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PRODUCT AND LABOR MARKET REGULATIONS, PRODUCTION PRICES, WAGES
AND PRODUCTIVITY

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ABSTRACT

This study is to our knowledge the first attempt to infer the consequences on productivity entailed by anticompetitive regulations in product and labor markets through their impacts on production prices and wages. Results are encouraging showing that changes in production prices and wages at country*industry levels are informative about the creation of rents impeding productivity in different ways and to different extents. A simulation based on these results and on OECD regulation indicators suggests that nearly all countries, in particular European countries, could expect sizeable gains in multifactor productivity over the years from an economic policy that would be able to reform product and labor market regulation practices.

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I. Introduction

An abundant literature investigates the productivity impacts of product and labor market imperfections – and of anticompetitive regulations affecting them (see Aghion and Howitt 2009 for a summary). This paper contributes to this literature. Its originality, broadening an idea already present in Askenazy, Cetto and Maarek (2013), is to infer the consequences on productivity entailed by anticompetitive regulations in product and labor markets through their impacts on production prices and wages. The second paper's main contribution is that we estimate simultaneously, through a consistent framework, the direct and indirect impacts of product market imperfections on productivity as well as the impact of labor market imperfections. The Diagram we present here is a good way to briefly explain this framework.

INCLUDE DIAGRAM about HERE

The right part of the diagram outlines the regression model which is central to our analysis, while the left part represents the calibration relationships which help us validate its interpretation and perform simulation of the Multifactor Productivity (MFP) gains resulting from structural reforms of product and labor markets, as gauged by the OECD indicators for Non-Manufacturing Regulations (NMR), Harmonized tariffs (HT) and Employment Protection Legislation (EPL). The regression model assumes that product market imperfections generate higher production prices and rents, which have direct and indirect impacts on MFP in manufacturing and service industries. Direct impacts reflect diminishing incentives and efforts for industries to improve efficiency and innovate for industries that can already charge high prices and benefit from rents. This is in particular the case of non-manufacturing industries often protected from competition by product market regulations, but would also be the case of manufacturing industries if protected from foreign competition by high tariff barriers. Indirect impacts also reflect weaker efficiency and innovation incentives and efforts from “downstream” industries if the profits and rents they can generate can be appropriated by “upstream” industries that have market power and can charge them high prices for the intermediate inputs they must use. Again this is often the case when the upstream industries are non-manufacturing.

The logic and assumptions of our model are similar for labor market imperfections than for the indirect impact of product market imperfections. Employment protection legislation, professional agreements and norms, shortage of qualified workers in number of industries, etc, contribute to higher wages. Higher wages tend to reduce profits and rents that can be appropriated by firms' owners and shareholders to the benefit of the workers, in particular high skill workers who have a stronger bargaining power than low skill workers. In turn, diminishing efficiency and innovation surplus can deter firms from making efforts to improve their efficiency and innovate, and thus have direct impacts on MFP.

It's worth underlining that an important hypothesis of our approach, which gets inspired from the idea from Blanchard and Giavazzi (2004), is that rents stem from the direct impact of product market anti-competitive regulations. The sharing of these rents between labour (wages) and capital (profits) depends on the bargaining power of labour directly influenced by labour market regulations. So, labour market regulations influence the rent sharing process but not the rent building one, and for this reason has no impact on production price.

Numerous papers have been devoted to the direct impact of product market imperfections and few papers have been devoted to their indirect impact. This paper is in the continuation of two previous studies (Bourlès et al., 2013, and Cetto, Lopez and Mairesse, 2013) focusing only on the indirect impact of non-manufacturing regulations.¹ Like these two studies, it relies on a country*industry panel and it is also based, but to a lesser degree and indirectly, on the unique information provided by the OECD regulation indicators. Thanks to its econometric analysis framework, this paper not only confirms but also greatly extends the scope of our two previous studies, notably in comparing the relative importance of the different channels. According to estimation results, there are significant productivity impacts of each channel, the main being the indirect NMR impact.

Section 2 describes our country*industry panel data sample, defines our six impact indicators of production prices and wages, and discuss the specification of our regression model. Section 3 gives and comments our main estimation results, while section 4 presents a policy evaluation of the productivity impacts of structural reforms of product and labor market regulations based on these results. Section 5 is a short conclusion.

¹ For other empirical investigations on the NMR indirect impact, see also Allegra et al. (2004) on Italy data, Forlani (2010) on France, Arnold et al. (2011) on the Czech Republic, and Barone and Cingano (2011) on country*industry panel data.

II. Sample, variables and regression model

Our analysis is grounded on an unbalanced country*industry*year panel data sample covering fourteen OECD countries and eighteen industries: thirteen mainly in “Manufacturing” and five mainly in “Service”. For lack of data for several country and/or sector in the earlier years, it is relatively unbalanced ranging for each country*industry time series from 1987 to 2007 at maximum, 6 years at minimum and about 12 years in average.²

Production prices, intermediate consumption and data used to calculate Multifactor Productivity (MFP) come mainly from OECD databases, while wages by skill level and physical investments by assets (mobilized to calculate MFP) come from the EUKLEMS database. The regulation indicators that we use to assess the economic significance of our results and to calibrate simulations of the potential impacts of structural reforms are constructed on the basis of the OECD indicators for Non-Manufacturing Regulations (NMR), Harmonized Tariffs (HT) and Employment Protection Legislation (EPL).³

As shown in the Diagram, the explanatory variables of MFP in our analysis, where MFP is noted in logarithm as mfp_{cit} for country c , industry i and year t , consist of four impact indicators based on production price data, two “direct” impact indicators $DM_{p_{cit}}$ and $DNM_{p_{cit}}$ for respectively manufacturing industries and service industries, and two “indirect” impact indicators $IM_{p_{cit}}$ and $INM_{p_{cit}}$ for impacts on “downstream” industries originating from respectively “upstream” manufacturing and service industries. They also consist of two impact indicators based on low skill (L) and high skill (H) wage data noted $JL_{w_{cit}}$ and $JH_{w_{cit}}$.

² The fourteen countries are: Austria, Canada, Czech Republic, Denmark, Finland, France, Germany, Italy, Japan, The Netherlands, Spain, Sweden, the United-Kingdom and the United States. For the sake of convenience, “Manufacturing” refers here to: food products, textiles, wood products, paper, chemicals products, non-metallic mineral products, metal products, machinery not elsewhere classified (n.e.c.), electrical equipment, transport equipment, manufacturing n.e.c., but also construction and hotels & restaurants; while “Service” refers to: transport & communication, retail distribution, banking services and professional services, but also energy. Overall our panel data sample counts 2820 observations, excluding the United States taken as the country of reference to control in particular for unobserved technical change at the industry level in our analysis.

³ Appendices A and B gives detailed information on the panel composition, the variables construction and the OECD indicators, and it also presents simple descriptive statistics.

The direct impact price indicators are simply defined as:

$$DM_{p_{cit}} = p_{cit} \text{ with } i \in M \quad DS_{p_{cit}} = p_{cit} \text{ with } i \in S$$

where p_{cit} is the production price index, in logarithm, for in country c , industry i and year t , normalized to be equal to 1 in year 2000 (with $i \in M$ for the manufacturing industries and $i \in S$ for the service industries). Because of the aggregate nature of our panel sample, the direct impact price coefficients we can expect to estimate with good precision are two average country*industry elasticities (not separate elasticities by country or industry, or country*industry).

The indirect impact price indicators are composite indicators of the same production prices but for the upstream industries, and are defined as:

$$IM_{p_{cit}} = \sum_{j \in M \& j \neq i} p_{cjt} * USE_i^j \quad INM_{p_{cit}} = \sum_{j \in S \& j \neq i} p_{cjt} * USE_i^j$$

where USE_i^j is the intensity-of-use of intermediate inputs, defined as the ratio of the intermediate consumption from industry j to industry i over the production of industry i and measured on the basis of the 2000 input-output table for the USA, taken as country of reference in our analysis. Here also, the coefficients that can be precisely estimated are two average country*industry elasticities. Note that interacting the log upstream industry price with the intermediate input intensity of use ratio is a proper way to take into account the intrinsic heterogeneity of their potential impact on downstream multifactor productivity, assuming that the higher is this ratio the higher is the impact of a given change in upstream industry price.

The impact low and high skill wage indicators are defined as:

$$JL_{w_{cit}} = w_{ct}^L * SHARE_i^L \quad JH_{w_{cit}} = w_{ct}^H * SHARE_i^H$$

where w_{ct}^L and w_{ct}^H are the country wage indices, in logarithms, for the low and high skill workers of country c , and $SHARE_i^L$ and $SHARE_i^H$ are the corresponding labor costs shares in the production value of industry i for the USA in 2000. Here, similarly to the cases of the direct and indirect impact price indicators, the coefficients we can hope to estimate precisely enough are two average country*industry elasticities and it is appropriate to interact the log

country low and high skill wages with the corresponding wage shares in production at the industry level for the USA in 2000.⁴

Finally, the specification of our regression model is the following:

$$\begin{aligned}
mfp_{cit} = & \alpha DM_{pci(t-1)} + \beta DNM_{pci(t-1)} + \gamma IM_{pci(t-1)} + \delta INM_{pci(t-1)} \\
& + \lambda JL_{wci(t-1)} + \mu JH_{wci(t-1)} \\
& + \theta mfp_{USi(t-1)} + \eta_c + \eta_i + \eta_t + \eta_{ci} + \eta_{ct} + \varepsilon_{cit}
\end{aligned} \tag{1}$$

where in addition to the six impact price and wage indicators just defined, the log USA multifactor productivity for industry i and year $(t-1)$ $mfp_{USi(t-1)}$ is included to mainly control for exogenous technical change at the industry level, choosing the USA which is at the world productivity frontier in most industries as an appropriate reference country for our analysis.⁵ $\alpha, \beta, \gamma, \delta, \lambda$ and μ are our elasticity parameters of interest. ε_{cit} is the idiosyncratic random error of the regression. η_c, η_i and η_t denote one way country, industry and year fixed effects that are usually included in regression model estimated on panel data sample such as ours in order to control for distinctive country, industry or period characteristics, which could affect the estimates of the parameters of interest. η_{ci} and η_{ct} stand for two way country-industry and country-year fixed effects.

