

Productivity Growth in Europe

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Abstract

This paper tests whether structural or firm-specific characteristics contributed more to (labor) productivity growth in the European Union between 2003 and 2008. It combines the Amadeus firm-level data on productivity and firm characteristics with country-level data describing regulatory environments from the World Bank's Doing Business surveys, foreign direct investment data from Eurostat, infrastructure quality assessments from the Global Competitiveness Report, and credit availability from the World Development Indicators. It finds that among the 12 newest members of the European Union, country characteristics are most important for firm

productivity growth, particularly the stock of inward foreign direct investment and the availability of credit. By contrast, among the more developed 15 elder European Union member countries, firm-level characteristics, such as industry, size, and international affiliation, are most important for growth. The quality of the regulatory environment, measured by Doing Business indicators, is importantly correlated with productivity growth in all cases. This finding suggests that European Union nations can realize significant benefits from improving regulations and encouraging inward and outward foreign direct investment.

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Productivity Growth in Europe

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1. Introduction and Main Findings

Between 2002 and 2008, the European Union (EU) experienced significant structural changes, including the introduction of the Euro, the 2004 expansion of the European Union, and the proliferation of international linkages worldwide. Responses to these changes among the EU member states included technological upgrades, adoption of new management processes, and regulatory reform.² Recent research efforts have revealed extensive heterogeneity in productivity growth across countries and sectors, even within narrowly defined industries.³ The twelve newest members of the European Union (EU12, the “New Europe”)⁴ experienced vigorous productivity growth, three to four times greater than the growth of the fifteen elder members of the European Union (EU15)⁵. However, as New Europe raced to catch up with Old, the southernmost states of Western Europe fell drastically behind, and experienced productivity contractions. What factors led to these disparate outcomes across members of the European Union? This paper disentangles the effects of country- and firm-level variables on productivity to answer the policy question of what countries may do to encourage greater productivity growth.

We use the 2010 Amadeus database,⁶ which provides firm-level data on employment, sector, age, and international affiliations. We augment this with country-level business environment indicators from the World Bank’s Doing Business (DB) database, foreign direct investment (FDI) data from Eurostat, infrastructure quality indicators from the Global Competitiveness Report, and credit availability data from the World Development Indicators (WDI). Using ordinary least squares (OLS) regression, we estimate the contribution of each factor to productivity growth between 2003 and 2008, both individually and as sets of either firm- or country-level variables.

For the EU12, country-level characteristics contribute the most toward explaining productivity growth. Of the variables included, the most influential are DB indices of government business regulation, the availability of credit, and the stock of inward foreign direct investment. The FDI is especially important in manufacturing sectors. Firms with international owners or affiliates grew significantly faster than purely domestic firms.⁷ These two effects suggest a role for government policies promoting FDI in improving productivity growth.

Among the EU15, we find that firm-level variables are the most important determinants of productivity—specifically, firm size and ownership. Smaller firms grow more quickly than large firms. Meanwhile, foreign-affiliated firms show much greater productivity gains compared with purely domestic firms: global headquarters grow most quickly, followed by domestic

² Aghion, Acemoglu, and Zilibotti (2006).

³ For surveys of the literature, see Wagner (2007); Foster, Haltiwanger, and Krizan (2001); Bartelsman, Haltiwanger, and Scarpetta (2004); Barba Navaretti and Venables (2004).

⁴ The EU12 consists of Bulgaria, Cyprus, the Czech Republic, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Romania, the Slovak Republic, and Slovenia. However, Cyprus and Malta are excluded from the analysis due to lack of data.

⁵ The EU15 consists of Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, the Netherlands, Portugal, Spain, Sweden, and the United Kingdom. However, Luxembourg and Ireland are excluded from the analysis due to lack of data.

⁶ Amadeus is a comprehensive firm-level database containing financial information for over 11 million public and private companies throughout Europe produced from the Bureau van Dijk

⁷ This result is common in the literature. See Dunne, Roberts, and Samuelson (1989); Ilmakunnas and Maliranta (2004); Smarzynska Javorcik (2004).

subsidiaries. Of the country-level variables, outward FDI and the quality of government regulation explain much of the variation across member nations, indicating that policy again plays a significant role in productivity growth.

The southern economies of the EU15—Greece, Italy, Portugal, and Spain (EU15 South)—stand out as exceptions to the general European trend toward productivity growth, experiencing falling productivity between 2003 and 2008. This decline is most likely explained by these nations' distribution of firms, which is skewed toward small and domestic producers, relative to the rest of the EU15. This context correlates strongly with regulatory regimes disadvantageous to the expansion of private industry.⁸ These small firms are less likely to have international affiliates, as evidenced by EU15 South's lower rates of outward FDI. This situation in turn reduces these states' ability to benefit from technology and knowledge transfers, accordingly reducing their potential for growth.

A key policy implication of this paper is that improving government regulation and encouraging FDI could help flagging European countries catch up to their neighbors. These policies may potentially be implemented more easily and more quickly than corresponding investments in infrastructure and education.

The remainder of the paper is organized as follows. Section 2 provides motivation and a survey of the current literature. Section 3 describes the data in detail, while Section 4 explains the methodology of the analysis. Section 5 contains a discussion of the results, broken up into three subsections. The first section describes the results for the EU12, the second for the EU15, and the third discusses the EU15 South. Section 6 concludes and offers suggestions for future research.

2. Motivation and Related Literature

The persistence of productivity differences—measured as either labor productivity or total factor productivity—across firms, even within narrowly defined industries, has inspired extensive research into its causes.⁹

At the national level, economists have posited explanations of productivity differences based on the country's business environment determined by government regulation, taxation, industrial support, and openness to international trade and FDI. Based on a set of 12 Organisation for Economic Co-operation and Development (OECD) countries and using industry-level data, Nicoletti and Scarpetta (2003) find that restrictive regulation in manufacturing tends to reduce multifactor productivity (MFP) growth. The authors suggest that such restrictive regulations reduce competitive pressures to invest in productivity-enhancing technologies. Using related approaches, Conway et al. (2006) and Arnold, Nicoletti, and Scarpetta (2008) reach similar conclusions for European countries, especially for technology-driven productivity improvements.¹⁰ We expand on these results by including eleven more European countries,

⁸ See Aterido, Hallward-Driemeir, and Carmen (2007).

⁹ Foster, Haltiwanger, and Krizan (2001) provide a seminal and rich review of the literature on productivity dynamics. This paper focuses on firm- and country-level variables. For analysis using product-level variables, see Bernard, Redding, and Schott (2006).

¹⁰ These studies use the framework proposed by Aghion and Griffith (2005) in which productivity growth within a country/sector is calculated in relation to the pace of the country/sector leader. This growth, in turn, depends on the business environment and policies in the follower country, especially those policies that promote firm rivalry and market entry. Arnold, Nicoletti and Scarpetta (2008) use firm-level data and focus on MFP growth. Nicoletti and

controlling for more country- and firm-level factors, and employing a resampling technique to ensure that the sample accurately reflects the population.

Wagle (2010) investigates the effects of regulation on FDI and concludes that FDI-increasing regulations prompt beneficiary firms to grow more quickly, through either selection effects or knowledge transfers.¹¹ We test for these effects using business environment variables.

Burda and Hunt (2001) take a different approach, investigating the effects on productivity when countries integrate their economies. They find evidence that less productive members of economic unions benefit from productivity transfers from their partners.¹² Winston (1993), Harrison (1994), and Meyer and Vickers (1997) suggest that integration improves productivity growth by increasing competition. This competition leads to the expectation of convergence. This paper considers both integration and international affiliations.

In this paper, we test for the effects of firm size, age, and ownership structure on labor-productivity growth.¹³ Dunne, Roberts, and Samuelson (1989), using a dataset including 200,000 U.S. manufacturing firms from 1967–1977, find that size is negatively correlated with growth, and that the expected growth rate of a firm declines with size for firms owned by single-plant firms, but increases with size for firms owned by multi-plant firms, suggesting synergies from FDI. The importance of FDI for growth is a persistent result throughout the literature,¹⁴ and one further supported by our findings.

The research most similar to that presented in this paper is the work of Anos Casero and Udomsaph (2009). The authors show a direct correlation between productivity growth and the quality of institutions and government policies. They also use the Amadeus dataset and employ principal component analysis to determine the business environment. However, their analysis covers only eight European countries, and their sample is somehow biased by the data availability in Amadeus.¹⁵ We improve on this by using resampling techniques and a larger universe of countries and firms.

This paper offers several novel additions to the literature. The Amadeus database is used in conjunction with a resampling technique to represent the underlying population and generate a representative, cross-country sample. By combining firm-, industry-, and country-level variables

Scarpetta (2003) also measure MFP but use industry-level information, while Conway et al. (2006) use industry-level data but measure labor productivity growth. All of these studies rely on OECD country samples.

¹¹ For more on FDI and growth, see Barba Navaretti and Venables (2004), Bernard and Jensen (1995), and Vogel and Wagner (2009).

¹² Specifically, Burda and Hunt (2001) suggest five mechanisms for productivity transfers: (1) capital accumulation, (2) migration, (3) FDI, (4) Hecksher-Ohlin factor price equalization, and (5) knowledge/technology spillovers. See also Akerlof et al. (1991).

¹³ There has been considerable disagreement among studies as to the causes of productivity growth. On one hand, using a panel of fourteen OECD countries for 1970–1987, Bernard and Jones (1993) find growth in total factor productivity (TFP) due to within-firm technological improvement and capital accumulation. Olley and Pakes (1996) and Restuccia and Rogerson (2007), on the other hand, find that productivity gains are primarily the result of reallocation of resources to high-productivity firms from low. Still other studies have found net entry to be the most influential motor.

¹⁴ Wagner (2011) suggests several pathways by which firms may benefit from inward FDI, including knowledge transfers and spillover effects. See Smarzynska Javorcik (2004) for growth effect from outward FDI; Barba Navaretti and Venables (2004) for a survey of empirical studies on productivity differences between foreign owned firms and domestic firms.

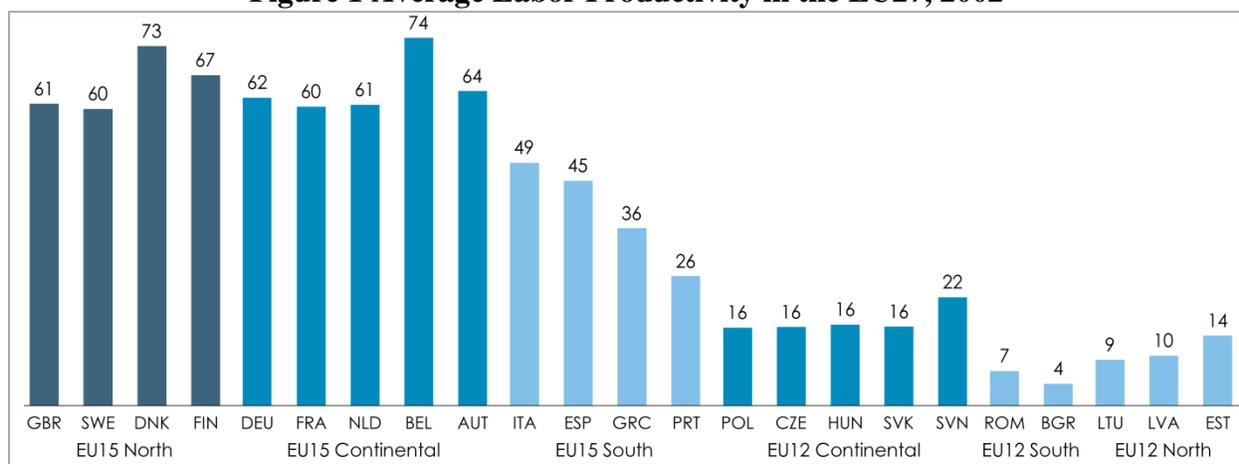
¹⁵ Over half of the firms included into the sample are from Romania.

to describe country characteristics comprehensively, we are able to form conclusions about the relative importance of these different levels of analysis. Of special note is the inclusion of principal component analysis of the DB business environment variables, which provide clear policy implications on how to improve productivity growth.

3. Data

Figure 1 and Figure 2 describe the average productivity levels by country and their growth rates over the period 2002–2008, respectively from the country-level statistics produced by Eurostat.¹⁶ While in 2002 the EU12 had much lower productivity levels on average than did the EU15, the EU12 also realized much greater increases in labor productivity through 2008. The EU15 South performed exceptionally weakly: Greece, Italy and Spain suffered *negative* productivity growth over the relevant period, while Portugal only realized a marginal productivity improvement.

Figure 1 Average Labor Productivity in the EU27, 2002

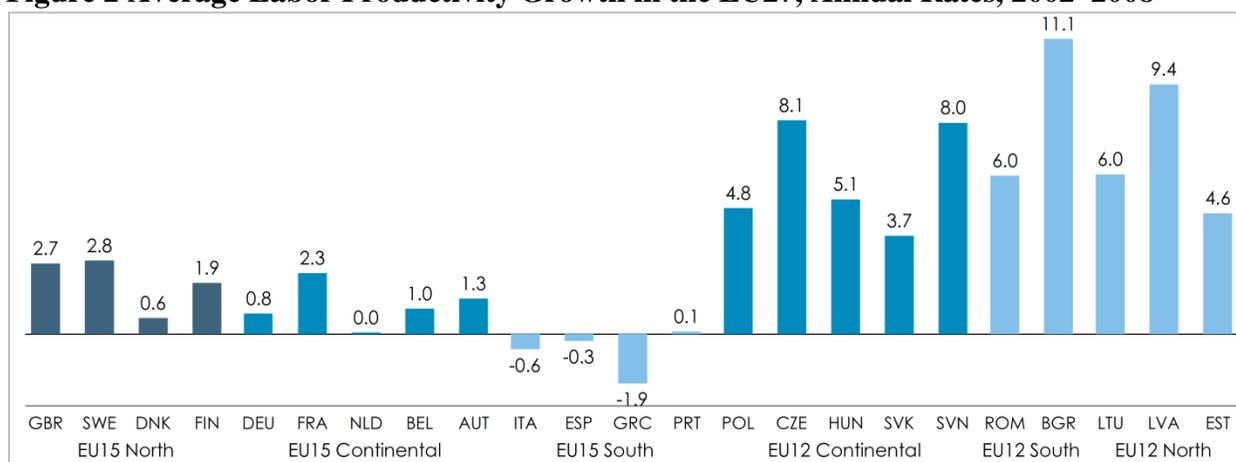


Source: World Bank staff calculations based on Eurostat.

