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The impact of labor market deregulation on productivity: a panel data analysis of 19 OECD countries (1960–2004)

Abstract: *Mainstream economists argue that unemployment can be reduced by deregulation of labor markets, that is, by easier firing, reduction of minimum wages and social benefits, and so forth. Our panel data analysis shows that wage-cost saving flexibilization of labor markets has a negative impact on labor productivity growth. A one percentage point change in growth rates of real wages leads to a change in labor productivity growth by 0.31–0.39 percentage points. This cannot solely be explained by hiring low-productive labor. Flexibilization of labor markets leads to a labor-intensive growth path that is problematic with an aging population in Europe.*

Key words: *employment growth, flexible labor, labor market deregulation, labor productivity growth, wage policy.*

Taking Walrasian general equilibrium theory as a point of departure, it is easy to argue that European unemployment could be reduced by curbing wage costs and by making labor markets more flexible. For many years now, economic think tanks have argued that the "flexibilization" of European factor markets (notably of labor markets) would help in the realization of higher job growth and extra welfare gains (see International

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Monetary Fund, 2007, pp. 67–69, box 2.2). The call for more flexible labor markets usually includes a demand for the easier firing of personnel, the realization of greater (downward) wage flexibility, or the reduction of minimum wages and social benefits (see, e.g., Organisation for Economic Co-operation and Development [OECD], 1999; 2003b). This corresponds to the consensus among many scholars about the harmful effects of extensive labor market regulation and wage inflexibility on unemployment (see, e.g., Blanchard and Wolfers, 2000; Nickell et al., 2005; Nunziata, 2005).

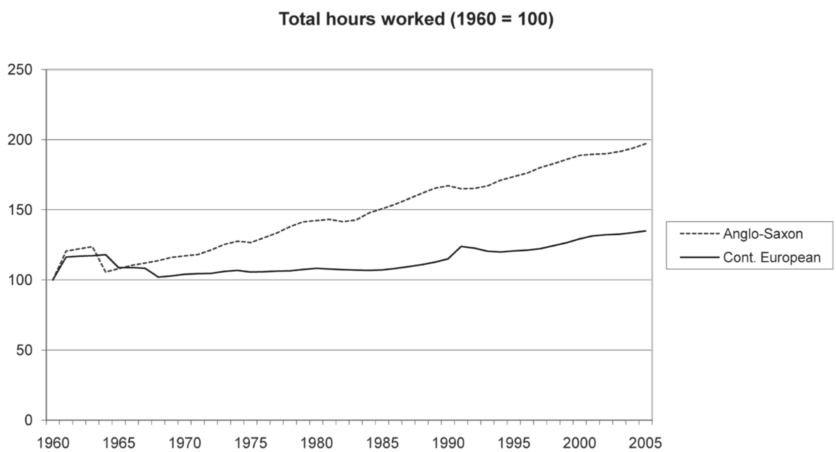
We argue that a strategy of wage cost reduction through more flexible labor markets in the OECD nations may be problematic. We do not deny that such a strategy may encourage job growth, but maintain that this is not a "free lunch." Rather than stimulating extra gross domestic product (GDP) growth, it may lead to a low-productive and highly labor-intensive growth model. Theoretical arguments and statistical illustrations will be given in the next section. In the third section, this hypothesis will be tested on panel data from 19 OECD countries over the period 1960–2004.

Our argument is illustrated with the aid of four figures. Figure 1 shows that, since the mid-1960s, real wage growth has been more modest in a group of "flexible" Anglo-Saxon countries compared to a group of Continental European countries having "rigid" labor markets. Various types of labor market institutions in the "Liberal Market Economies" (Hall and Soskice, 2001), such as easier firing, weaker trade unions, more modest social benefit systems, more decentralized wage bargaining, and so forth, have indeed helped to moderate real wage growth. Figure 2 shows what most economists would expect after having seen Figure 1: lower wage growth is related to a substantially higher growth of working hours. Figure 3, however, shows something remarkable. 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 1990s) 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 Figure 3 does not show evidence of a clear relationship between GDP growth and real wages. The logical implication of Figures 2 and 3 is that labor productivity growth was appreciably lower in Anglo-Saxon countries compared to Continental Europe up to the 1990s. Figure 4 shows that this is indeed the case. The figures shed new light on the job creation success of the Anglo-Saxons in Figure 2: the Anglo-Saxons indeed created more labor 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.

Figure 1 Development of real wages: Anglo-Saxon versus Continental European countries (1960–2005)

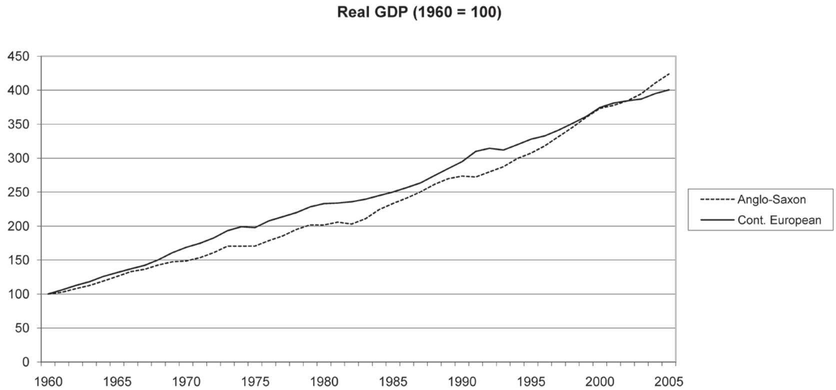
Source: Database of the Groningen Growth and Development Centre (www.ggdc.net).
Notes: Anglo-Saxon countries: Australia, Canada, New Zealand, United Kingdom, and United States. Cont. European countries: Austria, Belgium, Denmark, Finland, France, Germany, Italy, Netherlands, Portugal, Spain, and Sweden.

Figure 2 Development of total hours worked: Anglo-Saxon versus Continental European countries (1960–2005)



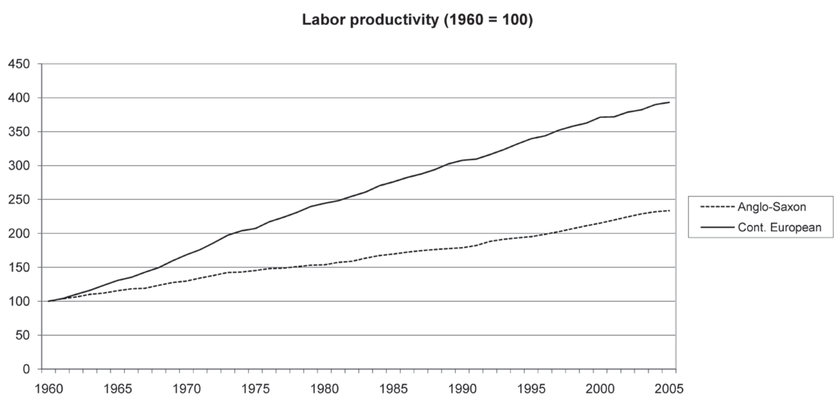
Source: Database of the Groningen Growth and Development Centre (www.ggdc.net).
Notes: Anglo-Saxon countries: Australia, Canada, New Zealand, United Kingdom, and United States. Cont. European countries: Austria, Belgium, Denmark, Finland, France, Germany, Italy, Netherlands, Portugal, Spain, and Sweden.