Including the country-industry fixed effects η_{ci} in our regression implies that the evidence on which we rely for estimation is only based on the within country*industry changes over time of our price and wage indicators; in the present context it is a necessity since these indicators are indices equal to 1 in the reference year 2000. Including the country*year fixed effects η_{ct} is a useful precaution protecting from a variety of sources of potential estimation biases, in particular differences in country multifactor productivity not related to product or labor market imperfections (and not captured by the presence of mfp_{US}), and endogeneity biases due to changes in prices and wages in response to country productivity shocks. It is also possible to substitute industry*year fixed effects η_{it} to mfp_{US} to control more fully for

⁴ Note that since the estimated elasticities of the indicators based on low and medium skill wages were not statistically different, we prefer to pull them together for more precision in our econometric analysis, and we refer to them for brevity simply as low skill wage indicator.

⁵ As we just explain, we rely on the data for USA in year 2000 in the computation of our indicators of indirect price impact and wage impact to avoid irrelevant variability in these indicators and the possibility of spurious correlations affecting our estimates. However, note that the estimation results are robust when using domestic I-O tables.

industry technical changes and other variation in industry multifactor productivity that are unrelated to product or labor market imperfections. As discussed in Cette, Lopez and Mairesse (2013), we can view the regression results obtained when including only η_{ct} or both η_{ct} and η_{it} as providing respectively upper and lower bound estimates, with some preference for the upper estimates. We will only consider them here, but we present the two types of estimates in Appendix C (Table C1). In spite of the inherent difficulties and uncertainties of our analysis, the estimates of the six prices and wages elasticities obtained in the two cases appear fairly robust overall, all six being negative as expected and three out of the six being not statistically different at the 5% or 10% confidence level.⁶

III. Estimation results

Besides the controls for fixed effects in our regression, we also rely on the Dynamic OLS (DOLS) estimator rather than on the Ordinary Least Squares (OLS) estimator in order to make sure that the estimated elasticities are not biased by short term correlations between the variables and the idiosyncratic error ε_{cit} , and that they can be considered as long term parameters.⁷ Our estimates are given in Table 1, in the last column for the full specification of the regression (i.e. written as (1) in the previous section), and in the columns before for simpler specifications where the direct and indirect production price indicators and the wage indicators are introduced each in turn and pulling manufacturing and service industries together (i.e. overall industries).

INCLUDE TABLE 1 about HERE

⁶ The estimated elasticities are smaller for JL_w , JH_w and IS_p when we control for both η_{ct} and η_{it} than when we only control for η_{ct} . This can be accounted by the fact that the reduction in variability in these indicators is much more important than for the other three indicators, when we control for η_{ct} and even more for both η_{ct} and η_{it} . See analysis of variance in Table A1 and A2 in Appendix A.

⁷ The DOLS estimator includes in the regression leads and lags for all variables. We have found enough keep one lead and one lag. The OLS and DOLS estimates of all elasticities are in fact quite close (See Table C1 in Appendix C), but the Hausman test performed concludes to the bias of the OLS estimator.

We can see that the estimated elasticities for all the indicators are negative and statistically significant, and practically not affected, or only slightly, by the presence of the other ones. We observe nonetheless that the service industry component appears much larger than for the manufacturing industry component: twice for the direct price indicator (about 0.8 versus 0.4) and even up to ten times for the indirect price indicators (about 5.0 versus 0.5). The same observation is true for the wage indicator: the high skill component is not far from being twice the low skill component (3.0 versus 1.7).⁸

IV. Simulation of potential impact of structural reforms

Although the estimated elasticities of our production price and wage indicators appear quite satisfactory, being of the expected sign, statistically significant and reasonably robust, we cannot directly interpret them in terms of the impacts on productivity of anticompetitive regulations in the product and labor markets, and in particular we cannot illustrate their implications in terms of potential impacts of structural reforms in these markets. Despite the particular care we have taken to control for errors of specification in our regression model as well as the consistency of our estimates, it is also good to confirm externally our interpretation that they indeed indirectly capture the impacts of regulations and not mainly some other economic factors. We can do both by estimating calibration relationships between the country*industry series of production prices and wages and the OECD indicators, providing a direct link to regulations and policy, namely the Non-Manufacturing Regulations (NMR) indicators, the Harmonized tariffs (HT) indicators for the manufacturing industries and the Employment Protection Legislation (EPL) indicators for the low and high skill wages. These indicators are based on very detailed information on laws, rules and market, country and industry settings, and they have the advantage to be to exogenous to productivity developments and directly related to underlying policies, at least to a major extent.

⁸ Note also that the elasticities are for very precisely estimated for DM_p , DS_p and IM_p but somewhat less so for JL_w , JH_w and particularly for IS_p , which are also the three much larger. The reason is likely the same that explains that the elasticity estimates for these three indicators are much reduced when we control for both η_{ct} and η_{it} (see footnote 5). The reduction in their variability is much more important than for the other three indicators, already when we control for η_{ct} and even more for both η_{ct} and η_{it} , as shown by the analysis of variance in Tables A1 and A2 in Appendix A.

In order to be congruent with our regression model, the calibration relations can be simply estimated as four OLS projections: two on NMR and HT indicators for manufacturing and service production prices respectively, and two on EPL indicators for low and high skill wages. The projection coefficients estimates we find corroborate that the correlations between changes in production prices and wages and changes in the OECD regulation indicators are positive and statistically significant.⁹ They allow us to interpret our findings and put them into perspective in terms of an illustrative simulation of the potential long term MFP gains by country, from adopting for all industries the “lightest practice” regulations observed in 2013. For the purpose of the simulation, “lightest practices” are defined as the averages of the three lowest levels of regulations in the different countries of our sample.¹⁰ A pervasive and simultaneous switch to lightest practices is thus an overly extreme and simplified example of structural reforms in product and labor markets, ignoring of course the many and great institutional and political difficulties of implementation. The results of this simulation are presented in Chart 1, where the height of bars indicates the long term overall MFP impacts of adoption of lightest practices for each country, and the size of their components correspond to the contributions of adoption of the lightest practices respectively related to the NMR, HT and EPL regulations.

INCLUDE CHART 1 about HERE

⁹ These results are documented in details in Table C2 Appendix C. Two OLS projections for production prices are conditional on all the fixed effects also included in our regression model, but the two ones for wages can only be conditional on country and year fixed effects since the wages series are only available at the country level. The three estimated calibration coefficients for manufacturing and service industries production prices and for low skill wages are statistically very significant (at a 1% confidence level), but the fourth one for high skill wages is only weakly significant (at a 10% confidence level).

¹⁰ Note that, although the USA is taken as the reference country and excluded from our estimation sample, we have included it in the simulation and in definition of lightest practices, thus extending to this country the average estimates obtained for the thirteen countries kept in the sample. Note also that unlike the NMR and EPL indicators updated for the year 2013, the most recent HT indicator available is for the year 2008, and we have simply assumed it had not changed in 2013.

We see that the total MFP gains in the long term are on average of about 4.4% and vary largely, depending on the initial regulation levels, from 1.1% in the UK to 7.0% in Czech Republic. The underlying regulatory components of these total gains are very different from one another but remain in proportion roughly similar across country. The gains from the reforms on the product markets amount on average to 2.5%, originating for 60.1% from the indirect impacts on non-manufacturing industries of the reforms in upstream service industries, for 26.2% from the direct impact of the reforms in service industries, and for only 5.3% and 8.3% from respectively the indirect and direct impacts in manufacturing of the reforms in upstream service industries and in manufacturing industries. The gains from the reforms of the EPL regulations are in average of 1.9%, arising for 73.2% from the reforms concerning the low skill labor market.¹¹

We have completed our simulation by a complementary analysis showing what could be the dynamic of the MFP impacts of the reforms. For this, we have estimated error correction models to represent the adjustment of production price and of MFP. This analysis (presented in Appendix D) suggests that 31.0% of total long term MFP gains being realized after six years in average. It is illustrated for the five following important European countries: France, Germany, Italy, Spain and UK, in Chart 2.

INCLUDE CHART 2 about HERE

We have also complemented our analysis by another policy simulation of the MFP gains that could be expected from the reduction of NMR and EPL regulations during the period 2007-2012 (but not of HT regulations, information on these indicators being unavailable after 2008). This ex-post simulation (presented in Appendix E) shows that the MFP gains attributable in the long term to these reductions are of about 0.6% on average and are mainly due to reforms on product markets, with the higher gains for Italy Austria (2.0%).

¹¹ Indeed, the industry total compensation of low skill workers is always higher than for high skill workers (two times higher on average) and the projection coefficient of wages on EPL indicators is about three times higher for low skill wages than for high skill wages.

