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Oleg Badunenko, Portsmouth Business School

Portsmouth Business School
http://www.port.ac.uk/portsmouth-business-school/

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Oleg Badunenko⋆

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This chapter builds a model in which labor market regulations influence labor productivity growth through labor market. The proposed model decomposes labor productivity growth into components attributable to (i) change in efficiency, (ii) technological change, (iii) physical capital deepening, (iv) human capital accumulation, and (v) labor market regulations change. The empirical analysis using data from the Penn World Tables and Economic Freedom of the World Data is performed for 1970−1995 and 1995−2014. The findings can be summarized as follows. First, physical capital deepening is the major driving force behind productivity growth over the entire period. Labor market regulations change contributing next to nothing during 1970−1995, becomes second most important force of economic growth after 1995. Second, relatively rich nations benefit more from labor market regulations change than relatively poor nations. Finally, the contribution of labor market regulations change to growth is stronger for countries with less liberalized labor markets.

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⋆ Economics and Finance Group, Portsmouth Business School, University of Portsmouth, Portsmouth, United Kingdom

1 Introduction

This chapter analyzes the effect of the *change* in the labor market rigidity (the level of labor market regulations) on productivity growth. Labor market regulations are seen as a significant culprit for economic growth despite the fact that labor markets have been liberalized over last decades in many economies (see e.g., Nickell and Layard, 1999). However, the relationship between labor market regulations and labor productivity has not been appropriately analyzed. The main interest of the economists seems to be the effect of changes in labor market regulations on the labor market and unemployment (Storm and Naastepad, 2009). Di Tella and MacCulloch (2005) show that increasing labor market flexibility increases both the employment rate and the rate of participation in the labor force. Javorcik and Spatareanu (2005) find evidence that greater labor market flexibility results in larger foreign direct investment inflows. Botero, Djankov, La Porta, Lopez-de Silanes and Shleifer (2004) conclude that heavier regulation of labor is accompanied by lower labor force participation and higher unemployment. Feldmann (2009) examines the effect of labor regulation on unemployment.

The focus in the literature on the impact of labor market regulations on labor market is not unexpected, since the existence of this influence is obvious and theoretically grounded (see e.g., Blanchard and Giavazzi, 2003). The direct influence of labor market regulations on labor productivity is not so easy to understand. In a typical analysis, labor productivity is regressed on some measure of labor market regulations to gauge the effect of labor market regulations. Such approach offers conclusion which is not unambiguous. The effect of labor market regulations on labor productivity is found to be either negative (e.g., Autor, Kerr and Kugler, 2007), or positive (see Auer, Berg and Coulibaly, 2005; Nickell and

Layard, 1999). Simple employment or labor productivity regressions (see e.g., Storm and Naastepad, 2009; Dew-Becker and Gordon, 2012) constitute not a structural but rather a reduced form approach and thus do not provide a mechanism or channel through which labor market regulations affect labor productivity. This chapter models such mechanism by assuming that labor market regulations affects labor productivity through labor market.

By its nature, this chapter is a cross-country study, which requires a rich and comparable data. This type of analysis is associated with two challenges. The first challenge is obtaining comparable data on labor market regulations for a number of nations over a long time period. For example, Javorcik and Spatareanu (2005) use a variety of proxies for labor market regulations, which exist for a limited number of countries and time periods. Lawson and Bierhanzl (2004) were among the first to use previous generation of the Gwartney, Lawson and Hall (2016) measures to construct a labor market flexibility index and advocated its use for studying labor market performance among countries. Aleksynska and Cazes (2014) on the other hand argue for cautious use of this labor market regulations index and indicators from other sources for research and policy advice. This chapter uses Gwartney et al. (2016) data allowing to develop a single index reflecting labor market regulations that is available for 20 countries before 1995 and for 52 countries thereafter.

The second challenge is modeling the effect of labor market regulations on labor productivity growth. Following the Solow model, cross-country income difference and economic growth were attributed to improvements in technology, investment in physical capital and accumulation of human capital. These causes, while vital, are only proximate causes of economic growth (Acemoglu, 2009). A more difficult task is to investigate the fundamental causes of differences in income and economic growth (e.g., Weil, 2014). Several studies choose to go beyond looking at proximate couses. Hall and Jones (1999) for example, find that variables attributable to physical and human capital only partially explained variation of output per worker across countries, while differences in "social infrastructure" (e.g., institutions and government policies) had the largest effect on the variation of economic development. Badunenko and Romero-Ávila (2013) investigate the role of changes in financial system, quality of institutions and legal environment in labor productivity growth. This chapter proposes a model that incorporates labor market regulations into productivity growth accounting framework.

The rest of the chapter is organized as follows. Section 2 describes the quintipartite decomposition of labor productivity growth which accounts for changes in labor market regulations. Data and empirical results are presented in sections 3 and 4, respectively. The final section concludes.

2 Productivity Growth Accounting using a Production Frontier Approach

2.1 Efficiency Measurement using Data Envelopment Analysis

We construct the world production-frontier and the associated efficiency levels of individual economies (distances from the frontier) nonparametrically.[1] The basic idea is to envelop the data in the smallest convex cone, where the upper

[1] The reader is referred to Färe, Grosskopf and Lovell (1994) for details on Data Envelopment Analysis.

boundary of this set represents the "best practice" production-frontier. One of the major benefits of this approach is that it does not require prior specification of the functional form of the technology. It is a data-driven approach, implemented with standard mathematical programming algorithms, which allows the data to tell the form of the production function.

Our technology contains five macroeconomic variables: aggregate output and four aggregate inputs – labor, physical and human capital, and labor market flexibility. To ease the exposition, labor market flexibility refers to the allocative efficiency-enhancing role of labor market regulations when allocating labor resources from workers to the best employment possibilities (see e.g., Bassanini and Ernst, 2002; Botero et al., 2004). Let $\langle Y_{it}, K_{it}, L_{it}, H_{it}, LMF_{it}\rangle$, $t = 1, 2, \ldots, T$, $i = 1, 2, \ldots, N$, represent T observations on these five variables for each of the N countries. We adopt a standard approach in the literature (e.g., Lucas, 1988; Klenow and Bils, 2000; Hall and Jones, 1999) and assume that human capital enters the technology as a multiplicative augmentation of physical labor input.[2] Furthermore, we consider labor market flexibility to multiplicatively augment the physical labor input, so that our NT observations are $\langle Y_{it}, K_{it}, \hat{L}_{it}\rangle$, $t = 1, 2, \ldots, T$, $i = 1, 2, \ldots, N$, where $\hat{L}_{it} = L_{it}H_{it}LMF_{it}$ is the amount of labor input measured in *effective* units in country i at time t. The constant returns to scale technology for the world in period t is constructed by using all the data up

[2] Such labor-augmenting human capital specification reflects the idea that human capital captures the efficiency units of labor embedded in raw labor (see Weil, 2014, chapter 6) for a textbook exposition. An alternative specification is the human-capital augmented Solow model where human capital enters the production function as an additional ordinary input, next to physical capital and raw labor (Mankiw, Romer and Weil, 1992). However, this type of formulation is not micro-founded (see Acemoglu, 2009, chapter 3 and 10 for a discussion on this issue).

to that point in time as

$$\mathcal{T}_t = \left\{ \begin{array}{r} \left\langle Y, \hat{L}, K \right\rangle \in \Re^3_+ | Y \leq \sum_{\tau \leq t} \sum_i z_{i\tau} Y_{i\tau}, \\ \hat{L} \geq \sum_{\tau \leq t} \sum_i z_{i\tau} \hat{L}_{i\tau}, \\ K \geq \sum_{\tau \leq t} \sum_i z_{i\tau} K_{i\tau}, \\ z_{i\tau} \geq 0 \ \forall \ i, \tau \end{array} \right\}, \qquad (1)$$

where $z_{i\tau}$ are the activity levels. By using all the previous years data, we preclude implosion of the frontier over time. It is difficult to believe that the world technological frontier could implode or that the stock of knowledge decays. Thus, following an approach first suggested by Diewert (1980), we chose to adopt a construction of the technology that precludes such technological degradation.

The Farrell (1957) (output-based) efficiency index for country i at time t is defined by

$$e_{it} = E(Y_{it}, \hat{L}_{it}, K_{it} | \mathcal{T}_t) = \min \left\{ \lambda \mid \left\langle Y_{it}/\lambda, \hat{L}_{it}, K_{it} \right\rangle \in \mathcal{T}_t \right\}. \qquad (2)$$

This index is the inverse of the maximal proportional amount that output Y_{it} can be expanded while remaining technologically feasible, given the technology and input quantities. It is less than or equal to unity and takes the value of unity if and only if the *it* observation is on the period-t production-frontier. In our special case of a scalar output, the output-based efficiency index equals the ratio of actual to potential output evaluated at the actual input quantities.[3]

[3] While there are several approaches to efficiency measurement, DEA is one of the most commonly employed. The other frequently employed method is Stochastic Frontier Analysis (SFA). For comparisons of these two approaches, see, for example, Gong and Sickles (1992); Bojanic, Caudill and Ford (1998), and Badunenko, Henderson and Kumbhakar (2012).