Figure 3 Development of real GDP: Anglo-Saxon versus Continental European countries (1960–2005)



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

Figure 4 Development of labor productivity: Anglo-Saxon versus Continental-European countries (1960–2005)



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

Our group of Continental European countries includes the Netherlands. One should note that, since the 1980s, this country is no longer typical for "rigid" Europe. During the 1980s and 1990s, the Netherlands experienced a development of wages, jobs, and labor productivity similar to that of the Anglo-Saxon countries, although within a different institutional framework (Naastepad and 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" labor market institutions, at least for "core" workers.[1]

As in the Anglo-Saxon countries, this policy was quite successful in creating jobs and only a 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 labor productivity growth (Kleinknecht, 1994; Naastepad and Kleinknecht, 2004; Van Schaik, 1994).

Many scholars objected to this suggestion using three main arguments. First, we should be happy with the high job growth. Second, it was argued that modest wage growth allows the hiring of workers with lower productivity. As far as there was a labor 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) labor 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 the next section, theoretical arguments are presented in favor of reversed causality, which is tested by means of a panel data analysis of 19 OECD countries (third section). This finding has far-reaching consequences, among others for the discussion about whether "rigid"

[1] One should note that the continued protection of "insiders" does not exclude that there was a rising share of flexible "outsiders" with nontypical working arrangements since the 1980s. Employment of the latter lead to substantial wage cost 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.

European labor markets should indeed be made more flexible. This will be discussed in the concluding section.

Theoretical arguments and further illustrations

In our opinion, there are at least five theoretical arguments in favor of the view that causality may run not only from productivity to wages, but also in the opposite direction: from wage growth to labor productivity growth. These arguments are as follows:

1. In standard neoclassical theory, an increase in the relative price of labor leads profit-maximizing firms to substitute capital for labor, shifting along a given production function, until the marginal productivity of labor equals the given real wage. Causality in this argument runs from relative factor prices to choice of technique and hence to productivity of labor.
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 labor 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 Foley and Michl, 1999; Hartog and Tjan, 1980). This can result in the aging of the capital stock (shown to have been one of the reasons behind the Dutch productivity crisis; see Naastepad and Kleinknecht, 2004).
3. According to the theory of induced technological change, a higher relative wage rate (wage share) increases the labor-saving bias of newly developed technology (Foley and Michl, 1999; Hicks, 1932; Kennedy, 1964; Ruttan, 1997). Ceteris paribus, a higher real wage growth will lead to a higher wage share, thus increasing the rate of the labor saving bias in induced technological change.
4. From the viewpoint of Schumpeterian creative destruction, it can be argued that innovating firms (compared to their noninnovative counterparts) can better cope with aggressive wage claims by trade unions. Innovators have market power due to monopoly rents from unique products 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 outcompete technological laggards. Conversely, modest wage growth and flexible labor 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 and Kleinknecht, 1999), higher effective demand enhances innovative activity. Analogously, Verdoorn's Law suggests that output growth has a positive impact on labor productivity growth (see McCombie et al., 2002). All this implies that a strategy of wage cost reduction might impede innovation and labor 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 labor productivity growth. Some theories point to a direct linkage between wages and labor productivity growth. Others, for example, 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 labor markets have forwarded four arguments of why rigid labor markets may impede productivity growth. First, rigidity could reduce the reallocation process of labor from old and declining sectors to new and dynamic ones (for a review of the effects of labor market institutions on economic performance, see Nickell and Layard, 1999). Second, the difficult or expensive firing of redundant personnel can frustrate labor-saving innovations at the firm level (Bassanini and Ernst, 2002; Scarpetta and Tressel, 2004). Third, well-protected workers may not work as 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

[3] Bhaduri and Marglin (1990) argue that this may be the case if an economy is "wage led" rather than "profit led."

[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-year lags avoids this problem.

countries that have decentralized bargaining regimes. It is less likely to be relevant to rigid "Rhineland" labor markets that rely more strongly on industry-level bargaining.

Against these arguments, the following counterarguments 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 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 labor-saving innovations as a high percentage leaves the firm voluntarily.[5]

Third, protection against dismissal may actually enhance productivity performance, as secure workers will be more willing to cooperate with management in developing labor-saving processes and in disclosing their (tacit) knowledge to the firm (see Lorenz, 1992; 1999). People threatened by easy firing have incentives to hide knowledge about how their work could be done more efficiently.

Fourth, "rigid" labor 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 (Polanyi, 1966). "Rigid" European labor markets are typically characterized by longer job tenures and reallocation of workers in internal (rather than external) labor markets. This 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

[5] Kleinknecht et al. (2006) report that, on average, 9–12 percent of a firm's personnel in the Netherlands leave voluntarily each year, the exact percentage depending on the state of the business cycle. Nickell and Layard report that this figure amounts to over 10 percent (1999, p. 363).

is important because labor contracts tend to be incompletely specified, offering room for opportunistic behavior. Reduction of loyalty and trust may explain why flexible Anglo-Saxon countries have substantially larger management bureaucracies, compared to "Rhineland" countries (Storm and 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 not dare to criticize management decisions. Lack of critical feedback from the shop floor may favor problematic management practices, top managers believing they are great visionary leaders who can hardly fail.

In addition to lower wage growth, such arguments about flexibility may contribute to explain why Anglo-Saxon countries experienced, over long periods, lower productivity growth compared to "Rhineland" countries, as shown in Table 1.

Table 1 summarizes key indicators of the long-run performance of five typical "Anglo-Saxon" countries (Australia, New Zealand, Canada, United Kingdom, and United States) compared to a group of 11 typical EU countries. The third pair of columns in Table 1 suggests that the Anglo-Saxon countries have shown superior growth performance in labor 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 pair of columns).

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 pairs of columns in Table 1 have a logical link: the relationship between GDP growth and that of *per hour worked* determines the growth of labor hours per 1 percent GDP growth in the third pair of columns.

