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JEL classification: O30, F23

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Productivity growth and global value chain participation in the digital age

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April 6, 2020

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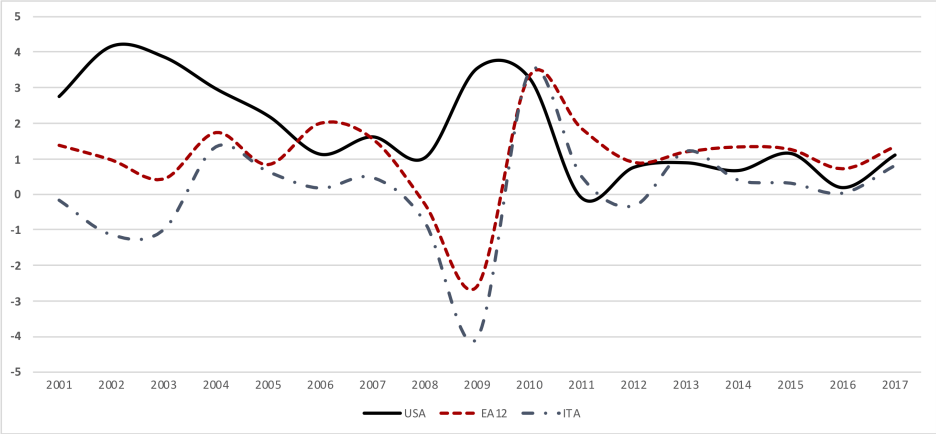
1 Introduction

Labor productivity growth has been declining in advanced economies since the beginning of the seventies (Bergeaud et al., 2016) experiencing a pronounced deceleration after the Great Recession (Figure 1). Many different explanations about the underlying causes of this so-called secular stagnation have been proposed so far but there is no consensus among researchers. Explanations vary from the view that the slowdown reflects cyclical factors related to the financial crisis to the belief that the decline is driven by longer-standing structural factors: measurement errors, misallocation of production inputs, changes in sectoral composition of the economy, reduction in the rate of technical progress and diffusion, the increasing necessity to adopt new business models to compete in the global market (ECB, 2017; Jona-Lasinio et al., 2019).

The empirical evidence suggests that after the financial crisis, the slowdown of labor productivity in the United States and Europe has been driven primarily by a fall in Multi Factor Productivity (MFP) associated with a marked reduction of capital per worker (capital deepening). Recent studies indicate that the decline of capital accumulation has been determined mainly by an accelerator response of investment to the prolonged demand weakness that contributed to reduce capital deepening (Ollivaud et al., 2018) thus negatively influencing MFP growth also via spillover effects (Jona-Lasinio et al., 2019). But the analysis of the drivers of the slowdown across countries is rather complex as there are relevant heterogeneities to be taken into account: some economies may require more emphasis on demand-side, as opposite to supply-side, factors. Additionally, the slowdown is even more puzzling because some countries are increasingly involved in the digital transformation that is expected to boost productivity (Pilat and Criscuolo, 2018), and they are also actively participating to the globalization of the production activity assumed to generate productivity gains, especially in the digital-intensive countries-sectors (Criscuolo and Timmis, 2017).

The aim of this paper is to provide fresh empirical evidence on the factors driving the slowdown by exploring the linkages between productivity growth and Global Value Chain (GVC) participation considering the extent of country-sectoral digitalization. We consider two modes of GVC participation: 1) *Forward* (i.e. domestic value added embodied in foreign exports), capturing the domestic value added content of gross exports and including the value added generated by the exporting industry during its production processes as well as any value added created from upstream domestic suppliers that is embodied in exports. This measure is likely to be higher for countries (and sectors) involved in upstream production, with output and exports of that country feeding into the production and exports of downstream producers (i.e. forward integration).
2) *Backward* (i.e. foreign value added embodied in domestic exports), measuring the value of imported intermediate goods and services that are embodied in a domestic industry's exports. The value added can be generated from any foreign industry upstream in the

Figure 1: Labor productivity growth in the Euro Area, the US and Italy (2000-2017) (% changes)



Note: The figure shows annual growth in gross value added per hour worked in Italy and EA-12 (Market Economy aggregate), and in the US (Business Sector). Source: authors' calculations based on Eurostat and BEA data.

production chain. It is used to measure the extent to which a country's exports are dependent on imported content, the so-called backward integration. It is therefore likely to be higher if a country (or sector) is involved in downstream production.

The analysis is structured into two steps: first we offer a comprehensive overview of the current productivity trends and their potential drivers in the European economies and in the US taking into account the scope of digital transformation at the industry level; then we investigate whether the reorganization of the production activity and the adoption of new business models, as captured by the extent of GVC participation (both forward and backward), contribute to gain new insights about the drivers of productivity growth in the modern economy.

The paper is organized as follows. Section 2 provides an overview of the literature while section 3 illustrates the data used in the analysis. Section 4 offers some descriptive evidence about the drivers of the slowdown, the extent of countries' participation in GVC and its correlation with productivity growth, distinguishing between different digital sectoral intensities. Section 5 presents the empirical strategy and discusses the econometric results. Section 6 concludes.

2 Background Literature

The rising relevance of global value chains in modern economies stimulated new research efforts investigating the linkages between industries and countries participation in GVCs and productivity gains (Jona-Lasinio and Meliciani, 2019; Criscuolo and Timmis, 2017). At the same time, another body of the literature explored the potential impact of the digital transformation on both productivity growth and GVC participation (Pilat and

Criscuolo, 2018). In the section below, we present the main findings of both strands of the literature in turn and bridge them together.

2.1 GVC participation and productivity growth

There are potentially several channels through which GVCs can foster productivity growth, Criscuolo and Timmis (2017) highlight some of them. First, there is the classical argument of gains from specialization: in a value chain, firms can specialize in the activities in which they are relatively more efficient and outsource the others (the analogous to product specialization in the classical literature on trade liberalization). Second, GVCs participation can affect productivity by allowing firms to have access to a larger variety of cheaper and/or higher quality and/or higher technology imported inputs. Third, GVCs facilitate knowledge spillovers stimulating the interaction between domestic firms and multinationals. Finally, similarly to the case of international trade, GVCs can give firms access to larger markets and increase competition, thus favoring the development of the most productive firms and inducing the exit of the least productive.

However, taking a different perspective, the relationship between GVC participation and productivity growth can be explored following the literature dating back to Coase (1937), focused on the identification of the forces driving the "make or buy" decision of a firm and evaluating the pros and cons of both market transactions and vertical integration. In principle, GVC participation puts the firm in the position of escaping from this dichotomy, as GVC involvement allows to choose between a wide array of market-based governance arrangements. The organization of the production process along a global value chain increases the extent of modularization, given the current level of technology, thus generating productivity gains. But Hortacsu and Syverson (2007) find that value chain integration increases firms' productivity, but the cause is not vertical integration per se. The productivity improvement is connected to the ability of operating in multiple ready-mix plants and to logistical advancements.

More recently, Grossman and Rossi-Hansberg (2008) suggested that offshoring and GVCs generate productivity gains as a result of the implied finer international division of labor acting as factor-augmenting technical change. Also Li and Liu (2014) and Baldwin and Robert-Nicoud (2014) emphasize a positive productivity effect from GVC participation generated by increased competition, greater diversity in input varieties, learning externalities and technology spillovers[1]. More up to date efforts instead investigate the impact of vertical specialization on countries participating in GVCs (Kummritz, 2016; Constantinescu et al., 2017). In particular, Kummritz (2016), considering 54 countries and 20 industries over 5 years, finds that an increase in GVC participation leads to higher domestic value added and productivity independently of countries' income levels. Using

[1]Earlier contributions focusing on the benefits of offshoring at the country level include Feenstra and Hanson (1996), Egger and Egger (2006), Amiti and Wei (2009), Winkler (2010).

an instrumental variable approach, he shows that a one percent increase in backward GVC participation stimulates an increase of 0.11% of domestic value added but there is no effect on labor productivity. On the other hand, a one percent increase in forward[2] GVC participation leads to 0.60% higher domestic value added and to 0.33% higher labor productivity. Constantinescu et al. (2017), using data on trade in value added from the World Input-Output Database, covering 13 sectors in 40 countries over 15 years find that participation in global value chains is a significant driver of labor productivity.

2.2 Productivity and digitalization

Other recent research efforts investigated the impact of the digitalization on productivity growth, identifying multiple mechanisms through which the digitization can spur productivity. Starting from VanArk (2016) who points to the shift from traditional ICT investment to spending on ICT services, observed in several advanced economies since 2000, as a possible source of productivity gains from digitalization. Moving from owning assets to purchasing services determines an increase in firm's business flexibility and an improvement of resource allocation by enabling sizable savings on ICT-related costs such as energy, labor or the building and maintenance of IT infrastructure. Taking a cost-saving perspective, Brynjolfsson et al. (2017) emphasize the efficiency gains attainable from the application of machine learning and artificial intelligence to the management of energy and materials usage. Mokyr (2014) suggests that digital technologies allow to raise the utilisation rate of fixed assets, as is the case with companies such as Uber, Airbnb and others who created rental markets for assets that were previously lying idle most of the time.

Such predictions are also supported by empirical studies showing a positive relation between the use of digital technologies and productivity at the firm level. This link may operate by fostering the adoption of improved business processes (Brynjolfsson et al., 2007), by automating routine tasks and complementing skilled workers in the execution of non-routine tasks (Akerman et al., 2015), or by facilitating product customisation and the set-up of production lines for new products and prototypes (Bartel et al., 2007). But the literature is not unanimous in this respect. Acemoglu et al. (2014), DeStefano et al. (2018), Bartelsman et al. (2016) find no evidence of a direct positive effect of digitalization on firm productivity, although Bartelsman et al. (2016) find a positive impact at the industry level, driven by spillovers, reallocation effects or firm entry and exit dynamics.

A recent study by Gal et al. (2019) investigates the influence of digitalization on productivity by combining firm-level cross-country data on multifactor productivity with cross-country data on adoption of a range of digital technologies at the industry level to account for spillovers from early adopters to other firms. They find evidence of a positive

[2]Measures of GVC participation include forward and backward linkages indicators as illustrated in appendix.

association between digital adoption and firm-level productivity, with a stronger effect for manufacturing industries and more generally for those industries that are intensive in routine tasks as well as for firms that are already highly productive. Thus, the heterogeneity of digital adoption rates across industries and their different effects at the firm level contribute to explain the disappointing productivity growth of the aggregate. They also suggest that the digitalization itself contributes to the increasing dispersion in productivity outcomes as the adoption and the exploitation of digital technologies require managerial ability, know-how or technical skills that are less accessible to less productive firms.

2.3 GVC participation and digitalization

So far, we have considered separately the mechanisms through which GVC participation and digitalization are likely to affect productivity growth. But the existence of strong linkages between these two factors can be posited, so that they may better be regarded as complementary.

The digital technological endowment may favor GVC participation via two main channels: reducing transportation and communication costs, thus facilitating the coordination of geographically dispersed production activities along the chain; increasing the quality and availability of a wide range of intermediate services widely used as inputs in the GVC production (Miroudot and Cadestin, 2017).

The endowment of adequate technology is shown to be a crucial element for GVC participation (Amador and Cabral, 2016), indispensable to coordinate the different stages of production ensuring sufficient logistic efficiency. Baldwin (2006) points out how the spatial unbundling of production stages, previously clustered in factories and offices in the 1990s, is largely caused by the falls in communication and coordination costs originated by the ICT revolution. As coordination and communication costs associated with international fragmentation fell below the expected cost advantages through specialization and economies of scale, companies found it more attractive to organize their production processes on an international scale (Backer and Flaig, 2017).

At the same time, digital technologies may also discourage GVC participation as rising (wage) costs in emerging economies and the development of sophisticated robots reducing the costs of domestic production may favor re-shoring of activities to developed economies.

Given the complexity of the aforementioned linkages, sectors are differently affected by the unfolding of the digital transformation, depending on their rate of adoption of the new technologies as well as on a variety of complementary factors such as organizational capital or managerial and technical skills[3]. In this paper we exploit such sectoral heterogeneity to investigate whether the relation between participation in global value chains

[3]See Gal et al. (2019) for a comprehensive exposition of the possible complementarities between digital technologies and other forms of capital.

