Is wage-cost saving labor market deregulation a free lunch?
Evidence from 19 OECD countries, 1960-2004

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Note to the Editor: Several of the tables in the Appendix are intended as information to the referees and can be omitted in a final version.

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Abstract

Labour productivity growth determines wage growth, but there is also a causal link in the opposite direction. Our panel data analysis of 19 OECD countries (1960-2004) shows that a one-percentage point change in growth rates of real wages corresponds to 0.31 - 0.39 percentage points change in labour productivity growth. This finding casts doubt on the desirability of wage-cost saving flexibilization of European labour markets. The latter may favor job growth but impedes labour productivity growth, which is problematic with an ageing population in Europe.

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I Introduction

Taking Walrasian general equilibrium theory as point of departure, it is easy to argue that European unemployment could be reduced by curbing wage costs and by making labour markets more flexible. For many years now, economic think tanks have argued that the 'flexibilization' of European factor markets (notably of labour markets) would help in the realization of higher job growth and extra welfare gains (see IMF, 2007). The call for more flexible labour markets usually includes a demand for the easier firing of personnel, the realization of greater wage flexibility (notably in the downward direction), or the reduction of minimum wages and social benefits (see e.g. OECD, 1999, 2003a). This corresponds to the consensus among many scholars about the harmful effects of extensive labour market regulation (sometimes interacting with economic shocks) and wage inflexibility on unemployment (see e.g. Nickell et al., 2005; Nunziata, 2005 and Blanchard & Wolfers, 2000).

We argue that a strategy of wage cost reduction via more flexible labour markets in the OECD area may be problematic. We do not deny that such a strategy may encourage job growth, but maintain that this is not a 'free lunch'. Rather than stimulating extra GDP growth, it may lead to a low-productive and highly labour-intensive growth model. In Part III, this hypothesis will be tested on panel data from 19 OECD countries over the period 1960 to 2004. Theoretical arguments and statistical illustrations will be given in Parts I and II.

Our argument is illustrated with the aid of four figures. Figure I-1 shows that, since the mid-1960s, real wage growth has been more modest in the 'flexible' Anglo-Saxon countries than in the 'rigid' labour markets of Continental Europe. Various types of labour market institutions in the 'Liberal Market Economies' (Hall & Soskice, 2001), such as easier firing, weaker trade unions, more modest social benefit systems, more decentralized wage bargaining, etc. have indeed helped to moderate real wage growth. Figure I-2 shows what most economists would expect after having seen Figure I-1: lower wage growth is related to a substantially higher growth in hours worked. Figure I-3 shows something remarkable, however. Lower wage growth did not lead to higher GDP growth in the Anglo-Saxon countries as compared to the European countries. Only recently (since the 1990's) has Anglo-Saxon GDP growth been higher. In the preceding period, however, GDP growth in Continental Europe was higher. In a long-term view, it seems reasonable to conclude that our Figures I-1 and I-3 do not show evidence of a clear relationship between GDP growth and real wages. The logical implication of Figures I-2 and I-3 is that labour productivity growth must be appreciably lower in Anglo-Saxon countries compared to Continental Europe, up to the 1990s. Figure I-4 shows that this is
indeed the case. The figures shed new light on the job creation success of the Anglo-Saxons in figure I-2: the Anglo-Saxons indeed created more labour hours, but this can hardly be ascribed to higher total output. The main reason is that their GDP per working hour grew at a lower rate.

Our group of Continental European countries includes the Netherlands. One should note that, since the 1980s, this country is not typical anymore for 'rigid' Europe. During the 1980s and 1990s, the Netherlands experienced a development of wages, jobs and labour productivity similar to that of the Anglo-Saxon countries, although within a different institutional framework (Naastepad & Kleinknecht, 2004). Following the famous 'Dutch Disease' of the 1970s, the Netherlands suffered severe and rapidly rising unemployment. Other than the Anglo-Saxon countries, however, the Netherlands achieved a very modest wage growth due to voluntary commitments made by the trade unions while maintaining many of their 'rigid' labour market institutions, at least for 'core' workers.¹

As in the Anglo-Saxon countries, this policy was quite successful in creating jobs and only few 'heretics' dared to utter any criticism, suggesting that the policy of wage moderation and flexibilization of (part of) the work force might be damaging to innovation and labour productivity growth (Kleinknecht, 1994; Van Schaik, 1994; Naastepad & Kleinknecht, 2004).

Many scholars objected to this suggestion using three main arguments. First, we should be happy with the high job growth, in spite of the associated losses in labour productivity growth. Secondly, it was argued that modest wage growth allows the hiring of workers with lower productivity. As far as there was a labour productivity growth slowdown, it mainly had to do with the employment of low-productive people that otherwise would not have worked at all.² Last but not least, it was argued that there was no proof of a causal relationship from (modest) wage growth to (low) labour productivity growth. It was reasoned that, in the statistical relationship between the two, causality runs from productivity growth to wage growth, and not vice versa (see Jansen 2004). Many observers found this plausible; it being in line with the old neoclassical view that technological change is 'manna from heaven'. This paper will question that popular belief.

In Part II, theoretical arguments will be presented in favor of reversed causality, which will be tested by means of a panel data analysis of 19 OECD countries (Part III). This fin-

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¹ One should note that the continued protection of 'insiders' does not exclude that there was a rising share of flexible 'outsiders' with non-typical working arrangements since the 1980s. Employment of the latter lead to substantial wage bill savings, which supported the policy of modest wage claims (Kleinknecht et al. 2006).
² When discussing our results, we will return to assessing the validity of this argument.
ding has far-reaching consequences, among others for the discussion about whether 'ri-
gid' European labour markets should indeed be made more flexible. This will be discus-
sed in the concluding section.

Insert Figures I-1 through I-4 here

II Theoretical arguments and further illustrations

In our opinion, there are at least five theoretical arguments in favor of the view that cau-
sality may run not only from productivity to wages, but also in the opposite direction:
from wage growth to labour productivity growth. These arguments are the following:

(1) In standard neoclassical theory, an increase in the relative price of labour leads pro-
fit-maximizing firms to substitute capital for labour, shifting along a given production
function, until the marginal productivity of labour equals the given real wage.

Causality in this argument runs from relative factor prices to choice of technique and
hence to productivity of labour.

(2) Using vintage models, it is easy to demonstrate that more aggressive wage policies
adopted by trade unions will cause the quicker replacement of old (and more labour
intensive) vintages of capital by new and more productive ones. A policy of modest
wage claims allows firms to exploit old vintages of capital over longer periods (see
Den Hartog & Tjan, 1980; Foley and Michl, 1999). This can result in the ageing of the
capital stock (shown to have been one of the reasons behind the Dutch productivity
危机; see Naastepad & Kleinknecht, 2004).

(3) According to the theory of induced technological change, a higher relative wage rate
(wage share) increases the labour-saving bias of newly developed technology
(Hicks, 1932; Kennedy, 1964; Ruttan, 1997; Michl and Foley, 1999). Ceteris paribus,
a higher real wage growth will lead to a higher wage share, thus increasing the rate
of the labour saving bias in induced technological change.

