in wage demands on the part of workers which offset the positive effects of a higher capital stock on employment. In our context, an increase in the foreign capital stock - for a given level of the domestic capital stock - will have no effect on the position of the wage setting schedule. It will, nevertheless, effect a movement along this schedule, thereby only partly offsetting the negative effect on domestic employment. And to the extent that the upward shift of the foreign wage setting curve does not further erode the increase in competitiveness of the foreign country, there will be an increase in the domestic unemployment rate. Equiproportional increases in the domestic and foreign capital stock essentially move both countries upwards along a vertical long-run wage-setting curve. Real wages increase in both countries but the unemployment rate in the very long-term is unaffected. The analysis becomes only slightly more complicated if we allow both countries' capital stocks to grow but at unequal rates. In this case there would be an upward shift in the wage setting schedules of both countries and as long as the growth rate of the foreign country's capital

[10] The empirical implications of changes in the labour supply are examined in Section IV.2.

stock is larger, the domestic [foreign] unemployment rate will be expected to increase [fall][11].

III. EMPIRICAL LINK BETWEEN UNEMPLOYMENT & CAPITAL ACCUMULATION

The scatter plots presented in Figure 1 (as well as the scatter plots for the other OECD countries[12]) clearly reveal that the relationship between the unemployment rate, u and the difference in growth rates of the capital stock, $\hat{k}$ is negative and non-linear. The relationship is nearly vertical at high rates of unemployment (and low rates of $\hat{k}$) and almost horizontal at low rates of unemployment (and high rates of $\hat{k}$). This is to be expected since when u is very low (i.e. when unemployment is mainly frictional) there can be no decreases in the unemployment rate as $\hat{k}$ increases.

Table 1. Summary of Regression Results for the Non-linear Model $u_t = e^{a+b(\hat{k}_t)} + e_t$

	1960-95 (full sample)			65-95	70-95	75-95
Countries	$\hat{\alpha}$	$\hat{\beta}$	$\overline{R}^2$			
Australia	-2.5 [.000]	-191.4 [.000]	.759	√	√	√
Austria	-3.0 [.000]	-109.3 [.000]	.567	√	√	√
Belgium	-2.4 [.000]	115. [.000]	.088	***x***	***x***	√
Canada	-2.5 [.000]	-16.5 [.075]	.010	√	√	√
Switzerland	-4.8 [.000]	-90.7 [.003]	.038	***x***	***x***	***x***
Germany	-3.1 [.000]	-275.0 [.000]	.859	√	√	√
Denmark	-2.7 [.000]	-173.9 [.000]	.682	√	√	√
Spain	-1.7 [.000]	-86.0 [.000]	.829	√	√	√
Finland	-3.4 [.000]	-216.9 [.000]	.875	√	√	√
France	-2.7 [.000]	-176.0 [.000]	.766	√	√	√
Great Britain	-3.1 [.000]	-159.1 [.000]	.647	√	√	√
Greece	-2.7 [.000]	-13.0 [.000]	.165	√	√	√
Ireland	-2.3 [.000]	23.2 [.006]	.028	***x***	√	√
Italy	-2.7 [.000]	-114.3 [.000]	.580	√	√	√

[11] An implication of the above analysis is that - *ceteris paribus* - the country with the higher wages will have the lower unemployment rate. This is reminiscent of the "wage curve" (see, Blanchflower and Oswald, 1995) in a regional context.

[12] To preserve space we do not report these plots here. However, in Table 1 below we report the regression analogue of these plots for all 20 countries for the full sample and several sub-periods.

Japan	-3.6 [.000]	-24.3 [.000]	.558	√	√	√
Netherlands	-3.2 [.000]	-155.1 [.000]	.413	√	√	√
Norway	-3.6 [.000]	-93.6 [.000]	.347	√	√	√
Portugal	-2.8 [.000]	-55.2 [.000]	.478	√	√	√
Sweden	-3.4 [.000]	-133.5 [.000]	.404	√	√	√
United States	-2.8 [.000]	26.5 [.000]	.087	***x***	***x***	***x***

Notes: (i) The full sample range is from 1960(2) to 1995(4) except for Germany which ends in 1989(4), France which starts in 1964(4) and Greece which ends in 1994(4). Except for the full sample range, all regressions start in the first quarter and end in the fourth quarter; (ii) The numbers is square brackets are *p-values* for the heteroscedastic-consistent *t-ratios*; (ii) **Õ** indicates that the relationship between u_t and $\hat{k}_t$ is negative and significant whereas, ***x*** denotes that it is not.