2.2 Quintipartite Decomposition of Labor Productivity Growth

We decompose labor productivity growth between base (b) and current (c) points in time into components attributable to (1) efficiency changes (technological catching-up), (2) technological change, (3) physical capital deepening, (4) human capital accumulation and (5) allocative efficiency from change in the labor market regulations. We first note that constant returns to scale allows us to construct the production-frontiers in the $\hat{y} - \hat{k}$ space, where $\hat{y} = Y/\hat{L}$ and $\hat{k} = K/\hat{L}$. Since by definition the efficiency index is simply the ratio of actual to potential output evaluated at the actual input quantities, the potential outputs per efficiency unit of labor in the two periods are given by $\overline{y}_b(\hat{k}_b) = \hat{y}_b/e_b$ and $\overline{y}_c(\hat{k}_c) = \hat{y}_c/e_c$, where e_b and e_c are the values of the efficiency indexes in the respective periods as calculated in (2) above. Accordingly,

$$\frac{\hat{y}_c}{\hat{y}_b} = \frac{e_c}{e_b} \times \frac{\overline{y}_c(\hat{k}_c)}{\overline{y}_b(\hat{k}_b)}. \tag{3}$$

Define four different levels of efficiency units of capital per efficiency unit of labor. Let $\tilde{k}_c^{H,LMF} = K_c/(L_c H_b LMF_b)$ denote the ratio of capital to labor measured in efficiency units under the counterfactual assumption that both human capital and labor market flexibility had not changed from their base period, $\tilde{k}_c^{LMF} = K_c/(L_c H_c LMF_b)$ the ratio of capital to labor measured in efficiency units under the counterfactual assumption that only labor market flexibility remained at its base-period level, $\tilde{k}_b^{H,LMF} = K_b/(L_b H_c LMF_c)$ the ratio of capital to labor measured in efficiency units under the counterfactual assumption that both human capital and labor market flexibility were equal to their current-period levels, and $\tilde{k}_b^{LMF} = K_b/(L_b H_b LMF_c)$ the ratio of capital to labor measured in efficiency units under the counterfactual assumption that only labor market flexibility was equal to its current-period level. Then $\overline{y}_b\left(\tilde{k}_c^{H,LMF}\right)$ and $\overline{y}_b\left(\tilde{k}_c^{LMF}\right)$ are the potential outputs per efficiency unit of labor at $\tilde{k}_c^{H,LMF}$ and $\tilde{k}_c^{LMF}$ using the base-period technology, and $\overline{y}_c\left(\tilde{k}_b^{H,LMF}\right)$ and $\overline{y}_c\left(\tilde{k}_b^{H}\right)$ are the potential outputs per efficiency unit of labor at $\tilde{k}_b^{H,LMF}$ and $\tilde{k}_b^{LMF}$ using the current-period technology. By multiplying the numerator and denominator of (3) alternatively by $\overline{y}_b\left(\hat{k}_c\right)\overline{y}_b\left(\tilde{k}_c^{H,LMF}\right)\overline{y}_b\left(\tilde{k}_c^{LMF}\right)$ and $\overline{y}_c\left(\hat{k}_b\right)\overline{y}_c\left(\tilde{k}_b^{H,LMF}\right)\overline{y}_c\left(\tilde{k}_b^{LMF}\right)$, we obtain two alternative decompositions of the growth of $\hat{y}$

$$\frac{\hat{y}_c}{\hat{y}_b}=\frac{e_c}{e_b}\times\frac{\overline{y}_c\left(\hat{k}_c\right)}{\overline{y}_b\left(\hat{k}_c\right)}\times\frac{\overline{y}_b\left(\tilde{k}_c^{H,LMF}\right)}{\overline{y}_b\left(\hat{k}_b\right)}\times\frac{\overline{y}_b\left(\tilde{k}_c^{LMF}\right)}{\overline{y}_b\left(\tilde{k}_c^{H,LMF}\right)}\times\frac{\overline{y}_b\left(\hat{k}_c\right)}{\overline{y}_b\left(\tilde{k}_c^{LMF}\right)},\tag{4}$$

and

$$\frac{\hat{y}_c}{\hat{y}_b}=\frac{e_c}{e_b}\times\frac{\overline{y}_c\left(\hat{k}_b\right)}{\overline{y}_b\left(\hat{k}_b\right)}\times\frac{\overline{y}_c\left(\hat{k}_c\right)}{\overline{y}_c\left(\tilde{k}_b^{H,LMF}\right)}\times\frac{\overline{y}_c\left(\tilde{k}_b^{H,LMF}\right)}{\overline{y}_c\left(\tilde{k}_b^{LMF}\right)}\times\frac{\overline{y}_c\left(\tilde{k}_b^{LMF}\right)}{\overline{y}_c\left(\hat{k}_b\right)}.\tag{5}$$

The growth of productivity, $y_t = Y_t/L_t$, can be decomposed into the growth of output per efficiency unit of labor and the growth of human capital, as follows:

$$\frac{y_c}{y_b}=\frac{H_c}{H_b}\times\frac{\hat{y}_c}{\hat{y}_b}.\tag{6}$$

Combining (4) and (5) with (6), we obtain

$$\begin{aligned}\frac{y_c}{y_b} &= \frac{e_c}{e_b}\times\frac{\overline{y}_c\left(\hat{k}_c\right)}{\overline{y}_b\left(\hat{k}_c\right)}\times\frac{\overline{y}_b\left(\tilde{k}_c^{H,LMF}\right)}{\overline{y}_b\left(\hat{k}_b\right)}\times\left[\frac{\overline{y}_b\left(\tilde{k}_c^{LMF}\right)}{\overline{y}_b\left(\tilde{k}_c^{H,LMF}\right)}\frac{H_c}{H_b}\right]\times\left[\frac{\overline{y}_b\left(\hat{k}_c\right)}{\overline{y}_b\left(\tilde{k}_c^{LMF}\right)}\frac{LMF_c}{LMF_b}\right] \\ &\equiv \text{EFFCH}\times\text{TECH}^c\times\text{KLACC}^b\times\text{HACC}^b\times\text{LMFCH}^b,\end{aligned}\tag{7}$$

and

$$\frac{y_c}{y_b} = \frac{e_c}{e_b} \times \frac{\overline{y}_c\left(\hat{k}_b\right)}{\overline{y}_b\left(\hat{k}_b\right)} \times \frac{\overline{y}_c\left(\hat{k}_c\right)}{\overline{y}_c\left(\tilde{k}_b^{H,LMF}\right)} \times \left[\frac{\overline{y}_c\left(\tilde{k}_b^{H,LMF}\right)}{\overline{y}_c\left(\tilde{k}_b^{LMF}\right)} \frac{H_c}{H_b}\right] \times \left[\frac{\overline{y}_c\left(\tilde{k}_b^{LMF}\right)}{\overline{y}_c\left(\hat{k}_b\right)} \frac{LMF_c}{LMF_b}\right] \quad (8)$$
$$\equiv \text{EFFCH} \times \text{TECH}^b \times \text{KLACC}^c \times \text{HACC}^c \times \text{LMFCH}^c.$$

These identities decompose growth of labor productivity in the two periods into changes in efficiency, technology, the capital-labor ratio, human capital accumulation and change in labor market flexibility. The decomposition in (4) measures technological change by the shift in the frontier in the output direction at the current-period effective capital to effective labor ratio, whereas the decomposition in (5) measures technological change by the shift in the frontier in the output direction at the base-period effective capital to effective labor ratio. Similarly, (7) measures the effect of physical, human capital accumulation, and financial development along the base-period frontier, whereas (8) measures the effect of physical, human capital accumulation, and change in labor market flexibility along the current-period frontier.