(4) From the viewpoint of Schumpeterian creative destruction, it can be argued that inno-
vating firms (compared to their non-innovative counterparts) can better cope with ag-
gleive wage claims by trade unions. Innovators have market power due to mono-
poly rents from unique product and process knowledge that acts as an entry barrier
to their markets. Higher real-wage growth enhances the Schumpeterian process of
creative destruction in which innovators push out non-innovators. Conversely, mo-
dest wage growth and flexible labour relations can enhance the likelihood of survival
of low quality entrepreneurs. While their survival is favorable to employment in the
short-run, it leads ultimately to a loss of innovative dynamism (Kleinknecht, 1998).
(5) According to Schmookler’s (1966) ‘demand-pull’ theory (for an assessment see Brouwer & Kleinknecht, 1999), higher effective demand enhances innovative activity. Analogically, Verdoorn’s Law suggests that output growth has a positive impact on labour productivity growth (see recently McCombie et al., 2002). All this implies that a strategy of wage cost reduction might impede innovation and labour productivity growth if it leads to a reduction of effective demand.³

A common element in these five arguments is that they propose a positive causal relationship from real wage growth to labour productivity growth. Some theories point to a direct linkage between wages and labour productivity growth. Others, e.g. the ‘creative destruction’ argument, suggest that overall innovation activity may slow down in response to lower wage cost pressure. Some arguments would lead us to expect that wages would affect productivity growth in the short or medium term (arguments 1, 2, and 5), while others are more likely to have an effect in the medium to long-term (arguments 3 and 4). Lags of up to nine years are therefore included in our regression estimate.⁴

In addition to wages, there may be other influences on productivity and innovation that are related to institutional differences between ‘Liberalized’ and ‘Coordinated’ market economies. Advocates of the flexibilization of labour markets have forwarded four arguments of why rigid labour markets may impede productivity growth. Firstly, rigidity could reduce the reallocation process of labour ‘from old and declining sectors to new and dynamic ones’ (for a review of the effects of labour market institutions on economic performance, see Nickell & Layard, 1999). Second, the difficult or expensive firing of redundant personnel can frustrate labour-saving innovations at the firm level (Bassanini & Ernst, 2002; Scarpetta & Tressel, 2004). Third, well-protected workers may work less hard. Fourth, there is a possibility that well-protected and powerful personnel could appropriate rents from innovation and productivity gains through higher wage claims, thus reducing the incentive to take innovative risks (Malcolmson, 1997). The latter argument might indeed be relevant to countries that have de-centralized bargaining regimes. It is less likely to be relevant to rigid ‘Rhineland’ labour markets that rely more strongly on centralized or coordinated bargaining.

Against these arguments, the following counter-arguments appear relevant: First, shifting personnel from old and declining to new and innovative activities may be hampered more by lack of adequate qualifications than by difficult firing. Easier firing and shorter job durations can discourage investment in training as pay-back periods tend to

³ Bhaduri & Marglin (1990) argue that this may be the case if an economy is ‘wage-led’ rather than ‘profit-lead’.
⁴ Another reason to include nine-year lags is to avoid endogeneity problems, which would theoretically arise if the residuals of the regression were serially correlated. Including nine lags avoids this problem; see below.
become shorter, thus making the shift of personnel to new activities more difficult. Moreover, new and innovative activities are likely to pay better than old and declining industries. Why could we then not rely on voluntary movements of personnel?

Second, in many countries, redundant personnel need not be a problem for labour-saving innovations as a high percentage leaves their firms voluntarily.\textsuperscript{5} Third, protection against dismissal may actually enhance productivity performance, as secure workers will be more willing to cooperate with management in developing labour-saving processes and in disclosing their (tacit) knowledge to the firm (see Lorenz, 1992, 1999). People threatened by firing have incentives to hide knowledge about how their work could be done more efficiently.

Fourth, 'rigid' labour markets may be favorable in industries where a Schumpeter II ('routinized') innovation model is relevant. The latter is based on the continuous accumulation of knowledge for (often) incremental innovations. Some parts of that knowledge consist of ill-documented 'tacit' knowledge based on personal experience that is hard to transfer. 'Rigid' labour markets are typically characterized by longer job tenures and the use of internal rather than external labour markets may favor accumulation of knowledge and of 'tacit' knowledge, in particular.

Fifth, shorter job durations in an Anglo-Saxon 'hire and fire' system may reduce trust, loyalty and commitment to the firm. Such a loss of 'social capital' has at least two disadvantages: (1) Knowledge about new technology and trade secrets may more easily leak to competitors; stronger positive externalities make investment in knowledge less attractive. (2) Lack of commitment to the firm makes workers less ready sometimes to take 'one step extra', beyond what is determined in their contract. This is important because labour contracts tend to be incompletely specified, offering room for opportunistic behaviour. The latter points may explain why flexible Anglo-Saxon countries have substantially larger management bureaucracies, compared to 'Rhineland' countries (Storm & Naastepad, 2007).

Sixth, longer-term contracts may strengthen a firm's historical memory and favor processes of organizational learning.

Seventh, easier firing of personnel shifts the power balance in favor of (top) management. People may no more dare criticizing management decisions. Lack of critical feedback from the shop floor may favor problematic management practices, top managers believing they are great visionary leaders that can hardly fail.

In addition to lower wage growth, such arguments about flexibility may contribute to explain why Anglo-Saxon countries tend to experience lower productivity growth compared to 'Rhineland' countries, as shown in Table II-1.

\textsuperscript{5} Kleinknecht et al. (2006) report that, on average, 9-12\% of a firm's personnel in the Netherlands leave voluntarily each year, the exact percentage depending on the state of the business cycle. Nickell & Layard report that this figure amounts to over 10\% (1999: 363).
Table II-1 summarizes key indicators of the long-run performance of five typical 'Anglo-Saxon' countries (Australia, New Zealand, Canada, UK and USA) compared to a group of 11 typical EU-countries. The third column in Table II-1 suggests that the Anglo-Saxon countries have shown superior growth performance in labour hours from the 1960s to the present. Contrary to what many observers might assume, however, this has little to do with differences in GDP growth: it is caused mainly by differences in growth of GDP per hour worked, causing high employment elasticities of GDP growth (third column).

We can see that employment elasticities of GDP growth in Continental Europe were even negative during the 1960s and 1970s. Despite high GDP growth, absolute numbers of working hours (slightly) diminished! From the 1980s to the present day, employment elasticities in the Continental European countries have been (modestly) positive. On the other hand, the Anglo-Saxon group has shown positive employment elasticities of GDP growth since the 1960s, and, in each period, the coefficients are substantially higher than in Europe (ranging between 0.34 and 0.55). It should be noted that the three columns in Table II-1 have a logical link: the relationship between GDP growth and that per hour worked determines the growth of labour hours per 1% GDP growth in the third column.

Table II-1 suggests that the superior long-term employment record of the Anglo-Saxon countries is caused primarily by weaker labour productivity growth, and at best to a minor extent by superior GDP growth. More recently, however, this pattern has changed. During the 1990s, Anglo-Saxon labour productivity growth approached Continental European standards; in the most recent period (2000-2004), it has even slightly exceeded that of the EU.

At present, we can only speculate about these changes. One reason, of course, for the resurgence of Anglo-Saxon productivity growth is the ICT revolution. The declining EU productivity growth (and improved job growth) may be due to the gradually increasing influence of Anglo-Saxon labour market practices in mainland Europe. In addition, the post-2001 recession seemed to hit EU countries more adversely than the USA. This may have depressed measured EU productivity growth through lower capacity utilization and/or the Verdoorn effect.