Based on the scatter plots we next estimate a *constant growth model*[13] of the form $u_t = e^{a+b(\hat{k}_t)} + e_t$. In Table 1 above we summarise the results of this estimation for 20 OECD countries, for the full period 1960-95, as well as for three sub-periods (1965-95, 1970-95, 1975-95). Note that the results (for the full sample) reveal that except for Belgium, Ireland and the United States, the relationship between u and $\hat{k}$ is negative and significant at the 5% level (with Canada being significant at the 7.5% level). Further note that Switzerland and the United States are the only countries for which the relationship between u and $\hat{k}$ is not negative and significant (at the 5% level) for any of the sub-periods[14].

We now focus on the apparent failure of our hypothesis for the United States. A closer examination of residuals from the above regression reveals a break in the relationship

[13] Obvious nonlinear alternatives, which are capable of approximating the rectangular hyperbolic shape in Figure 1, include the *constant elasticity* and the *reciprocal models*. However since $\hat{k}$ can take on negative values, the *constant elasticity model* is not applicable. Additionally, we found that the *reciprocal model*, commonly used to estimate Phillips curves [see, for example, Alogoskoufis and Smith, 1991], provided a substantially worse fit for all countries.

[14] The result for Switzerland is probably explained by its unique treatment of guest workers. They were allowed into the country only during business upswings and then were sent home during downturns. In that way Switzerland's unemployment rate remained practically constant. An anonymous referee suggested that openness may be a reason for the failure of our hypothesis for Belgium, Ireland and Switzerland. Our inclusion of an openness measure (imports plus exports over GDP) made our hypothesis go through only in the case of Belgium.

between u and $\hat{k}$ in 1974. The negative relationship seems to hold up to 1974, and permanently shifts thereafter. Indeed, after the introduction of an oil dummy in 1974 both $\hat{\alpha}$(=-3.1) and $\hat{\beta}$(=-24.9) are significant at the 1% level (i.e. $t_{\hat{\alpha}}$=-102.0 and $t_{\hat{\beta}}$=-3.98) and the $\overline{R}^2$ increases to 0.43. At first sight, one may be surprised that introducing an oil shock dummy would make such a difference for the U.S., which is - after all - an oil producing country itself. Nevertheless, oil shocks may have a more deleterious effect on unemployment in countries which are less heavily dependent on imported oil. As Phelps (1992, p 1480) observed, "..wouldn't a student of price theory say that where nationals are the owners of the oil, they will enjoy (on top of the substitution effect of a reduced demand wage) an income effect that adds to the rise of unemployment - more quitting, more shirking, more encouraging the union to raise wages, all because the employees are now more comfortably fixed with non-wage income?" It is also of interest to note that including an oil dummy for Canada - an oil producing country as well - produces a similar effect, e.g. after the introduction of an oil dummy in 1974 both $\hat{\alpha}$(=-2.67) and $\hat{\beta}$(=-84.1) are significant at the 1% level (i.e. $t_{\hat{\alpha}}$=-81.2 and $t_{\hat{\beta}}$=-9.38) and the $\overline{R}^2$ increases to 0.70. These results give some support to the Phelps's hypothesis[15].

IV. A MORE DETAILED INVESTIGATION FOR GERMANY, JAPAN AND THE U.K.

Having established the validity of our basic hypothesis for most OECD countries, we now proceed with a more detailed examination of the issue for Germany, Japan and the United Kingdom. We start by extending the model estimated above to address issues

[15] Further evidence in favour of the "Phelps hypothesis" is indicated by the fact that oil shock dummies do not enter significantly, for example, for either Germany or Japan, but enter significantly for the United Kingdom and Norway (both oil producing countries) but without upsetting our basic hypothesis.

concerning dynamic adjustment and conclude by examining the robustness of the extended model to potential specification errors.

IV.1 UNEMPLOYMENT & CAPITAL ACCUMULATION IN A DYNAMIC CONTEXT

To capture the inherent delays between capital formation and its effect on the unemployment rate we next estimate the following dynamic *constant growth model* using nonlinear least squares [NLS]

$$(11) \qquad (1-g_p L^p)u_t = e^{a+b(\hat{k}_{t-1})} + e_t, \quad e_t \sim IID(0, s_e^2)$$

where, a, b, and g_p are the parameters to be estimated and L is the lag operator[16]. From the scatter plots and units of measure, α and b are both expected to be negative.

