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Growth in Chains: EU Value Chain Productivity and its Slowdown

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Abstract

We examine value chain productivity within the EU15 from 1995 to 2017; a period marked by growth and its subsequent slowdown following the 2008 Financial Crisis. Using data on global value chains from the new OECD Inter-Country Input-Output Tables and KLEMS data, we construct a measure of total factor productivity (TFP) of value chains, indexed by their final producer industry.

Our findings indicate that the post-crisis slowdown in productivity growth within the EU15 is attributable to both weakened TFP growth in final producer industries and slightly negative TFP growth in the rest of the value chain. Using dynamic panel estimation, we demonstrate that the spillover effects of business-related intangibles on VC TFP growth were a significant contributor to growth before the crisis, whereas the returns to tangible investments have been weak. In addition, we perform an event study analysis of globalization shocks by examining the impact of bilateral investment agreements with China. Following the implementation of the agreement, we observe a positive impact on TFP. This improvement is accompanied by an increase in business-related intangibles within the final industry of the value chain, along with modest growth in tangibles. These findings suggest a positive productivity impact of globalization, and underscore the significant role of business-related intangibles over tangibles.

Tiivistelmä

Kasvua ketjuissa: EU:n arvoketjujen tuottavuus 1995–2017

Tutkimme arvoketjujen tuottavuutta EU15-alueella vuosina 1995–2017. Kokoamme arvoketjujen kokonaistuottavuuden (TFP) mittarin käyttäen globaaleja panos–tuotos- ja tuottavuusaineistoja.

Tuloksemme osoittavat, että tuottavuuden kasvun hidastuminen EU15-alueella finanssikriisin jälkeen johtuu paitsi arvoketjun lopputuottajien heikentyneestä TFP-kasvusta myös vaatimattomasta TFP-kasvusta muualla arvoketjussa. Käyttämällä dynaamista paneeliestimointia osoitamme, että liiketoimintaan liittyvien aineettomien hyödykkeiden synnyttämät läikkymisvaikutukset olivat merkittävä kasvun edistäjä erityisesti ennen finanssikriisiä, kun taas aineellisten investointien tuotot ovat olleet heikkoja. EU-maiden Kiinan kanssa solmimien kahdenvälisten investointisopimusten vaikutuksia tarkastelevan tapahtumatutkimuksen avulla arvioimme myös suoraan globalisaation vaikutuksia arvoketjujen tuottavuuteen. Sopimuksen täytäntöönpanon jälkeen havaitsemme myönteisen TFP-vaikutuksen. Tämä parannus liittyy liiketoimintaan liittyvien aineettomien hyödykkeiden lisääntymiseen arvoketjun lopputuotteen valmistavalla toimialalla sekä maltilliseen kasvuun aineellisten hyödykkeiden osalta arvoketjussa. Nämä havainnot viittaavat globalisaation myönteiseen tuottavuusvaikutukseen ja korostavat aineettomien hyödykkeiden merkittävää roolia eurooppalaisten arvoketjujen globalisoitumisessa.

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Keywords: Global value chains, Intangibles, Productivity, Globalization

Asiasanat: Kansainväliset arvoketjut, Aineettomat investoinnit, Tuottavuus, Globalisaatio

JEL: F60, O47, L16, O14, E22

1 Introduction

Despite living in an era marked by rapid technological advancements and a surge in new digital tools, European productivity growth has been sluggish since the 2008 Global Financial Crisis. Several factors might explain this decline, but a significant reason is likely the slowdown of globalization. Before the crisis, globalization enabled strong international resource reallocation. However, after the crisis, this process appears to have decelerated and been further challenged by the threats of geopolitics. Concurrently, many developing countries experienced a slowdown in the accumulation of investments and their spillover effects on productivity, thereby reducing their contribution to growth compared to the previous decade (van Ark et al., 2024). Linking these patterns together is complex, as they are associated with China's rise as a significant global economic power, more intricate global value chains, and the greater importance of intangible capital such as data, skills, management, and organizational improvements (Baldwin, 2006; Johnson and Noguera, 2012; Goldin et al., 2024).

In this paper, our aim is to provide more information on these complex patterns underlying globalization by examining value chain productivity within the EU15 from 1995 to 2017, a period marked by economic growth and its subsequent slowdown following the 2008 Financial Crisis. We make three key contributions. First, we construct a panel of total factor productivity (TFP) of value chains. Globalization has increased the complexity and internationality of value chains, making the traditional productivity analysis of individual industries less informative (Timmer, 2017)[1]. The value chain productivity measure collects primary production factors from the entire chain, and allows us to examine both TFP that emerges from the final producer industry and the rest of the value chain. Second, we combine recently collected datasets on intangibles with our VC TFP measurements, and study the relationship between productivity and intangibles, motivated by the rise of intangible investment as a crucial enabler of the shift to new technologies and the

[1]See also Timmer and Ye (2020). Both of these articles point out that internationally fragmented production has led to possibly severe mismeasurement of imported intermediate product prices, potentially distorting the traditional TFP measures. The construction of VC TFP does not require the use of intermediate input deflators.

restructuring of value chains.[2] Third, we examine how the value chain TFP has responded to improved accesibility of the global values chains by examining the case of bilateral investment treaties between China and the EU15 countries.

We begin by measuring the value chain TFP, which combines global value chains and industry-level data on inputs (labor and capital stock), using new OECD Inter-Country Input-Output Tables and KLEMS data and by following Timmer (2017) and Kuusi et al. (2022). The VC TFP measure accounts for all input factors used in the industry's global value chain.[3] Contrary to earlier studies which have calculated VC TFP figures for some specific industry, we construct VC TFP measures for 45 final producer industries of EU15 countries for the years 1995-2017. In total, we have a panel of 675 VC TFP series. We then examine VC TFP dynamics in EU15 countries during the different phases of globalization. We decompose productivity into TFP and different input contributions from both the final industry and the rest of the value chain. We find that the growth of VC TFP has slowed down since the financial crisis. The decline in productivity growth originates from both the final producer industry and the rest of the value chain.

Ultimately, our goal is to understand the factors influencing productivity dynamics. Using a dynamic panel-data estimation, we study the productivity dynamics of growth investments in the EU15 from 1995 to 2017. Our analysis indicates that business-related intangibles are significantly and positively correlated with the growth of VC TFP, suggesting spillover effects of intangible assets on the growth of VC TFP.[4] In contrast, we do not find a similar relationship with technology-related intangibles, such as Research and Development (R&D). Furthermore, we find that the relationship between business-related intangibles and VC TFP is not as strong when the sample is restricted to the period 2008-2017.

[2] See the EUKLEMS-INTANProd database https://euklems-intanprod-llee.luiss.it/ and Bontadini et al. (2023).

[3] We study economic activities associated with an industry (defined by ISIC Rev. 4 classification) that extends through the entire industry value chain, encompassing all production activities contributing to the final industry's output. While traditional analyses based on industry value added require strong separability assumptions (with data often not supporting the necessary conditions for sectoral value-added functions), we treat intermediate inputs from other industries like factor inputs in productivity analysis.

[4] A positive relation between traditional TFP and business-related intangibles has been documented before, see, for example, Corrado et al. (2017).

Finally, we conduct an event study on the effects of China-EU15 bilateral investment treaties from the early 2000s to offer a different point of view. We explore how integrating significantly more into global value chains affected productivity and growth investments in the phase of intensifying globalization. The analysis suggests that globalization has had a significant impact on productivity. VC TFP increases after a bilateral investment treaty comes into force. This increase is more prominent compared to the potential increases in traditional TFP measurements. Furthermore, this increase results from both the final producer industries and the rest of the value chain. Our findings indicate that these agreements have led to an increase in VC TFP, particularly in the market services and manufacturing industries. We also observe that business-related intangibles in the final producer industry increase following the event. Coupled with the results of the spillover analysis, this suggests that the VC TFP growth achieved by bilateral investment treaties with China is likely to be at least in part attributable to increases in business-related intangibles in the final producer industry.

The remainder of the paper is structured as follows. Section 2 provides a review of related literature, and Section 3 describes the construction of our data set. In Section 4, we present the methodology, both considering the formation of the value chain productivity and that used in the applications. The analysis is given in Section 5 and Section 6 concludes.

2 Related literature

This paper relates to a large literature on global value chains. In terms of measurement of productivity, our efforts are primarily driven by the challenges in accurately measuring the prices of intermediate inputs, which stem from transfer pricing practices in multinational enterprises, the complexities in valuing intangible flows, and the inadequate statistical systems for tracking intermediate prices amid quality improvements (Houseman and Mandel, 2015; Timmer, 2017; Goldin et al., 2024). We use a decomposition of the global value-added contents of the outputs and contributions of industries and of the other sectors in the upstream value chain (Leontief, 1936;

Wolff, 1994; Timmer, 2017; Timmer and Ye, 2020, Kuusi et al., 2022). The value chain approach makes visible both the substantial role of upstream industries to which industries have backward linkages as well as technology and knowledge investments as a source of productivity growth in the entire value chain (for a review, see Carvalho et al. (2021)).