Table 1 suggests that the superior long-term employment record of the Anglo-Saxon countries is caused primarily by weaker labor productivity growth, and at best to a minor extent by superior GDP growth. More

Table 1
GDP growth, labor productivity growth, and labor intensity of GDP growth: Anglo-Saxon countries compared to Continental European countries

	Average annual GDP growth		Average annual GDP growth per hour worked		Growth of labor hours per 1 percent GDP growth	
	Continental European	Anglo-Saxon	Continental European	Anglo-Saxon	Continental European	Anglo-Saxon
1950–1960	5.5	3.3	4.2	3.6	0.23	–0.09
1960–1973	5.1	4.1	5.2	2.7	–0.03	0.34
1973–1980	2.7	2.4	3.0	1.1	–0.14	0.55
1981–1990	2.6	3.2	2.4	1.4	0.07	0.55
1990–2000	2.4	3.1	1.9	1.9	0.21	0.40
2000–2004	1.3	2.5	1.1	1.6	0.15	0.35

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

Notes: Nonweighted averages across countries. Anglo-Saxon countries: Australia, Canada, New Zealand, United States, and United Kingdom. Cont. European countries: Austria, Belgium, Denmark, Finland, France, Germany, Italy, Netherlands, Portugal, Spain, and Sweden.

recently, however, this pattern has changed. During the 1990s, Anglo-Saxon labor productivity growth approached Continental European standards; in the most recent period (2000–4), it has even slightly exceeded that of the European Union.

At present, we can only speculate about these changes. Two reasons, of course, for the resurgence of Anglo-Saxon productivity growth are the information and communication technologies (ICT) revolution and a housing and mortgage bubble. The declining EU productivity growth (and improved job growth) may be due to a gradual introduction of Anglo-Saxon labor market practices in mainland Europe. In addition, the post-2001 recession seemed to hit EU countries more adversely than the United States. This may have depressed measured EU productivity growth through lower capacity utilization or the Verdoorn effect.

Panel data estimates

To test our hypothesis that wage growth influences labor productivity growth, data are used from 19 OECD countries over the period 1960–2004. The majority of these data comes from the Total Economy Database (May 2006) of the Groningen Growth and Development Centre, documented on the Internet (www.ggdc.net). The dependent variable is growth in value added per labor 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.[6]

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—that is, that (some lags of) the growth of labor productivity will cause the growth of real wages—while still obtaining consistent estimators. In Appendix A, a mathematical proof for this weak exogeneity condition is provided. Furthermore, in Appendix Table B1, a test is documented that does not reject the hypothesis of *no* serial correlation in the residuals of our main regression (column 1, Table 2). Nine lags are included in the regression specification in order to obtain this feature. This lag-structure is seemingly long, but from the

[6] This operation makes the independent variable predetermined.

Table 2
Factors that explain labor productivity growth in year *t*, 1960–2004: summary of fixed-effects GLS panel estimates on yearly data

Independent variables	Coefficients model 1	Coefficients model 2	Coefficients model 3	Coefficients model 4
Real Wage growth$_{it-1}$	–0.081***	–0.074***	–0.079***	–0.091***
Real Wage growth$_{it-2}$	0.020	0.010	0.006	0.060**
Real Wage growth$_{it-3}$	0.077***	0.068***	0.073***	0.094***
Real Wage growth$_{it-4\ \mathrm{to}\ 9}$	0.170**	0.131*	0.168**	0.294***
STATE DEPENDENCY: Productivity growth$_{it-1}$	0.082**	0.079*	0.067	–0.122***
STATE DEPENDENCY: Productivity growth$_{it-2}$	–0.044	–0.033	–0.039	–0.153***
STATE DEPENDENCY: Productivity growth$_{it-3}$	–0.044	–0.034	–0.025	–0.076*
STATE DEPENDENCY: Productivity growth$_{it-4\ \mathrm{to}\ 9}$	0.046	0.084	0.038	–0.015
GAP$_{it-1}$	0.037***	0.039***	0.049***	0.049***
VERDOORN$_{it}$ (GDP growth in year *t*)	0.55***	–0.031	0.47***	0.35***
VERDOORN$_{it-1}$ (GDP growth in year *t* – 1)	–0.31***	0.25	–0.25***	
Capacity utilization$_{it}$				
Growth of capital/output ratio in year *t*		–0.65***		
Δ output gap in year *t*			0.00046	0.0015*
Capacity utilization$_{it-1}$				
Growth of capital/output ratio in year *t* – 1		0.52***		
Δ output gap in year *t* – 1			–0.00106	

COUNTRY (dummy)	Yes	Yes	Yes	Yes
YEAR (dummy)	Yes	Yes	Yes	Yes
Total effect of real wage growth on growth of labor productivity (in the long run)	0.36***	0.31***	0.34***	0.39***
Number of observations	631	631	545	559
Log-likelihood	1,929	1,937	1,687	1,696

Notes: Regressions (1–4) are estimated using a fixed effects GLS panel estimator that allows panel-specific heteroskedasticity (stata-command: XTGLS (…), p(h); see the Stata manual, release 6, p. 360). Model 1 was tested for the appropriateness of allowing panel-specific heteroskedasticity, using a χ^2 test (result: χ^2 (18) = 5,521). Model 1 was tested for the presence of autocorrelation in the residuals, using a regression of the residuals on their own lags (up to 15-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 labor 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

$$\sum_{\tau=1}^{\tau=9}\left(b_{\text{wage growth},it-\tau}\right)/\left(1-\sum_{\tau=1}^{\tau=9}\left(b_{\text{labor productivity growth},it-\tau}\right)\right),$$

and tested using a χ^2 test for a nonlinear model. Model 1 was subjected to several robustness checks. First, we used a "leave one out" approach for the countries. Second, we subdivided the sample into various periods. Third, 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. Fourth, 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 labor productivity is significantly positive. Fifth, 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 labor productivity growth and wage growth. The results are robust for this experiment. Finally, Models 1 and 2 were reestimated 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, which is to be expected when using instruments, the results did not change substantially. See Appendix Table C1 for a more detailed report of all regression results of Model 1. * Significant at the 10 percent level; ** significant at the 5 percent level; *** significant at the 1 percent level.

above theoretical arguments we expect significant effects of changes in wages on growth of labor productivity even in the long run. Appendix Table C1 presents the full details of the fixed effects generalized least squares (GLS) panel estimates of Model 1 as summarized in Table 2.

We checked the robustness of the estimators of the main regression for a possible overparameterization by tentatively removing all the insignificant lags of labor 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 arose. 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 ordinary least squares (OLS), even in the case of no serial correlation in the residuals. Nickell (1981) shows, however, that this bias is 0(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 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.[7] 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.[8]

Judson and Owen (1999) tested the bias of the LSDV (least squares dummy variables estimator, that is, a dynamic fixed effects estimator) for the AR(1) case with the use of Monte Carlo simulations. They compared it with various other estimators, including the standard GMM (generalized

[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.

method of moments) estimators with lags of the dependent variables as instruments. Their results suggest that “The LSDV estimator performs just as well as or better than many alternatives when T = 30” (ibid., 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 0(1/*T*)).

