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ASSESSING THE IMPACT OF LABOUR MARKET POLICIES ON PRODUCTIVITY: A DIFFERENCE-IN-DIFFERENCES APPROACH

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SUMMARY

The impact of four labour market policies – employment protection legislation, minimum wages, parental leave and unemployment benefits – on productivity is examined here, using annual cross-country aggregate data on these policies and industry-level data on productivity from 1979 to 2003. We use a "difference-in-differences" framework, which exploits likely differences in the productivity effect of policies in different industries. Our identifying assumption is that a specific policy influences worker or firm behaviour, and thereby productivity, more in industries where the policy in question is likely to be more binding than in other industries. The advantage of this approach is twofold. First, as in standard cross-country analysis, we can exploit the cross-country variation of policies. Second, in contrast with standard cross-country analysis, we can control for unobserved factors that, on average, are likely to have the same effect on productivity in both policy-binding and non-binding industries.

RESUMÉ

Nous examinons l'impact de quatre politiques du marché du travail – la législation pour la protection de l'emploi, le salaire minimum, le congé parental et l'indemnisation du chômage – sur la productivité. Pour ces politiques, nous utilisons des données annuelles agrégées comparables entre pays ainsi que des données sectorielles sur la productivité de 1979 à 2003 sont utilisées. Nous analysons ces données sur la base d'une méthode de "différence de différences", qui exploite la variabilité des effets des politiques dans les différents secteurs. Notre stratégie d'identification se fonde sur l'hypothèse que les comportements des entreprises ou des salariés, et donc leur productivité, sont davantage influencés par une politique dans les secteurs d'activité où celle-ci est vraisemblablement plus contraignante. L'avantage de cette approche est double. D'une part, à l'instar des analyses agrégées concernant plusieurs pays, nous pouvons exploiter la variabilité des politiques entre les pays. D'autre part, contrairement à ces analyses, nous pouvons contrôler pour des facteurs inobservés qui, en moyenne, ont vraisemblablement le même effet sur la productivité dans les secteurs où les politiques sont contraignantes et dans les secteurs où elles ne le sont pas.

ASSESSING THE IMPACT OF LABOUR MARKET POLICIES ON PRODUCTIVITY: A DIFFERENCE-IN-DIFFERENCES APPROACH

1. Introduction*

1. During the 1990s, labour productivity growth accounted for at least half of GDP per capita growth in most OECD countries, and a considerably higher proportion in many of them (OECD, 2003a). As the populations of OECD countries age and the proportion of the population of working age falls, continued growth in productivity, along with increased labour force participation among currently underrepresented groups, will be important to maintain and improve living standards. As such, the role of policy in promoting or impeding productivity growth is likely to be of increasing interest in the decades to come.

2. The impact of structural policies, such as taxation or product market regulation, on productivity has been the subject of a number of recent empirical investigations (see *e.g.* Fölster and Henrekson, 2001, Nicoletti and Scarpetta, 2003 and Aghion *et al*., 2006). However, there is only limited empirical evidence on the impact of labour market policies on productivity, particularly at a cross-country level. While most labour market policies are aimed at influencing labour market indicators, such as unemployment or labour force participation, it is not inconceivable that they might also have (positive or negative) effects on productivity. Labour market policies that influence incentives for workers or firms to invest in training or education or directly increase human capital accumulation can affect productivity by altering the stock of human capital. Policies that discourage the movement of resources between declining and emerging firms, industries or activities can depress productivity by preventing firms from responding quickly to changes in technology or product demand. Policies that improve the quality of job matches or maintain high quality job matches for longer might increase the efficiency of labour resource allocation, increasing the level of productivity. Finally, labour market policies that increase employment can indirectly reduce average measured productivity by altering the skill composition of the workforce, generating diminishing returns to scale or encouraging the spread of low-skilled industries.

3. This paper examines the impact of four labour market policies – employment protection legislation (EPL), minimum wages, parental leave and unemployment benefits – on the level and/or growth of productivity, using cross-country data on these policies. Using cross-country data makes it possible to exploit the larger variation of policies between countries than within countries. Cross-country data on policies are typically analysed using aggregate models. This allows general equilibrium effects to be examined and is appropriate because policies are usually (relatively) homogeneous within a country at a given point in time. Yet, one fundamental problem with aggregate analysis is that it can be very difficult to determine, and control for, an exhaustive list of relevant confounding factors.

4. In this paper, we exploit the fact that productivity patterns *are not* homogeneous within a country and cross-country comparable productivity data are easily available at the industry level. Our main innovation is the use of a difference-in-differences framework, which is based on likely differences in the productivity effect of policies in different industries. Our specification is based on the assumption that the policies examined influence worker or firm behaviour more in some industries (referred to as "policy-binding industries" below) than others. For example, if stringent EPL reduces productivity by

*. This paper serves as analytical background to Chapter 2 of the 2007 OECD Employment Outlook (OECD, 2007a).

making it more difficult for resources to flow into high productivity activities, reforms to EPL are likely to have a greater impact on productivity in industries where, in the absence of regulations, firms would rely on laying off workers to make changes to staffing levels and organisation, rather than in industries where internal labour markets or voluntary turnover are more important. Likewise, changes in minimum wages or parental leave are likely to have a greater impact in industries where employment tends to be dominated by low-wage workers or women, respectively. We use the same framework to examine one of the channels through which unemployment benefits can affect productivity, although our findings on unemployment benefits are more tentative.

5. There are a number of advantages of using an industry-level difference-in-differences approach compared with standard aggregate-level cross-country analysis. First, the difference-in-differences specification allows us to control for unobserved factors that should have the same effect, on average, on productivity in industries where a particular policy is binding as in other industries. Second, the use of industry-level analysis allows us to focus more clearly on the direct channels of influence through which policies affect productivity by reducing the influence of the indirect effect that policies can have on productivity through their impact on employment (see OECD, 2007a, for a full discussion). Labour market policies that increase employment are likely to reduce average labour productivity. These composition effects have been shown to be substantial at an aggregate level.[1] However, within-industry analysis of the impact of changes in employment on productivity, which enables us to control for aggregate effects using time-by-country dummies, suggests that within-industry composition effects are likely to be negligible (see OECD, 2007b). This implies that industry-level analysis can meaningfully shed light on the impact of selected labour market policies on productivity, over and above any statistical/accounting effect brought about by changes in employment.

6. To our knowledge, only Micco and Pages (2006) have applied a similar methodology to the analysis of the impact of labour market policies on productivity. They use a difference-in-differences estimator on industry-level data for several OECD and non-OECD countries to study the relationship between layoff costs and the level of labour productivity, using US turnover rates to classify industries. While we use a more limited sample of countries than Micco and Pages (2006) by focusing only on OECD countries, our dataset covers a longer time period and contains more observations. This allows us to identify the effect of policies on productivity by simultaneously controlling for i) all fixed country-by-sector factors that might affect differences in productivity levels; ii) all aggregate time-varying factors that are likely to have the same effect on productivity in industries where policies are binding as in other industries; and iii) all industry-specific shocks and trends that are common across countries. Our analysis of EPL also differs from that of Micco and Pages (2006) because we use a measure of EPL on regular contracts, rather than an overall measure of EPL, and use a sample that includes both manufacturing and non-manufacturing industries. In addition, we use industry-level capital stock data, which allow us to examine the impact of policies on both labour productivity and multi-factor productivity (MFP). We also generalise the methodology to examine the impact of policies other than EPL on productivity.

7. The paper is organised as follows. The next section presents the empirical specification used in each of the difference-in-differences estimations. Section 3 outlines the common variables used in the

1. OECD estimates suggest that the apparent elasticity of labour productivity to hours-adjusted employment rates (total hours per capita) is in the range -0.4 to -0.9 (OECD, 2007). These estimates appear to be in line with those found in the literature (Bourles and Cette, 2005, 2007; Dew-Becker and Gordon, 2006, Gust and Marquez, 2004). The magnitude of the estimates implies that if the composition effect was the only channel linking labour market policies to productivity, a policy reform that increases total hours per capita by 1% would reduce labour productivity by 0.4% to 0.9% and result in an overall increase in GDP per capita of only 0.1% to 0.6%.

estimations. Sections 4, 5, 6 apply the methodology outlined in Section 2 to EPL, minimum wages, parental leave, respectively. Section 7 contains an extension to one of the possible channels through which unemployment benefit could affect productivity. Conclusions follow.

2. Difference-in-differences specification

8. The difference-in-differences approach used in this paper is based on a number of assumptions. First, a particular policy affects MFP and/or MFP growth. Second, the effect is greater in industries where the policy is more likely to be binding (hereafter called policy-binding industries). If industries can be split into two groups – policy-binding industries and other industries – then the difference between MFP growth in policy-binding industries and other industries can be modelled as a function of the policy:

$$\overline{\Delta \log MFP_{it}^{b}} - \overline{\Delta \log MFP_{it}^{nb}} = f(POL_{it}, \Delta POL_{it}) \qquad [1]$$

where *POL* stands for the policy, which is assumed to vary along the country *i* and the time *t* dimensions, while the bar indicates an average over different industries. In other words, the group of other industries (*nb*) is used as a control for the treated group (policy-binding industries (*b*)). The analysis is marginally more complex than standard treatment-control since observations in the treated group do not receive the same amount of treatment.[2]

9. If *f* is linear in *POL* and Δ*POL*, [1] can be estimated in differences using the following specification:

$$\Delta \log MFP_{ijt} = \beta I_{bj} \Delta POL_{it} + \gamma I_{bj} POL_{it} + \delta I_{bj} + \eta_{it} + \upsilon_{ijt} \qquad [2]$$

where I_b is the indicator function of the set of policy-binding industries *j* and Greek letters represent either coefficients or disturbances. Alternatively, [1] can be estimated using a specification in levels such as:

$$\log MFP_{ijt} = \beta I_{bj} POL_{it} + \gamma I_{bj} \sum_{k=0}^{t} POL_{ik} + \delta I_{bj} t + \mu_{ij} + \chi_{it} + \varepsilon_{ijt} \qquad [3]$$

where Greek letters represent either coefficients or disturbances. In fact, one can obtain [2] by simply first-differencing [3] and setting $\eta_{it} = \chi_{it} - \chi_{it-1}$ and $\upsilon_{ijt} = \varepsilon_{ijt} - \varepsilon_{ijt-1}$.

10. It is worth noting here how equations [2] or [3] differ from the specification in Micco and Pages (2006). First, in principle, we allow for policies to have an effect on the growth rate of productivity where appropriate, rather than only examining level effects. Second, we use repeated cross-section data, thereby reducing the risk that estimates are confounded by cyclical factors or time-specific shocks. Third, and perhaps more important, all time-invariant factors affecting productivity in one industry are controlled for.

11. The advantage of [3] with respect to [2] is that it can better capture lagged effect of independent variables on productivity. Alternatively, one could estimate [2] using long-differences (several years), at the price of dramatically reducing sample size. For this reason, insofar as long-run effects are the object of analysis, we will restrict our attention to specifications derived from [3] and resort to [2] using long-differences only in certain sensitivity exercises.

2. More precisely, the estimation framework used here can be seen as a difference-in-difference-in-differences approach, since we exploit variations across country, over time and across policy-binding and other industries.

12. To the extent that industries might be in different stages of their life-cycle, [3] can be augmented by including a full system of two-dimensional disturbances:

$$\log MFP_{ijt} = \beta I_{bj} POL_{it} + \gamma I_{bj} \sum_{k=0}^{t} POL_{ik} + \mu_{ij} + \chi_{it} + \varsigma_{jt} + \varepsilon_{ijt} \qquad [4]$$

13. Given that ΔPOL can be seen as the short-term effect of *POL*, models considered up to [4] are dynamic. A more natural representation of a dynamic model would allow for slow adjustment of the dependent variable. In the case of equation [4], this yields:

$$\log MFP_{ijt} = \alpha_2 \log MFP_{ijt-1} + \beta I_{bj} POL_{it} + \gamma I_{bj} \sum_{k=0}^{t} POL_{ik} + \mu_{ij} + \chi_{it} + \varsigma_{jt} + \varepsilon_{ijt}\,. \qquad [5]$$

14. In dynamic models, however, minor specification errors can lead to serious inconsistency problems. In particular, in models where policy indicators are relatively invariant over time (as in the case for EPL), the structure of autocorrelation is unlikely to be captured by an autoregressive formulation. For this reason we prefer to restrict our attention to the static counterpart of equation [5] – that is specifications derived from equation [4] – using specifications derived by [5] only in certain sensitivity exercises. For the same reason, we assume that policy variables have an impact either on growth only (that is $\partial f/\partial \Delta POL=0$ in [1]) or on efficiency only (that is $\partial f/\partial$POL=0 in [1]), basing our choice on the predictions of the existing theoretical literature. So equation [4] is appropriate subject to the restrictions $\beta = 0$ (for growth only) or $\gamma = 0$ (for levels only). Hereafter, estimates of β or γ will be referred to as the "level effect" and the "growth effect", respectively, of the policy *POL*. Models incorporating both a growth and level effect are estimated for model selection purposes only where the theoretical literature does not provide unambiguous guidance.

15. The Schumpeterian growth literature suggests that appropriate models of productivity growth at the industry (or firm) level should include, as explanatory variables, productivity growth of the industry productivity leader as well as the productivity gap (in level terms) between each observation and the industry productivity leader (Aghion and Howitt, 2006; Griffith, Redding and van Reenen, 2004). In the case of equation [2], this would imply estimating:

$$\begin{aligned}\Delta \log MFP_{ijt} &= \alpha \Delta \log MFP^{F}_{jt} - \phi(\log MFP_{ijt-1} - \log MFP^{F}_{jt-1}) \\ &\quad + \beta I_{bj} \Delta POL_{it} + \gamma I_{bj} POL_{it} + I_{bj} + \eta_{it} + \varepsilon_{ijt}\end{aligned}\,.$$

where *F* (for frontier) denotes the country on the world productivity frontier for industry *j*.[3] If industry-by-time dummies are also included to capture differences in industry life-cycles, the productivity level and growth of the industry leader will be collinear to industry-by-time dummies. This implies that one can circumvent the problem of estimating cross-country comparable productivity levels[4] and estimate the following simple model with a lagged dependent variable:

$$\Delta \log MFP_{ijt} = -\phi \log MFP_{ijt-1} + \beta I_{bj} \Delta POL_{it} + \gamma I_{bj} POL_{it} + \varsigma_{it} + \eta_{it} + \varepsilon_{ijt}\,. \qquad [6]$$

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3. In contrast with [2], this equation cannot be easily transformed in level terms.

4. Cross-country comparisons of MFP levels have always proved to be problematic, particularly in non-manufacturing industries. For instance, Nicoletti and Scarpetta (2003) report Italy to be the productivity leader in both financial intermediation and retail, which is hard to believe.

16. As this model is likely to suffer from the same problems discussed above as any other dynamic model, it will be used only in certain sensitivity exercises.[5]

17. In the absence of recent cross-country, industry-level MFP data, a Cobb-Douglas production function with constant returns to scale is assumed and we estimate [4] using:

$$\log y_{ijt} = \delta \log k_{ijt} + \beta I_b POL_{it} + \gamma I_{bj} \sum_{k=0}^{t} POL_{ik} + \mu_{ij} + \chi_{it} + \varsigma_{jt} + \varepsilon_{ijt} \qquad [7]$$

where y is labour productivity, and k is the capital-labour ratio, subject to the restrictions $\beta = 0$ or $\gamma = 0$, depending on the policy under examination. Equation [7] is the baseline specification for results presented in the following sections.

18. Assuming that other factors might affect MFP, we estimate [7] as:

$$\begin{aligned}\log y_{ijt} = \delta \log k_{ijt} + \beta I_b POL_{it} + \gamma I_{bj} \sum_{k=0}^{t} POL_{ik} + \sum\nolimits_m \gamma_m CNTRL1_{ijt}^{m} + \\ + I_{bj} \sum\nolimits_n \gamma_n CNTRL2_{ijt}^{n} + \mu_{ij} + \chi_{it} + \varsigma_{jt} + \varepsilon_{ijt}\end{aligned} \qquad [8]$$

where m indexes control variables (*CNTRL*1) that affect MFP in all industries, and n indexes control variables (*CNTRL*2) that affect MFP more in policy-binding industries than in other industries. In order to estimate the impact of policies on labour productivity, we estimate specifications [7] and [8], omitting the capital-labour ratio. We estimate all equations using OLS and including two-dimensional dummies to capture two-dimensional disturbances.

19. The coefficients estimated using [7] and [8] represent the marginal effect of a change in the policy variable, *POL*, on either the growth rate or level of productivity in policy-binding industries compared to that in non-binding industries. It would be useful, however, to have an idea of the magnitude of the impact of policies on aggregate productivity. Under somewhat restrictive assumptions, this impact can be estimated by multiplying the estimated effect in policy-binding industries by the share of these industries in total GDP. This assumes that there is zero impact of the policy in other industries (and in all industries that are not included in the sample used in the analysis). As such, aggregate estimates represent a lower bound of the actual impact of the policy on aggregate productivity.

3. Data

20. As discussed in Section 2, we use aggregate cross-country data on policies and institutions from a variety of OECD datasets (see Annex 1). We match these data with industry-level data on productivity and capital stock. The main source of labour productivity data for the analyses is the 60-Industry Database of the Groningen Growth and Development Centre (http://www.ggdc.net). Data are included for the industries listed in Table 3.1. Industries excluded from the analysis are agriculture, hunting, forestry and fishing, mining and quarrying, business services, public administration and defence, education, health and social work and other community, social and personal services. These industries are excluded because they include sizeable public sector employment or because it is difficult to measure their productivity accurately.

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5. In order to better capture lagged effects, lagged policy variables will be also added to equation [6].

Table 3.1. **List of industries**

ISIC code [a]	Description
15-16	Food products, beverages and tobacco manufacturing
17-19	Textiles, textile products, leather and footwear manufacturing
20	Wood and wood/cork products manufacturing
21-22	Pulp, paper and paper products manufacturing, printing and publishing
23-25	Chemical, rubber, plastics and fuel products manufacturing
26	Other non-metallic minerals manufacturing
27-28	Basic metals and fabricated metal products manufacturing
29-33	Machinery and equipment manufacturing
34-35	Transport equipment manufacturing
36-37	Manufacturing not elsewhere classified
40-41	Electricity, gas and water supply
45	Construction
50-52	Wholesale and retail trade and repairs
55	Hotels and restaurants
60-64	Transport, storage and communications services
65-67	Financial intermediation

a) International Standard Industry Classification (ISIC) (Revision 3) 2-digit code.

21. In the absence of up-to-date industry-level measures of MFP, we estimate the impact of policies on MFP by using labour productivity as the dependent variable and including gross capital stock as a control variable in the regressions. Capital stock data are from the OECD STAN database. For countries for which the capital stock is not available or where industry coverage is insufficient, capital stocks are reconstructed from gross fixed capital formation using a perpetual inventory method (see Annex 1 for full details).

22. Following Bassanini and Duval (2006), data for Finland and Sweden in 1991 and 1992 are removed from the sample, and different country fixed effects used for both countries over the two sub-periods 1970-1990 and 1993-2003.[6] Data for Germany are only included for the period from 1993 to 2003. Both these choices are made to control for highly country-specific factors – including the collapse of the Soviet Union for Finland, reunification of Germany and the Swedish banking crises – that are likely to have had an impact on productivity in the early 1990s and that cannot be captured using the policy control variables or other controls included in the analyses.

23. Additional data issues are discussed in the next four sections. A full description of all raw variables and their sources as well as descriptive statistics are in Annex 1.