These two decompositions do not yield the same results unless the technology is Hicks neutral. In other words, the decomposition is path dependent. This ambiguity is resolved by adopting the "Fisher Ideal" decomposition. This is based on geometric averages of the two measures of the effects of technological change, capital deepening, human capital accumulation and change in labor market flexibilityand obtained mechanically by multiplying the numerator and denominator of

(3) by $\left(\overline{y}_b\left(\hat{k}_c\right)\overline{y}_b\left(\tilde{k}_c^{H,LMF}\right)\overline{y}_b\left(\tilde{k}_c^{LMF}\right)\right)^{1/2}\left(\overline{y}_c\left(\hat{k}_b\right)\overline{y}_c\left(\tilde{k}_b^{H,LMF}\right)\overline{y}_c\left(\tilde{k}_b^{LMF}\right)\right)^{1/2}$:

$$\begin{aligned}\frac{y_c}{y_b} &= \text{EFFCH} \times (\text{TECH}^b \cdot \text{TECH}^c)^{1/2} \times (\text{KLACC}^b \cdot \text{KLACC}^c)^{1/2} \\ &\quad \times (\text{HACC}^b \cdot \text{HACC}^c)^{1/2} \times (\text{LMFCH}^b \cdot \text{LMFCH}^c)^{1/2} \\ &\equiv \text{EFFCH} \times \text{TECH} \times \text{KLACC} \times \text{HACC} \times \text{LMFCH}. \qquad (9)\end{aligned}$$

3 Data

The data for output, physical capital and labor were retrieved from the real national accounts better known as the Penn World Tables (see Feenstra, Inklaar and Timmer, 2015).[4] For constructing the human capital index, we follow Badunenko and Romero-Ávila (2013) using Barro and Lee (2013) educational data set.

3.1 Labor Market Flexibility

The data for labor market regulations comes from the Economic Freedom of the World Data, which is compiled by the Fraser Institute (Gwartney et al., 2016).[5] The variable 'Labor market regulations' is an index on scale from 0 to 10, which is a simple average of six components: (i) hiring regulations and minimum wage, (ii) hiring and firing regulations, (iii) centralized collective bargaining, (iv) hours regulations, (v) mandated cost of worker dismissal, and (vi) conscription.[6] The scale means that the larger is the index the weaker is the regulation. The index effectively measures labor market flexibility, i.e., smaller index implies less

[4] Penn World Tables can be downloaded from http://dx.doi.org/10.15141/S5J01T.

[5] The data can be retrieved from http://www.freetheworld.com/datasets_efw.html.

[6] Alternatively, factor analysis can be used to construct an index (Storm and Naastepad, 2009).

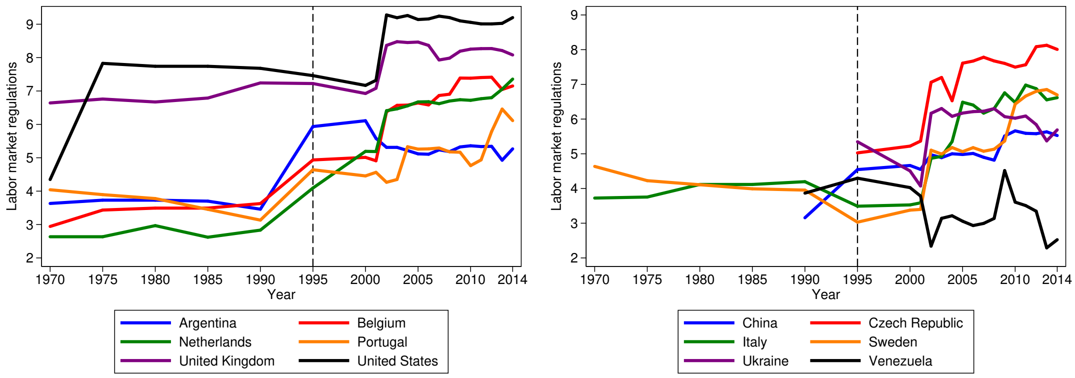

Figure 1: Labor market regulations index for selected countries

Notes: Index is based on six components: (i) hiring regulations and minimum wage, (ii) hiring and firing regulations, (iii) centralized collective bargaining, (iv) hours regulations, (v) mandated cost of worker dismissal, and (vi) conscription. Larger index means weaker regulation.

flexible labor market. If labor market regulations index increases, we say that labor market becomes more flexible. The data from the Economic Freedom of the World Data are available from 1970 to 2014.[7]

Figure 1 shows evolution of the index between 1970 and 2014 for 12 selected countries. A number of features are worth noting. First, for many countries labor market regulations index is available only from the 1990s. This impacts to some extent the time period that is considered in this chapter. Second, the major liberalizations of the labor markets around the world occurred in the 2000s. Although the United States and United Kingdom were the champions of labor market flexibility before the 2000s, they managed to make their labor market less regulated still. Third, most European countries were gradually making their

[7] Before 1995 the labor market regulations index is available for the following 20 countries: Argentina, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Italy, Japan, Netherlands, New, Zealand, Norway, Portugal, Spain, Sweden, Switzerland, United Kingdom, and United States. After 1995, the data are additionally available for the following 32 nations: Australia, Brazil, Chile, China, Colombia, Czech, Republic, Egypt, Hong Kong, Hungary, Iceland, India, Indonesia, Ireland, Israel, Jordan, Republic of Korea, Luxembourg, Malaysia, Mexico, Peru, Philippines, Poland, Russia, Singapore, Slovakia, South, Africa, Taiwan, Thailand, Turkey, Ukraine, Venezuela, and Zimbabwe.

labor market less rigid, but the level of flexibility is still lagging behind those of the United States and United Kingdom. Ukraine, for example leaped forward in the early 2000s, but then, if anything, went slightly back. Czech Republic was consistently lowering barriers in labor market reaching UK's level of labor market flexibility in 2014. Forth, China's labor market regulations index was on the rise, growing from 3 in 1990 to 5 in 2014. Finally, Latin American Countries seemed to have embraced the trend of lifting the rigidities of labor market in the 1990s, but the degree of labor market regulations leveled off right after that. In case of Venezuela, labor market became even more regulated, reaching second lowest level in 2014 (only Angola's labor market regulations index was lower).

The labor market regulations index includes six components. For selected countries, Figure 2 displays the changes of each of the components over time. With negligible exceptions, all components except for conscription were changing gradually or were not changing at all. Conscription needs special attention for two reasons. First, it either does not change at all, or when it does, it does so considerably. Over the entire sample period, conscription in the United Kingdom and United States (form 1975) is non-existent, while it is compulsory for all in China. On the other hand, many countries went from fully compulsory conscription in 1970 to its complete abolishment in the 2000s (e.g., Argentina and Netherlands). Sweden abolished conscription in 2010.

This peculiar component may therefore influence how the Labor market regulations index is constructed. Figure 3 displays evolution of the Labor market regulations index discarding conscription component. It confirms that the index changes quantitatively, but qualitatively the trend remains the same. This will prove to be important since the decomposition of labor productivity given in (9) is constructed in such a way that this change should not make the overall con-