III Panel data estimates

PLEASE INSERT TABLE II-1 ABOUT HERE
To test our hypothesis that wage growth influences labour productivity growth, data are used from 19 OECD countries over the period 1960-2004. The majority of these data come from the *Total Economy Database (May 2006)* of the Groningen Growth and Development Centre, documented on the internet ([http://www.ggdc.net/](http://www.ggdc.net/)). The dependent variable is growth in value added per labour hour. In the regression, lags of the dependent variable are included as right hand variables to allow for dynamics in the relationship. In such a model, the absence of serial correlation in the residuals is required to obtain consistent estimators. The key independent variable, of course, is the annual percentage growth of real wages. We include this variable with lags in order to avoid endogeneity problems.

In this context, the absence of serial correlation is essential not only because of our inclusion of a lagged dependent variable in the regression. It is also necessary because we explicitly allow for reversed causation with respect to the growth of real wages - i.e. that (some lags of) the growth of labour productivity will cause the growth of real wages - while still obtaining consistent estimators. In the Appendix, a mathematical proof for this weak exogeneity condition is provided. Furthermore, in the Appendix (Table A1), a test is documented that does not reject the hypothesis of no serial correlation in the residuals of our main regression (column 1, table III-1). Nine lags are included in the regression specification in order to obtain this feature. This lag-structure seemingly is long, but from the above theoretical arguments we expect significant effects of changes in wages on growth of labour productivity even in the long run.

We checked the robustness of the estimators of the main regression for a possible over-parameterization by tentatively removing all the insignificant lags of labour productivity growth and real wage growth from the regression. Our results turned out to be robust for this manipulation. However, when removing some of the lags, problems with autocorrelation in the residuals arise. It should be noted that the problem of autocorrelation came back in quite a number of alternative specifications of our basic model that we ran for robustness checks.

We use a dynamic fixed effects estimator, which is known to be biased if estimated by OLS, even in the case of no serial correlation in the residuals. Nickell (1981) shows, however, that this bias is \( O(1/T) \) and therefore becomes less important as \( T \) grows. The intuition behind this result is that the endogeneity of the lagged dependent variable stems from it being correlated with lagged values of the error term of the regression. The lagged residual (which correlates with the lagged dependent) appears on the right hand side of the regression equation after the within-transformation, as a component of the

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6 This operation makes the independent variable predetermined.
time-averaged error term. The contribution of the lagged error term in the average error term becomes smaller, however, as the time dimension increases. Thus the endogeneity bias becomes smaller if the time dimension increases for the time average of the error term consists of only one error term that is correlated with the lagged dependent, while the error terms of all the other times are not. Extending the time-dimension therefore amounts to diminishing the contribution of the correlated error term. In the limiting case, the contribution of this sole error term is negligible.

Judson and Owen (1999) test the bias of the LSDV (Least Squares Dummy Variables estimator, i.e. a dynamic fixed effects estimator) for the AR(1) case with the use of Monte Carlo simulations. They compare it with various other estimators, including the standard GMM estimators with lags of the dependent variables as instruments. Their results suggest that "The LSDV estimator performs just as well or better than many alternatives when T=30" (p. 10). In our sample, T is about 45. In our case, we include more than one lagged dependent variable. Lee (2007) extends the Nickell (1981) case for higher-order autoregressive panel models and obtains the same result (i.e. that the bias is $O(1/T)$).

Apart from lags of the real wage growth – the variable of our main interest – we add control variables, including:

- **STATE DEPENDENCY**: Past labour productivity growth may forecast future productivity growth. It may be that conditions that favored (or impeded) productivity growth in the past will persist and create some state dependency. It has been argued that this variable is essential: high (low) labour productivity growth in the past may have caused high (low) wage growth, and may also cause high (low) productivity growth in the present. If state dependency in labour productivity growth indeed exists, non-correction for past productivity growth may lead to misspecification in that (state dependent) productivity gains would probably be ascribed to high wage growth, rather than to past productivity gains (this point was made by Jansen, 2004: 418).

- **GAP**: The relative difference between a country’s labour productivity level and that of the country with the highest level of labour productivity in the sample. The larger a country's distance from the best-practice country, the greater are the possibilities for imitation and 'catching up'. We therefore expect GAP to have a positive sign. To

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7 Technically, the lagged dependent variable is correlated not only with its contemporaneous error term, but also with other lagged error terms. However, in the I(0) case, this correlation dies out over time, which explains why the results obtained by Nickell (1981) and Lee (2007) only hold in the I(1) case.

8 An analogous argument can be made for the correlation of the time-average of the dependent variable with the error term (or with the time average of the error term, for that matter): the ratio of endogenous to exogenous parts in the average dependent tends to zero when the time dimension tends to infinity.
avoid endogeneity problems, this variable is included with a two-year lag, so it is not correlated with the dependent variable by construction.

- **VERDOORN**: The Verdoorn relationship (sometimes called the Kaldor-Verdoorn relationship) assumes a positive impact of annual GDP growth on labour productivity growth.
- **COUNTRY**: In order to correct for unobserved country-specific influences on labour productivity growth, country dummies are added.
- **YEAR**: To correct for general time-specific impacts, we include year dummies.
- **CAPACITY UTILIZATION**: This variable is added as our measure of labour productivity (value added per labour hour) is sensitive to fluctuations in capacity utilization over the business cycle, due to labour hoarding. For example if, in a business cycle upswing, growing use of hoarded labour was accompanied by a growth of real wages, the extra growth of value added per labour hour might wrongly be ascribed to rising wages. Therefore, robustness checks were made including various indicators of capacity utilization in the regression. We alternatively used the growth of the capital/output ratio, the change in the output gap as well as various alternative measures of fluctuations in capacity utilization.

Precise definitions of all variables are given in the Appendix (Table A2). Descriptive statistics are presented in Table A3.

Our regression equation has the form:

\[
\hat{\lambda} = \alpha_i + \sum_k \beta_{1k} \hat{w}_{t-k} + \sum_k \beta_{2k} \hat{\lambda}_{t-k} + \beta_3 \hat{Q} + \beta_4 Z + \varepsilon
\]  

(1)

Where \( \hat{\lambda} \) denotes the growth of labour productivity; \( \hat{w}_{t-k} \) the growth of real wages at time \( t-k \); \( \hat{Q} \) the growth of output; \( \alpha_i \) are country fixed effects and \( \varepsilon \) is an error term. \( Z \) is a vector of control variables.

Although we are mainly interested in the coefficients that reflect the effect of wage growth on labour productivity growth, one should note that our regression equation is similar to regression equations found in the literature on estimating the dynamic version of the Verdoorn law. Apart from some of our controls, regression equation (1) has similarity with the regression equations used in Drakopolous and Theodosiou (1991) and Fase and Winder (1999). Drakopolous and Theodosiou (1991) follow the approach suggested by McCombie and De Ridder (1983), using the ratio between actual and potential output as an indicator for capacity utilization. As a robustness check, we also implemented this suggestion.

Fase and Winder (1999) use a cointegration approach to test for a long-run relationship between labour productivity, output and the real wage, which they interpret as Ver-
doorn’s regularity. They derive this specification starting from a CES-production function. The real wage (growth) then controls for substitution between labour and capital. Clearly, we do not just interpret the coefficient for real wage growth as the substitution elasticity in a neoclassical production function. We take into account all the mechanisms mentioned above. Moreover, we add control variables which stem from other frameworks than a production function approach.