Several articles have studied the motives for offshoring arising from the interaction of several complex factors (Baldwin and Robert-Nicoud, 2014). The motivation for trading tasks and offshoring typically lies in differences in the sophistication of technology and wage levels between countries. Existing empirical studies often suggest that foreign sourcing is a complement to, rather than a substitute for, domestic activity (Martinez-Galan and Fontoura, 2019; Adarov and Stehrer, 2019). Moreover, in developed countries, there tends to be a shift towards more non-routine and more interactive tasks, and the use of highly educated workers (Becker et al., 2013; Reijnders and de Vries, 2018), which benefits industries that are intangible intensive (Jona-Lasinio and Meliciani, 2019).

Our work contributes to the previous literature by showing more evidence that growing international trade and better organization of international production into global value chains led to productivity gains in the 2000s (Constantinescu et al., 2019; Goldin et al., 2024). Our work relates to evidence showing that intangible capital has contributed positively to productivity growth (Corrado et al., 2022; Corrado et al., 2017; and van Ark et al., 2024). By studying VC TFP, our work complements the research efforts of van Ark et al. (2024) that uses the EUKLEMS-INTANProd industry-level database to study the contribution of intangible capital deepening to labor productivity growth and TFP spillovers from intangible capital.

Our event study analysis relates with studies of the broader impacts of China (and other countries) on local market dynamics through international trade, see for example, Autor et al. (2013) and Autor et al. (2016). These studies have acknowledged, the identification of value chain dynamics requires a source of plausibly exogenous variation for regional exposure to value chains. In recent years, the focus in the literature has been in the role of shocks in value chains (see, e.g., Baqaee and Farhi, 2019: Acemoglu and Tahbaz-Salehi, 2020; Elliott et al., 2022), emphasizing complexity featured with customized supplier relationships and non-competitive markets. Also, there is an expansion of literature that studies empirically the propagation of shocks (Bonadio et al., 2021; Sforza and Steininger, 2020; Boehm et al., 2019; Carvalho et al., 2021; Meier and Pinto, 2020). Considering earlier studies related to the bilateral investment treaties (BIT) with China in particular, see, for example, Zeng and Lu (2016).

3 Data

To form our VC TFP panel, that covers the years 1995-2017 and includes 675 VC TFP series for the EU15 industries, we combine data from OECD, World KLEMS, The Conference Board and Penn world tables 10.1. Two key dataset are: OECD Inter-Country Input-Output Tables (ICIO) and World KLEMS data (KLEMs). ICIO input-output tables cover 76 individual countries (38 OECD countries and 38 non-OECD economies) and an aggregate for the rest of the world (ROW). For each country it provides input-output data for 45 industries. KLEMS provides input factor data (labor and capital inputs and shares) for 30 countries and basically the same industries.[5] Additionally, we gather input factor data for 7 other countries from OECD STAN database, which has the same industry classification as ICIO. For those countries for which we do not have industry level factor inputs data we use country-level data from Penn world tables 10.1 (PWT10.1).[6] Finally, we calculate aggregate input factor and weighted average input share series for ROW using PWT10.1 that provides input factor data in levels.

For some countries we impute missing input factor and input share values for the years 1995-2008.[7] Furthermore, following Kuusi et al. (2022), if we lack data for certain industries in a certain

[5]We use the ICIO industry classification in our dataset and adjust the industry division in the KLEMS data accordingly. Note that for China the industry classification is somewhat different from EU KLEMS data. In this case the most closest industry (or the nearest higher level aggregate) is used as a proxy for the ICIO industry.

[6]PWT10.1 lacks labor and capital share data for BGD, KHM, MMR, PAK and VNM. For these countries this data is from The Conference Board (TCB). Additionally, both PWT10.1 and TCB lack data for BRN, for this country we use the input factors and shares calculated for ROW.

[7]For BEL (years 1995-1998) and BGR, HRV, CYP, EST, GRC, HUN, IRL, LVA, LTU, LUX, MLT, POL, PRT, ROU, SVN (years 1995-2007) the KLEMS labour services volume indices are continued using the growth rates of persons employed. For USA the missing values for year 1995 of KLEMS capital service volume index are set to be the same as in 1996. For CAN capital and labor shares are set to be the same as in year 2007 (years 1995-2006) and for

country we use the "next" aggregate level data as a proxy of this industry.[8] This is reasonable because we deal with growth rates and input shares. Undeniably, this adds some inaccuracy to our measures, but the next-level data can be considered a good proxy because the growth rates of a certain industry are likely highly correlated with the next aggregate-level data.

Out of 76 countries we have meaningful input data at industry-level for 37 countries.[9] For those countries which for no industry-level data is available we use country-level input data. The 37 countries for which we have input data at industry-level include the most developed and largest economies of the world (also new KLEMS data for China industries). Therefore, arguably, for the EU15 countries we study, the input factor and share data is available at industry level for most parts of their global value chains. Therefore, regardless of the data shortages, for the EU15 the measure of global value chain TFP can be considered an (good) approximation of the "true" global value chain TFP.

Other variables, such as traditional TFP and output are from KLEMS. The intangible variables are also from KLEMS and the division of total intangibles to technology related and business innovation related intangibles is calculated following van Ark et al. (2024) and Corrado et al. (2022).[10] Data on Bilateral Investment Treaties (BIT) are from UNCTAD.

the years 1995-1996 in some industries the missing data for total employment are replaced by the value in year 1998. For CHL the missing values for year 1995 of OECD Stan net capital stock are set to be the same as in 1996 and capital and labor shares are set to be the same as in year 2007 (years 1995-2006). Note also that in some rare cases, for some specific industry and year, there are negative value added values in the data. In these cases, we replace the negative value with a near-zero positive value to enable the use of logarithms.

[8]For example, if data for petroleum and coal products (19) is missing for certain country, we use data for chemical, rubber, plastics, fuel products and other non-metallic mineral products (19-23) and if this data is also missing we then use data for whole manufacturing (c). Ultimately, we use data for total value added if no other closely related aggregate data is available.

[9]Note that while for most countries the data covers the different industries rather comprehensively there are some exception. For example, for CHL we only have industrial data on a high level of aggregation.

[10]Technology related intangibles are formed by summing the real values of computer software and databases, R&D, entertainment, artistic and literary originals and mineral exploration from KLEMS intangibles data. Accordingly, business innovation related intangibles include new product development costs in the financial industry, industrial design, brand, organizational capital and training.

4 Methodology

4.1 Value chain productivity

We aim to calculate industry-level TFP that accounts for all input factors used in the industry's value chain (VC TFP). The calculation of VC TFP relies on two key methodological achievements in the literature. Firstly, we calculate value added contributions of the global value chain using the hypothetical extraction method by Los et al. (2016). Accordingly, the difference between the actual global value added distribution and a hypothetical distribution, where the production of a certain industry is set to zero, gives the total value added in the value chain of this industry. Secondly, following Timmer (2017) and Kuusi et al. (2022), using these industry's value added contribution to the global value chain and country-industry specific input factors we calculate input factor requirements of a certain industry. Finally, the input factor requirements and country-industry specific input shares allow us to derive VC TFP for a certain industry from a traditional production function.

We next describe the derivation of VC TFP in more detail, for more see Los et al. (2016), Timmer (2017) and Kuusi et al. (2022). The hypothetical extraction method is as follows.

$$VA = v(I - A)^{-1}Y * i \tag{1}$$

where VA is a value chain matrix that contains industry- and country specific value added contributions, v is a row vector of the ratios of value added to gross output, i is a column vector of ones implying that it sums all elements of the final demand matrix Y. $(I - A)^{-1}$ is the Leontief inverse where I is a identity matrix and A is a matrix that contains the use of intermediate products.

The hypothetical world where certain country-industry's production is excluded can be derived by extracting this industry' production of final goods and intermediate products to other industries in own and other countries and calculate VA again. The hypothetical world is denoted VA*. Then,

$$\Delta VA = VA - VA* \tag{2}$$

ΔVA contains the value added contributions of different industries of different countries to the specific industry in question. Further on we denote these value added contributions VAVC and each contributions share as VAs. Value chain TFP of country-industry J can be obtained as follows (for brevity time index t is dropped):

$$\Delta log(Q_J) = \sum_{j=1}^{3465} \overline{VAs}_{Jj}(\overline{\alpha}_L^j * \Delta log(\tilde{L}_j) + \overline{\alpha}_K^j * \Delta log(\tilde{K}_j)) + \Delta log(TFP_J) \tag{3}$$

where

$$\tilde{L}_j = \frac{L_j VAVC_{Jj}}{VA_j}, \tilde{K}_j = \frac{K_j VAVC_{Jj}}{VA_j} \tag{4}$$

In equation (3) Q is output in real terms, $\tilde{L}$ is labor and $\tilde{K}$ is capital requirements and TFP is total factor productivity. $\overline{VAs_{Jj}}$ is the Törnqvist share of value added contribution's yearly share of country-industry j from the country-industry's J value chain. In equations (4) L_j is labor input and K_j is capital input in real terms of country-industry j. VA_j is total value added of country-industry j and $VAVC_{Jj}$ is the value added contribution of country-industry j from the country-industry's J value chain. $\overline{\alpha}_{L,K}$ are the Törnqvist shares of the yearly labor and capital shares of country-industry j. We can solve TFP from equation (3) because we have data on everything else.