Note: Labor productivity is defined as value-added per employee. For Belgium and Greece, productivity levels are from 2003. Data are in thousands of 2005 U.S. dollars. The following sectors are included: manufacturing, wholesale/retail trade, hotels/restaurants, transport/communications, and real estate/business services.

¹⁶ The aggregate figures on labor productivity growth presented in this paper are based on the Eurostat Structural Business Statistics database (SBS) for contestable sectors. As such, these data do not exactly mirror the aggregations presented in Table 1, which rely on WDI/International Labour Organization (ILO) data and include mining, energy utilities, financial intermediation, government, and other services, such as education and health. In addition, the data from SBS and ILO reflect different time periods: 2002–2008 and 1995–2009, respectively.

Figure 2 Average Labor Productivity Growth in the EU27, Annual Rates, 2002–2008



Source: World Bank staff calculations based on Eurostat.

Note: The time period considered varies by country: Belgium (2003–08), Greece (2003–07), and Great Britain, France, Czech Republic, Latvia, and Romania (2002–07). The following sectors are included: manufacturing, wholesale/retail trade, hotels/restaurants, transport/communications, and real estate/business services.

In order to conduct a firm-level analysis, we rely on the Amadeus database. For each firm, we extracted from Amadeus the following variables: total number of employees,¹⁷ as an indicator of firm size; sector (NACE 1.1 digit) of firm’s primary economic activity; year of registration to determine the firm’s age; and the global ultimate owner of the firm, to identify the firm’s ownership structure. We also include data on value-added¹⁸ as a company performance indicator. Originally, all value-added figures were denominated in (nominal) local currencies. In order to allow for cross-country comparison, these values were deflated using four broad sector-level gross domestic product (GDP) deflators¹⁹ and finally converted to 2005 U.S. dollars.²⁰ Productivity is then defined as value-added per employee (labor productivity). We restrict the analysis to labor productivity for two reasons. First, the labor measure is directly observable at the firm level. Second, it avoids the bias arising from the simultaneity between productivity and inputs encountered with total factor productivity (TFP) estimations.²¹

While Amadeus constitutes a rich and detailed database, its coverage is skewed in favor of large firms, thereby underestimating the distribution with regards to small businesses. In order to ensure representativeness, we apply a re-sampling technique in which random draws are taken for each size-sector-country stratum according to the true population of firms. See Appendix IV for a further discussion of the re-sampling methodology. We restrict our analysis and applicable results to firms with 10 employees or more, and group them into five categories: microenterprises with 10–49 employees, small firms with 50–249, medium firms with 250–499, large firms with 500–999, and very large firms with more than 1,000 employees. Firms are only

¹⁷ The reported number of employees includes all part-time and full-time employees, both temporary and permanent.

¹⁸ Value-added is defined in Amadeus as period profit plus depreciation, taxation, interest payments, and employment costs.

¹⁹ To express values in 2005 local currency units, deflation was undertaken using United Nations Economic Commission for Europe (UNECE) data with the following sector aggregations: i) manufacturing; ii) construction; iii) wholesale & retail trade, repairs, hotels & restaurants, transport & communications; and iv) real estate, renting & business activities (see UNECE *Statistical Database*. <http://w3.unece.org/pxweb/>).

²⁰ Using annual average exchange rates obtained from the WDI dataset (World Bank. *World Development Indicators*. <http://databank.worldbank.org>).

²¹ See Dachs, Ebersberger, and Löff (2008).

removed from the database after at least five years of non-reporting.²² It is therefore impossible to distinguish between firms that exit the dataset due to failure or for some other reason, such as employment reduction or merger. The analysis is therefore focused on a balanced sample of surviving firms—firms present for the entire date range. We note that this precludes productivity growth due to firm entry and exit and could imply that the sample firms are likely to be more productive than the population average because firms too unproductive to survive drop out.

Table 1 shows the final samples' compositions and compares their derived aggregate labor productivity growth rates with those derived from Eurostat for 2003–2007, the years for which Eurostat and Amadeus overlap. Evidence suggests that the samples mirror productivity trends at the macro level, lending credence to the use of micro data to explain macroeconomic growth.²³

Table 1 Aggregate Annual Productivity Growth, 2002–2007: Amadeus and Eurostat

	Sample 1 (10+ employees)					Sample 2 (50+ employees)				
	Obs	Manufacturing		Services (w/o construction)		Obs	Manufacturing		Services (w/o construction)	
EU12		Amadeus	Eurostat	Amadeus	Eurostat		Amadeus	Eurostat	Amadeus	Eurostat
Bulgaria	-	-	12.81%	-	9.75%	256	9.20%	13.66%	8.10%	8.18%
Czech Rep.	2,410	6.00%	8.22%	6.20%	5.65%	532	6.80%	8.42%	7.30%	5.71%
Estonia	561	9.10%	10.76%	8.70%	6.41%	85	6.80%	10.47%	6.50%	3.70%
Poland	3,811	3.20%	1.14%	7.20%	4.28%	1,267	1.20%	0.37%	2.10%	3.75%
Romania	4,249	5.90%	7.47%	2.80%	4.84%	853	5.30%	8.44%	5.50%	5.03%
Slovak Rep.	-	-	9.60%	-	1.66%	196	8.40%	9.87%	15.30%	1.28%
Slovenia	526	5.70%	10.49%	2.80%	6.34%	104	6.40%	10.04%	5.60%	1.26%
EU15										
Belgium	2,485	1.60%	2.89%	0.80%	0.54%	366	2.70%	3.46%	1.50%	0.40%
Finland	1,036	11.10%	7.03%	4.80%	2.92%	147	4.30%	7.02%	9.80%	2.78%
France	15,029	4.40%	3.89%	2.60%	1.10%	2,322	3.70%	3.77%	4.80%	0.41%
Germany	-	-	3.38%	-	0.99%	2,733	2.50%	3.67%	2.20%	1.58%
Great Britain	-	-	3.61%	-	3.21%	2,408	3.00%	3.76%	1.20%	3.68%
Italy	17,143	2.40%	1.92%	1.90%	0.73%	1,788	1.10%	1.99%	-0.70%	-0.12%
Norway	1,523	-6.60%	-3.90%	5.60%	7.10%	189	2.20%	4.70%	-4.40%	-3.80%
Portugal	-	-	2.85%	-	-0.80%	493	2.70%	3.53%	-2.20%	-2.54%
Spain	16,850	1.50%	1.48%	0.90%	0.14%	1,884	1.10%	1.15%	-1.30%	-0.08%
Sweden	2,436	4.30%	6.03%	2.10%	1.72%	383	4.40%	6.48%	2.50%	1.74%
Total	68,059					16,006				

World Bank staff calculations based on Eurostat *and* Amadeus

Note: Aggregate figures from Amadeus for each country are computed defining labor productivity as total value-added divided by total number of employees.

²² Firms that stop reporting their financial statements are represented as "not available/missing" for four years following the last available filing.

²³ Appendix II shows the kernel density estimations of annualized growth of labor productivity (2003–2008) for each sample for two regional cuts: EU15 and EU12. Both estimations use the Epanechnikov kernel function with a bandwidth of 0.5. Appendix III presents the corresponding firm-level summary statistics. For both samples, the distribution for EU12 firms is higher than for EU15, suggesting that EU12 firms realized greater productivity growth. A Kolmogorov-Smirnov test for equality of distribution functions rejects the null hypothesis at the 1 percent.

We include several variables to account for country-level variation. From the WDI database, we define access to credit as measured by the ratio of private sector credit to GDP and skills as measured by the percent of the workforce with tertiary education. Quality of infrastructure is measured by an index taken from the Global Competitiveness Report,²⁴ a survey of business leaders published by the World Economic Forum. Foreign direct investment inward and outward stock are measured as the ratios of stock to GDP for manufacturing and for service sectors, from the Eurostat SBS.

To assess the regulatory environment within each country, we employ the World Bank's Doing Business²⁵ (DB) database. Using principal component analysis, we construct a comprehensive index of all regulatory policies, *all_DB*.²⁶ A second variable, *DB_business_startup*, indexes barriers to entry and exit, including the costs of starting a business, registering property, and closing a business. *DB_business_operations* indexes the difficulty of operating a firm, including securing construction permits, paying taxes, trading across borders, and employing workers. Finally, *DB_institutional_environment* is an index of the quality of the legal and institutional framework for enterprises, including the level of protection for minority shareholders, the quality of the credit information systems, and the cost and speed of contract enforcement. All indices are coded such that higher values indicate better regulation.²⁷ Summary statistics are provided in Appendix XII.

4. Methodology

We use the following specification to analyze productivity growth in Europe.

$$\begin{aligned} \Delta \ln(Prod_i)_{03-08} = & \alpha + \beta_2 \ln(Prod_i)_{03} + \beta_2 Age_{i,03} + \beta_3 Size_{i,03} + \beta_4 OwnType_{i,03} + \beta_5 \Delta(\ln wFDI)_{03-08}^j \\ & + \beta_6 \Delta(\ln OutFDI)_{03-08}^j + \beta_7 \Delta(\ln Credit)_{03-08}^j + \beta_8 \Delta(\ln Skills)_{03-08}^j + \beta_9 \Delta(\ln Bus.Reg)_{03-08}^j \\ & + \beta_{10} \Delta(\ln Infra)_{03-08}^j + \sum_m \varphi Sector_m + \sum_j \gamma Country_j + \epsilon_i \end{aligned} \quad \text{Eq. (1)}$$

The variable $\Delta \ln(Prod_i)_{03-08}$ is the annualized growth rate of labor productivity (defined as value-added per employee) for firm i from 2003 to 2008.²⁸

Size, is expressed in terms of number of employees on the company's payroll, and is divided into five previously mentioned categories. Microenterprises are mostly family-owned and have a limited division of tasks. Flexibility in labor usage and minimal overhead costs allow microenterprises to reach a baseline level of efficiency. However, limited access to capital

²⁴ World Economic Forum. *Global Competitiveness Report*. <http://www.weforum.org/issues/global-competitiveness>.

²⁵ World Bank. *Doing Business*. <http://doingbusiness.org/>.

²⁶ For a discussion of principal component analysis, see Appendix V.

²⁷ Given that the principal component analysis is built on the basis of indicators, it shares the indicators' methodological limitations. To verify the quality of the principal component analysis indicator, we compare it with an alternative measure of the quality of business regulation, the Product Market Regulation indicator constructed by the Organisation for Economic Co-operation and Development. The correlation between the comprehensive principal component analysis index of *Doing Business* indicators and the economy-wide Product Market Regulation indicator is very high (-0.74) using 2008 data (World Bank 2009) for the 39 countries for which both indicators are available.

²⁸ $\Delta \ln(Prod)_{i,03-08}$ is calculated as $\frac{[\ln(Prod_{i,08}) - \ln(Prod_{i,03})]}{(2008 - 2003)}$.

investments constrains microenterprises from scaling up operations, especially in capital-intensive sectors, suggesting that smaller firms grow more slowly.²⁹

Age in years is divided into categories of 1–5 years old, 6–10, 11–20, 21–30, and older than 31. Learning and selection effects imply that younger firms will grow more quickly³⁰.

Ownership type is operationalized as a categorical variable denoting whether the firm is a *global headquarters* with foreign subsidiaries³¹, a *foreign-affiliated* firm³², or a *purely domestic* firm.³³ The coefficients on ownership categories capture the effects of foreign affiliation. Specifically, the coefficient on *foreign* captures the productivity benefits that a foreign-owned firm realizes from intra-organizational transfers and integration in global markets. The coefficient on *global headquarters* captures benefits to firms from investing abroad to expand their consumer base and increase efficiency. We expect that global headquarters will grow most quickly, followed by foreign-affiliates. Purely domestic firms will have the slowest growth.

$\Delta(\text{InwFDI})_{03-08}^j$ measures the change in the inward stock of FDI in country j . $\Delta(\text{OutFDI})_{03-08}^j$ measures the same for outward stock of FDI. $\Delta(\text{Credit})_{03-08}^j$ measures changes in the ratio of private sector credit to GDP. $\Delta(\text{Skills})_{03-08}^j$ measures changes in the percentage of the workforce with a tertiary education. $\Delta(\text{Bus.Reg})_{03-08}^j$ measures changes in business regulation. We predict that better regulations will be positively correlated with more rapid productivity growth.

$\Delta(\text{Infra})_{03-08}^j$ measures variation in the quality of infrastructure. The log of productivity in 2003 is included to control for initial firm characteristics: firms that begin with higher productivity levels may realize slower growth rates.³⁴ We include country and sector fixed-effects, which account for unobserved country- and industry-specific characteristics that might affect productivity growth. Sector_m is a vector of sector dummy variables defined at the NACE 1.1 level, while Country_j is a vector of country dummy variables.