Following the famous Baumol argument, services may have lower productivity gains than manufacturing or agriculture. It could therefore be argued that one should control for the share of services in the total economy. A counter-argument could be that service shares may be endogenous: a strategy of low wage and low labour productivity growth may favor the emergence of low-productive (personal) services. Moreover, it could be argued that at least part of the apparent shift from manufacturing to service employment in the past 20-30 years is a statistical artifact: many services (e.g. catering, cleaning or security) were in the past performed by employees of manufacturing firms and were statistically counted as 'manufacturing' work. Once contracted-out, those same activities are called 'services' although, in real terms, little change occurs. Nevertheless, we tenta-tively included, in several versions of our estimates, the contribution of services to total GDP. These versions are not documented in Table III-1, as service shares turned out insignificant and had little influence on the other coefficients.

It is obvious that our dependent variable is influenced by fluctuations in capacity utilization. We therefore explore the impact of alternative measures for the latter. One possible measure is percentage changes in the capital/output ratio. Model 2 in Table III-1 includes (a contemporaneous and a lagged value of) the growth of the capital/output ratio. As expected, the inclusion of this capacity measure causes a loss of significance of the Verdoorn-coefficient. In fact, the Verdoorn effect becomes even insignificant. It is reassuring, however, that the coefficients of the other variables (notably of the wage growth variable) change little when including the growth of the capital/output ratio. In addition to the regressions documented in the table, we ran several other regressions with increasing lags of the capital/output ratio. This did not alter the results. While inclusion of the capital/output ratio allows for a better control for capacity effects, this is not our pre-ferred version. Inclusion of the capital/output ratio may be problematic as the validity of the construction of the capital stock may be doubted (Robinson, 1953-54; Felipe and Fisher, 2003). This entails the risk of obtaining biased coefficients due to errors-of-measurement. Furthermore, it may be argued that correction for fluctuations in capacity

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9 It is impossible, however, to establish the direction of causality within the cointegration relation. Therefore, we do not use a cointegration term in our own model.
utilization is at least partly done by including GDP growth (i.e. the Verdoorn-effect) in the regression.
When including an alternative measure of capacity utilization (i.e. changes in the difference between actual and potential output), the Verdoorn effect becomes significant again (model 3). This also holds when including inflationary pressure as an alternative capacity utilization measure (not documented here). Finally, we document in model 4 a version that is perhaps most popular in the literature: a contemporaneous term for the Verdoorn coefficient and the difference between actual and potential output (both without lags). This model behaves as expected: both coefficients are significant and have the expected sign. With this version, however, the residues have a significant degree of autocorrelation which raises doubts about reliability.

PLEASE INSERT TABLE III-1 ABOUT HERE

As to the size of the coefficients, it is possible to distinguish between short-term and long-term effects in that lagged values of different regressors were included in the model. The long-term value can be interpreted as the accumulated effect of all short-term effects through time. The accumulation process runs as follows: a permanent difference starting in year y (of: say, 1) in an explanatory variable (say: x) has the (first order) effect of raising labour productivity growth with its coefficient b_x. In year y+1, we not only have the first order effect b_x, caused by the rise of x in year y+1 but also two second order effects: (1) a direct second order effect caused by the rise of x in year y (equal to the coefficient of the lagged value of x) and (2) an indirect second order effect through the growth of the lagged value of labour productivity (itself caused by the difference in x in year y) on the growth of labour productivity in year y+1. This effect equals b_x*b_{growth}, where b_{growth} denotes the coefficient of the lagged value of labour productivity. In the following year (year y+2), we not only have first and second order, but also third order effects. Adding all the effects of the different orders and letting y → ∞ yields the following formula with which to calculate the long-run effect of a permanent change of one unit in the variable x:

\[ \sum_{T=T_b}^{T_e} (b_{x_{it-T}})/(1 - \sum_{\tau=T_b}^{T_e} (b_{\text{labour productivity growth, it-}\tau})) \]

where the symbols T_b and T_e denote the begin and end lag of x and \( \tau_b \) and \( \tau_e \) the begin and end lag of labour productivity growth. In interpreting the coefficients, a short and a long-term value will be reported.

Furthermore, our estimates suggest that there is some evidence of state dependency in labour productivity growth. Labour productivity growth delayed has, in several versions of our model, positive effects on labour productivity growth. It should be emphasized that a very careful control for effects of past labour productivity growth on future labour pro-
ductivity growth is required, due to the arguments mentioned above (Jansen, 2004). This is a reason for our inclusion of up to nine years lags, which gives a maximum chance of measuring any possible influence of this variable. Another advantage from inclusion of these lags is that they eliminated auto regression in our residuals. While short-lagged labour productivity growth tends to be significant in most versions, the long-run, cumulative, effect of lagged labour productivity growth on the current growth of labour productivity is modest. An F-test based on our main regression (column 1, table III-1) on whether the cumulative effect is significantly different from zero could not reject the null-hypothesis (p-value = 0.4). This indicates that, in the long run, labour productivity growth is no self-propelling force\(^{10}\).

The GAP variable behaves as expected: a country’s one-percent distance in productivity level towards the country with the highest level leads, on average, to 0.037% extra growth of its labour productivity in the short term and to 0.039% extra growth in the long term.

The Verdoorn effect has a long-run value between 0.24 and 0.37 which corresponds to the lower bound of results commonly found in the literature. The Verdoorn coefficient on the contemporaneous GDP growth has a value of around 0.5, the lagged value being negative with a magnitude of around 0.25. The negative sign of the lag may come as a surprise. On the other hand, recent contributors to the literature on the Verdoorn law also recognize that there is some “instability” of the law in a time series perspective (McCombie et al., 2002, p. 106).

In our main regression, the total Verdoorn effect is 0.37 and significant. Depending on the indicator we use for the capacity utilization, the Verdoorn effect remains significant or becomes insignificant. If we include the growth of the capital/output ratio, the capacity utilization indicator picks up the significant effect. This would imply that the Verdoorn coefficient is mainly capacity driven. However, above we noted the problematic nature of the concept and measurement of the capital stock. Another caveat behind this specification is that GDP growth has a high degree of multicollinearity with the growth of the capital/output ratio.\(^{11}\) Implementing the McCombie and De Ridder (1983) specification yields a significant Verdoorn coefficient\(^ {12}\).

\(^{10}\) Which may be expected, labor productivity growth being I(0).

\(^{11}\) As an additional robustness check, we used the first difference of inflation as an alternative control for capacity utilization. The results (not documented here) turned out to be quite similar to the regressions using the output gap as an indicator for capacity utilization.

\(^{12}\) Another potential caveat in estimating the Verdoorn relation is that it is possibly endogenous to labour productivity. We therefore also experimented with instrumentation, which lead, as expected, to a loss of significance of the coefficient representing the Verdoorn relationship. These
In models 1 and 3, it was found that a double inclusion of GDP growth was appropriate, judging from the significance levels. By the way, as mentioned above, model 4 documents a version, perhaps more popular in the literature, with only the contemporaneous Verdoorn coefficient. This model behaves as expected but is less reliable due to auto regression in the residuals. For the purpose of the present study, the Verdoorn relation is used simply as a control variable. We trust that the versions documented in the tables are plausible. Fortunately, whichever version of a Verdoorn specification was used, all other variables (and notably the coefficient of wage growth) remained robust.