Two aspects regarding the specification of (11) are noteworthy. First, we now allow for the effects of $\hat{k}$ on u to be distributed over a number of time periods. Since our theory does not provide guidance regarding the shape or length of the lag distribution, the number of time periods, p, will be determined statistically. Note that estimating the lag structure in this fashion provides more flexibility than the simple *geometric lag model* since it allows for initial change(s) in the lag weight(s) before they taper off and approach zero[17].

Second, in contrast to the scatter plots/regressions reported in Figure 1 and Table 1 which are in terms of contemporaneous u and $\hat{k}$, the above model incorporates a one

[16] Note that although application of NLS in this context is subject to finite sample bias [since u_{t-1} is not orthogonal to $e_{t+1}, e_{t+2} \ldots, e_{t+T}$] it will be consistent as long as the errors are serially uncorrelated.

[17] Clearly the *rational lag model* [see Jorgenson, 1966] would provide even greater flexibility in estimating the unknown lag structure. However we found this unnecessary since additional lags of $\hat{k}$ proved to be insignificant for all countries.

period lag of $\hat{k}$. Although we clearly sacrifice some efficiency by opting for the predetermined value of $\hat{k}$, our aim is to avoid inconsistent parameter estimates arising from the potential endogeneity of contemporaneous $\hat{k}$. While the endogeneity or exogeneity of $\hat{k}$ is commonly treated as a testable assumption, Davidson and McKinnon [1993], more accurately, point out that what is being tested is rather the effect on the parameter estimates of any endogeneity that may be present. For example, using the Durbin-Wu-Hausman [DWH] test we can compare NLS, which is efficient [or more efficient] under the null but inconsistent under the alternative, with the NIV [i.e. nonlinear instrumental variables] estimator which is consistent [and less efficient] under both hypotheses. Since the DWH test[18] requires application of NIV, we need to obtain a valid set of instruments which are correlated with $\hat{k}_t$ but orthogonal to e_t. Unfortunately, we found the conclusions resulting from application of the DWH test statistic, to be quite sensitive to our choice of instruments[19]. Accordingly our decision to use pre-determined $\hat{k}$ in (12) with the associated efficiency loss, is a risk averse one reflecting the uncertainty regarding the effect that the potential endogenity of contemporaneous $\hat{k}$ has on the NLS parameter estimates.

The estimated dynamic models set out in (11) for Germany, Japan and the United Kingdom are reported below in Table 2. As expected, the estimated values of α and β are negative and [more importantly] significant for all countries. Additionally, the models appear

[18] Calculated as follows: $DWH = (\mathbf{b}_{NLS} - \mathbf{b}_{NIV})'(\Sigma_{NLS} - \Sigma_{NIV})^{-1}(\mathbf{b}_{NLS} - \mathbf{b}_{NIV}) \sim c^2(k)$, where $\mathbf{b}_{NLS}$ $\mathbf{b}_{NIV}$ are the vectors of estimated parameters of NLS and NIV respectively, Σ_{NLS}, Σ_{NIV} are the estimated variance covariance matrices of NLS and NIV respectively and k refers to the degrees of freedom which are equal to the rank of $(\Sigma_{NLS} - \Sigma_{NIV})$.

[19] In addition to using predetermined u and $\hat{k}$ we also experimented with contemporaneous and/or lagged values of the growth in the labour force, the real wage, own GDP, rest of OECD GDP and relative unit labour costs.

to be performing quite satisfactorily with respect to the diagnostic tests of specification and misspecification.

Given the nonlinear functional form employed in the estimations, to discover how changes in the evolution of relative stocks affect the unemployment rate in the steady-state, we need to simulate the model for each country. Our simulations in Figure 2 below show the effects on the unemployment rate resulting from a permanent increase in $\hat{k}$ by one percentage point. The results of this exercise show that the expected steady-state reductions in the unemployment rate resulting from the shock are about 0.4, 0.8 and 1.0 percentage points for Germany, Japan and the United Kingdom respectively. Additionally, the simulations indicate that it takes approximately 5, 15 and 12 years for Germany, Japan and the United Kingdom respectively to reach their new steady state values after the shock.