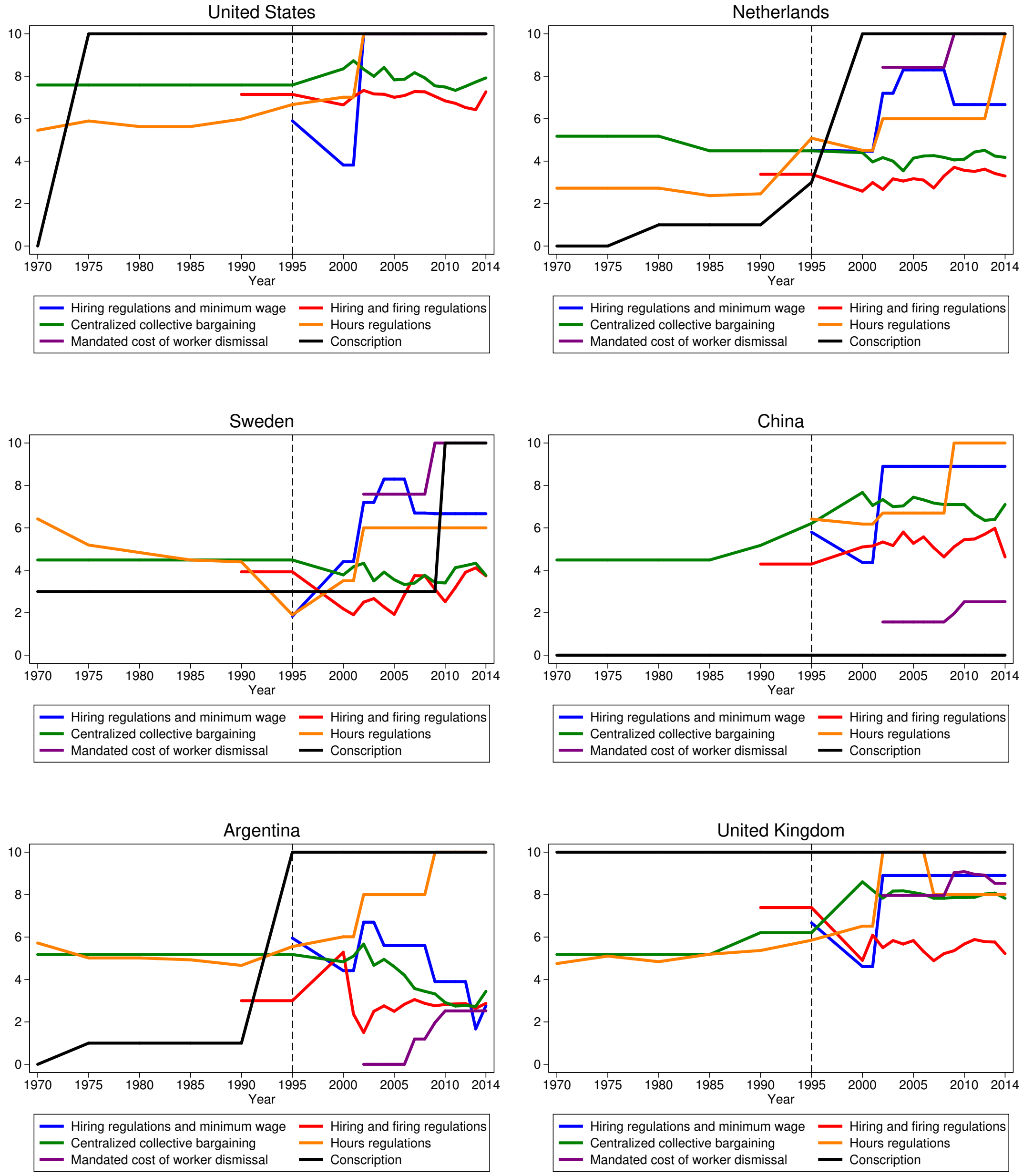

Figure 2: Components of Labor market regulations index for selected countries
Note: Larger value of a given component means weaker regulation in that area.

clusion decidedly different essentially because the level correction roughly washes out in *changes*.

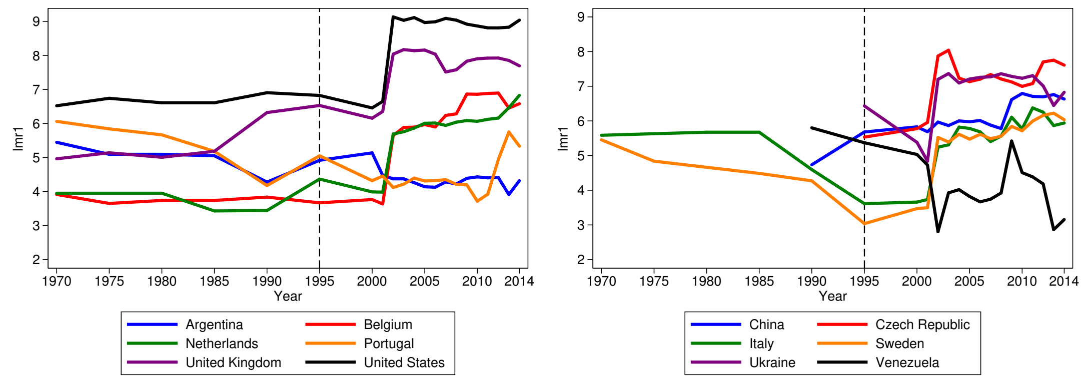

Figure 3: Labor market regulations index for selected countries, discarding conscription
Notes: Index is based on five components: (i) hiring regulations and minimum wage, (ii) hiring and firing regulations, (iii) centralized collective bargaining, (iv) hours regulations, and (v) mandated cost of worker dismissal. Larger index means weaker regulation.

4 Empirical Results

It has been noted that the major liberalization of the labor markets in different parts of the world occurred around 2000. For example, Boeri (2005) draws on variety of sources to provide evidence that OECD countries have set the course to reform labor markets. Furthermore, around 1995, the dynamics of productivity growth has changed. Productivity growth has slowed down in Europe, but accelerated in US (e.g., Dew-Becker and Gordon, 2012). This time period therefore suggests a natural break in analyzing labor productivity growth. In this section we examine the effect the change in labor market flexibility had on labor productivity growth before and after the above mentioned liberalizations. We first consider the change in labor productivity growth in terms of the decomposition (9) from 1970 to 1995, a period without notable changes to labor market regulations. We then present the results of labor productivity growth decomposition from 1995 to 2014, a time period marked by great changes in labor market flexibility.

We consider differences in results introduced by how the labor market regulations index is constructed. Let *LMF1* denote the index based on six components: (i) hiring regulations and minimum wage, (ii) hiring and firing regulations, (iii) centralized collective bargaining, (iv) hours regulations, (v) mandated cost of worker dismissal, and (vi) conscription. Let *LMF2* denote the index, which discards conscription information.

Table 1 reports the country-specific estimates (for the base period 1970 and the current period 1995) of efficiency scores (e_{1970} and e_{1995}) and the country-specific components of the decomposition of productivity growth from 1970 to 1995 using the *LMF1* measure. Table 2 presents the results using the *LMF2* measure. Tables 3 and 4 show the results of the decomposition using the *LMF1* and *LMF2* measure respectively for the period 1995−2014 for 52 nations, while Tables 5 and 6 give the subsample of results for 20 countries available for the period 1970−1995.[8] Both Table 3 and Table 5 as well as Table 4 and Table 6 are presented to show that the main conclusions are robust and are not driven by the choice of the sample.

4.1 The World Production Frontier

The first column in Table 1 shows the efficiency scores measured relative to the frontier formed by observations in 1970. The second column shows the efficiencies scores relative to the frontier formed by observations in 1970 and 1995, which ensures that the technological regress is precluded. Argentina, Austria, France and the Netherlands define the 1970 world production frontier. The 1995 observations of France and Italy define the 1995 frontier. The average efficiency score

[8] Although the results using the *LMF1* and *LMF2* measure differ quantitatively, the conclusions remain qualitatively the same.

Table 1: Efficiency levels in base and current time periods and percentage change of the quintipartite decomposition indexes based on the *LMF1* measure, 1970−1995

Country	e_{1970}	e_{1995}	(PRODCH -1) × 100)	(EFFCH -1) × 100	(TECH -1) × 100	(KLACC -1) × 100	(HACC -1) × 100	(LMFCH -1) × 100
Argentina	1.00	0.70	226.2	−30.2	0.0	285.6	6.5	13.8
Austria	1.00	0.78	112.4	−22.5	7.4	92.2	10.1	20.5
Belgium	0.93	0.82	92.7	−11.8	7.8	20.6	16.8	44.0
Canada	0.78	0.66	42.4	−14.7	1.0	56.2	7.8	−1.8
Denmark	0.81	0.76	58.7	−5.9	2.3	39.7	7.6	9.6
Finland	0.68	0.81	123.1	19.3	16.5	65.2	19.7	−18.8
France	1.00	1.00	71.3	0.0	13.7	31.7	16.5	−1.8
Germany	0.68	0.84	115.8	23.9	6.0	35.0	14.9	5.8
Greece	0.82	0.64	82.9	−22.0	15.3	56.9	19.9	8.1
Italy	0.90	1.00	130.6	11.1	21.4	48.4	20.8	−4.6
Japan	0.61	0.70	175.9	14.4	0.1	128.7	8.2	−2.6
Netherlands	1.00	0.86	56.8	−13.8	7.2	13.9	11.5	33.6
New Zealand	0.72	0.62	56.8	−14.2	0.0	66.3	3.1	6.6
Norway	0.67	0.88	114.9	31.8	3.8	38.1	11.3	2.1
Portugal	0.99	0.65	78.1	−34.5	4.1	84.6	28.4	10.2
Spain	0.97	0.86	116.3	−10.9	8.6	82.0	14.4	7.3
Sweden	0.76	0.89	73.5	18.4	15.0	58.0	10.7	−27.2
Switzerland	0.79	0.68	28.9	−13.9	1.7	35.7	3.9	4.5
United Kingdom	0.60	0.66	76.3	8.7	0.3	42.8	9.2	3.8
United States	0.95	0.76	41.9	−20.3	2.2	22.4	6.0	34.4
Average	0.83	0.78	93.8	−4.4	6.7	65.2	12.4	7.4

has decreased by 5%. This is a result already documented in the literature (see Badunenko, Henderson and Zelenyuk, 2017). Surprisingly, the efficiency score of the United States has dropped from 0.95 to 0.76 and that of Japan remained virtually the same.

When we consider the *LMF2* measure (Table 2), the 1965 world production frontier is defined by the same nations except that Belgium replaces the Netherlands on the frontier. Belgium was quite close to the frontier with the *LMF1* measure and the efficiency score of the Netherlands is 0.98 with the *LMF2* measure.

Both Table 5 and 6, where different measures of labor market regulations were used, suggest that only 2014 observation of Norway defines the 2014 frontier and the average efficiency falls even more than before 1995. When we consider the full sample of 52 countries, Egypt is on the frontier in both 1995 and 2014. It seems to be defining the 2014 frontier at relatively low capital-labor ratios.