4. Employment protection legislation

Previous research

24. In recent years, the discussion on the overall economic impact of layoff regulations has shifted from their possible effect on employment and unemployment to the drag on growth imposed by binding regulations. Stringent layoff regulations increase the cost of firing workers making firms reluctant to hire new workers, particularly if they expect to make significant employment changes in the future. As such, EPL could impede flexibility, making it more difficult for firms to react quickly to changes in technology or product demand that require reallocation of staff or downsizing, and slowing the flow of labour resources into emerging high productivity firms, industries or activities (Hopenhayn and Rogerson, 1993; Saint-Paul, 1997, 2002). In addition, stringent EPL might discourage firms from experimenting with new technologies, characterised by higher mean returns but also higher variance, in order to avoid the risk of

6. The only exception are models derived from equation [6] to avoid excessive reduction of sample size due to the inclusion of lagged differences of policy variables.

paying high firing costs (Bartelsman *et al.*, 2004). Layoff protection might also reduce worker effort because there is less threat of layoff in response to poor work performance or absenteeism (Ichino and Riphahn, 2001).

25. Alternatively, layoff regulations could provide additional job security for workers, increasing job tenure and work effort and making workers more likely to invest in firm- or job-specific human capital (Soskice, 1997; Belot, Boone and van Ours, 2002).[7] Stringent layoff regulations might also spur productivity-enhancing investments by incumbent firms in order to avoid downsizing (Koeniger, 2005).

26. The existing cross-country evidence on the relationship between EPL and productivity growth is inconclusive. DeFreitas and Marshall (1998) find that strict EPL has a negative impact on labour productivity growth in the manufacturing industries of a sample of Latin American and Asian countries. Nickell and Layard (1999) and Koeniger (2005) find a weak positive relationship between EPL strictness and both MFP and labour productivity growth for samples of OECD countries.[8] Autor, Kerr and Kugler (2007) study the impact of exceptions to the employment-at-will doctrine in the United States on several performance variables by using cross-state differences in the date of their adoption. They find that some of the restrictions have positive effect on capital deepening, negative effect on MFP and no effect on labour productivity. Using a difference-in-differences estimator on industry-level data for several OECD and non-OECD countries, Micco and Pages (2006) find a negative relationship between layoff costs and the level of labour productivity. Yet, this effect appears to depend entirely on the presence of Nigeria in the sample. Ichino and Riphahn (2001) and Riphahn (2004) find that EPL in Germany significantly increases absenteeism, probably reducing productivity.

27. There is some support for the argument that EPL slows the speed of labour adjustment into new high productivity industries. Burgess, Knetter and Michelacci (2000) find that countries with stricter EPL have slower rates of adjustment of productivity to long run levels, however they point out that the direction of causality could run from productivity growth to EPL strictness.[9] More recent evidence using difference-in-differences techniques suggests that layoff regulations have significantly positive effects on job turnover and, particularly, job destruction (Boeri and Jimeno, 2005; Micco and Pages, 2006; Haltiwanger, Scarpetta and Schweiger, 2006). Messina and Vallanti (2006) find that the negative impact of EPL on job turnover, job creation and job destruction is greater in industries where total employment is contracting and where firms cannot achieve substantial reductions in employment levels by purely relying on voluntary quits. Yet, the impact of EPL on firm growth appears to be, at best, small (Boeri and Jimeno, 2005; Schivardi and Torrini, 2003).

Data and methods

28. The sample used for the analysis in this section covers 18 OECD countries over the years 1982-2003. The countries included in the sample are Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Japan, the Netherlands, Norway, Portugal, Spain, Sweden, the

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7. Yet, stringent EPL might induce substitution of specific for general skills. As the former are of no use if workers need to change industry or occupation in the aftermath of major shocks, this might have a negative effect on productivity, particularly in times of diffusion of radical new technological paradigms (Wasmer, 2006).

8. In Nickell and Layard (1999), the relationship between labour productivity and EPL is not statistically significant once the productivity gap to the United States is included in regressions, but the relationship between MFP growth and EPL continues to hold.

9. For example, countries that have a comparative advantage in volatile, high productivity industries might implement stricter EPL in response to political pressure to ease the social costs of labour adjustment.

United Kingdom and the United States. Due to data availability, not all years or industries are included in the estimation sample for MFP for every country.

29. The baseline model uses a cardinal index of EPL for regular contracts varying in theory from zero to six from least to most stringent (see Annex 1 for data sources). For the sample used in the analysis, values of the EPL index ranged from 0.17 in the United States to 4.83 in Portugal. The mean value in 1982 was 2.29, falling slightly to 2.20 in 2003. An alternative measure of EPL for temporary contracts and an overall measure of EPL stringency are used to test the sensitivity of the baseline results. Descriptive statistics for the variables used in the analysis can be found in Annex 2.

30. The impact of EPL on productivity growth is estimated based on the assumption that the effect of EPL on productivity is stronger in industries where EPL is binding, which in turn are identified as industries with relatively high layoff propensity. If firms need to lay off workers to restructure their operations in response to changes in technologies or product demand, high firing costs are likely to slow the pace of resource reallocation. In contrast, in industries where firms can restructure through internal adjustments or by relying on natural attrition of staff, changes in EPL could be expected to have little impact on labour reallocation, and subsequently productivity.

31. US layoff rates from the 2004 CPS Displaced Workers Supplement are used as a proxy for underlying layoff propensity. Layoff rates in a particularly country are likely to be influenced by prevailing EPL: industries that would have high layoff rates in the absence of EPL might record low layoff rates in countries where firing costs are very high. Using layoff rates for the United States (where EPL is weak) reduces the likelihood that the indicator for EPL-binding industries is correlated with EPL. A potential problem with using US layoff rates as a measure of underlying layoff propensity is that unemployment insurance premia in the United States are, in part, dependent on the risk of future layoff. It is possible that, despite very weak EPL, this imposes an additional cost for firing workers in high layoff industries, acting like firing restrictions in these industries. It is not clear what impact this could have on the results. However, sensitivity testing to the use of alternative indicators for EPL-binding industries based on turnover shows that the baseline results are relatively robust.

32. For the baseline specification, EPL-binding industries are defined as those where the layoff rate is above the average layoff rate for all industries in each of the three years 2001 to 2003. Using this definition, the following industries are defined as EPL-binding: textiles, textile product, leather and footwear manufacturing; basic metals and fabricated metal products manufacturing; machinery and equipment manufacturing (excluding transport equipment); manufacturing not otherwise classified; and transport and storage and communication services. Some alternative measures derived from US layoff rates are used as a sensitivity test (see next sub-section).

33. Due to the lack of comparable cross-country data on layoff rates, there is no way of checking whether our indicator based on US layoff rates accurately captures the underlying layoff propensity in all countries in the sample. For countries with substantially different industrial structures to the United States, the measure used might not be a good indicator of whether EPL is binding. In order to test the sensitivity of results to the use of this indicator, some alternative indicators based on US average job turnover rates are used. One advantage of using measures based on US average job turnover rates is that they have been shown to explain a large fraction of cross-industry variation in job turnover rates within OECD countries (Haltiwanger, Scarpetta and Schweiger, 2006), making the choice of the United States as a benchmark less crucial. Turnover rates are also arguably more appropriate measures of the degree to which EPL on temporary contracts is binding than measures based on layoffs, so are used in specifications that include EPL on temporary contracts or overall EPL stringency.

Results

34. Table 4.1 presents baseline estimates of the impact of EPL on regular contracts on labour productivity and MFP in EPL-binding industries compared to non-binding industries. As theory does not unambiguously predict whether EPL is more likely to affect productivity levels only or growth rates, a model selection exercise is undertaken, where we test alternative specifications allowing for a growth effect, a level effect or a growth and level effect. Growth effects are identified through the coefficient of a cumulative variable, constructed by adding EPL values in each year (see Section 2 above). The results suggest that EPL has a negative impact on the growth of both MFP and labour productivity. The estimated level effect of EPL on productivity is not statistically significant once a growth effect is included in the specification. The growth specification (second and fifth columns) is adopted as the baseline in the remainder of this section.

Table 4.1. **Effect of EPL on MFP and labour productivity[a] – baseline and model selection**

Results from OLS estimation of difference-in-differences models

	MFP with level effect		MFP with growth effect		MFP with level and growth effect		Labour productivity with level effect		Labour productivity with growth effect		Labour productivity with level and growth effect	
Level effect of EPL	0.053	[2.82]***			0.013	[0.65]	0.042	[2.16]**			0.018	[0.95]
Growth effect of EPL			-0.003	[4.58]***	-0.003	[4.05]***			-0.001	[2.35]**	-0.001	[1.88]*
Capital stock	0.217	[11.22]***	0.224	[11.66]***	0.223	[11.50]***						
Country x year dummies	yes		yes		yes		yes		yes		yes	
Country x industry dummies	yes		yes		yes		yes		yes		yes	
Industry x year dummies	yes		yes		yes		yes		yes		yes	
Observations	4168		4168		4168		6064		6064		6064	
R-squared	1		1		1		1		1		1	

MFP: multi-factor productivity; EPL: employment protection legislation; OLS: ordinary least squares.
Robust t-statistics in brackets. * significant at 10%; ** significant at 5%; *** significant at 1%.

a) Dependent variable is the logarithm of labour productivity. Capital stock is the logarithm of the capital-to-labour ratio. The table reports the relative effect of EPL between binding and non-binding industries. Binding industries are those where the layoff rate is above the average layoff rate for all industries for each year from 2001 to 2003. See Annex 1 for details on data and sources.

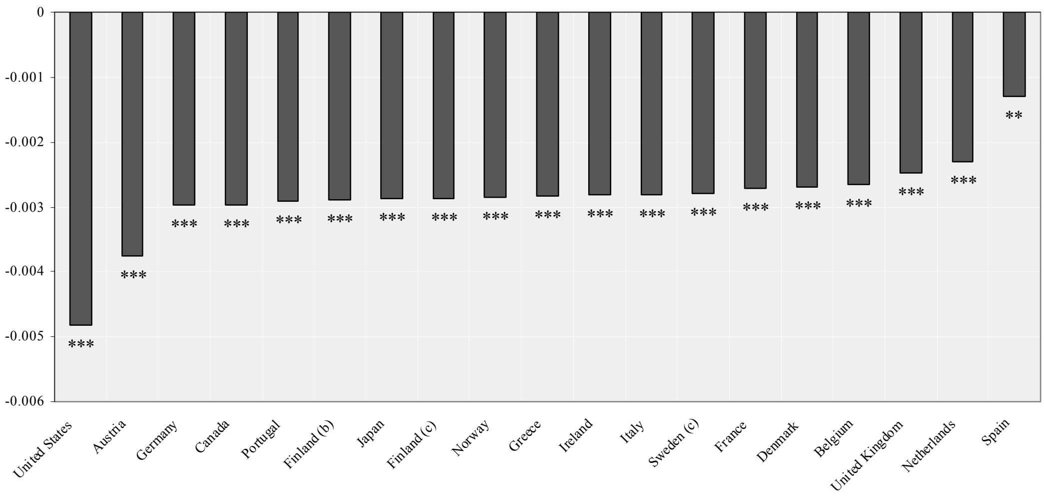
Source: OECD estimates.

35. The baseline results are relatively robust to changes in the sample of countries used in the analysis (Figure 4.1). Coefficients on EPL for the MFP specification are always negative and statistically significant. With the exception of samples excluding the United States or Spain, the coefficients from country sub-samples are remarkably close in size to the baseline coefficients. The results for labour productivity are slightly less robust: removing either the United Kingdom or Spain from the sample results in a non-significant coefficient on EPL, although the point estimates remain negative.

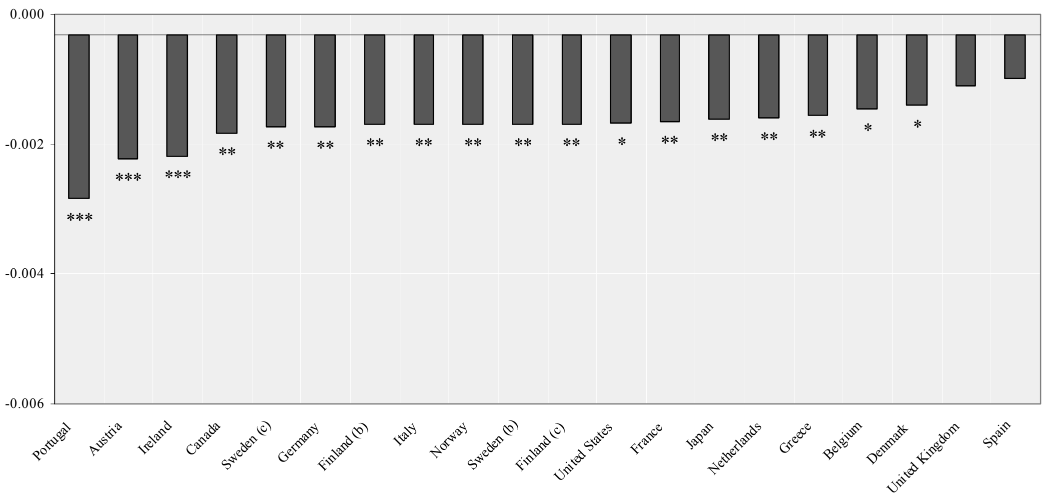
Figure 4.1. **Effect of EPL on MFP and labour productivity growth[a] – sensitivity to countries in sample**

Coefficient on growth effect of EPL from OLS estimation of difference-in-differences models when countries are excluded one-by-one from the sample

Panel A. MFP



Panel B. Labour productivity



MFP: multi-factor productivity; EPL: employment protection legislation; OLS: ordinary least squares.
* significant at 10%; ** significant at 5%; *** significant at 1%.

a) The chart reports the relative effect of EPL between binding and non-binding industries obtained by excluding groups (country and country by period in the case of Sweden and Finland) one-by-one. Excluded groups are reported in the label of each bar. Binding industries are those where the layoff rate is above the average layoff rate for all industries for each year from 2001 to 2003. The benchmark specifications correspond to results reported in the second and fifth columns of Table 4.1. See Annex 1 for details on data and sources.

b) 1982-1990.

c) 1993-2003.

d) Groups are in order of magnitude of coefficients.

Source: OECD estimates.

36. As discussed in the data section, we use a number of alternative indicators for EPL-binding industries to test the sensitivity of the baseline specification. The results of the sensitivity tests reported in Table 4.2 show that the baseline results prove relatively robust to the use of different indicators. The first four measures (first four columns) are alternative measures calculated using US layoff rates. *Layoff 1* is the baseline specification, where an industry is defined as EPL-binding if the layoff rate is above the average layoff rate for all industries in each of the three years for which layoff data are available (2001 to 2003). *Layoff 2* is slightly less restrictive in that an industry is defined as EPL-binding if the layoff rate is above the average for two of the three years for which data are available. *Layoff 3* is equal to one for industries where the average layoff rate over the period from 2001 to 2003 was higher than the average layoff rate for all industries over the same time period. *Layoff 4* defines EPL-binding industries as those where the layoff rate is above the average in 2002 and 2003. This allows for the possibility that higher-than-average layoff rates may have been recorded in some high-tech industries in 2001 as a result of the dot-com slowdown at that time, and that such high layoff rates were not reflective of the underlying layoff propensity of those industries.

37. As discussed in the data section, two alternative measures based on US job turnover rates are also used to test the sensitivity of the baseline results. One disadvantage of measures based on job turnover rates is that they tend to have high value in industries characterised by a high share of hires and/or voluntary quits in total turnover. To minimise biases stemming from this source, we include separate country-by-time dummies for downsizing or constant industries (manufacturing and energy) and upsizing industries (services and construction) in the specifications using indicators based on job turnover. *Turnover 1* (fifth column, top panel) uses US average job turnover rates, computed at the industry level, interacted with the EPL index (because this is a continuous rather than an indicator variable, these results are not directly comparable with the baseline results).[10] *Turnover 2* (first column, bottom panel) is an indicator variable equal to one for industries where the average job turnover rate over the period from 1990 to 1996 is above the average for all industries over that period. The estimated impact of EPL on productivity using *Turnover 2* is comparable to the baseline estimates. As a further comparison, we re-estimate the models using layoff-based indicators and the full set of dummy variables. The results (final four columns, bottom panel) are similar to those estimated using the standard set of dummy variables. Overall, the coefficient capturing the growth effect of EPL appears to be always negative and significant.

10. The use of quantitative indicator can be justified based on the stability of the distribution of turnover rates across countries (see Haltiwanger, Scarpetta and Schweiger, 2006 and Micco and Pages, 2006). The growth effect of EPL for each industry can be obtained by multiplying the reported coefficient in Table 4.2 by the industry average of job turnover (equal to 0.19 at the sample average job turnover).

Table 4.2. **Effect of EPL on MFP growth[a] – sensitivity to EPL-binding indicators**

Results from OLS estimation of difference-in-differences models

	Layoff 1		Layoff 2		Layoff 3		Layoff 4		Turnover 1 + full dummies	
Growth effect of EPL	-0.003	[4.58]***	-0.002	[2.65]***	-0.001	[2.23]**	-0.002	[3.43]***	-0.014	[2.32]**
Capital stock	0.224	[11.66]***	0.225	[11.67]***	0.222	[11.49]***	0.227	[11.70]***	0.237	[11.58]***
Country x year dummies	yes		yes		yes		yes		yes	
Country x industry dummies	yes		yes		yes		yes		yes	
Country x year x service industry dummies	no		no		no		no		yes	
Industry x year dummies	yes		yes		yes		yes		yes	
Observations	4168		4168		4168		4168		4168	
R-squared	1		1		1		1		1	
	Turnover 2 + full dummies		**Layoff 1 + full dummies**		**Layoff 2 + full dummies**		**Layoff 3 + full dummies**		**Layoff 4 + full dummies**	
Growth effect of EPL	-0.002	[3.36]***	-0.003	[4.34]***	-0.002	[2.74]***	-0.001	[2.10]**	-0.002	[3.23]***
Capital stock	0.244	[11.95]***	0.232	[11.36]***	0.235	[11.52]***	0.231	[11.27]***	0.237	[11.46]***
Country x year dummies	yes		yes		yes		yes		yes	
Country x industry dummies	yes		yes		yes		yes		yes	
Country x year x service industry dummies	yes		yes		yes		yes		yes	
Industry x year dummies	yes		yes		yes		yes		yes	
Observations	4168		4168		4168		4168		4168	
R-squared	1		1		1		1		1	

MFP: multi-factor productivity; EPL: employment protection legislation; OLS: ordinary least squares.
Robust t-statistics in brackets. ** significant at 5%; *** significant at 1%.

a) Dependent variable is the logarithm of labour productivity. Capital stock is the logarithm of the capital-to-labour ratio. The table reports the relative effect of EPL between binding and non-binding industries. See Annex 1 for details on data and sources.

b) Layoff 1: binding industries are those where the layoff rate is above the average layoff rate for all industries for each year from 2001 to 2003.

c) Layoff 2: binding industries are those where the layoff rate is above the average layoff rate for all industries for two of the three years 2001 to 2003.

d) Layoff 3: binding industries are those where the average layoff rate over the period from 2001 to 2003 is above the average layoff rate for all industries over the period from 2001 to 2003.

e) Layoff 4: binding industries are those where the layoff rate is above the average layoff rate for all industries for both 2002 and 2003.

f) Turnover 1: The reported coefficient corresponds to the interaction of the average job turnover rate over the period 1990 to 1996 with the EPL variable. The growth effect of EPL for each industry can be obtained by multiplying the reported coefficient by the industry average of job turnover (at the sample average job turnover is equal to 0.19).

g) Turnover 2: binding industries are those where the average job turnover rate over the period 1990 to 1996 is above the average job turnover rate for all industries over the period from 1990 to 1996

Source: OECD estimates.