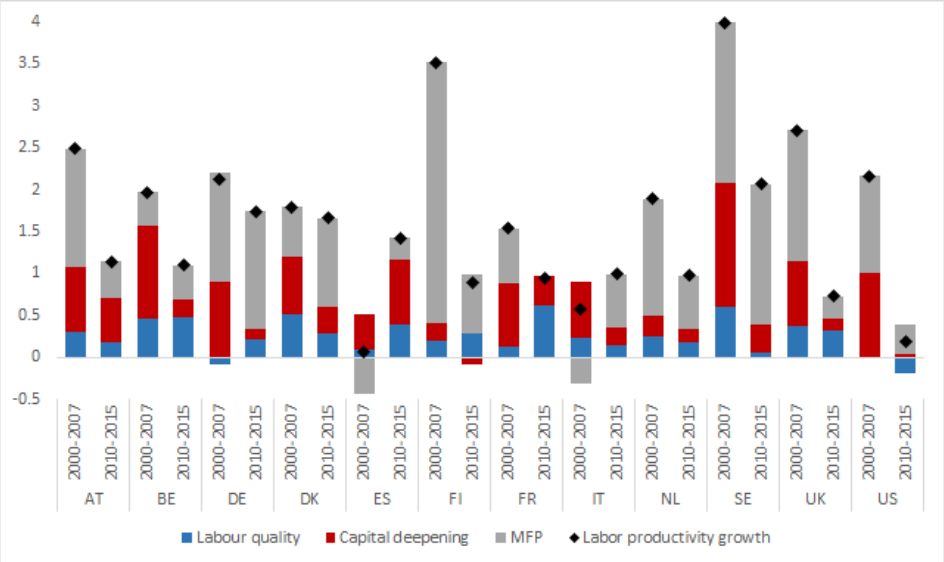
and productivity growth varies with the extent of digital intensity.

3 Data description and measures of GVC participation

The database employed in this paper includes GVC indicators, data on tangible and ICT capital as well as standard growth accounting variables such as output and labor input. The source for GVC measures of participation is the World Input Output Database (WIOD) while the main source for output, labor, tangible and ICT capital is the EU KLEMS database (see O'Mahony and Timmer 2009, for details). A set of control variables for the econometric analysis are gathered from the World Bank database. The analysis covers the years 2000-2014[4]for 12 European countries (AT, BE, DE, DK, ES, FI, FR, IT, NL, PR, SE, UK) plus US and 30 Nace Rev 2 industries. The measures of GVC participation are computed from WIOD data tracking the origin and the destination of value added embodied in gross exports, by country and sector, and following the approach proposed by Koopman et al. (2010, 2014). These indicators are built assuming that industry's production depends on its own value added and input from other industries, both domestic and foreign. By means of this decomposition we generate two standard indicators for GVC participation: DVAX, capturing the domestic value added in foreign exports, and FVAX, measuring the foreign value added in domestic exports. DVAX and FVAX represent two different modes of participation respectively: a) "Forward", assessing the extent to which domestic exports are used by foreign firms as inputs to produce their own exports. This is the "seller-related" measure or supply side in GVCs; b) "Backward", measuring the extent to which domestic firms use foreign intermediate value added for exporting activities. This is the "Buyer" perspective or sourcing side in GVCs. Backward participation is therefore likely to be higher if a sector is involved in downstream production as opposed to Forward, which is likely to be higher for sectors conducing mainly upstream productions. Therefore, the mechanisms through which GVC participation may potentially affect productivity growth can differ depending on the position of the firm along the chain. In principle, backward activities favor the exploitation of complementarities between domestic and foreign capabilities and the access to more advanced foreign technology potentially beneficial for growth. Forward activities instead, increase exposure to new ideas and incentives to upgrade the production process, thus facilitating gains from specialization.

[4]The time coverage of our analysis is determined by the availability of WIOD data that are up to 2014.

Figure 2: Contributions to labor productivity growth (%)



Note: The figure compares average factors contribution to annual growth in gross value added per hour worked in selected advanced economies over the periods 2000-2007 and 2010-2015. For the post-crisis years, data refer to 2010-2014 for Italy and Sweden. Source: authors' calculations based on EUKLEMS data.

4 Descriptive evidence

4.1 Sources of productivity growth

We provide descriptive evidence on the sources of the slowdown adopting a standard growth accounting approach (GA)[5] for 12 EU economies and the US over the years 2000-2015 distinguishing between three groups of industries: "high" (HD), "medium" (MD) and "low" (LD) digital-intensive, (see Calvino et al. (2018)[6]). On this basis it is possible to disentangle individual sectoral contribution to aggregate productivity growth and assess the extent to which productivity growth differentials between countries vary with their sectoral digital intensity.

As a first step, we look at the traditional decomposition of the sources of growth and then we add the digital sectoral dimension into the analysis.

Figure 2 presents the standard sources of growth results before (2000-2007) and after (2010-2015) the financial crisis for the sample economies. The early 2000s were characterized by heterogeneous performances among advanced economies, with some European countries (UK, Finland, Sweden) outpacing the performance of the US, while others (Spain, Italy and, to a lesser extent, France) lagging behind. Since 2007, however, productivity growth recorded a widespread decline converging towards historically low average

[5]Tinbergen (1942), Solow (1957), Jorgenson and Griliches (1967) and Diewert (1976).

[6]Sectors are ranked by their degree of digital intensity over the period 2001-2015 across five dimensions: tangible and intangible ICT investment, purchases of intermediate ICT goods and services, use of robots, proportion of ICT specialists, share of online sales.

growth rates across countries. In 2000-2007, labor productivity growth has been driven by capital deepening in Belgium, France, Italy, Spain and Denmark (ranging from 0.4pp in Spain to 1.1pp in Belgium), whereas MFP accounted for a major share of labor productivity growth (from 1.2pp in the US to 3.1pp in Finland) in the remaining economies. In the post-crisis period, the contribution of capital deepening dropped significantly in most of the European countries (-0.1pp in Finland, 0.5 pp in Austria but 0.8 pp in Spain).

Over the same period of time, the MFP slowdown was even more pronounced and widespread: the average growth rate was almost zero in the US and negative in the European economies[7]. In the pre-crisis years, MFP accounted for a large portion of the productivity growth rate differentials between the Mediterranean economies (Italy and Spain) and the other countries, providing a negative contribution (on average by 0.32 pp and 0.45 pp respectively) to labor productivity growth. After 2008-09, the contribution of MFP increased in Denmark, Germany, Italy and Spain, remained stable in Belgium, and decreased in the remaining economies. In Finland, France, Germany and Spain, the slowdown in capital deepening and MFP growth was partly counterbalanced by an increase in the contribution from labor quality.

4.1.1 Productivity growth in the digital sectors

Now we add the digital sectoral dimension to our analysis, looking first at the average shares of value added of the three digital industry groups in 2000-2007 and 2010-2015 (Table 1). The data reveal that: High digital-intensive sectors are expanding in the sample economies (mainly in DK, FI, UK and NLD) compared to pre-crisis years; Medium digital-intensive sectors represent the largest share of value added in most of the sample economies, while Low digital-intensive industries are rather heterogeneous across countries (down in DK and NLD, up in IT and FI).

The data in Figure 3 show that medium digital-intensive sectors are the main productivity drivers across most of the sample economies (detailed results by industry are reported in the appendix) being the best performer (figure 4), compared to HD and LD sectors. The evidence is the same before and after the crisis (Spain and Austria were exceptions in the years leading to the crisis, while in Germany HD sectors have been growing at the same pace as MD sectors since 2010).

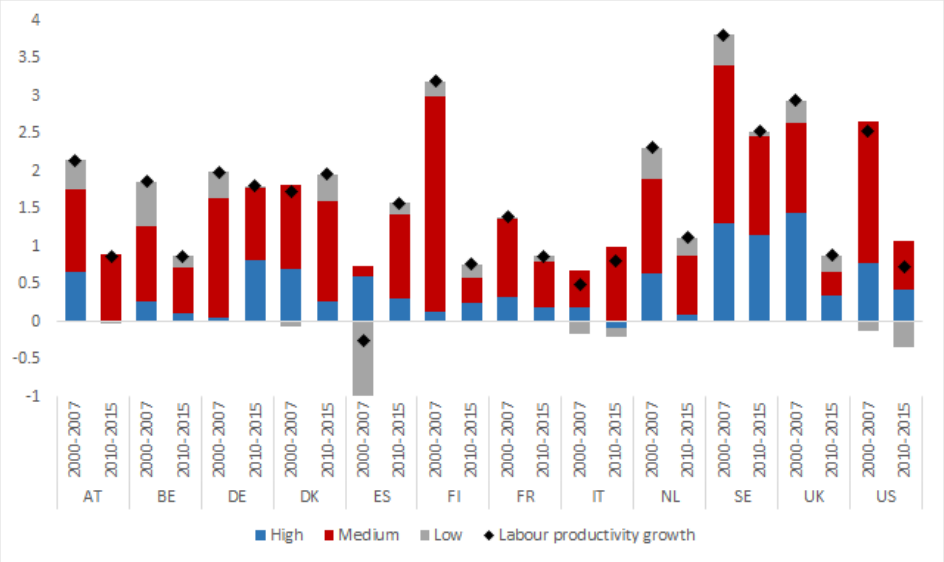
As to the HD group of industries, their average labor productivity growth has halved in the US after the crisis and in the European economies lagged behind, with the only exceptions of Germany, Spain and, above all, Sweden. In this respect, the performance of the Italian economy has been particularly striking, decreasing from an already small 0.4% average growth in the pre-crisis years to -0.1% between 2010 and 2015 (in both cases, the lowest values in the sample), driven by the dismal performance of MFP growth

[7]However, excluding the crisis years, 2008 and 2009, from the calculations we get a different and more varied picture

Table 1: Total value added shares of sectors by digital intensity

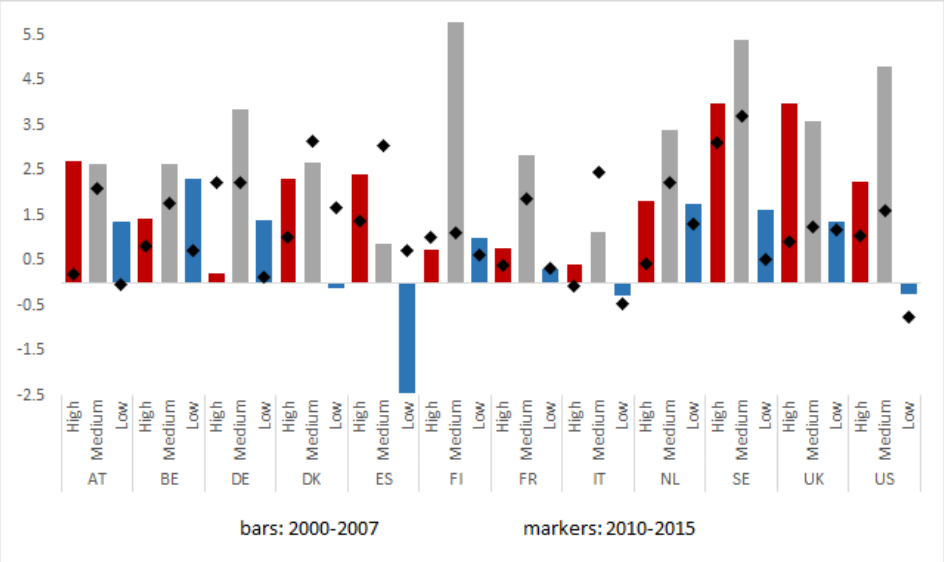
Country	Shares of total Value Added					
	HD		MD		LD	
	2000-2007	2010-2015	2000-2007	2010-2015	2000-2007	2010-2015
Austria	0.26	0.27	0.43	0.42	0.32	0.31
Belgium	0.34	0.37	0.41	0.37	0.26	0.27
Germany	0.36	0.37	0.42	0.41	0.21	0.22
Denmark	0.27	0.32	0.43	0.43	0.29	0.25
Spain	0.26	0.29	0.38	0.37	0.40	0.39
Finland	0.22	0.27	0.52	0.44	0.26	0.29
France	0.36	0.38	0.37	0.33	0.27	0.29
Italy	0.31	0.32	0.43	0.39	0.27	0.29
Netherlands	0.37	0.41	0.39	0.36	0.24	0.23
Sweden	0.32	0.35	0.41	0.38	0.26	0.27
UK	0.37	0.42	0.36	0.32	0.27	0.26
USA	0.35	0.37	0.42	0.42	0.22	0.22

Figure 3: Digital sectoral contributions to labor productivity growth (%)



Note: The contribution of each sector to labor productivity growth of the HD, MD and LD aggregates is computed as the weighted difference between the growth rate of real gross value added and that of hours worked. For each sector, the weights are computed as the share in nominal gross value added and total hours worked respectively of total market economy aggregates. Sectors contributions are then summed up based on their digital-intensity classification. Source: authors' calculations based on EUKLEMS data.