Our main result, of course, relates to the coefficients of wage growth. From the cumulative effects of the coefficients of wage growth and of lagged labour productivity growth, it can be concluded that a one-percentage point reduction in wage growth will result in a long-run 0.31 - 0.39% reduction of labour productivity growth. The coefficient is lowest (0.31) if the capital/output ratio is included (model 2). These results come close to those reported by Naastepad (2006) based on Dutch data. Naastepad reports a coefficient of 0.52. This slightly higher coefficient is to be expected, as Naastepad's regressions do not control for reversed causality.

We interpret these results in the light of the theoretical arguments discussed in section II. There is one competing hypothesis for explanation of our results: the growth in low-productive jobs hypothesis. According to our arguments, real wages cause changes in labour productivity because they not only influence labour productivity of newly created jobs but, more importantly, they change labour productivity growth of existing jobs. This interpretation contradicts the view expressed by the OECD (2003b). They interpret the finding that "a weak trade-off may exist between gains in employment and productivity" as arising from newly created jobs at the bottom of the labour market: "For example, decentralization of wage bargaining and trimming back of high minimum wages may tend to lower wages, at least in the lower ranges of the earnings distribution. Similarly, relaxing employment protection legislation (...) may encourage expansion of low-productivity/low-pay jobs in services." (Box 1.4, p. 42.). These low-productive jobs – the OECD's reasoning continues – are created in flexible countries, but not in rigid countries due to too high (minimum) wages or social benefits. In this view, the loss in average labour productivity growth is mainly a negative by-product of extra jobs created in the low wage segment.

versions are not documented in Table III-1, as instrumentation tended to yield similar outcomes. The only difference is that levels of significance tended to be slightly lower, which is to be expected when instruments are used.
In our view, the reasoning by the OECD is unsatisfactory for several reasons. First, it does not take account of our theoretical arguments that suggest a causal link from wage growth to labour productivity growth. The vintage argument and the creative destruction argument, in particular, would lead us to expect losses in productivity growth in existing jobs. Secondly, if correct, the OECD argument would imply that the ‘flexible’ Anglo-Saxon countries exhibit a higher GDP growth than the 'rigid' Europeans do. This can be derived as follows. If modest wage growth and flexible labour relations do not affect labour productivity growth in existing jobs (as implied in the OECD argument), then the new (albeit low-productive) jobs in flexible countries should result in extra GDP growth. Our figure I-3 presents evidence against this hypothesis: in the long run, GDP growth in the Anglo-Saxon countries seems not to depart from European GDP growth. Finally, from a normative viewpoint, it may be asked whether it is wise to have people locked in low-productive jobs since, in the near future, Europe will face an ageing population. The share of people at working age will shrink. To meet that challenge, it seems wise to enable highly productive work by systematically investing in education, rather than to have many low-educated people trapped in work that produces little value added.

Finally, as a GLS procedure is used, we cannot rely on an R²-statistic. To illustrate the realism of our model, therefore, a dynamic simulation is used. Figure III-1 compares statistically observed labour productivity growth to labour productivity growth that is simulated, using the estimated coefficients taken from model 1. We consider these simulations satisfactory and reassuring.

Figure III/1: Comparison between observed labour productivity growth and simulated labour productivity growth

Insert Figure III-1 about here

VI Conclusions

At first sight, our above Figures I-1 and I-2 seem to confirm what everyone would expect: modest wage growth in flexible Anglo-Saxon economies leads to a substantially higher growth in labour input. This seems to confirm the neoclassical belief of a trade-off between wages and employment. However, Figure I-3 shows that – contrary to popular belief – high Anglo-Saxon job growth can hardly be attributed to enhanced GDP growth. Figure I-4 shows what tends to be overlooked: between the 1960s and early 1990s, the 'flexible' Anglo-Saxon countries showed much weaker labour productivity growth than
the ‘rigid’ European economies. Our panel data analysis shows that a causal link indeed exists between wage growth and labour productivity growth, 1% extra wage growth causing about 1/3% extra productivity growth.

We discussed a competing explanation of this effect, i.e. the *growth in low-productive jobs* hypothesis as proposed by the OECD (2003b). We argued that, if correct, this hypothesis would predict a higher GDP growth in the flexible Anglo-Saxon countries: if productivity growth of *existing* jobs remained unchanged and the reduction of labour productivity growth was exclusively due to hiring of (otherwise unemployed) people with low qualifications, then there should be extra GDP growth in the flexible Anglo-Saxon countries. Figure I-3 shows this is not the case.

There is of course evidence of a higher GDP growth in the USA, notably since the 1990s, but this may have different reasons, e.g. rising real estate prices that unleashed a mortgage boom. It has been shown elsewhere that ‘mortgage Keynesianism’ related to booming housing markets may cause substantial extra GDP growth, at least in the short run. Figure I-3 shows that, in the long run (1960s to the present), GDP growth in the Anglo-Saxon countries is not higher than in Europe. We conclude that lower wage growth reduces labour productivity growth also in *existing* jobs and that this is a major cause behind the higher growth of labour hours in the Anglo-Saxon countries (Figure I-2).

Table II-1 illustrates the same argument, suggesting that the stronger growth of labour hours in the Anglo-Saxon countries since the 1960s has little systematic relationship with (higher) GDP growth. The main driving force behind superior employment growth was weaker labour productivity growth. As GDP per working hour grew more slowly than in the EU since the 1960s, the Anglo-Saxon countries needed many more hours of work in order to achieve a one-percent growth of GDP. Seemingly, the relatively modest wage growth in the Anglo-Saxon countries (compared to the EU) drove them into a relatively low-productive and more labour-intensive growth model.

There are, of course, reasons to be pleased with high job growth. It is good for the social cohesion of society; the reduction of unemployment reduces the need for social transfers and thus helps to curb public expenditures and the tax burden (or the built up of government debt). On the other hand, it might be asked whether such a growth model is as at-

---

13 According to simulations with the Morkmon model of the Dutch Central Bank, rapidly rising housing prices and related extra mortgages by house-owners in the Netherlands caused an extra growth of GDP by about 1% in 1999 and 2000 (DNB, 2002, p. 29-38). As US housing prices roughly doubled between 1995 and 2005, similar (perhaps even higher) effects may apply to the US economy.
tractive as it looks (see also Ebersberger & Pyka, 2002). We see several reasons for doubt.

First, a highly labour-intensive GDP growth means loss of welfare in terms of leisure time. Would it not have been better to maintain high wage cost pressure and thus high rates of labour productivity growth? If, as a result, unemployment should reach levels that are considered socially unacceptable, trade unions could still proceed with a strategy of reducing labour hours per employee. While Faggio & Nickell complain about a 'mistaken belief' (2007: 437) that shorter working hours would reduce unemployment, Table II-1 suggests that this strategy was highly successful in the past. The table shows that, during 1960-1973, a 5.1% GDP growth rate in Europe coincided with an even slightly negative elasticity of employment with respect to GDP (-0.03). In other words, the absolute numbers of hours worked declined, on average, by 0.15% per year (i.e. 5.1% GDP growth times -0.03). In spite of the negative employment elasticity of GDP growth, most EU countries tended towards full employment in the early 1970s. This was achieved because, at that period, trade unions managed to reduce working hours per week and to negotiate longer holidays. This would appear to be a more intelligent strategy than to create jobs by sacrificing wages, thereby bringing down labour productivity growth. In any case, free time is also welfare.