4.2 Factors behind the productivity dynamics

4.2.1 A dynamic panel-data estimation

Following recent work on intangibles and productivity growth, see van Ark et al. (2024), Corrado et al. (2022) and Corrado et al. (2017), we examine the relationship between intangibles and VC TFP growth by utilizing dynamic panel data methods. We use a standard generalized method of moments (GMM) based difference and system dynamic panel estimator (Blundell and Bond, 1998). This method has been widely used to assess various growth factors from panel data.[11] The model

[11] The estimator is necessary because in the growth model, the explained variable from the previous year is potentially correlated with other regional and sectoral differences, often unobserved, and thus traditional least squares may provide a biased impact estimator. Instead, the dynamic panel estimator employs lagged values of variables and their changes as instruments in a way that mitigates this bias.

integrates two methods: 1. the traditional difference-form dynamic panel estimation, where level-form model variables are instrumented by their lagged changes (Arellano and Bond, 1991), and 2. the method where difference-form model variables are estimated using their lagged levels. The use of instrumental variables reduces the problems that arise from potential measurement errors in the constructed VC TFP because the use of instruments provides more reliably an unbiased impact estimate, as long as the measurement error is not systematic.

The model we estimate is based on assumptions very similar to those in Blundell and Bond (1998). It includes as explanatory variables the lagged value of the dependent variable from the previous year (first lag) and, for other explanatory variables, the current value and the first lag. For the dependent variable and explanatory variables, all preceding lags (2-4) are used as instruments in levels and the first lag difference as an instrument in the level equation. This method is typical for addressing potential dynamic panel bias and endogeneity in variables. Following the example of Holtz-Eakin et al. (1988), missing observations due to lagging are replaced with zeros, and the lagged values for each time period are introduced into the model as separate instruments. In line with Roodman (2009), time trends and other exogenous explanatory variables also function in the model as conventional instruments in level form.

The functionality of the utilized method is evaluated through various statistical tests. Firstly, the method is based on the assumption that the instruments are uncorrelated with the model's error term. This assumption can be assessed by testing the overidentifying restrictions of the instruments (Hansen's J statistic). Based on model testing, there is no evidence of this issue: the exogeneity assumption cannot be rejected based on the test statistic.

4.2.2 Investment treaties as policy shocks: An event-study design

To further demonstrate how value chain-based TFP could provide us with a deeper understanding of how productivity has developed, we study how the removal of global investments barriers have affected value chains. To study how the emergence of China as a pivotal, new player in the value chains has affected the value chains of EU15 industries we focus on China's treaties with EU countries. We use data on bilateral investment treaties (BITs) signed between China and the EU countries in the period 2000–2014 to form an event study setup where the years when the treaties enter into force serve as treatment periods.[12]

These treaties provide us with direct evidence of the effects of changes in the access to China's value chains as they included both national treatment provisions and more comprehensive two-way provisions, allowing investor-to-state dispute settlement (see, e.g., CopenhagenEconomics (2012)). Moreover, BITs are agreements between two countries regarding the promotion and protection of investments made by investors from the respective countries in each other's territory. Typically, the aim of BITs is both to protect investments abroad in countries where investor rights are not already protected through existing agreements and to encourage the adoption of market-oriented domestic policies that treat private investment in an open, transparent, and non-discriminatory way.

Our "treatment" is assigned at country-level and we examine how it affects the value chains of different industries in the EU15 countries. There are reasons to suspect treatment effect heterogeneity, for example, because the countries receiving treatment might differ in how their value chains were tied to China before the treaty. Furthermore, the effect of later events might differ from the earlier ones because China had become more developed. Therefore, we utilize the event study methodology provided by Callaway and Sant'Anna (2021), which is robust with treatment effect heterogeneity.

As a baseline, we form our control group from countries where only a first generation BITs agreement with China is in force.[13] All treated countries had a first generation BIT which they then replaced with a second generation BIT.[14] The treated countries (event time) are Netherlands (2004), Sweden (2004), Germany (2005), Finland (2006), Portugal (2008), Spain (2008), Belgium (2009),

[12]Another possibility would be to consider the years when the treaties are signed as the event years but according to our analysis on pre-trends our choice is more suitable. Furthermore, Zeng and Lu (2016), who study BITs and foreign direct investment (FDI), also find that when treaties enter into force, they seem to exert a strong effect on investment flows while signing as such does not necessarily boost FDI.

[13]We also include Ireland to the control group which is the only country in the EU with no BITs agreement with China.

[14]In all cases a new agreement replaced the old one except for Sweden where the old agreement was updated with an amendment.

Luxembourg (2009) and France (2010). The baseline control group includes Austria, Denmark, Greece, Ireland, Italy and United Kingdom.

As CopenhagenEconomics (2012) argue, there are strong reasons why the first generation BITs were likely less effective than the second generation BITs. The first generation of treaties (signed before 1998) did not include national treatment provisions and only allowed investors recourse to international arbitration to adjudicate disputes concerning the amount of compensation for expropriation, whereas the second-generation treaties included both national treatment provisions and more comprehensive provisions, allowing investor-to-state dispute settlements concerning all substantive protections.

We focus on an event windows that starts 7 years before the event and end 7 years after the event. This is to ensure that all treated countries provide observations to all coefficient estimates. Note that the last event occurred in 2010. Another reason is that the wider the event window the more likely other "large" country-level policy changes and or shock distorts the analysis. The pre-trend coefficients for the first event in 2004 already reaches the year 1997. Overall, we have observations from 15 countries in our sample, 9 are treated and 6 are controls. This means that we are dealing with rather few clusters at the policy-level. Furthermore, Callaway and Sant'Anna (2021) state that the bootstrap method they develop to produce simultaneous confidence intervals does not necessarily produce liable interference when there are only few clusters. Therefore, we follow Callaway and Sant'Anna (2021) and report clustered errors at unit-level (country-industry).[15]

There is a concern that because our policy takes place at country-level many other possible shocks could have happened simultaneuosly. However, our events are quite evenly distributed within the years 2004-2010. Also, since we are dealing with EU15 countries many possible other "large" country-level shocks are common among the control and treated group. Moreover, all treated countries were already in the euro currency union in 1999 and also China joined the world trade organization (WTO) in 2001. However, clearly some caution should be taken when interpreting these results as causal.

[15] Recently, a lot of attention has been put on at which level one should cluster for correct inference, see, for example, Abadie et al. (2023) and MacKinnon et al. (2023).

In the appendix, we discuss briefly the robustness of our baseline results when altering the control group, the event window, and the cluster level. Furthermore, we also run our main results with classic "two-way fixed effects" and the approach by Borusyak et al. (2024) that also provides treatment effect heterogeneity robust estimates and might be more efficient but is based on somewhat stricter assumptions. For more on the differences of these estimators, see de Chaisemartin and D'Haultfœuille (2022).

5 Analysis

5.1 The rise and fall of the European VC productivity growth

We measure output growth and decompose it into TFP and input growth within value chains, reported in Table 1.[16] Between 1995 and 2017, market services exhibited the highest annual output growth at 2.7%, while manufacturing recorded the lowest at 0.9%, with an overall average growth of 1.6%. Post-2008, output growth stagnated, averaging just 0.3% annually between 2008 and 2017 (Table 4).

In Table 1, we show a detailed breakdown of growth into input and TFP contributions. It reveals significant variation in growth structure. In non-manufacturing sectors, average output growth has predominantly been driven by input increases, whereas value chain TFP growth has been minimal in market services and even negative in other services, utilities, and construction. Conversely, manufacturing has experienced substantial growth through increases in VC TFP. Post-2008, both components have exhibited declines. Manufacturing has seen a general decline in value chain input growth, although TFP growth has remained positive. In other sectors, there is a consistent decline in VC TFP across industries.

Examining growth rates by country for market services and manufacturing separately (Table 5), in market services, VC TFP grows most robustly in Finland, Germany, Denmark, and Austria.

[16] We examine the value-added composition in our value chains data as well as revisit previous examples of value chain productivity dynamics in the Appendix.

Finland's growth is primarily attributed to ICT services, while Germany's is linked to automotive production. The lowest growth has been in Greece, Italy, and Belgium. Repeating the analysis for 2008-2017, Denmark, Sweden, and Germany show the largest growth, with Belgium, the Netherlands, and Italy exhibiting the persistently lowest growth.

When examining VC TFP in the manufacturing sector, we see that Spain, the United Kingdom, Finland, and Germany have shown significant growth. Particularly, Spain experienced robust productivity growth post-2008, accompanied by a substantial reduction in inputs. In subsequent years, Finland, Denmark, Germany, and Austria also managed to improve VC TFP with reduced inputs, though their reductions were less pronounced than Spain's. Notably, Denmark and Germany achieved VC productivity growth in both manufacturing and market services.

Conversely, Greece, Luxembourg, and Belgium have experienced sluggish VC TFP growth. This poor performance is evident in both manufacturing and market services within these countries.

Table 1: Output growth and its decomposition into TFP and input growth contribution within value chains for different sectors (rows)

	1995-2007			2008-2017		
	Output growth	Input contr.	VC TFP	Output growth	Input contr.	VC TFP
Manufacturing	2.5	1.3	1.2	-0.7	-0.8	0.1
Market serv	4.6	3.8	0.8	1.1	1.6	-0.5
Other serv	1.8	2.2	-0.4	0.9	1.5	-0.6
Utilities + cons	2.8	2.5	0.3	0.0	0.8	-0.8
Average	3.2	2.4	0.8	0.1	0.4	-0.2

5.1.1 TFP decomposition: The final industry and the rest of the VC

The TFP contribution from the entire value chain cannot be directly attributed to a specific segment within it. However, we utilized value-added growth-based TFP growth estimates sourced from the EU KLEMS dataset to overcome the problem. Following the methodology of Timmer (2017), we used these estimates to differentiate the TFP growth contributions of the final producer industry from the rest of the upstream value chain.[17]

[17] VC-based TFP can be considered a weighted average of TFP from the final stage of production and its upstream stages, with the value-added shares of the industries in the value chain serving as weights. Although this method has

Table 2: Output growth and its decomposition for market services by country (rows).