Figure 4: Labor productivity growth by sectoral digital intensity (%)



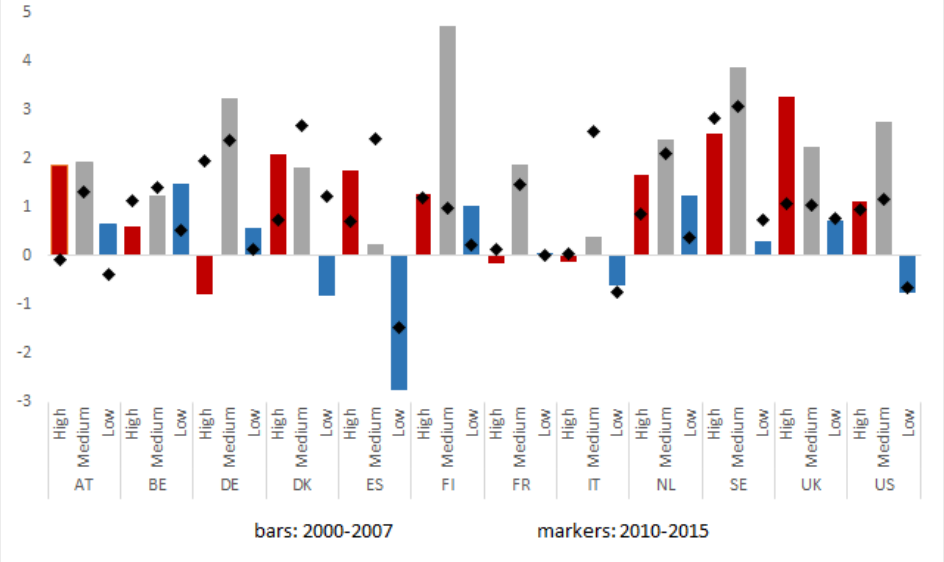
Note: Labor productivity for HD, MD and LD aggregates is calculated after constructing annual Tornqvist indices of constant price value added and of hours worked for each aggregate. Source: authors' calculations based on EUKLEMS data.

over the entire period (figure 5). Countries experiencing a slowdown in MFP growth in 2010-2015 show a more widespread productivity decline across sectors, independently of the extent of digital intensity (HD sectors in France and Sweden, and LD sectors in UK and the US are the only exceptions). As to the countries where MFP growth increased, the improvement is accounted for mainly by MD sectors in Denmark, Italy and Spain, and by the HD sector in Germany.

Professional services have been the main drag on labor productivity growth in most countries, providing a positive contribution over the whole period in Sweden, UK and the US. Then Wholesale and retail services boosted aggregate productivity growth in all advanced economies, although with a declining contribution besides the Mediterranean economies (Italy moved from an average of 0.11 pp to 0.45 pp in 2010-2015, up from 0.11pp and Spain from -0.19pp to 0.57pp).

In 2000-07, labor productivity growth was mainly driven by services: Telecommunication services in France and Italy (contributing on average to 0.28pp and 0.26pp, respectively), Financial services in Spain (0.56pp), Wholesale services in Germany (0.7pp) and in the US (0.6pp). Swedish productivity growth instead was largely affected by the manufacturing of Electrical and optical equipment (0.7pp) growing at remarkably high rates over this period. Between 2000 and 2007, Telecommunications experienced highly differentiated yearly rates of growth across countries recording 6% in Germany, 10% in Spain, 11% in Italy and Sweden, and 12% in France. At the same time, productivity growth was particularly high in Electrical and optical equipment, increasing by 17% in the US, 15% in Sweden, 7% in France and Germany, and around 4% in Spain and 2%

Figure 5: TFP productivity growth by sectoral digital intensity (%)



Note: MFP growth is computed by dividing the change in the volume index of gross value added by the change of a Tornqvist index of combined labor and capital inputs. Since hereby we are using hours worked as a measure of labor input, the index of combined inputs does not reflect the labor force composition effect, which is in contrast captured by the MFP. Source: authors' calculations based on EUKLEMS data.

in Italy. The very same sectors acting as the largest contributors to labor productivity growth before the crisis account for most of the slowdown observed at the aggregate level since 2010. Although the slowdown has been widespread across countries and sectors, a few exceptions emerge. Among them, Professional services in Spain (with average labor productivity growth increasing from -2.8% to 1.9%), IT services in Germany (from 3.2% to 5.6%), Transport equipment in France, Germany, Italy and Sweden (with increases between 0.5pp and 2.5pp), manufacturing sectors in Spain and Italy (from 2.5% to 3.4% and from 1.5% to 3.2%, respectively).

4.2 Global value chain participation, digitalization and productivity growth

In this section we merge the evidence on GVC participation and productivity taking account of the degree of digital intensity in the above mentioned three sectoral groups. Figure 6 shows the average intensity of forward and backward participation over the years 2000-2014 and distinguishes the extent of participation between high, medium and low digital intensive sectors. The scope of GVC participation varies significantly across countries and industries. Overall, the extent of forward participation is relatively homogeneous across countries, while backward participation appears significantly heterogeneous. On average, forward linkages predominate in high and low digital-intensive sectors, while backward linkages look as the main mode of participation for the medium digital-intensive

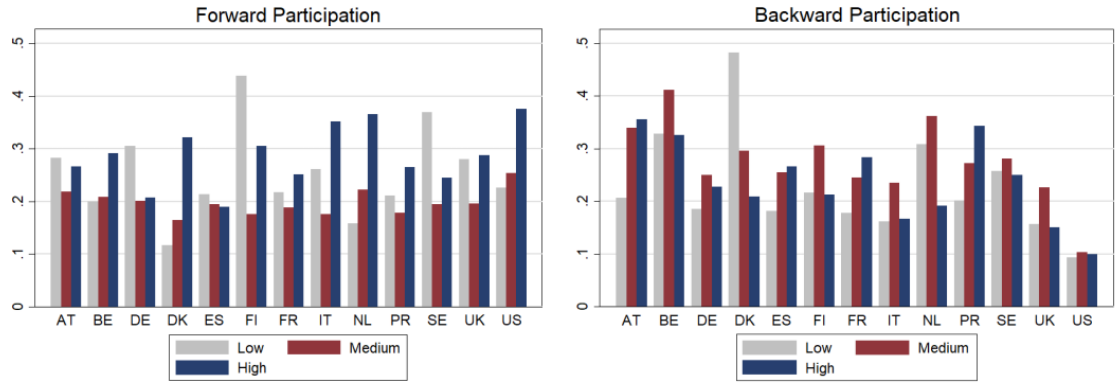


Figure 6: GVC participation in the digital sectors: average values over the years 2000-2014

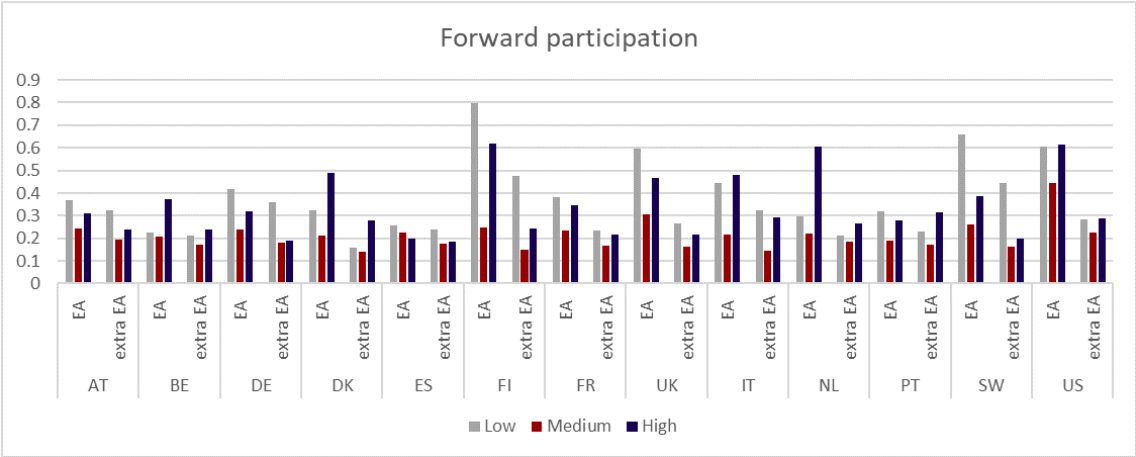


Figure 7: Forward participation intra and extra EA

industries, which are predominantly in manufacturing. Figures[8] 7 and 8 show the average rate of participation, distinguishing the partner economies between intra and extra euro area countries to get additional insights on the likely effect of market integration on the extent and mode of participation. The underlying hypothesis is that economic integration might favor GVC participation simply eliminating currency risk and tariffs. When production processes encompass multiple border crossings (GVC production) the trade costs are amplified, thus affecting the competitiveness of the entire value chain. Moreover, the EU economies share the same business climate thus benefiting from smaller intra-firms monitoring costs. Our sample economies show stronger forward linkages intra-euro area compared to the extra-euro area, especially in the high digital sector, likely because high digital-intensive productions are mainly characterized by lower transaction and labor costs, thus determining smaller incentives for high income countries to outsource this type of production. Backward linkages are instead more differentiated. Finally, figure 9 shows the relationship between the average rates of growth of labor productivity and GVC participation (both for forward and backward) in the three sectoral groups before

[8]Both GVC indicators are normalized by exports.

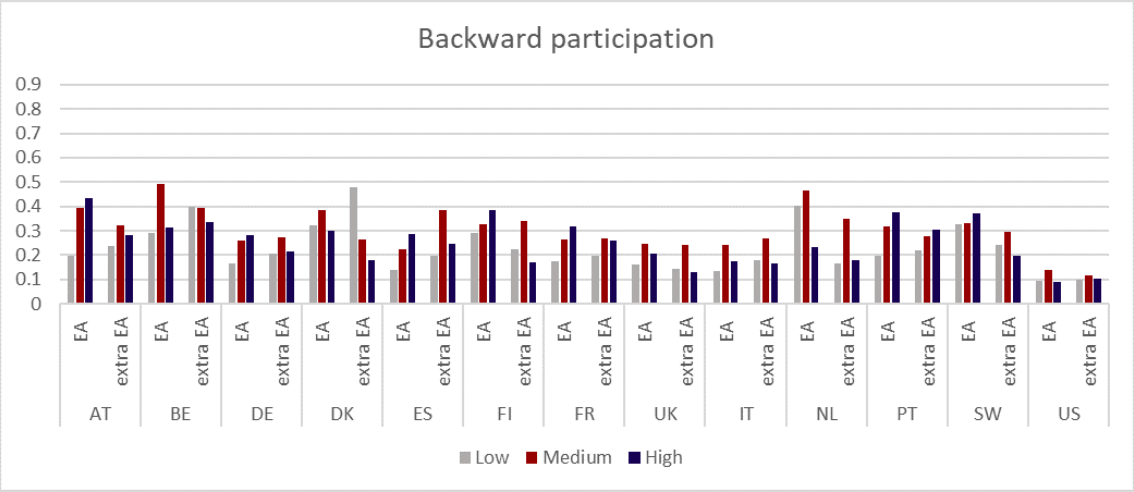


Figure 8: Backward participation intra and extra EA

(2000/2007) and after crisis (2008/2014).

Productivity growth and GVC participation are positively correlated with relatively stronger linkages in the high digital sectors for forward participation, compared to backward. Also, the productivity slowdown has been relatively less pronounced in the high digital sectors compared to the medium and particularly to the low digital-intensive industries. Moreover, the impact of the financial crisis on the extent of GVC participation has been differentiated both between the two modes of participation and digital groups. In 2008-2014, high digital industries increased the scope of backward participation in France or experienced just a small slowdown in Germany and the Netherlands. Interestingly, in the Netherlands, the low digital-intensive sectors were relatively more involved in both forward and backward participation after the financial crisis. This suggests that GVC participation associated to the digitalization might mitigate the impact of a global shock (financial crisis) on the organization of the production process. Finally, the data suggest that the links between GVC participation and productivity vary substantially with the extent of sectoral digitalization and that a deeper investigation of the multiple dimensions of this relationship is warranted. This is the goal of the next section.