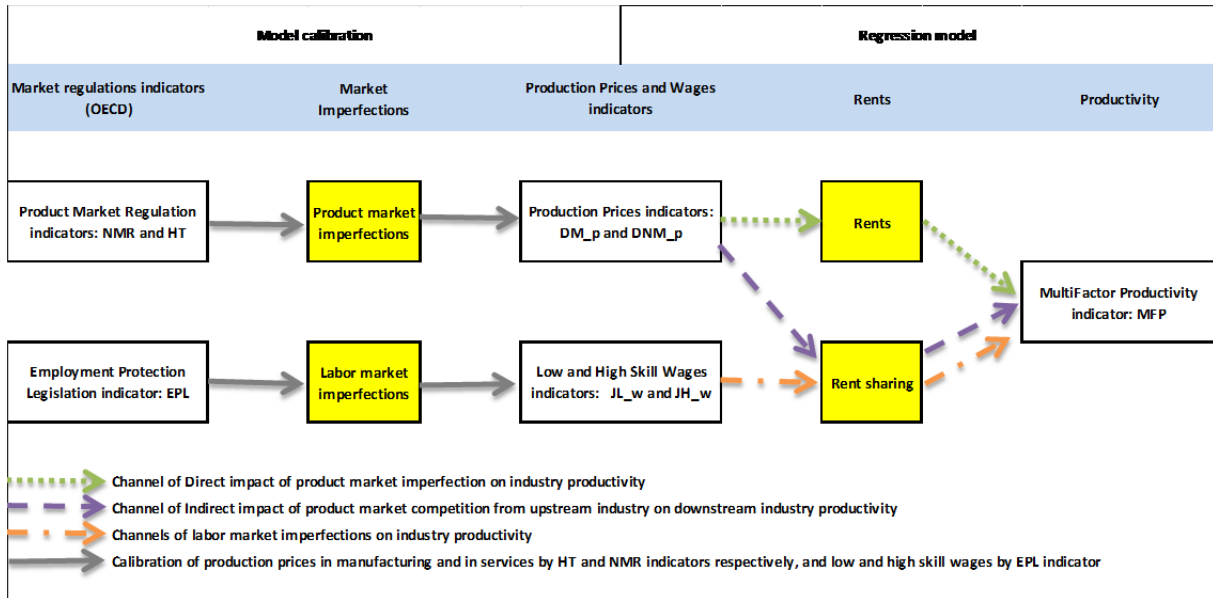
V. To conclude

This study is to our knowledge the first attempt to infer the consequences on productivity entailed by anticompetitive regulations in product and labor markets through their impacts on production prices and wages. Results are encouraging notwithstanding the great difficulties of the issues at stake and the intrinsic limitations of relying on a macroeconomic country*industry panel. Production prices and wages are indicative of rent building and sharing processes which are impeding productivity in different ways and to different extents and which are arising from market imperfections as gauged by the OECD product and labor market regulations indicators. A simulation based on these results suggests that nearly all countries, in particular European countries, could expect important gains in multifactor productivity over the years from an economic policy that would be able to implement the lightest industry and labor regulation practices.

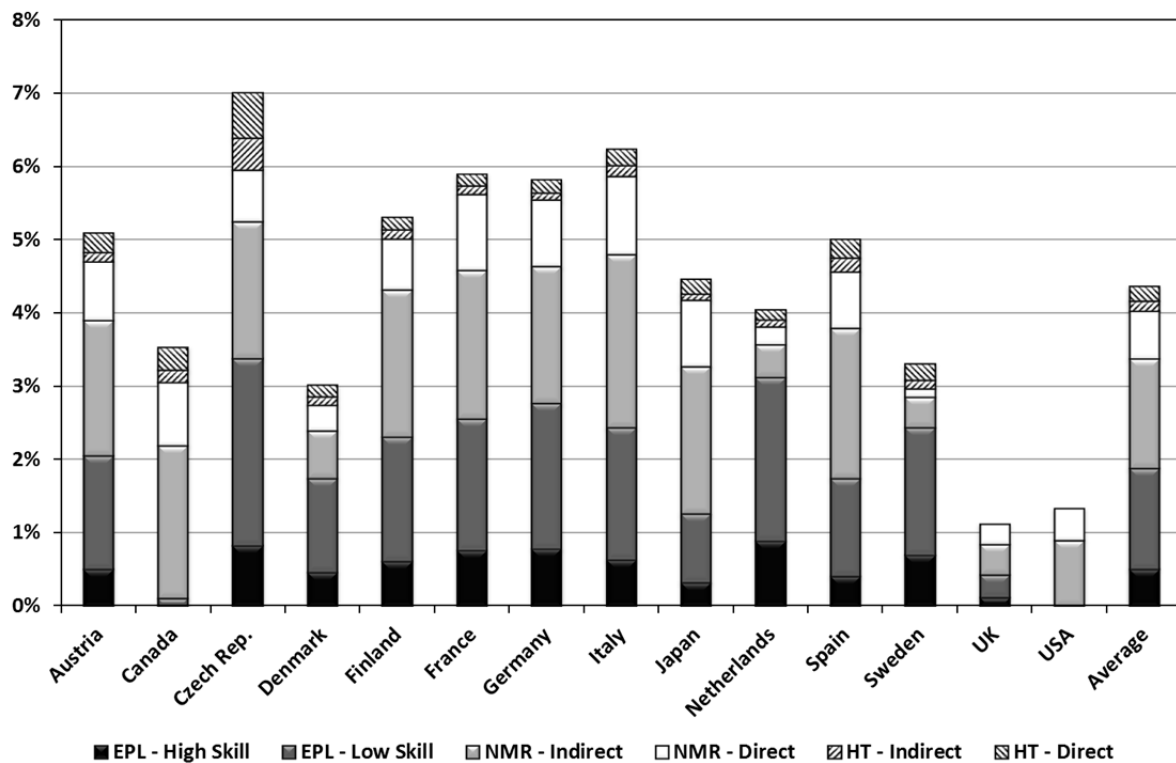
Our estimates and simulations are based on huge hypotheses and for this reason our results must be considered with caution. In particular, the productivity impact of ambitious structural reform programs consisting in the adoption of the lightest regulation practices is large and should get confirmation from other analyses based on other approaches. Nevertheless, concerning their largest component, the indirect impact of non-manufacturing regulation changes, they are totally consistent with our previous two evaluations based on other methodologies (see Bourlès et al., 2013, and Cette, Lopez and Mairesse, 2013). We can also remark that ambitious structural reform programs implemented in some countries over the last decades had even larger MFP impacts (see Bergeaud, Cette and Lecat, 2014). For example, from the reform program implementation in the early 80s in The Netherlands or the early 90s in Australia, Canada and Sweden, the MFP growth increased in these four countries for at least 1 percentage point in average over the next ten years compared to the previous ten years. Historical country experiences seem to give a strong confirmation to our results. Nevertheless, as told before, we do not comment in our analysis institutional and political difficulties of the implementation of such ambitious structural reform programs. We can only observe that the four country examples evoked before were knowing high economic difficulties before the implementation of their reform programs.

Diagram, Charts 1 to 2 and Table 1

Diagram: Regression model and calibration relationships



**Chart 1: Simulated long-term impacts on MFP
from the adoption of the lightest practices**



EPL – High Skill and EPL – Low Skill: Long run impacts through high and lowskill wages, respectively.

NMR – Indirect and NMR – Direct: : Long run indirect and direct impacts through production prices in non-manufacturing industries, respectively.

HT – Indirect and HT – Direct: Long run indirect and direct impacts through production prices in manufacturing industries, respectively.

Chart 2: Simulated evolution of impacts on MFP from the adoption of the lightest practices for France, Germany, Italy, Spain and United-Kingdom

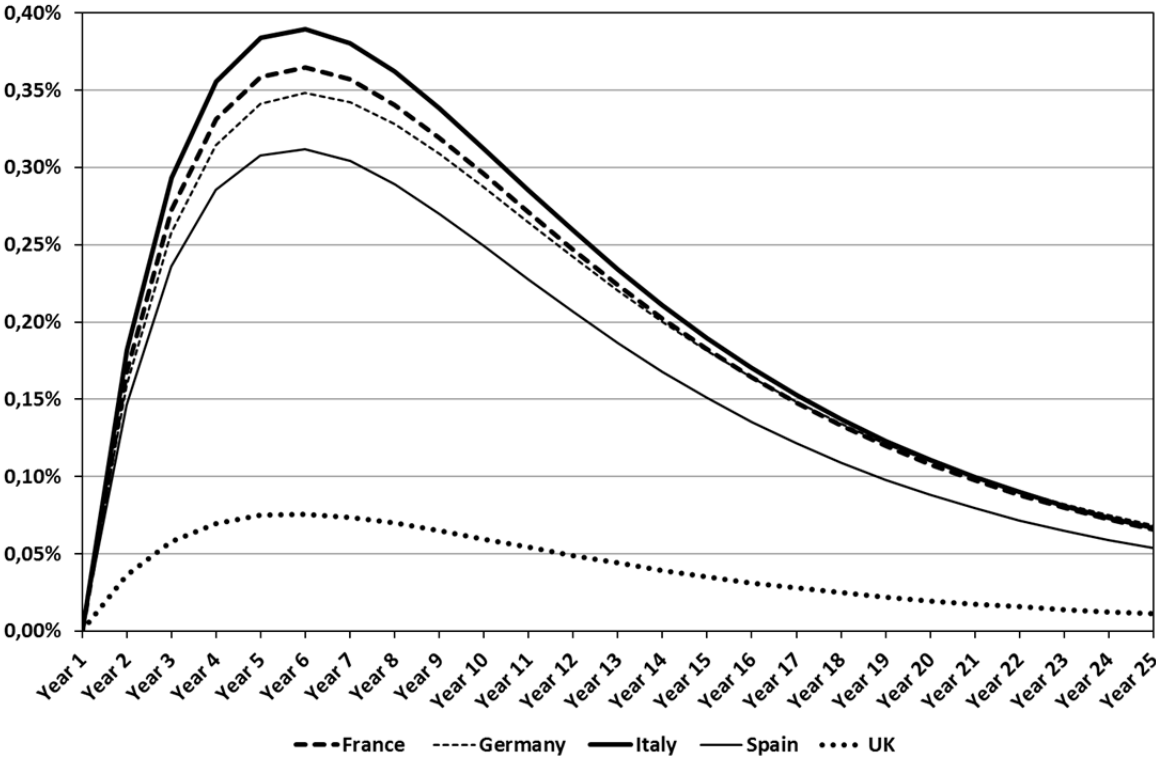


Table 1: Estimation results

Dependent variable: <i>mfp</i>		(1)	(2)	(3)	(4)	(5)	(6)
US MFP (<i>mfp^{US}</i>)		0.688*** [0.014]	0.821*** [0.013]	0.704*** [0.014]	0.808*** [0.012]	0.720*** [0.014]	0.756*** [0.015]
Direct prices in	All industries	-0.513*** [0.034]		-0.523*** [0.033]		-0.441*** [0.033]	
	Manufacturing industries (<i>DM_p</i>)						-0.379*** [0.037]
	Non-Manuf. industries (<i>DNM_p</i>)						-0.827*** [0.090]
Indirect prices from	All industries		-0.486*** [0.074]	-0.546*** [0.070]		-0.479*** [0.068]	
	Manufacturing industries (<i>IM_p</i>)						-0.446*** [0.069]
	Non-Manuf. industries (<i>INM_p</i>)						-5.060*** [0.898]
Country wages * industry labour share	All Skills				-2.338*** [0.165]	-2.091*** [0.170]	
	High Skills (<i>JH_w</i>)						-3.043*** [0.329]
	Low Skills (<i>JL_w</i>)						-1.743*** [0.215]
Observations		2820	2820	2820	2820	2820	2820
R-squared		0.779	0.760	0.785	0.774	0.798	0.804

*** Significant at 1%; ** significant at 5%; *significant at 10%.

Standard errors between brackets.