We employ ordinary least squares (OLS) with errors clustered by country in order to allow for possible correlations in growth rates between co-national firms. Regressions are run separately for EU15 and EU12 countries to investigate the sources of the differences between the two

²⁹ This is a common prediction in the literature. See Bartelsman, Haltiwanger, and Scarpetta (2009); Ayyagari, Demircuc-Kunt and Maksimovic (2011)

³⁰ Various studies have shown that conditional on size and survival rate, young firms tend to grow faster than older firms due to diminishing returns to learning. See Klepper and Thompson, 2007; Dunne, Roberts and Samuelson, 1989.

³¹ Due to an idiosyncrasy of the Bureau van Dijk, co-national affiliates of headquarters firms with foreign subsidiaries are also listed as global headquarters.

³² Foreign-owned firms are classified as those which have at least 51 percent foreign ownership. For 34 percent of firms classified as foreign affiliated by Bureau van Dijk, we cannot identify the exact ownership stake. However, as they are mostly small firms, we assume they are not publicly traded firms in which the parent's ownership could be diluted and are therefore managerially fully in control of the foreign parent.

³³ Given that the sample excludes all firms that were involved in merger and acquisitions operations, the ownership structure of a firm observed in 2009 is assumed to be the same as in 2003. We follow Brown and Earle (2002) in using the latest ownership status to create ownership dummies for 2003. However, it is worth noting that we are not able to control for cases in which the firm ownership structure has changed due to a joint venture.

³⁴ The inclusion of this variable may reflect convergence as proposed by Barro and Sala-i-Martin (1992). We expect the coefficient of baseline productivity level to be negative.

groups.³⁵ We also separate manufacturing and services to illuminate the drivers of productivity growth in different sectors. The construction sector is excluded from the analysis given its cyclical nature (Burns and Grebler, 1982). Results are then presented separately for EU12 and EU15 as well as for manufacturing and services industries. Within manufacturing and services, the model distinguishes between firms belonging to different NACE 1.1 categories.

Two samples were defined according to the ratio between the targeted number of companies (in the population) and the number of sampled firms: Sample 1 contains firms with at least 10 employees, covers fewer countries, but has more firms; Sample 2 contains firms with at least 50 employees, covers more countries, but fewer companies.³⁶ Once these samples were drawn, we excluded extreme outliers³⁷ and then defined two *final* samples. Regressions are performed for Sample 1. Sample 2 is used as a robustness check, the results of which are found in Appendices VI–IX.

5. Results

In this section, we present the results of our analysis for the EU12, EU15, and EU15 South.

5.1 EU12

The first question to answer is which category of determinants—country or firm—matters most in explaining productivity growth in the EU12. Our results indicate that for these less developed economies, country is still the dominant factor in growth. The exclusion of firm characteristics from the regression for manufacturing sectors reduces the explanatory power of the model by 8 percent. However, when country dummies are excluded, the model loses roughly four times as much predictive power (33 percent). For service sectors, a similar pattern emerges since the explanatory power of the model falls more when dropping country-fixed effects (23 percent) than when excluding firm characteristics variables (8 percent). Country dummies presented in columns (1) and (7) of Table 2 indicate that firms similar in terms of size, age, ownership and industry perform differently across countries in EU12 region. For example, the productivity of a manufacturing firm in the Czech Republic on average grows at a rate 3.8 percentage points higher than a similar manufacturer in Slovenia (see column 1). For more, see Appendix VI.³⁸

The more relevant question for policy is which factor within country correlates best with growth. The results point to ownership. We observe that global headquarters firms grow 6.7 percent more quickly than purely domestic firms in manufacturing and 3.1 percent more quickly in services,

³⁵ The separations observed in the kernel densities presented in Appendix II suggest that the performance of firms is in fact different in these two regions.

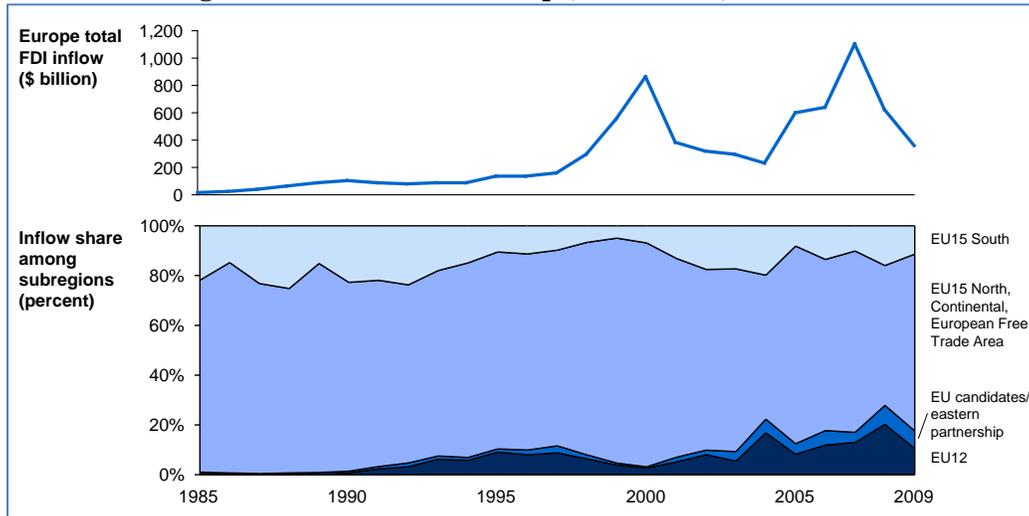
³⁶ See Appendix IV for more details on how these samples were defined.

³⁷ A three-step procedure was implemented to control for extreme outliers. First, firms involved in merger and acquisitions operations were excluded from analysis: growth via merger is outside the scope of this paper. Second, companies whose annual productivity growth was more than three standard deviations away from the mean in each country were excluded. Third, in order to control for extreme outliers in terms of employment, we adopted criteria conditioned on firm size. For firms with fewer than 50 employees, we dropped observations for which the annual change in employment in any year was greater than 300 percent. For firms with more than 50 employees, we dropped those observations with an annual change greater than 50 percent. We also dropped observations for which the annual growth rate in any year exceeded 1000 percent.

³⁸ For a discussion of results from Sample 2, see Appendix VIII.1.

ceteris paribus. Surprisingly, the age of the firm is never statistically significant. In both manufacturing and service sectors, size is negatively correlated with productivity growth.³⁹

Figure 3 FDI Flows into Europe, All Sectors, 1985–2009



Source: World Bank staff calculations based on United Nations Conference on Trade and Development (UNCTAD) data.

Table 2 presents the estimation results for Eq. (1) for the EU12. Columns (1) and (7) show the results of the complete model split into manufacturing and services industries, while the remaining columns present the results using the various sub-indices of business operations.

Productivity gains are correlated with increases in the availability of private credit, stock of inward FDI, workforce education, and business environment—especially trade and taxes. A one standard deviation increase in the overall business regulation index is conditionally correlated with a 6.35 percent increase in productivity growth for the average manufacturing firm and 7.93 percent for the average service firm. A one standard deviation improvement in the tax regulations index is correlated with 4.77 percent and 7.10 percent increases in labor productivity for manufacturing and service firms, respectively. A one standard deviation increase in the trade regulation index is associated with a 7.48 percent increase for the average service firm, but is not statistically significant in the manufacturing industry.

³⁹ For a second method of evaluating the relative impact of firm-level variables, see Appendix XII.

Table 2 Firm-level Productivity Growth and Changes in Country Characteristics in the EU12

	Manufacturing						Services (except construction)					
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Ln(prod)2003	-0.1237*** (0.005)	-0.1237*** (0.005)	-0.1237*** (0.005)	-0.1237*** (0.005)	-0.1237*** (0.005)	-0.1237*** (0.005)	-0.1122*** (0.003)	-0.1122*** (0.003)	-0.1122*** (0.003)	-0.1122*** (0.003)	-0.1122*** (0.003)	-0.1122*** (0.003)
Size(50-249)¹	-0.0156** (0.007)	-0.0156** (0.007)	-0.0156** (0.007)	-0.0156** (0.007)	-0.0156** (0.007)	-0.0156** (0.007)	-0.0130*** (0.004)	-0.0130*** (0.004)	-0.0130*** (0.004)	-0.0130*** (0.004)	-0.0130*** (0.004)	-0.0130*** (0.004)
Size(250-499)¹	-0.0530*** (0.012)	-0.0530*** (0.012)	-0.0530*** (0.012)	-0.0530*** (0.012)	-0.0530*** (0.012)	-0.0530*** (0.012)	-0.0269*** (0.009)	-0.0269*** (0.009)	-0.0269*** (0.009)	-0.0269*** (0.009)	-0.0269*** (0.009)	-0.0269*** (0.009)
Size(500-999)¹	-0.0229 (0.019)	-0.0229 (0.019)	-0.0229 (0.019)	-0.0229 (0.019)	-0.0229 (0.019)	-0.0229 (0.019)	-0.014 (0.015)	-0.014 (0.015)	-0.014 (0.015)	-0.014 (0.015)	-0.014 (0.015)	-0.014 (0.015)
Size(1000+)¹	-0.0582** (0.029)	-0.0582** (0.029)	-0.0582** (0.029)	-0.0582** (0.029)	-0.0582** (0.029)	-0.0582** (0.029)	-0.0217 (0.032)	-0.0217 (0.032)	-0.0217 (0.032)	-0.0217 (0.032)	-0.0217 (0.032)	-0.0217 (0.032)
Age(6-10)²	-0.001 (0.009)	-0.001 (0.009)	-0.001 (0.009)	-0.001 (0.009)	-0.001 (0.009)	-0.001 (0.009)	0.0013 (0.005)	0.0013 (0.005)	0.0013 (0.005)	0.0013 (0.005)	0.0013 (0.005)	0.0013 (0.005)
Age(11-20)²	-0.0027 (0.009)	-0.0027 (0.009)	-0.0027 (0.009)	-0.0027 (0.009)	-0.0027 (0.009)	-0.0027 (0.009)	-0.0017 (0.005)	-0.0017 (0.005)	-0.0017 (0.005)	-0.0017 (0.005)	-0.0017 (0.005)	-0.0017 (0.005)
Age(21-30)²	0.0102 (0.021)	0.0102 (0.021)	0.0102 (0.021)	0.0102 (0.021)	0.0102 (0.021)	0.0102 (0.021)	-0.0132 (0.018)	-0.0132 (0.018)	-0.0132 (0.018)	-0.0132 (0.018)	-0.0132 (0.018)	-0.0132 (0.018)
Age(>=31)²	0.0079 (0.018)	0.0079 (0.018)	0.0079 (0.018)	0.0079 (0.018)	0.0079 (0.018)	0.0079 (0.018)	-0.0036 (0.010)	-0.0036 (0.010)	-0.0036 (0.010)	-0.0036 (0.010)	-0.0036 (0.010)	-0.0036 (0.010)
Global Head.³	0.0670** (0.033)	0.0670** (0.033)	0.0670** (0.033)	0.0670** (0.033)	0.0670** (0.033)	0.0670** (0.033)	0.0309* (0.018)	0.0309* (0.018)	0.0309* (0.018)	0.0309* (0.018)	0.0309* (0.018)	0.0309* (0.018)
Foreign aff.³	0.0298*** (0.010)	0.0298*** (0.010)	0.0298*** (0.010)	0.0298*** (0.010)	0.0298*** (0.010)	0.0298*** (0.010)	0.0276*** (0.005)	0.0276*** (0.005)	0.0276*** (0.005)	0.0276*** (0.005)	0.0276*** (0.005)	0.0276*** (0.005)
var0308_instock_gdp⁴	0.0199*** (0.001)	0.0166*** (0.002)	0.0167*** (0.001)	0.0165*** (0.001)	0.0157*** (0.002)	0.0182*** (0.001)	0.0062*** (0.002)	0.0032*** (0.001)	0.0039*** (0.001)	0.0091*** (0.003)	0.0037*** (0.002)	0.0012*** (0.000)
var0308_credit_gdp	0.0017*** (0.000)	0.0017*** (0.000)	0.0018*** (0.000)	0.0018*** (0.000)	0.00167** (0.000)	0.0019*** (0.000)	0.0011*** (0.000)	0.0005*** (0.001)	0.0006*** (0.000)	0.0012*** (0.000)	0.0007*** (0.000)	0.0004*** (0.000)
var0308_skills	0.0123***	0.0128**	0.0139***	0.0164**	0.0118**	0.0146*	0.0139***	0.0121***	0.0133***	0.0106	0.0136***	0.0125***

	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.000)	(0.001)	(0.002)	(0.001)	(0.000)
var0308_all_DB	0.010***						0.012***					
	(0.000)						(0.002)					
var0308_Busin_Oper.		0.0051***						0.0095***				
		(0.000)						(0.001)				
var0308_Permit			-0.031						-0.0341***			
			(0.004)						(0.004)			
var0308_Tax				0.014***						0.0206***		
				(0.000)						(0.004)		
var0308_Trade					0.006						0.0068***	
					(0.004)						(0.001)	
var0308_Empl						0.0039***						0.0045***
						(0.000)						(0.001)
_cons	1.4740***	1.4601***	1.5082***	1.5064***	1.4581***	1.5367***	0.5355***	0.7963***	1.4579***	1.6703***	0.6826***	1.2818***
	(0.064)	(0.071)	(0.062)	(0.061)	(0.072)	(0.077)	(0.093)	(0.066)	(0.047)	(0.065)	(0.077)	(0.040)
NACE dummies	Yes	Yes	Yes	Yes								
Country dummies	Yes	Yes	Yes	Yes								
R-squared	0.2185	0.2185	0.2185	0.2185	0.2185	0.2185	0.2007	0.2007	0.2007	0.2007	0.2007	0.2007
N. obs	3925	3925	3925	3925	3925	3925	5927	5927	5927	5927	5927	5927

¹ (10-49) is the omitted size category.