	1995-2007			2008-2017		
	Output growth	Input contr.	VC TFP	Output growth	Input contr.	VC TFP
AUT	5.3 %	3.9	1.5	0.6 %	1.0	-0.4
BEL	2.6 %	2.9	-0.3	1.6 %	2.6	-0.9
DEU	4.3 %	3.3	1.1	2.1 %	1.6	0.5
DNK	5.3 %	4.7	0.6	1.3 %	0.7	0.6
ESP	5.2 %	5.5	-0.3	1.0 %	1.2	-0.1
FIN	4.8 %	2.8	2.0	1.0 %	1.1	0.0
FRA	4.4 %	3.7	0.7	1.7 %	2.2	-0.5
GBR	4.0 %	2.3	1.7	1.5 %	1.9	-0.4
GRC				-1.9 %	1.4	-3.3
ITA	3.4 %	3.8	-0.4	-0.3 %	0.3	-0.6
LUX				3.7 %	3.8	-0.1
NLD	5.1 %	4.0	1.1	1.9 %	2.7	-0.8
SWE	4.5 %	4.0	0.5	2.1 %	1.7	0.4
Total	2.8 %	2.6	0.2	1.1 %	1.6	-0.5

Table 3: Output growth and its decomposition for manufacturing by country.

	1995-2007			2008-2017		
	Output growth	Input contr.	VC TFP	Output growth	Input contr.	VC TFP
AUT	4.0 %	2.3	1.8	1.2 %	1.1	0.1
BEL	1.2 %	0.5	0.7	-0.9 %	-0.1	-0.8
DEU	2.7 %	1.1	1.7	0.4 %	0.0	0.3
DNK	1.2 %	0.8	0.3	-0.8 %	-1.3	0.5
ESP	3.1 %	2.5	0.5	-0.3 %	-2.3	2.0
FIN	4.0 %	2.2	1.8	-0.8 %	-1.2	0.4
FRA	2.2 %	1.3	0.9	-0.8 %	-0.5	-0.2
GBR	1.4 %	-1.5	2.9	-0.8 %	-0.8	0.0
GRC				-4.0 %	-3.8	-0.2
ITA	2.5 %	2.5	0.0	-1.4 %	-1.3	-0.1
LUX				-1.9 %	-1.4	-0.5
NLD	2.4 %	1.1	1.3	0.8 %	0.9	-0.1
Average	2.5 %	1.3	1.2	-0.7 %	-0.8	0.1

When assessing upstream TFP growth, we find notable differences in Table 4 . In the construction and utilities sector, upstream contributed significantly more to overall productivity growth compared to the industry itself, roughly 0.3 percentage points annually versus 0.0 points from the industry in 1995-2007. After that,the difference has remained similar while both TFP components have been negative since 2008. This aligns with prior findings regarding the productivity decomposition in construction, as discussed by Kuusi et al. (2022).

its limitations and is applicable only to industries with KLEMS-derived TFP calculations, it nonetheless facilitates tracing the VC TFP back to the various segments of the chain.

Market services and manufacturing have not seen significant productivity gains through their value chains; most of the growth stems from the final producer industry. The other VC TFP contribution has been positive in 1995-2007 while it turned negative in the latter period 2008-2017. The productivity has been especially poor in market services.

There is interesting variation in productivity dynamics across countries in the period 2008-2017 (Table 5). In market services, industries in Spain, Denmark, Sweden and Germany have been able to increase at the same time their final producer productivity and the productivity of their value chains. On the other hand, Greece and the UK have experienced poor performance in their value chains. In manufacturing, industries both in Spain and Greece have been able to increase the value chain productivity outside their final industries, while in most cases the performance has been weak.

Table 4: TFP decomposition to final industry TFP and the rest of the value chain TFP by sector (rows)

	1995-2007		2008-2017	
	Final TFP	Other VC TFP	Final TFP	Other VC TFP
Manufacturing	1.0	0.2	0.3	-0.1
Market serv	0.8	0.1	0.0	-0.5
Other serv	-0.6	0.2	-0.4	-0.2
Utilities + cons	0.0	0.3	-0.6	-0.2
Average	0.7	0.2	0.0	-0.3

5.1.2 Details of the input growth

We also analyzed the contribution of input growth, breaking it down into components derived from labor and capital growth both domestically and internationally. Table 6 reveals a significant decline in the growth of labor and capital. In the manufacturing sector, there has been a reduction in both foreign and domestic labor inputs, indicating a decrease in the international engagement of these industries. Similarly, in market services, input growth has also declined; however, the contribution of domestic capital growth has remained stable at 0.9 percentage points per annum, on average. This pattern is also observed in other non-manufacturing industries regarding capital

Table 5: TFP decomposition to final industry TFP and the rest of the value chain TFP by country (rows) in 2008-2017.

	Market services 08-		Manufacturing 08-	
	Final TFP	Other VC TFP	Final TFP	Other VC TFP
AUT	0.1	-0.5	0.0	0.1
BEL	-0.2	-0.7	0.3	-1.1
DEU	0.4	0.1	0.3	0.0
DNK	0.5	0.1	0.8	-0.3
ESP	-0.3	0.2	0.3	1.7
FIN	0.2	-0.3	0.3	0.1
FRA	0.0	-0.5	0.3	-0.5
GBR	1.3	-1.8	0.8	-0.8
GRC	-1.6	-1.7	-0.6	0.3
ITA	-0.3	-0.3	0.0	0.0
LUX	0.1	-0.2	2.9	-3.4
NLD	0.0	-0.8	0.3	-0.4
SWE	0.2	0.1		

growth. Labor growth has primarily occurred in other services, such as public services, while other non-manufacturing sectors have not seen the substantial decline experienced in manufacturing.

Table 7 provides a further decomposition of input growth into domestic and foreign components, incorporating the respective contributions of capital and labor. The results are generally consistent across different countries. In manufacturing, the Netherlands and Austria have seen positive growth in foreign input, whereas most countries have experienced declining contributions from inputs. In market services, the domestic contribution has been uniformly positive, whereas the foreign component has exhibited more varied patterns. The Benelux countries (Belgium, Netherlands, and Luxembourg) have shown significant foreign growth contributions due to substantial increases in both foreign capital and labor. These countries play a crucial role in the European service sector, noted for their advanced financial services, logistics, and IT capabilities. Conversely, Spain, Greece, and Italy have witnessed a decline in the contribution of foreign inputs.

5.2 Explaining productivity dynamics: A dynamic panel-data estimation

Ultimately, our goal is to understand the factors influencing productivity dynamics during the evolution of globalization. Specifically, we focus on the dynamics of long-term growth investments

Table 6: Decomposition of input contributions to output growth by sector and period (rows), percentage points

		Labor		Capital	
	Total	Domestic	Foreign	Domestic	Foreign
Manufacturing					
95-07	1.3	-0.1	0.2	0.7	0.6
08-17	-0.8	-0.6	-0.3	0.1	0.1
Market services					
95-07	3.8	1.2	0.3	1.9	0.4
08-17	1.6	0.3	0.1	0.9	0.3
Other services					
95-07	2.2	1.2	0.1	0.7	0.2
08-17	1.5	0.8	0.0	0.5	0.1
Utilities + cons					
95-07	2.5	0.5	0.3	1.2	0.5
08-17	0.8	0.0	-0.2	0.9	0.1

Table 7: Domestic and foreign input contribution to output growth by country (row), percentage points

	Manufacturing		Market services	
	Domestic	Foreign	Domestic	Foreign
AUT	0.3	0.8	0.5	0.5
BEL	-0.2	0.1	1.6	0.9
DEU	0.0	0.0	1.1	0.5
DNK	-0.8	-0.5	0.6	0.1
ESP	-1.5	-0.8	1.4	-0.2
FIN	-0.5	-0.8	0.8	0.3
FRA	-0.4	-0.2	1.9	0.3
GBR	-0.4	-0.5	1.8	0.1
GRC	-2.5	-1.2	1.6	-0.2
ITA	-0.7	-0.6	0.5	-0.2
LUX	-0.1	-1.4	1.3	2.5
NLD	0.1	0.7	1.7	0.9
SWE			1.6	0.1

in the EU15, with an emphasis on intangible assets (such as data, skills, management, and organizational improvements) and the adoption of new digital technologies. The increase or absence of intangible investment has significantly impacted the success or failure in transitioning to new technologies. Building on recent research on intangibles and productivity growth by van Ark et al. (2024), Corrado et al. (2022), and Corrado et al. (2017), we examine the relationship between intangibles and VC TFP growth. Our approach dissects the role of business-related intangibles in various segments of the value chain.

To study the possible spillover effects, we performed a dynamic panel estimation with several model specifications reported in Table 8. In model (1), we use the full panel for manufacturing and market service industries. In models (2) and (3), we separately analyze the periods before 2008 and after that. In models (4) and (5), we use the full panel, but separately analyze the manufacturing and market service industries, respectively. In model (6), we analyze TFP without the contribution of the final industry, focusing only on the rest of the value chain. Model (7) decomposes the growth contribution of inputs into four subcategories (domestic and foreign labor and capital). Finally, model (8) is the same as model (1) but the dependent variable is the traditional TFP instead of VC TFP.