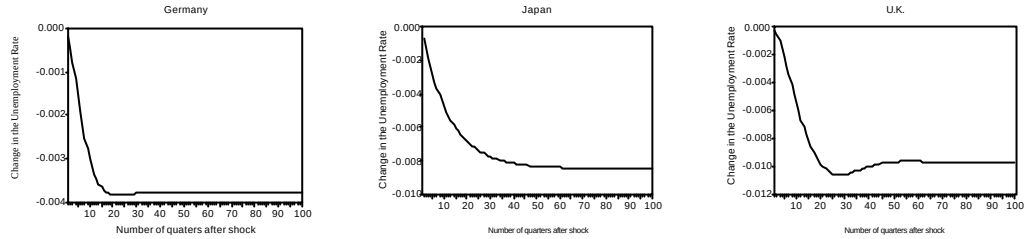
Table 2. NLS Estimates of the Basic Dynamic Model in (11) for Germany, Japan and the United Kingdom

Parameter Estimates	Germany 1961(3)-1989(4)[δ]	Japan 1961(2)-1995(4)	U.K. 1961(4)-1995(4)
α	-6.07	-5.82	-6.78
	(-25.41)*	(-13.64)*	(-17.33)*
β	-251.44	-42.12	-135.28
	(-6.08)*	(-5.30)*	(-3.01)*
γ_1	1.64	0.92	1.56
	(17.82)*	(23.33)*	(15.19)*
γ_2	-0.68	*n/a*	-0.36
	-(7.77)*		(-2.05)**
γ_3	*n/a*	*n/a*	-0.22
			(-2.82)*
Diagnostic Statistics			
$\overline{R}^2$	0.99	0.98	0.99
S.E.	0.001	0.0001	0.002
S_1	0.00 [0.947]	0.00 [0.959]	0.90 [0.343]
S_2	1.28 [0.528]	2.09 [0.353]	1.23 [0.541]
S_3	2.20 [0.532]	3.20 [0.362]	1.85 [0.604]
S_4	4.59 [0.332]	3.61 [0.461]	3.01 [0.556]
T_1	0.03 [0.856]	2.84 [0.092]	0.39 [0.532]

T_2	0.27 [0.606]	4.22 [0.040]	1.17 [0.280]

- **§** The German sample is truncated to 1989(4) due to reunification.
- Numbers in parentheses are t-ratios based on White's heteroscedastic consistent standard errors.
- *, and ** indicate significance at the 1 and 5 percent levels respectively.
- Number in square brackets are probability values.
- *n/a*: not applicable, i.e. the variable was not significant at the 5% level and hence dropped.
- S_1 to S_4: Lagrange Multiplier tests for 1st to 4th order autocorrelation, distributed asymptotically as $\chi^2(1)$ to $\chi^2(4)$.
- T_1: RESET test, distributed asymptotically as $\chi^2(1)$.
- T_2: Heteroscedasitcity test, distributed asymptotically as $\chi^2(1)$.

Figure 2. Unemployment Rate Changes Resulting from a Permanent 1% Point Increase in the Rate of Relative Capital Accumulation



IV.2 EXTENSIONS OF THE BASIC DYNAMIC MODEL

Having established the statistical importance of $\hat{k}$ as a determinant of u, we next examine to what extent the evolution of competitiveness and the labour force can either augment or supplant the negative relationship between u and $\hat{k}$. Additionally to test whether $\hat{k}$ may be inadvertently acting as a proxy for traditional aggregate demand arguments we include the rates of growth in domestic aggregate demand and in the rest of the OECD as possible determinants of the unemployment rate.

To assess the importance of these extensions, we re-estimate (11) using a stepwise regression procedure[20] to determine whether lagged growth in the labour force, $\Delta \ln l_f$,

[20] The stepwise search algorithm we employ proceeds through a combination of forward and backward variable selection. Starting with the basic dynamic model in (11), we first fit four different regression models [i.e. equation (11) plus each of the "extra" conditioning variables in turn]. We next examine the heteroscedastic consistent t-ratio for the extra variable in each model. If the 0.05 probability level value is achieved, that variable is added to the basic model given by (11). Following this we next check whether any of the variables from the basic dynamic model [i.e. $\hat{k}_{t-1}$ and predetermined values of u] should be dropped. If an "extra" variable enters at stage-1 we next fit all two variable combinations for

own GDP, $\Delta \ln y$, Rest of OECD [ROECD] GDP, $\Delta \ln y^*$ and competitiveness, $\Delta \ln c$ enter the basic dynamic model. Predetermined values for each variable are again employed for the same reasons given in Section III for using lagged $\hat{k}$. The general model implied by the above extensions is given by

$$(12) \qquad (1-\gamma_p L^p)u_t = e^{\alpha+\beta(\hat{k}_{t-1})} + \delta_1 \Delta \ln \Delta l_{f,t-1} + \delta_2 \Delta \ln y_{t-1} + \delta_3 \Delta \ln y^*_{t-1} + \delta_4 \Delta \ln c_{t-1} + \varepsilon_t .$$