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

- *STATE DEPENDENCY*: Past labor 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) labor 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 labor productivity growth indeed exists, noncorrection 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, p. 418).
- *GAP*: The relative difference between a country’s labor productivity level and that of the country with the highest level of labor 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 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 labor productivity growth.
- *COUNTRY*: In order to correct for unobserved country-specific influences on labor 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 labor productivity (value added per labor hour) is sensitive to fluctuations in capacity utilization over the business cycle, due

> to labor hoarding. For example, in a business cycle upswing, if growing use of hoarded labor was accompanied by a growth of real wages, the extra growth of value added per labor 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 Appendix D. Descriptive statistics are presented in Appendix Table E1.

Our regression equation has the form:

$$\hat{\lambda} = \alpha_i + \sum_k \beta_{1,k} \hat{w}_{t-k} + \sum_k \beta_{2,k} \hat{\lambda}_{t-k} + \beta_3 \hat{Q} + \beta_4' Z + \varepsilon, \tag{1}$$

where $\hat{\lambda}$ denotes the growth of labor productivity, $\hat{w}_{t-k}$ is the growth of real wages at time $t - k$, $\hat{Q}$ is the growth of output, α_i is country fixed effects, ε is an error term, and Z is a vector of control variables.

Although we are mainly interested in the coefficients that reflect the effect of wage growth on labor 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) used a cointegration approach to test for a long-run relationship between labor productivity, output, *and the real wage,* which they interpreted as Verdoorn's regularity.[9] They derived this specification starting from a CES (constant elasticity of substitution)-production function. The real wage (growth) then controlled for substitution between labor 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 that stem from other frameworks rather than a production function approach.

[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.

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 counterargument could be that service shares may be endogenous: a strategy of low wage and low labor 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, and 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 tentatively included, in several versions of our estimates, the contribution of services to total GDP. These versions are not documented in Table 2, 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 2 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 preferred version. Inclusion of the capital/output ratio may be problematic as the validity of the construction of the capital stock may be doubted (Felipe and Fisher, 2003; Robinson, 1953–54). This entails the risk of obtaining biased coefficients due to errors of measurement. Furthermore, it may be argued that correction for fluctuations in capacity 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.

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 in an explanatory variable (e.g., x) has the (first-order) effect of raising labor 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 labor productivity (itself caused by the difference in x in year y) on the growth of labor productivity in year $y + 1$. This effect equals $b_x * b_{\lambda,\text{growth}}$, where $b_{\lambda,\text{growth}}$ denotes the coefficient of the lagged value of labor 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 $y \rightarrow \infty$ yields the following formula with which to calculate the long-run effect of a permanent change of one unit in the variable x:

$$\sum_{T=Tb}^{T=Te}\left(b_{x,it-T}\right) / \left(1-\sum_{\tau=\tau b}^{\tau=\tau e}\left(b_{\text{labor productivity growth},it-\tau}\right)\right),$$

where the symbols T_b and T_e denote the begin and end lag of x and τ_b and τ_e the begin and end lag of labor 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 labor productivity growth. Labor productivity growth delayed has, in several versions of our model, positive effects on labor productivity growth. It should be emphasized that a very careful control for effects of past labor productivity growth on future labor productivity growth is required, due to the arguments mentioned above (Jansen, 2004). This is a reason for our inclusion of up to nine year 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 autoregression in our residuals. While short-lagged labor productivity growth tends to be significant in most versions, the long-term, cumulative effect of lagged labor productivity growth on the current growth of labor productivity is modest. An *F*-test based on our main regression (column 1, Table 2) 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, labor productivity growth is no self-propelling force.[10]

The GAP variable behaves as expected: a country's 1 percent distance in productivity level from the country with the highest level leads, on average, to 0.037 percent extra growth of its labor productivity in the short term and to 0.039 percent 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, we above 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 labor productivity. We therefore also experimented with instrumentation, which led, as expected, to a loss of significance of the coefficient representing the Verdoorn relationship. These versions are not documented in Table 2, as instrumenta-

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 labor productivity growth, it can be concluded that a 1 percentage point reduction in wage growth will result in a 0.31–0.39 percent long-run reduction of labor 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 labor productivity growth because they not only influence labor productivity growth of newly created jobs but, more importantly, they change labor productivity growth of *existing* jobs. This interpretation contradicts the view expressed by the OECD (2003a). 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 labor 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" (ibid., p. 42, box 1.4). 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.

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tion 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 this view, the loss in average labor productivity growth is mainly a negative by-product of extra jobs created in the low wage segment.

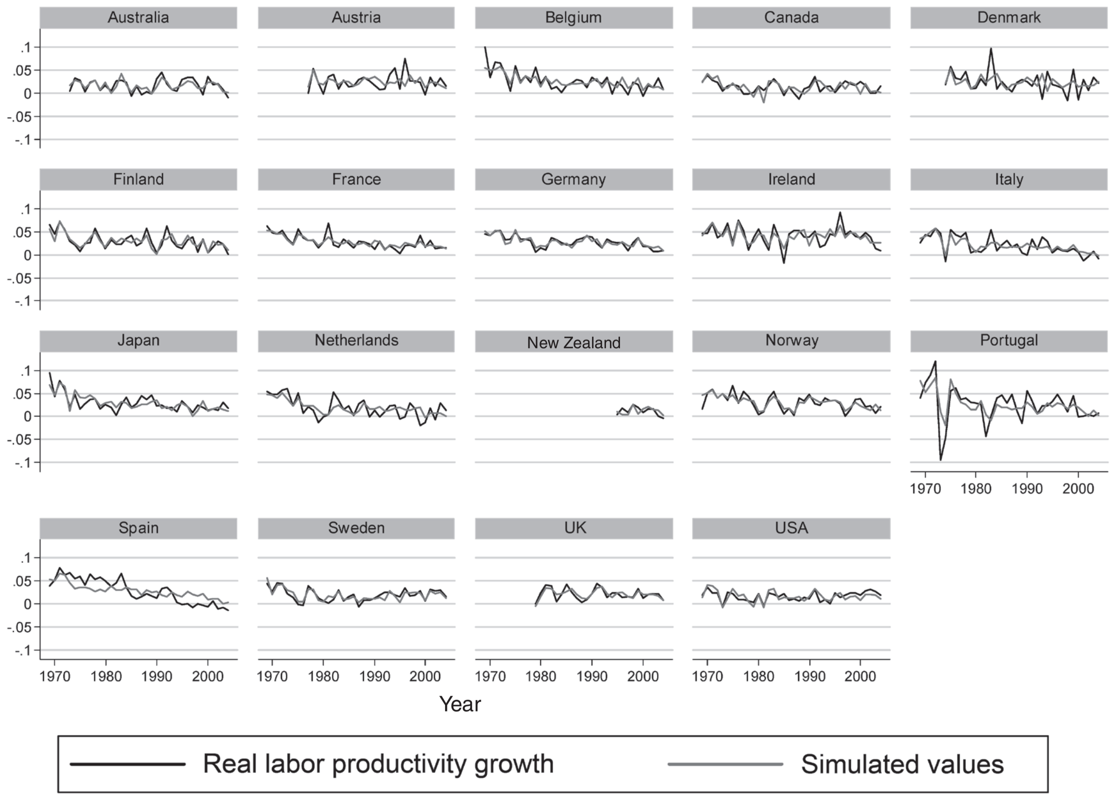
In our view, the reasoning by the OECD is unsatisfactory for several reasons. First, it does not take account of our theoretical arguments that suggest a causal link from wage growth to labor productivity growth. The vintage argument and the creative destruction argument, in particular, would lead us to expect losses in productivity growth in *existing* jobs. Second, 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 labor relations do *not* affect labor 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. Figure 5 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, it may be asked whether it is wise having people locked in low-productive jobs since, in the near future, Europe will face an aging population. The share of working age people will shrink and many new (and probably labor-intensive) jobs in age-related services need to be created. To meet that challenge, it seems wise to enable more productive work by systematic investments 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 R^2-statistic. To illustrate the realism of our model, therefore, a dynamic simulation is used. Figure 5 compares statistically observed labor productivity growth to labor productivity growth that is simulated using the estimated coefficients taken from Model 1. We consider these simulations satisfactory and reassuring.