As an explanatory variable, we use (ln-)intangible capital stocks. For tangible inputs, we first construct an index series, 1995 = 1, based on the annual growth rates of aggregate factor inputs (or their labor and capital components) used in our calculation of the VC TFP. Then, we take natural logarithms to study relative changes in inputs.

Our empirical analysis confirms a strong relationship between business intangibles and value-chain TFP. According to our findings, a 10% increase in the business capital stock translates into roughly 0.7 percentage point increase in the VC TFP growth rate, as indicated by the result row (*Bus. intangibles*). If the stock is temporarily increased, the effect also remains temporary, as indicated by the negative value at t-1 (*Bus. intangibles*$_{t-1}$).[18] The effect can be observed in both manufacturing and market services, albeit it is moderately larger in market services. When we repeat the analysis with traditional TFP in model (8), we do not find a statistically significant impact.

We also find that the technology related intangibles have a much smaller and statistically insignificant relationship with the VC TFP. This finding holds consistently in our different spec-

[18] Given the standard time structure of our explanatory variables, when there is a permanent change ΔK in the capital stock initiating at period t, the initial $\Delta logK_t$ shock remains in effect, whereas further changes $\Delta logK_{t+s}$ are nullified by the lagged impacts $\Delta logK_{t+s-1}$, as indicated by the negative coefficient. In case of a one-time shock, the effect is nullified at t+1. Given that the term $Dependent_{t-1}$ is close to zero, there are no further dynamic effects arising from the dependent variable autocorrelation.

ifications. Considering recent findings in van Ark et al. (2024), that business related intangibles are highly complementary with other types of capital, it is likely that the relationship between intangibles and VC TFP is more complex than our estimation suggest. However, in this paper we do not consider the interactions between different types of capital. Nevertheless, it seems that business related intangibles are directly more strongly linked with VC TFP than technology related intangibles.

We find that tangible input growth has had a negative impact on productivity, when we explain TFP with the growth accounting contributions. Further details in model (7) suggest that this effect is clearly visible with capital and is large and persistent. An increase in capital contribution results in a corresponding fall in TFP growth. It appears that European value chains have large problems in their investment efficiency. Similar problems seem not to plague changes in labor contributions.

Our measurement allows us to analyze separately TFP growth in the rest of the value chain (upstream TFP) in a manner described more closely in the previous section. Interestingly, we find that upstream TFP is sensitive to intangible investments by the final producer industry suggesting that the final industries intangibles also raise the TFP of the rest of the upstream, for example, by complementary innovations or knowledge spillovers. Moreover, the point estimate is even larger than for the whole value chain, suggesting that some of the intangible investments may be directed towards the larger value chain beyond the industry boundaries. We also find that the increases in market-service value-added shares in the foreign part of the value chain are in a positive relationship with upstream TFP.

As detailed in the Appendix, there was a notable shift in value chain structures between 1995 and 2017. The value-added share of the private service sector rose by 4.2 percentage points, whereas the shares of the final industry, manufacturing, and the final sector declined proportionately, particularly within the foreign segment of the value chain (see Table 13 in the Appendix). Significant contributors to this rise include professional, scientific, technical, administrative, support, financial, insurance, and trade activities.

Table 8: Estimation of spillover effects from inputs to the growth of VC TFP, a dynamic panel estimation with different model specifications.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	95-17	95-07	08-17	Manu.	Serv.	95-17	Details	95-17
	$\Delta VCTFP$	$\Delta VCTFP$	$\Delta VCTFP$	$\Delta VCTFP$	$\Delta VCTFP$	Upst. $\Delta VCTFP$	$\Delta VCTFP$	$\Delta KLEMSTFP$
Dependent$_{t-1}$	-0.10	-0.05	-0.15	0.06	-0.14	-0.17	-0.10	-0.00
	(0.07)	(0.07)	(0.07)	(0.05)	(0.09)	(0.10)	(0.09)	(0.04)
Bus. Intangibles	0.07**	0.24***	0.05	0.06*	0.07**	0.09***	0.07**	0.09
	(0.02)	(0.06)	(0.02)	(0.03)	(0.02)	(0.02)	(0.02)	(0.06)
Bus. Intangibles$_{t-1}$	-0.08***	-0.25***	-0.06*	-0.07*	-0.08**	-0.09***	-0.08***	-0.10
	(0.02)	(0.06)	(0.02)	(0.03)	(0.02)	(0.02)	(0.02)	(0.06)
Tech. intangibles	0.01	0.01	0.01	-0.00	0.02	0.01	0.01	0.01
	(0.01)	(0.01)	(0.01)	(0.01)	(0.02)	(0.01)	(0.01)	(0.01)
Tech. intangibles$_{t-1}$	0.01	0.00	0.00	0.01	-0.01	-0.01	-0.00	0.00
	(0.01)	(0.01)	(0.01)	(0.01)	(0.02)	(0.01)	(0.01)	(0.01)
Tangibles	-0.38***	-0.51***	-0.35***	-0.27***	-0.45***	-0.40***		-0.14
	(0.05)	(0.08)	(0.05)	(0.06)	(0.05)	(0.05)		(0.12)
Tangibles$_{t-1}$	0.38***	0.52***	0.35***	0.28***	0.45***	0.41***		0.13
	(0.05)	(0.09)	(0.05)	(0.06)	(0.05)	(0.05)		(0.12)
Share of foreign market serv	-0.26	-0.00	-0.31	-0.15	-0.36	0.40**	-0.44*	-1.08*
	(0.20)	(0.35)	(0.25)	(0.25)	(0.27)	(0.15)	(0.22)	(0.55)
Share of foreign market serv$_{t-1}$	0.27	0.01	0.33	0.13	0.34	-0.39*	0.44*	1.16*
	(0.19)	(0.36)	(0.24)	(0.24)	(0.26)	(0.16)	(0.21)	(0.53)
Domestic L							-0.17	
							(0.11)	
Domestic L$_{t-1}$							0.15	
							(0.12)	
Foreign L							0.37	
							(0.23)	
Foreign L$_{t-1}$							-0.33	
							(0.23)	
Domestic K							-0.79***	
							(0.14)	
Domestic K$_{t-1}$							0.82***	
							(0.14)	
Foreign K							-1.02***	
							(0.19)	
Foreign K$_{t-1}$							1.03***	
							(0.21)	
Constant	-0.07***	0.00	-0.06**	0.00	0.00	-0.05***	0.04***	-0.00
	(0.01)	(0.02)	(0.02)	(.)	(.)	(0.01)	(0.01)	(0.04)
Observations	5752	2748	3004	2342	3410	4802	5752	5074
Number of industries	318	277	318	136	182	257	318	259
Hansen(p)	1.00	0.95	1.00	1.00	1.00	1.00	1.00	1.00
AR1(p)	0.01	0.01	0.02	0.00	0.04	0.05	0.02	0.00
AR2(p)	1.00	0.84	0.54	0.21	0.92	0.91	0.97	0.39

Standard error statistics in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Note: $\Delta VCTFP$, $Upstr\ \Delta VCTFP$, and $\Delta KLEMSTFP$ are the annual growth rates of VC TFP, TFP of the upstream part, and the EU KLEMS output-based TFP, respectively. As an explanatory variable, we use (ln-)intangible capital stocks ($Bus.$ and $Tech.\ intangibles$). For tangible inputs ($Tangibles$), we first construct an index series, 1995 = 1, based on the annual growth rates of aggregate factor inputs (or their domestic and foreign labor and capital components, $Domestic\ L\ Foreign\ L$, $Foreign\ K$, $Domestic\ K$, respectively) used in our calculation of the VC TFP. Then we take natural logarithms to study relative input growth. $Share\ of\ foreign\ market\ serv$ is the VA share of foreign market services in the GVC, as measured by the exlusion method.

To examine this further, a variable was introduced to measure the foreign share of private services in total value added (ranging from 0 to 1). An increase in this share resulted in a 0.4 percentage point rise in VC TFP for every 1 percentage point increase in the share (model 6). This effect was temporary, but remained in effect if the change in share was permanent.

Finally, we use the Arellano-Bond tests to check whether the idiosyncratic error term is serially correlated, as well as test the overidentifying restrictions of the instruments (Hansen's J statistic). Based on model testing, we do not find evidence of problems in the statistical inference.

5.3 Shocks to globalization: Bilateral investment treaties with China

The dynamic panel estimation provides a general view of the role of spillovers of different growth factors on the VC TFP. In this section, we take a different view, and report the results of our event study analysis on bilateral investment treaties between the EU15 countries and China. While being more specific, an event study approach allows us to link productivity dynamics to a clearly defined shock on the access to global value chains.