38. We also experiment with a number of alternative models to test the robustness of the results (see Table 4.3), along the lines discussed in Section 2. First, the baseline equation is estimated in long-differences (4 years), using a specification of the type of equation [2] (first two columns).[11] Second, we estimate a dynamic model in levels (see eq. [5] – third column). Third, a Schumpeterian model of growth is estimated (see eq. [6] – fourth column). Although the significance of results varies, point

11. Insofar as ΣEPL is a cumulative variable, one might worry about possible unit roots and lack of cointegration among key variables. From this perspective, a difference specification has the advantage of avoiding unit root problems by construction. Yet, the importance of checking robustness to a difference specification must not be exaggerated insofar as Levin-Lin tests for unit roots in panel data (see Levin, Lin and Chu, 2002) show no evidence of unit root in both productivity levels and the cumulative EPL variable.

estimates are no smaller than those obtained with the baseline specification and always significant at the 10% level. The estimation results of these alternative models provide some support for our decision to use a baseline difference-in-differences model that includes a growth effect, although they do not conclusively rule out the possibility that EPL could affect both the level and growth rate of productivity simultaneously.

Table 4.3. **Effect of EPL on MFP growth[a] – sensitivity to model variation**

	Long-differences, growth + level effect		Long-differences, growth effect only		Dynamic model in levels		Schumpeterian model (dynamic and in growth rates)	
Level effect of EPL	-0.033	[1.16]			-0.079	[1.98]**	-0.040	[1.26]
Growth effect of EPL	-0.004	[1.78]*	-0.003	[1.67]*	-0.003	[2.13]**	-0.003	[1.65]*
Capital stock	0.137	[2.94]***	0.134	[2.90]***	0.347	[5.46]***	0.269	[5.12]***
Country x year dummies	yes		yes		yes		yes	
Country x industry dummies	no		no		yes		no	
Industry x year dummies	yes		yes		yes		yes	
Observations	701		701		4055		3773	
R-squared	0.47		0.47		1		1	

MFP: multi-factor productivity; EPL: employment protection legislation; OLS: ordinary least squares.
Robust t-statistics in brackets. ** significant at 5%; *** significant at 1%.

a) Dependent variable is the logarithm of labour productivity. Capital stock is the logarithm of the capital-to-labour ratio. The table reports only long-run relative effect of EPL between binding and non-binding industries. See Annex 1 for details on data and sources.

Source: OECD estimates.

39. We also augment the baseline specification by including a range of control variables to test the sensitivity of the baseline results and examine possible interactions between EPL and other policy variables. Table 4.4 shows that the size and statistical significance of the estimated coefficient on EPL remains relatively unchanged by the inclusion of control variables.

Table 4.4. **Effect of EPL on MFP and labour productivity growth[a] – sensitivity to inclusion of control variables**

Results from OLS estimation of difference-in-differences models

Panel A: MFP

	Baseline + PMR		Baseline + PMR + interaction		Baseline + level effect of ARR		Baseline + growth effect of ARR		Baseline + PMR + growth effect of ARR	
Growth effect of EPL	-0.003	[4.96]***	-0.003	[3.56]***	-0.003	[4.44]***	-0.003	[5.25]***	-0.003	[5.15]***
PMR	-0.029	[3.63]***	-0.031	[3.87]***					-0.024	[2.74]***
Growth effect of EPL*PMR			0.000	[1.33]						
Level effect of ARR					-0.001	[1.46]				
Growth effect of ARR							0.000	[2.75]***	0.000	[1.15]
Capital stock	0.226	[11.75]***	0.226	[11.72]***	0.225	[11.70]***	0.223	[11.63]***	0.225	[11.72]***
Observations	4168		4168		4168		4168		4168	
R-squared	1		1		1		1		1	

Panel B: Labour productivity

	Baseline + PMR		Baseline + PMR + interaction		Baseline + level effect of ARR		Baseline + growth effect of ARR		Baseline + PMR + growth effect of ARR	
Growth effect of EPL	-0.002	[2.74]***	-0.002	[2.49]**	-0.001	[2.05]**	-0.002	[3.28]***	-0.002	[3.08]***
PMR	-0.044	[5.37]***	-0.043	[5.41]***					-0.035	[3.85]***
Growth effect of EPL*PMR			0.000	[0.31]						
Level effect of ARR					-0.001	[1.37]				
Growth effect of ARR							0.000	[4.48]***	0.000	[2.00]**
Observations	6064		6064		6064		6064		6064	
R-squared	1		1		1		1		1	

MFP: multi-factor productivity; EPL: employment protection legislation; OLS: ordinary least squares; PMR: product market regulation; ARR: average unemployment benefit replacement rate;
Robust t-statistics in brackets. * significant at 10%; ** significant at 5%; *** significant at 1%.

a) Dependent variable is the logarithm of labour productivity. Capital stock is the logarithm of the capital-to-labour ratio. The table reports the relative effect of EPL between binding and non-binding industries. Binding industries are those where the layoff rate is above the average layoff rate for all industries for each year from 2001 to 2003. See Annex 1 for details on data and sources.

Source: OECD estimates.

40. If stringent EPL slows productivity growth by impeding the flow of resources into high productivity activities, it could be expected that the impact of EPL on productivity is smaller where other institutions depress firm incentives to improve productivity. Insofar as lack of product market competition can dampen these incentives (see *e.g.* Nicoletti and Scarpetta, 2003 and references therein), we could expect the effect of EPL on productivity to be smaller where product market regulation (PMR) is strongly anti-competitive. To test this hypothesis, an aggregate index of stringency of PMR and an interaction between PMR and the growth effect of EPL are included in the specification. Both variables are interacted with the dummy variable for EPL-binding industries, so the coefficients represent the marginal effect of a change in PMR on productivity in EPL-binding industries compared with non-binding industries. The results (Table 4.4) show that strong PMR tends to depress productivity in EPL-binding industries, but there appears to be no evidence that the negative impact of EPL on productivity is less important in countries with strongly anti-competitive PMR.

41. The average unemployment benefit replacement rate (ARR) is also included as a control variable in such a way that its coefficient captures either a "level effect" (interacting the ARR variable with the EPL-binding industry dummy) or a "growth effect" (using a cumulative ARR variable interacted with the EPL-binding industry dummy). The results (Table 4.4) suggest that generous unemployment benefits have a positive impact on productivity growth in EPL-binding industries, but do not substantially change the

results for EPL. The possible impact of unemployment benefits on productivity is discussed in more detail in Section 7.

42. Partial EPL reforms, whereby regulations on temporary contracts are weakened while maintaining strict EPL on regular contracts, have been shown to be associated with increasing labour market duality in OECD countries (see *e.g.* OECD, 2004). An expansion in temporary work could have opposing effects on productivity. On the one hand, temporary contracts could increase flexibility so that firms can adapt quickly to changes in technology or product demand and move resources easily into emerging, high productivity activities. Temporary workers might also display greater work effort than other workers if they perceive that good performance could lead to contract renewal or a permanent job offer (Engellandt and Riphahn, 2004). On the other hand, there is some evidence that temporary workers are less likely to participate in job-related training (OECD, 2002; Albert, Garcia-Serrano and Hernanz, 2005; Bassanini *et al.*, 2007; Draca and Green, 2004), or even are more prone to workplace accidents (Guadalupe, 2003).

43. To test whether reform of EPL on temporary contracts has the same effect on productivity as reform of EPL on regular contracts, a number of alternative specifications are estimated using indices of EPL on regular contracts, EPL on temporary contracts and an overall measure of EPL stringency. Insofar as indicators based on turnover are perhaps better suited to identify industries where hiring restrictions are binding, indicators based on both layoffs and turnover are used in the estimation. The results (Table 4.5) show that a decrease in the overall level of EPL is associated with faster MFP growth. However, the results do not shed further light on the productivity effects of partial EPL reforms. When indices for EPL on both temporary and regular contracts are included, the coefficient on the index for temporary contracts is sometimes insignificant and never significantly greater than the coefficient on the index for EPL on regular contracts.

Table 4.5. **Effect of EPL on MFP and labour productivity growth[a] – sensitivity to measures of EPL**

Results from OLS estimation of difference-in-differences models

Panel A. Layoff 1[b] used as binding indicator

	MFP with EPL total		MFP with EPL regular, temporary and interaction between regular and temporary		MFP with EPL regular and temporary	
EPL total	-0.001	[2.02]**				
EPL regular			-0.004	[6.22]***	-0.003	[4.87]***
EPL temporary			-0.001	[2.35]**	0.001	[1.76]*
EPL regular x temporary			-0.003	[5.34]***		
Capital stock	0.232	[11.00]***	0.225	[10.63]***	0.237	[11.26]***
Country x year dummies	yes		yes		yes	
Country x year x service industry dummies	yes		yes		yes	
Country x industry dummies	yes		yes		yes	
Industry x year dummies	yes		yes		yes	
Observations	3912		3912		3912	
R-squared	1		1		1	

Table 4.5. **(continued)**

Panel B. Turnover 1[c] used as binding indicator

	MFP with EPL total		MFP with EPL regular, temporary and interaction between regular and temporary		MFP with EPL regular and temporary	
EPL total	-0.015	[2.65]***				
EPL regular			-0.008	[1.36]	-0.008	[1.34]
EPL temporary			-0.009	[1.80]*	-0.008	[1.87]*
EPL regular x temporary			-0.003	[0.52]		
Capital stock	0.234	[11.00]***	0.234	[10.84]***	0.235	[10.85]***
Country x year dummies	yes		yes		yes	
Country x year x service industry dummies	yes		yes		yes	
Country x industry dummies	yes		yes		yes	
Industry x year dummies	yes		yes		yes	
Observations	3912		3912		3912	
R-squared	1		1		1	

Panel C. Turnover 2[d] used as binding indicator

	MFP with EPL total		MFP with EPL regular, temporary and interaction between regular and temporary		MFP with EPL regular and temporary	
EPL total	-0.002	[2.26]**				
EPL regular			-0.002	[2.86]***	-0.002	[2.67]***
EPL temporary			-0.001	[1.20]	0.000	[0.48]
EPL regular x temporary			-0.001	[1.40]		
Capital stock	0.237	[11.33]***	0.243	[11.20]***	0.245	[11.36]***
Country x year dummies	yes		yes		yes	
Country x year x service industry dummies	yes		yes		yes	
Country x industry dummies	yes		yes		yes	
Industry x year dummies	yes		yes		yes	
Observations	3912		3912		3912	
R-squared	1		1		1	

MFP: multi-factor productivity; EPL: employment protection legislation; OLS: ordinary least squares. See Annex 1 for full description of EPL variables.
Robust t-statistics in brackets. * significant at 10%; ** significant at 5%; *** significant at 1%.

a) Dependent variable is the logarithm of labour productivity. Capital stock is the logarithm of the capital-to-labour ratio. The table reports the relative effect of EPL between binding and non-binding industries. See Annex 1 for details on data and sources.

b) Layoff 1: binding industries are those where the layoff rate is above the average layoff rate for all industries for each year from 2001 to 2003.

c) Turnover 1: The reported coefficient corresponds to the interaction of the average job turnover rate over the period 1990 to 1996 with the EPL variables. The growth effect of EPL for each industry can be obtained by multiplying the reported coefficient by the industry average of job turnover (at the sample average job turnover is equal to 0.19).

d) Turnover 2: binding industries are those where the average job turnover rate over the period 1990 to 1996 is above the average job turnover rate for all industries over the period from 1990 to 1996.

Source: OECD estimates.

44. It has been argued that high statutory or contractual employment protection might act as a signalling device to workers about firm commitment, increasing worker effort or incentives to invest in firm-specific human capital (Soskice, 1997). If this is the case, firing regulations might have less negative effect in industries characterised by cumulative technologies, where innovation relies heavily on internal know-how and specific human capital is therefore more important. Using the taxonomy for manufacturing developed by Bassanini and Ernst (2002), we therefore re-estimate the baseline specification separately for cumulative (machinery and transport equipment) and non-cumulative (all other manufacturing) industries. The results in Table 4.6 show that there is no evidence of a smaller effect of EPL on productivity in cumulative industries. In fact, the negative effect of EPL on productivity appears to be larger in cumulative industries, although given that these results were obtained from a sample including just two industries, they should be treated with caution.

Table 4.6. **Effect of EPL on MFP and labour productivity growth[a] – sensitivity to changes in industries**

Results from OLS estimation of difference-in-differences models

	MFP manufacturing		MFP cumulative		MFP non-cumulative		Labour productivity manufacturing		Labour productivity cumulative		Labour productivity non-cumulative	
Growth effect of EPL	-0.004	[5.39]***	-0.010	[5.86]***	-0.002	[3.22]***	-0.002	[2.93]***	-0.014	[9.85]***	0.000	[0.27]
Capital stock	0.183	[7.27]***	0.264	[2.95]***	0.241	[7.75]***						
Country x year dummies	yes		yes		yes		yes		yes		yes	
Country x industry dummies	yes		yes		yes		yes		yes		yes	
Industry x year dummies	yes		yes		yes		yes		yes		yes	
Observations	2649		550		2099		3790		758		3032	
R-squared	1		1		1		1		1		1	

MFP: multi-factor productivity; EPL: employment protection legislation; OLS: ordinary least squares.
Robust t-statistics in brackets. *** significant at 1%.

a) Dependent variable is the logarithm of labour productivity. Capital stock is the logarithm of the capital-to-labour ratio. The table reports the relative effect of EPL between binding and non-binding industries. Binding industries are those where the layoff rate is above the average layoff rate for all industries for each year from 2001 to 2003. Cumulative industries are machinery and transport equipment manufacturing. Non-cumulative industries are all other manufacturing industries. See Annex 1 for details on data and sources.

Source: OECD estimates.

45. The results presented above show the differential impact of EPL on productivity growth in EPL-binding industries compared to non-binding industries. In order to get an indication of the aggregate impact of EPL on productivity, we assume that EPL has no impact on productivity growth in non-binding industries (and in industries that are not included in our sample). The aggregate effect is then estimated by multiplying the estimated coefficient on EPL from the baseline model by GDP in EPL-binding industries as a proportion of total GDP in 2002, averaged over the countries included in the sample. These assumptions are likely to produce an estimate of the lower bound of the actual aggregate effect of EPL on productivity. A one-point increase in the index of EPL stringency – roughly corresponding to one standard deviation in the cross-country distribution of the EPL index for regular contracts – appears to reduce the growth rate of labour productivity by at least 0.02 percentage points and the growth rate of MFP by at least 0.04 percentage points. The fact that EPL appears to have a stronger effect on MFP growth than labour productivity might reflect a positive impact on capital deepening, which is consistent with the findings of Autor, Kerr and Kugler (2007) for the United States.

5. Minimum wages

Previous research

46. The debate on the employment impact of minimum wages is fierce and almost endless, but no clear-cut evidence has emerged that minimum wages have an adverse effect on aggregate unemployment

(see OECD, 2006b for a survey of recent literature). Minimum wages have been also criticised for their possible negative impact on productivity. In particular, by compressing wage relativities between skilled and unskilled jobs, minimum wages could reduce incentives for the unskilled to invest in training. More importantly, high minimum wages prevent low-wage workers from accepting wage cuts to finance training (Rosen, 1972). Minimum wages could also influence firms' innovation decisions. Boone (2000), for instance, argues that if the level of the minimum wage exceeds workers' productivity, firms will over-invest in labour-saving innovation. This reduces investment in innovations that improve the quality of products (and enhance long run growth) and therefore reduces productivity growth below the optimal level.

47. Alternatively, however, by compressing the lower tail of the wage distribution without necessarily affecting individual productivity, minimum wages could increase employers' incentive to pay for training as they can reap the difference between productivity and wage growth after training (see *e.g.* Acemoglu and Pischke, 1999, 2003). Moreover, unskilled workers could have a greater incentive to invest in human capital to avoid unemployment (Cahuc and Michel, 1996; Agell and Lommerud, 1997; Agell, 1999).

48. Available evidence also suggests that high minimum wages can reduce demand for unskilled labour, relative to skilled labour, thereby leading to substitution of skilled for unskilled workers, without necessarily an overall change in the employment level (Neumark and Wascher, 2006; Aaronson and French, 2007). If more skilled labour is employed and more unskilled labour is excluded from employment, the aggregate skill level of the workforce will increase, thereby raising average measured productivity, without necessarily affecting individual productivity.

49. There is very little existing empirical evidence on the impact of minimum wages on productivity. Kahn (2006) finds that the ratio of the minimum to median wage is negatively related to MFP growth in French manufacturing industries, although when she includes a control for the unemployment benefit replacement rate, the coefficients on both variables are statistically insignificant. Research is more abundant on the effect of minimum wages on training, but no consensus emerges as to the overall effect of minimum wages.[12]

Data and methods

50. The impact of minimum wages on average measured productivity is estimated using a sample of 11 OECD countries over the years 1979-2003. The countries included in the sample are Belgium, Canada, France, Greece, Ireland, Japan, the Netherlands, Portugal, Spain, the United Kingdom and the United States. Data for the United Kingdom and Ireland cover the period 2000-2003, following the introduction of a statutory minimum wage in 1999-2000 in these countries. Due to data availability, not all years or industries are included in the estimation sample for MFP for every country (see Annex 1 for full details of data and sources).

51. Minimum wages are measured as the ratio of the gross statutory minimum wage to median wage. The average ratio of minimum to median wages for the countries in the sample fell from 52% in 1979 to 39% in 2003. The countries in the sample with the highest minimum wage are the Netherlands, France, Greece and Portugal (close to 60%), while Japan, Spain and the United States have the lowest ratio (close to 30%). Descriptive statistics for all the variables used in the analysis can be found in Annex 2.

52. The key identifying assumption is that changes in minimum wages have a greater impact on productivity in industries that are more heavily reliant on low-wage workers. However, it is possible that

12. See Grossberg and Sicilian (1998), Neumark and Wascher (2001), and Acemoglu and Pischke (2003) for the United States, and Arulampalam, Booth and Bryan (2004) for the United Kingdom.

changes in minimum wages could have an impact on the incidence of low-wage workers in particular industries. In countries where statutory minimum wages are very high, firms might shift towards capital- and skill-intensive technologies in specific industries where this is technically feasible, reducing the incidence of low-wage workers. In order to overcome this potential source of endogeneity, we develop an indicator for low-wage industries based on the incidence of low-wage workers by industry in the United Kingdom prior to the introduction of the minimum wage in that country in 1999. Data are from the British Household Panel Survey (BHPS) component of the European Community Household Panel (ECHP) for the years 1994-1999. We define an industry as low-wage if its average proportion of low-wage workers between 1994 and 1999 was above the cross-industry median over the same period, where low-wage workers are defined as wage and salary employees working at least 30 hours per week with gross monthly wages less than two thirds of the median wage of all workers.[13] Using this definition, the following industries are classified as low-wage: textiles, textile products, leather and footwear manufacturing; wood and wood/cork products manufacturing; pulp, paper and paper products manufacturing, printing and publishing; electricity, gas and water supply; wholesale and retail trade and repairs; and hotels and restaurants.

53. It is possible that the distribution of low-wage workers in the United Kingdom prior to the introduction of the minimum wage reflected idiosyncratic economic conditions, rather than an underlying industry propensity for employing low-wage workers. In order to investigate this issue, we compare our low-wage data for the United Kingdom with ECHP data on wages for 12 countries (Austria, Belgium, Denmark, France, Germany, Ireland, Italy, the Netherlands, Portugal, Spain and the United Kingdom) for the years 1994-2001. First, it appears that the proportion of low-wage workers, defined in the same way as for the United Kingdom, does not vary significantly over time in each country. Doing a simple analysis of variance, it appears that the time dimension explains only an insignificant share of the total variance, in contrast with the country and industry dimensions. Second, once data are averaged over time, a regression including country dummies and the 1994-1999 UK proportion of low-wage workers appears to explain 50% of the cross-country/cross-industry variance of the proportion of low-wage workers (Table 5.1, first column). Industry and country effects do not appear to explain more than 51% of the cross-country variance of the proportion of low-wage workers (second column). In other words, it is difficult to find an industry-invariant indicator that can better capture variations in the proportion of low-wage workers that are not explained by country-invariant level effects (which have no bearing in our analysis). Yet, given that the 1994-1999 UK proportion of low-wage workers explains only a limited share of the total variance, it is probably more cautious to use a qualitative rather than a quantitative indicator.[14] A model including country effects and our qualitative indicator of low-wage industries (UK industries with an average proportion of low-wage workers above the UK median in 1994-1999) appears to explain 38% of the cross-country/cross-industry variance of the proportion of low-wage workers (third column), only slightly less than the proportion explained by country effects and country-specific dummies for industries with a sample average proportion of low-wage workers above the country median (fourth column). To test the sensitivity of the baseline results to the use of the UK low-wage indicator, we develop a number of alternative indicators, based on shares of low-wage workers by industry averaged across all countries in the ECHP for the years 1994-2001. The results of sensitivity tests which re-estimate the baseline results using these alternative indicators are shown in the next section.