Second, many economists still propagate that 'rigid' labour markets in Continental Europe should be made more flexible. In fact, the call for more flexible labour relations is one for lower wages. It is interesting to confront such claims to evidence from micro-data. For example, firm-level estimates in the Netherlands indeed show that firms employing higher shares of flexible personnel pay lower wages. Estimates of sales equations, however, also show that firms with high shares of flexible labour (paying lower wages) do not conquer market shares from 'rigid' firms. The explanation is that firms with plenty of flexible labour realize lower productivity gains (Kleinknecht et al. 2006). Here again, we see that an orientation towards wage reduction is paying less than expected: lower wages are, to a significant degree, compensated by lower labour productivity growth.

Third, many observers will probably agree that, in view of Europe's ageing population, labour will become scarce in the near future. Together with a shrinking working population, demand by elderly people for care services will grow, services that are likely to be quite labour-intensive. In this context, it must be asked whether the Anglo-Saxon countries are well served with their low-productive and labour-intensive growth regime. Efforts can be made, of course, to augment labour market participation, but such a strategy has its limitations: the higher labour participation becomes, the more difficult it is to increase
it further. A labour-extensive growth regime (as in the 1960s and 1970s in Europe; see Table II-1), based on high wage cost pressure and high rates of labour productivity growth, would seem more promising if the aim is to master the challenges of a smaller working population and of a rising share of pensioners in need of care services.

Finally, our analysis suggests new research in two directions. First, our estimates raise some doubt about the realism of the Verdoorn Law. Several chapters in McCombie et al. (2002) provide evidence in favor of the Verdoorn Law (or the Kaldor-Verdoorn Law): labour productivity growth also depends on growth of GDP. This has an important policy implication. As supply side thinkers beat the Keynesians in the 1980s and 1990s, many governments in Europe became reluctant to engage in fiscal stimulation of the economy during recessions. If the evidence in favor of Schmooklerian 'demand-pull' effects for product innovation (Brouwer & Kleinknecht, 1999) and of Verdoorn effects for labour productivity growth were indeed valid, this would imply that neglect of demand in economic policy might, during certain periods, have weakened innovation and productivity growth in Europe. Given the role of innovation and productivity for exports (Hughes, 1988; Carlin et al., 2001; Kleinknecht & Oostendorp, 2002), this is likely to weaken the competitive position of European suppliers on international markets. Seen from this perspective, the defeat of Keynesianism would appear not to have been helpful to the European Commission's Lisbon agenda. The question is, however, how real is the Verdoorn effect? Our results suggest that the Verdoorn relationship might be less stable than is often assumed and at least part of the evidence of Verdoorn effects may have been driven by fluctuations in capacity utilization. Given the obvious relevance of this issue, our results call for more in-depth analyses of the Verdoorn Law.

Second, many large macro-econometric models of the economy still treat labour productivity as being independent of wages. They do not recognize that downward wage flexibility, wage-cost saving flexibilization of labour relations or other ways of curbing wage-costs would harm labour productivity growth. It would now be interesting building the causal relationship between wages and labour productivity explicitly into one or the other of those models, using our above coefficients. We definitely believe that a number of model outcomes and policy implications will change significantly.

IV Literature


IMF. *World Economic Outlook* (see Box 2.2 by Anthony Annett), Washington D.C., 2007.


Kleinknecht, A. *Heeft Nederland een loongolf nodig?* (Do the Netherlands need a wave of wage increases? in Dutch), Inaugural Lecture as a Professor of Economics at the Free University of Amsterdam, September 1994.


Appendix

PLEASE INSERT TABLE A1 ABOUT HERE

A2 Description of data

Data for the period 1960-2004 cover the following OECD countries: Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Ireland, Italy, Japan, The Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, UK and the USA. Series for Germany are for West-Germany until 1990; from then onwards they cover united Germany.

Sources of the data are:


All growth variables are calculated from the levels as: \( x_{growth} = (x_t - x_{t-1})/\text{average}(x_{t-1};x_t) \)

STATE DEPENDENCY = the growth of labour productivity. Labour productivity is obtained from the GGDC. It represents value added per hour worked and is expressed in 2005 US$ price levels with updated 2002 EKS Purchasing Power Parities (PPPs).

REAL WAGE GROWTH = the growth of the real wage.
The real wage is expressed in 2005 US$ price levels with updated 2002 EKS PPPs. It is calculated as: wage share in national income * labour productivity. The series for wage shares are at factor costs includes remuneration for the self-employed. They are obtained from the Eurostat-Ameco database. Labour productivity is described above.

\[ GAP_t = \frac{\text{MAX}_i(\text{labour productivity}_i) - \text{labour productivity}_{t, i}}{\text{MAX}_i(\text{labour productivity}_i)} \]

Labour productivity series are obtained from GGDC.

VERDOORN = the growth of GDP; GDP is obtained from the GGDC in 2005 US$ price levels with updated 2002 EKS PPPs

CAPACITY UTILIZATION
- The growth of the capital/output ratio. Output is GDP as described above. The capital stock is obtained from Eurostat's Ameco database in 2000 Euros.
- $\Delta$ output gap is the first difference of the OECD’s output gap, which refers to the difference between actual and potential gross domestic product (GDP) as a per cent of potential GDP.

PLEASE INSERT TABLE A3 ABOUT HERE (A3 Country-wise descriptive tables)

PLEASE INSERT TABLE A4 ABOUT HERE (Table A4 Full details of fixed effects GLS panel estimates of Model 1 as summarized in Table III/1 in current text)
A5 Proof of consistency when there is no serial correlation in the residuals

The regression equation (1) can be written in the form:
\[
\hat{\lambda}_{it} = \alpha_i + (\hat{\omega}_{it-1}, ..., \hat{\omega}_{it-k}, \hat{\lambda}_{it-1}, ..., \hat{\lambda}_{it-k}) \beta_1 + Z_{it}' \beta_2 + \epsilon_{it}
\]  
(2)

where \(\hat{\lambda}\) denotes the growth of labour productivity, \(\hat{\omega}\) denotes the growth of wages, \(Z\) a vector of control variables and \(\epsilon\) is the error term. The subscripts \(i, t\) are for country, year respectively.

We want to allow for the reversed causation. Let’s suppose that the reversed causation can be modeled as follows:
\[
\hat{w}_{it} = c + (\hat{\omega}_{it-1}, ..., \hat{\omega}_{it-m}, \hat{\lambda}_{it-1}, ..., \hat{\lambda}_{it-m}) \gamma + \mu_{it}
\]  
(3)

where \(\mu\) denotes the idiosyncratic error term and \(c\) includes all other exogenous observed and unobserved factors.

Now, suppose that, in the regression equation (a), we have serial correlation in the residuals of the general form:
\[
\epsilon_{it} = \omega_{it} + \sum \rho_{i-t} \epsilon_{it-d}
\]  
(4)

where \(\omega_{it} \sim IID, N(0, \sigma_{it}^2)\).

Then, by substituting (3) and (4) into (2), we obtain:
\[
\hat{\lambda}_{it} = \alpha_i + (\hat{\omega}_{it-2}, ..., \hat{\omega}_{it-(k+m)}, \hat{\lambda}_{it-1}, ..., \hat{\lambda}_{it-(k+m)}) \beta_1^* + Z_{it}' \beta_2^* + \omega_{it} + \sum \rho_{i-t} \epsilon_{it-d}
\]  
(5)

From (5) we can see that the error terms are uncorrelated with the regressors if the condition: \(\rho = 0 \forall l \leq k + m = 0\) holds.