5.3.1 Effects on VC TFP

Difference between VC TFP and traditional TFP

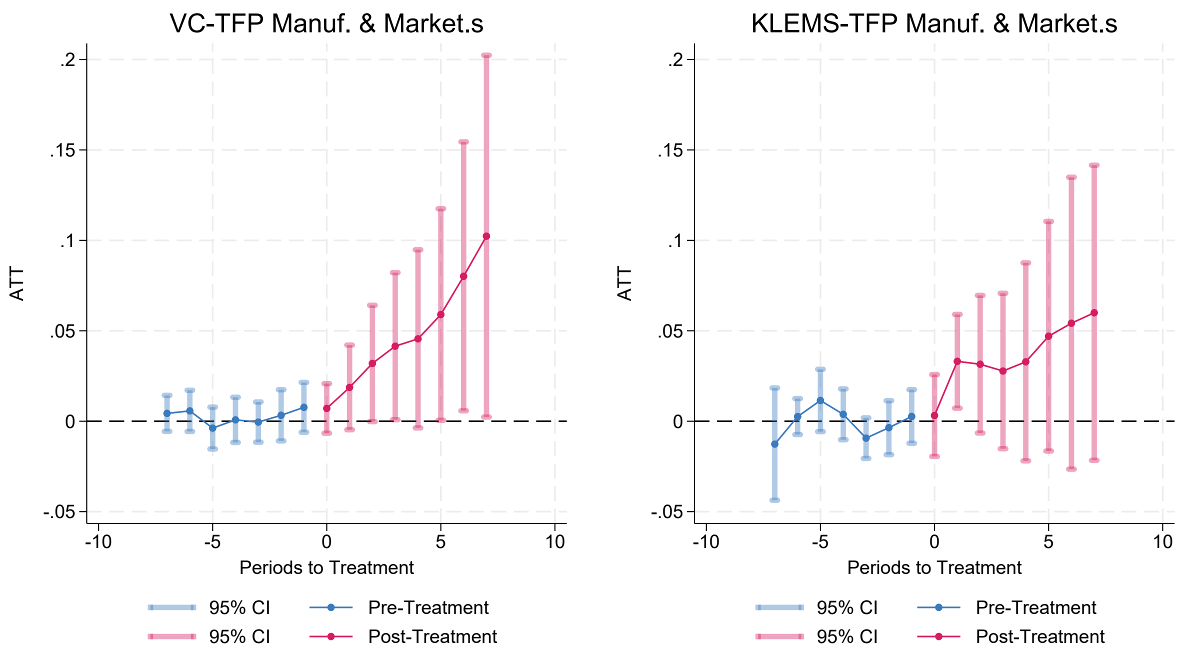
We concentrate on the market sector (manufacturing and market services), which is more likely to be affected by bilateral investment treaties.[19] We first study whether the results differ between the total factor productivity measured in the traditional way for each industry and the total factor productivity of the value chain of each industry. In Figure 1 we depict the dynamic effects on both traditional TFP and VC TFP of a sample consisting of manufacturing and market service industries.

Both TFP measures seem to increase after BITs treaties enter into force. However, the increase is more pronounced considering the VC TFP measure. In both cases before the event the pre-trend coefficients deviate closely around zero indicating that on average the control and treated group evolved similarly before the treaties entered into force.

[19] However, the results shown in Figure 1 are seemingly similar for the sample with all industries included.

In Table 9 we report the pre and post group-time average treatment effects of the event window. According to these results, the VC TFP is on average 5 percent higher compared to the control group within the seven year after treatment. However, also the traditional TFP is 4 percent higher than the control group. Nevertheless, considering the VC TFP, the result is statistically more significance confirmed also by the wild bootstrap confidence intervals. Considering pre-event effects, in both cases the estimated coefficient is zero and the wild bootstrap confidence intervals range from -0.01 to 0.01 indicating that the parallel trends assumption is likely not violated.

Figure 1: Development of TFP after BITs agreement enters into force

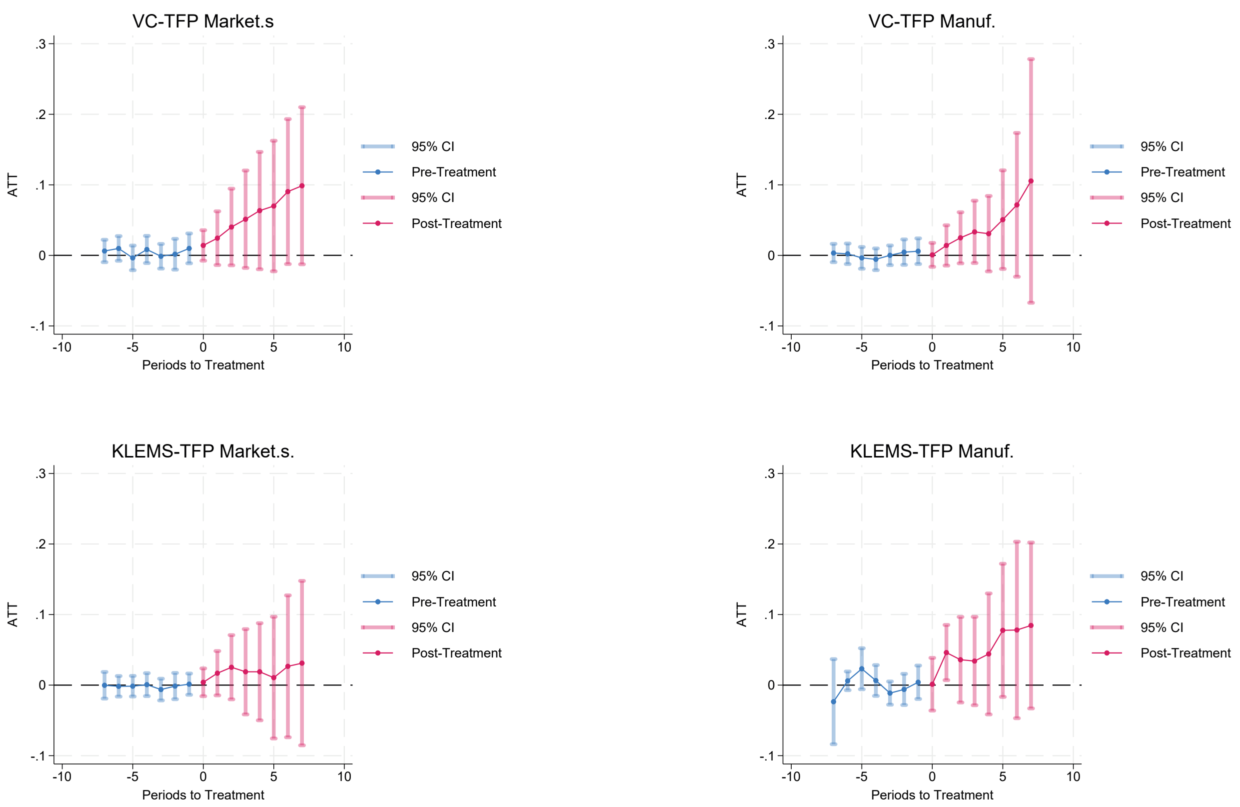


Note: The dots are event coefficients and the bars their bootstrapped 95 % confidence intervals clustered at unit level. The pre-treatment coefficients are blue and the post-treatment coefficients red.

In Figure 2 we further investigate the source of the difference between the two measures in figure 1. We depict the dynamic effects for both manufacturing and market services separately and notice that the difference seems to come from the market service industries. The VC TFP of market services deviates clearer from zero after the event compared to the traditional TFP, whereas, while not identical either, the effect on manufacturing industries is more similar between the two measures.

According to the results in Table 9, the pre and post group-time average treatment effects of the event window, the difference between VC TFP and traditional TFP is clearly more pronounced considering market services; the increase after the event is 6 percent for VC TFP but only 2 percent for traditional TFP. Furthermore, the estimate for traditional TFP within market services is clearly not statistically significant. In all cases, the pre-event coefficients do not statistically deviate from zero.

Figure 2: Development of TFP after BITs agreement enters into force



Note: The dots are event coefficients and the bars their bootstrapped 95 % confidence intervals clustered at unit level. The pre-treatment coefficients are blue and the post-treatment coefficients red.