² (1-5) is the omitted age category.

³ Purely domestic is the omitted ownership category.

⁴ var0308_instock_gdp is related to the stock of inward FDI in the manufacturing industry. var0308_instock_gdp is related to the stock of inward FDI in the services industry.

Note 1: The variables for infrastructure and stock of outward FDI were excluded due to multicollinearity.

Note 2: All PCA indices of business regulation (all_DB, DB_business_startup, DB_business_operations, and DB_institutional_environment) were included in the analysis.

However, only all_DB and DB_business_operations were statistically significant. The sub-indicators for DB_business_operations (permit, tax, trade, and employment) are also included in the results above.

Significance: *** 1%, ** 5%, * 10%.

The combination of the importance of foreign ownership and the positive effect of inward FDI on productivity growth suggests a prominent role for FDI in the emerging European economies. Indeed, Eastern Europe has received large volumes of FDI since the 2004 EU expansion. Theory and experience indicate that openness to foreign investment helped these economies generate employment, upgrade technology, and improve managerial knowledge to accelerate productivity growth. In this regard, business regulations play an important role in attracting FDI, even after controlling for market size and factor endowments (Wagle, 2010; Demekas et al., 2007).

5.2 EU15 Results

Among the more developed nations of the EU15, firm-level characteristics predominate over country-level variables. The exclusion of country dummies from the regression on manufacturing firms reduces the explanatory power of the model by 19 percent; for the service firms, the model loses 11 percent. Running the regression without firm characteristics reduces its explanatory power by 25 percent in both manufacturing and service (see Appendix VII).

Ownership, size, and age are important correlates of productivity growth in the EU15 region.⁴⁰ Global headquarters firms grow more quickly than purely domestic firms: 2.3 percentage points more quickly in manufacturing industries and 2.9 percentage points in service industries. Foreign-owned firms also perform better than their purely domestic counterparts: 1.8 percent better in manufacturing and 2.4 percent in services. Unlike in the EU12, size does matter in the EU15: larger firms realize greater productivity growth. Firms that have between 50 and 500 employees grow more than firms with 10 to 49 employees: 1.5 percent more in manufacturing, and 1.2 percent in services. Older firms in service sectors grow more quickly than the younger firms; in manufacturing, age is not statistically significant.

Country-level variables remain a factor: locating in one country or another can net productivity gains of up to 7 percent for manufacturing firms and 5 percent for services firms. However, country performances differ widely across sectors: Norway realized the greatest productivity growth in services but also the least growth in manufacturing.⁴¹

Table 3 presents the EU15 estimation results for Eq. (1). In manufacturing, productivity gains are correlated with increases in workforce education and stock of outward FDI; in services, these are not significant. Improving business regulations—especially trade, tax, and labor regulations—produces gains in labor productivity growth, both in manufacturing and in services.

⁴⁰ For a second method of evaluating the relative impact of firm-level variables, see Appendix XIII.

⁴¹ For a discussion of results from Sample 2, see Appendix VIII.2.

Table 3 Firm-level Productivity Growth and Changes in Country Characteristics in the EU15

	Manufacturing						Services (except construction)					
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Ln(Prod)2003	-0.0904*** (0.004)	-0.0904*** (0.004)	-0.0904*** (0.004)	-0.0904*** (0.004)	-0.0904*** (0.004)	-0.0895*** (0.004)	-0.0850*** (0.003)	-0.0850*** (0.003)	-0.0850*** (0.003)	-0.0850*** (0.003)	-0.0850*** (0.003)	-0.0850*** (0.003)
Size(50-249)¹	0.0053* (0.003)	0.0053* (0.003)	0.0054* (0.003)	0.0053* (0.003)	0.0053* (0.003)	0.0060** (0.003)	0.0057*** (0.002)	0.0057*** (0.002)	0.0057*** (0.002)	0.0057*** (0.002)	0.0057*** (0.002)	0.0057*** (0.002)
Size(250-499)¹	0.0149* (0.008)	0.0149* (0.008)	0.0149* (0.008)	0.0149* (0.008)	0.0149* (0.008)	0.0148* (0.008)	0.0118* (0.006)	0.0118* (0.006)	0.0118* (0.006)	0.0118* (0.006)	0.0118* (0.006)	0.0118* (0.006)
Size(500-999)¹	-0.0051 (0.013)	-0.0051 (0.013)	-0.0049 (0.013)	-0.005 (0.013)	-0.005 (0.013)	-0.0047 (0.013)	-0.0081 (0.008)	-0.0081 (0.008)	-0.0081 (0.008)	-0.0081 (0.008)	-0.0081 (0.008)	-0.0081 (0.008)
Size(1000+)¹	0.0035 (0.013)	0.0035 (0.013)	0.0036 (0.013)	0.0036 (0.013)	0.0036 (0.013)	0.0036 (0.013)	0.0256* (0.015)	0.0256* (0.015)	0.0256* (0.015)	0.0256* (0.015)	0.0256* (0.015)	0.0256* (0.015)
Age(6-10)²	-0.0012 (0.003)	-0.0011 (0.003)	-0.0013 (0.003)	-0.0012 (0.003)	-0.0012 (0.003)	-0.0017 (0.003)	-0.003 (0.002)	-0.003 (0.002)	-0.003 (0.002)	-0.003 (0.002)	-0.003 (0.002)	-0.003 (0.002)
Age(11-20)²	0.002 (0.003)	0.002 (0.003)	0.002 (0.003)	0.002 (0.003)	0.002 (0.003)	0.0022 (0.003)	0.0016 (0.002)	0.0016 (0.002)	0.0016 (0.002)	0.0016 (0.002)	0.0016 (0.002)	0.0016 (0.002)
Age(21-30)²	0.0054 (0.003)	0.0054 (0.003)	0.005 (0.003)	0.0053 (0.003)	0.0052 (0.003)	0.003 (0.003)	0.0049** (0.002)	0.0049** (0.002)	0.0049** (0.002)	0.0049** (0.002)	0.0049** (0.002)	0.0049** (0.002)
Age(>=31)²	0.0053 (0.003)	0.0053 (0.003)	0.0058* (0.003)	0.0055* (0.003)	0.0057* (0.003)	0.0042 (0.003)	0.0065*** (0.002)	0.0065*** (0.002)	0.0065*** (0.002)	0.0065*** (0.002)	0.0065*** (0.002)	0.0065*** (0.002)
Global Head.³	0.0213*** (0.005)	0.0213*** (0.005)	0.0216*** (0.005)	0.0214*** (0.005)	0.0215*** (0.005)	0.0228*** (0.005)	0.0287*** (0.004)	0.0287*** (0.004)	0.0287*** (0.004)	0.0287*** (0.004)	0.0287*** (0.004)	0.0287*** (0.004)
Foreign aff.³	0.0175*** (0.004)	0.0175*** (0.004)	0.0179*** (0.004)	0.0176*** (0.004)	0.0177*** (0.004)	0.0184*** (0.004)	0.0236*** (0.002)	0.0236*** (0.002)	0.0236*** (0.002)	0.0236*** (0.002)	0.0236*** (0.002)	0.0236*** (0.002)
var0308_instock_gdp⁴	-0.0152*** (0.003)	-0.0148*** (0.003)	-0.0196*** (0.003)	-0.0145*** (0.003)	-0.0182*** (0.003)	-0.0213*** (0.003)	-0.0022** (0.001)	-0.0023** (0.001)	-0.0023** (0.001)	-0.0024* (0.001)	-0.0023** (0.001)	-0.0022** (0.001)
var0308_outstock_gdp⁴	0.005*** (0.001)	0.008*** (0.000)	0.007*** (0.000)	0.005*** (0.00)	0.008*** (0.000)	0.0024*** (0.001)	0.003 (0.001)	0.001 (0.001)	0.003 (0.002)	0.003 (0.001)	0.002 (0.001)	0.001 (0.000)
var0308_credit_gdp	-0.0004** (0.000)	-0.0004** (0.000)	-0.0008** (0.000)	-0.0005** (0.000)	-0.0011** (0.000)	-0.0006** (0.000)	-0.0005*** (0.000)	-0.0005*** (0.000)	-0.0005*** (0.000)	-0.0005*** (0.000)	-0.0005*** (0.000)	-0.0005*** (0.000)

var0308_skills	0.0015*** (0.000)	0.0010*** (0.000)	0.0013*** (0.000)	0.0004* (0.000)	0.0013*** (0.000)	0.0025*** (0.000)	0.0011 (0.000)	0.0011 (0.000)	0.0010 (0.000)	0.0009 (0.000)	0.0011 (0.000)	0.0008 (0.000)
var0308_all_DB	0.0052*** (0.000)						0.003** (0.000)					
var0308_Busin. Oper		0.0041*** (0.000)						0.002** (0.000)				
var0308_Permit			-0.0163*** (0.002)						-0.0024 (0.009)			
var0308_Tax				0.0192*** (0.001)						0.0129** (0.000)		
var0308_Trade					0.0030*** (0.000)						0.002** (0.000)	
var0308_Empl						0.0031*** (0.000)						0.0029** (0.000)
_cons	1.0152*** (0.049)	1.0143*** (0.049)	1.0137*** (0.049)	1.0149*** (0.049)	1.0134*** (0.049)	0.9790*** (0.049)	0.9571*** (0.034)	0.9570*** (0.034)	0.9566*** (0.034)	0.9569*** (0.034)	0.9567*** (0.034)	0.9576*** (0.034)
NACE dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R-squared	0.1318	0.1318	0.1327	0.1321	0.1324	0.136	0.1115	0.1115	0.1115	0.1115	0.1115	0.1115
N. obs	16,800	16,800	16,800	16,800	16,800	16,800	28,360	28,360	28,360	28,360	28,360	28,360

¹ (10-49) is the omitted size category.

² (1-5) is the omitted age category.

³ Purely domestic is the omitted ownership category.

⁴ var0308_instock_gdp(var0308_outstock_gdp) is related to the stock of inward (outward) FDI in the manufacturing industry. var0308_instock_gdp(var0308_outstock_gdp) is related to the stock of inward (outward) FDI in the services industry.

Note 1: The variables for infrastructure and stock of outward FDI were excluded due to multicollinearity.

Note 2: All PCA indices of business regulation (all_DB, DB_business_startup, DB_business_operations, and DB_institutional_environment) were included in the analysis.

However, only all_DB and DB_business_operations were statistically significant. The sub-indicators for DB_business_operations (permit, tax, trade, and employment) are also included in the results above.

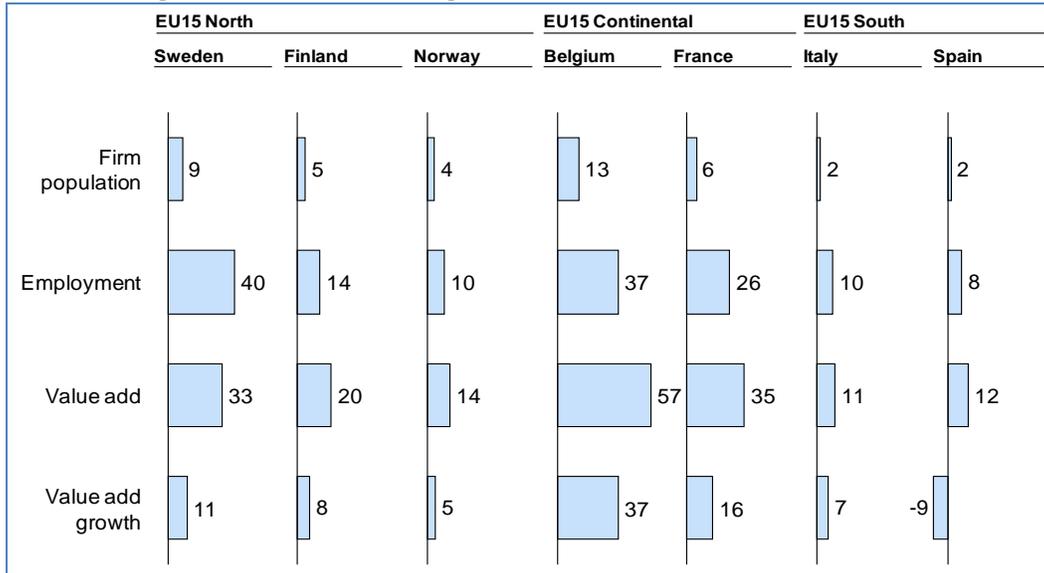
Significance: *** 1%, ** 5%, * 10%.

A one standard deviation increase in the overall business regulation index leads to a 3.4 percent productivity increase for the average manufacturing firm and a 1.7 percent increase for the average service firm. A one standard deviation increase in the tax index correlates to a 3 percent increase in manufacturing and 2 percent in services. A one standard deviation increase of the trade index leads to 3.16 and 2.10 percent increases for manufacturing firms and service firms, respectively. A one standard deviation increase in the employment regulation index raises labor productivity by 1.52 in manufacturing and 1.42 percent in services.⁴²

5.3 EU15 South

While the majority of the EU15 countries experienced positive productivity growth from 2003 to 2008, the southernmost countries—Greece, Italy, Portugal, and Spain—experienced a contraction. Given the results of the previous section on the importance of firm size, foreign-affiliation, and outward FDI for productivity, the answer may lie in their mix of firms.