Conclusions

Superior growth of labor input in flexible Anglo-Saxon economies is *not* due to superior GDP growth. Over a long period (1960–95), it has been due to a lower growth of labor productivity when compared to "rigid" European economies. Only after 1995, the picture changed as the ICT boom enhanced U.S. labor productivity growth. At the same time, several European countries experienced a worsening labor productivity performance as they gradually engaged in wage-cost saving flexibilization of their labor markets. Our panel data analysis shows that there is indeed a causal link between wage growth and labor productivity growth. One

Figure 5 Comparison between observed and simulated labor productivity growth



percent higher (lower) wage growth causes about 1/3 percent higher (lower) labor productivity growth. We argue that wage-cost saving effects of flexible labor relations translate into lower labor productivity growth through capital-labor substitution, vintage effects, induced technical change, creative destruction, and demand-pull effects. Moreover, we argue that flexible hiring and firing has negative effects on knowledge accumulation. For example, higher labor turnover makes firm-sponsored training less attractive; it also diminishes loyalty and commitment of people. The latter leads to easier leaking of knowledge, enhances the growth of management bureaucracies for monitoring and control, and weakens the historical memory of organizations. Notably the Schumpeter II innovation model, based on continuous historical accumulation of (tacit) knowledge, is likely to function less efficiently with a higher labor turnover under easy hire and fire.

We argued that only a part of the decline in labor productivity growth can be explained by increased hiring of low-productive people thanks to reduced minimum wages and reduced social benefits as proposed by OECD (2003a). There are theoretical reasons to believe that there is also a slowdown of labor productivity growth in *existing* jobs. Moreover, had labor productivity growth in existing jobs been unaffected by labor market deregulation, then the extra jobs for low productive people should have resulted in GDP growth that is higher in the Anglo-Saxon countries compared to "rigid" Europe (where low-productive people are deterred from the labor market). Figure 3 shows that this is *not* the case. There is evidence of higher GDP growth in the United States, notably since the 1990s, but this may have different reasons, such as a bubble in housing markets and a mortgage boom. It has been shown elsewhere that "mortgage Keynesianism" related to booming housing markets may cause substantial extra GDP growth—as long as it lasts.[13] We conclude that lower wage growth reduces labor productivity growth also in *existing* jobs and that this is a major cause behind the superior growth of labor hours in the Anglo-Saxon countries (Figure 2).

There are, of course, reasons to be pleased with more employment. It may be favorable for the social cohesion of society and it helps solving government budget problems. On the other hand, it might be asked wheth-

[13] Simulations with the Morkmon model of the Dutch Central Bank suggest that rapidly rising housing prices and related extra mortgages by house owners in the Netherlands caused an extra growth of GDP by about 1 percent in 1999 and 2000 (DNB, 2002, pp. 29–38). As U.S. housing prices roughly doubled between 1995 and 2005, effects of similar size may apply to the U.S. economy.

er such a growth model is as attractive as it looks (see also Ebersberger and Pyka, 2002). We see several reasons for doubt.

First, a highly labor-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 labor 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 labor hours per employee. While Faggio and Nickell complain about a "mistaken belief" (2007, p. 437) that shorter working hours would reduce unemployment, Table 1 suggests that this strategy was successful in the past: during 1960–73, a 5.1 percent 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 percent per year (i.e., 5.1 percent GDP growth times –0.03). In spite of the negative employment elasticity of GDP growth, most EU countries tended toward full employment in the early 1970s. This was achieved because trade unions negotiated shorter working weeks and longer holidays. This would appear to be a more intelligent strategy than creating jobs by sacrificing wages, thereby bringing down labor productivity growth. In any case, free time is also welfare.

Second, the call for more flexible labor markets 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 show that firms employing high shares of flexible personnel pay lower wages and flexible workers earn less per hour, compared to similar workers with tenured jobs. Estimates of sales equations, however, also show that firms with high shares of flexible labor do *not* conquer market shares from "rigid" firms—in spite of paying lower wages. The explanation is that firms with plenty of flexible labor realize lower productivity gains (Kleinknecht et al. 2006). More evidence that flexible labor reduces labor productivity growth is reported from a sample of 3000 Italian firms by Lucidi and Kleinknecht (2010). Clearly, downward wage flexibility is paying less than expected: lower wages are, to a significant degree, compensated by lower labor productivity gains.

Third, many observers agree that, with an aging European population, labor will become scarce. Together with a shrinking working population, demand by elderly people for care services will grow—services that are likely to be quite labor intensive. In this context, it must be asked whether we are well served with a low-productive and labor-intensive growth regime in the rest of the economy. A labor-extensive growth regime (as in the 1960s and 1970s in Europe; see Table 1), based on high wage cost pressure and high rates of labor productivity growth, would seem more promising for solving the aging problem.

Finally, our results suggest new research in two directions: first, our estimates raise doubts about the stability of Verdoorn's Law, which has an important policy implication. As Keynesians were beaten by supply side thinkers 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 and Kleinknecht, 1999) and of Verdoorn effects for labor productivity growth were indeed valid, this would imply that neglect of demand in economic policy might have weakened innovation and productivity growth in Europe. So far, 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 at least part of the evidence of Verdoorn effects might have been driven by fluctuations in capacity utilization. This calls for more research on the Verdoorn Law.