Our regression equation (1) contains 9 lags of the dependent variable and of wage growth. So \(k = 9\) in our case. The shortest lag for which there is serial correlation in the error terms of this equation is the 17th lag, so \(l = 17\). We can deduct that in the model for the reversed causation (3), we can include up to 7 lags of productivity growth without obtaining biased coefficients in the regression of (1). We feel confident that such a long time horizon is not important in wage setting.

\(^{14}\) Although theoretically we could allow for panel specific autocorrelation, in the context of our estimation this has little relevance because the time-span of our data is too limited to provide accurate estimates and standard errors of this form of autocorrelation (Baccaro and Rei, 2005). Thus we pool the autocorrelation over the panels.
# Tables

### Table II-1: GDP growth, labour productivity growth and labour intensity of GDP growth. Anglo-Saxon countries compared to Continental European countries

<table>
<thead>
<tr>
<th>Period</th>
<th>Average annual GDP growth</th>
<th>Average annual GDP growth per hour worked</th>
<th>Growth of labour hours per 1% GDP growth</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Cont.-European</td>
<td>Anglo-Saxon</td>
<td>Cont.-European</td>
</tr>
<tr>
<td>1950-1960</td>
<td>5.5</td>
<td>3.3</td>
<td>4.2</td>
</tr>
<tr>
<td>1960-1973</td>
<td>5.1</td>
<td>4.1</td>
<td>5.2</td>
</tr>
<tr>
<td>1973-1980</td>
<td>2.7</td>
<td>2.4</td>
<td>3.0</td>
</tr>
<tr>
<td>1981-1990</td>
<td>2.6</td>
<td>3.2</td>
<td>2.4</td>
</tr>
<tr>
<td>1990-2000</td>
<td>2.4</td>
<td>3.1</td>
<td>1.9</td>
</tr>
<tr>
<td>2000-2004</td>
<td>1.3</td>
<td>2.5</td>
<td>1.1</td>
</tr>
</tbody>
</table>

**Notes:**
- Anglo-Saxon countries: Australia, Canada, New Zealand, US and UK.
- Cont.-European countries: Austria, Belgium, Denmark, Finland, France, Germany, Italy, Netherlands, Portugal, Spain, Sweden
Table III-1: Factors that explain labour productivity growth in year t, 1960-2004.
Summary of fixed-effects GLS panel estimates on yearly data

<table>
<thead>
<tr>
<th>Independent variables:</th>
<th>Coefficients model 1:</th>
<th>Coefficients model 2:</th>
<th>Coefficients model 3:</th>
<th>Coefficients model 4:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Real Wage growth_{it-1}</td>
<td>0.081***</td>
<td>0.074***</td>
<td>0.079***</td>
<td>0.091***</td>
</tr>
<tr>
<td>Real Wage growth_{it-2}</td>
<td>0.020</td>
<td>0.010</td>
<td>0.006</td>
<td>0.062***</td>
</tr>
<tr>
<td>Real Wage growth_{it-3}</td>
<td>0.077***</td>
<td>0.068***</td>
<td>0.073***</td>
<td>0.094***</td>
</tr>
<tr>
<td>Real Wage growth_{it-4 to 9}</td>
<td>0.170***</td>
<td>0.131*</td>
<td>0.168**</td>
<td>0.294***</td>
</tr>
<tr>
<td>STATE DEPENDENCY: Productivity growth_{it-1}</td>
<td>0.082**</td>
<td>0.079*</td>
<td>0.067</td>
<td>-0.122***</td>
</tr>
<tr>
<td>STATE DEPENDENCY: Productivity growth_{it-2}</td>
<td>-0.044</td>
<td>-0.033</td>
<td>-0.039</td>
<td>-0.153***</td>
</tr>
<tr>
<td>STATE DEPENDENCY: Productivity growth_{it-3}</td>
<td>-0.044</td>
<td>-0.034</td>
<td>-0.025</td>
<td>-0.076*</td>
</tr>
<tr>
<td>STATE DEPENDENCY: Productivity growth_{it-4 to 9}</td>
<td>0.046</td>
<td>0.084</td>
<td>0.038</td>
<td>-0.015</td>
</tr>
<tr>
<td>GAP_{it-1}</td>
<td>0.037***</td>
<td>0.039***</td>
<td>0.049***</td>
<td>0.049***</td>
</tr>
<tr>
<td>VERDOORN_{it} (GDP growth in year t)</td>
<td>0.65***</td>
<td>-0.031</td>
<td>0.47***</td>
<td>0.35***</td>
</tr>
<tr>
<td>VERDOORN_{it-1} (GDP growth in year t-1)</td>
<td>-0.31***</td>
<td>0.25</td>
<td>-0.25***</td>
<td>0.00046</td>
</tr>
<tr>
<td>Capacity utilization_{it}</td>
<td>growth of capital/output ratio in year t</td>
<td>-0.65***</td>
<td>0.52***</td>
<td>-0.0106</td>
</tr>
<tr>
<td>Δ output gap in year t</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>YEAR (dummy)</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Total effect of real wage growth on growth of labour productivity (in the long run)</td>
<td>0.36***</td>
<td>0.31***</td>
<td>0.34***</td>
<td>0.39***</td>
</tr>
</tbody>
</table>

Number of observations: 631 631 545 559
Log-likelihood 1929 1937 1687 1696

* significant at 10% level; ** significant at 5% level; *** significant at 1% level

Notes:
- Regressions (1 – 4) are estimated using a fixed effects GLS panel estimator which allows panel-specific heteroskedasticity (stata-command: XTGLS (…), p(h); see Stata Manual, Release 6, p. 360).
- Model 1 was tested for the appropriateness of allowing panel-specific heteroskedasticity, using a Chi^2-test (result: Chi^2 (18) = 5521).
- Model 1 was tested for the presence of autocorrelation in the residuals, using a regression of the residuals on their own lags (up to fifteen-year lags). All forms of autocorrelation were rejected. We tested how many lags of wage growth and productivity growth had to be included in order to get rid of significant autocorrelation. Nine successive lags of real wage growth and of labour productivity growth were necessary to achieve this. The first two models above do not exhibit significant autocorrelation in the residuals.
- The total (long run) effect of wage growth is calculated as ∑_{r=1}^{9} (b_{wagegrowth,it-r})/(1 - ∑_{r=1}^{9} (b_{labourproductivitygrowth,it-r})) and tested using a Chi^2-test for a non-linear model.
- Model 1 was subjected to several robustness checks. First, we used a ‘leave one out’ approach for the countries. Secondly, we subdivided the sample into various periods. Thirdly, a regression was run including country-specific time trends instead of (as well as supplementary to) time-specific effects. The results proved robust for such manipulations. Fourthly, testing the possible impact of past wage growth and of past productivity growth on present productivity growth, we experimented with shorter and longer time lags (first 1 year and then successively adding lags of up to 9 years). It turned out that, with all successive time lags, the total effect of real wage growth on the growth of labour productivity is significantly positive. Fifthly, we ran a regression including an indicator for the share of services to capture productivity effects resulting from changes in the sectoral composition of the economy. This did not affect our regressors.
- To test whether our results might be due to over parameterization, we ran a regression including only significant lags of labour productivity growth and wage growth. The results are robust for this experiment.
- Finally, models 1 and 2 were re-estimated using Instrumental Variables (stata-command: IVreg2) for Verdoorn_{it} (model 1) and Verdoorn_{it} and Capacity_{it} (model 2) with heteroskedastic robust standard errors. Up to nine year lags of the suspected variables were used as valid (according to Hansen’s J-test) and relevant (according to Anderson’s IV-relevance test) instruments. Apart from the loss of some significance, that is to be expected when using instruments, the results did not change substantially.