Table 2: Efficiency levels in base and current time periods and percentage change of the quintipartite decomposition indexes based on the *LMF2* measure, 1970−1995

Country	e_{1970}	e_{1995}	(PRODCH -1) × 100)	(EFFCH -1) × 100	(TECH -1) × 100	(KLACC -1) × 100	(HACC -1) × 100	(LMFCH -1) × 100
Argentina	1.00	0.90	226.2	−10.0	1.5	246.2	8.5	−5.0
Austria	1.00	0.78	112.4	−22.0	23.7	105.0	10.2	−2.5
Belgium	1.00	0.94	92.7	−5.8	46.3	27.8	14.0	−4.1
Canada	0.99	0.78	42.4	−21.5	6.6	48.0	12.4	2.3
Denmark	0.92	0.81	58.7	−11.9	8.5	38.2	11.5	7.6
Finland	0.77	0.81	123.1	5.2	38.4	71.8	17.4	−24.0
France	1.00	1.00	71.3	0.0	35.2	34.9	14.6	−18.1
Germany	0.69	0.86	115.8	25.0	23.8	39.7	13.2	−11.8
Greece	0.80	0.58	82.9	−27.6	30.1	73.8	18.3	−5.5
Italy	0.87	1.00	130.6	15.2	43.3	58.2	18.4	−25.4
Japan	0.76	0.88	175.9	15.8	1.7	121.2	6.3	−0.3
Netherlands	0.98	0.89	56.8	−9.3	22.5	19.8	10.2	6.8
New Zealand	0.91	0.78	56.8	−14.6	2.0	49.7	3.2	16.5
Norway	0.68	0.92	114.9	33.9	14.4	44.5	10.5	−12.2
Portugal	0.99	0.66	78.1	−33.2	18.5	95.2	32.0	−12.8
Spain	0.97	0.87	116.3	−10.4	25.8	95.0	17.5	−16.3
Sweden	0.86	0.91	73.5	6.1	37.4	61.7	10.4	−33.3
Switzerland	0.88	0.72	28.9	−17.7	5.3	40.9	6.0	−0.4
United Kingdom	0.83	0.82	76.3	−1.4	3.6	31.9	13.5	15.2
United States	0.92	0.91	41.9	−1.3	4.5	23.1	8.8	2.7
Average	0.89	0.84	93.8	−4.3	19.7	66.3	12.8	−6.0

Many of the developed nations have become less efficient and those who moved to the frontier are mostly countries who started from a low base of efficiency and who have relatively low capital-labor ratios such as Ukraine, Russia, or Jordan (Badunenko, Henderson and Russell, 2013).

4.2 Proximate and Fundamental Forces of Labor Productivity Growth

The last five columns in Tables 1−6 report growth of labor productivity along with components of the quintipartite decomposition in (9). The growth of labor productivity was on average twice as large between 1970 and 1995 than it was between 1995 and 2014. Labor productivity growth became slow for all nations (see e.g., Dew-Becker and Gordon, 2012) with notable exceptions of Norway,

Table 3: Efficiency levels in base and current time periods and percentage change of the quintipartite decomposition indexes based on the *LMF1* measure, 1995−2014

Country	e_{1995}	e_{2014}	(PRODCH -1) × 100)	(EFFCH -1) × 100	(TECH -1) × 100	(KLACC -1) × 100	(HACC -1) × 100	(LMFCH -1) × 100
Argentina	0.62	0.69	31.8	10.0	0.3	19.6	3.8	−3.8
Australia	0.67	0.58	25.5	−13.5	4.2	12.1	0.1	24.0
Austria	0.76	0.61	37.6	−20.4	9.2	28.6	5.7	16.4
Belgium	0.79	0.56	34.1	−29.5	7.7	36.5	5.1	23.2
Brazil	0.59	0.46	52.9	−21.8	1.7	72.1	21.2	−7.9
Canada	0.59	0.53	18.5	−10.3	2.5	13.2	5.0	8.4
Chile	0.74	0.63	57.2	−14.0	1.5	71.4	6.4	−1.3
China	0.46	0.40	254.0	−14.3	0.1	257.8	9.4	5.4
Colombia	0.58	0.50	31.3	−14.8	0.7	32.5	8.1	7.0
Czech Republic	0.45	0.39	53.6	−14.3	3.5	29.4	3.0	30.0
Denmark	0.71	0.57	53.9	−19.5	4.8	35.4	6.0	27.0
Egypt	1.00	1.00	106.2	0.0	0.7	92.4	11.6	−4.7
Finland	0.81	0.59	26.6	−26.6	12.6	11.9	8.5	26.2
France	1.00	0.64	42.7	−35.7	11.3	32.6	7.6	39.8
Germany	0.81	0.64	41.0	−21.2	6.8	24.5	2.8	31.0
Greece	0.64	0.55	41.3	−14.1	14.4	20.3	10.2	8.4
Hong Kong	0.67	0.49	27.4	−27.4	3.4	45.6	7.4	8.6
Hungary	0.58	0.46	59.2	−21.0	2.0	69.3	6.9	9.2
Iceland	0.57	0.51	27.7	−11.7	4.8	14.2	8.0	11.8
India	0.37	0.41	223.4	12.6	0.7	166.3	7.8	−0.6
Indonesia	0.70	0.39	109.7	−44.1	1.6	226.0	7.0	5.9
Ireland	0.74	0.73	97.1	−0.1	7.0	64.1	6.7	5.3
Israel	0.84	0.64	7.4	−23.3	4.1	4.1	7.7	20.0
Italy	1.00	0.51	22.4	−49.1	16.2	20.6	10.9	54.8
Japan	0.62	0.49	10.9	−20.9	1.2	29.0	3.9	3.5
Jordan	0.51	0.61	180.9	19.7	0.6	107.4	9.9	2.3
Korea, Republic of	0.71	0.63	59.0	−10.2	2.9	54.3	7.2	4.1
Luxembourg	0.80	0.60	9.9	−25.8	8.5	17.5	10.6	5.1
Malaysia	0.55	0.53	58.9	−3.0	0.8	50.6	7.0	0.9
Mexico	0.58	0.55	36.9	−4.9	1.0	37.6	7.9	−4.0
Netherlands	0.82	0.60	54.1	−27.4	6.2	37.2	5.1	38.5
New Zealand	0.55	0.55	19.2	−1.0	0.2	14.0	0.4	5.0
Norway	0.84	1.00	113.6	19.1	12.4	47.8	6.3	1.6
Peru	0.48	0.46	86.8	−2.9	1.0	56.3	7.1	13.8
Philippines	0.44	0.41	42.7	−8.5	0.9	47.6	6.1	−1.2
Poland	0.67	0.68	102.8	1.6	0.7	47.6	7.9	24.4
Portugal	0.63	0.48	74.7	−23.7	12.4	49.3	12.7	21.0
Russia	0.47	0.70	65.9	49.2	2.4	−15.5	10.2	16.7
Singapore	0.56	0.60	180.9	7.8	4.0	84.7	20.4	12.6
Slovakia	0.53	0.48	84.1	−9.1	0.8	46.2	6.7	28.8
South Africa	0.75	0.49	28.6	−35.4	0.6	66.7	17.2	1.4
Spain	0.85	0.60	48.9	−30.1	13.0	39.6	9.6	23.2
Sweden	0.89	0.60	40.2	−32.7	10.4	16.0	5.5	54.0
Switzerland	0.62	0.63	58.0	1.6	4.1	23.8	2.7	17.5
Taiwan	1.00	0.75	46.2	−24.7	3.4	68.0	9.3	2.3
Thailand	0.44	0.42	54.2	−4.1	0.5	51.2	9.4	−3.4
Turkey	0.90	0.85	77.9	−5.8	3.3	71.8	10.1	−3.3
Ukraine	0.21	0.43	123.1	97.8	0.8	6.0	3.4	2.1
United Kingdom	0.57	0.48	32.9	−15.1	2.1	39.8	4.7	4.9
United States	0.67	0.64	36.3	−3.7	1.9	20.1	2.4	13.0
Venezuela	0.55	0.62	63.8	13.8	8.9	51.1	16.7	−25.0
Zimbabwe	1.00	0.26	−61.0	−74.2	0.0	49.9	4.6	−3.7
Average	0.67	0.57	61.8	−11.1	4.4	50.3	7.7	11.5

Table 4: Efficiency levels in base and current time periods and percentage change of the quintipartite decomposition indexes based on the *LMF2* measure, 1995−2014