Country*industry and country*year fixed effects included.

Estimator: DOLS estimates performed with one lag and one lead (corresponding coefficients not presented)

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APPENDIX A: RELATION (1) DATA

This appendix presents data sources of and calculation methods required to mobilize relation (1) variables as well as their variance analysis. Merging different sets, we were able to assemble a cleaned unbalanced country-industry panel dataset of 2,812 observations from 1987 to 2007 on fourteen countries (Austria, Canada, Czech Republic, Denmark, Finland, France, Germany, Italy, Japan, The Netherlands, Spain, Sweden, The United-Kingdom and The United States) and eighteen industries. These industries are thirteen manufacturing industries (food products, textiles, wood products, paper, chemicals products, non-metallic mineral products, metal products, machinery n.e.c., electrical equipment, transport equipment, manufacturing n.e.c., construction and hotels & restaurants) and five non-manufacturing industries (energy, transport & communication, retail distribution, banking services and professional services).¹²

Multi-Factor Productivity (MFP)

Relation (1) mobilizes the MFP levels. These levels are calculated for a base year (2000) and then extended over the sample period using data on MFP growth calculated as follow (with minuscule for logarithm):

$$\Delta mfp_{cit} = \Delta va_{cit} - (\alpha_i \cdot \Delta l_{cit} + \beta_i \cdot \Delta c_{cit}^I + \gamma_i \cdot \Delta c_{cit}^{NI} + \Delta c_{cit}^S + \theta_i \cdot \Delta k_{cit})$$

where VA_{cit} is the Value Added in constant price of country c , industry i at time t , L is the total employment in number of workers, C^I , C^{NI} and C^S the physical capital stocks of, respectively, Information and communication technology (I), Non-ICT equipments (NI) and non-residential Structure (S), K the knowledge capital stock and α_i , β_i , γ_i and θ_i the output elasticity of these factors in industry i , approximated by the factor cost shares over total cost in the USA, averaged on the 1987-2007 period for each industry.

Capital stocks are calculated from investment data using the permanent inventory method and assuming constant geometric rates of depreciation: 5% for non-residential structures, 10% for non-ICT equipment, 20% for ICT equipments and 25% for R&D. In order to compute investments in constant prices, we have used investment deflators at the national level. Because of the lack of specific price information for R&D, we have used as a proxy the

¹² To ease the presentation, ‘Construction’ and ‘Hotels and Restaurants’ industries are included into the ‘manufacturing’ group.

manufacturing production deflator. To improve comparability, we have assumed for all countries that the ratio of investment prices over the GDP price is the same as for the USA for the ICT investments in hardware, software and telecommunications equipment. Indeed, the USA is by far the country that most extensively relies on hedonic methods to measure these prices.

Data on value added and employment come from the OECD STAN dataset, data on R&D expenses from the ANBERD OECD dataset and data on other product investment from the EUKLEMS dataset. Since R&D is not yet treated as an investment in the national accounts data gathered by OECD, we had to correct both the industry value added by adding (“expensing out”) the intermediate consumption of their R&D activities and the industry number of employees by subtracting the number of R&D personnel (to avoid “double counting”). Note also that we had to modify the price index of value added, and hence its value in constant price, for the “Electrical and optical equipment” industry, which includes communication and computing equipment. In the same way as for the ICT investment, we assumed that in this industry the ratio of value added prices over the GDP price is the same in all countries as for the USA.

Chart A1 presents the sample average of industries in 2000 of the ratio of domestic MFP over the USA MFP: each country is lagging behind the USA. Chart A2 presents the box plots of the yearly MFP growth by country: there are important industry positive or negative MFP changes, but the country median MFP growth is positive and much smaller, from 0.35% in Spain and 1.01% in Canada to 2.97% and 4.28% in Czech Republic.

INCLUDE CHART A1 and A2 about HERE

Upstream burden indicators

Our empirical investigation mobilizes industry relative production prices (i.e. production prices over the GDP price) and real wages as indexes of market regulations. Data on production prices come from the OECD STAN dataset and data on wages by skills from the EUKLEMS dataset.

Chart A3 shows the manufacturing and non-manufacturing sample average annual growth rates of relative production prices. These prices have decreased in most countries, likely because prices of public services – as they are measured by national accounting services - are growing faster than the other parts of GDP. There are important relative production price growth differences across countries. Chart A4 shows the sample average annual growth rate of real wages for high skills and low skills workers. The real wage increases are almost the same on average for the two worker’s groups. As for the relative production prices, there are important real wage growth differences across countries.

INCLUDE CHART A3 and A4 about HERE

We assume that the product market regulations not only impact directly the productivity of the regulated industries but also indirectly the productivity of industries using intermediate inputs (called the downstream industries) produced by the regulated industries (called the upstream industries). If this indirect effect is true, the impact should be growing with the intensity of use of intermediate inputs from the upstream industries. In order to test this conjecture, we build upstream burden indicators of the manufacturing and non-manufacturing relative production prices according to the following ways:

$$IM_p_{cit} = \sum_{j \in m \text{ \& } j \neq i} p_{ct}^j * USE_i^j \quad INM_p_{cit} = \sum_{j \in s \text{ \& } j \neq i} p_{ct}^j * USE_i^j$$

Where p^j is the production price, in logarithm, of upstream industry j ($j \in m$ for the manufacturing industries and $j \in s$ for the non-manufacturing industries) and USE_i^j stands for the intensity-of-use in industry i of intermediate inputs from industry j over the total output of industry i .

We prefer to use a fixed reference input-output table to compute the intensity-of-use ratios rather than the different country and year input and output tables, to avoid endogeneity biases that might arise from potential correlations between such ratios and productivity. Indeed, upstream regulations may influence the use of domestic intermediate inputs. We have actually used the 2000 input-output table for the USA, this country being already taken as a reference

for the productivity gap. For similar endogeneity as well as measurement error concerns, note also that we exclude within-industry intermediate consumption.

In the same way, wage burden indicators for high and low skill workers are constructed according to the following equations:

$$JL_{w_{cit}} = w_{ct}^L * SHARE_i^L \quad JH_{w_{cit}} = w_{ct}^H * SHARE_i^H$$

Where w^L and w^H are the real wages, in logarithm, of low and high skill workers, $SHARE^L$ and $SHARE^H$ are the intensity-of-use of low and high skill workers, measured as the ratio of the low and high skill labour costs over production in 2000 in the USA. The motivations to refer to the USA in 2000 are the same as for the intensity-of-use of intermediate inputs.¹³

Variance analysis

Our main estimates include country*industry and country*year fixed effects. The country*industry fixed effects are unavoidable as production price explanatory variables are indices with an arbitrary base 100 in 2000. Country*year fixed effects are also very important. If government reacts to the aggregate economic situation by changing the regulations, the country*year fixed effects will offset the corresponding endogeneity biases, as in a difference-in-difference approach. Moreover, it is important to stress that country*year fixed effects can act as good proxies for a variety of omitted variables. In particular they can take into account differences between countries in technical progress, in the development of labor force education and skills, and in changes in international trade conditions, in cyclical position, etc... In the same way, industry*year fixed effects could take into account differences between industries. However, our main estimates omit these fixed effects. This section explains our choice.

Table A1 summarizes the results of a variance analysis of relation (1) variables on the full set of possible fixed effects. Each column presents the residual standard-deviation of the regressions of each variable on a set of fixed effects. For the first column, the regression

¹³ Although EUKLEMS provide time series of average wages at the country*industry level for low, medium and high skill levels, we could not rely on them since once we control for the appropriate fixed effects to be included in our analysis (see regression (1) below) their remaining variability appears very small and particularly noisy. We thus chose to rely on time series of wages at the country level interacted with labor cost shares at the industry level. In spite of the fact that their remaining variability is also very small, we obtain with them more reliable and reasonable estimates.

includes the minimum set of fixed effects: country, industry and country*industry fixed effects (these fixed effects are required as price levels are not comparable across countries and industries). Thus, column (1) shows the dispersion of the within ‘individual’ changes of the variables values and column (2) and (3) show how much of this variability would be taken into account when other fixed effects are included. As first differences are maybe easier to interpret, Table A2 shows the variance analysis of relation (1) variables first differences.¹⁴ Column (1) of Table A2 shows the standard-deviation of the variables first differences, while columns (2) and (3) gives them after controlling respectively for country*year fixed effects and both country*year and industry*year fixed effects. According to both tables, the standard-deviations of some variables are relatively small, particularly the upstream burden indicators of the non-manufacturing relative production prices and the wage burden indicators. Moreover, these standard-deviation are reduced significantly when controlling for country*year and industry*year fixed effects. Therefore, we prefer to omit the industry*year fixed effects in our main estimates.

INCLUDE Table A1 and A2 about HERE

¹⁴ Note that when using the first difference estimator rather than the within industry-country changes, but still controlling for country*year fixed effects, the estimated relation (1) coefficients are not qualitatively different but sometimes smaller and with higher coefficient standard-deviation and thus not statistically significant.

APPENDIX B: OECD REGULATION INDICATORS

We assume that relative production prices and real wages are indexes of product and labor market regulations. In order to confirm this hypothesis, we estimate the relation between these prices and OECD regulation indicators. Then, the estimation results are used to provide a policy simulation (see section 4). We mobilize three sets of OECD regulation indicators: (i) Non-Manufacturing Regulation (NMR) indicators, available only on non-manufacturing industries (including energy); (ii) Harmonized Tariffs (HT) indicators, available on manufacturing industries; and (iii) Employment Protection Legislation (EPL) indicators. The OECD provides anti-competitive regulation indicators only for non-manufacturing industries as most of the anticompetitive regulations are concentrated in these industries in OECD countries. Similarly, HT indicators are particularly relevant in manufacturing industries, as manufacturing products are the major part of trade. The following paragraphs present these OECD indicators.