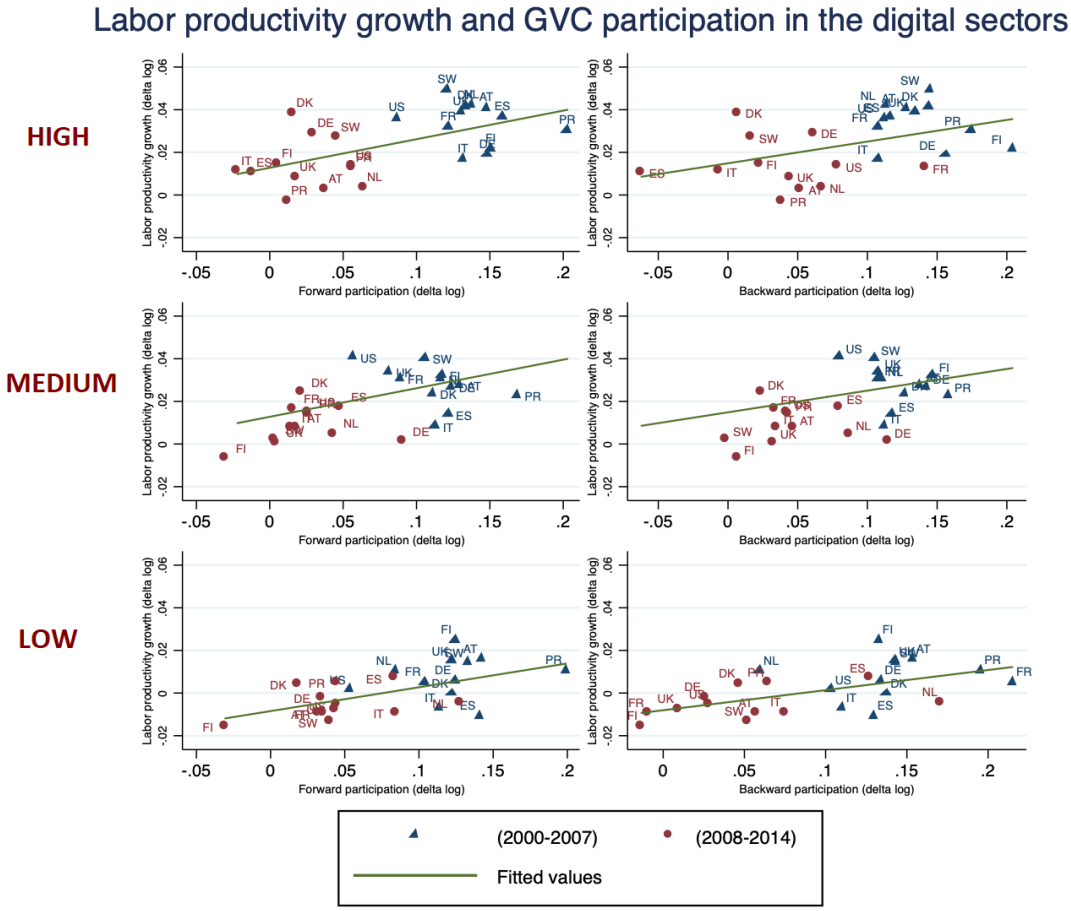


Figure 9: Productivity and GVC participation growth by digital sectors

5 Empirical strategy

5.1 Econometric approach

We further explore the relationship between GVC participation and productivity growth estimating a standard production function augmented with measures of backward and forward participation. Our benchmark equation is as follows:

$$(1) \qquad \Delta ln(Y/L)_{i,c,t} = \beta_0 + \beta_1 \Delta \ln(K^j/L)_{i,c,t} + \beta_2 \Delta \ln(GVC^z)_{i,c,t} + \delta_i + \gamma_t + \varepsilon_{i,c,t}$$

where c is country, i industry and t time; Y is total value added, L are hours worked, K^j is capital stock with j=total, tangible, R&D and software capital assets; GVC refers to the mode of global value chain participation with z=dvax (forward) and fvax (backward), and δ_i and γ_t are industry and time dummies.

As it is well known in the empirical literature, the estimation of a production function as equation (1) might be biased as it can violate the assumption of strict exogeneity of factor inputs, and might be affected by structural identification problems related to measurement errors and multicollinearity. Moreover, equation (1) may suffer from reverse causality because more productive sectors might be in the position of participating more intensively in GVCs, reversing the direction of the relation we test. Thus, we estimate equation (1) resorting also to Instrumental Variables (IV) as suggested by Ackerberg et al (2015), and we follow Kummritz (2016) to identify the proper instruments for participation. Specific instruments are generated summing the predicted bilateral value added flows obtained combining a measure of trade and industry distance over countries and sectors (Kummritz, 2016)[9]. In the following section we illustrate our main empirical findings.

5.2 Econometric results

Table 2 shows the first set of results for equation (1). All regressions contain industry and time fixed effects and are estimated both by Generalized Least Squares (GLS) (odd cols) and IV (even cols). Columns 1 to 4 present results for the productivity impact of forward participation while columns 5 to 8 refer to backward participation. As expected, total capital stock has a positive and statistically significant coefficient across all specifications with bigger IV coefficients, thus suggesting an underestimation bias in the GLS estimates. Then, as shown by (Corrado et al., 2017) intangible assets are likely to generate larger productivity returns compared to traditional capital assets so that we also check

[9]The detailed description of the construction of the instruments for GVC participation is described in the appendix.

for differential effects of tangible and intangible assets types in equation (1). Cols 3,4 and 7,8 distinguish capital assets between tangible, R&D and Software. Both GLS and IV estimated coefficients for the three asset types are statistically significant, thus corroborating the evidence of a positive productivity impact from intangibles also in a framework accounting for GVC participation. This results is consistent with the argument provided by **?** claiming that intangible assets such as standards, specifications, R&D achievements, as well as software and organizational know-how are typically scalable assets, imposing negligible marginal costs following the initial investment made to create them and resulting in infinite returns to scale. The difference in scale economies between tangible and intangible assets implies that the firms controlling intangible-intensive parts of the chain will be in the position of experiencing a relatively larger productivity improvement from network participation as output expands. This is why intangible capital is an essential element for productivity growth along the chain (Jona-Lasinio and Meliciani, 2019).

Both modes of GVC participation positively and significantly affect productivity growth, with forward linkages exerting a stronger impact compared to backward participation. As empirical research in support of the theoretical predictions linking GVCs to productivity is limited and because most of the empirical analysis focused mainly on the impact of backward participation, we do not have a comparable benchmark for our empirical results on forward linkages. But to get the sense of the size of the effects generated by both participation modes we quantify the contribution of participation to labor productivity growth using columns 4 and 8 in Table 2. Forward participation accounts for 0.008 percentage points per year for a growth rate of productivity equal to 0.015 percent per year. That is a rather large contribution compared to backward participation which accounts for 0.002 percentage points.

Table 2: Productivity growth and GVC participation: benchmark specification

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Forward participation				Backward participation			
VARIABLES	xtgls	IV	xtgls	IV	xtgls	IV	xtgls	IV
$\Delta \ln(K^{tot}/L)$	0.300***	0.503***			0.289***	0.802***		
	(0.017)	(0.106)			(0.017)	(0.217)		
$\Delta \ln(dvax)$	0.079***	0.144***	0.049***	0.114***				
	(0.006)	(0.022)	(0.005)	(0.018)				
$\Delta \ln(K^{tang}/L)$			0.086***	0.168**			0.088***	0.165**
			(0.014)	(0.077)			(0.014)	(0.077)
$\Delta \ln(K^{R\&D}/L)$			0.027***	0.035*			0.026***	0.031*
			(0.006)	(0.018)			(0.006)	(0.018)
$\Delta \ln(K^{Sw}/L)$			0.062***	0.089**			0.055***	0.096**
			(0.010)	(0.041)			(0.009)	(0.042)
$\Delta \ln(fvax)$					0.015***	0.042***	0.012***	0.027***
					(0.003)	(0.010)	(0.002)	(0.007)
Observations	3,486	2,699	2,839	2,431	3,494	2,795	2,844	2,433
Year FE	YES	YES	YES	YES	YES	YES	YES	YES
Sector FE	YES	YES	YES	YES	YES	YES	YES	YES

Table 3: Productivity growth and GVC participation accounting for digital intensities

			Forward			Backward		
VARIABLES	Forward	Backward	Low	Medium	High	Low	Medium	High
$\Delta \ln(K^{tang}/L)$	0.095***	0.0918***	0.222***	0.0881***	0.0673***	0.224***	0.0828***	0.0699***
	(0.0148)	(0.0149)	(0.0386)	(0.0233)	(0.0225)	(0.0391)	(0.0235)	(0.0224)
$\Delta \ln(K^{R\&D}/L)$	0.0279***	0.0273***	0.011	0.0346***	0.0349***	0.01	0.0391***	0.0335***
	(0.0067)	(0.0066)	(0.009)	(0.0117)	(0.013)	(0.0089)	(0.0117)	(0.0129)
$\Delta \ln(K^{Sw}/L)$	0.0563***	0.0517***	0.0458**	0.0552***	0.0902***	0.0385*	0.0503***	0.0938***
	(0.011)	(0.0104)	(0.0197)	(0.0161)	(0.0224)	(0.0197)	(0.0154)	(0.0215)
$\Delta \ln(dvax)$	0.0467***		0.0259***	0.0691***	0.0369***			
	(0.00498)		(0.007)	(0.00804)	(0.0139)			
$\Delta \ln(fvax)$		0.0123***				0.011***	0.0235***	-0.0007
		(0.00227)				(0.00378)	(0.00417)	(0.00769)
$\Delta \ln(pop)$	-0.107*	-0.119*	-0.184	-0.0319	-0.121	-0.23*	-0.0388	-0.153
	(0.0635)	(0.0611)	(0.135)	(0.0924)	(0.126)	(0.133)	(0.0873)	(0.122)
$\Delta \ln(tax)$	-0.0103	-0.00857	-0.014	-0.00217	-0.0319	-0.00916	0.0004	-0.0309
	(0.0156)	(0.0149)	(0.0326)	(0.0238)	(0.0271)	(0.0326)	(0.0227)	(0.026)
$\Delta \ln(reg)$	-0.0231**	-0.0149	0.0198	-0.0522**	-0.015	0.0274	-0.0415***	-0.0085
	(0.0113)	(0.0109)	(0.023)	(0.0165)	(0.0218)	(0.0229)	(0.016)	(0.0206)
Observations	2,435	2,439	503	1,296	636	507	1,296	636
year FE	YES	YES	YES	YES	YES	YES	YES	YES
sector FE	YES	YES	YES	YES	YES	YES	YES	YES

Finally, to check the robustness of our results, in Table 3 we test equation (1) including controls for country size (population), the degree of market regulation (reg) and fiscal pressure, measured as corporate tax rate (tax). The results are broadly unaffected. Indeed, market regulation has a small impact on productivity growth, country size is barely significant while fiscal pressure has no effect. Then, columns 3 to 8 divide the sample into three subsamples (high, medium and low digital sectors) to check if the impact on productivity growth differs depending on the extent of sectoral digitalization. Interestingly, R&D is statistically insignificant for the low intensive sectors but highly significant for both high and medium intensive digital sectors. In contrast, software and tangible capital appear as key factors for productivity growth across all sectors. However, the effect associated with tangible capital is positive but decreasing with digital intensity, while the contribution of software to productivity growth increases with the extent of digitalization. This result suggests a likely complementary relationship between intangible assets and digitalization (Pilat and Criscuolo, 2018).

As to GVC participation, its impact on productivity growth is generally positive and significant, although we do not find evidence of an effect of backward participation in high digital-intensive sectors. At the same time, the impact is stronger in medium digital-intensive sectors for both modes of participation.
The digitalization is supposed to have stronger productivity effects for industries that are intensive in routine tasks (Gal et al., 2019); as the medium digital intensive sector is mainly composed of manufacturing industries, the positive effect on productivity in these sectors seems to magnify the gains from GVC integration.

We also find that forward participation generates a relatively stronger effect on productivity growth, compared to backward participation. As a first approximation, we assume that the larger productivity-enhancing effect of forward linkages depends on the implied possibilities of accessing larger markets and from a finer division of international labor that positively affect competition. For the advanced countries (as our sample), given their higher level of technological development, this kind of gains seems more significant than the ones connected to the access to more advanced foreign technology, which are more linked to backward participation. However, our findings suggest that besides the existence of a strong positive link between GVC and productivity growth, further investigation of the multiple channels through which this relation operates is warranted.