Figure 4 Share of Foreign Firms (% of total) in EU15, 2008

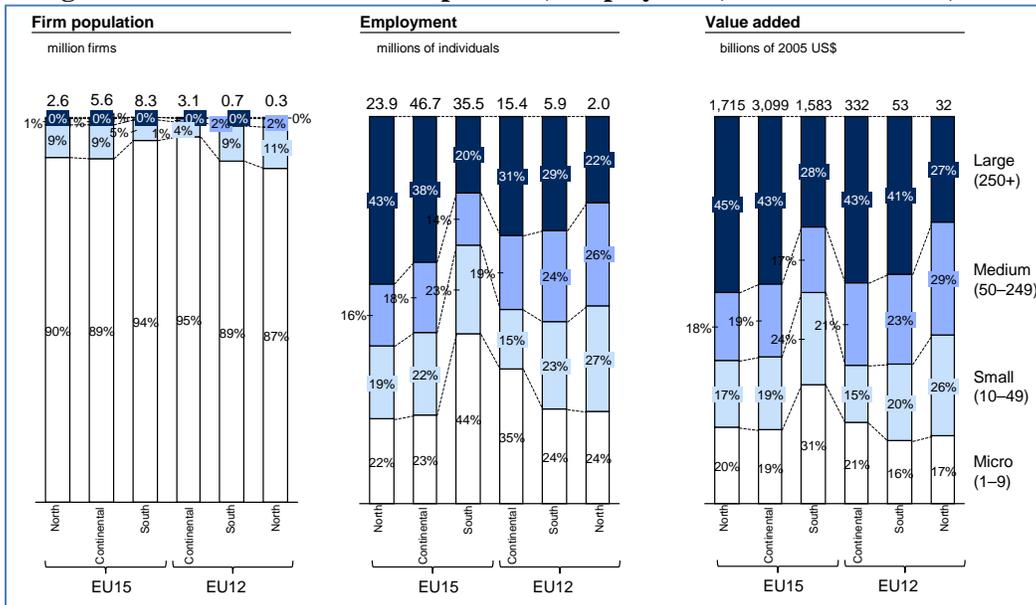


Source: World Bank staff calculations based on Amadeus.

Amadeus data show that less than 3 percent of Italian and Spanish firms are global headquarters (Figure 4). The distribution of firm size in the EU15 South is skewed towards microenterprises; very small, family-operated firms play a much greater role in the economies of Southern Europe than in the other developed economies of Western Europe. Microenterprises account for roughly one third of all value-added generated in the EU15 South and employ roughly half the workforce. When small and medium enterprises are added to microenterprises, they together employ four out of five workers in Southern Europe. These figures are nearly double those in the rest of Europe, where larger enterprises play a more significant role (Figure 5).

⁴² Results for the second sample are similar in sign and magnitude; See Appendix XI.

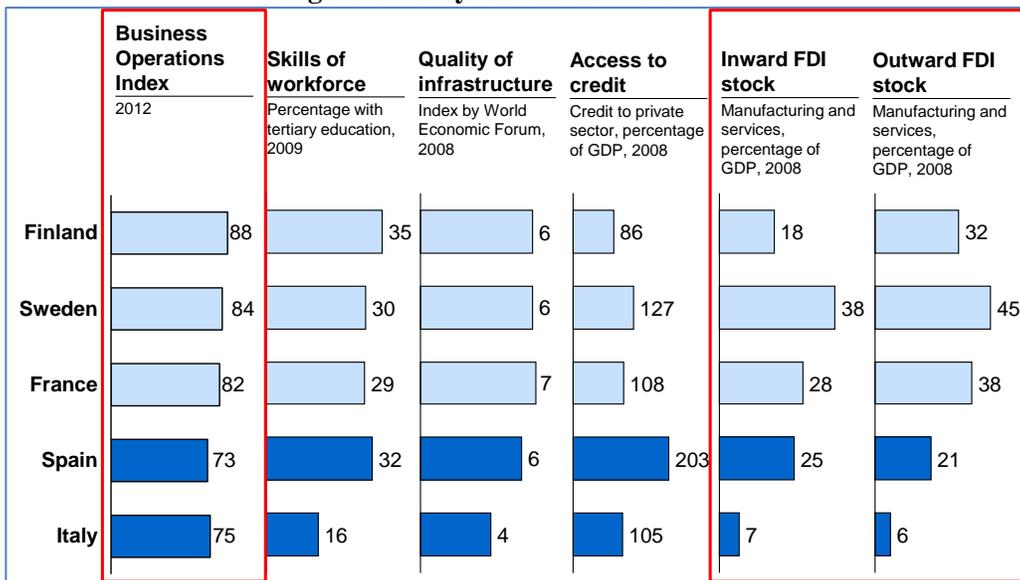
Figure 5 Distribution of Firm Population, Employment, and Value-added, 2007



Source: World Bank staff calculations based on Eurostat.

The EU15 South also suffers from unfavorable domestic business environments. In comparison to rest of the EU15, the EU15 South rated consistently lower in regulatory indices and in outward FDI (Figure 6). Successful countries in Northern and Continental Europe were able not only to nurture domestic firms that invested abroad, but also to attract foreign firms to invest domestically, as reflected in their FDI stocks. This situation in turn allowed greater access to foreign markets and increased demand (Antras and Helpman, 2004). This finding implies that Southern Europe may realize productivity improvements by loosening restrictive regulatory requirements, encouraging competition, and supporting both outward and inward FDI.

Figure 6 Policy Variables in the EU15



6. Conclusion

Using a panel of micro-data on firms from 12 EU countries⁴³ from 2003 to 2008, this paper addresses the confusing proliferation of suggested determinants of productivity growth and seeks to provide clear policy implications. The literature has generated theories attributing growth to country, industry, firm, and even product characteristics. Studies have thus far found support for each of these, but have failed to determine which among the many correlates are most critical for growth. We specify a model incorporating initial conditions, firm age, size, international affiliation, business environment indices, and FDI to assess the relative importance of each in explaining growth in labor productivity. We divide our sample into two groups, New Europe and Old, and obtain results for each.

In the economies of the EU12, country-level variables dominate—the most important of which are the stock of inward FDI, business regulations facilitating foreign investment, and the availability of private credit. The most important firm-level characteristic is international affiliation, either as headquarters of a multinational corporation or as subsidiary of a foreign firm. These results suggest that accession to the EU has been beneficial for new members because the ease with which foreign firms may now penetrate these new markets has facilitated the transfer of technology and the diffusion of best practices. The clear policy implication is that developing countries may realize significant productivity gains by taking the relatively easy steps of improving their regulatory regimes and creating environments attractive to inward FDI before addressing the more costly requirements of improving infrastructure and better educating their workforces.

With the EU15, firm-level characteristics dominate. Among these, the most critical are international affiliation and firm size. The most important country-level factor is outward FDI. Taken together, these results argue strongly for the role played by multinational corporations in driving productivity growth in developed countries. Thus, it is not surprising that firm size contributes to productivity growth in the EU15: as the large amount of FDI shows, firms in Western Europe are transforming themselves into headquarters of multinational corporations, and thus require more personnel to manage their global interests.

However, the success of the EU15 was not shared equally by all member countries. The four southernmost nations of Greece, Italy, Portugal, and Spain suffered productivity losses. Our analysis suggests that the failure of these nations to perform may be attributed to disadvantageous and restrictive regulatory regimes, leading to a relative preponderance of small- and medium-size firms. These factors discourage international participation and sharply limit the EU15 South's ability to benefit from knowledge transfers from abroad, economies of scale, and production-reallocation efficiencies. However, these states may still achieve gains by reforming their regulatory regimes to encourage the expansion of outward FDI.

The experience of the EU15 South in relation to the rest of the EU15 raises an interesting implication for the EU12. While this paper divides Old and New Europe into two separate regions, implying at some level a fundamental difference, it may be that this difference is not necessarily intrinsic. Indeed, as Demekas et al. (2007) suggest, it may simply be the case that different characteristics matter more at different levels of economic development. The research

⁴³ For sample 2 (with firms with at least 50 employees), the sample comprises 17 countries.

remains to be done to find exactly at what point of development country-level attributes become less important than firm-level characteristics in predicting productivity growth, and how all these factors interact.

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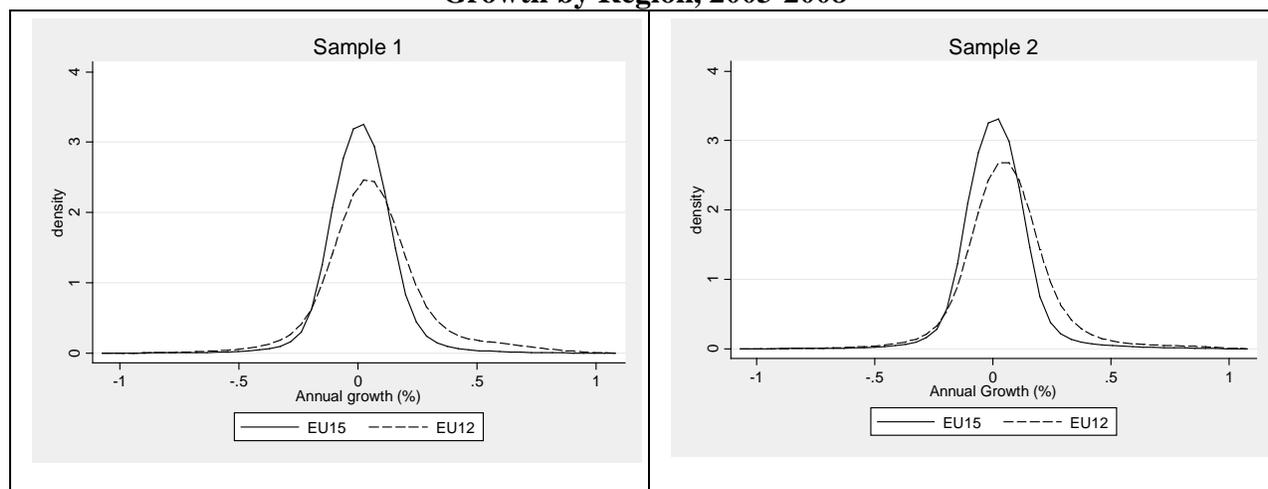
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Appendix I Sector Classification

N.o	NACE 1.1 class	Description
1	DA	Manufacture of food products, beverages and tobacco
2	DB	Manufacture of textiles and textile products
3	DC	Manufacture of leather and leather products
4	DD	Manufacture of wood and wood products
5	DE	Manufacture of pulp, paper and paper products; publishing and printing
6	DF	Manufacture of coke, refined petroleum products and nuclear fuel
7	DG	Manufacture of chemicals, chemical products and man-made fibres
8	DH	Manufacture of rubber and plastic products
9	DI	Manufacture of other non-metallic mineral products
10	DJ	Manufacture of basic metals and fabricated metal products
11	DK	Manufacture of machinery and equipment n.e.c.
12	DL	Manufacture of electrical and optical equipment
		Manufacture of transport equipment
13	DM except DM35.1 (DM34, DM35.2, DM35.3, DM35.4 and DM35.5)	
14	DM35.1	Building and repairing of ships and boats
15	DN	Manufacturing n.e.c.
16	F	Construction
17	G	Wholesale and retail trade; repair of motor vehicles, motorcycles and personal and household goods
18	H	Hotels and restaurants
19	I60, I61, I62, I63 and I641	Transport and storage
20	I64.2	Telecommunications
21	K70	Real estate activities
22	K71	Renting of machinery and equipment without operator and of personal and household goods
23	K72	Computer and related activities
		Research and development & Professional services
24	K73+ (K74.1, K74.2 k74.3, K74.4)	
25	(K74.5 K74.6, K74.7, K74.8)	Operational services

Appendix II Nonparametric Density Estimations of Annualized Labor Productivity Growth by Region, 2003-2008



Appendix III Annual Growth Rate at Firm Level (in %), 2003-2008

	Mean	Std. Dev	p5th	p95th
Sample 1				
EU15	1.5	14.4	-14.5	19.1
EU12	7.0	23.3	-22.2	48.2
sample2				
EU15	1.8	16.7	-14.4	19.7
EU12	6.3	19.8	-17.9	35.9

Appendix IV: Re-sampling Procedure

Although the Amadeus database is very rich and detailed, its distribution does not necessarily reflect the underlying population distribution of firms across size classes, sectors, and countries. One reason behind this lack of representativeness is the fact that the Amadeus data only include balance-sheet information and income statements for companies above a certain size in the European Union and in a number of Central and Eastern Europe countries. Therefore, the data tend to be skewed in favor of medium and large firms. In addition, not all firms in the database report all critical output and input variables, reducing the number of firms for which labor productivity and total factor productivity can be estimated. This situation implies that once productivity figures are obtained, the final sample may not be representative of the population distribution of firms in the country, which can potentially bias the results.

In order to ensure representativeness of the firm-level samples used in the paper, and align them with the distribution of the underlying firm population at the country, sector and size levels, the Amadeus dataset was re-sampled using a three step re-sampling method.

First, using population distribution figures for firms above 10 employees from the Eurostat Structural Business Statistics database for the year 2006, a sample size of 150,000 firms was designed using three stratification criteria: size (10–19, 20–49, 50–249, and 250+), sector (NACE 1.1), and country. The countries included in the Eurostat Structural Business Statistics database are: Austria, Belgium, Bosnia, Bulgaria, Croatia, the Czech Republic, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Macedonia, the Netherlands, Norway, Poland, Portugal, Romania, Serbia, the Slovak Republic, Slovenia, Spain, Sweden, Ukraine, and the United Kingdom. For Bosnia and Herzegovina, Serbia, Croatia, and Ukraine, Eurostat Structural Business Statistics were not available, so population figures were extracted from the World Bank BEEPS database for 2007.⁴⁴

Second, including only firms for which at least three years of information on value added was available, random draws (without replacement) were taken for each size-sector-country stratum in the sample according to the population distribution figures. Table IV.1 presents the ratio, by country and size strata, of the targeted number of companies to the number of sampled firms.