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13. Industries in the ECHP are slightly more aggregated than in our sample: the following industries are grouped together in the ECHP: ISIC 20-22, 23-26 and 29-37. We assign the same proportion of low-wage workers to each of the sub-industries in our sample as applies to the more aggregated industry group from the ECHP.

14. In comparison, Haltiwanger, Scarpetta and Schweiger, show that country effects and US job turnover rates alone can explain up to 75% of the total variance of job turnover rates in a large sample of OECD and non-OECD countries. This explained share is much greater than the 50% of total variance explained by UK data in the case of the proportion of low-wage workers.

Table 5.1. **Cross-country/cross-industry analysis of variance of the proportion of low-wage workers**

Proportion of explained variance in cross-country/cross-industry models

Dependent variable: Proportion of low-wage workers	UK proportion and country effects		Industry and country effects		Dummy for above-median UK proportion and country effects		Country-specific dummies for above-median proportion and country effects	
UK proportion of low-wage workers	0.357	[46.68]***						
Industry dummies			0.365	[4.12]***				
Dummy for UK proportion of low-wage workers > country median					0.159	[12.84]***		
Dummies for proportion of low-wage workers > country median							0.293	[31.94]***
Country dummies	0.643	[7.65]***	0.635	[7.16]***	0.841	[6.38]***	0.637	[6.31]***
Total (R-squared)	0.500		0.506		0.382		0.454	
Observations	144		144		144		144	

F-statistics in brackets.
*** significant at 1% level.

Source: OECD estimates.

54. It is possible that the minimum wage variable used in the analysis is endogenous, due to the correlation between average productivity and median wages. The baseline specification is initially estimated using both ordinary least squares (OLS) and instrumental variables (IV) approaches,[15] using the logarithm of the real minimum wage in 2 000 US dollars PPP as an instrument for the ratio of the minimum wage to median earnings. For the baseline specification, a Hausman test for endogeneity (see *e.g.* Wooldridge, 2002) rejects the hypothesis that the ratio of the minimum wage to median earnings is exogenous,[16] so the discussion in the next section focuses on the IV estimates.

Results

55. The baseline IV and OLS results are presented in Table 5.2. As mentioned in the previous section, the minimum wage variable is shown to be endogenous in the baseline specification, so the IV estimates are used as the baseline. As it is not immediately clear from the existing literature whether minimum wages are likely to have an effect on the level or growth rate of productivity, a model selection exercise is undertaken including both level and growth effects separately and together into the baseline specification. The results suggest that minimum wages affect the level of productivity, rather than the growth rate. Therefore specifications presented in the remainder of this section include only a level effect of minimum wages on productivity. The results show that an increase in the minimum wage is associated with a small, but statistically significant, increase in average productivity in low-wage industries compared with other industries. The size of the effect is similar for labour productivity and MFP.

15. Two-stage least squares is used throughout.

16. Hausman test statistics are 15.51 for the MFP model and 7.91 for the labour productivity model.

Table 5.2. **Effect of the minimum wage on MFP and labour productivity[a] – baseline and model selection**

Results from IV and OLS estimation of difference-in-differences models

Panel A. IV estimates

	MFP with level effect	MFP with growth effect	MFP with level and growth effect	Labour productivity with level effect	Labour productivity with growth effect	Labour productivity with level and growth effect
Level effect of minimum wage	0.006 [2.28]**		0.005 [0.96]	0.007 [3.01]***		0.007 [3.19]***
Growth effect of minimum wage		0.000 [1.16]	0.000 [0.18]		0.001 [2.45]**	0.000 [0.93]
Capital stock	0.121 [5.30]***	0.131 [5.85]***	0.123 [5.09]***			
Country x year dummies	yes	yes	yes	yes	yes	yes
Country x industry dummies	yes	yes	yes	yes	yes	yes
Industry x year dummies	yes	yes	yes	yes	yes	yes
F-test on instrument for min. wage	2133.3	129.1	1155.0	1933.5	42.1	982.5
Observations	2439	2439	2439	3664	3664	3664
R-squared	1	1	1	1	1	1

Panel B. OLS estimates

	MFP with level effect	MFP with growth effect	MFP with level and growth effect	Labour productivity with level effect	Labour productivity with growth effect	Labour productivity with level and growth effect
Level effect of minimum wage	-0.001 [0.33]		0.000 [0.23]	0.001 [0.76]		0.002 [0.90]
Growth effect of minimum wage		0.000 [0.80]	0.000 [0.79]		0.000 [0.84]	0.000 [1.00]
Capital stock	0.129 [5.68]***	0.128 [5.64]***	0.128 [5.65]***			
Country x year dummies	yes	yes	yes	yes	yes	yes
Country x industry dummies	yes	yes	yes	yes	yes	yes
Industry x year dummies	yes	yes	yes	yes	yes	yes
Observations	2439	2439	2439	3664	3664	3664
R-squared	1	1	1	1	1	1

MFP: multi-factor productivity; IV: instrumental variables; OLS: ordinary least squares.
Robust t-statistics in brackets. ** significant at 5%; *** significant at 1%.

a) Dependent variable is the logarithm of labour productivity. Capital stock is the logarithm of the capital-to-labour ratio. Minimum wage is ratio of the minimum wage to median earnings. The table reports the relative effect of minimum wage between low-wage and other industries. Low-wage industries are derived from BHPS-ECHP data on wages for the United Kingdom prior to the introduction of the minimum wage in 1999. An industry is defined to be low-wage if its average proportion of low-wage workers between 1994 and 1999 was above the cross-industry sample median over the same period. See Annex 1 for details on data and sources.

Source: OECD estimates.

56. Existing empirical research fails to find strong evidence of a link between minimum wages and overall employment levels. However, in order to rule out the possibility that the observed positive relationship between minimum wages and productivity is purely the result of a composition effect due to lower employment, the baseline specification is augmented with the log of total hours worked as a control variable.[17] Although this variable is likely to be endogenous, there is evidence that its estimate is, if anything, downward biased (OECD, 2007b). Therefore, if minimum wages negatively affect employment and composition effects are sizeable, the inclusion of total hours worked in the specification will not be problematic insofar as it will at most tend to bias the coefficient on minimum wages towards zero, that is against finding any significantly positive effect. The results are reported in Table 5.3. As expected, higher employment levels are associated with lower productivity. The coefficient on minimum wages is virtually unchanged when the control for employment is included, indicating that the positive relationship between

17. The logarithm of total employment is also tested and the results (not reported) are very similar to those shown for log of total hours.

minimum wages and productivity cannot be explained entirely as a composition effect due to a link between minimum wages and employment levels.

Table 5.3. **Effect of the minimum wage on MFP and labour productivity[a] – controlling for employment**

Results from IV estimation of difference-in-differences models

	MFP		Labour productivity	
Minimum wage	0.006	[2.60]***	0.006	[2.86]***
Log total hours	-0.339	[9.25]***	-0.359	[13.06]***
Capital stock	0.042	[1.85]*		
Observations	2439		3664	
R-squared	1		1	
F test on instruments	2165.77		1936.67	

MFP: multi-factor productivity; IV: instrumental variables.
Robust t-statistics in brackets. * significant at 10%; *** significant at 1%.

a) Dependent variable is the logarithm of labour productivity. Capital stock is the logarithm of the capital-to-labour ratio. Minimum wage is ratio of the minimum wage to median earnings. The table reports the relative effect of minimum wage between low-age and other industries. Low-wage industries are derived from BHPS-ECHP data on wages for the United Kingdom prior to the introduction of the minimum wage in 1999. An industry is defined to be low-wage if its average proportion of low-wage workers between 1994 and 1999 was above the cross-industry sample median over the same period. See Annex 1 for details on data and sources.

Source: OECD estimates.

57. The result in Table 5.3, however, does not rule out the possibility that the positive impact of minimum wages on productivity is simply due to *substitution* effects (where unskilled workers are priced out of the labour market, resulting in a substitution of skilled for unskilled workers without any overall change in employment). Neither does it provide a conclusive way of disentangling substitution effects from the possibility that higher productivity is the result of improved training incentives. Empirical specifications incorporating a growth effect of minimum wages reported in Table 5.2 suggest that minimum wages have a more significant impact on the level of productivity than on its growth rate. Insofar as the training channel would likely affect the growth rate as well as the level of productivity, the results in Table 5.2 provides some, albeit weak, evidence that substitution of skilled for unskilled workers explains at least part of the story.

58. Competing explanations – that is, training versus skilled/unskilled substitution effects – however, have very different policy implications. In fact, while the training story implies a virtuous link between minimum wages and productivity, the substitution story would suggest that the positive productivity effect is purely a statistical artefact and point to undesirable distributional consequences of excessive minimum wages. The possibility that a large proportion of the productivity effect of minimum wages is due to reduced demand for unskilled workers should be kept in mind when drawing policy implications from these results.

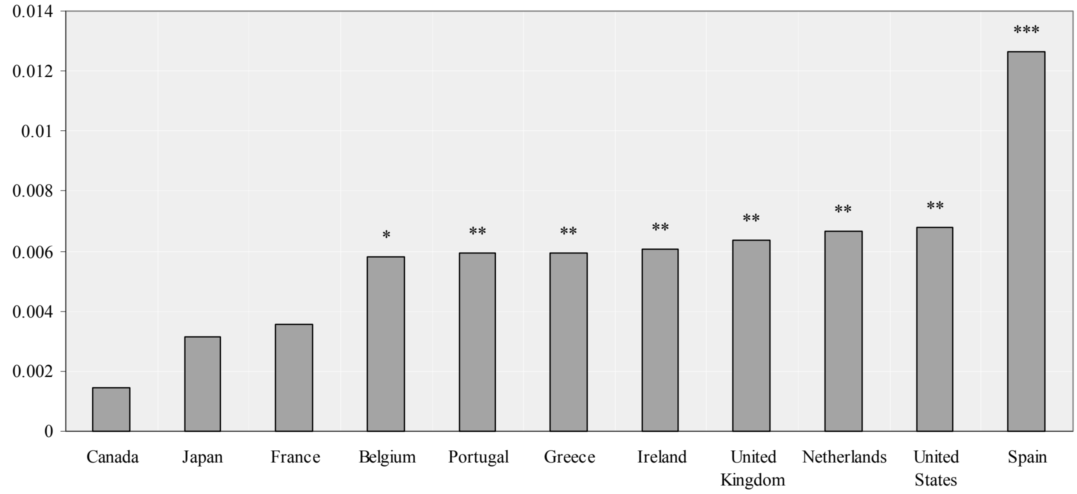
59. The baseline results for labour productivity are relatively stable for changes in the countries included in the estimation sample (see Figure 5.1). In all cases, coefficients on minimum wages are positive and statistically significant. The results for MFP are less stable: removing Canada, France or Japan from the sample reduces the size and significance of the estimated coefficients. Part of this effect is due to the smaller sample size used to estimate MFP – when the labour productivity results are re-estimated using the same sample as used for MFP, the coefficient obtained after removing Canada from the sample is no longer statistically significant. However, the coefficients for labour productivity obtained after removing

France or Japan continue to be statistically significant, indicating that the labour productivity results are somewhat more resilient to changes in the sample of countries used than the MFP results.

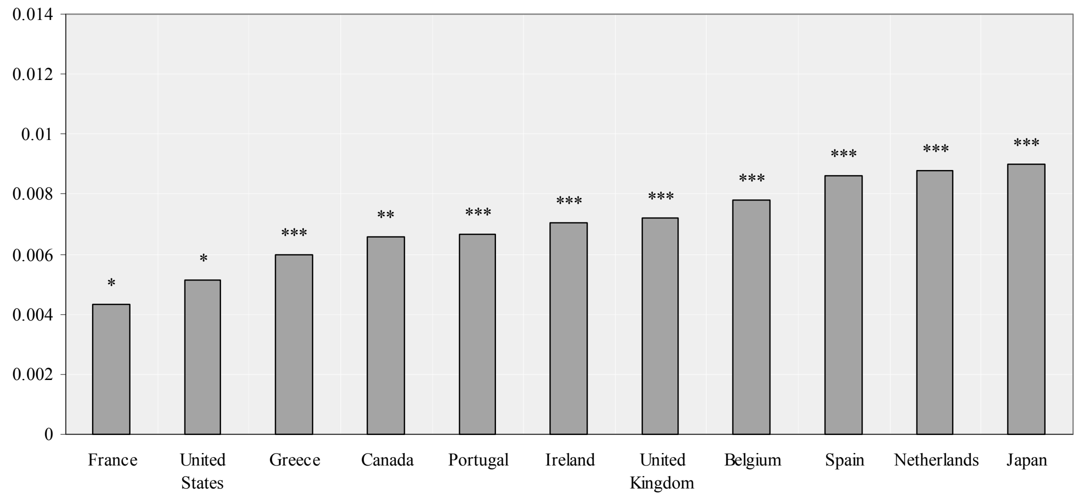
Figure 5.1. **Effect of the minimum wage on MFP and labour productivity[a] – sensitivity to countries included in sample**

Coefficient on minimum wage level effect from IV estimation of difference-in-differences models when countries are excluded one-by-one from the sample

Panel A. MFP



Panel B. Labour productivity



MFP: multi-factor productivity; IV: instrumental variables.
** significant at 5%; *** significant at 1%.

a) The benchmark specifications correspond to results reported in Table 5.2, Columns 1 and 4. See Annex 1 for details on data and sources.

Source: OECD estimates.

60. The baseline results assume that factors other than minimum wages have the same impact on productivity in low-wage and other industries. To test the sensitivity of the baseline results to this

assumption, the baseline specification is augmented with a number of policy and economic variables (see Table 5.4). Overall, the baseline results are relatively robust to the inclusion of control variables. In all but one of the specifications incorporating controls, the coefficients on minimum wages remain positive and statistically significant.

Table 5.4. **Effect of the minimum wage on MFP and labour productivity[a] – sensitivity to control variables**

Results from IV estimation of difference-in-differences models

Panel A: MFP

	Baseline + tax wedge	Baseline + tax wedge + interaction	Baseline + ARR	Baseline + ARR + interaction	Baseline + output gap	Baseline + tax wedge + ARR + output gap
Minimum wage	0.010 [3.76]***	0.011 [3.98]***	0.004 [1.69]*	0.006 [2.34]**	0.007 [2.87]***	0.007 [2.56]**
Tax wedge	-0.009 [3.96]***	-0.009 [4.21]***				-0.005 [2.24]**
Minimum wage x tax wedge		0.000 [0.96]				
ARR			0.008 [5.20]***	0.008 [5.54]***		0.007 [4.70]***
Minimum wage x ARR				0.000 [2.22]**		
Output gap					0.007 [2.34]**	0.005 [1.66]*
Capital stock	0.129 [6.01]***	0.128 [5.94]***	0.114 [5.34]***	0.111 [5.19]***	0.119 [5.55]***	0.118 [5.49]***
Observations	2439	2439	2439	2439	2439	2439
R-squared	1	1	1	1	1	1
F test on instr. for min. wage	1548.7	836.8	2653.4	1356.8	2080.3	1858.5
F test on instr. for interaction		962.9		1884.0		

Panel B: Labour productivity

	Baseline + tax wedge	Baseline + tax wedge + interaction	Baseline + ARR	Baseline + ARR + interaction	Baseline + output gap	Baseline + tax wedge + ARR + output gap
Minimum wage	0.009 [3.61]***	0.007 [1.85]*	0.006 [2.92]***	0.006 [2.89]***	0.008 [3.30]***	0.007 [3.20]***
Tax wedge	-0.003 [2.43]**	-0.001 [0.22]				-0.002 [1.60]
Minimum wage x tax wedge		0.000 [0.68]				
ARR			0.005 [4.39]***	0.005 [2.78]***		0.005 [4.52]***
Minimum wage x ARR				0.000 [0.61]		
Output gap					0.004 [1.82]*	0.000 [0.12]
Observations	3664	3664	3664	3664	3664	3664
R-squared	1	1	1	1	1	1
F test on instr. for min. wage	1650.9	828.3	3645.1	2092.5	1794.2	3245.1
F test on instr. for interaction		134.6		171.2		

MFP: multi-factor productivity; IV: instrumental variables; ARR: average unemployment benefit replacement rate.
Robust t-statistics in brackets. * significant at 10%; ** significant at 5%; *** significant at 1%.

a) Dependent variable is the logarithm of labour productivity. Capital stock is the logarithm of the capital-to-labour ratio. Minimum wage is ratio of the minimum wage to median earnings. The table reports the relative effect of minimum wage between low-wage and other industries. Low-wage industries are derived from BHPS-ECHP data on wages for the United Kingdom prior to the introduction of the minimum wage in 1999. An industry is defined to be low-wage if its average proportion of low-wage workers between 1994 and 1999 was above the cross-industry sample median over the same period. See Annex 1 for details on data and sources.

Source: OECD estimates.

61. Previous OECD research (see OECD, 2006a) shows that minimum wages can influence the way in which the tax wedge affects unemployment. Higher minimum wages make it more difficult for employers to pass on tax increases to workers, reducing demand for labour. If minimum wages intensify the negative effect of taxes on employment, resulting lower employment rates could induce higher levels of productivity through a composition effect. In this way, the estimated positive impact of minimum wages on productivity could simply be a result of their amplifying the effect of taxes on employment. In order to test this hypothesis, we include the tax wedge separately and interacted with the minimum wage variable.[18]

18. The interaction term is created by multiplying the deviations of the minimum wage and the tax wedge from their sample means. The same approach is adopted for all interaction terms included in the analyses in this paper.

The coefficient on the interaction term reported in Table 5.4 is not statistically significant and the inclusion of the tax wedge appears to make little difference to the estimated coefficients on minimum wages.

62. The higher the minimum wage relative to the unemployment benefit replacement rate, the greater the opportunity cost of remaining unemployed. If minimum wages increase productivity by reducing demand for unskilled labour and providing incentives for unskilled workers to invest in training to avoid unemployment, high replacement rates could dull this effect by reducing the opportunity cost of remaining unemployed. To test this hypothesis, the average unemployment benefit replacement rate is included as a control variable both individually and interacted with minimum wages. The coefficient on the replacement rate reported in Table 5.4 is positive and statistically significant, and its inclusion reduces the size of the coefficient on minimum wages. The coefficient on the interaction term is negative, but only statistically significant in the MFP estimation. This provides qualified support for the hypothesis that high replacement rates reduce the positive impact of minimum wages on productivity, although the result does not hold for the full estimation sample for labour productivity.[19]

63. As mentioned in the previous section, we test the baseline results for sensitivity to the definition of low-wage industries. Table 5.5 shows that the results derived from both OLS and IV specifications are relatively robust to the use of alternative indicators based on either the distribution of low-wage workers in the United Kingdom (*Low-wage 1*) or the average distribution of low-wage workers by industry across a number of European countries (*Low-wage 2* and *Low-wage 3*).[20]

19. Alternatively, the result could indicate that in low-wage industries, higher minimum wages reduce the positive impact of unemployment benefits on productivity (see Section 7 for a full discussion of the possible effects of unemployment benefits on productivity). In short, if unemployment benefits increase productivity by giving the unemployed a buffer of time or resources to find a well-matched job, higher minimum wages will dampen this effect by increasing the opportunity cost for low skilled workers of remaining unemployed and creating an incentive for the unemployed to move quickly into any available job vacancy.