Country	e_{1995}	e_{2014}	(PRODCH -1) × 100)	(EFFCH -1) × 100	(TECH -1) × 100	(KLACC -1) × 100	(HACC -1) × 100	(LMFCH -1) × 100
Argentina	0.74	0.87	31.8	17.5	0.9	12.0	6.8	−7.0
Australia	0.80	0.66	25.5	−17.2	2.6	15.0	0.1	28.3
Austria	0.76	0.62	37.6	−18.0	3.4	32.4	4.9	16.8
Belgium	0.94	0.61	34.1	−35.5	6.7	30.0	5.7	41.7
Brazil	0.61	0.50	52.9	−18.6	1.4	70.9	18.6	−8.6
Canada	0.70	0.60	18.5	−13.3	1.8	17.4	4.0	9.8
Chile	0.74	0.65	57.2	−12.4	1.7	71.8	6.1	−3.2
China	0.44	0.40	254.0	−8.3	0.2	243.5	6.3	5.5
Colombia	0.58	0.50	31.3	−14.0	1.5	32.6	7.7	5.4
Czech Republic	0.47	0.44	53.6	−6.7	1.9	33.5	3.9	16.5
Denmark	0.73	0.59	53.9	−19.2	2.1	42.5	5.8	23.6
Egypt	1.00	1.00	106.2	0.0	1.5	87.5	15.8	−6.5
Finland	0.81	0.61	26.6	−24.1	6.5	12.6	8.2	28.5
France	1.00	0.79	42.7	−21.3	4.5	30.2	7.0	24.5
Germany	0.83	0.73	41.0	−12.0	3.2	29.3	2.6	17.1
Greece	0.57	0.60	41.3	3.9	3.5	22.9	9.8	−2.6
Hong Kong	0.78	0.53	27.4	−31.8	2.0	54.3	8.7	9.3
Hungary	0.60	0.54	59.2	−11.1	1.4	68.6	5.7	−0.9
Iceland	0.65	0.57	27.7	−12.7	2.7	17.7	6.7	13.3
India	0.39	0.47	223.4	19.4	0.8	143.3	10.2	0.3
Indonesia	0.67	0.44	109.7	−34.9	1.0	229.6	8.4	−10.8
Ireland	0.88	0.80	97.1	−8.5	6.1	75.1	7.4	8.0
Israel	0.80	0.66	7.4	−18.3	1.5	4.5	7.0	15.7
Italy	1.00	0.62	22.4	−37.6	3.8	16.0	10.2	47.8
Japan	0.73	0.57	10.9	−22.6	1.1	27.4	4.6	6.4
Jordan	0.59	0.66	180.9	11.5	1.2	109.4	13.1	5.1
Korea, Republic of	0.71	0.64	59.0	−9.6	1.1	59.4	6.7	2.2
Luxembourg	0.94	0.66	9.9	−30.1	10.4	16.1	12.2	9.3
Malaysia	0.61	0.59	58.9	−2.5	0.7	43.7	9.8	2.7
Mexico	0.60	0.59	36.9	−0.7	0.9	34.1	7.1	−4.9
Netherlands	0.84	0.66	54.1	−21.2	2.9	44.7	4.8	25.3
New Zealand	0.64	0.63	19.2	−2.2	0.5	8.7	0.3	11.3
Norway	0.86	1.00	113.6	16.6	6.7	54.4	5.4	5.5
Peru	0.48	0.52	86.8	8.3	1.9	61.3	6.4	−1.3
Philippines	0.53	0.46	42.7	−14.4	1.9	56.5	4.9	−0.3
Poland	0.68	0.74	102.8	9.0	0.9	49.8	6.9	15.1
Portugal	0.63	0.64	74.7	0.8	3.2	44.7	11.8	3.9
Russia	0.45	0.72	65.9	60.5	1.1	−14.7	9.2	9.8
Singapore	0.55	0.60	180.9	9.2	1.5	95.6	17.9	9.9
Slovakia	0.54	0.56	84.1	4.1	0.8	45.9	5.7	13.7
South Africa	0.85	0.59	28.6	−30.9	0.7	55.7	13.8	4.3
Spain	0.85	0.82	48.9	−3.3	3.4	30.8	8.8	4.5
Sweden	0.91	0.68	40.2	−25.9	7.0	17.6	5.2	42.9
Switzerland	0.64	0.67	58.0	4.9	1.9	28.5	2.3	12.5
Taiwan	1.00	0.78	46.2	−21.7	1.4	75.3	9.2	−3.9
Thailand	0.44	0.43	54.2	−1.6	1.2	49.9	9.2	−5.5
Turkey	0.91	0.87	77.9	−5.0	1.5	76.8	9.2	−4.4
Ukraine	0.22	0.43	123.1	96.3	1.6	6.0	3.4	2.0
United Kingdom	0.69	0.54	32.9	−21.7	1.6	45.7	5.6	8.6
United States	0.79	0.72	36.3	−8.5	1.5	23.6	2.9	15.4
Venezuela	0.54	0.61	63.8	13.1	2.6	56.5	15.1	−21.6
Zimbabwe	1.00	0.30	−61.0	−70.0	0.3	28.0	13.2	−10.6
Average	0.71	0.62	61.8	−7.5	2.4	50.5	7.7	8.3

Table 5: Efficiency levels in base and current time periods and percentage change of the quintipartite decomposition indexes based on the *LMF1* measure, 1995−2014

Country	e_{1995}	e_{2014}	(PRODCH -1) × 100)	(EFFCH -1) × 100	(TECH -1) × 100	(KLACC -1) × 100	(HACC -1) × 100	(LMFCH -1) × 100
Argentina	0.62	0.69	31.8	10.0	0.3	19.6	3.8	−3.8
Austria	0.76	0.61	37.6	−20.4	9.2	28.6	5.7	16.4
Belgium	0.79	0.56	34.1	−29.5	7.7	36.5	5.1	23.2
Canada	0.59	0.53	18.5	−10.3	2.5	13.2	5.0	8.4
Denmark	0.71	0.57	53.9	−19.5	4.8	35.4	6.0	27.0
Finland	0.81	0.59	26.6	−26.6	12.6	11.9	8.5	26.2
France	1.00	0.64	42.7	−35.7	11.3	32.6	7.6	39.8
Germany	0.81	0.64	41.0	−21.2	6.8	24.5	2.8	31.0
Greece	0.64	0.55	41.3	−14.1	14.4	20.3	10.2	8.4
Italy	1.00	0.51	22.4	−49.1	16.2	20.6	10.9	54.8
Japan	0.62	0.49	10.9	−20.9	1.2	29.0	3.9	3.5
Netherlands	0.82	0.60	54.1	−27.4	6.2	37.2	5.1	38.5
New Zealand	0.55	0.55	19.2	−1.0	0.2	14.0	0.4	5.0
Norway	0.84	1.00	113.6	19.1	12.4	47.8	6.3	1.6
Portugal	0.63	0.48	74.7	−23.7	12.4	49.3	12.7	21.0
Spain	0.85	0.60	48.9	−30.1	13.0	39.6	9.6	23.2
Sweden	0.89	0.60	40.2	−32.7	10.4	16.0	5.5	54.0
Switzerland	0.62	0.63	58.0	1.6	4.1	23.8	2.7	17.5
United Kingdom	0.57	0.48	32.9	−15.1	2.1	39.8	4.7	4.9
United States	0.67	0.64	36.3	−3.7	1.9	20.1	2.4	13.0
Average	0.74	0.60	41.9	−17.5	7.5	28.0	5.9	20.7

Table 6: Efficiency levels in base and current time periods and percentage change of the quintipartite decomposition indexes based on the *LMF2* measure, 1995−2014

Country	e_{1995}	e_{2014}	(PRODCH -1) × 100)	(EFFCH -1) × 100	(TECH -1) × 100	(KLACC -1) × 100	(HACC -1) × 100	(LMFCH -1) × 100
Argentina	0.74	0.87	31.8	17.5	0.9	12.0	6.8	−7.0
Austria	0.76	0.62	37.6	−18.0	3.4	32.4	4.9	16.8
Belgium	0.94	0.61	34.1	−35.5	6.7	30.0	5.7	41.7
Canada	0.70	0.60	18.5	−13.3	1.8	17.4	4.0	9.8
Denmark	0.73	0.59	53.9	−19.2	2.1	42.5	5.8	23.6
Finland	0.81	0.61	26.6	−24.1	6.5	12.6	8.2	28.5
France	1.00	0.79	42.7	−21.3	4.5	30.2	7.0	24.5
Germany	0.83	0.73	41.0	−12.0	3.2	29.3	2.6	17.1
Greece	0.57	0.60	41.3	3.9	3.5	22.9	9.8	−2.6
Italy	1.00	0.62	22.4	−37.6	3.8	16.0	10.2	47.8
Japan	0.73	0.57	10.9	−22.6	1.1	27.4	4.6	6.4
Netherlands	0.84	0.66	54.1	−21.2	2.9	44.7	4.8	25.3
New Zealand	0.64	0.63	19.2	−2.2	0.5	8.7	0.3	11.3
Norway	0.86	1.00	113.6	16.6	6.7	54.4	5.4	5.5
Portugal	0.63	0.64	74.7	0.8	3.2	44.7	11.8	3.9
Spain	0.85	0.82	48.9	−3.3	3.4	30.8	8.8	4.5
Sweden	0.91	0.68	40.2	−25.9	7.0	17.6	5.2	42.9
Switzerland	0.64	0.67	58.0	4.9	1.9	28.5	2.3	12.5
United Kingdom	0.69	0.54	32.9	−21.7	1.6	45.7	5.6	8.6
United States	0.79	0.72	36.3	−8.5	1.5	23.6	2.9	15.4
Average	0.78	0.68	41.9	−12.1	3.3	28.6	5.8	16.8

Denmark, and Portugal. Switzerland turned out to grow in the second time period even more than it did in the first time period.