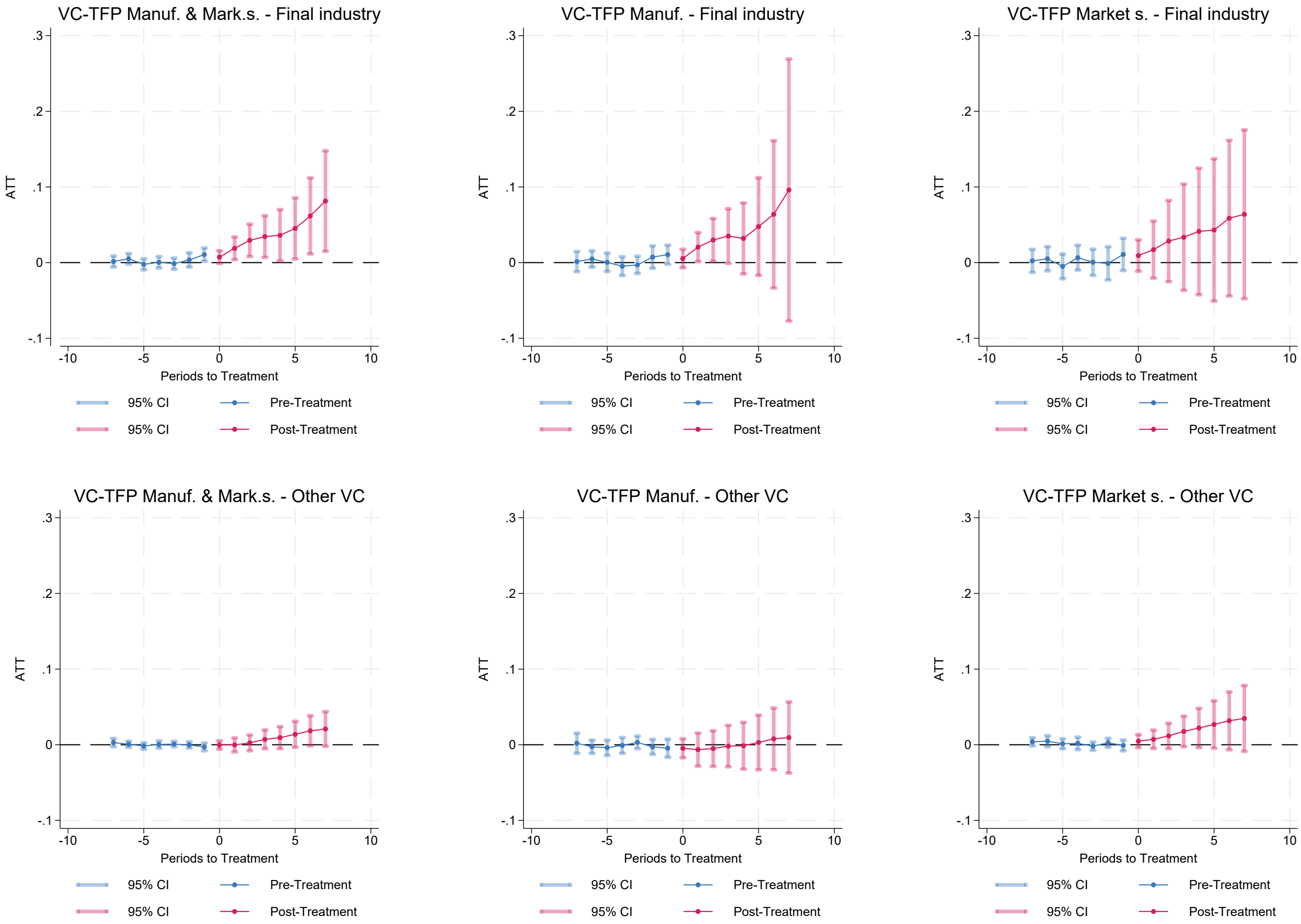
TFP of the final industry and the TFP of the rest of the chain

We have shown before that a focus on the final industry is restrictive for understanding productivity growth. The dissection of VC TFP between the final sector and the rest of the value chain is crucial for understanding the nuanced impacts of various activities in the VC. TFP growth in the final sector often serves as a catalyst for enhanced productivity across the entire value chain. By isolating the contributions of the final sector, we can pinpoint the sources of efficiency gains due to globalization, ultimately fostering a more targeted approach to policy-making and resource allocation.

Instead, here we decompose the evolution of VC TFP to TFP forming up from final industry and all the rest of the industries. This gives an understanding of which part of the value chain the productivity improvements of the industry's value chain are coming from. Figure 3 depicts the dynamic effects on TFP of the final producer industries and TFP of the rest of the upstream industries.

Overall, the improvements in VC TFP seem to spring from the final industry, at least more strongly than from other industries in the value chain. However, examining manufacturing and market services separately reveals that the TFP improvements in the value chain spring more clearly from the final producer industry within manufacturing industries. By contrast, within market services, the final industry and other industries both seem to improve the value chain's TFP after the event. However, the increase in other industries seems more certain than the increase in final industry.

Figure 3: Development of TFP after BITs agreement enters into force



Note: The dots are event coefficients and the bars their bootstrapped 95 % confidence intervals clustered at unit level. The pre-treatment coefficients are blue and the post-treatment coefficients red.

In Table 9 we report the pre and post group-time average treatment effects of the event window for TFP forming up from the final industry and all the rest of the industries. Note that all the pre-event coefficients are statistically insignificant also in these specifications. Accordingly, after the event, VC TFP increases mostly because final industry's TFP increases 4 percent on average. Considering manufacturing industries, the increase in VC TFP seems to come completely from TFP of the final industry. In contrast, when considering market service industries, both final and other upstream industries TFP have a positive coefficient (final 4 percent, other 2 percent). However, only the coefficient for other industries is statistically significant.

5.3.2 Effects on tangibles, intangibles and final producer value added

Output, inputs, value added and domestic value share

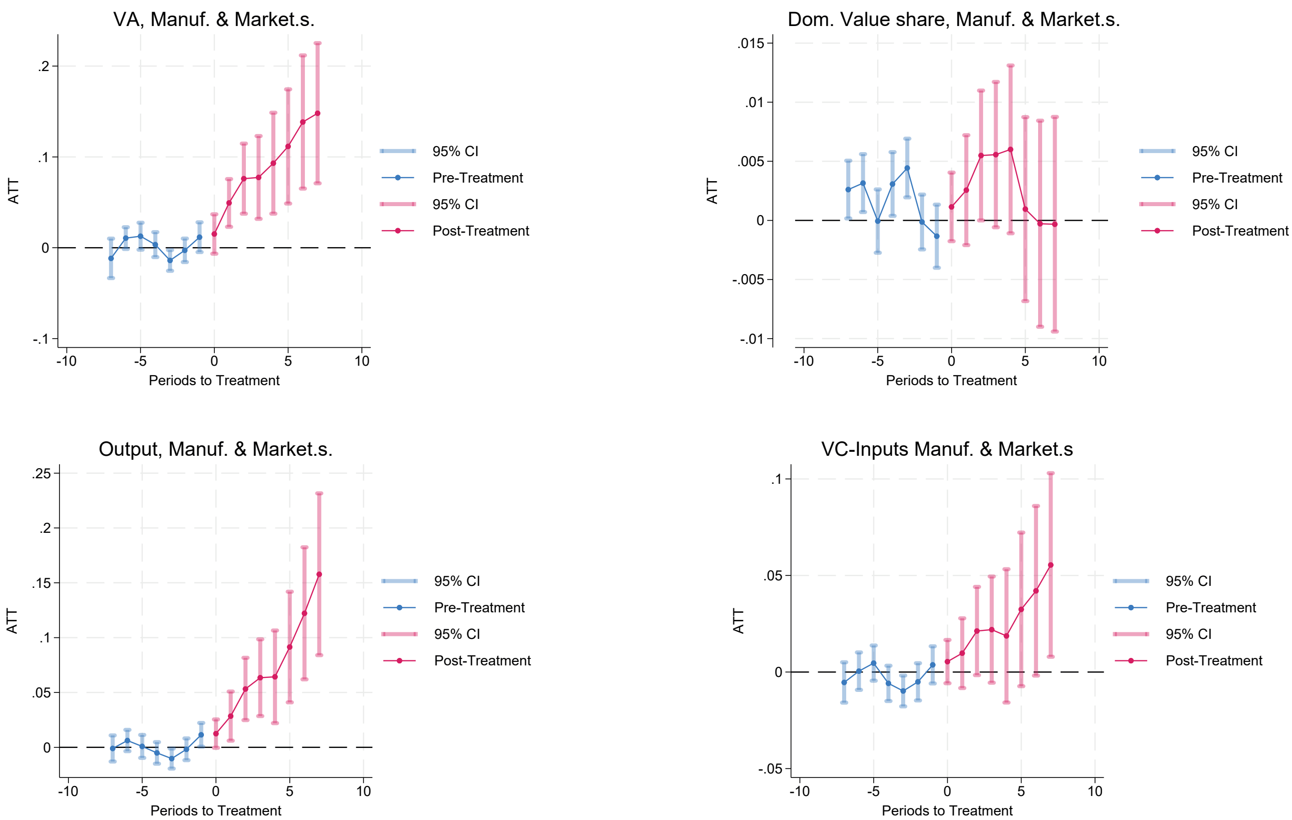
In Figure 4 we depict the effect on output (log) and the total inputs (log) of the value chain. This is to show how the effect to VC TFP is formed. On average country-industry's output increases clearly after the event, whereas total inputs of the value chain also increase but clearly to a lesser degree. Therefore, VC TFP, which is calculated by subtracting input contributions from output, also increases.

In a broad sense, these results are in line with the results of the dynamic panel estimations shown in Section 5.2. The dynamic panel estimations suggest that higher tangible inputs dilute VC TFP growth. The only moderate increase in inputs compared to the clearly stronger increase in output leaves space for higher VC TFP compared to the control group even if the increased inputs simultaneously to some extent suppress TFP.

In Figure 4 we also depict how BITs treaties have on average affected value added (log) of the final producer industry. After the event value added has increased clearly compared to the control group. We also study how the event has affected the domestic value share of the value chain. However, we find no clear effect on this share.

As shown in Table 9, on average after the event country-industry value added has increased 9 percent compared to the control group. Country-industry output has increased 7 percent. Country-industry value chain's inputs have increased 3 percent. Considering the pre-event coefficients for output, input and value added all are not statistically different from zero. Considering domestic value share, the pre-event and post-event coefficients are both near zero. However, the results indicate that the pre-event coefficient is statistically different from zero. Practically taken, this difference seems negligible, because accordingly the domestic value share is on average 0.002 percentage points higher than in the control group.

Figure 4: Development of Value added, output, inputs and domestic value share after BITs agreement enters into force



Note: The dots are event coefficients and the bars their bootstrapped 95 % confidence intervals clustered at unit level. The pre-treatment coefficients are blue and the post-treatment coefficients red.