20. In certain specifications, Hausman tests fail to reject the hypothesis of exogeneity of the minimum wage indicator. In those cases, OLS estimates are likely to be consistent and more efficient than IV estimates. Yet, in all cases where the exogeneity assumption is not rejected, OLS estimates suggest a positive effect of minimum wages on productivity.

Table 5.5. **Effect of the minimum wage on MFP and labour productivity[a] – sensitivity to alternative low-wage indicators**

Results from OLS and IV[b] estimation of difference-in-differences model

Panel A. MFP

	Low-wage 1				Low-wage 2				Low-wage 3			
	OLS		IV		OLS		IV		OLS		IV	
Minimum wage	-0.007	[2.92]***	0.008	[2.72]***	0.003	[1.26]	0.010	[4.03]***	0.006	[2.57]**	0.010	[3.82]***
Capital stock	0.137	[6.06]***	0.118	[5.10]***	0.125	[5.57]***	0.116	[5.15]***	0.126	[5.70]***	0.125	[5.68]***
Country x year dummies	yes		yes		yes		yes		yes		yes	
Country x industry dummies	yes		yes		yes		yes		yes		yes	
Industry x year dummies	yes		yes		yes		yes		yes		yes	
F-test on instr. for min. wage			2089.8				2164.3				2232.9	
Hausman test statistic			72.2				20.5				6.2	
Observations	2439		2439		2439		2439		2439		2439	
R-squared	1		1		1		1		1		1	

Panel B. Labour productivity

	Low-wage 1				Low-wage 2				Low-wage 3			
	OLS		IV		OLS		IV		OLS		IV	
Minimum wage	0.001	[0.38]	0.004	[1.81]*	0.004	[2.50]**	0.005	[2.13]**	0.007	[4.36]***	0.006	[2.42]**
Country x year dummies	yes		yes		yes		yes		yes		yes	
Country x industry dummies	yes		yes		yes		yes		yes		yes	
Industry x year dummies	yes		yes		yes		yes		yes		yes	
F-test on instr. for min. wage			1933.51				1933.5				1933.51	
Hausman test statistic			3.37				0.2				0.4	
Observations	3664		3664		3664		3664		3664		3664	
R-squared	1		1		1		1		1		1	

MFP: multi-factor productivity; OLS: ordinary least squares; IV: instrumental variables.
Robust t-statistics in brackets. * significant at 10%; ** significant at 5%; *** significant at 1%.

a) Dependent variable is the logarithm of labour productivity. Capital stock is the logarithm of the capital-to-labour ratio. Minimum wage is ratio of the minimum wage to median earnings. The table reports the relative effect of minimum wage between low-wage and other industries. Low-wage industries are derived from ECHP data on wages (see notes below). See Annex 1 for details on data and sources.

b) The logarithm of real minimum wage in 2000 US dollars PPP is used as an instrument for the ratio of the minimum wage to median earnings.

c) Low-wage 1: low-wage industries are defined as industries where the average share of low-wage workers in the United Kingdom prior to the introduction of the minimum wage in 1999 is above the mean proportion for all industries in the sample. Alternatively, the same classification of industries is obtained if low-wage industries are defined as industries where the share of low-wage workers across the ECHP sample of European countries is above the median proportion for all industries in the sample in an above-average number of countries and years.

d) Low-wage 2: low-wage industries are defined as industries where the share of low-wage workers across the ECHP sample of European countries is above the mean proportion for all industries in the sample in an above-average number of countries and years.

e) Low-wage 3: low-wage industries are defined as industries where the average share of low-wage workers across the ECHP sample of European countries is above the mean (or median) proportion for all industries in the sample in an above-average number of years.

Source: OECD estimates.

64. The baseline estimates, which give the marginal effect of minimum wages on average productivity in low-wage industries compared with other industries, can be used to provide some idea of the aggregate impact of minimum wages on productivity. For this purpose, we assume that changes in the minimum wage have no effect on productivity in non-low-wage industries or in industries not included in the sample. As such, our estimates represent a lower-bound of the actual aggregate impact. We estimate that an increase of ten percentage points in the ratio of the statutory minimum wage to median wages (approximately equal to the cross-country standard deviation in minimum wages) is associated with an

increase of between 1.7 and 2.0 percentages points in the long-run level of both average labour productivity and MFP. However, as mentioned above, at least part of this effect is likely due to reduced demand for unskilled workers relative to skilled workers rather than to the effect of minimum wages on the incentives to train.

6. Parental leave

Previous research

65. Family friendly policies, such as parental leave, employer provision of child care, flexible working hours or leave to care for sick family members, could have a positive impact on productivity by making it easier for parents to balance paid work with family responsibilities, thus improving their morale and work effort and promoting continuous attachment to the workforce. In the absence of family friendly working arrangements, working parents, particularly women, might leave the workforce completely for extended periods of time, reducing their total work experience and accumulated job-specific human capital. Firms and workers who are assured of an ongoing employment relationship might also be more likely to invest in training to increase levels of human capital. Alternatively, policies such as leave or part-time work that reduce the amount of time parents spend working could impede productivity by reducing access to training and leading to human capital depreciation. Policies that increase the cost to employers of employing parents could lead to discriminatory and inefficient hiring outcomes, whereby highly-skilled women are concentrated in low-skilled jobs. In addition, if new workers lacking in job-specific skills are hired to replace employees taking parental leave, productivity could fall, at least temporarily.

66. Existing studies of the impact of family friendly working arrangements on productivity tend to be based on relatively small-scale surveys of managers' perceptions of productivity or turnover. The results are mixed and difficult to generalise (Baughman, Holtz-Eakin and DiNardi, 2003; Gray, 2002; Bloom and Van Reenen, 2006). One reason for the lack of cross-country comparisons of the productivity effects of family friendly working arrangements is that cross-country data on the use or provision of family friendly working arrangements are scarce. Some family friendly working arrangements are mandated by national or regional governments, but in many cases, responsibility for the provision of family friendly working arrangements is left to employers, making it difficult to determine levels of coverage in a way that enables cross-country comparison. A notable exception is parental leave. Most OECD countries have mandated parental leave arrangements, with compulsory maternity leave around the time of childbirth, and additional (paid or unpaid) leave after the birth. Because comparable cross-country data are available over a reasonably long period of time, parental leave will be the focus of the analysis in this section.

67. There is very little existing empirical evidence on the direct productivity impact of parental leave. Gray (2002) finds that the provision of paid parental leave has no significant impact on manager-reported measures of labour productivity, financial performance, turnover or absenteeism, but significantly increases employee-reported satisfaction with pay. But paid parental leave increases significantly employee-reported satisfaction with pay.

68. To the extent that higher productivity is reflected in higher wages, the literature examining the impact of parental leave on wages provides more evidence on the expected relationship between parental leave and productivity.[21] Time spent out of the workforce after childbirth can have a negative impact on subsequent wages for women. Much of this negative impact is due to human capital depreciation or loss of opportunities to accumulate human capital while away from work (see *e.g.* Datta Gupta and Smith, 2002).

21. Almost all of the research in this area focuses on women's wages, primarily because women are far more likely than men to take parental leave. An exception is Albrecht *et al.* (1999), who find that the wage penalty for taking parental leave is much higher for men than women.

However, a number of studies have shown that the availability and use of parental leave mitigates the negative effects of children on women's wages for two reasons. First, access to parental leave seems to reduce the length of career breaks following the birth of a child (Ronsen and Sundstrom, 1996; Berger and Waldfogel, 2004; Dex *et al.*, 1998; Burgess *et al.*, 2007; Joshi, Paci and Waldfogel, 1999). Second, women with access to parental leave are more likely to return to the job they held before the birth of their child, allowing them to capitalise on the benefits of accumulated tenure with their old employer, such as seniority, training and access to internal labour markets (Baker and Milligan, 2005; Waldfogel 1998; Waldfogel, Higuchi and Abe, 1999; Waldfogel, 1995, 1998; Baum, 2002; Phipps, Burton and Lethbridge, 2001).

Data and methods

69. The analysis of the effect of parental leave on productivity is based on the assumption that parental leave has a greater impact on productivity in industries where employment is female-dominated. The analysis uses a sample of 18 OECD countries over the period 1980-1999 (1999 is the latest year for which comparable cross-country data on parental leave are available). The countries included in the sample are Austria, Belgium, Canada, Denmark, Finland, France, Germany (1993-1999), Ireland, Italy, Japan, Norway, the Netherlands, Spain, Sweden, the United Kingdom and the United States. Greece and Portugal are also included in the sample for labour productivity. Due to data availability, not all years or industries are included in the estimation sample for MFP for every country. Data for the year 1979 (which are used in the analysis of other policies in this paper) are excluded from the sample because the results are overly sensitive to an increase from 14 to 162 weeks in unpaid parental leave in Spain between 1979 and 1980.

70. Two policy measures of parental leave are used in the analysis: total weeks of legislated unpaid parental leave including child care leave; and total weeks of legislated paid maternity leave, estimated at average manufacturing worker wages (see Annex 1 for details on data and sources). In 1980, there was an average of 12.4 weeks of paid maternity leave and 41.0 weeks of unpaid parental leave in the countries in the sample, rising to an average of 17.5 weeks of paid maternity leave and 88.4 weeks of unpaid parental leave in 1999. The lowest values recorded in the sample are zero weeks of paid maternity leave in the United States over the whole sample period, and zero weeks of unpaid parental leave between 1979 and 1992. The highest value for paid maternity leave is 57.6 weeks in Sweden in 1993 and 1994. Both Spain (1990-1999) and Finland (1993-1999) record the highest value for unpaid parental leave of 164 weeks. Descriptive statistics for all the variables used in the analysis can be found in Annex 2.

71. It is possible that changes in parental leave policy could have an impact on whether particular industries are female-dominated. For example, very long periods of parental leave might impose high non-wages costs on businesses, such as the cost of replacing employees on parental leave or retraining employees returning from parental leave. In countries where mandated parental leave is very long, industries where these costs are high (for example, industries where skills depreciate rapidly when employees are on leave) might be less inclined to employ women in order to avoid these costs, making these industries less likely to be female-dominated than in the absence of long periods of mandated leave.

72. In order to overcome this possible source of endogeneity, we develop an indicator for female-dominated industries by averaging the proportion of women employed in each industry over the years from 1995 to 2002 and over a sample of European countries from the European Labour Force Survey. An industry is classified as female-dominated if the proportion of women employed in that industry is higher than the proportion of women employed across the whole economy. In the baseline model, the female-dominated industries are: textiles, textile products, leather and footwear manufacturing; wholesale and retail trade; hotels and restaurants; and financial intermediation.

73. There is a high degree of conformity in Europe in the ranking of industries based on the proportion of women employed, suggesting that our indicator is likely to be a reasonably accurate measure of female-dominated industries for the countries in the sample. Of the 15 countries which form the sample for defining female-dominated industries, the Spearman rank correlation between the European average ranking of industries and the ranking within individual countries was over 0.95 in 13 countries, and between 0.90 and 0.95 in a further two. Portugal had a rank correlation of 0.86 with the European average ranking, which is still very high. A basic examination of data for the United States (albeit using a different, and much coarser, industry classification) indicates that a ranking of industries based on the proportion of women employed using data from the Current Employment Survey would produce similar results. The industries in the United States with the largest proportion of women employed are financial services, accommodation and food services and retail trade.[22]

Results

74. Table 6.1 shows the results of a model selection exercise to find the most appropriate baseline specification. A number of alternative specifications are tested to allow for non-linearity in the relationship between parental leave and productivity. The log specification (second and fifth columns of each panel) appears to fit the data best for both paid and unpaid leave, and is used as the baseline specification in the results that follow. There is no consistent evidence of a quadratic relationship. Specifications allowing the coefficient on leave to vary between long and short periods of leave or introducing leave as a series of dummy variables do not produce convincing results, probably due to the lack of variability in leave periods over time within most countries. These results are not reported.

22. Unfortunately the data are not available to distinguish between different types of manufacturing industries. However, the broad categories used show that non-durable goods manufacturing (which includes textiles and food manufacturing industries) has a higher proportion of women employed than durable goods manufacturing.

Table 6.1. **Effect of parental leave on MFP and labour productivity[a] – baseline and model selection**

Results from OLS estimation of difference-in-differences model

Panel A: Paid maternity leave

	MFP baseline linear		MFP baseline log-linear		MFP baseline quadratic		Labour productivity baseline linear		Labour productivity baseline log-linear		Labour productivity baseline quadratic	
PML	0.001	[0.84]			0.011	[2.26]**	0.003	[3.68]***			0.001	[0.32]
Log of PML			0.050	[1.78]*					0.030	[1.24]		
Squared PML					-0.019	[2.20]**					0.002	[0.46]
Capital stock	0.197	[9.45]***	0.197	[9.47]***	0.196	[9.48]***						
Country x year dummies	yes		yes		yes		yes		yes		yes	
Country x industry dummies	yes		yes		yes		yes		yes		yes	
Industry x year dummies	yes		yes		yes		yes		yes		yes	
Observations	3611		3611		3611		5488		5488		5488	
R-squared	1		1		1		1		1		1	

Panel B: Unpaid parental leave

	MFP baseline linear		MFP baseline log-linear		MFP baseline quadratic		Labour productivity baseline linear		Labour productivity baseline log-linear		Labour productivity baseline quadratic	
UPL	0.000	[0.73]			0.000	[0.59]	0.000	[1.31]			-0.001	[1.59]
Log of UPL			0.018	[2.40]**					0.014	[1.90]*		
Squared UPL					0.000	[0.98]					0.001	[2.73]***
Capital stock	0.197	[9.48]***	0.197	[9.51]***	0.197	[9.47]***						
Country x year dummies	yes		yes		yes		yes		yes		yes	
Country x industry dummies	yes		yes		yes		yes		yes		yes	
Industry x year dummies	yes		yes		yes		yes		yes		yes	
Observations	3611		3611		3611		5488		5488		5488	
R-squared	1		1		1		1		1		1	

MFP: multi-factor productivity; PML: paid maternity leave; UPL: unpaid parental leave; OLS: ordinary least squares.
Robust t-statistics in brackets. * significant at 10%; ** significant at 5%; *** significant at 1%.

a) Dependent variable is the logarithm of labour productivity. Capital stock is the logarithm of the capital-to-labour ratio. The table reports the relative effect of unemployment benefits between female-dominated and other industries. An industry is classified as female-dominated if the proportion of women employed in that industry is higher than the proportion of women employed across the whole economy. Parental leave variables are measured in weeks. See Annex 1 for details on data and sources.

Source: OECD estimates.

75. The size of the coefficients suggests that parental leave has a positive impact on productivity in female-dominated industries, with the impact of a percentage change in paid leave around twice to three times the size of that for unpaid leave. Given that the average number of weeks of paid leave for the sample is 15 weeks and the average number of weeks of unpaid leave is 65 weeks, the marginal effect of an additional week of paid leave on productivity appears to be far greater than for an additional week of unpaid leave. However, the results for paid maternity leave are only statistically significant for MFP in the baseline specification. We re-estimate the same model for a more disaggregated sample of industries using data at a 2-digit ISIC level for 37 industries (capital stock is not available at this level of aggregation, and therefore the impact on MFP is not re-estimated), increasing the sample size and the accuracy with which industries are classified as female dominated. (For example, in the baseline analysis, wholesale and retail trade are grouped together and classified as female-dominated. In the disaggregated analysis, the industries are treated separately. Retail trade is classified as female-dominated, but not wholesale trade.) The results

(Table 6.2) show a positive and statistically significant effect of paid maternity leave on labour productivity, of a slightly larger magnitude than that shown in Table 6.1.

Table 6.2. **Effect of parental leave on labour productivity[a] – results using disaggregated data**

Results from OLS estimation of difference-in-differences model

	PML baseline linear	PML baseline log-linear	UPL baseline linear	UPL baseline log-linear
PML	0.004 [3.56]***			
Log of PML		0.048 [1.69]*		
UPL			0.001 [2.54]**	
Log of UPL				0.024 [3.00]***
Country x year dummies	yes	yes	yes	yes
Country x industry dummies	yes	yes	yes	yes
Industry x year dummies	yes	yes	yes	yes
Observations	12720	12720	12720	12720
R-squared	0.99	0.99	0.99	0.99

PML: weeks of paid maternity leave; UPL: weeks of unpaid parental leave; OLS: ordinary least squares.
Robust t-statistics in brackets. * significant at 10%; ** significant at 5%; *** significant at 1%.

a) Dependent variable is the logarithm of labour productivity. Capital stock is the logarithm of the capital-to-labour ratio. The table reports the relative effect of parental leave between female-dominated and other industries. An industry is classified as female-dominated if the proportion of women employed in that industry is higher than the proportion of women employed across the whole economy. Parental leave variables are measured in weeks. See Annex 1 for details on data and sources.

Source: OECD estimates.

76. The statistical significance of the baseline results is sensitive to changes in the countries included in the sample. To some extent, this is to be expected given that the difference-in-differences specification involves using a complete system of two-dimensional dummy variables, so the results are identified by changes in parental leave within a particular country over time. In some countries, there is very little across-time variation in parental leave variables, making it difficult to identify a result. In most cases where removing a country from the sample results in a non-significant coefficient on parental leave, the point estimates remain of a similar magnitude to the baseline results. The lack of statistical significance of these estimates could simply be due to the reduced sample size.

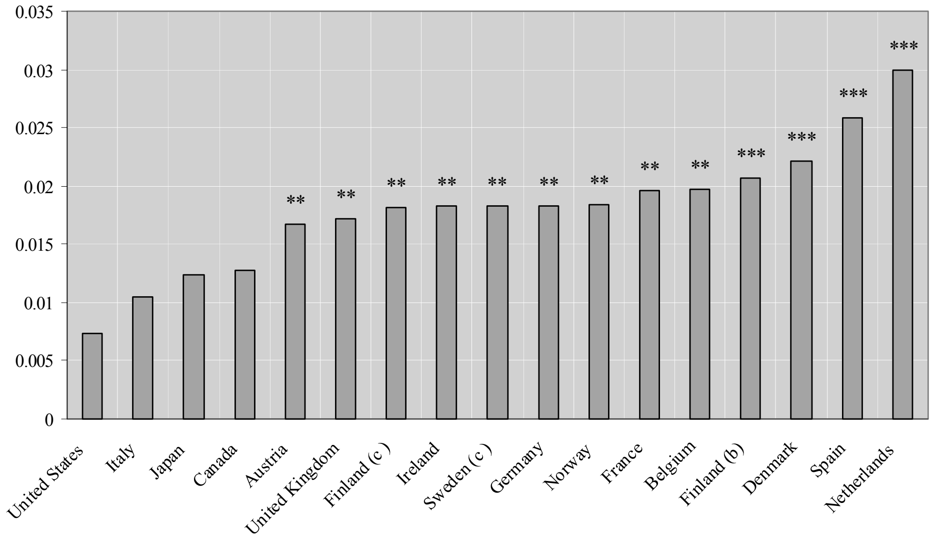
77. Of more concern is when removing a particular country from the sample results in a dramatic reduction in both the size of the estimated coefficient and its statistical significance. Removing the United States from the sample reduces the magnitude of the coefficient on unpaid parental leave by a factor of six for both labour productivity and MFP (Figure 6.1). Smaller, but still substantial, reductions in the size of the coefficients result from removing Japan, Ireland or the United Kingdom from the sample. Removing all four countries from the sample results in a very small or even negative effect of unpaid parental leave on productivity, although the results are far from being statistically significant. In all four of these countries, large increases in unpaid parental leave occurred during the sample period. In the United States, unpaid leave was increased from zero to 12 weeks in 1993; in Japan from 14 to 58 weeks in 1992; in Ireland, from 14 to 42 weeks in 1998; and in the United Kingdom from 18 to 44 weeks in 1999. However, Austria, Belgium, Denmark, Finland, France, the Netherlands, Norway and Portugal all experienced increases in the length of unpaid leave of 52 weeks or more during the sample period, so it seems unlikely that the results indicate that only large changes in the length of leave matter for productivity improvements. Instead, the sensitivity of the baseline results to the inclusion of Japan, Ireland, the United Kingdom and the United States could indicate that additional unpaid parental leave has very little impact on productivity except in countries where there is little or no paid maternity leave: at the times of

the increases in unpaid parental leave, these countries had less than 10 weeks of paid maternity leave (zero weeks in the case of the United States), compared with a sample average of more than 15 weeks.