6 Conclusions and next steps

In this paper, we explored the linkages between GVC participation and productivity growth taking into account the extent of sectoral digitalization in a sample of 12 European economies and the US in 2000-2014. Our findings support the existence of a positive linkage between different modes of GVC participation and productivity growth, which is

stronger for forward linkages in high and medium digital intensive sectors. On the other hand, the correlation between participation and productivity looks relatively weaker in the low digital intensive industries. The analysis developed so far reinforces the idea that the increasing relevance of GVC participation and the consequent reorganization of the production processes might significantly affect productivity growth and that a deeper investigation of the multiple mechanisms through which different modes of GVC participation affect productivity in the modern digital economies is warranted.

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Appendix

A Building the indicators of GVC participation

To compute our measures of GVC participation we follow the approach suggested by Koopman et al. (2014). Suppose to have a G-country, N-sector production and trade system where matrix **X** represents gross output. Gross output can be used either as intermediate or final good. From the harmonised input-output tables we can then derive **A** the matrix of input-output coefficients, describing the units of intermediate goods needed to produce one unit of gross output. Multiplying **AX** we obtain the matrix of goods for intermediate use. The relationship between gross output, intermediate goods, and final demand goods can then be expressed as:

$$X = AX + Y \tag{2}$$

With **Y** representing the matrix of goof for final use. We can rearrange the previous equation as X= BY with:

$$B = (I - A)^{-1} \tag{3}$$

B is the Leontief inverse matrix which elements consider the total output required both directly and indirectly to produce a unit of goods for final demand. To obtain the GVC indicators we need to calculate the value-added share matrix **V** and the matrix of gross export **E**. Finally, multiplying the **V** matrix with **B** and the matrix of gross exports **E**, we get the matrix **vae**. For the general G-country N-sector case, this is given below:

$$vae = \begin{bmatrix} v_1 & 0 & \cdots & 0 \\ 0 & v_2 & \cdots & 0 \\ \vdots & \vdots & \ddots & \vdots \\ 0 & 0 & \cdots & v_{gn} \end{bmatrix} \begin{bmatrix} b_{11} & b_{12} & \cdots & b_{1g} \\ b_{21} & b_{22} & \cdots & b_{2g} \\ \vdots & \vdots & \ddots & \vdots \\ b_{g1} & b_{g2} & \cdots & b_{gg} \end{bmatrix} \begin{bmatrix} e_1 & 0 & \cdots & 0 \\ 0 & e_2 & \cdots & 0 \\ \vdots & \vdots & \ddots & \vdots \\ 0 & 0 & \cdots & e_{gn} \end{bmatrix}$$

In a simple example with two countries (i and j) and industries (k and l) we can zoom in to see the exact matrices content:

$$\begin{bmatrix} v_{ik} & 0 & 0 & 0 \\ 0 & v_{il} & 0 & 0 \\ 0 & 0 & v_{jk} & 0 \\ 0 & 0 & 0 & v_{jl} \end{bmatrix} \begin{bmatrix} b_{ikik} & b_{ikil} & b_{ikjk} & b_{ikjl} \\ b_{ilik} & b_{ilil} & b_{iljk} & b_{il}l \\ b_{jkik} & b_{jkil} & b_{jkjk} & b_{jkjl} \\ b_{jlik} & b_{jlil} & b_{jljk} & b_{jljl} \end{bmatrix} \begin{bmatrix} e_{ik} & 0 & 0 & 0 \\ 0 & e_{il} & 0 & 0 \\ 0 & 0 & e_{jk} & 0 \\ 0 & 0 & 0 & e_{jl} \end{bmatrix} = \begin{bmatrix} vae_{ikik} & vae_{ikil} & vae_{ikjk} & vae_{ikjl} \\ vae_{ilik} & vae_{ilil} & vae_{iljk} & vae_{il}l \\ vae_{jkik} & vae_{jkil} & vae_{jkjk} & vae_{jkjl} \\ vae_{jlik} & vae_{jlil} & vae_{jljk} & vae_{jljl} \end{bmatrix}$$

From the **vae** matrix we can derive a decomposition of gross exports into value added along four dimensions: source country, source industry, using country, and using industry. For instance,

vae_{ikjl} is the the value added of industry k from country i in the exports of industry l from country j Defining ik as the domestic country i industry k and jl as the foregin country j industry l, DVAX of ik, the forward linkage indicator is obtained as:

$$DVAX_{ik} = \sum_{l} \sum_{j} vae_{ikjl} \tag{4}$$

With $i \neq l$. It represents the row sum of the elements of the vae matrix of country i sector k and is equal to the sum of value added from the domestic industry k of country i in the exports of all industries l in all foreign countries j.

FVAX of ik, the backward linkage indicator is obtained as:

$$FVAX_{ik} = \sum_{l} \sum_{j} vae_{jlik} \tag{5}$$

With $i \neq l$. It represents the column sum of the elements of the vae matrix of country i sector k and is equal to the sum of value added from all industries l of all foreign countries l in the exports of industry k in country i.

B Instrumenting GVC participation

The estimation of our benchmark equation may violate the assumption of strict exogeneity therefore we choose to follow the Kummritz (2016) approach instrumenting for GVC participation .

Both the GVCs indicators we use are calculated summing up for each country and sector combination, bilateral value added flows,therefore to built our IV we need at first to predict the bilateral value added flows then used as instruments in a 2SLS. To predict the vae_{ijkl} flows we need to take in account two dimensions:the distance between countries i and j and the distance between industries k and j. We could estimate country distance using the bilateral trade costs and the industrial distance as the number of intermediate stages between them: the interaction of this two components will be use in a "zero" stage to instrument the vae bilateral flows .

The gravity model augmented to consider GVCs (Noguera, 2012) shows how the vae_{ij} flow depends not only on the bilateral trade costs τ_{ij} but also on the trade costs τ_{ic} of all the countries which sent indirectly value added to j through i mediation. If we exclude τ_{ij}, namely the trade cost between the two countries we are considering, we can use the normalised sum of the bilateral trade costs to predict the country distance component of the vae_{ij} flow. Given the exclusion of τ_{ij}, the indirect bilateral cost has the advantage to be exogenous respect to the vae_{ij} flow we try to instrument.

Thus, the first part of the instrument will be the average trade cost weighted by the trade partner export share:

$$\tau_{ijt} = \sum_{c} \tau_{ict} * \frac{e_{ict}}{\sum_c e_{ict}} \tag{6}$$

Where $c \neq i, j$

Considered the country level we need to address the industry one. To instrument GVC participation we need to take into account also industrial distance since, the value added between sectors could flow directly if the sectors are close or it can flow indirectly via other sectors if they are involved in different stages of production Thus, the larger the industrial distance, the larger the probability that third sector affects the trade relation.

The industrial distance is calculated using upstreamness and downstreamness developed by Antràs and Chor (2013):

$$upstreamness_k = \sum_j \sum_l \frac{a_{ikjl} * y_{ik}}{y_{lj}} * upstreamness_l \tag{7}$$

$$downstreamness_k = \sum_j \sum_l a_{jlik} * downstreamness_l \tag{8}$$

Where y is total output and a the share of inputs in outputs obtained from the matrix of input-output coefficients. The indicator of industrial distance used is calculated as:

$$inddistance_{kl} = \frac{1}{upstreamness_k * downstreamness_l} \tag{9}$$

Where upstreamness represents how far is a sector as a seller of value added from the final demand and downstreamness represents how far is a sector as a buyer of value added from primary inputs.

Eventually, to implement the IV strategy, we need to combine this two elements to predict an instrument of the *vae* flows which can be used in a 2SLS strategy.

We predict the bilateral value added flows as:

$$\ln vae_{ikjlt} = \beta_0 + \beta_1 \ln (\tau_{ij} * indistance_{kl}) + \gamma_{ik} + \gamma_{ky} + \gamma_{iy} \tag{10}$$

And we obtain our instruments for fvax and dvax aggregating the *vae* flows as:

$$fvax_{ikt} = \sum_l \sum_j vae_{jlikt} \tag{11}$$

(12) $$dvax_{ikt} = \sum_{l} \sum_{j} vae_{ikjlt}$$

We estimate 4 different instrumental variables as in Kummritz (2016): the first is the same as the one in Kummritz (2016) with bilateral gross export trade costs and industrial distance aggregated for all the years in the sample, the second is estimated using bilateral gross export trade costs and industrial distance computed for every year, the third is generated using bilateral value added trade costs and industrial distance aggregated over time in our the sample and finally the fourth is obtained using bilateral value added trade costs and industrial distance calculated for every year.

C Growth accounting analysis

Table 4: Sources of growth

Country	Labor Productivity growth		Contributions of components					
			Labor quality		Capital deepening		MFP	
	2000-2007	2010-2015	2000-2007	2010-2015	2000-2007	2010-2015	2000-2007	2010-2015
Austria	2.49	1.14	0.30	0.18	0.77	0.53	1.42	0.44
Belgium	1.97	1.09	0.46	0.48	1.11	0.20	0.39	0.41
Germany	2.12	1.74	-0.08	0.21	0.90	0.11	1.30	1.41
Denmark	1.79	1.66	0.51	0.27	0.68	0.32	0.60	1.07
Spain	0.07	1.42	0.10	0.40	0.42	0.77	-0.45	0.26
Finland	3.52	0.89	0.20	0.28	0.21	-0.10	3.11	0.71
France	1.54	0.95	0.12	0.62	0.77	0.35	0.65	-0.02
Italy	0.57	0.99	0.23	0.14	0.66	0.21	-0.32	0.64
Netherlands	1.89	0.97	0.25	0.18	0.24	0.15	1.39	0.64
Sweden	3.99	2.06	0.60	0.05	1.47	0.34	1.92	1.67
UK	2.71	0.73	0.37	0.32	0.77	0.14	1.57	0.27
USA	2.16	0.19	0.01	-0.19	1.01	0.04	1.15	0.35

The table compares average factors contribution to annual growth in gross value added per hour worked in selected advanced economies over the periods 2000-2007 and 2010-2015 for the market Economy aggregate. The contribution of labor and capital is measured as the growth rate of the volume indices of labor and capital services, multiplied by the share of each input compensation in total value added. For the post-crisis years, data refer to 2010-2014 for Italy and Sweden. Source: authors' calculations based on EUKLEMS data.

Table 5: Productivity growth and contributions from the digital sectors

Country	Labor Productivity growth						Sectoral Contributions					
	HD		MD		LD		HD		MD		LD	
	2000/07	2010/15	2000/07	2010/15	2000/07	2010/15	2000/07	2010/15	2000/07	2010/15	2000/07	2010/15
Austria	2.69	0.2	2.62	2.1	1.35	-0.03	0.65	-0.01	1.11	0.90	0.39	-0.01
Belgium	1.41	0.82	2.65	1.76	2.31	0.73	0.26	0.12	1.00	0.60	0.60	0.16
Germany	0.21	2.21	3.83	2.22	1.37	0.14	0.04	0.81	1.60	0.97	0.35	0.02
Denmark	2.32	1.00	2.65	3.14	-0.13	1.66	0.70	0.26	1.11	1.33	-0.08	0.37
Spain	2.40	1.37	0.87	3.04	-2.46	0.71	0.60	0.30	0.13	1.12	-0.99	0.16
Finland	0.74	1.03	5.78	1.11	1.00	0.62	0.13	0.25	2.87	0.33	0.19	0.18
France	0.76	0.40	2.84	1.86	0.29	0.33	0.32	0.19	1.04	0.60	0.04	0.08
Italy	0.40	-0.08	1.14	2.46	-0.28	-0.46	0.18	-0.09	0.49	1.00	-0.17	-0.11
Netherlands	1.80	0.41	3.40	2.23	1.75	1.29	0.64	0.10	1.25	0.78	0.42	0.24
Sweden	3.99	3.11	5.39	3.70	1.63	0.50	1.30	1.15	2.10	1.32	0.42	0.06
UK	3.98	0.92	3.60	1.25	1.34	1.17	1.45	0.34	1.19	0.32	0.30	0.21
USA	2.23	1.04	4.79	1.62	-0.24	-0.76	0.78	0.42	1.87	0.66	-0.12	-0.35

The table shows labor productivity growth (LPG) for sectors classified according to the degree of digital intensity (Calvino et al. (2018)), and their contributions to aggregate (Market Economy, excluding Agriculture, Mining, and Manufacturing of Coke and refined petroleum products) LPG. This is calculated as the difference in the growth rates of annual Tornqvist indices of constant price value added and of labor input (hours). The contribution of each sector to LPG of the HD, MD and LD aggregates is computed as the weighted difference between the growth rate of real gross value added and that of hours worked. For each sector, the weights are computed as the share in nominal gross value added and total hours worked respectively of total market economy aggregates. Sectors contributions are then summed up based on their digital-intensity classification. Source: authors' calculations based on EUKLEMS data.