The results of the quintipartite decomposition suggest that failure to catch-up (get closer to the frontier) is the most important reason for this on average and also individually for almost all countries in the sample (Badunenko et al., 2013). During 1970−1995 many countries managed to improve their efficiency, whereas during 1995−2014 only a handful of countries have become substantially more efficient, specifically, Ukraine, Russia, Jordan, and Norway. Norway defines the 2014 frontier in both the narrow sample of 20 and the extended sample of 52 nations.

Only a small number of countries benefited from technological change. On average the contribution of the component *TECH* is very small, but it is bigger during 1970−1995 than it is after 1995. As a matter of fact, change in technology is the second largest source of growth after physical capital deepening during 1970−1995.

All four tables suggest that physical capital deepening is the dominant force of productivity growth no matter what time period is considered (Kumar and Russell, 2002; Henderson and Russell, 2005; Badunenko and Romero-Ávila, 2013). Physical capital deepening is mainly responsible for growth on average and for the majority of nations. Its importance has abated after 1995 in absolute terms, but its contribution is still much larger than that of any other component of the decomposition. Exceptions are Ukraine, where physical capital deepening has contributed almost nothing to labor productivity growth[9] and Russia, where

[9] Labor productivity in Ukraine has grown mainly because of technological catching-up, i.e., producing closer to the world production frontier.

physical capital deepening has actually prevented labor productivity from growing (Badunenko and Tochkov, 2010).

The contribution of human capital accumulation is about 10% over the whole period, being slightly larger during 1970−1995 and slightly smaller during 1995−2014. The magnitudes shown in the tables are comparable with those in Henderson and Russell (2005), who found that if human capital is ignored, the portion of the contribution of human capital accumulation would in fact be attributed to the contribution of physical capital deepening. Notable here is that human capital accumulation contributed more than labor market regulations change to labor productivity during 1970−1995, being the third largest source of growth. During 1995−2014 its contribution became much smaller and human capital accumulation transformed into the second smallest source of growth.

Tables 1 and 2 show that the contribution of labor market regulations change was on average small if not negative using the *LMF2* measure before 1995. In a regression-based analysis, the effect of labor market regulations on labor productivity seems to depend on how it is defined. Buchele and Christiansen (1999) find that labor market regulations defined by 'worker rights and labor-management cooperation index' had a positive and significant effect on labor productivity during 1979−1994. Employment Protection Legislation had a positive and significant effect on labor productivity for the period 1976−1992 (Nickell and Layard, 1999), but was negative for 1982−2003 (OECD, 2007). Tables 2 suggests that only few countries benefited from changes in labor market regulations. If we compare Tables 2 and 6 (or 1 and 5), where the sample and labor market flexibility measure are the same, it becomes obvious that labor market regulations change becomes important force behind labor productivity growth. Changes in labor market flexibility have prevented labor productivity from growing only in

Argentina and Greece. Belgium, Italy and Sweden benefited from changing labor market flexibility the most. In Belgium, labor market regulations change is the major driver of productivity growth. The last row in Tables 2 and 6 indicate that contribution of labor market regulations change turned from being negligible for the period 1970−1995 to the second only to physical capital deepening for the period 1995−2014.

Tables 3 and 4 and reports the results from the extended sample. The inference drawn from Tables 5 and 6 remains the same, i.e., labor market regulations change becomes the second most important source of labor productivity growth both on average and for single nations. For some nations such as Australia, Chech Republic, Finnland, France, Germany, Italy, the Netherlands, and Sweden labor market regulations change is the principal driver of labor productivity growth after 1995. The above-average contribution of labor market regulations change in Denmark can be attributed to reduced employment protection and increased social protection, termed the system of "flexicurity" or protected mobility (Auer, 2007).

The numbers for components in Tables 1−6 do not add up to labor productivity growth column. These tables also do not show the relative importance of a component. To gauge what percent a component contributes to labor productivity growth, both sides of (9) are log-transformed, divided by log of labor productivity and multiplied by 100. Table 7 shows the averages for each sample and time period.[10]

The contribution of physical capital deepening to labor productivity growth is the strongest among components. From 75% to 85% of labor productivity growth

[10] The numbers in Table 7 add up to 0.

Table 7: Percentage contributions of components of the quintipartite decomposition to labor productivity growth

Period	Measure	Sample[a]	Contribution of				
			EFFCH	TECH	KLACC	HACC	LMFCH
1970−1995	*LMF1*	Narrow	−15.22	10.14	73.80	18.96	12.32
1970−1995	*LMF2*	Narrow	−15.42	27.96	76.05	20.50	−9.09
1995−2014	*LMF1*	Wide	−54.50	14.00	84.09	21.42	34.98
1995−2014	*LMF2*	Wide	−45.02	8.40	85.35	20.95	30.33
1995−2014	*LMF1*	Narrow	−78.90	21.82	79.90	19.07	58.11
1995−2014	*LMF2*	Narrow	−61.24	10.30	79.46	19.04	52.44

[a] Narrow and wide samples are the samples of 20 and 52 nations respectfully.

can be attributed to physical capital deepening on average. Although the contribution of physical capital deepening has fallen in absolute terms over time, it has stayed virtually the same in relative terms. Roughly 20% of labor productivity growth is due to human capital accumulation. Technical change contributes other 10 to 20% on average. These three conclusions hold irrespective of which labor market regulations measure is used, and which sample and time period is considered. The lack of catch-up has increased over time. And Table 7 additionally suggests that this problem is greater for the narrow sample, which mainly contains developed countries. Approximately one third of labor productivity growth can be ascribed to labor market regulations change for the wide sample and about 55% for the narrow sample for the period 1995−2014 up from 10% before 1995.

To identify if relatively richer or relatively poorer countries benefited more from labor market regulations change, the upper panel of Figure 4 shows the scatter plot of the LMFCH component from (9) for the time period from 1970−1995 against the 1970 level of output per unit of labor along with the fitted line. The LMFCH component is plotted against the 1970 level of labor market regulations in the lower panel of Figure 4. Scatter plot and fitted lines of the LMFCH component for the 1995−2014 comparison and initial levels of the 1995 are shown in upper and lower panels of Figure 5.

Two observations are worth noting. First, a positive relationship between LMFCH and output per worker in 1970 evinces the upper panel of Figure 4. However nations that were relatively richer in 1970 do not benefit statistically more from labor market regulations change than relatively poorer nations for the 1970−1995 comparison. The slope of the fitted line is positive and its p-value is 0.28. The upper panel of Figure 5 tells a different story for the 1995−2014 comparison. The nations that were relatively richer in 1995 have on average benefited more from labor market regulations change. The slope coefficient of the fitted line is positive and statistically significant.

Second, starting from 1995, the contribution of labor market regulations change is bigger for nations, whose level of labor market regulations was lower. The slopes of the fitted lines in lower panels of Figures 4 and 5 are negative, however only the slope in the lower panel of the Figure 5 is statistically significant (p-value is 0.0007).

All in all, the analysis demonstrates that the effect of labor market regulations change on labor productivity growth gains importance after 1995. It becomes evident if we recall Figure 1, which shows that the major labor market liberalizations occurred around this break point. Small and insignificant changes of labor market regulations or no changes at all are bound to go unnoticed or even cause harm as Table 2 suggests. Big positive changes in labor markets which happened in the end of the 1990s seem to have brought about positive productivity gains.