The OECD NMR indicators measure to what extent competition and firm choices are restricted where there are no *a priori* reasons for government interference, or where regulatory goals could plausibly be achieved by less coercive means. They are based on detailed information on laws, rules and market and industry settings and cover energy (gas and electricity), transport (rail, road and air) and communication (post, fixed and cellular telecommunications), retail distribution and professional services (see Conway and Nicoletti, 2007, for a more detailed presentation). In addition, we use also the indicator of restrictions to competition in banking constructed by de Serres *et al.* (2006). Chart B1 shows the values of these indicators in 2013, which is the year used for the policy evaluation, as well as the lightest practice defined as the average of the three smallest indicator values in each industry.¹⁵ We observe important differences across countries and between industry regulations within countries. Indeed, it is worth noting that the same country can be ranked among the most regulated in one industry and among the less regulated in another industry.

¹⁵ Note that the calculations of the 2013 OECD NMR indicators (used for the policy simulations) take into account new questions. The OECD provides an update including these questions for the 2008 NMR indicator values but not before this year. The comparison of 2008 values with and without these new questions shows some differences but doesn't change country ranking.

INCLUDE Chart B1 about HERE

The OECD Harmonized Tariff (HT) indicators are computed from the 6-digit level of the Harmonized system product classification, with tariffs being defined as the *ad valorem* tariff rates applied to the most favoured nation. Tariff data have been aggregated into indicators for 2-digit ISIC Rev. 3 industries using import-based weights. The indicators are coded between 0 and 6 according to the average production weighted tariffs, with 0 for the smallest tariffs (see Nicoletti and Scarpetta, 2003, for a more detailed presentation). No HT indicators are available for the ‘Construction’ and ‘Hotels and restaurants’ industries, so we use the OECD Foreign Direct Investment (FDI) restrictiveness indicators for these industries. This last indicators measure different forms of discrimination against foreign firms, such as i) restrictions on foreign ownership, i.e. limitations of the share of companies’ equity capital in a particular sector that are not applied to domestic firms; ii) obligatory screening and approval procedures for foreign affiliates; iii) operational constraints or controls for affiliates of foreign companies, including constraints to the mobility of foreign professionals working in these affiliates. The FDI indicator is primarily based on information from the GATS Commitments and country submissions to the OECD Code of Liberalization of Capital Movements (see Golub and Koyama, 2006, for a more detailed presentation).

Chart B2 shows the HT indicator values in 2007, which is the year used for the policy evaluation, as well as the lightest practice. The HT indicators are higher in the food products (ISIC code 15-16) and in the textiles (17-19) industries than in other industries, with important differences between countries.

INCLUDE Chart B2 about HERE

The OECD provides various labor market regulation indicators: unemployment replacement rates, expenditures on labour market programs, statutory minimum wages, union members and Employment Protection Legislations (EPL). Bassanini and Venn (2008) provide an

empirical analysis of the impact of these various indicators on productivity. Our analysis focus on the EPL indicators, which is the most frequently used in the empirical literature on the impact of labour market regulations on productivity and growth. As the OECD NMR indicators, the EPL indicators are based on detailed information on laws, rules and market settings. They measure the procedures and cost involved in dismissing individual workers with regular contract (data on collective dismissal is available only since 1998) and regulations on temporary contracts, including regulations on fixed-term and temporary work agency contracts (see 2013 OECD Employment Outlook for more information).

Chart B3 shows the values of EPL on regular and on temporary contracts in 2013 as well as the lightest practice. The EPL indicator values are high in continental European countries relatively to the other countries, particularly for the regular contracts.

INCLUDE Chart B3 about HERE

APPENDIX C: ROBUSTNESS ANALYSIS

This appendix evaluates the robustness of our estimations to three assumptions: (i) the fixed effect list choice; (ii) the use of the Dynamic OLS estimator; and (iii) the assumption that production prices and real wages are indexes of product and labor market imperfections.

Estimator and fixed effects sensitivity analysis

Relation (1) includes country, industry, country*industry and year fixed effects to take into account of omission bias otherwise possible, but no industry*year fixed. Industry*year fixed effects could take into account industry specific omitted variables, notably technical change, but to introduce these last fixed effects would lead to explain almost all the variability of many relation (1) variables (see the variance analysis in appendix A).

Table C1 shows the estimation results when these fixed effects are included (columns 3 and 4) and when they are omitted (columns 1 and 2, corresponding to columns 4 and 5 of Table 1). The introduction of industry*year fixed effects leads to a reduction of the absolute value of every coefficients. This reduction doesn't change qualitatively the results when we focus on all industries and all workers. When we distinguish the impact of manufacturing and non-manufacturing production prices and of high and low skill real wages, the coefficients of the upstream non-manufacturing burden indicator and of the low skill wages burden indicator are no more statistically significant. The lack of data variability may explain these results. However the main estimates (columns 1 and 2) for these variables should be taken with caution.

These estimations mobilize the Dynamic OLS (DOLS) estimator in order to take into account of possible simultaneity between the non-stationary variables. Table C1 shows also the robustness of the estimation results to the use of the OLS estimator (columns 5 and 6). The results are very close to the DOLS estimates. However, according to a Hausman test the OLS estimates are not consistent, so we prefer to use the DOLS estimates.

INCLUDE Table C1 about HERE

Estimated impact of regulations on production prices

We estimate the relations of relative production prices and real wages with OECD regulation indicators. We estimate four equations: (i) the impact of OECD NMR indicators on relative production prices in non-manufacturing industries; (ii) the impact of OECD HT indicators on relative production prices in manufacturing industries; (iii) the impact of OECD EPL indicators on low skill real wages and (iv) on low skill real wages. The impact of NMR and HT indicators are estimated on the same cross country-industry sample as relation (1), broken down between non-manufacturing and manufacturing industry groups, and include the same set of fixed effects, i.e. country*industry and country*year fixed effects. Real wages are measured at the national level, so the impacts of EPL indicators are estimated on country panel data over the period 1987-2007 and include country and year fixed effects.

Tables C2 presents the estimation results. All the coefficients are statistically significant and of the expected positive sign. In other words, these results support the assumption that relative production prices and real wages are relevant indexes of product market and labor market regulations.¹⁶

INCLUDE Table C2 about HERE

¹⁶ The policy simulations presented in section 4 give economic significance to the estimated coefficient of Table C2. According to these simulations, a switch to the lightest practices would imply, on average and on long-term, a 1.71% decrease of production prices (1.23% from the NMR reforms and 0.48% from the HT reforms), a real wage decrease of 2.00% for the high skill workers and of 5.73% for the low skill workers.

APPENDIX D: SPEED OF ADJUSTMENT, AN ERROR CORRECTION MODEL

DOLS estimates of relation (1) (Table 1) provide the long-term impact of relative production prices and real wages on MFP. In the same way, Table C2 presents the long-term relations of relative production prices and real wages with the OECD regulation indicators. However, it is interesting in term of policy recommendations to evaluate the speed of adjustment to these long-term effects. This appendix presents estimates of this speed of adjustment.

The speed of adjustment is estimated in two steps. First, we calculate the difference between the current values of our dependent variables (DM_p , DNM_p , IM_p , INM_p , JH_w , JL_w , pgf) and its long-term prediction.¹⁷ This difference is called the Error Correction term, noted EC . Then, we estimate the impact of this term on the evolution of the variable, according to the following equation (with Δ indicating a first difference):

$$\Delta DNM_p_{cit} = \pi^a * CE_{cit-1}^a + \epsilon_{cit}^a$$

$$\Delta DM_p_{cit} = \pi^b * CE_{cit-1}^b + \epsilon_{cit}^b$$

$$\Delta JH_w_{cit} = \pi^c * CE_{ct-1}^c + \epsilon_{ct}^c$$

$$\Delta JL_w_{cit} = \pi^d * CE_{ct-1}^d + \epsilon_{ct}^d$$

$$\Delta mfp_{cit} = \pi^{pgf} * CE_{cit-1}^{mfp} + \epsilon_{cit}$$

Table D presents the corresponding estimation results. As expected, a smaller value than the long-term prediction has a positive and significant impact on growth for MFP as well as relative production prices and real wages.

INCLUDE Table D about HERE

¹⁷ This difference would be equal to the residual of the long-term estimation if we use the OLS estimator. However, as we use the DOLS estimator this no longer true.

APPENDIX E: IMPACT OF 2008-2013 STRUCTURAL REFORMS

This appendix shows an evaluation of the impact of the reforms implemented over the 2008-2013 period. This evaluation mobilizes the OECD NMR indicators and EPL indicators, exactly the EPL on regular contracts, but not the HT indicators, which are not available after 2008.

Chart E1 shows the OECD NMR and EPL regulation indicators changes over the 2008-2013 period.¹⁸ All countries have implemented pro-competitive regulation reforms, with important differences across countries, whereas anti-competitive reforms are very few. EPL reforms are less numerous and they correspond to small changes of the indicator.

INCLUDE Table E1 about HERE

The evaluation method of MFP gains from implemented reforms is the same as for the MFP gains from a switch to the lightest practice in 2013 shown in section 4: we use estimation results of the relations of relative production prices and real wages with the OECD regulation indicators (see Table C2) and of relation (1) (see Table, column (5)) to calculate the impact of reforms on MFP at the industry level, then we aggregate these gains using value added shares of each industry over the whole economy as weights.

Chart E2 shows the long-term MFP gains of the implemented reforms. The differences across countries come from the differences in excess regulations (the results are not sensible to the cross country differences in value added shares). Therefore, the higher MFP gains are for the Italy and come from its reforms of NMR (several reforms in transport and communication industries and reforms in professional services). Note that, according to the Appendix D estimation results, only part of these MFP gains would be realized in 2014.

INCLUDE Table E2 about HERE

¹⁸ Data on USA NMR indicators are not available after 2008.