C.1 Productivity growth and industry contributions

Table 6: Austria

	Labor productivity growth		Contributions of components: Labor		Capital		MFP		Contribution to aggregate labor productivity growth	
	2000-2007	2010-2015	2000-2007	2010-2015	2000-2007	2010-2015	2000-2007	2010-2015	2000-2007	2010-2015
Food, beverages, tob.	3.77	1.02	0.25	0.14	0.77	0.55	2.75	0.34	0.11	0.03
Textiles	4.51	2.46	0.44	0.17	1.85	0.48	2.23	1.81	0.06	0.02
Wood and paper	3.06	4.43	0.18	0.15	0.39	0.07	2.49	4.21	0.09	0.11
Chemicals	6.00	3.37	0.25	0.11	2.19	0.76	3.56	2.49	0.12	0.09
Rubber and plastics	1.85	3.73	0.21	0.14	0.84	1.00	0.79	2.58	0.05	0.09
Metals	1.82	3.44	0.26	0.15	0.58	0.41	0.99	2.87	0.09	0.16
Electrical and optical	3.68	2.92	0.17	0.12	1.70	2.77	1.80	0.04	0.13	0.10
Machinery, equip. n.e.c.	5.94	2.16	0.24	0.13	1.83	1.27	3.87	0.76	0.19	0.09
Transport equip	6.33	2.35	0.22	0.10	2.33	1.03	3.77	1.21	0.16	0.06
Other manufacturing	3.86	4.00	0.45	0.16	0.88	0.87	2.53	2.97	0.08	0.09
Electricity, gas, water	0.97	-0.67	0.20	-0.19	0.36	0.51	0.41	-0.99	0.04	-0.02
Construction	1.21	-1.78	0.32	-0.11	0.77	-0.18	0.12	-1.49	0.12	-0.17
Wholesale, retail trade	1.59	0.86	0.14	0.03	0.10	0.42	1.34	0.41	0.27	0.16
Transportation, storage	0.99	1.08	-0.20	-0.09	1.21	0.64	-0.02	0.53	0.08	0.08
Accomodation, food	1.25	0.95	-0.07	0.13	0.18	0.45	1.14	0.37	0.05	0.07
Publishing, audiovisual	2.53	-0.67	0.85	0.19	0.77	0.06	0.92	-0.93	0.03	0.00
Telecommunications	7.37	-3.65	0.09	0.13	2.70	-0.19	4.58	-3.58	0.11	-0.07
IT, other information	2.03	1.75	0.76	0.20	0.69	0.62	0.58	0.94	0.05	0.05
Finance and insurance	4.40	0.70	0.32	0.10	0.18	0.73	3.89	-0.13	0.32	0.02
Professional services	0.72	0.02	0.12	0.38	1.14	0.16	-0.53	-0.52	-0.01	-0.06
Arts and other services	0.77	0.02	0.73	-0.13	0.26	0.21	-0.22	-0.05		
Arts, entert., recreation	0.19	0.36	0.50	-0.35	-0.09	0.23	-0.22	0.47	0.00	0.01
Other services	0.94	-0.19	0.71	0.08	0.44	0.21	-0.21	-0.47	0.02	-0.01

Low Digital Intensity Medium Digital Intensity High Digital Intensity

Table 7: Belgium

	Labor productivity growth		Contributions of components: Labor		Capital		MFP		Contribution to aggregate labor productivity growth	
	2000-2007	2010-2015	2000-2007	2010-2015	2000-2007	2010-2015	2000-2007	2010-2015	2000-2007	2010-2015
Food, beverages, tob.	3.73	3.36	0.14	0.25	0.45	0.22	3.14	2.89	0.12	0.10
Textiles	5.06	-0.24	0.47	0.38	0.07	-1.59	4.52	0.97	0.07	0.00
Wood and paper	4.59	0.22	0.19	0.21	0.81	-0.77	3.59	0.77	0.08	0.01
Chemicals	1.75	2.30	0.17	0.33	2.41	0.17	-0.83	1.81	0.10	0.14
Rubber and plastics	3.50	1.32	0.26	0.39	0.43	-0.61	2.81	1.53	0.08	0.02
Metals	2.45	10.62	0.23	0.36	0.17	-0.33	2.05	10.59	0.10	0.28
Electrical and optical	5.03	-2.02	0.48	0.61	0.15	-1.34	4.40	-1.30	0.08	-0.03
Machinery, equip. n.e.c.	3.82	0.89	0.20	0.35	0.45	0.12	3.17	0.42	0.06	0.01
Transport equip	4.05	3.80	0.31	0.40	0.74	-0.83	3.00	4.23	0.09	0.05
Other manufacturing	0.83	0.41	0.28	0.33	-0.03	-0.53	0.57	0.62	0.01	0.00
Electricity, gas, water	0.21	-1.26	-0.29	0.37	-0.53	-0.11	1.04	-1.51	0.02	-0.04
Construction	3.17	0.77	0.11	0.22	1.52	0.59	1.54	-0.04	0.22	0.06
Wholesale, retail trade	2.41	0.82	0.25	0.28	1.71	0.69	0.45	-0.15	0.45	0.15
Transportation, storage	1.54	1.20	0.38	0.34	0.86	0.00	0.30	0.85	0.14	0.10
Accomodation, food	3.09	-1.42	0.03	0.11	0.77	-0.47	2.29	-1.07	0.10	-0.06
Publishing, audiovisual	0.05	1.55	0.43	0.33	1.80	1.75	-2.17	-0.52	0.00	0.01
Telecommunications	7.80	1.61	0.44	0.27	0.69	1.45	6.66	-0.11	0.21	0.01
IT, other information	0.93	1.43	0.40	0.22	2.42	1.25	-1.90	-0.04	0.05	0.05
Finance and insurance	2.14	3.29	0.29	0.28	1.44	-0.52	0.41	3.53	0.14	0.25
Professional services	0.01	-0.17	0.16	0.29	0.83	-0.14	-0.99	-0.32	-0.26	-0.25
Arts and other services	0.53	0.56	0.41	0.59	0.71	0.18	-0.58	-0.21		
Arts, entert., recreation	-2.63	0.01	0.23	0.27	0.79	0.11	-3.65	-0.38	-0.03	-0.01
Other services	1.74	0.74	0.55	0.75	0.46	0.11	0.73	-0.12	0.03	0.01

Low Digital Intensity Medium Digital Intensity High Digital Intensity

Table 8: Germany

	Labor productivity growth		Contributions of components: Labor		Capital		MFP		Contribution to aggregate labor productivity growth	
	2000-2007	2010-2015	2000-2007	2010-2015	2000-2007	2010-2015	2000-2007	2010-2015	2000-2007	2010-2015
Food, beverages, tob.	0.19	1.27	0.04	0.32	0.27	-0.20	-0.12	1.15	0.01	0.03
Textiles	4.44	2.49	0.15	0.32	0.80	0.30	3.49	1.88	0.04	0.01
Wood and paper	2.34	2.55	0.22	0.29	0.32	-0.35	1.80	2.62	0.04	0.04
Chemicals	5.00	1.13	-0.13	0.19	0.23	-1.79	4.89	2.74	0.16	0.08
Rubber and plastics	3.56	2.81	0.02	0.27	0.16	-0.58	3.38	3.12	0.09	0.07
Metals	2.26	3.79	0.06	0.30	0.43	-0.61	1.76	4.10	0.10	0.15
Electrical and optical	7.22	3.65	-0.08	0.25	1.01	-0.49	6.29	3.89	0.32	0.18
Machinery, equip. n.e.c.	3.01	2.14	0.13	0.28	0.94	-0.62	1.93	2.49	0.14	0.12
Transport equip	4.72	7.17	0.12	0.23	1.10	0.61	3.50	6.33	0.25	0.48
Other manufacturing	4.20	1.44	-0.03	0.33	0.28	-0.23	3.94	1.33	0.09	0.03
Electricity, gas, water	1.21	-0.68	-0.10	-0.15	1.15	-0.82	0.16	0.28	0.01	-0.01
Construction	-0.18	1.03	0.19	0.08	0.03	0.23	-0.40	0.72	0.11	0.05
Wholesale, retail trade	4.22	1.91	-0.15	0.31	0.45	0.43	3.92	1.16	0.66	0.28
Transportation, storage	3.39	-1.07	0.05	-0.13	1.37	0.15	1.98	-1.09	0.22	-0.07
Accomodation, food	0.07	1.05	0.11	0.17	0.02	0.03	-0.05	0.85	0.00	0.02
Publishing, audiovisual	-0.03	0.55	0.13	0.31	0.94	0.85	-1.10	-0.60	0.00	0.01
Telecommunications	6.43	6.64	-0.03	0.18	0.96	3.47	5.50	2.99	0.13	0.05
IT, other information	3.20	5.56	-0.34	0.45	-0.13	0.66	3.67	4.46	0.11	0.20
Finance and insurance	-3.19	2.02	0.23	0.00	0.09	0.44	-3.52	1.58	-0.25	0.12
Professional services	-1.52	-0.08	-0.45	0.05	1.63	-0.24	-2.70	0.12	-0.20	-0.05
Arts and other services	-0.38	0.27	-0.22	0.28	0.57	0.25	-0.72	-0.26		
Arts, entert., recreation	-1.31	0.61	-0.26	0.08	0.83	-0.14	-1.88	0.68	-0.03	0.01
Other services	0.01	-0.02	-0.23	0.35	0.39	0.37	-0.15	-0.75	-0.01	0.01

Low Digital Intensity Medium Digital Intensity High Digital Intensity

Table 9: Denmark

	Labor productivity growth		Contributions of components: Labor		Capital		MFP		Contribution to aggregate labor productivity growth	
	2000-2007	2010-2015	2000-2007	2010-2015	2000-2007	2010-2015	2000-2007	2010-2015	2000-2007	2010-2015
Food, beverages, tob.	0.66	0.41	0.70	0.35	1.56	0.96	-1.60	-0.90	0.02	0.03
Textiles	2.26	2.27	0.98	0.39	0.82	0.30	0.47	1.59	0.02	0.01
Wood and paper	2.80	3.24	0.48	0.35	0.67	0.06	1.65	2.83	0.05	0.04
Chemicals	1.46	5.78	-0.09	0.14	2.01	1.25	-0.47	4.39	0.07	0.38
Rubber and plastics	3.29	0.89	-0.91	0.34	1.19	0.16	3.01	0.40	0.07	0.01
Metals	0.44	1.96	0.27	0.38	0.36	-0.27	-0.19	1.84	0.02	0.04
Electrical and optical	5.52	4.31	1.26	0.25	2.50	0.87	1.76	3.19	0.13	0.08
Machinery, equip. n.e.c.	4.50	5.27	-0.44	0.30	0.78	1.01	4.17	3.96	0.18	0.19
Transport equip	1.82	6.41	1.09	0.31	1.35	0.14	-0.62	5.96	0.02	0.03
Other manufacturing	3.51	6.47	-0.55	0.25	0.80	0.64	3.26	5.58	0.08	0.14
Electricity, gas, water	-0.04	1.34	-0.49	0.26	2.06	2.32	-1.62	-1.24	-0.03	0.01
Construction	-0.95	0.98	0.49	0.44	0.05	-0.01	-1.49	0.55	-0.14	0.08
Wholesale, retail trade	2.42	1.67	0.02	0.15	0.25	0.00	2.15	1.52	0.45	0.34
Transportation, storage	1.73	3.64	0.17	0.41	1.39	0.70	0.17	2.53	0.17	0.32
Accomodation, food	-2.89	-0.08	0.32	0.65	-0.46	-0.56	-2.75	-0.17	-0.10	-0.07
Publishing, audiovisual	4.44	3.97	-2.19	0.36	1.87	-0.45	4.76	4.06	0.09	0.09
Telecommunications	14.16	14.86	1.18	0.19	5.03	2.32	7.95	12.35	0.30	0.25
IT, other information	2.77	1.22	-0.28	0.45	-0.19	0.28	3.24	0.49	0.08	0.04
Finance and insurance	6.48	-0.14	0.43	0.55	-0.17	1.98	6.22	-2.67	0.57	-0.12
Professional services	-1.90	0.80	1.15	0.39	0.23	-0.10	-3.28	0.52	-0.27	0.04
Arts and other services	-0.89	0.47	0.59	0.34	0.35	-0.33	-1.82	0.46		
Arts, entert., recreation	-2.22	0.09	-0.53	0.05	-0.11	-0.94	-1.57	0.98	-0.05	0.00
Other services	-0.18	0.62	1.63	0.63	0.23	0.02	-2.04	-0.03	0.00	0.02