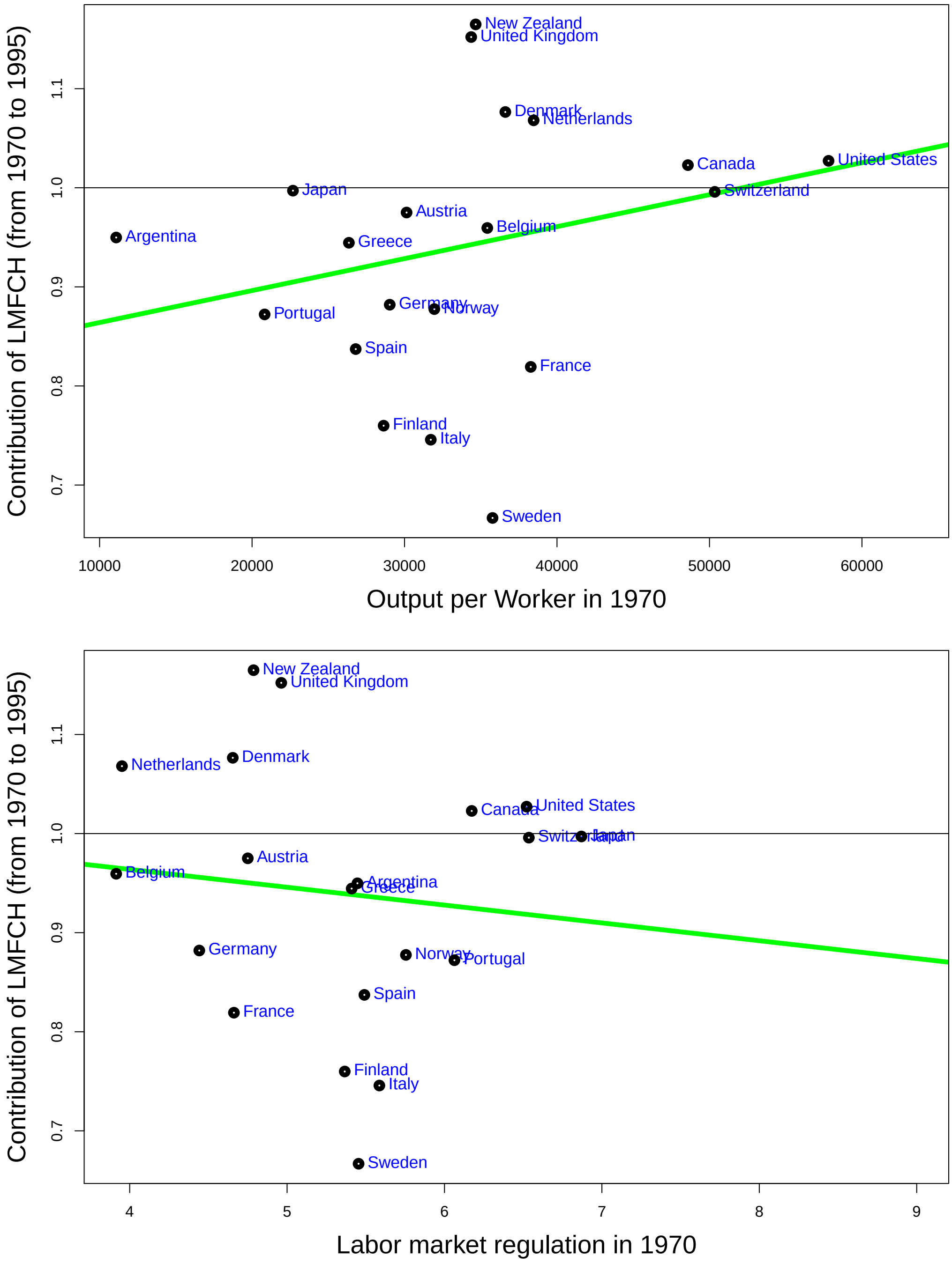

Figure 4: Contribution of LMFCH plotted against output per worker in 1970 (upper panel) and labor market regulations level (lower panel) in 1970. Each panel contains a regression line. The slopes of regression lines in upper and lower panels are 3.2×10^{-06} and -0.018 with p-values 0.28 and 0.63, respectively.

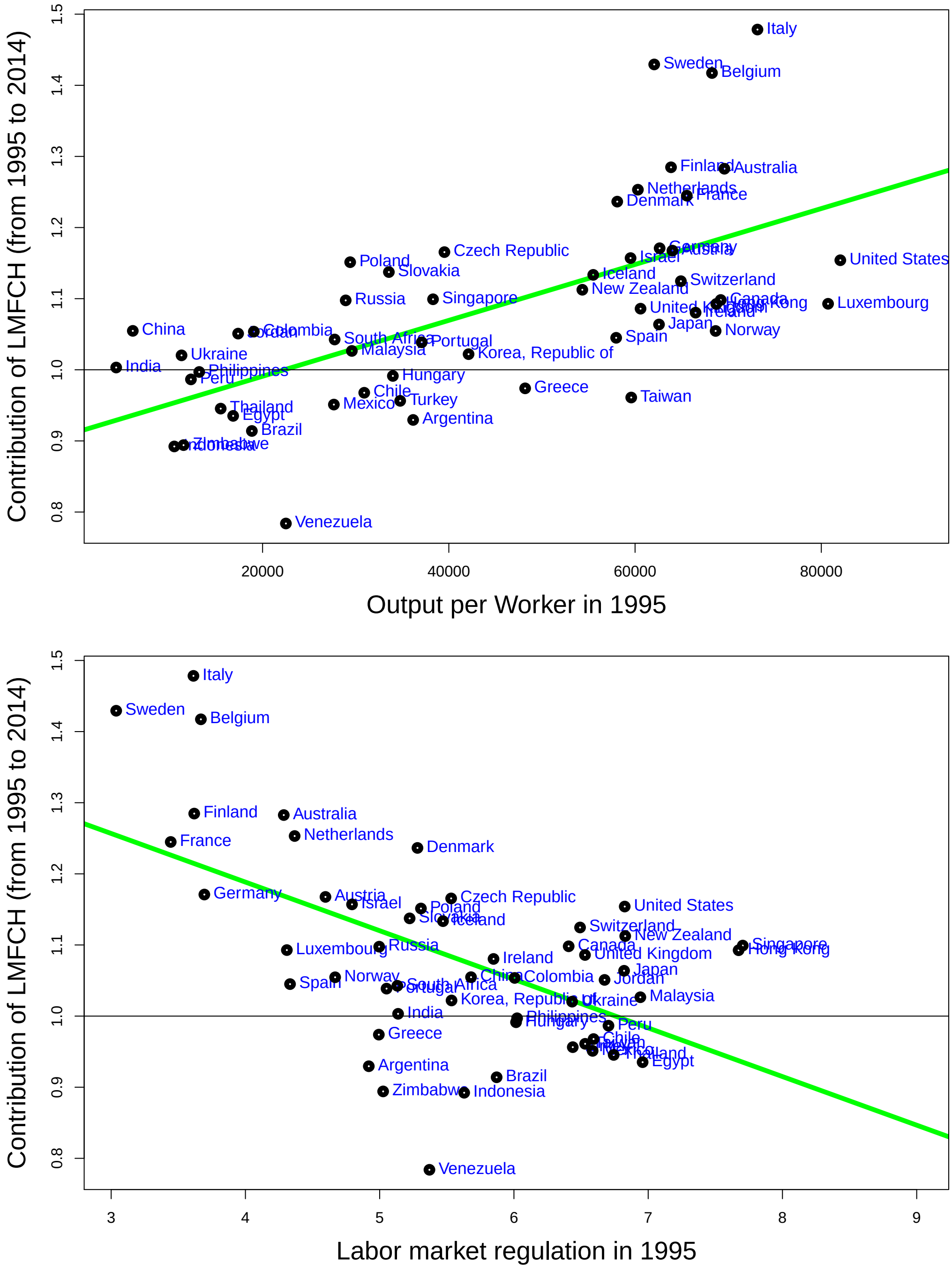

Figure 5: Contribution of LMFCH plotted against output per worker in 1995 (upper panel) and labor market regulations level (lower panel) in 1995. Each panel contains a regression line. The slopes of regression lines in upper and lower panels are 3.93×10^{-6} and -0.068 with p-values 3.62×10^{-7} and 1.44×10^{-5}, respectively.

5 Conclusion

Examining the patterns of labor productivity growth is important for making meaningful and effective economic policy. As economy evolves, the strength and composition of sources of growth change which has to be reflected in decisions of policy makers. In this chapter, it is assumed that labor market regulations affect labor productivity growth through labor market. Labor productivity growth is decomposed into components attributable to (i) change in efficiency, (ii) technological change, (iii) physical capital deepening, (iv) human capital accumulation, and (v) labor market regulations change. This model is examined empirically using data from the Penn World Tables and Economic Freedom of the World Data, the latter being compiled by the Fraser Institute.

The analysis is performed separately for 1970−1995 and 1995−2014. We find that physical capital deepening is the predominant driving force behind productivity growth from 1970−1995 and remains strong during 1995−2014. The relative contribution of physical capital deepening to labor productivity growth remains the same over time. Human capital accumulation is the second most important source of growth during before 1995 but it becomes less economically significant after 1995. Labor market regulations change contributing very little during 1970−1995 becomes the second most important force of economic growth for the period 1995−2014.

Furthermore, labor market regulations change benefits relatively rich nations more that relatively poor nations, implying that it is as useful to conduct policies to liberalize labor markets in rich countries as it is in poor countries. Finally, the contribution of labor market regulations change to growth is stronger for nations where labor markets are less liberalized. This means that nations where labor market rigidities are the largest would be greatly rewarded for easing these rigidities.

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