Third, two samples were defined. The first sample (firms with 10+ employees) contains countries for which the ratio between the number of sampled firms and the number of population firms was at least 80 percent per size class. The second sample (firms with 50+ employees) contains countries for which the related ratio was at least 60 percent of size class.

Table IV.1 - Firm Population Versus Estimation Sample after Resampling

Country	Size class (%)				Total
	10-19	20-49	50-249	250+	
Austria	0.4	1.0	4.3	11.0	1.4
Belgium	100.0	100.3	99.8	99.4	100.0
Bosnia and Herzegovina	70.7	100.4	99.6	94.7	79.0

⁴⁴ For more information visit: www.enterprisesurveys.org.

Bulgaria	43.0	72.6	95.0	86.9	62.0
Croatia	99.9	99.8	100.7	98.7	99.9
Czech Rep	74.1	89.4	97.6	94.1	83.2
Estonia	99.9	99.7	98.4	78.4	99.1
Finland	99.9	99.2	98.3	98.3	99.4
France	99.9	99.9	100.1	99.9	99.9
Germany	2.4	12.1	61.2	92.6	15.3
Greece*	0.0	0.0	0.0	0.0	0.0
Hungary	1.2	1.8	6.8	23.9	2.6
Ireland*	0.0	0.0	0.0	0.0	0.0
Italy	95.4	100.0	100.1	99.2	97.0
Latvia	1.2	2.4	12.3	36.1	4.0
Lithuania	0.0	0.0	0.0	0.0	0.0
FYR Macedonia	0.0	0.0	5.4	0.0	0.2
Netherlands	10.0	53.7	51.6	61.6	36.1
Norway	93.1	94.8	95.4	79.0	93.5
Poland	68.7	85.8	99.6	100.2	83.4
Portugal	57.3	62.9	90.1	98.8	63.6
Romania	99.9	99.9	99.9	96.2	99.8
Serbia	100.0	99.9	100.3	100.3	100.0
Slovak Rep	33.9	24.0	96.8	95.7	45.5
Slovenia	90.6	97.2	100.5	96.6	94.4
Spain	100.0	100.0	100.1	99.6	100.0
Sweden	99.9	100.2	99.9	98.4	99.9
Ukraine	91.9	97.2	100.0	97.0	94.0
United Kingdom	34.1	88.9	100.1	99.8	58.9

Source: World Bank staff calculations based on Amadeus and Eurostat

*For Greece and Ireland, the Amadeus data do not have any information for valued added, that is why the number of firms drawn was zero.

Appendix V Principal Component Analysis

Doing Business variables cover ten topics: starting a business, dealing with construction permits, registering property, getting credit, protecting investors, paying taxes, trading across borders, enforcing contracts, employing workers, and closing a business. Each of these indicators is constructed on several sub-indicators, such as procedures, time, and required cost to start a business. The variables included in this analysis are indices created using a principal component analysis for each Doing Business topic. The principal component analysis indices are linear combinations of Doing Business sub-indicators, where each sub-indicator is optimally weighted to maximize indicator variance. All indices are coded such that a higher number indicated more complex and inhibitive regulation on a scale of 0 to 100.

We use the principal component methodology to construct an index of all the Doing Business variables. We further create an index measuring the difficulties associated with operating and maintaining a business. Business operations includes variables for paying taxes, trading across borders, employing workers, and obtaining construction permits. Paying taxes indicates the tax burdens faced by a typical medium-sized company and includes a measure of the administrative costs of compliance. Trading across borders measures the procedural burden of exporting and importing a standardized cargo of goods by counting the number of required documents such shipment requires—from the contractual agreement between the two parties to the delivery of goods—along with the time necessary for completion. Employing workers measures difficulties in hiring, required redundancy in workers, and the rigidity of working hours. Construction permits measures the total cost of building a warehouse, including necessary licenses and permits, completing required notifications and inspections, and connecting utilities.

To verify the quality of the principal component analysis indicator, we compare it with an alternative measure of the quality of business regulation, the Product Market Regulation indicators constructed by the Organisation for Economic Co-operation and Development (OECD 2011). Results indicate a strong correlation (0.74) between our synthetic all Doing Business variable and that of the OECD for the countries covered by both databases. The OECD indices do not comprehensively cover Europe annually, hence the construction of Doing Business indices.

Appendix VI Decomposition of Explanatory Power: EU12

	Manufacturing			Services (except construction)		
	All controls	no country	no firm/sector	All	no country	no firm/sector
ln_ip2_usd05_03	-0.1237*** (0.005)	-0.0899*** (0.005)	-0.1167*** (0.005)	-0.1122*** (0.003)	-0.0869*** (0.003)	-0.1053*** (0.003)
Size(50-249)¹	-0.0156** (0.007)	-0.0119* (0.007)		-0.0130*** (0.004)	-0.0100** (0.005)	
Size(250-499)¹	-0.0530*** (0.012)	-0.0438*** (0.013)		-0.0269*** (0.009)	-0.0204** (0.010)	
Size(500-999)¹	-0.0229 (0.019)	-0.0286 (0.019)		-0.014 (0.015)	-0.0152 (0.015)	
Size(1000+)	-0.0582** (0.029)	-0.0731*** (0.027)		-0.0217 (0.032)	-0.0233 (0.031)	
Age(6-10)	-0.001 (0.009)	0.0074 (0.010)		0.0013 (0.005)	0.0054 (0.006)	
Age(11-20)	-0.0027 (0.009)	0.0153 (0.009)		-0.0017 (0.005)	0.0091 (0.006)	
Age(21-30)	0.0102 (0.021)	0.0452** (0.021)		-0.0132 (0.018)	0.019 (0.017)	
Age(>=31)	0.0079 (0.018)	0.0249 (0.017)		-0.0036 (0.010)	0.0032 (0.010)	
Global Head.	0.0670** (0.033)	0.1019*** (0.036)		0.0309* (0.018)	0.0547*** (0.018)	
Czech Rep.⁴	0.0384*** (0.010)		0.0466*** (0.009)	0.0344*** (0.007)		0.0475*** (0.007)
Estonia	-0.0371** (0.017)		-0.0280* (0.015)	-0.0384*** (0.010)		-0.0258*** (0.009)
Poland	-0.0209*** (0.008)		-0.0237*** (0.007)	-0.0152*** (0.005)		-0.0110** (0.005)
Romania	-0.1437*** (0.010)		-0.1488*** (0.009)	-0.1114*** (0.007)		-0.1054*** (0.007)
_cons	1.2183*** (0.049)	0.8398*** (0.044)	1.1768*** (0.049)	1.0991*** (0.029)	0.8168*** (0.025)	1.0681*** (0.028)
NACE dummies	Yes	Yes	No	Yes	Yes	No
R-squared	0.2185	0.1462	0.2002	0.2007	0.1544	0.1839
N. obs	3925	3925	3925	5,927	5,927	5,927

¹ (10-49) is the omitted size category.

² (1-5) is the omitted age category.

³ Purely domestic is the omitted ownership category.

⁴ Slovenia is the omitted country.

Significance: *** 1%, ** 5%, * 10%.

Appendix VII Decomposition of Explanatory Power: EU15 (sample 1)

	Manufacturing			Services (except construction)		
	All	no country	no firm/sector	All	no country	no firm/sector
Ln(Prod)2003	-0.0896*** (0.004)	-0.0815*** (0.004)	-0.0796*** (0.004)	-0.0850*** (0.003)	-0.0772*** (0.003)	-0.0743*** (0.003)
Size(50-249)¹	0.0059** (0.003)	0.0039 (0.003)		0.0057*** (0.002)	0.0042** (0.002)	
Size(250-499)¹	0.0148* (0.008)	0.008 (0.008)		0.0118* (0.006)	0.0087 (0.006)	
Size(500-999)¹	-0.0046 (0.013)	-0.0124 (0.013)		-0.0081 (0.008)	-0.0126* (0.008)	
Size(1000+)¹	0.0037 (0.013)	0.0038 (0.013)		0.0256* (0.015)	0.0256* (0.015)	
Age(6-10)²	-0.0018 (0.003)	-0.0053 (0.003)		-0.003 (0.002)	-0.0057*** (0.002)	
Age(11-20)²	0.0021 (0.003)	-0.0007 (0.003)		0.0016 (0.002)	0.0004 (0.002)	
Age(21-30)²	0.0031 (0.003)	0.0057* (0.003)		0.0049** (0.002)	0.0074*** (0.002)	
Age(>=31)²	0.0046 (0.003)	0.0104*** (0.003)		0.0065*** (0.002)	0.0085*** (0.002)	
Global Head.³	0.0228*** (0.005)	0.0260*** (0.005)		0.0287*** (0.004)	0.0285*** (0.004)	
Foreign aff.³	0.0185*** (0.004)	0.0225*** (0.003)		0.0236*** (0.002)	0.0236*** (0.002)	
Belgium	-0.0001 (0.007)		-0.0077 (0.007)	0.0091* (0.005)		0.0031 (0.005)
Spain	-0.0630*** (0.005)		-0.0728*** (0.005)	-0.0302*** (0.004)		-0.0414*** (0.004)
France	-0.0224*** (0.005)		-0.0236*** (0.005)	-0.006 (0.004)		-0.0067* (0.004)
Italy	-0.0167*** (0.005)		-0.0291*** (0.005)	0.0089** (0.004)		-0.0035 (0.004)
Norway	-0.0723*** (0.009)		-0.0857*** (0.009)	0.0161*** (0.005)		0.0022 (0.005)
Sweden	-0.0306*** (0.007)		-0.0319*** (0.007)	-0.0074 (0.006)		-0.0113** (0.006)
_cons	1.0112*** (0.048)	0.8907*** (0.045)	0.9162*** (0.047)	0.9349*** (0.033)	0.8441*** (0.031)	0.8331*** (0.031)
NACE dummies	Yes	Yes	No	Yes	Yes	No
R-squared	0.136	0.1105	0.1052	0.1115	0.0995	0.0851
N. obs	16,800	16,800	16,800	28,400	28,400	28,400

¹(10-49) is the omitted size category; ²(1-5) is the omitted age category; ³Purely domestic is the omitted ownership category. Finland is the omitted country. Significance: *** 1%, ** 5%, * 10%.

Appendix VIII Discussion of Sample 2 (Firms with 50+ Employees)

VIII.1 EU12

When performing the exclusion exercise with the sample of surviving firms with a minimum of 50 employees, the results show a slightly different picture: country and firm characteristics are *equally* important. In fact, in the regression for manufacturing industries, excluding the country dummies reduces the explanatory power of the model by 19 percent; dropping firm characteristics variables reduces the explanatory power of the model by 15 percent. In the services industry, dropping country fixed-effects reduces the explanatory power by 13 percent while the exclusion of firm characteristics leads to a reduction of 16 percent. Country dummies also differ greatly from one another suggesting similar companies have different performance in different countries. A manufacturing firm in the Czech Republic on average grows 0.9 percentage points faster than a similar manufacturer in Slovenia.

Results from the counterfactual exercise comparing how the estimated country dummies change when adding each one of the firm variables for Sample 2 corroborate the results from Sample 1. First, firm ownership still appears as the most relevant characteristic for explaining productivity growth in the EU12. Foreign-owned firms grow faster than purely domestic ones, both in manufacturing and in services (1.2 and 2.2 percent more, respectively). Global-headquarter firms also grow more in comparison with purely domestic firms: 3.6 percent more in manufacturing and 3.9 percent in services. Again, size seems to matter less, though larger firms do grow more slowly in productivity, particularly in manufacturing. Finally, age has the opposite effect on productivity depending on the industry. In manufacturing, older firms grow more quickly: firms between 21 and 30 years old grow on average 3.4 percent more than firms less than 6 years old. In services, the opposite happens: firms older than 31 years grow on average 3.7 percent more slowly than the youngest group.

Performing the same counterfactual exercise between a Czech manufacturing firm and a Slovenian manufacturing firm again supports the previous results. The average productivity gap between a Czech and Slovenian firm with more than 50 employees in manufacturing is 2.7 percent. However, if considering two firms with the same baseline productivity, this gap falls to 1.8 percent. When limiting the observation to two firms with the same sector specialization, the gap is unaffected (1.7 percent). Finally, if the two firms share the same ownership, size, and age composition, the gap falls to 0.9 percent. The remaining effect is then country specific. Results are available upon request.

VIII.2 EU15

For both manufacturing and services industries, the firm-level characteristics matter most. Excluding firm characteristics from the manufacturing and services models reduces their explanatory power by 22 and 25 percent, respectively. When dropping country fixed-effects the models lose less of their explanatory power: 20 in manufacturing and 13 percent in services. See Appendix IX.

Results of the exclusion exercise from Sample 2 do not differ significantly from those of Sample 1. Again, ownership, size and age are important firm characteristics for productivity. Foreign-

affiliated firms grow more quickly: 1.9 percentage points for global headquarters in manufacturing and 2.61 percentage points for services. Size is also important in Western Europe: larger firms grow more rapidly in productivity. Firms that have more than 1,000 employees experienced greater productivity growth than firms with 50 to 249 employees. Again, older firms in service sectors grow more than younger firms; in manufacturing, age is not statistically significant. See Appendix X.