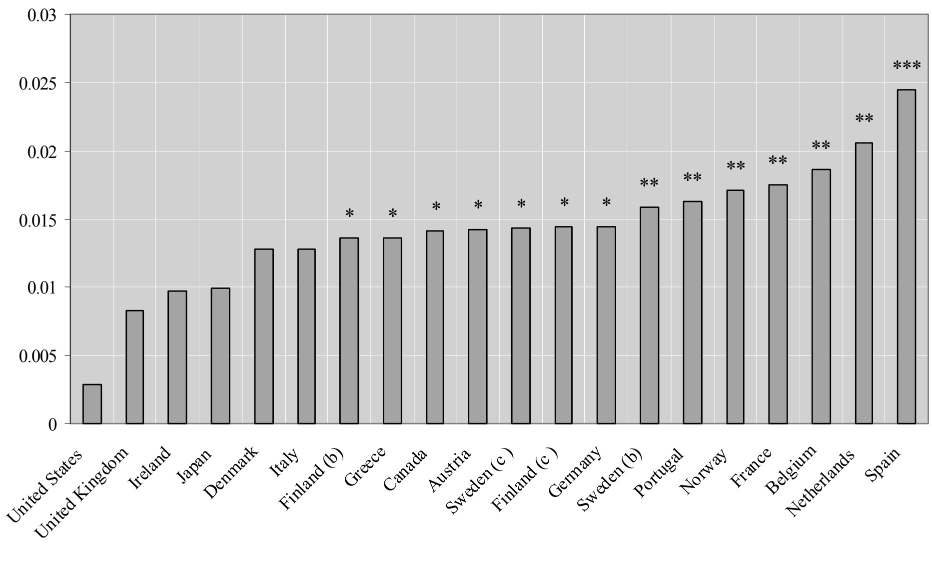
Figure 6.1. **Effect of unpaid parental leave on MFP and labour productivity[a] – sensitivity to changes in the sample of countries**

Coefficient on log of unpaid parental leave from OLS estimation of difference-in-differences models when countries are excluded one-by-one from the sample

Panel A: MFP



Panel B: Labour productivity



MFP: multi-factor productivity; OLS: ordinary least squares.
* significant at 10%; ** significant at 5%; *** significant at 1%.

a) The benchmark specifications correspond to results reported in Table 6.1, panel B, columns 2 and 5. See Annex 1 for details on data and sources.

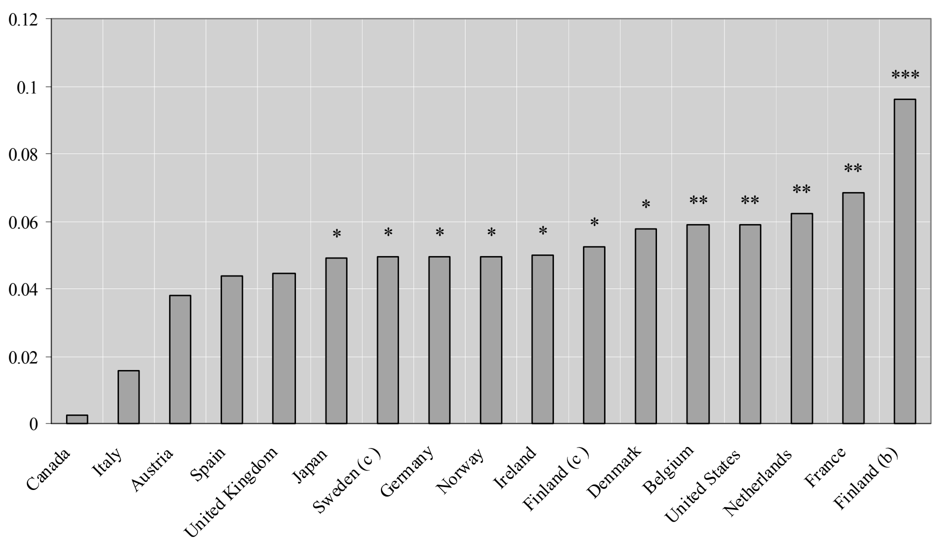
Source: OECD estimates.

78. The coefficient on the log of paid maternity leave for MFP is reduced by more than half from the baseline results (and is not statistically significant) when either Canada or Italy are removed from the sample (Figure 6.2). Canada and Italy are the only countries in the sample where the length of paid maternity leave fell over the period used in the analysis, from around 9 to 8 weeks in Canada and from 19 to 17 weeks in Italy. In fact, with these data, removing these countries from the sample might make it difficult to disentangle the effect of paid maternity leave from that of other factors driving increased female labour force participation, which over the sample period has an upward trend almost in every country.

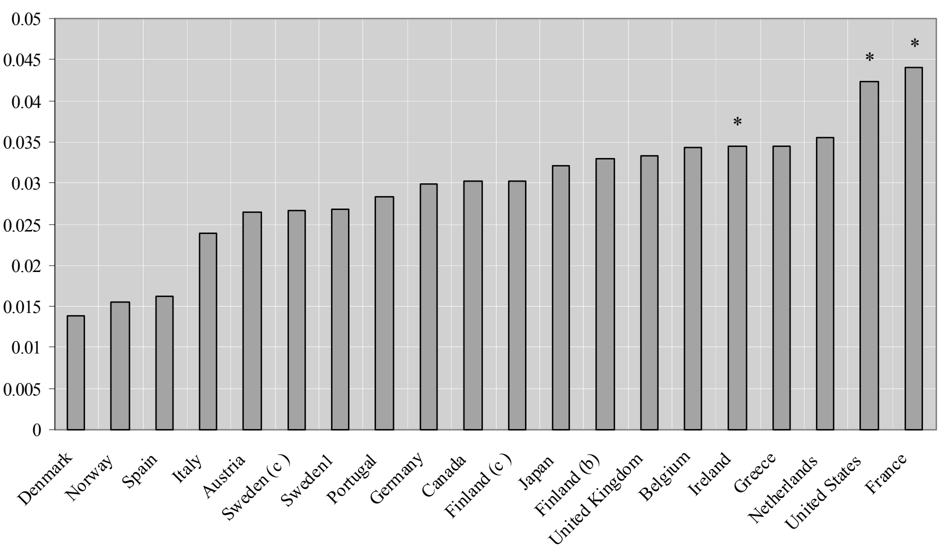
Figure 6.2. **Effect of paid maternity leave on MFP and labour productivity[a] – sensitivity to changes in the sample of countries**

Coefficient on log of paid maternity leave from OLS estimation of difference-in-differences models when countries are excluded one-by-one from the sample

Panel A: MFP



Panel B: Labour productivity



MFP: multi-factor productivity; OLS: ordinary least squares.
* significant at 10%; ** significant at 5%; *** significant at 1%.
a) The benchmark specifications correspond to results reported in Table 6.1, panel A, columns 2 and 5. See Annex 1 for details on data and sources.

Source: OECD estimates.

79. The results of the sensitivity tests above suggest the possibility that the effect of paid maternity leave on productivity could be influenced by the length of unpaid parental leave, and vice versa. These

two variables are positively, but not strongly, correlated (correlation coefficient is 0.42). We tested for a possible interaction between these two variables by augmenting the baseline specification with paid maternity leave and unpaid parental leave, and the interaction between the two variables. However, the results (not shown here) do not provide clear evidence of a relationship between the two types of leave as they are extremely sensitive to changes in the sample of countries included in the analysis.

80. It is possible that at least part of the increase in average measured productivity resulting from an increase in the length of parental leave is due to changes in the level of employment rather than changes in individual productivity. For example, if firms believe that an extension of parental leave will impose additional costs on employing parents (such as hiring and training replacement workers), they could reduce total employment, which could lead to higher productivity through the composition effects discussed in Section 1. Over the longer term, firms might substitute capital for labour in order to reduce the potential cost of parental leave, increasing the capital-to-labour ratio and raising labour productivity. To control for possible composition effects, the baseline specification is augmented by including the log of total hours worked. As discussed in Section 5, this method of controlling for employment is problematic because the coefficient of hours worked is likely to be downward biased due to endogeneity. As a result, the estimated coefficients on parental leave variables might be biased downwards. However, it provides a simple means of assessing whether composition effects due to changes in employment are likely to be important in explaining productivity changes.

81. Table 6.3 shows that higher employment is indeed associated with lower productivity. For unpaid parental leave, controlling for employment reduces the size of the coefficients (and increases the standard errors) slightly, suggesting that composition effects can account for some, but clearly not all, of the positive impact of unpaid parental leave on productivity. For paid maternity leave, controlling for employment has a more important impact on the estimated coefficients, which fall by up to half (and are statistically insignificant) compared with the baseline specification. This suggests that employment and composition effects could play an important role in explaining why paid maternity leave appears to increase productivity. However, further examination shows that this result is sensitive to the countries included in the sample: excluding either Finland (1980-1990) or France from the sample results in a positive and significant coefficient on paid maternity leave for MFP. Given the potential endogeneity of employment rates, the overall importance of composition effects in the case of paid maternity leave is unclear: some of the estimated positive impact of paid maternity leave on productivity is likely due to composition effects, with these more important in some countries than others.[23] In any case, there is no evidence that parental leave has a negative impact on productivity.

23. The results of a difference-in-difference regression with the log of total hours as the dependent variable rather than productivity (available upon request) suggest that increases in the length of paid maternity leave have a negative impact on employment in only two countries with relatively generous paid leave provisions (Denmark and Norway). Removing these countries from the sample results in a non-significant coefficient on paid maternity leave.

Table 6.3. **Effect of parental leave on MFP and labour productivity[a] – controlling for employment**

Results from OLS estimation of difference-in-differences model

	Paid maternity leave - MFP	Paid maternity leave - labour productivity	Unpaid parental leave - MFP	Unpaid parental leave - labour productivity
Log PML	0.029 [1.02]	0.015 [0.64]		
Log UPL			0.015 [1.95]*	0.012 [1.60]
Log total hours	-0.225 [6.38]***	-0.293 [9.95]***	-0.226 [6.42]***	-0.293 [9.95]***
Capital stock	0.119 [5.39]***		0.119 [5.42]***	
Observations	3611	5488	3611	5488
R-squared	1	1	1	1

MFP: multi-factor productivity; PML: weeks of paid maternity leave; UPL: weeks of unpaid parental leave; OLS: ordinary least squares.
Robust t-statistics in brackets. * significant at 10%; *** significant at 1%.

a) Dependent variable is the logarithm of labour productivity. Capital stock is the logarithm of the capital-to-labour ratio. The table reports the relative effect of parental leave between female-dominated and other industries. An industry is classified as female-dominated if the proportion of women employed in that industry is higher than the proportion of women employed across the whole economy. Parental leave variables are measured in weeks. See Annex 1 for details on data and sources.

Source: OECD estimates.

82. The baseline results assume that parental leave is the only factor that affects productivity in female-dominated industries more than in non-female-dominated industries. In reality, a range of other policy and demographic factors that influence women's labour force participation could have a similar impact on productivity as parental leave if they promote continuous labour force participation and preserve high quality job matches. We augment the baseline model with various controls for tax incentives (labour tax wedge, tax incentives for part-time work and the relative marginal tax rate for second earners), women's education level, public expenditures on childcare and other policies that are known to affect women's employment rates (product market regulation and the average unemployment benefit replacement rate).[24] Table 6.4 shows that most control variables have little effect on the size or significance of the estimated effect of unpaid parental leave on productivity. However, controlling for public expenditure on child care reduces the size (and significance) of the estimated coefficient on unpaid parental leave, in the case of labour productivity. This suggests that it is difficult to distinguish empirically between the impact of parental leave and of other family-friendly policies aimed at increasing work-attachment.

24. There are also other unobservable factors that could affect productivity in female-dominated industries more than in non-female-dominated industries, such as employer provision of family-friendly working arrangements. There is some evidence that employer provision of family-friendly working arrangements is likely to be more prevalent in female-dominated industries (Bardoel *et al.*, 1999). Therefore, its omission from the empirical specification might bias estimates of the impact of parental leave on productivity in these industries.

Table 6.4. **Effect of unpaid parental leave on MFP and labour productivity[a] – sensitivity to control variables**

Results from OLS estimation of difference-in-differences model

Panel A: MFP

	Baseline + taxes	Baseline + female education	Baseline + child care	Baseline + ARR + PMR
Log of UPL	0.023 [2.84]***	0.020 [2.73]***	0.013 [1.64]	0.015 [1.95]*
Tax wedge	0.000 [0.14]			
Tax incentives for PT work	-0.009 [3.10]***			
Rel. MTR on 2nd earners	0.008 [0.23]			
Female education		0.013 [0.60]		
Public child care expenditure			0.000 [0.30]	
ARR				0.000 [0.38]
PMR				0.006 [0.53]
Capital stock	0.23009 [9.77]***	0.19657 [9.48]***	0.23855 [9.65]***	0.1907 [9.72]***
Observations	3311	3611	3141	3727
R-squared	1	1	0.99	1

Panel B: Labour productivity

	Baseline + taxes	Baseline + female education	Baseline + child care	Baseline + ARR + PMR
Log of UPL	0.018 [2.11]**	0.017 [2.05]**	0.007 [0.82]	0.016 [2.15]**
Tax wedge	0.006 [3.34]***			
Tax incentives for PT work	-0.004 [1.29]			
Rel. MTR on 2nd earners	0.110 [2.67]***			
Female education		0.015 [1.80]*		
Public child care expenditure			0.000 [2.62]***	
ARR				0.001 [1.52]
PMR				-0.009 [0.88]
Observations	4656	5168	4368	5760
R-squared	1	1	0.99	1

MFP: multi-factor productivity; UPL: weeks of unpaid parental leave; OLS: ordinary least squares; MTR: marginal tax rate; ARR: average unemployment benefit replacement rate; PMR: product market regulation
Robust t-statistics in brackets. * significant at 10%; ** significant at 5%; *** significant at 1%.

a) Dependent variable is the logarithm of labour productivity. Capital stock is the logarithm of the capital-to-labour ratio. The table reports the relative effect of parental leave between female-dominated and other industries. An industry is classified as female-dominated if the proportion of women employed in that industry is higher than the proportion of women employed across the whole economy. Parental leave variables are measured in weeks. See Annex 1 for details on data and sources.

Source: OECD estimates.

83. Table 6.5 shows that the impact of paid maternity leave on productivity is somewhat more sensitive to the inclusion of control variables. Including controls increases the size and significance of the estimated effect of paid maternity leave on labour productivity, but, in some specifications, reduces the impact on MFP. It is possible that least part of the productivity impact of paid maternity leave on productivity operates through its effect on incentives for capital accumulation. Increases in paid maternity leave entitlements might prompt employers to invest in capital as a means of replacing workers on maternity leave, increasing the capital-to-labour ratio and labour productivity without affecting MFP. Again, these results cast some doubt on the size of the productivity impact of increases in paid maternity leave, but do not provide any evidence of a negative relationship.

Table 6.5. **Effect of paid maternity leave on MFP and labour productivity[a] – sensitivity to control variables**

Results from OLS estimation of difference-in-differences model

Panel A: MFP

	Baseline + taxes		Baseline + female education		Baseline + child care		Baseline + ARR + PMR	
Log of PML	0.028	[0.80]	0.051	[1.81]*	0.065	[1.88]*	0.044	[1.71]*
Tax wedge	-0.001	[0.37]						
Tax incentives for PT work	-0.007	[2.40]**						
Rel. MTR on 2nd earners	0.002	[0.04]						
Female education			-0.005	[0.24]				
Public child care expenditure					0.000	[0.61]		
ARR							-0.001	[0.82]
PMR							0.009	[0.83]
Capital stock	0.231	[9.75]***	0.197	[9.48]***	0.238	[9.63]***	0.190	[9.67]***
Observations	3311		3611		3141		3727	
R-squared	1		1		0.99		1	

Panel B: Labour productivity

	Baseline + taxes		Baseline + female education		Baseline + child care		Baseline + ARR + PMR	
Log of PML	0.095	[3.51]***	0.031	[1.06]	0.041	[1.52]	0.017	[0.78]
Tax wedge	0.008	[3.72]***						
Tax incentives for PT work	0.000	[0.08]						
Rel. MTR on 2nd earners	0.130	[3.08]***						
Female education			0.004	[0.40]				
Public child care expenditure					0.000	[1.91]*		
ARR							0.001	[1.53]
PMR							-0.007	[0.62]
Observations	4656		5168		4368		5760	
R-squared	1		1		0.99		1	

MFP: multi-factor productivity; PML: weeks of paid maternity leave; OLS: ordinary least squares; MTR: marginal tax rate; ARR: average unemployment benefit replacement rate; PMR: product market regulation.
Robust t-statistics in brackets. * significant at 10%; ** significant at 5%; *** significant at 1%.

a) Dependent variable is the logarithm of labour productivity. Capital stock is the logarithm of the capital-to-labour ratio. The table reports the relative effect of parental leave between female-dominated and other industries. An industry is classified as female-dominated if the proportion of women employed in that industry is higher than the proportion of women employed across the whole economy. Parental leave variables are measured in weeks. See Annex 1 for details on data and sources.

Source: OECD estimates.

84. We estimate the overall impact of parental leave on productivity from the baseline results by multiplying the estimated coefficient on parental leave by the share of female-dominated industries in total GDP in 1999, averaged over the countries included in the sample. In aggregate terms, an increase of one week in the length of available leave is associated with an increase in aggregate labour productivity and MFP of up to 0.01 percentage points for unpaid parental leave and up to 0.07 percentage points for paid maternity leave. However, as mentioned earlier, the statistical significance of the estimates (particularly for paid maternity leave) is sensitive to the sample used and the inclusion of control variables.

7. Unemployment benefits

Previous research

85. There are a number of channels through which unemployment benefits could affect productivity. First, generous unemployment benefits have been shown to reduce employment rates (see *e.g.* OECD, 2006a) so could have a positive effect on productivity through their effect on employment. In particular, by increasing the reservation wage, generous unemployment insurance tends to price low-productivity workers out of jobs in imperfect labour markets (Lagos, 2006), increasing the average productivity level of the workforce.

86. Second, generous unemployment benefits (in terms of duration, replacement rate or both) may provide a buffer of time and resources to allow the unemployed to find a job that suits their skills and experience, resulting in higher quality matches between the unemployed and available job vacancies (Marimon and Zilibotti, 1999). Higher quality job matches should increase productivity levels as resources are used more efficiently. If higher quality job matches last longer, there could also be an impact on human capital accumulation. For example, workers with longer tenure might be more likely to receive training from their employer, or have greater incentives to themselves invest in training.