The extra regressors are added linearly in (12) for each country, since (i) scatter plots of the u on each of the extra arguments and (ii) scatter plots of the residuals from equation (11) on each of the additional variables did not reveal any nonlinearities[21].

Table 3. Final Models Selected Using the Stepwise Specification Strategy

	Basic DynamicModel¶	
Parameters	Germany	Germany
	1965(3)-1989(4)	1961(3)-1989(4)
α	-6.08 [0.000]	-6.07 [0.000]
β	-252.6 [0.000]	-251.4 [0.000]
γ_1	1.65 [0.000]	1.64 [0.000]
γ_2	-0.70 [0.000]	-0.68 [0.000]
	Basic DynamicModel + Lagged Competitiveness Growth§	
Parameters	Japan	Japan
	1965(3)-1995(4)	1962(4)-1995(4)§
α	-5.69 [0.000]	-5.63 [0.000]
β	-43.40 [0.000]	-42.63 [0.000]
γ_1	0.91 [0.000]	0.90 [0.000]
δ_4	0.01 [0.013]	0.01 [0.011]
	Basic DynamicModel	
Parameters	U.K.	U.K.
	1965(3)-1995(4)	1961(4)-1995(4)
α	-6.74 [0.000]	-6.78 [0.000]
β	-124.3 [0.009]	-135.3 [0.000]

the remaining variables and repeat the above procedure for deleting and adding variables until no further variables can be either included or excluded.

[21] These twenty four scatter plots are not presented to preserve space but will be made available on request. Further note, given that both the values of the estimated regression coefficients and their standard errors depend on the covariance between the conditioning variables, a robust outcome to the above variable selection procedure relies on the lack of high correlation between the regressors. Examination of these correlations (not presented to preserve space but provided on request) reveals that the stepwise search procedure should produce sensible outcomes since the variables considered exhibit extremely low cross correlations.

γ_1	1.75 [0.000]	1.56 [0.000]
γ_2	-0.77 [0.000]	-0.36 [0.042]
γ_3	*n/a*	-0.22 [0.006]

- The numbers in square brackets are probability values used to determine the significance of the heteroscedastic consistent t-ratios.
- As in Table 1, the number of lags, p in the basic dynamic model is determined statistically.
- § Given the extremely small changes in α, β, and γ for Japan reported in this Table relative to their values in Table 1 [i.e. when competitiveness is excluded], re-simulating the model, not surprisingly, does not produce discernibly different results.
- ¥ This regression starts in 1962(4) instead of 1961(2) since competitiveness is not available prior to 1962(3) for Japan.

Table 3 above reports the final stage of applying the stepwise regression procedure described in footnote 19[22]. These results show that of all the extra potential arguments only competitiveness is retained for Japan[23]. In addition to the shorter time period used for the estimations (see footnote 21), Table 3 also reports the estimations for the longer time period used in Table 1. The latter is possible since the labour force is not an included regressor in any of the models.

In summary, the absence of the domestic and rest of the OECD demand measures as determinants of the unemployment rate is noteworthy. It establishes that even in a fast growing world economy only those countries which have higher rates of capital accumulation than their trade partners can expect lower unemployment rates. It also provides indirect evidence that the *ex-post* substitutability between capital and labour is not large.