The counterfactual exercise using an Italian and a Finnish manufacturing firm shows very similar results for Sample 2. An average Finnish firm with more than 50 employees grows 2.3 percentage points more rapidly than does a similarly sized Italian firm. Regarding two firms in the same sector, the gap would fall to 2.1 percentage points. Finally, if the two firms were identical in ownership, size, and age, the gap would fall to 1.6 percentage points. The remaining effect is country specific. Country effects may cause differences in productivity growth of up to 9.6 percentage points in manufacturing and 8.4 in services. Again, country performances differ widely across sectors: Norway leads in terms of productivity growth in services, but is among the slowest-improving countries in manufacturing. See Appendix XI.

Appendix IX Decomposition of Explanatory Power: EU15 (sample 2)

	Manufacturing			Services (except construction)		
	All	no country	no firm/sector	All	no country	no firm/sector
Ln(Prod)2003	-0.0943*** (0.008)	-0.0829*** (0.008)	-0.0806*** (0.008)	-0.0782*** (0.007)	-0.0703*** (0.006)	-0.0652*** (0.006)
Size(250-499)¹	0.0055 (0.006)	0.0073 (0.006)		-0.0021 (0.004)	0.0005 (0.004)	
Size(500-999)¹	0.0096 (0.008)	0.0115 (0.009)		-0.0058 (0.006)	-0.0032 (0.006)	
Size(1000+)	0.0414*** (0.010)	0.0478*** (0.010)		0.0221*** (0.009)	0.0289*** (0.009)	
Age(6-10)	-0.0105 (0.008)	-0.0126 (0.008)		-0.0094 (0.006)	-0.0119** (0.006)	
Age(11-20)	-0.004 (0.008)	-0.0058 (0.008)		0.0033 (0.005)	0.0008 (0.005)	
Age(21-30)	-0.0002 (0.007)	-0.0037 (0.007)		0.0023 (0.005)	-0.0015 (0.005)	
Age(>=31)	0.0022 (0.007)	-0.005 (0.007)		0.0116** (0.006)	0.0013 (0.005)	
Global Head.	0.0199*** (0.005)	0.0137*** (0.005)		0.0261*** (0.006)	0.0178*** (0.005)	
Foreign aff.	0.0151*** (0.006)	0.0113** (0.005)		0.0259*** (0.004)	0.0204*** (0.004)	
Belgium	-0.0101 (0.011)		-0.0158 (0.011)	-0.0046 (0.010)		-0.0007 (0.010)
Germany	-0.0162** (0.007)		-0.0154** (0.008)	0.0089 (0.009)		0.008 (0.009)
Spain	-0.0606*** (0.008)		-0.0660*** (0.008)	-0.0245*** (0.009)		-0.0338*** (0.009)
France	-0.0262*** (0.007)		-0.0231*** (0.007)	-0.0068 (0.008)		-0.002 (0.009)
Great Britain	-0.0595*** (0.009)		-0.0531*** (0.009)	-0.0318*** (0.009)		-0.0179** (0.009)
Italy	-0.0161* (0.008)		-0.0240*** (0.008)	0.01 (0.009)		0.0008 (0.009)
Norway	-0.0565*** (0.021)		-0.0730*** (0.020)	0.0219* (0.013)		0.0073 (0.012)
Portugal	-0.1067*** (0.012)		-0.1179*** (0.012)	-0.0624*** (0.010)		-0.0694*** (0.011)
Sweden	-0.019 (0.014)		-0.0188 (0.014)	-0.0086 (0.013)		-0.008 (0.013)
_cons	1.0821*** (0.091)	0.9256*** (0.085)	0.9342*** (0.088)	0.8712*** (0.072)	0.7821*** (0.069)	0.7406*** (0.065)
NACE dummies	Yes	Yes	No	Yes	Yes	No
R-squared	0.1515	0.1203	0.1186	0.1127	0.0981	0.0841
N. obs	4775	4775	4775	6316	6316	6316

¹(50–249) is the omitted size category, ²(1–5) is the omitted age category, ³Purely domestic is the omitted ownership category. Finland is the omitted country. Significance: *** 1%, ** 5%, * 10%.

Appendix X Firm-level Productivity Growth in the EU15 (sample 2)

	Manufacturing					Services (except construction)				
	All controls (1)	Ownership + sector+ baseline prod+ country dummies (2)	Sector+ baseline prod+ country dummies (3)	Baseline prod + country dummies (4)	Only country dummies (5)	All controls (6)	Ownership + sector+ baseline prod+ country dummies (7)	Sector+ baseline prod+ country dummies (8)	Baseline prod + country dummies (9)	Only country dummies (10)
Ln(prod) 2003	-0.0943*** (0.008)	-0.0924*** (0.008)	-0.0888*** (0.008)	-0.0806*** (0.008)		-0.0782*** (0.007)	-0.0774*** (0.007)	-0.0738*** (0.006)	-0.0652*** (0.006)	
Size(250-499)¹	0.0055 (0.006)					-0.0021 (0.004)				
Size(500-999)¹	0.0096 (0.008)					-0.0058 (0.006)				
Size(1000+)	0.0414*** (0.010)					0.0221*** (0.009)				
Age(6-10)	-0.0105 (0.008)					-0.0094 (0.006)				
Age(11-20)	-0.004 (0.008)					0.0033 (0.005)				
Age(21-30)	-0.0002 (0.007)					0.0023 (0.005)				
Age(>=31)	0.0022 (0.007)					0.0116** (0.006)				
Global Head.	0.0199*** (0.005)	0.0228*** (0.005)				0.0261*** (0.006)	0.0268*** (0.005)			
Foreign aff.	0.0151*** (0.006)	0.0180*** (0.005)				0.0259*** (0.004)	0.0259*** (0.004)			
Belgium	-0.0101 (0.011)	-0.0106 (0.011)	-0.0117 (0.011)	-0.0158 (0.011)	-0.0407*** (0.011)	-0.0046 (0.010)	-0.0038 (0.010)	-0.0037 (0.010)	-0.0007 (0.010)	-0.0265** (0.010)
Germany	-0.0162** (0.007)	-0.0125* (0.007)	-0.0173** (0.007)	-0.0154** (0.008)	-0.0376*** (0.007)	0.0089 (0.009)	0.0109 (0.009)	0.0061 (0.009)	0.008 (0.009)	-0.0180** (0.009)

Spain	-0.0606*** (0.008)	-0.0604*** (0.008)	-0.0656*** (0.008)	-0.0660*** (0.008)	-0.0659*** (0.009)	-0.0245*** (0.009)	-0.0257*** (0.009)	-0.0312*** (0.009)	-0.0338*** (0.009)	-0.0262*** (0.009)
France	-0.0262*** (0.007)	-0.0235*** (0.007)	-0.0237*** (0.007)	-0.0231*** (0.007)	-0.0176** (0.008)	-0.0068 (0.008)	-0.0035 (0.008)	-0.0027 (0.008)	-0.002 (0.009)	-0.0085 (0.009)
Great Britain	-0.0595*** (0.009)	-0.0556*** (0.008)	-0.0525*** (0.008)	-0.0531*** (0.009)	-0.0510*** (0.011)	-0.0318*** (0.009)	-0.0241*** (0.009)	-0.0179** (0.009)	-0.0179** (0.009)	-0.0202** (0.009)
Italy	-0.0161* (0.008)	-0.0152* (0.008)	-0.0211*** (0.008)	-0.0240*** (0.008)	-0.0233*** (0.009)	0.01 (0.009)	0.0103 (0.009)	0.0045 (0.009)	0.0008 (0.009)	-0.007 (0.009)
Norway	-0.0565*** (0.021)	-0.0590*** (0.020)	-0.0654*** (0.020)	-0.0730*** (0.020)	-0.1161*** (0.020)	0.0219* (0.013)	0.0188 (0.012)	0.0128 (0.012)	0.0073 (0.012)	-0.0039 (0.014)
Portugal	-0.1067*** (0.012)	-0.1046*** (0.011)	-0.1083*** (0.012)	-0.1179*** (0.012)	-0.0612*** (0.011)	-0.0624*** (0.010)	-0.0618*** (0.010)	-0.0655*** (0.010)	-0.0694*** (0.011)	-0.0403*** (0.011)
Sweden	-0.019 (0.014)	-0.0176 (0.013)	-0.0194 (0.013)	-0.0188 (0.014)	-0.0006 (0.015)	-0.0086 (0.013)	-0.0073 (0.013)	-0.0089 (0.013)	-0.008 (0.013)	-0.001 (0.012)
_cons	1.0821*** (0.091)	1.0596*** (0.091)	1.0302*** (0.090)	0.9342*** (0.088)	0.0502*** (0.007)	0.8712*** (0.072)	0.8656*** (0.071)	0.8381*** (0.070)	0.7406*** (0.065)	0.0349*** (0.008)
NACE dummies	Yes	Yes	Yes	No	No	Yes	Yes	Yes	No	No
R-squared	0.1515	0.1475	0.1428	0.1186	0.0173	0.1127	0.1102	0.104	0.0841	0.0028
N. obs	4775	4775	4775	4775	4803	6316	6316	6316	6316	6391

¹(50–249) is the omitted size category.

²(1–5) is the omitted age category.

³Purely domestic is the omitted ownership category.

Finland is the omitted country.

Significance: *** 1%, ** 5%, * 10%.

Appendix XI Firm-level Productivity Growth and Changes in Country Characteristics in the EU15: Complete Results (sample 2)

	Manufacturing						services(except construction)					
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Ln(Prod)2003	-0.0892*** (0.008)	-0.0893*** (0.008)	-0.0908*** (0.008)	-0.0893*** (0.008)	-0.0894*** (0.008)	-0.0901*** (0.008)	-0.0775*** (0.007)	-0.0775*** (0.007)	-0.0771*** (0.007)	-0.0778*** (0.007)	-0.0775*** (0.007)	-0.0771*** (0.007)
Size(250-499)¹	0.0038 (0.006)	0.0038 (0.006)	0.0032 (0.006)	0.004 (0.006)	0.0037 (0.006)	0.0037 (0.006)	-0.0025 (0.004)	-0.0025 (0.004)	-0.003 (0.004)	-0.0023 (0.004)	-0.0026 (0.004)	-0.0031 (0.004)
Size(500-999)¹	0.006 (0.008)	0.0059 (0.008)	0.0054 (0.008)	0.0063 (0.008)	0.0059 (0.008)	0.0062 (0.008)	-0.0067 (0.006)	-0.0068 (0.006)	-0.0079 (0.006)	-0.0061 (0.006)	-0.007 (0.006)	-0.0079 (0.006)
Size(1000+)¹	0.0375*** (0.010)	0.0375*** (0.010)	0.0359*** (0.010)	0.0382*** (0.010)	0.0373*** (0.010)	0.0368*** (0.010)	0.0207** (0.009)	0.0204** (0.009)	0.0195** (0.009)	0.0213** (0.009)	0.0202** (0.009)	0.0196** (0.009)
Age(6-10)²	-0.0112 (0.008)	-0.0112 (0.008)	-0.0115 (0.008)	-0.011 (0.008)	-0.0112 (0.008)	-0.0114 (0.008)	-0.0093 (0.006)	-0.0092 (0.006)	-0.0097 (0.006)	-0.0091 (0.006)	-0.0092 (0.006)	-0.0097 (0.006)
Age(11-20)²	-0.0043 (0.008)	-0.0041 (0.008)	-0.0036 (0.008)	-0.0041 (0.008)	-0.0041 (0.008)	-0.0045 (0.008)	0.0032 (0.005)	0.0033 (0.005)	0.0032 (0.005)	0.0033 (0.005)	0.0034 (0.005)	0.0032 (0.005)
Age(21-30)²	0.0012 (0.007)	0.0012 (0.007)	0.0022 (0.007)	0.001 (0.007)	0.0014 (0.007)	0.0012 (0.007)	0.0012 (0.005)	0.0015 (0.005)	0.0027 (0.005)	0.0012 (0.005)	0.0019 (0.005)	0.0028 (0.005)
Age(>=31)²	0.0032 (0.007)	0.0029 (0.007)	0.0034 (0.007)	0.0026 (0.007)	0.003 (0.007)	0.0039 (0.007)	0.0082 (0.006)	0.0079 (0.006)	0.0103* (0.006)	0.0079 (0.006)	0.0079 (0.006)	0.0105* (0.006)
Global Head.³	0.0199*** (0.005)	0.0197*** (0.005)	0.0204*** (0.005)	0.0194*** (0.005)	0.0198*** (0.005)	0.0211*** (0.005)	0.0246*** (0.005)	0.0244*** (0.005)	0.0258*** (0.005)	0.0243*** (0.005)	0.0243*** (0.005)	0.0258*** (0.005)
Foreign aff.³	0.0170*** (0.006)	0.0167*** (0.006)	0.0177*** (0.005)	0.0161*** (0.006)	0.0168*** (0.006)	0.0185*** (0.005)	0.0248*** (0.004)	0.0246*** (0.004)	0.0264*** (0.004)	0.0243*** (0.004)	0.0247*** (0.004)	0.0265*** (0.004)
var0308_instock_gdp⁴	-0.0021 (0.002)	-0.0025 (0.002)	-0.0004 (0.002)	-0.0040* (0.002)	-0.002 (0.002)	-0.0012 (0.003)	-0.0068*** (0.001)	-0.0059*** (0.001)	-0.0050*** (0.001)	-0.0051*** (0.001)	-0.0064*** (0.001)	-0.0055*** (0.001)
var0308_outstock_gdp⁴	0.0052*** (0.002)	0.0055*** (0.002)	0.0032** (0.001)	0.0063*** (0.002)	0.0052*** (0.002)	0.0032** (0.001)	0.0006 (0.001)	0.0004 (0.001)	0.0017** (0.001)	-0.0005 (0.001)	0.0008 (0.001)	0.0020*** (0.001)
var0308_credit_gdp	-0.0007*** (0.000)	-0.0006*** (0.000)	-0.0006*** (0.000)	-0.0007*** (0.000)	-0.0007*** (0.000)	-0.0006*** (0.000)	-0.0003*** (0.000)	-0.0002*** (0.000)	-0.0002*** (0.000)	-0.0005*** (0.000)	-0.0002*** (0.000)	-0.0002*** (0.000)
var0308_skills	0.0003 (0.000)	0.0004 (0.000)	0.0001 (0.000)	0.0010** (0.000)	0.0003 (0.000)	0.0003 (0.000)	0.0001 (0.000)	0.0002 (0.000)	0.0002 (0.000)	0.0012*** (0.000)	0.0001 (0.000)	0.0002 (0.000)

var0308_all_DB	0.0018**						0.0021***						
	(0.000)						(0.001)						
var0308_group2_DB		0.0016***						0.0015***					
		(0.000)						(0.000)					
var0308_Permit_			0.0047*						0.0013				
			(0.003)						(0.002)				
var0308_Tax_				0.0057***						0.0104***			
				(0.001)						(0.002)			
var0308_Trade_					0.0016***						0.0011***		
					(0.000)						(0.000)		
var0308_Empl						0.0015						0.0002	
						(0.001)						(0.000)	
_cons	1.0012***	1.0010***	1.0168***	1.0016***	1.0038***	1.0134***	0.8740***	0.8738***	0.8642***	0.8824***	0.8747***	0.8657***	
	(0.090)	(0.089)	(0.087)	(0.089)	(0.089)	(0.088)	(0.072)	(0.072)	(0.073)	(0.073)	(0.072)	(0.073)	
NACE dummies	Yes												
Country dummies	Yes												
R-squared	0.139	0.1394	0.1385	0.1404	0.1392	0.1381	0.1097	0.1097	0.1085	0.1108	0.1096	0.1085	
N. obs	4775	4775	4775	4775	4775	4775	6,316	6,316	6,316	6,316	6,316	6,316	

¹ (10–49) is the omitted size category.