87. Furthermore, it is possible that the provision of generous unemployment benefits also encourages the creation of higher productivity jobs (Acemoglu and Shimer, 1999, 2000). Higher productivity jobs might carry with them a higher risk of layoff if they tend to be in more volatile innovative activities or require workers with more specific skills so carry greater risk of job mismatch. If this is the case, in the absence of unemployment benefits, the unemployed will have an incentive to apply for low productivity jobs with a corresponding low risk of future layoff and firms will find it more difficult to fill higher productivity positions. To the extent that opening a vacancy is costly, fewer vacancies in these positions will be opened. In this context, generous unemployment benefits could allow the unemployed to risk future layoff by taking a higher productivity job (and also increase the quality of matches), knowing that if they were laid off they would be supported by a safety net. Firms might therefore be more likely to offer such jobs, increasing the share of high productivity jobs and the aggregate level of productivity.

88. Unemployment benefits could also have some adverse effects on productivity. It is well-established that generous unemployment benefits can increase the duration of unemployment spells and the overall level of unemployment (see OECD, 2006a, for a survey of recent literature). This could have a negative impact on productivity through inefficient use of resources and depreciation of human capital during long spells of unemployment. In addition, by reducing the opportunity cost of unemployment, generous unemployment benefits could encourage existing employees to reduce their work effort, thereby lowering productivity (see *e.g.* Shapiro and Stiglitz, 1984; Albrecht and Vroman, 1996).

89. Given the range of possible impacts of unemployment benefits on productivity, the net effect is, *a priori*, ambiguous. In addition, since more generous unemployment benefits are associated with lower aggregate employment rates, the overall effect of higher unemployment benefits on living standards (as measured by growth of GDP per capita) will be negative unless a positive productivity effect compensates fully for the negative employment effect. Using a long time-series of data on unemployment benefit replacement rates, OECD (2007a) finds that the net impact of more generous unemployment benefits on the level of GDP per capita is negligible. These results suggest that any negative impact of unemployment benefits on employment is offset fully by a net positive impact of unemployment benefits on average measured productivity. Of course, at least some of the observed higher productivity associated with more generous unemployment benefits is likely to be the result of the composition effect of lower employment. However, the long-run elasticity of GDP per capita to changes in benefit generosity appears to be much smaller than the corresponding elasticity of the employment rate, cautiously suggesting that the generosity

of unemployment benefits is likely to have a positive effect on productivity, over and above composition effects.

Data and methods

90. This section tentatively applies the difference-in-differences methodology described in Section 2 to examine one of the channels through which unemployment benefits might affect productivity: the creation of higher productivity, higher risk jobs. The analysis is based on the (somewhat restrictive) assumptions that high-risk/high-productivity jobs are more likely to be created in risky industries and that the effects of unemployment benefits on productivity through other channels affect both risky and non-risky industries equally. Under these assumptions, the difference between changes in productivity in risky and non-risky industries can be modelled as a function of unemployment benefits. Unfortunately, the difference-in-differences technique does not lend itself to examining whether unemployment benefits are associated with better quality job matches: it is hard to conceive of a reason why job match quality should matter more for productivity in some industries than others. The analysis in this section is therefore more limited in its usefulness for explaining productivity than the other analyses in this paper, but nevertheless provides some evidence on one of the potential channels of influence.

91. Unemployment benefits are measured by an average of gross replacement rates across various earnings levels, family situations and durations of unemployment. The estimation uses a sample of 18 OECD countries over the years from 1979 to 2003. The sample includes Austria, Belgium, Canada, Germany, Denmark, Spain, Finland, France, the United Kingdom, Greece, Ireland, Italy, Japan, the Netherlands, Norway, Portugal, Sweden and the USA.[25] Due to data availability, not all years or industries are included in the estimation sample for MFP for every country (See Annex 1 for details on data and sources). Descriptive statistics for all the variables used in the analysis can be found in Annex 2.

92. Risky industries are industries where new jobs are more likely to be destroyed. Intuitively risky industries should be characterised by high job creation and high job-destruction of newly created jobs. It is possible to proxy this concept by looking at job creation by entering firms and job destruction due to exit of recently entered firms, both obtained from the OECD firm-level database. An industry can be considered to be riskier the higher the employment share of its firms that only survive one year in total industry employment, or, which is the same, where the job creation rate due to entrant firms that do not survive one year is higher. For the purpose of the econometric analysis, we construct a dummy variable for risky industries based on this indicator. The dummy variable takes value one when the share of firms that only survive for one year in total employment is above the average for all industries and zero otherwise. The indicator is calculated as an average across countries for the years 1977-2000 using firm-level data for Denmark, France, Germany (1993 and later), Italy, the Netherlands, Portugal, the United Kingdom and the United States.

93. Our risky industry indicator has the disadvantage of not considering job creation and destruction in incumbent firms. Alternative measure of "riskiness" can be constructed using standard job turnover data (computed using a methodology similar to Davis, Haltiwanger and Schuh, 1996). However, they have the disadvantage that they do not track destruction of newly created jobs. For instance, it is clear that an indicator of turnover would not serve the purpose, as fast but steadily expanding or contracting industries can have high turnover without necessarily being high-risk industries. Indicators of excess job turnover, although more appropriate, suffer from the same problem whenever industries are composed of many sub-industries, some of which might be steadily growing or contracting. Nevertheless, we test the sensitivity of the baseline results by using a measure of excess job turnover for the United States, where

25. Canadian data on average replacement rates refer only to the Province of Ontario. Yet, eliminating Canada from the sample has very little impact on the baseline results (see Figure 7.1).

risky industries are defined as those with excess job turnover rates above the average for all industries. The results (not reported) are almost identical to the baseline results reported in the next section.

94. The estimation is complicated by the interaction between unemployment benefits and job tenure: more generous unemployment benefits are associated with matches that last longer and therefore longer job tenure. However, risky industries are likely to have shorter job tenure than non-risky industries. Although it is not obvious whether, as a result of more generous unemployment benefits, longer-living tenure matches will occur more frequently in industries characterised by high or low tenure, it is clear this effect might act as a confounding factor. In order to control for it, the interaction between the industry average of years of tenure and the average replacement rate is included as a control in all specifications.

Results

95. We undertake a model selection exercise to establish the most suitable baseline specification (see Table 7.1). For MFP, the results clearly favour a model including only a level effect – the coefficient on the growth effect is not significant either alone or when combined with the level effect. For labour productivity, the results are not clear cut. The coefficient on the growth effect is small, but statistically significant, in both specifications where it is used.

Table 7.1. **Effect of unemployment benefits on MFP and labour productivity[a] – baseline and model selection**

Results from OLS estimation of difference-in-differences models

	MFP with level effect		MFP with growth effect		MFP with level and growth effect		Labour productivity with level effect		Labour productivity with growth level		Labour productivity with level and growth effect	
Level effect of ARR	0.003	[4.72]***			0.003	[4.61]***	0.007	[9.78]***			0.007	[10.02]***
Growth effect of ARR			0.000	[0.11]	0.000	[0.61]			0.000	[2.94]***	0.000	[3.64]***
Capital stock	0.191	[11.25]***	0.196	[11.46]***	0.191	[11.24]***						
Country x year dummies	yes		yes		yes		yes		yes		yes	
Country x industry dummies	yes		yes		yes		yes		yes		yes	
Industry x year dummies	yes		yes		yes		yes		yes		yes	
Observations	4584		4584		4584		6880		6880		6880	
R-squared	1		1		1		1		1		1	

MFP: multi-factor productivity; ARR: average replacement rate; OLS: ordinary least squares.
Robust t-statistics in brackets. *** significant at 1%.

a) Dependent variable is the logarithm of labour productivity. Capital stock is the logarithm of the capital-to-labour ratio. The table reports the relative effect of unemployment benefits between risky and other industries. Risky industries are defined as those whose share of firms that only survive for one year in total employment is above the average for all industries. All specifications include the interaction between ARR and average industry tenure. See Annex 1 for details on data and sources.

Source: OECD estimates.

96. In order to further examine whether unemployment benefits are likely to have a growth or level effect on productivity in risky industries, the baseline model for labour productivity is re-estimated using a more disaggregated measure of risky industries. This increases the sample size from 16 to 22 industries. Unfortunately, capital stock data are not available at this level of aggregation, so re-estimating the results for MFP is not possible. Table 7.2 shows that the results for labour productivity are broadly consistent with the baseline results. The coefficients on the level effect of unemployment benefits are slightly smaller, but still statistically significant. There appears to be no statistically significant effect of unemployment benefits on labour productivity growth using this specification. Therefore, the baseline specification used in the remainder of this section includes only a level effect.

Table 7.2. **Effect of unemployment benefits on labour productivity[a] – disaggregated results**

Results from OLS estimation of difference-in-differences models

	Labour productivity with level effect		Labour productivity with growth level		Labour productivity with level and growth effect	
Level effect of ARR	0.004	[4.93]***			0.005	[5.17]***
Growth effect of ARR			0.000	[0.22]	0.000	[0.18]
Country x year dummies	yes		yes		yes	
Country x industry dummies	yes		yes		yes	
Industry x year dummies	yes		yes		yes	
Observations	9458		9453		9453	
R-squared	0.99		0.99		0.99	

ARR: average replacement rate; OLS: ordinary least squares.
Robust t-statistics in brackets. *** significant at 1%.

a) Dependent variable is the logarithm of labour productivity. Capital stock is the logarithm of the capital-to-labour ratio. The table reports the relative effect of unemployment benefits between risky and other industries. Risky industries are defined as those whose share of firms that only survive for one year in total employment is above the average for all industries. All specifications include the interaction between ARR and average industry tenure. See Annex 1 for details on data and sources.

Source: OECD estimates.

97. As discussed in the previous section, the baseline results include a control for employment tenure. As a sensitivity test, we derive a stratified mean-group estimator: the sample is broken into three groups of industries on the basis of similar average tenure (excluding industries with too extreme values for average tenure); after checking that productivity comparisons within each group are not dependent on the interaction between average tenure and average replacement rates, a separate estimate is obtained for each group; the overall effect is derived by averaging group-specific estimates. The results, shown in Table 7.3, are similar to the baseline results that include a control for tenure.

Table 7.3. **Average effect of unemployment benefits on MFP and labour productivity[a] – groups based on tenure**

Results from mean group estimation of difference-in-differences models

	MFP		Labour productivity	
Average replacement rate	0.004	[4.67]***	0.006	[7.47]***
Country x year dummies	yes		yes	
Country x sector dummies	yes		yes	
Sector x year dummies	yes		yes	
Observations	3259		5160	
R-squared	1		1	

MFP: multi-factor productivity.
Robust t-statistics in brackets. *** significant at 1%.

a) Dependent variable is the logarithm of labour productivity. Capital stock is the logarithm of the capital-to-labour ratio and is included as a control in the MFP estimation. The table reports the relative effect of unemployment benefits between risky and other industries. Risky industries are defined as those whose share of firms that only survive for one year in total employment is above the average for all industries. Only industries with cross-country/cross-time average tenure comprised between 9 and 12 years are included. Industries are divided in three groups according to tenure: 9 to 10 years; 10 to 11 years; and 11 to 12 years. Only average effects of ARR are shown. See Annex 1 for details on data and sources.

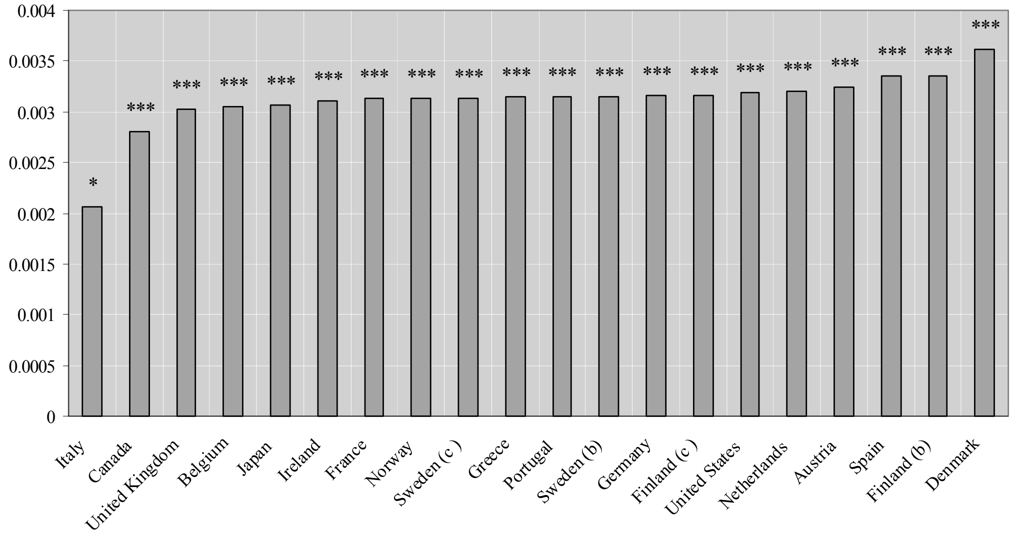
Source: OECD estimates.

98. The baseline results are robust to changes in the countries included in the sample. Figure 7.1 shows that the coefficient on the average replacement rate remains positive and statistically significant when countries are removed one-by-one from the sample.

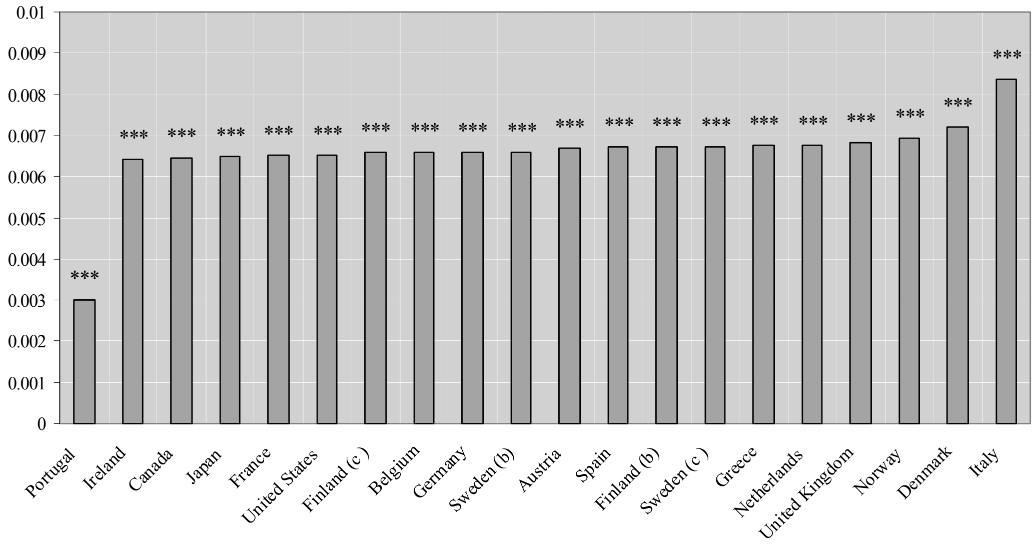
Figure 7.1. **Effect of unemployment benefits on MFP and labour productivity[a] – sensitivity to changes in countries in the sample**

Coefficient on ARR from OLS estimation of difference-in-differences models when countries are excluded one-by-one from the sample

Panel A: MFP



Panel B: Labour productivity



MFP: multi-factor productivity; ARR: average replacement rate; OLS: ordinary least squares.
* significant at 10%; *** significant at 1%.

a) The benchmark specifications correspond to results reported in Table 7.1, columns 1 and 4. See Annex 1 for details on data and sources.

Source: OECD estimates.

99. It is possible that all or some of the observed positive impact of unemployment benefits on productivity is due to a composition effect: generous unemployment benefits may lead to lower employment, reducing measured average productivity by reducing the proportion of unskilled workers employed, increasing the proportion of labour intensive industries or due to diminishing returns to labour inputs. In order to test the importance of composition effects in explaining the baseline results, we augment the baseline specification with a control for the log of total hours worked. As discussed in Section 5, this could bias the estimated impact of unemployment benefits on productivity downwards due to possible endogeneity. The results (Table 7.4) indicate that the composition effect plays little role in explaining the productivity impact of unemployment benefits. The coefficients on unemployment benefits for both MFP and labour productivity are very similar to the baseline results.

Table 7.4. **Effect of unemployment benefits on MFP and labour productivity[a] – controlling for employment**

Results from OLS estimation of difference-in-differences models

	MFP		Labour productivity	
Average replacement rate	0.003	[3.94]***	0.006	[9.28]***
ARR*average tenure	0.001	[3.27]***	0.001	[5.60]***
Log of total hours	-0.200	[6.83]***	-0.249	[10.24]***
Capital stock	0.127	[6.99]***		
Observations	4584		6880	
R-squared	1		1	

ARR: average replacement rate; OLS: ordinary least squares.
Robust t-statistics in brackets. *** significant at 1%.

a) Dependent variable is the logarithm of labour productivity. Capital stock is the logarithm of the capital-to-labour ratio. The table reports the relative effect of unemployment benefits between risky and other industries. Risky industries are defined as those whose share of firms that only survive for one year in total employment is above the average for all industries. All specifications include the interaction between ARR and average industry tenure. See Annex 1 for details on data and sources.

Source: OECD estimates.

100. We also test the sensitivity of the baseline results to the assumption that unemployment benefits are the only factor that influence productivity more in risky industries than in non-risky industries by including a number of relevant control variables. Table 7.5 shows that including other variables that are correlated with unemployment benefits (such as EPL, product market regulation or the tax wedge) interacted with the dummy for risky industries has very little impact on the baseline estimates for both MFP and labour productivity.

Table 7.5. **Effect of unemployment benefits on MFP and labour productivity[a] – sensitivity to controls**

Results from OLS estimation of difference-in-differences models

Panel A: MFP

	Baseline + EPL	Baseline + PMR	Baseline + tax wedge	Baseline + PMR + tax wedge
Average replacement rate	0.003 [4.66]***	0.003 [4.24]***	0.003 [4.52]***	0.003 [3.95]***
EPL	0.015 [1.27]			
PMR		0.021 [2.47]**		0.022 [2.66]***
Tax wedge			0.000 [0.28]	-0.001 [0.72]
Capital stock	0.2193 [11.45]***	0.1913 [11.29]***	0.192 [11.30]***	0.192 [11.35]***
Observations	4168	4584	4584	4584
R-squared	1	1	1	1

Panel B: Labour productivity

	Baseline + EPL	Baseline + PMR	Baseline + tax wedge	Baseline + PMR + tax wedge
Average replacement rate	0.005 [6.46]***	0.007 [9.85]***	0.007 [10.02]***	0.007 [10.26]***
EPL	-0.002 [0.17]			
PMR		-0.006 [0.80]		-0.016 [1.91]*
Tax wedge			0.002 [2.27]**	0.003 [2.69]***
Observations	6064	6880	6880	6880
R-squared	1	1	1	1

ARR: average replacement rate; OLS: ordinary least squares.
Robust t-statistics in brackets. * significant at 10%; ** significant at 5%; *** significant at 1%.

a) Dependent variable is the logarithm of labour productivity. Capital stock is the logarithm of the capital-to-labour ratio. The table reports the relative effect of unemployment benefits between risky and other industries. Risky industries are defined as those whose share of firms that only survive for one year in total employment is above the average for all industries. All specifications include the interaction between ARR and average industry tenure. See Annex 1 for details on data and sources.

Source: OECD estimates.

8. Conclusions

101. This paper presents a general framework for estimating the aggregate impact of labour market policies and institutions on productivity using industry-level data. The key identification assumption used in the paper is that certain policies, defined at the aggregate level, are likely to affect productivity more in industries where they are more binding than in other industries. Subject to this assumption, we develop a simple difference-in-differences methodology, which allows us to identify the effect of policies by relating differential changes in productivity across industries, countries and time to changes in the relevant policy variables. Cross-country productivity data are easily available at the industry level so this method allows us to control for aggregate confounding factors that, on average, are likely to have a similar impact on productivity in policy-binding and other industries, while at the same time fully exploiting the institutional and policy variety available in cross-country data. For this reason, this framework appears to be an improvement over cross-country macroeconometric regressions and complements existing microeconometric analyses. Yet, the validity of inferences made using this method relies on the validity of the identification assumption. In particular, the identification of an appropriate classification for policy-binding industries and the robustness of estimates to changes in the classification should be subjected to close scrutiny.