V. Concluding Remarks

Our findings suggest that the differences in capital accumulation amongst OECD countries are very important in explaining their vastly differing unemployment rate

[22] Note that these estimations start in 1965(3) instead of 1961(1) since the labour force level is not reported in the OECD Quarterly Labour Force Statistics database prior to 1965(1).
[23] In contrast to the above variable selection strategy we have found that application of the general-to-specific variable selection strategy produces the same results as reported in Table 3.

experiences over the last thirty-five years. Our explanation for this phenomenon is essentially a supply-side one: an increase in the domestic capital stock relative to the foreign capital stock allows domestic firms to compete more effectively and to capture market share at the expense of foreign firms. Equiproportional increases in the domestic and foreign capital stock essentially move both countries upwards along a vertical long-run wage-setting curve. Real wages increase in both countries but the unemployment rate in the very long-term is unaffected. However, if the domestic country accumulates capital at a slower pace than the foreign country it will suffer - *ceteris paribus* - higher unemployment rates than the foreign country for prolonged periods of time. This may eventually induce downward shifts of the short-to-medium-term upward sloping wage setting schedule, thereby preventing a continuous upward movement of the unemployment rate[24]. In other words, this paper explains the medium- to long-term variations [caused by differential rates of capital accumulation] around the untrended very long-term unemployment rate brought to the attention of the profession by LNJ [1991].

There is, however, an important difference between the policy conclusions drawn by LNJ [1991] and this paper. They downplay the importance of capital accumulation. To them "the main social institutions that affect unemployment are the unemployment benefit system and the system of wage determination" [LNJ, 1991, p.3][25]. Although we do not want to argue about the importance of these factors, we want to note that our results indicate that a complete understanding of their effects on the unemployment rate must take

[24] For an explanation of why the wage setting schedule by be vertical in the long-run see Lindbeck and Snower [1988].

[25] Phelps [1992] in his review of LNJ (1991) criticises their focus on the institutional mechanisms and their exclusion of more direct economic interactions.

account of how they influence the rate of relative capital accumulation[26]. In any case, our results indicate that policies which encourage a faster rate of capital accumulation should be a necessary component of any policy package aimed at reducing unemployment.

[26] For example, Daveri and Tabellini [1997] provide evidence of how the system of wage determination, by stifling the incentives for firms to accumulate capital in the face of higher labour taxes, can contribute to higher unemployment.

VI. References

Alogoskoufis, G. and Smith, R.: The Phillips Curve, the Persistence of Inflation, and the Lucas Critique: Evidence from Exchange-Rate Regimes. *American Economic Review*, 81, 1254-75, 1991.

Alogoskoufis, G., Bean, C., Bertola, G., Cohen, D., Dolado, J., and Saint-Paul, G.: Unemployment: Choices for Europe. (CEPR, London), 1995.

Bean, C.R.: European Unemployment: A Survey. *Journal of Economic Literature*, 32, 573-619, 1994.

Benassy, J.P.: Imperfect Competition, Capital Shortages and Unemployment Persistence, *Scandinavian Journal of Economics*, 99, 1, 19-31, 1997.

Blanchard, O.J.: Revisiting European Unemployment, Unemployment, Capital Accumulation, and Factor Prices. *mimeo*, (Massachusetts Institute of Technology), 1998.

Blanchard, O.J.: The Medium Run. *Brookings Papers on Economic Activity*, 2, 89-158, 1997.

Blanchard, O.J.: The Wage-Price Spiral. *Quarterly Journal of Economics*, 101, 543-65, 1986.

Blanchflower, D.G. and Oswald, A.: The Wage Curve. (MIT Press, Cambridge, MA), 1995.

Brander, J. and Spencer, B.: Export Subsides and Market Share Rivalry. *Journal of International Economics*, 18, 83-100, 1985.

Carlin, W. and Soskice, D.: Macroeconomics and the Wage Bargain. (Oxford University Press, Oxford), 1990.

Caballero, R. and Hammour, M.L.: Jobless Growth: Appropriability, Factor Substitution, and Unemployment. *Carnegie-Rochester Series on Public Policy*, 48, 51-94, 1998a.

Caballero, R.J. and Hammour, M.L.: The Macroeconomics of Specificity, *Journal of Political Economy*, 103, 724-767, 1998b.

de la Croix, D. and Fagnart, J.F.: Underemployment of Production Factors in a Forward-Looking Model. *Labour Economics*, 2, 131-59, 1995.

de la Croix, D. and Licandro, O.: Underemployment, Irreversibilities and Growth Under Trade Unionism. *Scandinavian Journal of Economics*, 97, 3, 385-99, 1995.

Daveri, F. and Tabellini, G.: Unemployment, Growth and Taxation in Industrial Countries. (CEPR Discussion Paper No, 1681), 1997.

Davidson, R. and McKinnon, J.: Estimation and Inference in Econometrics. (Oxford University Press, Oxford), 1993.

Drèze, J.H. and Bean, C.R.: Europe's Unemployment Problem. (MIT Press, Cambridge, MA), 1990.