Second, it would be interesting building our above coefficients into large macro-econometric models of the economy. Explicit recognition of the negative effects on labor productivity growth of downward wage flexibility and of wage-cost saving flexibilization of labor relations might substantially change model outcomes.

REFERENCES

Baccaro, L., and Rei, D. "Institutional Determinants of Unemployment in OECD Countries: A Time Series Cross-Section Analysis." International Labor Organization Discussion Paper no. 160/2005, Geneva, 2005.

Bassanini, A., and Ernst, E. "Labor Market Institutions, Product Market Regulations, and Innovation: Cross-Country Evidence." OECD Economics Department Working Paper no. 316, Paris, 2002.

Bhaduri, A., and Marglin, S. "Unemployment and the Real Wage: The Economic Basis for Contesting Political Ideologies." *Cambridge Journal of Economics,* 1990, *14* (4), 375–393.

Blanchard, O., and Wolfers, J. "The Role of Shocks and Institutions in the Rise of European Unemployment: The Aggregate Evidence." *Economic Journal,* 2000, *110* (462), 1–33.

Brouwer, E., and Kleinknecht, A. "Keynes-Plus? Effective Demand and Changes in Firm-Level R&D." *Cambridge Journal of Economics,* 1999, *23* (3), 385–391.

Drakopolous, S.A., and Theodosiou, I. "Kaldorian Approach to Greek Economic Growth." *Applied Economics,* 1991, *23* (2), 1683–1689.

DNB (De Nederlandse Bank). "Vermogensbeheer Nederlandse gezinnen onder de loep" [Analyzing Wealth Management by Dutch Families]. Quarterly Report by the DNB, Amsterdam, June 2002.

Ebersberger, B., and Pyka, A. "Innovation and Sectoral Employment: A Trade-Off Between Compensation Mechanisms." *Labor,* 2002, *16* (4), 635–665.

Faggio, G., and Nickell, S. "Patterns of Work Across the OECD." *Economic Journal,* 2007, *117* (521), 416–439.

Fase, M.M.G., and Winder, C.C.A. "Baumol's Law and Verdoorn's Regularity." *De Economist,* 1999, *147* (3), 277–291.

Felipe, J., and Fisher, F.M. "Aggregation in Production Functions: What Applied Economists Should Know." *Metroeconomica,* 2003, *54* (2–3), 208–262.

Foley, D.K., and Michl, R.T. *Growth and Distribution.* Cambridge: Harvard University Press, 1999.

Hall, P.A., and Soskice, D. *Varieties of Capitalism.* Oxford: Oxford University Press, 2001.

Hartog, H. Den, and Tjan, H.S. "A Clay-Clay Vintage Model Approach for Sectors of Industry in the Netherlands." *De Economist,* 1980, *128* (2), 129–188.

Hicks, J. *The Theory of Wages.* London: Macmillan, 1932.

International Monetary Fund (IMF). *World Economic Outlook.* Washington, DC: IMF, 2007.

Jansen, J.W. "Kleinknechthypothese mist empirisch bewijs" [No Empirical Proof for the Kleinknecht Hypothesis]. *Economisch Statistische Berichten,* 2004, *89* (4441), 418.

Judson, R.A., and Owen, L.A. "Estimating Dynamic Panel Data Models: A Guide for Macroeconomists." *Economic Letters,* 1999, *65* (1), 9–15.

Kennedy, C. "Induced Bias in Innovation and the Theory of Distribution." *Economic Journal,* 1964, *74* (295), 541–547.

Kleinknecht, A. "Heeft Nederland een loongolf nodig?" [Do the Netherlands Need a Wave of Wage Increases?]. Inaugural Lecture as a Professor of Economics at the Free University of Amsterdam, 1994.

———. "Is Labor Market Flexibility Harmful to Innovation?" *Cambridge Journal of Economics,* 1998, *22* (3), 387–396.

Kleinknecht, A.; Oostendorp, R.M.; Pradhan, M.P.; and Naastepad, C.W.M. "Flexible Labor, Firm Performance and the Dutch Job Creation Miracle." *International Review of Applied Economics,* 2006, *20* (2), 171–187.

Lee, Y. "Bias Correction in Dynamic Panels Under Time Series Misspecification." Working paper, Department of Economics, University of Michigan, Ann Arbor, February 2007 (available at http://papers.ssrn.com/sol3/papers.cfm?abstract_id=1004386).

Lorenz, E.H. "Trust and the Flexible Firm: International Comparisons." *Industrial Relations,* 1992, *31* (3), 455–472.

———. "Trust, Contract and Economic Cooperation." *Cambridge Journal of Economics,* 1999, *23* (3), 301–316.

Lucidi, F., and Kleinknecht, A. "Little Innovation, Many Jobs: An Econometric Analysis of the Italian Labor Productivity Crisis." *Cambridge Journal of Economics,* 2010, *34* (3), 525–546.

Malcolmson, J. "Contracts, Hold-Up, and Labor Markets." *Journal of Economic Literature,* 1997, *35* (4), 1916–1957.

McCombie, J., and De Ridder, J. "Increasing Returns, Productivity and Output Growth: The Case of the United States." *Journal of Post Keynesian Economics,* Spring 1983, *5* (3), 373–387.

McCombie, J.; Pugno, M.; and Soro, B. *Productivity Growth and Economic Performance: Essays on Verdoorn's Law.* London: Palgrave/Macmillan, 2002.

Naastepad, C.W.M. “Technology, Demand and Distribution: A Cumulative Growth Model with an Application to the Dutch Productivity Growth Slowdown.” *Cambridge Journal of Economics,* 2006, *30* (3), 403–434.

Naastepad, C.W.M., and Kleinknecht, A. “The Dutch Productivity Slowdown: The Culprit at Last?” *Structural Change and Economic Dynamics,* 2004, *15* (2), 137–163.

Nickell, S. “Biases in Dynamic Models with Fixed Effects.” *Econometrica,* 1981, *49* (6), 1417–1426.

Nickell, S., and Layard, R. “Labor Market Institutions and Economic Performance.” In O.E. Ashenfelter and D. Card (eds.), *Handbook of Labor Economics,* pt. 3, vol. 3. Amsterdam: Elsevier, 1999, pp. 3029–3084.

Nickell, S.; Nunziata, L.; and Ochel, W. “Unemployment in the OECD Since the 1960s: What Do We Know?” *Economic Journal,* 2005, *115* (500), 1–27.

Nunziata, L. “Institutions and Wage Determination: A Multi-Country Approach.” *Oxford Bulletin of Economics and Statistics,* 2005, *67* (4), 435–465.

Organization for Economic Cooperation and Development (OECD). “Employment Protection and Labor Market Performance.” *Employment Outlook,* Paris: OECD Publications, 1999.

———. *Employment Outlook.* Paris: OECD Publications, 2003a.