Low Digital Intensity Medium Digital Intensity High Digital Intensity

Table 10: Spain

	Labor productivity growth		Contributions of components: Labor		Capital		MFP		Contribution to aggregate labor productivity growth	
	2000-2007	2010-2015	2000-2007	2010-2015	2000-2007	2010-2015	2000-2007	2010-2015	2000-2007	2010-2015
Food, beverages, tob.	2.79	-1.02	-0.52	0.44	0.33	1.29	2.98	-2.74	0.10	-0.05
Textiles	3.55	1.86	0.41	0.58	1.30	-0.77	1.84	2.05	0.10	0.03
Wood and paper	1.27	3.88	-0.06	0.60	1.21	0.94	0.12	2.34	0.02	0.06
Chemicals	2.42	2.39	-0.56	0.41	0.42	1.35	2.56	0.63	0.07	0.05
Rubber and plastics	0.81	3.45	0.33	0.60	0.83	0.32	-0.36	2.53	0.02	0.05
Metals	0.11	8.20	0.04	0.65	-0.03	0.53	0.10	7.02	0.01	0.23
Electrical and optical	4.27	2.93	-0.76	0.51	0.97	0.29	4.07	2.14	0.06	0.02
Machinery, equip. n.e.c.	2.74	2.66	-0.41	0.54	0.79	-0.34	2.35	2.46	0.04	0.04
Transport equip	5.48	5.10	0.25	0.54	2.30	-2.39	2.94	6.95	0.12	0.12
Other manufacturing	2.64	3.59	-0.87	0.60	-0.09	1.00	3.59	1.98	0.03	0.08
Electricity, gas, water	0.95	-1.37	-0.15	-0.11	-0.33	3.93	1.43	-5.19	0.11	-0.06
Construction	-3.92	1.60	-0.03	0.50	-0.16	3.24	-3.73	-2.14	-0.79	0.17
Wholesale, retail trade	0.56	2.60	-0.23	0.38	0.96	0.67	-0.17	1.54	-0.19	0.57
Transportation, storage	-1.21	3.04	0.81	0.50	1.41	0.99	-3.42	1.54	-0.08	0.21
Accomodation, food	-4.05	-1.00	0.03	0.18	0.53	-0.26	-4.61	-0.92	-0.34	-0.12
Publishing, audiovisual	-3.25	-0.97	-0.36	0.78	0.32	1.88	-3.22	-3.63	-0.03	-0.02
Telecommunications	10.19	7.29	-0.16	0.25	5.88	0.54	4.48	6.50	0.25	0.22
IT, other information	3.32	-0.36	0.01	0.75	-0.49	0.71	3.80	-1.82	0.07	0.01
Finance and insurance	7.20	-2.74	-0.25	0.38	0.25	2.18	7.20	-5.30	0.56	-0.26
Professional services	-2.83	1.86	0.92	0.50	0.82	0.61	-4.57	0.74	-0.40	0.21
Arts and other services	0.23	-0.49	1.08	0.70	1.05	-0.02	-1.89	-1.18		
Arts, entert., recreation	2.63	-2.55	1.49	0.62						
Other services	-2.09	1.60	0.97	0.74						

Low Digital Intensity Medium Digital Intensity High Digital Intensity

Table 11: Finland

	Labor productivity growth		Contributions of components: Labor		Capital		MFP		Contribution to aggregate labor productivity growth	
	2000-2007	2010-2015	2000-2007	2010-2015	2000-2007	2010-2015	2000-2007	2010-2015	2000-2007	2010-2015
Food, beverages, tob.	6.81	-4.51	0.18	0.32	0.85	-0.69	5.79	-4.14	0.17	-0.11
Textiles	3.31	1.06	0.64	0.56	0.20	-0.77	2.47	1.26	0.04	0.02
Wood and paper	4.20	5.96	0.15	0.33	0.87	-0.49	3.19	6.11	0.25	0.22
Chemicals	3.09	3.32	0.09	0.18	1.00	0.13	1.99	3.01	0.07	0.09
Rubber and plastics	3.37	1.41	0.24	0.34	0.32	-0.08	2.81	1.15	0.08	0.02
Metals	4.38	3.22	0.09	0.38	0.01	-0.03	4.28	2.87	0.20	0.11
Electrical and optical	13.32	-1.09	0.63	0.25	4.93	1.33	7.76	-2.67	1.46	-0.25
Machinery, equip. n.e.c.	4.75	-0.07	0.11	0.30	-0.53	0.49	5.17	-0.86	0.18	0.00
Transport equip	0.60	3.45	0.10	0.41	-0.27	0.23	0.77	2.81	0.01	0.03
Other manufacturing	2.09	0.55	0.31	0.45	0.56	-0.89	1.22	0.98	0.05	0.02
Electricity, gas, water	2.50	1.51	-0.09	0.04	0.96	2.18	1.62	-0.71	0.09	0.07
Construction	-0.29	0.08	-0.27	0.10	0.36	0.00	-0.38	-0.03	-0.13	0.00
Wholesale, retail trade	3.96	1.21	0.26	0.23	-0.49	-0.02	4.19	0.99	0.53	0.19
Transportation, storage	0.39	3.44	0.12	-0.04	-0.36	0.31	0.64	3.17	0.03	0.31
Accomodation, food	2.75	-2.85	0.27	-0.09	0.02	0.00	2.46	-2.76	0.04	-0.09
Publishing, audiovisual	0.74	-1.53	0.44	0.46	-0.37	0.85	0.66	-2.84	0.02	-0.03
Telecommunications	10.71	6.90	0.22	0.23	2.10	-0.93	8.39	7.60	0.28	0.12
IT, other information	2.18	5.73	0.38	0.57	0.95	1.79	0.85	3.37	0.06	0.27
Finance and insurance	-0.79	0.63	-0.56	0.42	-1.89	-0.72	1.67	0.93	-0.01	0.02
Professional services	-0.64	-0.47	-0.65	0.56	-0.04	-0.18	0.06	-0.85	-0.18	-0.10
Arts and other services	-0.21	-2.00	0.24	0.05	-0.03	-0.20	-0.42	-1.86		
Arts, entert., recreation	-0.43	-1.77	0.03	0.04	0.07	-0.18	-0.53	-1.63	-0.02	-0.04
Other services	-0.02	-2.14	0.40	0.07	-0.09	-0.19	-0.33	-2.02	-0.03	-0.09

Low Digital Intensity Medium Digital Intensity High Digital Intensity

Table 12: France

	Labor productivity growth		Contributions of components: Labor		Capital		MFP		Contribution to aggregate labor productivity growth	
	2000-2007	2010-2015	2000-2007	2010-2015	2000-2007	2010-2015	2000-2007	2010-2015	2000-2007	2010-2015
Food, beverages, tob.	1.81	1.21	0.42	0.49	0.61	-0.48	0.79	1.19	0.07	0.04
Textiles	6.35	3.42	0.58	0.65	1.42	0.06	4.35	2.71	0.09	0.02
Wood and paper	2.69	3.47	0.42	0.68	0.91	0.06	1.37	2.73	0.05	0.04
Chemicals	5.42	3.41	0.77	0.37	2.91	1.67	1.74	1.36	0.12	0.07
Rubber and plastics	4.49	1.47	-0.03	0.59	1.06	0.57	3.45	0.31	0.10	0.02
Metals	2.08	1.79	0.32	0.62	0.95	0.33	0.80	0.84	0.06	0.04
Electrical and optical	7.36	5.18	0.67	0.55	0.95	0.80	5.74	3.83	0.14	0.07
Machinery, equip. n.e.c.	5.25	3.54	0.40	0.57	1.11	0.67	3.74	2.31	0.07	0.04
Transport equip	0.85	2.02	-0.10	0.52	1.70	1.05	-0.76	0.45	0.01	0.03
Other manufacturing	3.05	1.63	-0.12	0.69	0.47	0.54	2.70	0.39	0.08	0.04
Electricity, gas, water	1.23	0.28	-0.10	-0.15	0.71	1.07	0.62	-0.64	0.06	0.04
Construction	-0.17	-1.50	-0.20	0.67	0.06	0.01	-0.03	-2.18	-0.08	-0.13
Wholesale, retail trade	1.27	1.49	0.07	0.60	0.64	0.13	0.56	0.77	0.19	0.25
Transportation, storage	0.82	1.77	0.11	0.52	0.76	0.53	-0.05	0.71	0.05	0.13
Accomodation, food	-0.67	0.50	-0.18	0.34	0.23	-0.01	-0.72	0.17	-0.06	0.00
Publishing, audiovisual	1.98	1.00	0.10	0.86	1.34	0.88	0.55	-0.74	0.05	0.02
Telecommunications	11.55	6.94	0.85	0.48	5.13	2.79	5.57	3.68	0.28	0.14
IT, other information	1.43	0.72	0.24	1.08	1.02	0.42	0.17	-0.78	0.08	0.05
Finance and insurance	1.76	0.70	-0.27	0.45	1.80	0.67	0.22	-0.42	0.12	0.07
Professional services	-1.05	-0.28	-0.41	0.66	0.26	0.02	-0.90	-0.95	-0.20	-0.07
Arts and other services	2.68	-0.37	1.29	0.85	0.66	0.13	0.72	-1.35		
Arts, entert., recreation	4.97	0.00	3.38	0.40	0.32	0.25	1.27	-0.65	0.10	-0.01
Other services	1.05	-0.73	0.52	1.25	0.19	0.01	0.33	-1.99	0.02	-0.03

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Table 13: Italy

	Labor productivity growth		Contributions of components: Labor		Capital		MFP		Contribution to aggregate labor productivity growth	
	2000-2007	2010-2015	2000-2007	2010-2015	2000-2007	2010-2015	2000-2007	2010-2015	2000-2007	2010-2015
Food, beverages, tob.	0.04	2.03	0.29	0.29	0.93	0.29	-1.18	1.91	0.00	0.05
Textiles	1.32	4.40	0.53	0.29	1.33	0.69	-0.53	4.63	0.06	0.11
Wood and paper	1.22	3.50	0.42	0.32	0.11	0.79	0.69	3.05	0.03	0.06
Chemicals	1.47	4.57	0.45	0.23	1.51	0.66	-0.49	4.25	0.02	0.08
Rubber and plastics	1.58	3.42	0.55	0.30	0.17	0.77	0.87	2.24	0.04	0.07
Metals	1.91	4.25	0.58	0.32	0.36	0.37	0.96	4.30	0.08	0.16
Electrical and optical	2.48	1.78	0.56	0.27	1.27	0.63	0.66	0.61	0.05	0.03
Machinery, equip. n.e.c.	2.26	2.70	0.55	0.28	0.56	0.24	1.14	2.79	0.08	0.09
Transport equip	1.56	3.68	0.58	0.28	0.84	1.51	0.15	1.04	0.03	0.06
Other manufacturing	1.12	0.25	0.47	0.33	0.22	-0.26	0.42	0.11	0.02	0.01
Electricity, gas, water	0.31	-4.01	0.41	-0.05	2.02	-0.64	-2.13	-4.03	0.01	-0.16
Construction	-0.91	0.09	-0.27	0.43	-0.06	0.60	-0.59	-0.75	-0.17	0.11
Wholesale, retail trade	0.72	2.29	0.05	0.07	0.91	-0.14	-0.24	2.30	0.11	0.45
Transportation, storage	1.93	-0.93	0.59	0.03	0.75	0.10	0.58	-0.92	0.15	-0.08
Accomodation, food	-2.16	-0.43	-0.15	-0.09	-0.16	-0.40	-1.84	-0.02	-0.18	-0.04
Publishing, audiovisual	-0.17	-4.00	-0.10	0.19	1.04	1.49	-1.11	-5.66	0.01	-0.05
Telecommunications	10.90	4.16	0.12	0.08	4.25	6.56	6.53	-1.09	0.26	0.02
IT, other information	-0.03	-0.03	-0.04	0.22	-0.25	-0.02	0.25	0.99	0.01	0.00
Finance and insurance	2.25	2.21	0.39	-0.04	0.43	0.36	1.42	2.15	0.19	0.13
Professional services	-2.08	-1.75	-0.12	-0.09	0.22	-0.52	-2.18	-1.25	-0.25	-0.26
Arts and other services	-1.39	-1.18	0.69	0.02	0.89	-0.31	-2.97	-0.16		
Arts, entert., recreation	-1.04	-0.89	1.22	0.01	0.35	-0.36	-2.62	0.53	-0.01	-0.02
Other services	-1.87	-1.31	0.24	0.09	1.22	-0.25	-3.34	-0.62	-0.06	-0.04