² (1–5) is the omitted age category.

³ Purely domestic is the omitted ownership category.

⁴ var0308_instock_gdp(var0308_outstock_gdp) is related to the stock of inward (outward) FDI in the manufacturing industry. var0308_instock_gdp(var0308_outstock_gdp) is related to the stock of inward (outward) FDI in the services industry.

Note 1: The variables for infrastructure and stock of outward FDI were excluded due to multicollinearity.

Note 2: All PCA indices of business regulation (all_DB, DB_business_startup, DB_business_operations, and DB_institutional_environment) were included in the analysis.

However, only all_DB and DB_business_operations were statistically significant. The sub-indicators for DB_business_operations (permit, tax, trade, and employment) are also included in the results above.

Appendix XII Firm-level Productivity Growth in the EU12

	Manufacturing					Services (except construction)				
	All controls (1)	Ownership + sector+ baseline prod+ country dummies (2)	Sector+ baseline prod+ country dummies (3)	Baseline prod + country dummies (4)	Only country dummies (5)	All controls (6)	Ownership + sector+ baseline prod+ country dummies (7)	Sector+ baseline prod+ country dummies (8)	Baseline prod + country dummies (9)	Only country dummies (10)
Ln(prod) 2003	-0.1237*** (0.005)	-0.1242*** (0.005)	-0.1227*** (0.005)	-0.1167*** (0.005)		-0.1122*** (0.003)	-0.1120*** (0.003)	-0.1108*** (0.003)	-0.1053*** (0.003)	
Size(50-249)¹	-0.0156** (0.007)					-0.0130*** (0.004)				
Size(250-499)¹	-0.0530*** (0.012)					-0.0269*** (0.009)				
Size(500-999)¹	-0.0229 (0.019)					-0.014 (0.015)				
Size(1000+)¹	-0.0582** (0.029)					-0.0217 (0.032)				
Age(6-10)²	-0.001 (0.009)					0.0013 (0.005)				
Age(11-20)²	-0.0027 (0.009)					-0.0017 (0.005)				
Age(21-30)²	0.0102 (0.021)					-0.0132 (0.018)				
Age(>=31)²	0.0079 (0.018)					-0.0036 (0.010)				
Global Head³	0.0670** (0.033)	0.0589* (0.033)				0.0309* (0.018)	0.0253 (0.018)			
Foreign aff.³	0.0298*** (0.010)	0.0269*** (0.009)				0.0276*** (0.005)	0.0270*** (0.005)			
Czech Rep.⁴	0.0384*** (0.010)	0.0371*** (0.010)	0.0457*** (0.009)	0.0466*** (0.009)	0.0666*** (0.010)	0.0344*** (0.007)	0.0349*** (0.007)	0.0437*** (0.007)	0.0475*** (0.007)	0.0893*** (0.007)

Estonia	-0.0371**	-0.0346**	-0.0201	-0.0280*	0.0436***	-0.0384***	-0.0365***	-0.0233**	-0.0258***	0.0457***
	(0.017)	(0.017)	(0.015)	(0.015)	(0.017)	(0.010)	(0.010)	(0.009)	(0.009)	(0.011)
Poland	-0.0209***	-0.0242***	-0.0212***	-0.0237***	0.0051	-0.0152***	-0.0171***	-0.0152***	-0.0110**	0.0241***
	(0.008)	(0.008)	(0.007)	(0.007)	(0.008)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)
Romania	-0.1437***	-0.1440***	-0.1408***	-0.1488***	0.0057	-0.1114***	-0.1105***	-0.1078***	-0.1054***	0.0533***
	(0.010)	(0.010)	(0.009)	(0.009)	(0.009)	(0.007)	(0.007)	(0.007)	(0.007)	(0.006)
_cons	1.2183***	1.2161***	1.2039***	1.1768***	0.0438***	1.0991***	1.0923***	1.0819***	1.0681***	0.0212***
	(0.049)	(0.048)	(0.048)	(0.049)	(0.006)	(0.029)	(0.029)	(0.028)	(0.028)	(0.005)
NACE dummies	Yes	Yes	Yes	No	No	Yes	Yes	Yes	No	No
R-squared	0.2185	0.2153	0.2124	0.2002	0.0128	0.2007	0.1998	0.1975	0.1839	0.0122
N. obs	3925	3925	3925	3925	3981	5,927	5,927	5,927	5,927	5,927

¹ (10-49) is the omitted size category.

² (1-5) is the omitted age category.

³ Purely domestic is the omitted ownership category.

⁴ Slovenia is the omitted country.

Significance: Significance: *** 1%, ** 5%, * 10%.

A second and complementary method to evaluate the role of firm characteristics in productivity growth is through a counterfactual exercise comparing how the estimated country dummies change when adding each one of the firm variables: baseline productivity, sector, ownership, size, and age. To implement this, we use a reduced form of Eq. (1). The results are given above for the EU12 and in Appendix XIII for the EU15.

$$\Delta \ln(Prod_i)_{03-08} = \alpha + \beta_2 \ln(Prod_i)_{03} + \beta_2 Age_{i,03} + \beta_3 Size_{i,03} + \beta_4 OwnType_{i,03} + \sum_m \varphi Sector_m + \sum_j \gamma Country_j + \epsilon_i \quad \text{Eq. (2)}$$

For example, if the model includes only country dummies, the average productivity gap between a Czech and a Slovenian manufacturing firm is 6.6 percent. Upon adding baseline productivity, this gap falls to 4.7 percent. Adding sector dummies does not change the result (4.6 percent). When including the ownership and size controls, the gap falls to 3.8 percent, indicating that the Czech Republic has an adverse mix of firm characteristics. The residual difference is country specific.

Appendix XIII Firm-level Productivity Growth in EU15 countries

	Manufacturing					Services (except construction)				
	All controls (1)	Ownership + sector+ baseline prod+ country dummies (2)	Sector+ baseline prod+ country dummies (3)	Baseline prod + country dummies (4)	Only country dummies (5)	All controls (6)	Ownership + sector+ baseline prod+ country dummies (7)	Sector+ baseline prod+ country dummies (8)	Baseline prod + country dummies (9)	Only country dummies (10)
Ln(prod) 2003	-0.0896*** (0.004)	-0.0888*** (0.004)	-0.0860*** (0.004)	-0.0796*** (0.004)		-0.0850*** (0.003)	-0.0842*** (0.003)	-0.0817*** (0.003)	-0.0743*** (0.003)	
Size(50-249)¹	0.0059** (0.003)					0.0057*** (0.002)				
Size(250-499)¹	0.0148* (0.008)					0.0118* (0.006)				
Size(500-999)¹	-0.0046 (0.013)					-0.0081 (0.008)				
Size(1000+)¹	0.0037 (0.013)					0.0256* (0.015)				
Age(6-10)²	-0.0018 (0.003)					-0.003 (0.002)				
Age(11-20)²	0.0021 (0.003)					0.0016 (0.002)				
Age(21-30)²	0.0031 (0.003)					0.0049** (0.002)				
Age(>=31)²	0.0046 (0.003)					0.0065*** (0.002)				
Global Head.³	0.0228*** (0.005)	0.0254*** (0.005)				0.0287*** (0.004)	0.0307*** (0.004)			
Foreign aff.³	0.0185*** (0.004)	0.0203*** (0.004)				0.0236*** (0.002)	0.0245*** (0.002)			
Belgium⁴	-0.0001 (0.007)	0.0005 (0.007)	-0.003 (0.007)	-0.0077 (0.007)	-0.0297*** (0.007)	0.0091* (0.005)	0.0096* (0.005)	0.0046 (0.005)	0.0031 (0.005)	-0.0218*** (0.005)

Spain	-0.0630*** (0.005)	-0.0632*** (0.005)	-0.0694*** (0.005)	-0.0728*** (0.005)	-0.0532*** (0.005)	-0.0302*** (0.004)	-0.0308*** (0.004)	-0.0378*** (0.004)	-0.0414*** (0.004)	-0.0244*** (0.004)
France	-0.0224*** (0.005)	-0.0213*** (0.005)	-0.0224*** (0.005)	-0.0236*** (0.005)	-0.0225*** (0.005)	-0.006 (0.004)	-0.0038 (0.004)	-0.0058 (0.004)	-0.0067* (0.004)	-0.0157*** (0.004)
Italy	-0.0167*** (0.005)	-0.0167*** (0.005)	-0.0237*** (0.005)	-0.0291*** (0.005)	-0.0288*** (0.005)	0.0089** (0.004)	0.0091** (0.004)	0.0012 (0.004)	-0.0035 (0.004)	-0.0123*** (0.004)
Norway	-0.0723*** (0.009)	-0.0730*** (0.009)	-0.0801*** (0.009)	-0.0857*** (0.009)	-0.1222*** (0.009)	0.0161*** (0.005)	0.0149*** (0.005)	0.008 (0.005)	0.0022 (0.005)	0.0044 (0.006)
Sweden	-0.0306*** (0.007)	-0.0300*** (0.007)	-0.0343*** (0.007)	-0.0319*** (0.007)	-0.0152** (0.007)	-0.0074 (0.006)	-0.007 (0.006)	-0.0124** (0.006)	-0.0113** (0.006)	-0.0025 (0.006)
_cons	1.0112*** (0.048)	1.0049*** (0.048)	0.9822*** (0.047)	0.9162*** (0.047)	0.0502*** (0.005)	0.9349*** (0.033)	0.9299*** (0.033)	0.9116*** (0.032)	0.8331*** (0.031)	0.0308*** (0.004)
NACE dummies	Yes	Yes	Yes	No	No	Yes	Yes	Yes	No	No
R-squared	0.136	0.1353	0.1318	0.1052	0.0181	0.1115	0.1107	0.1066	0.0851	0.0024
N. obs	16,800	16,800	16,800	16,800	16,800	28,366	28,366	28,366	28,366	28,366

¹ (10-49) is the omitted size category.

² (1-5) is the omitted age category.

³ Purely domestic is the omitted ownership category.

⁴ Finland is the omitted country.

Significance: *** 1%, ** 5%, * 10%.

We can perform the same counterfactual exercise for the EU15 countries as we did for the EU12 by analyzing how the country dummies change when adding each one of the firm controls. If we include only country dummies, then a Finnish manufacturing firm grows 2.9 percent more quickly than an Italian manufacturer. If we include sector specialization, the gap falls to 2.4 percent. If the two firms were identical in terms of size, age, and ownership, we would predict a gap of just 1.7 percent in favor of the Finnish firm. These results suggest that, ownership, size, and sector are the most important firm characteristics

Appendix XIV Summary Statistics for Variation in Country Characteristics, 2003–2008

	EU15		EU12	
	mean	s.d.	mean	s.d.
FDI in stock manufacturing (% over GDP)	2.29	2.68	1.3	1.28
FDI out stock manufacturing(% over GDP)	2.95	3.46	0.16	0.31
FDI in stock services(% over GDP)	3.16	2.93	3.98	3.56
FDI out stock services(% over GDP)	3.23	5.84	1.58	2.05
Credit to private sector(% over GDP)	40.19	31.69	27.52	8.4
Skills (% of workforce with tertiary education)	2.14	5.37	3.01	1.45
All DB indicators*	4.38	6.48	6.76	6.15
DB_Business Operations*	4.67	8.44	5.54	8.43
Dealing with Construction Permits*	0.4	0.77	0.35	1.39
Paying Taxes*	1.45	1.54	1.36	3.33
Trading Across Borders*	4.92	10.38	6.42	10.61
Employing Workers*	2.08	4.86	0.65	3.87

*All indicators were constructed through a principal component analysis (PCA) based on Doing Business (DB) data. All indicators were coded such that higher values indicate simpler regulation.