———. *The Sources of Economic Growth in the OECD Countries.* Paris: OECD Publications, 2003b.

Polanyi, M. *The Tacit Dimension.* London: Routledge, 1966.

Robinson, J. “The Production Function and the Theory of Capital.” *Review of Economic Studies,* 1953–54, *21* (2), 81–106.

Ruttan, V.W. “Induced Innovation, Evolutionary Theory and Path Dependence: Sources of Technical Change.” *Economic Journal,* 1997, *107* (444), 1520–1529.

Scarpetta, S., and Tressel, T. “Boosting Productivity via Innovation and Adoption of New Technologies: Any Role for Labor Market Institution? World Bank Policy Research Working Paper no. 3273, Washington, DC, April 2004.

Schmookler, J. *Invention and Economic Growth.* Cambridge: Harvard University Press, 1966.

Storm, S., and Naastepad, C.W.M. “Why Labor Market Regulation May Pay Off: Worker Motivation, Co-ordination and Productivity Growth.” International Labor Organization, Economic and Labor Market Paper 2007/4, Geneva, 2007.

Van Schaik, A.B.T.M. “Loonmatiging en arbeidsproductiviteit” [Wage Restraint and Labor Productivity]. *Economisch Statistische Berichten,* 1994, *91* (4498), 970–972.

Appendix A: Proof of consistency when there is no serial correlation in the residuals

Regression Equation (1) can be written in the form:

$$\hat{\lambda}_{it} = \alpha_i + \left(\hat{w}_{it-1},\ldots,\hat{w}_{it-k},\hat{\lambda}_{it-1},\ldots,\hat{\lambda}_{it-k}\right)\beta_1 + Z'_{it}\beta_2 + \varepsilon_{it}, \tag{A1}$$

where $\hat{\lambda}$ denotes the growth of labor productivity, $\hat{w}$ denotes the growth of wages, Z a vector of control variables and ε is the error term. The subscripts i, t are for country and year, respectively. α_i and the βs are coefficients.

We want to allow for the reversed causation. Let's suppose that the reversed causation can be modeled as follows:

$$\hat{w}_{it} = c + \left(\hat{w}_{it-1},\ldots,\hat{w}_{it-m},\hat{\lambda}_{it},\ldots,\hat{\lambda}_{it-m-1}\right)\gamma + \mu_{it}, \tag{A2}$$

where μ denotes the idiosyncratic error term and c includes all other exogenous observed and unobserved factors.

Now, suppose that, in the regression Equation (A1), we have serial correlation in the residuals of the general form:[14]

$$\varepsilon_{it} = \omega_{it} + \textstyle\sum_l \rho_{t-1}\varepsilon_{it-1}, \tag{A3}$$

where $\omega_{it} \sim IID, N(0,\sigma^2_\omega)$.

Then, by substituting (A2) and (A3) into (A1), we obtain

$$\begin{aligned}\hat{\lambda}_{it} = \alpha_i + \left(\hat{w}_{it-2},\ldots,\hat{w}_{it-(k+m)},\hat{\lambda}_{it-1},\ldots,\hat{\lambda}_{it-(k+m+1)}\right)\beta^*_1 \\ + Z^{*\prime}_{it}\beta^*_2 + \omega_{it} + \textstyle\sum_l \rho_{t-1}\varepsilon_{it-1}.\end{aligned} \tag{A4}$$

From Equation (A4), we can see that the error terms are uncorrelated with the regressors if the condition $\rho = 0 \forall l \leq k + m + 1 = 0$ 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 seventeenth 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.

Appendix B

Table B1
Coefficients of autoregressions of the residuals of Table 2, Model 1 (summary of OLS estimates)

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

Notes: None of the regressions yields a significant result, using a confidence level of 90 percent. All autoregressions include a constant term, using OLS. Stata-command: reg (. . .).

Appendix C

Table C1
Full details of fixed effects GLS panel estimates of Model 1 as summarized in Table 2

	Coefficient	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	

Notes: The regression is estimated using a fixed effects GLS panel estimator that allows panel-specific heteroskedasticity (stata-command: XTGLS (...) p(h); see the Stata manual, release 6, p. 360).

Appendix D: Description of the data

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

Sources of the data are as follows:

- The Conference Board and Groningen Growth and Development Centre (GGDC, Total Economy Database, May 2006, www.ggdc.net.
- Annual macroeconomic database AMECO from Eurostat, http://ec.europa.eu/economy_finance/db_indicators/ameco/index_en.htm.
- OECD Statistics, http://stats.oecd.org/index.aspx.

All growth variables are calculated from the levels as

$$x_{\text{growth}} = (x_t - x_{t-1})/\text{average}\ (x_{t-1};x_t).$$

STATE DEPENDENCY = the growth of labor productivity. Labor productivity is obtained from the GGDC. It represents value added per hour worked and is expressed in 2005 U.S. dollar price levels with updated 2002 EKS (Eltoto, Kovacs, and Szulc) purchasing power parities (PPPs).

REAL WAGE GROWTH = the growth of the real wage. The real wage is expressed in 2005 U.S. dollar price levels with updated 2002 EKS PPPs. It is calculated as wage share in national income * labor productivity. The series for wage shares are at factor costs and include remuneration for the self-employed. They are obtained from the Eurostat-AMECO database. Labor productivity is described above.

GAP_{it} = [MAX$_i$(labor productivity$_{.t}$) – labor productivity$_{it}$]/MAX$_i$(labor productivity$_{.t}$)). Labor productivity series are obtained from GGDC.

VERDOORN = the growth of GDP. GDP is obtained from the GGDC in 2005 U.S. dollar 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.
- Δ 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 percent of potential GDP.

Appendix E

Table E1
Country-wise descriptive tables

Country/variable	Number of observations	Mean	Standard deviation	Minimum	Maximum
Australia					
Labor productivity growth	41	0.02	0.01	–0.01	0.05
Real wage growth	41	0.02	0.03	–0.04	0.11
Gap	43	0.29	0.04	0.21	0.37
GDP growth	45	0.04	0.02	0.00	0.07
Capital/output growth	45	0.00	0.02	–0.03	0.03
Δ output gap	37	–0.06	1.58	–3.76	3.22
Austria					
Labor productivity growth	37	0.03	0.02	0.00	0.10
Real wage growth	37	0.03	0.02	–0.01	0.09
Gap	39	0.26	0.08	0.16	0.53
GDP growth	45	0.03	0.02	0.00	0.07
Capital/output growth	45	0.00	0.02	–0.03	0.04
Δ output gap	37	–0.06	1.45	–3.69	2.71
Belgium					
Labor productivity growth	45	0.03	0.02	–0.01	0.10
Real wage growth	45	0.03	0.03	–0.01	0.09
Gap	48	0.20	0.12	0.05	0.46
GDP growth	45	0.03	0.02	–0.01	0.07
Capital/output growth	45	0.00	0.02	–0.03	0.05
Δ output gap	37	0.06	1.60	–4.96	2.51