Charts A1 to E2 and Tables A1 to D

Chart A1

Multi-Factor Productivity relatively to the USA, sample average of industries in 2000

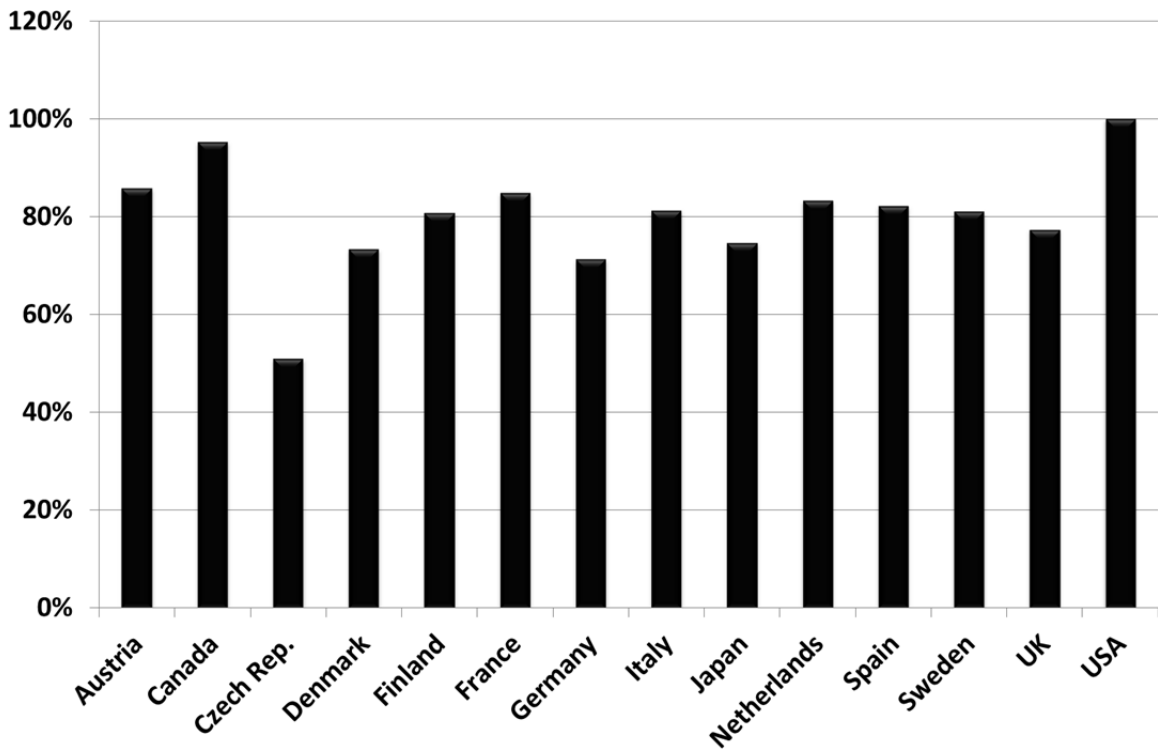


Chart A2

Multi-Factor Productivity growth, sample average of industries in 2000, in percent

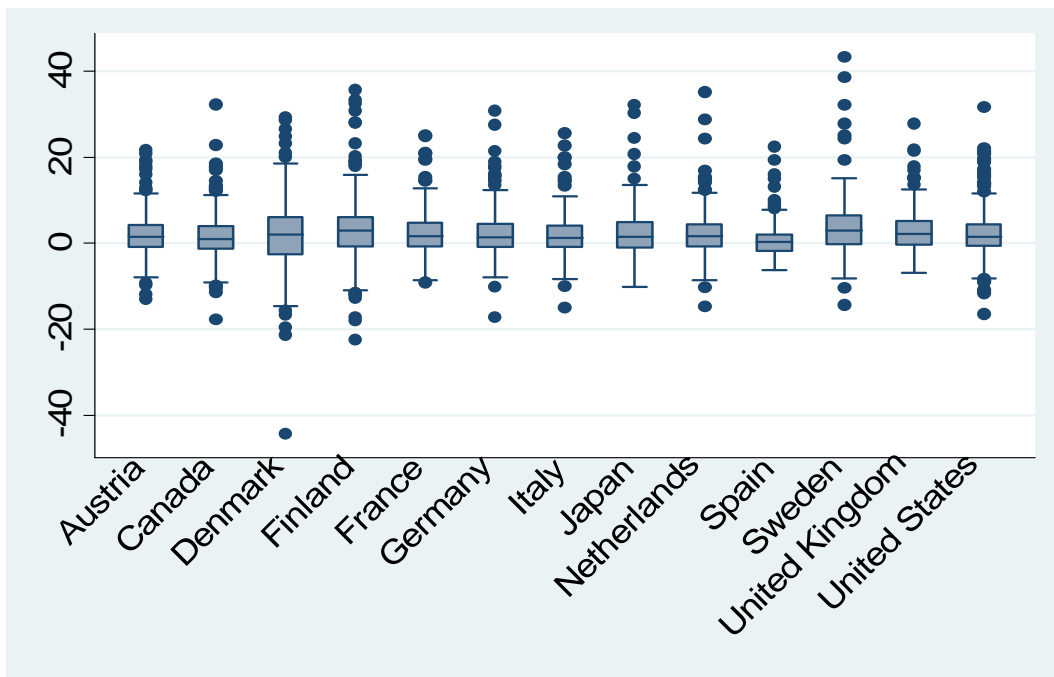


Chart A3

Sample average annual growth of relative production prices

Relative production prices are the ratio of industry production prices over GDP price