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Table 14: Netherlands

	Labor productivity growth		Contributions of components: Labor		Capital		MFP		Contribution to aggregate labor productivity growth	
	2000-2007	2010-2015	2000-2007	2010-2015	2000-2007	2010-2015	2000-2007	2010-2015	2000-2007	2010-2015
Food, beverages, tob.	6.81	-4.51	0.18	0.32	0.85	-0.69	5.79	-4.14	0.17	-0.11
Textiles	3.31	1.06	0.64	0.56	0.20	-0.77	2.47	1.26	0.04	0.02
Wood and paper	4.20	5.96	0.15	0.33	0.87	-0.49	3.19	6.11	0.25	0.22
Chemicals	3.09	3.32	0.09	0.18	1.00	0.13	1.99	3.01	0.07	0.09
Rubber and plastics	3.37	1.41	0.24	0.34	0.32	-0.08	2.81	1.15	0.08	0.02
Metals	4.38	3.22	0.09	0.38	0.01	-0.03	4.28	2.87	0.20	0.11
Electrical and optical	13.32	-1.09	0.63	0.25	4.93	1.33	7.76	-2.67	1.46	-0.25
Machinery, equip. n.e.c.	4.75	-0.07	0.11	0.30	-0.53	0.49	5.17	-0.86	0.18	0.00
Transport equip	0.60	3.45	0.10	0.41	-0.27	0.23	0.77	2.81	0.01	0.03
Other manufacturing	2.09	0.55	0.31	0.45	0.56	-0.89	1.22	0.98	0.05	0.02
Electricity, gas, water	2.50	1.51	-0.09	0.04	0.96	2.18	1.62	-0.71	0.09	0.07
Construction	-0.29	0.08	-0.27	0.10	0.36	0.00	-0.38	-0.03	-0.13	0.00
Wholesale, retail trade	3.96	1.21	0.26	0.23	-0.49	-0.02	4.19	0.99	0.53	0.19
Transportation, storage	0.39	3.44	0.12	-0.04	-0.36	0.31	0.64	3.17	0.03	0.31
Accomodation, food	2.75	-2.85	0.27	-0.09	0.02	0.00	2.46	-2.76	0.04	-0.09
Publishing, audiovisual	0.74	-1.53	0.44	0.46	-0.37	0.85	0.66	-2.84	0.02	-0.03
Telecommunications	10.71	6.90	0.22	0.23	2.10	-0.93	8.39	7.60	0.28	0.12
IT, other information	2.18	5.73	0.38	0.57	0.95	1.79	0.85	3.37	0.06	0.27
Finance and insurance	-0.79	0.63	-0.56	0.42	-1.89	-0.72	1.67	0.93	-0.01	0.02
Professional services	-0.64	-0.47	-0.65	0.56	-0.04	-0.18	0.06	-0.85	-0.18	-0.10
Arts and other services	-0.21	-2.00	0.24	0.05	-0.03	-0.20	-0.42	-1.86		
Arts, entert., recreation	-0.43	-1.77	0.03	0.04	0.07	-0.18	-0.53	-1.63	-0.02	-0.04
Other services	-0.02	-2.14	0.40	0.07	-0.09	-0.19	-0.33	-2.02	-0.03	-0.09

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Table 15: Sweden

	Labor productivity growth		Contributions of components: Labor		Capital		MFP		Contribution to aggregate labor productivity growth	
	2000-2007	2010-2015	2000-2007	2010-2015	2000-2007	2010-2015	2000-2007	2010-2015	2000-2007	2010-2015
Food, beverages, tob.	3.60	2.74	-0.17	0.05	2.36	0.93	1.41	1.76	0.08	0.06
Textiles	3.85	1.61	0.00	0.07	0.79	-0.06	3.06	1.60	0.02	0.00
Wood and paper	2.63	1.44	0.00	0.05	1.27	0.22	1.36	1.16	0.12	0.05
Chemicals										
Rubber and plastics	4.53	2.74	0.45	0.05	0.64	0.43	3.44	2.25	0.07	0.03
Metals	2.88	7.14	-0.01	0.05	1.09	0.79	1.80	6.29	0.13	0.24
Electrical and optical	14.93	6.72	1.05	0.03	4.35	2.52	9.54	4.16	0.72	0.29
Machinery, equip. n.e.c.	6.48	6.30	1.31	0.05	1.59	2.90	3.58	3.35	0.23	0.18
Transport equip	6.02	6.54	0.90	0.05	1.14	1.39	3.97	5.11	0.26	0.22
Other manufacturing	4.76	0.01	0.28	0.06	1.13	1.34	3.35	-1.39	0.09	0.00
Electricity, gas, water	-0.54	1.28	-0.24	-0.14	-0.31	0.01	0.00	1.41	0.04	0.11
Construction	1.93	-1.31	-0.13	-0.05	0.93	-0.58	1.14	-0.67	0.12	-0.16
Wholesale, retail trade	4.69	3.10	0.42	0.17	1.12	0.04	3.15	2.89	0.71	0.48
Transportation, storage	2.08	2.46	0.11	0.16	2.22	0.58	-0.25	1.72	0.19	0.21
Accomodation, food	0.29	-1.41	0.23	-0.05	0.27	-0.68	-0.21	-0.68	-0.02	-0.15
Publishing, audiovisual	2.42	3.75	0.85	0.24	2.09	0.84	-0.52	2.66	0.05	0.08
Telecommunications	10.76	7.20	0.28	0.13	2.88	0.36	7.60	6.71	0.23	0.12
IT, other information	4.16	4.00	1.76	0.27	1.56	1.65	0.84	2.08	0.17	0.21
Finance and insurance	3.80	4.61	0.77	0.35	1.52	1.55	1.52	2.71	0.24	0.28
Professional services	2.52	1.80	1.20	-0.43	1.69	-0.14	-0.37	2.38	0.32	0.28
Arts and other services	1.41	0.67	1.47	-0.01	0.88	0.04	-0.94	0.64		
Arts, entert., recreation	0.02	-0.43	0.45	0.05	1.26	-0.34	-1.68	-0.15	-0.02	-0.04
Other services	2.38	1.65	2.41	0.13	0.29	0.22	-0.32	1.30	0.07	0.04

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Table 16: UK

	Labor productivity growth		Contributions of components: Labor		Capital		MFP		Contribution to aggregate labor productivity growth	
	2000-2007	2010-2015	2000-2007	2010-2015	2000-2007	2010-2015	2000-2007	2010-2015	2000-2007	2010-2015
Food, beverages, tob.	2.71	1.25	0.61	0.49	1.19	0.04	0.91	0.72	0.07	0.03
Textiles	7.57	-2.25	1.00	0.55	1.00	-0.90	5.56	-1.90	0.09	-0.01
Wood and paper	2.84	-1.03	0.32	0.56	0.22	-0.45	2.31	-1.13	0.05	-0.01
Chemicals	6.73	-0.52	0.41	0.33	3.06	0.24	3.27	-1.10	0.11	-0.05
Rubber and plastics	4.23	-0.28	0.71	0.56	0.63	-0.29	2.88	-0.56	0.08	0.00
Metals	4.46	2.13	0.61	0.58	0.58	-0.50	3.28	2.05	0.11	0.04
Electrical and optical	4.14	0.51	0.95	0.56	0.07	-0.32	3.12	0.26	0.07	0.00
Machinery, equip. n.e.c.	5.38	0.68	0.84	0.63	0.58	0.05	3.97	-0.01	0.07	0.00
Transport equip	4.51	7.20	0.80	0.56	1.26	-0.16	2.45	6.81	0.08	0.13
Other manufacturing	3.62	2.09	0.35	0.50	1.00	-0.19	2.28	1.78	0.07	0.03
Electricity, gas, water	0.60	-2.46	-0.55	-0.50	2.61	1.17	-1.45	-3.13	0.05	-0.03
Construction	0.36	2.61	-0.12	0.30	-0.19	0.09	0.68	2.22	0.01	0.23
Wholesale, retail trade	2.71	2.15	0.28	0.46	1.25	0.65	1.18	1.05	0.48	0.32
Transportation, storage	2.69	1.31	1.10	0.39	0.71	-0.05	0.89	0.97	0.18	0.09
Accomodation, food	1.09	-0.51	0.01	0.32	0.34	-0.03	0.74	-0.80	-0.01	-0.11
Publishing, audiovisual	2.50	2.25	0.81	0.51	-0.02	-0.52	1.71	2.26	0.07	0.07
Telecommunications	10.53	-1.00	0.31	0.38	1.55	-1.16	8.67	-0.21	0.31	-0.01
IT, other information	3.51	2.07	0.37	0.57	0.85	-0.28	2.29	1.77	0.15	0.12
Finance and insurance	5.07	-1.52	0.77	0.74	1.28	1.02	3.02	-3.28	0.51	-0.24
Professional services	2.98	2.48	0.90	0.30	0.27	-0.45	1.81	2.63	0.42	0.31
Arts and other services	-0.44	-0.28	-0.15	0.22	1.06	0.09	-1.34	-0.58		
Arts, entert., recreation	-0.21	-1.68	0.15	0.42	1.23	0.26	-1.60	-2.35	-0.02	-0.06
Other services	-0.53	0.80	-0.32	0.28	0.90	-0.06	-1.11	0.58	-0.02	0.03

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Table 17: USA

	Labor productivity growth		Contributions of components: Labor		Capital		MFP		Contribution to aggregate labor productivity growth	
	2000-2007	2010-2015	2000-2007	2010-2015	2000-2007	2010-2015	2000-2007	2010-2015	2000-2007	2010-2015
Food, beverages, tob.	2.41	-3.00	0.14	0.16	1.30	0.52	0.98	-3.68	0.05	-0.07
Textiles	3.03	1.54	0.95	1.02	1.12	-0.29	0.96	0.81	0.06	0.01
Wood and paper	3.27	-0.05	0.26	0.29	0.96	-0.05	2.05	-0.29	0.07	0.00
Chemicals	4.84	-1.13	0.27	0.05	4.26	1.94	0.31	-3.12	0.10	-0.02
Rubber and plastics	1.45	-0.55	0.31	0.04	1.32	-0.41	-0.18	-0.19	0.02	-0.01
Metals	2.01	1.05	0.42	0.28	0.47	-0.75	1.12	1.52	0.05	0.01
Electrical and optical	16.77	4.30	0.67	-0.15	2.13	0.80	13.97	3.64	0.51	0.13
Machinery, equip. n.e.c.	4.28	0.49	0.50	0.30	0.91	-0.23	2.87	0.43	0.06	0.01
Transport equip	6.31	4.52	0.40	-0.49	1.57	-0.89	4.34	5.90	0.15	0.12
Other manufacturing	3.68	-0.61	0.43	-0.17	1.53	0.23	1.72	-0.67	0.05	-0.01
Electricity, gas, water	-1.05	-0.10	-0.03	-0.01	1.61	0.69	-2.64	-0.78	-0.03	0.02
Construction	-2.21	-0.42	0.00	0.15	0.48	-0.32	-2.69	-0.25	-0.22	-0.07
Wholesale, retail trade	2.85	1.65	0.16	0.12	1.47	0.12	1.21	1.41	0.55	0.31
Transportation, storage	1.52	-1.14	0.11	-0.03	0.31	0.02	1.10	-1.13	0.08	-0.07
Accomodation, food	1.05	0.17	0.06	-0.01	0.43	-0.61	0.57	0.79	0.00	-0.16
Publishing, audiovisual	6.71	3.72	0.36	0.44	3.64	2.01	2.71	1.27	0.39	0.21
Telecommunications										
IT, other information	6.47	3.20	0.45	0.27	0.37	0.96	5.64	1.97	0.16	0.11
Finance and insurance	2.97	0.09	0.40	0.55	1.72	0.39	0.85	-0.86	0.38	0.05
Professional services	1.26	1.19	0.48	0.14	0.91	0.00	-0.14	1.05	0.15	0.14
Arts and other services	-0.66	0.65	-0.15	0.18	0.75	0.06	-1.26	0.41		
Arts, entert., recreation	0.75	1.47	0.22	0.26	0.68	-0.14	-0.16	1.36	0.01	0.02
Other services	-1.28	0.12	-0.36	0.03	0.76	0.09	-1.68	0.00	-0.06	-0.01

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