Gordon, R.: Is There a Trade-Off Between Unemployment and Productivity Growth, in D.J. Snower and G. de la Dehesa (eds) Unemployment Policy: Government Options for the Labour Market. (CU Press, Cambridge), 1997.

Jorgenson, D.: Rational Distributed Lag Functions. *Econometrica*, 34, 135-149, 1966.

Helpman, E. and Krugman, P.: 1989, Trade Policy and Market Structure. (MIT Press, Cambridge, MA), 1989.

Layard, R.S. and Nickell, S.: Unemployment in Britain. *Economica*, 53, 121-169, 1986.

Layard, R.S., Nickell, S. and Jackman, R.: Unemployment: Macroeconomic Performance and the Labour Market. (Oxford University Press, Oxford), 1991.

Lindbeck, A. and Snower, D.J.: The Insider-Outsider Theory of Employment and Unemployment. (MIT Press, Cambridge, MA), 1988.

Ljungqvist, L. and Sargent, T.: The European Unemployment Dilemma. *Journal of Political Economy*, 106, 514-550, 1988.

Malinvaud, E.: Profitability and Unemployment. (Cambridge University Press, Cambridge), 1980.

Nickell, S.: Unemployment: Questions and Some Answers. *Economic Journal*, 108, 802-816, 1998.

Nickell, S.: Unemployment and Labor Market Rigidities: Europe versus North America. *Journal of Economic Perspectives*, 11, 55-74, 1997.

Phelps, E.S.: Money-Wage Dynamics and Labor Market Equilibrium. *Journal of Political Economy*, 76, 678-711, 1968.

Phelps, E.S.: A Review of Unemployment, Journal of Economic Literature, XXX, 1476-1490, 1992.

Phelps, E.S.: Structural Slumps: The Modern Equilibrium Theory of Unemployment Interest and Assets. (Harvard University Press, Cambridge, MA), 1994.

Phelps, E. and Zoega, G.: Natural-Rate Theory and OECD Unemployment. *Economic Journal*, 108, 782-801, 1998.

Rowthorn, R.: Conflict, Inflation and Money. *Cambridge Journal of Economics*, 1, 215-239, 1977.

Rowthorn, R.: Capital Formation and Unemployment. *Oxford Review of Economic Policy*, 11, 26-39, 1996.

Siebert, H.: Labor Market Rigidities: At the Root of Unemployment in Europe. *Journal of Economic Perspectives*, 11, 37-54, 1997.

Sneessens, H.R.; Investment and the Inflation-Unemployment Tradeoff in a Macroeconomic Rationing Model with Monopolist Competition. *European Economic Review*, 31, 781-808, 1987.

Sneessens, H.R. and Drèze, J.H.: A Discussion of Unemployment, Comparing Traditional Concepts and Disequilibrium Economics. *Economica*, Supplement, 53, S89-119, 1996.

VII. Data Appendix

Variables	Definitions	Sources
u	unemployment rate	BSD
$\hat{k}_t = \Delta \ln k_t - \sum w_{j,t} \Delta \ln k_{j,t}$	relative rate of capital accumulation	
$\Delta \ln k_t$	own rate of capital stock growth	BSD
$\sum w_{j,t} \Delta \ln k_{j,t}$	weighted sum of real capital stock growth in Rest OECD	
$w_{j,t}$	real GDP weights in ROECD	
$\Delta \ln l_f$	labour force growth	QLF
$\Delta \ln y$	real GDP growth	BSD
$\Delta \ln y^*$	ROECD real GDP growth	BSD
$\Delta \ln c$	competitiveness growth [relative unit labour cost manufacturing, common currency]	EO

- Note that the 25 OECD countries include Australia, Austria, Belgium, Canada, Switzerland, Germany, Denmark, Spain, Finland, France, Great Britain, Greece, Ireland, Iceland, Italy, Japan, Luxembourg, Mexico, New Zealand, Netherlands, Norway, Portugal, Sweden, Turkey, United States. However, five countries were not included due either to not reporting any capital stock data [e.g. Turkey & Mexico] or insufficient coverage for capital stock [e.g. Iceland's data starts in 1979 & New Zealand's in 1981] or insufficient coverage for the unemployment rate [e.g. Luxembourg's data starts in 1974].

- BSD, QLF and EO refer to the OECD Business Sector, Quarterly Labour Force Statistics and Economic Outlook Databases respectively.