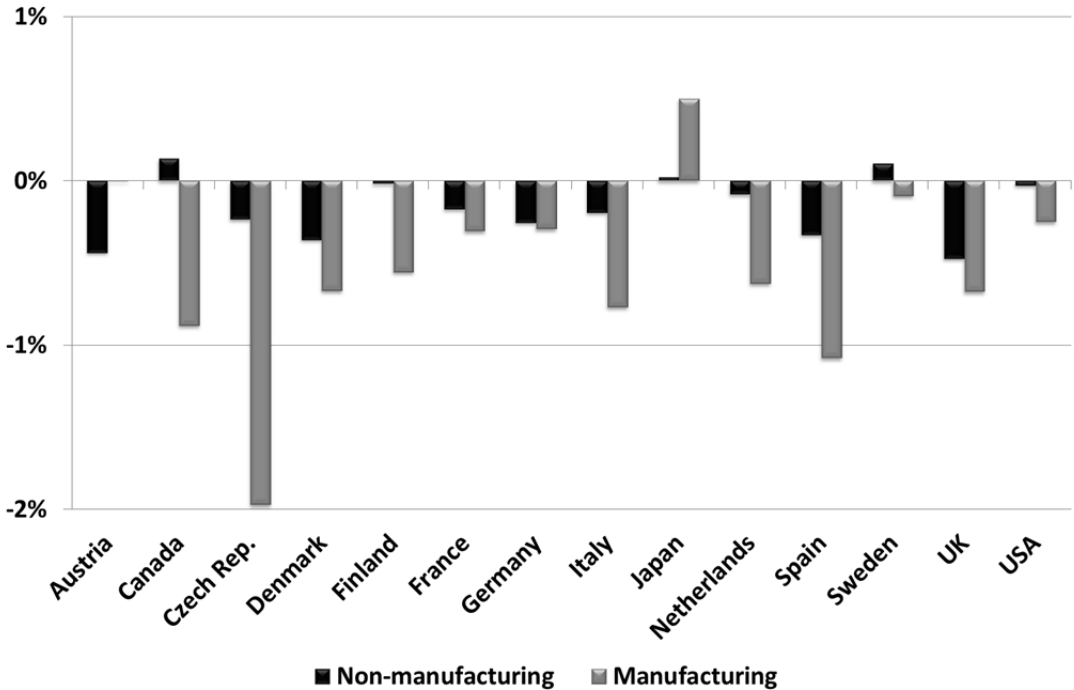


Chart A4

Sample average annual growth of real wages, by skill level

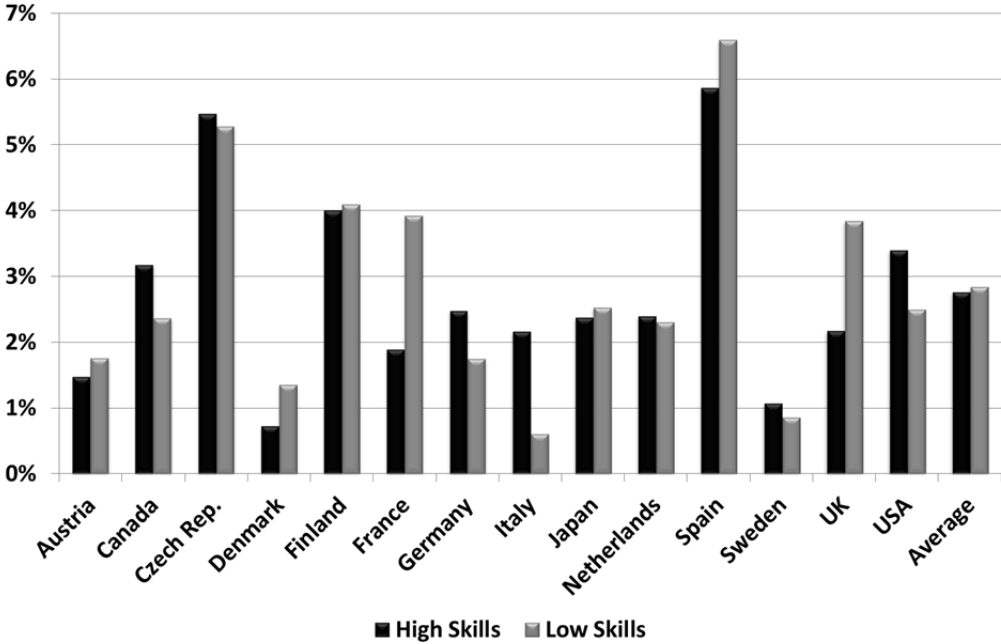
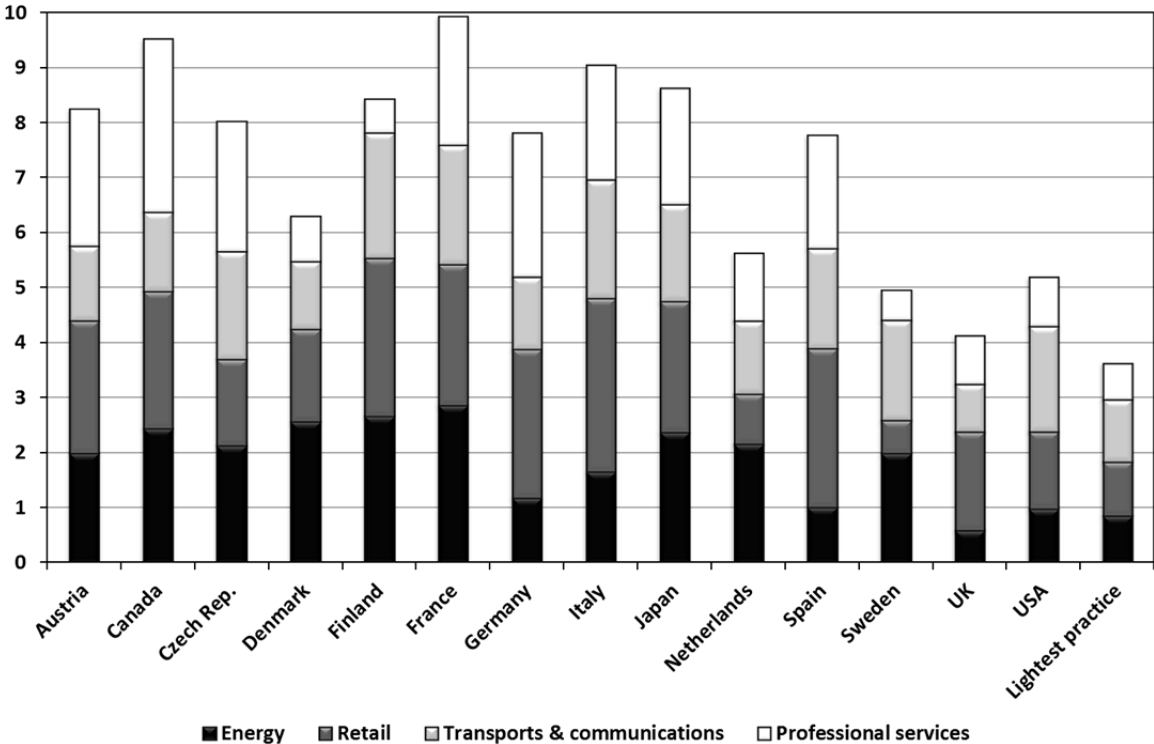
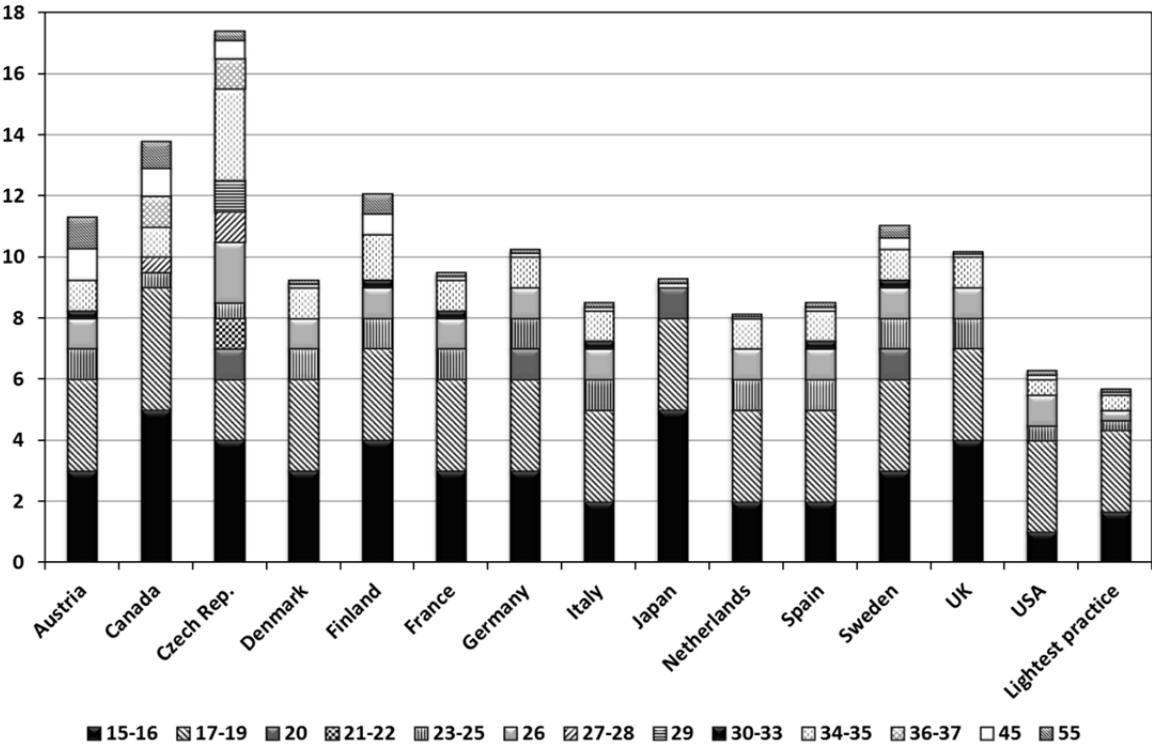


Chart B1
OECD anticompetitive Non-Manufacturing Regulation (NMR) indicators in 2013
 Scale 0-6 for each indicator, 0 for the most pro-competitive



The values for the Bank indicator are for 2007, as there is no update available.

Chart B2
OECD Harmonized Tariff indicators in 2007, by country-industry
 Scale 0-6 for each industry, 0 for the smallest tariffs



ISIC rev. 3 codes are presented for each of the following industries (ISIC code between parentheses): food products (15-16), textiles (17-19), wood products (20), paper (21-22), chemicals products(23-25), non-metallic mineral products (26), metal products (27-28), machinery n.e.c. (29), electrical equipment (30-33), transport equipment (34-35), manufacturing n.e.c. (36-37), construction (45) and hotels & restaurants (55).
 For the ‘Construction’ and ‘Hotels and restaurants’ industries (ISIC code 45 and 55, respectively), the OECD Foreign Direct Investment restrictiveness indicators are presented.

Chart B3

OECD Employment Protection Legislation (EPL) indicator in 2013

Scale 0-6, 0 for the most flexible country labour market

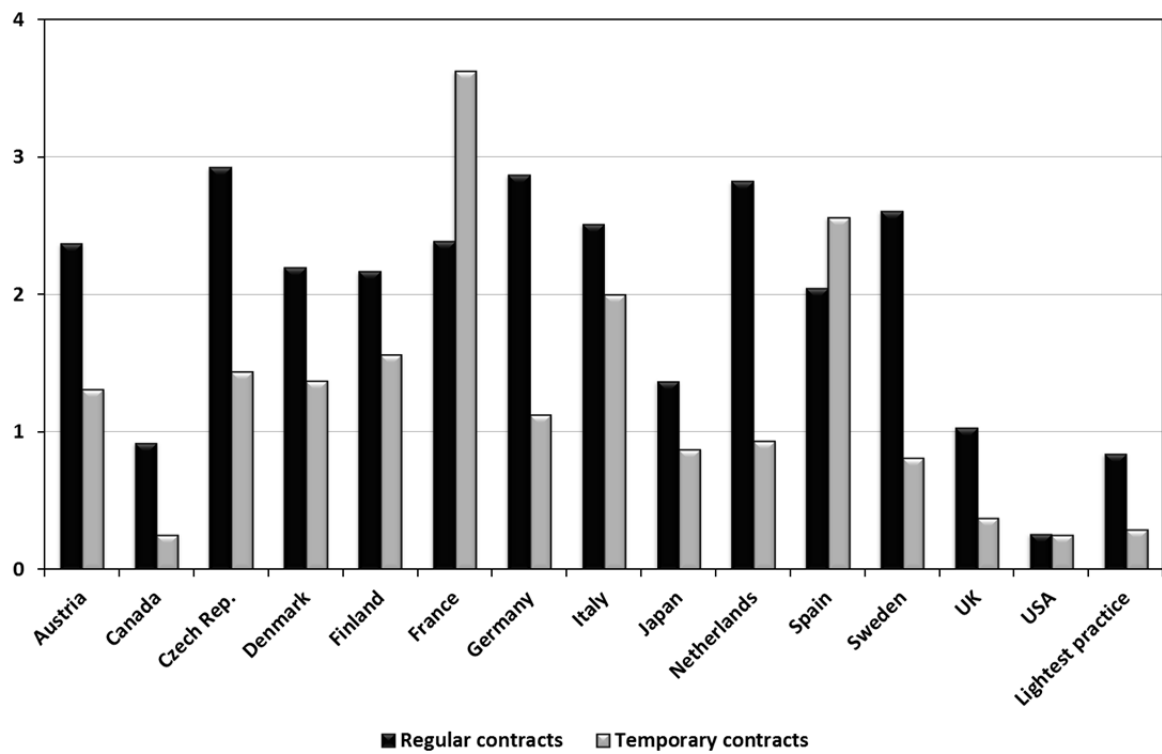
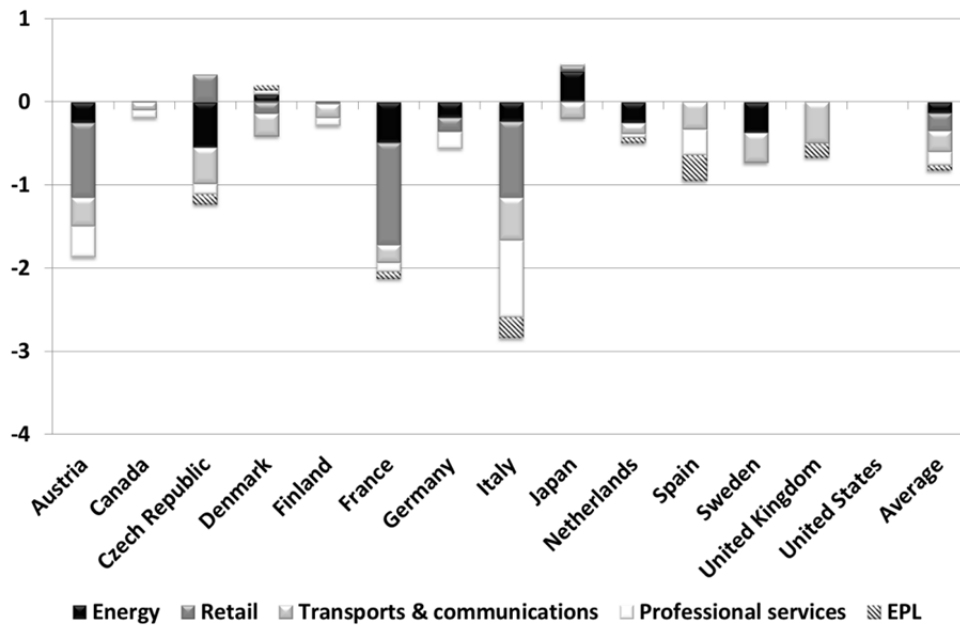