See Appendix Table A4 for a more detailed report of all regression results of model 1.
Table AI: Coefficients of auto regressions of the residuals of Table III-1, model 1.  
(Summary of OLS estimates)

<table>
<thead>
<tr>
<th>Independent variables</th>
<th>Coefficient</th>
<th>t-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>LAG 1</td>
<td>-0.024</td>
<td>-0.60</td>
</tr>
<tr>
<td>LAG 2</td>
<td>0.038</td>
<td>0.94</td>
</tr>
<tr>
<td>LAG 3</td>
<td>-0.017</td>
<td>-0.42</td>
</tr>
<tr>
<td>LAG 4</td>
<td>-0.031</td>
<td>-0.74</td>
</tr>
<tr>
<td>LAG 5</td>
<td>0.052</td>
<td>1.29</td>
</tr>
<tr>
<td>LAG 6</td>
<td>-0.037</td>
<td>-0.89</td>
</tr>
<tr>
<td>LAG 7</td>
<td>0.057</td>
<td>1.38</td>
</tr>
<tr>
<td>LAG 8</td>
<td>-0.023</td>
<td>-0.53</td>
</tr>
<tr>
<td>LAG 9</td>
<td>0.066</td>
<td>1.48</td>
</tr>
<tr>
<td>LAG 10</td>
<td>-0.048</td>
<td>-1.07</td>
</tr>
<tr>
<td>LAG 11</td>
<td>0.014</td>
<td>0.30</td>
</tr>
<tr>
<td>LAG 12</td>
<td>-0.056</td>
<td>-1.19</td>
</tr>
<tr>
<td>LAG 13</td>
<td>-0.048</td>
<td>-0.99</td>
</tr>
<tr>
<td>LAG 14</td>
<td>-0.072</td>
<td>-1.47</td>
</tr>
<tr>
<td>LAG 15</td>
<td>-0.027</td>
<td>-0.55</td>
</tr>
</tbody>
</table>

Notes:
- None of the regressions yields a significant result, using a confidence level of 90%.
- All auto regressions include a constant term, using OLS.
- Stata-command: `reg (…
<table>
<thead>
<tr>
<th>Variable</th>
<th># observations</th>
<th>Mean</th>
<th>Std. dev.</th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>labor prod. growth</td>
<td>41</td>
<td>0.02</td>
<td>0.01</td>
<td>-0.01</td>
<td>0.05</td>
</tr>
<tr>
<td>Real wage growth</td>
<td>41</td>
<td>0.02</td>
<td>0.03</td>
<td>-0.04</td>
<td>0.11</td>
</tr>
<tr>
<td>Gap</td>
<td>43</td>
<td>0.29</td>
<td>0.04</td>
<td>0.21</td>
<td>0.37</td>
</tr>
<tr>
<td>GDP growth</td>
<td>45</td>
<td>0.04</td>
<td>0.02</td>
<td>0.00</td>
<td>0.07</td>
</tr>
<tr>
<td>capital/output growth</td>
<td>45</td>
<td>0.00</td>
<td>0.02</td>
<td>-0.03</td>
<td>0.03</td>
</tr>
<tr>
<td>∆ output gap</td>
<td>37</td>
<td>-0.06</td>
<td>1.58</td>
<td>-3.76</td>
<td>3.22</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Variable</th>
<th># observations</th>
<th>Mean</th>
<th>Std. dev.</th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
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Table A4  
Full details of fixed effects GLS panel estimates of Model 1 as summarized in Table III/1 in current text

|                                      | Coef. | z-value | P(|z|) |
|--------------------------------------|-------|---------|--------|
| Real Wage growth_{it-1}              | 0.081 | 3.07    | 0.00   |
| Real Wage growth_{it-2}              | 0.020 | 0.76    | 0.45   |
| Real Wage growth_{it-3}              | 0.077 | 2.89    | 0.00   |
| Real Wage growth_{it-4}              | 0.014 | 0.53    | 0.60   |
| Real Wage growth_{it-5}              | 0.0054| 0.2     | 0.84   |
| Real Wage growth_{it-6}              | 0.044 | 1.61    | 0.11   |
| Real Wage growth_{it-7}              | 0.031 | 1.13    | 0.26   |
| Real Wage growth_{it-8}              | 0.012 | 0.44    | 0.66   |
| Real Wage growth_{it-9}              | 0.061 | 2.29    | 0.022  |
| STATE DEPENDENCY: Productivity growth_{it-1} | 0.082 | 1.96    | 0.05   |
| STATE DEPENDENCY: Productivity growth_{it-2} | -0.044| -1.21   | 0.23   |
| STATE DEPENDENCY: Productivity growth_{it-3} | -0.043| -1.21   | 0.23   |
| STATE DEPENDENCY: Productivity growth_{it-4} | 0.027 | 0.78    | 0.44   |
| STATE DEPENDENCY: Productivity growth_{it-5} | 0.070 | 1.99    | 0.047  |
| STATE DEPENDENCY: Productivity growth_{it-6} | -0.032| -0.91   | 0.36   |
| STATE DEPENDENCY: Productivity growth_{it-7} | -0.0056| -0.16  | 0.87   |
| STATE DEPENDENCY: Productivity growth_{it-8} | -0.020| -0.58   | 0.56   |
| STATE DEPENDENCY: Productivity growth_{it-9} | -0.0020| -0.06  | 0.95   |
| GAP_{it-1}                            | 0.037 | 4.45    | 0      |
| VERDOORN_{it} (GDP growth in same year)| 0.55  | 17.4    | 0      |
| VERDOORN_{it-1} (GDP growth one year delayed) | -0.31 | -8.44  | 0      |
| COUNTRY (dummy)                       | Yes   |         |        |
| YEAR (dummy)                         | Yes   |         |        |

**Note:**
- The regression is estimated using a fixed effects GLS panel estimator which allows panel-specific heteroskedasticity (stata-command: XTGLS (...), p(h); see Stata Manual, Release 6, p. 360).
Figures

Figure I-1: Development of real wages: Anglo-Saxon versus Continental-European countries (1960-2004)

Source: Database of the Groningen Growth and Development Centre (http://www.ggdc.net/).

Figure I-2: Development of total hours worked: Anglo-Saxon versus Continental-European countries (1960-2004)

Source: Database of the Groningen Growth and Development Centre (http://www.ggdc.net/).
Figure I-3: Development of real GDP: Anglo-Saxon versus Continental-European countries (1960-2004)

Anglo-Saxon countries: Australia, Canada, New Zealand, UK and USA;
Cont.-European countries: Austria, Belgium, Denmark, Finland, France, Germany, Italy, Netherlands, Portugal, Spain, Sweden;
Source: Database of the Groningen Growth and Development Centre (http://www.ggdc.net/).

Figure I-4: Development of labour productivity: Anglo-Saxon versus Continental-European countries (1960-2004)

Anglo-Saxon countries: Australia, Canada, New Zealand, UK and USA;
Cont.-European countries: Austria, Belgium, Denmark, Finland, France, Germany, Italy, Netherlands, Portugal, Spain, Sweden;
Source: Database of the Groningen Growth and Development Centre (http://www.ggdc.net/).
Real labour productivity growth  Simulated values

Years