Canada					
Labor productivity growth	45	0.02	0.01	–0.01	0.05
Real wage growth	44	0.01	0.02	–0.03	0.04
Gap	47	0.23	0.08	0.11	0.38
GDP growth	45	0.04	0.02	–0.03	0.07
Capital/output growth	45	0.00	0.02	–0.04	0.06
Δ output gap	37	0.01	1.79	–5.69	2.83
Denmark					
Labor productivity growth	40	0.03	0.02	–0.02	0.10
Real wage growth	40	0.02	0.02	–0.05	0.08
Gap	42	0.28	0.05	0.20	0.40
GDP growth	45	0.03	0.02	–0.01	0.09
Capital/output growth	45	0.00	0.02	–0.05	0.04
Δ output gap	35	0.04	1.77	–3.13	4.38
Finland					
Labor productivity growth	45	0.03	0.02	0.00	0.09
Real wage growth	45	0.03	0.02	–0.02	0.09
Gap	47	0.38	0.09	0.27	0.57
GDP growth	45	0.03	0.03	–0.07	0.09
Capital/output growth	45	0.00	0.03	–0.05	0.08
Δ output gap	32	0.04	2.40	–7.87	3.53
France					
Labor productivity growth	45	0.03	0.02	0.00	0.07
Real wage growth	45	0.03	0.02	0.00	0.07
Gap	47	0.16	0.11	0.03	0.41
GDP growth	45	0.03	0.02	–0.01	0.07
Capital/output growth	45	0.00	0.01	–0.03	0.04
Δ output gap	36	0.00	1.23	–3.34	2.21

(continues)

Table E1
(continued)

Variable	Number of observations	Mean	Standard deviation	Minimum	Maximum
Germany					
Labor productivity growth	45	0.03	0.02	0.01	0.07
Real wage growth	45	0.03	0.02	–0.01	0.07
Gap	48	0.22	0.09	0.08	0.44
GDP growth	45	0.03	0.02	–0.01	0.07
Capital/output growth	45	0.00	0.02	–0.03	0.04
Δ output gap	16	–0.12	1.31	–3.11	2.16
Ireland					
Labor productivity growth	45	0.04	0.02	–0.02	0.09
Real wage growth	45	0.04	0.03	–0.02	0.11
Gap	48	0.43	0.16	0.15	0.66
GDP growth	45	0.05	0.03	0.00	0.11
Capital/output growth	45	0.00	0.03	–0.07	0.04
Δ output gap	29	–0.17	1.95	–3.12	4.04
Italy					
Labor productivity growth	45	0.03	0.03	–0.01	0.10
Real wage growth	45	0.03	0.03	–0.01	0.12
Gap	47	0.23	0.10	0.14	0.51
GDP growth	45	0.03	0.02	–0.02	0.08
Capital/output growth	45	0.00	0.02	–0.03	0.06
Δ output gap	37	–0.10	1.69	–5.57	3.00

Japan					
Labor productivity growth	45	0.04	0.03	0.00	0.11
Real wage growth	45	0.04	0.03	–0.01	0.11
Gap	47	0.48	0.11	0.36	0.74
GDP growth	45	0.04	0.04	–0.01	0.12
Capital/output growth	45	0.00	0.03	–0.07	0.09
Δ output gap	37	0.03	1.81	–5.77	3.70
Netherlands					
Labor productivity growth	45	0.02	0.02	–0.02	0.07
Real wage growth	45	0.03	0.03	–0.03	0.08
Gap	48	0.08	0.08	0.00	0.23
GDP growth	45	0.03	0.02	–0.01	0.08
Capital/output growth	45	0.00	0.02	–0.03	0.04
Δ output gap	36	0.09	1.43	–2.86	2.18
New Zealand					
Labor productivity growth	45	0.01	0.03	–0.06	0.08
Real wage growth	19	0.01	0.02	–0.01	0.04
Gap	48	0.38	0.11	0.00	0.52
GDP growth	45	0.03	0.03	–0.05	0.10
Capital/output growth	45	0.00	0.03	–0.09	0.07
Δ output gap	27	0.04	1.67	–3.11	3.99
Norway					
Labor productivity growth	45	0.03	0.02	0.00	0.07
Real wage growth	45	0.03	0.04	–0.10	0.11
Gap	48	0.14	0.13	0.00	0.38
GDP growth	45	0.04	0.02	0.00	0.07
Capital/output growth	45	0.00	0.02	–0.04	0.03
Δ output gap	30	0.27	1.49	–3.06	3.18

(continues)

Table E1
(continued)

Variable	Number of observations	Mean	Standard deviation	Minimum	Maximum
Portugal					
Labor productivity growth	45	0.03	0.04	–0.09	0.12
Real wage growth	45	0.04	0.05	–0.06	0.17
Gap	48	0.61	0.06	0.54	0.76
GDP growth	45	0.04	0.03	–0.04	0.11
Capital/output growth	45	0.00	0.03	–0.06	0.09
Δ output gap	30	–0.10	2.21	–4.91	4.34
Spain					
Labor productivity growth	45	0.04	0.03	–0.01	0.11
Real wage growth	45	0.04	0.04	–0.03	0.12
Gap	46	0.40	0.14	0.21	0.69
GDP growth	45	0.05	0.03	–0.01	0.12
Capital/output growth	45	–0.01	0.03	–0.10	0.04
Δ output gap	29	–0.02	1.45	–4.06	2.98
Sweden					
Labor productivity growth	45	0.03	0.02	–0.01	0.08
Real wage growth	45	0.03	0.02	–0.03	0.07
Gap	47	0.26	0.05	0.17	0.36
GDP growth	45	0.03	0.02	–0.02	0.07
Capital/output growth	45	0.00	0.02	–0.03	0.04
Δ output gap	37	–0.07	1.58	–3.61	2.33

United Kingdom					
Labor productivity growth	45	0.03	0.01	0.00	0.05
Real wage growth	35	0.02	0.02	–0.02	0.06
Gap	47	0.30	0.04	0.24	0.37
GDP growth	45	0.02	0.02	–0.02	0.07
Capital/output growth	45	0.00	0.02	–0.04	0.04
Δ output gap	37	0.11	1.77	–3.81	4.79
United States					
Labor productivity growth	45	0.02	0.01	–0.01	0.04
Real wage growth	45	0.02	0.01	–0.01	0.04
Gap	47	0.11	0.08	0.00	0.23
GDP growth	45	0.03	0.02	–0.02	0.07
Capital/output growth	45	–0.01	0.02	–0.04	0.04
Δ output gap	37	0.03	1.81	–4.73	3.60