Chart E1

OECD EPL and NMR indicator changes over the 2008-2013 period



Scale of the indicators in levels: 0-6, 0 for the most pro-competitive/flexible country. ISIC rev. 3 codes are presented for each upstream industry (ISIC code between parentheses): energy (40-41), retail services (50-52), transport and communication (60-64), professional services (72-74).

Chart E2

Simulated long-term impact on MFP from the implementation of structural reforms over 2008-2013

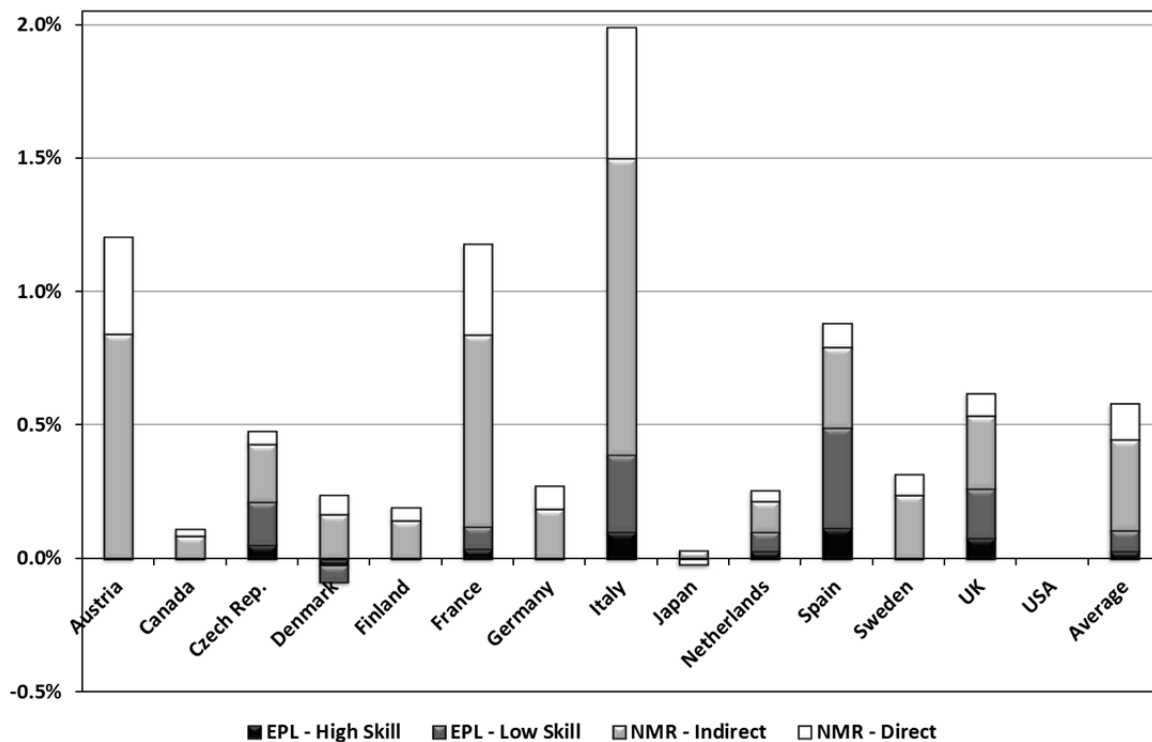


Table A1

Analysis of variance of the relation (1) variables controlling for the fixed effects

		(1)	(2)	(3)
Fixed effects	Country*industry	Y	Y	Y
	Country*year	N	Y	Y
	Industry*year	N	N	Y
MFP (<i>mfp</i>)		0.193	0.163	0.079
USA MFP (<i>mfp^{US}</i>)		0.189	0.164	0.000*
Indirect prices	Manuf. industries (<i>IM_p</i>)	0.041	0.030	0.019
	Non-manuf. industries (<i>INM_m</i>)	0.009	0.003	0.002
Direct prices	Manuf. industries (<i>DM_p</i>)	0.070	0.067	0.051
	Non-manuf. industries (<i>DNM_p</i>)	0.032	0.030	0.028
Country wages * industry labour share	High Skills (<i>JH_w</i>)	0.013	0.007	0.004
	Low Skills (<i>JL_w</i>)	0.025	0.010	0.006
Degree of freedom		2591	2433	2173
Observations		2820	2820	2820

*The variability in (*mfp^{US}*) is necessarily null when controlling for industry*year fixed effects.

Columns (1), (2) and (3) give the standard deviations of the variables after controlling for fixed effects.

Table A2

Analysis of variance of the relation (1) variables in terms of first-differences controlling for the fixed effects

		(1)	(2)	(3)
Fixed effects	Country*year	N	Y	Y
	Industry*year	N	N	Y
MFP (<i>mfp</i>)		0.066	0.064	0.052
USA MFP (<i>mfp</i>^{US})		0.058	0.057	0.000*
Indirect prices	Manuf. industries (<i>IM_p</i>)	0.016	0.011	0.008
	Non-manuf. industries (<i>INM_p</i>)	0.004	0.0015	0.002
Direct prices	Manuf. industries (<i>DM_p</i>)	0.030	0.028	0.021
	Non-manuf. industries (<i>DNM_p</i>)	0.018	0.018	0.018
Country wages * industry labor shares	High Skills (<i>JH_w</i>)	0.004	0.003	0.002
	Low Skills (<i>JL_w</i>)	0.007	0.003	0.003
Degree of freedom		2590	2432	2172
Observations		2591	2591	2591

*The variability in (*mfp*^{US}) is necessarily null when controlling for industry*year fixed effects.

Column (1) gives the standard deviations of the first difference of the variables, while columns (2) and (3) gives them after controlling respectively for country*year fixed effects and both country*year and industry*year fixed effects.

Table C1

Estimation results of the relation (1), sensitivity to industry*year fixed effectsDependent variable: MFP (*mfp*)

Estimator		DOLS				OLS	
		(1)	(2)	(3)	(4)	(5)	(6)
US MFP (<i>mfp</i>^{US})		0.720*** [0.014]	0.756*** [0.015]	–	–	0.687*** [0.013]	0.717*** [0.014]
Indirect prices in	All industries	-0.479*** [0.068]		-0.278*** [0.090]		-0.392*** [0.064]	
	Manuf. indus. (<i>IM_p</i>)		-0.446*** [0.069]		-0.271*** [0.091]		-0.359*** [0.064]
	NM indus. (<i>INM_p</i>)		-5.060*** [0.898]		-0.798 [0.872]		-4.838*** [0.844]
Direct prices from	All industries	-0.441*** [0.033]		-0.248*** [0.030]		-0.460*** [0.031]	
	Manuf. indus. (<i>DM_p</i>)		-0.379*** [0.037]		-0.130*** [0.033]		-0.406*** [0.034]
	NM indus. (<i>DNM_p</i>)		-0.827*** [0.090]		-0.719*** [0.080]		-0.785*** [0.080]
Country wages * industry labour share	All Skills	-2.091*** [0.170]		-0.499* [0.285]		-1.650*** [0.157]	
	High Skills (<i>I_w^H</i>)		-3.043*** [0.329]		-2.162*** [0.477]		-2.412*** [0.292]
	Low Skills (<i>I_w^L</i>)		-1.743*** [0.215]		-0.112 [0.339]		-1.327*** [0.202]
Observations		2820	2820	2820	2820	2820	2820
R-squared		0.798	0.804	0.872	0.877	0.783	0.788
Industry*year fixed effects		N	N	Y	Y	N	N

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

Standard errors between brackets.

Country*industry and country*year fixed effects included.

Table C2

Product market

Dep. variable	Relative production prices		Real wages	
	(1)	(2)	(3)	(4)
	Non-manuf. industries	Manuf. industries	High skills	Low skills
Regulations indicators⁽¹⁾	0.024*** [0.005]	0.031*** [0.005]	0.030* [0.017]	0.087*** [0.017]
Observations	753	2067	238	238
R-squared	0.457	0.201	0.998	0.998

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

Standard errors between brackets.

Country*industry and country*year fixed effects are included.

(1): The regulation indicators are the NMR indicators in column 1, the HT indicators in column 2 and the EPL indicator in column 3 and 4.

Table D
Adjustment coefficients

Dependent variable	MFP growth (Δmfp)	Relative production price growth (Δp)		Real wage growth (Δw)	
		Non-manuf.	Manuf.	High skills	Low skills
	(1)	(2)	(3)	(4)	(5)
Error Correction term (EC)	-0.215***	-0.235***	-0.025**	-0.119***	-0.066**
	[0.013]	[0.027]	[0.010]	[0.036]	[0.033]
Observations	2820	753	2067	225	225
R-squared	0.095	0.088	0.004	0.056	0.039

*** significant at 1%; ** significant at 5%; *significant at 10%.
Standard errors between brackets.

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