102. The four applications presented in this paper go some way to filling a gap in the literature regarding the relationship between labour market policies and productivity. The clearest result emerging from the analysis is that strict statutory employment protection for regular contracts appears to dampen productivity growth, most likely by restricting the movement of labour into emerging, high-productivity activities, firms or industries. However, it is not clear whether partial reforms to EPL, whereby rules on temporary contracts are relaxed while leaving EPL on regular contracts unchanged, would have any impact on productivity.

103. Results for other policies are more tentative and/or the policy implications of these findings are less clear. For example, while higher minimum wages appear to be associated with higher average productivity levels, it is unclear to what extent this reflects improved incentives to invest in training or substitution of skilled for unskilled workers. Parental leave also appears to increase average productivity but these results are somewhat sensitive to the empirical specification used and at least some of the productivity impact of parental leave in some countries can be explained by composition effects. Generous unemployment benefits are associated with higher productivity in risky industries, but policy implications can be derived from this finding only based on restrictive assumptions. In addition, other possible productivity impacts of unemployment benefits, such as their impact on job match quality, could not be assessed using the difference-in-differences framework.

ANNEX 1: DATA SOURCES

Labour productivity

Definition: value added in volume terms (base 100 in 2000) divided by the product of average hours worked and total persons engaged.

Source: OECD calculation using Groningen Growth and Development Centre 60-Industry database.

Gross fixed capital formation

Definition: gross fixed capital formation in volume terms.

Source: OECD STAN database (current and previous editions).

Capital stock

Definition: gross capital stock in volume terms.

Source: OECD STAN database (current and previous editions).

Data adjustments: For countries, for which the capital stock was not available or industry coverage was insufficient, capital stocks were reconstructed from gross fixed capital formation using a perpetual inventory method. The iterative process is described below.

STEP 1: For each industry-by-country combination (including countries with non-missing data) it is assumed that $K_t = I_t + (1-d)K_{t-1}$, where K is the estimate of capital stock to be constructed, I is gross fixed capital formation and d is depreciation. This assumption implies that the capital-to-labour ratio k can be written as a function of the investment-to-labour ratio i, the growth rate of employment g_E, the depreciation rate, and the lagged value of the capital-to-labour ratio, that is: $k_t = i_t + ((1-d)/(1+g_{Et}))k_{t-1}$. In the first year, the capital-labour ratio and the investment-to-labour ratio are assumed to be in the steady state and growing at the same rate. Therefore, the capital-to-labour ratio in the first year can be written as $k_0 = (1+g_E^*)i_1/((1+g_E^*)g_I^* + d)$, where g_I, is the growth rate of the investment-to-labour ratio and * stands for steady-state values. Steady-state growth rates of the investment-to-labour ratio and employment are computed from country-by-industry averages of investment-to-labour ratio and employment growth over the sample period. Five-year moving averages are used for start and end values in order to smooth the weight of possible outliers in start and end dates. As depreciation rates are unknown, for each industry, a grid of depreciation rates is considered (covering all possible depreciation rates from 0.5% to 10%, with an increment of 0.5%). This step produces therefore 20 possible series of the capital-to-labour ratio.

STEP 2: For countries with non-missing data for capital stock, the growth rate of the observed values was regressed on the growth rate of the step 1 measures without the constant.

STEP 3: The “best” step 1 measure for each industry is selected as the one whose step 2 estimated coefficient is closest to 1, thereby more closely resembling observed series of the capital-to-labour ratio. The distance between each estimated coefficient and 1 is measured by the mean absolute deviation from 1.

STEP 4: The capital-to-labour ratios in the first year are divided by the step 2 estimated coefficient of the selected best measure, thereby increasing all initial values if the coefficient is smaller than one and decreasing them if it is greater than one.

STEP 5: New series of capital-to-labour ratios are obtained from new starting values using the formula $k_t = i_t + ((1-d)/(1+g_{Et}))k_{t-1}$ and the same grid as before for depreciation rates.

Steps from 2 to 5 are then repeated until the estimated error on growth rates for the best measures becomes smaller than 0.1% – after 50 iterations, convergence is not attained only in the case of one industry (hotels and restaurants); no measure was therefore constructed for that industry. At that point the best measure of the capital-to-labour ratio is retained for countries for which the capital stock was not available or industry coverage was insufficient. However, its first five years are dropped, in order to reduce sensitivity to potential errors in starting values. Additionally, gross fixed capital formation in the Energy industry was set to missing before 1984 to reduce the influence of the second oil shock.

As a check on the quality of the procedure one can look at derived depreciation rates by industry, which indeed look plausible (Table A1.1).

Table A1.1. **Estimated capital stock depreciation rates**

Estimates of depreciation rates by industry obtained through the iterative procedure used to reconstruct missing capital stocks

ISIC Rev. 3	Description	Depreciation (%)
15-16	Food products, beverages and tobacco manufacturing	4.5
17-19	Textiles, textile products, leather and footwear manufacturing	5
20	Wood and wood/cork products manufacturing	2.5
21-22	Pulp, paper and paper products manufacturing, printing and publishing	4
23-25	Chemical, rubber, plastics and fuel products manufacturing	2.5
26	Other non-metallic minerals manufacturing	3.5
27-28	Basic metals and fabricated metal products manufacturing	2.5
29-33	Machinery and equipment manufacturing	2.5
34-35	Transport equipment manufacturing	3
36-37	Manufacturing not elsewhere classified	2.5
40-41	Electricity, gas and water supply	1
45	Construction	3.5
50-52	Wholesale and retail trade and repairs	7.5
55	Hotels and restaurants	n.a.
60-64	Transport, storage and communications services	3
65-67	Financial intermediation	7.5

n.a.: not available.

Source: OECD estimates.

EPL for regular contracts

Definition: OECD summary indicator of the stringency of employment protection legislation on regular contracts.

Source: OECD (2004), OECD Employment Outlook.

EPL for temporary contracts

Definition: OECD summary indicator of restrictions on the use of temporary contracts by firms.

Source: OECD (2004), OECD Employment Outlook.

EPL total

Definition: OECD summary indicator of the stringency of employment protection legislation incorporating both regular contracts and temporary work.

Source: OECD (2004), OECD Employment Outlook.

Average unemployment benefit replacement rate

Definition: average unemployment benefit replacement rate across two income situations (100% and 67% of APW earnings), three family situations (single, with dependent spouse, with spouse in work) and three different unemployment durations (first year, second and third years, and fourth and fifth years of unemployment).

Source: OECD Benefits and Wages database.

Data adjustments: original data are available only for odd years. Data for even years are obtained by linear interpolation.

Product market regulation

Definition: OECD summary indicator of regulatory impediments to product market competition in seven non-manufacturing industries. The data used in this paper cover regulations and market conditions in seven energy and service industries: gas, electricity, post, telecommunications (mobile and fixed services), passenger air transport, railways (passenger and freight services) and road freight.

Source: Conway *et al.* (2006).

Data adjustments: Following Bassanini and Duval (2006), data are assumed to be constant between 1970 and 1974.

Employment

Definition: total persons engaged.

Source: OECD calculation using Groningen Growth and Development Centre 60-Industry database.

Total hours worked

Definition: product of average hours worked and total persons engaged.

Source: OECD calculation using Groningen Growth and Development Centre 60-Industry database.

Tax wedge

Definition: tax wedge between the labour cost to the employment and the corresponding net take-home pay of the employee for a single-earner couple with two children earning 100% of average production workers earnings. The tax wedge expressed the sum of personal income tax and all social security contributions as a percentage of total labour cost.

Source: OECD, Taxing Wages.

Data adjustments: Austria: original data include employers' social security contributions starting from 1997 only, thereby inducing an upward shift in tax wedge from this year; the tax wedge starting from 1997 is therefore recalculated based on the fact that employers' contribution rates to social security remained unchanged between 1996 and 1997. Netherlands: unlike other years, in 2002 and 2003 APW earnings are just above the threshold beyond which employers and employees no longer have to contribute to the national health insurance plan (private medical insurance is typically provided instead), thereby inducing a temporary decline in tax wedge; this issue is addressed by replacing the 2002 and 2003 observations by data obtained by linear interpolation between the 2001 and 2004 observations.

Output gap

Definition: OECD measure of the gap between actual and potential output as a percentage of potential output.

Source: OECD Economic Outlook database.

Ratio of statutory minimum wage to median wage

Definition: Ratio of statutory minimum wage to median wage, in percent.

Source: OECD Minimum Wages database.

Real minimum wage

Definition: Minimum wage in 2000 US dollars PPP.

Source: OECD Minimum Wages database.

Weeks of unpaid parental leave

Definition: maximum number of leave weeks that can be taken by a mother for the birth of a first child as maternity leave, parental leave and childcare leave. Focus is on the most generous provisions that can be obtained, even though these may not apply to all women depending on their employment history or income. Only leave provided under national legislation is used (variations in schemes by region, province, länder, or caton are not included).

Source: Gauthier and Bortnik (2001).

Weeks of paid maternity leave

Definition: maximum number of paid leave weeks that can be taken by a mother for the birth of a first child as maternity leave or parental leave. Focus is on the most generous provisions that can be obtained, even though these may not apply to all women depending on their employment history or income. Only leave provided under national legislation is used (variations in schemes by region, province, länder, or caton are not included). Does not include lump-sum benefits paid upon birth of a child where these are not connected to a maternity leave scheme.

Source: Gauthier and Bortnik (2001).

Data adjustments: calculated by multiplying weeks of unpaid maternity leave by the maternity leave replacement rate. Where cash benefits are paid as flat-rate benefits, they were converted into a percentage using data on the average female wage in manufacturing and the average female hours worked in manufacturing published in the ILO Yearbook of Labour Statistics.

Tax incentives for part-time work

Definition: increase in household disposable income between a situation where the husband earns the entire household income (133% of average production worker earnings) and a situation where husband and wife share earnings (100% and 33% of average production worker earnings respectively) for a couple with two children. Denoting the first scenario by A and the second by B, the calculation is:

$$Tax\, incentives\, to\, part-time = \frac{(Household\, net\, income)_A - (Household\, net\, income)_B}{(Household\, net\, income)_A}$$

Source: OECD calculations based on OECD tax models.

Data adjustments: as this series began after 1980 for some countries, missing data prior to the first observation were replaced with the value of the variable in the first year it was available.

Public expenditure on child-care

Definition: public spending on formal day care and pre-primary school per child in 1995 PPP-USD. Data on formal day care do not include tax expenditures (*i.e.* tax allowances and tax credits for child-care expenses) unless they are refundable. Spending on pre-primary school includes both direct and indirect – *i.e.* transfers and payments to private entities – expenditure.

Source: the main sources for formal day care and pre-primary school spending are the OECD Social Expenditures database and the OECD Education database respectively. The target population of children for formal day care and pre-primary school is calculated using data on age of entry to primary school from the UNESCO Statistical Yearbook (various years) and data on the number of children by age category from national sources for EU countries and from the United Nations World Population Prospects 1950-2050 (the 2000 revisions, February 2001) for other countries.

Data adjustments: country-specific details are provided in Jaumotte (2004) In addition, as this series began after 1980 for some countries, missing data were extrapolated from existing data using the average growth rate of expenditures on child-care for each country over the period for which data were available.

Relative marginal tax rates on second earners

Definition: ratio of the marginal tax rate on the second earner to the tax wedge for a single-earner couple with two children earning 100% of APW earnings (see definition of the "labour tax wedge" above). The marginal tax rate on the second earner is in turn defined as the share of the wife's earnings which goes into paying additional household taxes:

$$Tax\,2nd\,earner = 1 - \frac{(Household\ Net\ Income)_B - (Household\ Net\ Income)_A}{(Household\ Gross\ Income)_B - (Household\ Gross\ Income)_A}$$

where A denotes the situation in which the wife does not earn any income and B denotes the situation in which the wife's gross earnings are X%of APW. Two different tax rates are calculated, depending on whether the wife is assumed to work full-time (X = 67%) or part-time (X = 33%). In all cases it is assumed that the husband earns 100% of APW and that the couple has two children. The difference between gross and net income includes income taxes, employee's social security contribution, and universal cash benefits. Means-tested benefits based on household income are not included (apart from some child benefits that vary with income) due to lack of time-series information. However, such benefits are usually less relevant at levels of household income above 100% of APW.

Source: OECD calculations based on OECD tax models.

Data adjustments: as this series began after 1980 for some countries, missing data prior to the first observation were replaced with the value of the variable in the first year it was available.

Female education

Definition: number of years of education of female population aged 25 years and over.

Source: Barro and Lee (2000).

Industry layoff rate

Definition: employed persons laid off as a result of the plant or company closing down or moving, insufficient work or their position or shift being abolished as a proportion of total employment in each industry. Data refer to the United States, from 2001 to 2003.

Source: OECD calculations based on January 2004 US Current Population Survey and Displaced Worker Supplement and OECD STAN database.

Data adjustments: layoffs calculated for each of the years 2001, 2002 and 2003. Total employment for each year is estimated for January 2004 from CPS and deflated by employment growth rate between 2004 and each year. Employment growth rates are calculated using STAN database and refer to dependent employment.

Average job turnover rate

Definition: Average gross job turnover rate aggregated from establishment level data (assuming, for continuous firms, that net employment changes are equal to gross employment changes). Data refer to the United States, from 1990 to 1996.

Source: Haltiwanger *et al.* (2006).

Average excess job turnover rate

Definition: difference between the average gross job turnover rate and the absolute value of the difference between job creation and job destruction rates. Data are aggregated from establishment level data (assuming, for continuous firms, that net employment changes are equal to gross employment changes). Data refer to the United States, from 1990 to 1996.

Source: Haltiwanger *et al.* (2006).

Share of low-wage workers

Definition: UK share of wage and salary employees working at least 30 hours per week with gross monthly wages less than two-thirds of the median wage in total workers, averaged over 1994-99.

Source: British Household Panel Survey module of the European Community Household Panel.

Employment share of entering firms surviving for only one year

Definition: proportion of total employment in new firms in a given year that exit that same year. This is equal to the product of the ratio of employment in entering firms to total employment and the ratio of employment of firms that do not survive until the following year to total employment in entering firms, that is:

$$Share\ of\ \ Entrants = Job\ Creation\ Rate\left(1-\frac{Employment\ of\ \ survivors}{Employment\ of\ \ All\ Entrants}\right)$$

Source: OECD calculations from the OECD Firm-Level database.

Data adjustments: equal to employment in entry firms that last one year only, divided by total employment. Calculated as an average across countries and years using firm-level data from Germany (1993-2000), Denmark, France, UK, Italy, the Netherlands, Portugal and the United States for the years 1977-2000.

Proportion of female employment

Definition: proportion of women in total employment by industry.

Source: OECD calculations based on data from the European Union Labour Force Survey from 1995 to 2002.

Data adjustments: total employment of women divided by total employment averaged over years for each country and then over countries for each industry. The countries included in the sample are Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, the Netherlands, Norway, Portugal, Spain, Switzerland, Sweden and the United Kingdom.

ANNEX 2: DESCRIPTIVE STATISTICS

Table A2.1. **Descriptive statistics – EPL**

	Labour productivity sample					MFP sample				
	N	Mean	SD	Min.	Max.	N	Mean	SD	Min.	Max.
Log labour productivity	6064	-3.15	1.54	-6.06	3.37	4168	-3.17	1.32	-5.62	2.82
Log capital stock	-	-	-	-	-	4168	-3.21	2.24	-6.76	4.85
EPL on regular contracts	6064	2.23	1.00	0.17	5.00	4168	2.07	0.90	0.17	4.33
EPL on temporary contracts	6064	2.39	1.56	0.25	5.38	4168	2.30	1.54	0.25	5.38
EPL (overall)	6064	2.31	1.10	0.20	4.19	4168	2.19	1.04	0.20	3.80
Average replacement rate	6064	29.09	13.98	0.35	64.94	4168	30.49	14.54	0.35	64.94
Product market regulation	6064	3.96	1.33	1.05	6.00	4168	3.75	1.34	1.05	6.00
Log total hours	6064	12.71	1.59	9.11	17.51	4168	12.90	1.54	9.31	17.51

Table A2.2. **Descriptive statistics – minimum wages**

	Labour productivity sample					MFP sample				
	N	Mean	SD	Min.	Max.	N	Mean	SD	Min.	Max.
Log labour productivity	3664	-3.31	1.75	-6.20	3.37	2439	-3.20	1.50	-5.62	2.82
Log capital stock	-	-	-	-	-	2439	-3.36	2.35	-6.71	4.85
Ratio of minimum to median wage	3664	46.24	10.37	29.00	65.00	2439	45.04	9.85	29.00	62.00
Log real minimum wage	3664	1.70	0.28	1.16	2.18	2439	1.78	0.24	1.24	2.07
Tax wedge	3664	28.27	9.14	6.40	43.60	2439	29.13	9.21	6.40	42.70
Average replacement rate	3664	26.98	14.89	5.94	55.87	2439	29.70	14.04	8.58	55.87
Output gap	3664	-0.78	2.54	-10.72	5.68	2439	-0.62	2.18	-6.78	4.43
Log total hours	3664	13.19	1.54	9.40	17.51	2439	13.34	1.50	9.40	17.51

Table A2.3. **Descriptive statistics – parental leave**

	Labour productivity sample					MFP sample				
	N	Mean	SD	Min.	Max.	N	Mean	SD	Min.	Max.
Log labour productivity	5488	-3.22	1.54	-6.20	2.89	3611	-3.19	1.40	-5.22	2.82
Log capital stock	-	-	-	-	-	3611	-3.07	2.22	-6.63	4.85
Weeks of paid maternity leave	5488	15.24	10.44	0.00	57.60	3611	15.23	9.62	0.00	43.16
Weeks of unpaid parental leave	5488	65.25	52.25	0.00	164.00	3611	71.85	56.83	0.00	164.00
Tax wedge	5488	30.62	8.33	9.30	45.50	3611	31.17	8.27	11.90	44.90
Tax incentives for PT work	4656	103.71	3.60	96.33	113.49	3311	103.55	3.63	96.33	112.46
Relative marginal tax rate for 2nd earners	4656	0.95	0.37	0.30	2.01	3311	0.99	0.41	0.30	2.01
Female education	5168	8.21	2.02	2.84	12.19	3611	8.35	1.81	4.53	12.19
Public expenditure on child care	4368	1858.41	1553.17	33.70	8008.72	3141	1984.25	1599.75	121.82	8008.72
Average replacement rate	5488	28.20	14.23	0.35	64.94	3611	29.69	15.00	0.35	64.94
Product market regulation	5488	4.38	1.18	1.21	6.00	3611	4.18	1.22	1.21	6.00
Log total hours	5488	12.72	1.58	9.11	17.50	3611	13.00	1.52	9.41	17.50

Table A2.4. **Descriptive statistics – unemployment benefits**

	Labour productivity sample					MFP sample				
	N	Mean	SD	Min.	Max.	N	Mean	SD	Min.	Max.
Log labour productivity	6880	-3.18	1.54	-6.20	3.37	4584	-3.19	1.34	-5.62	2.82
Log capital stock	-	-	-	-	-	4584	-3.19	2.22	-6.76	4.85
Average replacement rate	6880	28.49	14.10	0.35	64.94	4584	30.08	14.60	0.35	64.94
EPL	6064	2.31	1.10	0.20	4.19	4168	2.19	1.04	0.20	3.80
Tax wedge	6880	30.30	8.48	6.40	45.50	4584	30.90	8.32	6.40	44.90
Product market regulation	6880	4.11	1.34	1.05	6.00	4584	3.88	1.35	1.05	6.00
Log total hours	6880	12.72	1.59	9.11	17.51	4584	12.92	1.54	9.31	17.51

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