Final producer industry's intangibles

We examine how the BITs treaties affect intangible investments of the final industry of the value chain.[20] In figure 5 we depict how total intangibles, business related intangibles, and technology related intangibles react to BITs. Only business related intangibles seem to increase after the BITs treaties enter into force. The group-time average effect for business related intangibles shown in

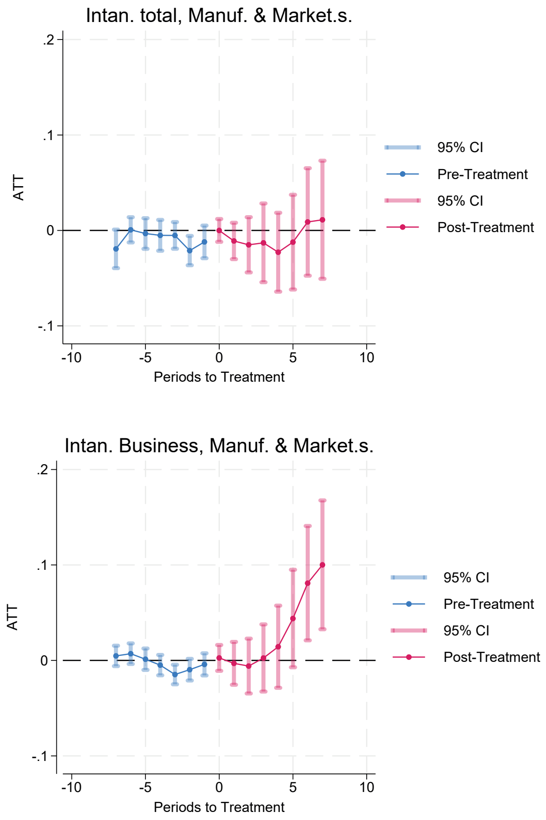
[20]It would be possible to decompose capital inputs into different forms of capital in equation (3) and examine how intangible capital evolves in the whole value chain. However, due to lack of data, it would require much imputation to fill-in each country-industry involved in the global value chain. This would likely result in a very imprecise outcome. For this reason, we examine only the intangibles of the final producer industry.

Table 9 indicate a 5 percent increase after the event. Whereas, the post-event average effects for total and technology related intangibles are statistically insignificant.

These results are in line with the results of the dynamic panel-data estimation in Section 5.2. According to those results, business related intangibles reflect positive spillovers to VC TFP growth. In this light, it seems reasonable that business related intangibles increase after the bilateral treaties enter into force, proposing that at least partly this increase in business related intangibles is driving the increase in VC TFP.

Note that, due to data availability, the sample size differs within these specifications. Data coverage is highest ($N = 8818$) for business related intangibles and smallest ($N = 5803$) for total intangibles (requires that there is data on both business and technology intangibles). Because total intangibles is the sum of business and technology intangibles we would expect to see it raise after the event. However, considering total intangibles we might lose many of those observations which rise business related intangibles, because we lack data on technology related intangibles which could explain why we do not see an increase in total intangibles.

Figure 5: Development of Final industry intangibles after BITs agreement enters into force



Note: The dots are event coefficients and the bars their bootstrapped 95 % confidence intervals clustered at unit level. The pre-treatment coefficients are blue and the post-treatment coefficients red. Note that the sample size differs between the different specifications. It is 5803 for "Intangibles total", 5831 for "Intangibles tech" and 8818 for "Intangibles business".

We also study manufacturing industries and market services separately. In both cases, business related intangibles raise after the event and among manufacturing industries the increase is more certain. Considering total and technology related intangibles, given the available sample, within both industry groups we find no clear effects. We also study whether the BITs treaties affect the intensity of intangible investments (intangible investments divided by value added). We find no clear effects on the intensities.

Table 9: Pre- and Post ATT

	Pre					**Post**					**Obs.**
	Coefficient	Std,err,	p-value	[Conf, Intervals]	[Conf, Interv, wBoot]	Coefficient	Std,err,	p-value	[Conf, Intervals]	[Conf, Interv, wBoot]	
VC TFP	0.00	0.00	0.41	[0.00 0.01]	[-0.01 0.01]	0.05	0.02	0.00	[0.02 0.08]	[0.00 0.09]	8994
Traditional TFP	0.00	0.00	0.79	[-0.01 0.00]	[-0.01 0.01]	0.04	0.02	0.04	[0.00 0.07]	[-0.01 0.08]	8994
VC TFP manuf.	0.00	0.00	0.70	[0.00 0.01]	[-0.01 0.01]	0.04	0.02	0.03	[0.00 0.08]	[-0.01 0.10]	4862
Traditional TFP manuf.	0.00	0.00	0.97	[-0.01 0.01]	[-0.01 0.01]	0.05	0.03	0.05	[0.00 0.10]	[-0.02 0.12]	4862
VC TFP M.services	0.00	0.01	0.45	[-0.01 0.02]	[-0.01 0.02]	0.06	0.03	0.03	[0.00 0.11]	[-0.01 0.13]	4132
Traditional TFP M.services	0.00	0.00	0.73	[-0.01 0.01]	[-0.01 0.01]	0.02	0.02	0.40	[-0.03 0.06]	[-0.04 0.08]	4132
Value added	0.00	0.00	0.73	[-0.01 0.01]	[-0.01 0.01]	0.09	0.02	0.00	[0.04 0.14]	[0.02 0.15]	8993
Domestic value share	0.00	0.00	0.00	[0.00 0.00]	[0.00 0.00]	0.00	0.00	0.38	[0.00 0.01]	[-0.01 0.01]	8994
Output	0.00	0.00	0.99	[-0.01 0.01]	[-0.01 0.01]	0.07	0.02	0.00	[0.04 0.11]	[0.02 0.13]	8994
VC-inputs	0.00	0.00	0.44	[-0.01 0.00]	[-0.01 0.01]	0.03	0.01	0.08	[0.00 0.05]	[-0.01 0.07]	8994
MM final	0.00	0.00	0.39	[0.00 0.01]	[-0.01 0.01]	0.04	0.02	0.01	[0.01 0.07]	[0.00 0.08]	8994
MM other than final	0.00	0.00	0.97	[0.00 0.00]	[0.00 0.00]	0.01	0.01	0.16	[0.00 0.02]	[-0.01 0.03]	8994
Manuf. final	0.00	0.00	0.28	[0.00 0.01]	[0.00 0.01]	0.04	0.02	0.02	[0.01 0.08]	[-0.01 0.09]	4862
Manuf. other than final	0.00	0.00	0.37	[0.00 0.00]	[-0.01 0.00]	0.00	0.01	0.99	[-0.02 0.02]	[-0.03 0.03]	4862
M.Services final	0.00	0.01	0.64	[-0.01 0.01]	[-0.01 0.02]	0.04	0.03	0.17	[-0.02 0.09]	[-0.03 0.11]	4132
M.Services other than final	0.00	0.00	0.25	[0.00 0.00]	[0.00 0.01]	0.02	0.01	0.02	[0.00 0.04]	[0.00 0.04]	4132
MM Intangibles total	-0.01	0.00	0.02	[-0.02 0.00]	[-0.02 0.00]	-0.01	0.02	0.70	[-0.04 0.03]	[-0.06 0.04]	5803
MM Business Intangibles	0.00	0.00	0.31	[-0.01 0.00]	[-0.01 0.01]	0.05	0.02	0.01	[0.01 0.08]	[0.00 0.10]	8818
MM Technology Intangibles	-0.01	0.01	0.45	[-0.02 0.01]	[-0.02 0.01]	0.03	0.03	0.22	[-0.02 0.08]	[-0.04 0.11]	5831

Note: This table consist of asymptotic standard errors (clustered at industry-country level), p-values and confidence intervals for averaged pre-event coefficients and average post-event coefficients. For comparison also confidence intervals from wild bootstrap are reported. Additionally, the number of total observations for each specification is reported.

6 Concluding remarks

European productivity growth has slowed since the 2008 Global Financial Crisis, despite rapid technological advancements and new digital tools. In this paper, we investigated the underlying value chain productivity patterns. We combined new OECD Inter-Country Input-Output Tables and KLEMS data and other data sources to construct a panel of value chain TFP for industries of EU15 countries from 1995 to 2017.

Aligned with the previous findings of weak productivity dynamics, we present evidence of stagnation in the VC TFP growth since 2008. However, beneath the surface, the productivity picture is more nuanced. According to our results, the value-added share of outsourced private services has increased within the VCs, while the final contributor to input growth has been capital growth in the service sector. Furthermore, the productivity development in final producer industry and also slightly negative TFP growth of the rest of the value chain explain the slowdown in productivity in recent years. Given the vast pace with which the productivity of developing countries is growing, it is somewhat surprising that the EU15 countries on average seem to have been unable to internalize this growth in any parts of their value chains. However, we also observe significant variation across industries in the TFP composition between the final industry and the rest of the value chain.

Recently, a lot of attention has been given to intangible investments and their possible spillover effect on productivity. With our VC TFP panel, we studied the possible spillover effect of intangibles to productivity growth using a dynamic panel regressions with system GMM. We found some evidence of spillovers. The model suggests that intangible business capital significantly contributes to VC TFP, while technology intangibles has a lesser impact. However, when the sample is restricted to the period 2008-2017 also business related intangible are less pronouncedly related with VC TFP growth. Throughout the period, we observed that an increase in tangible assets led to a decrease in VC TFP. Thus, in terms of productivity improvements, the recent period has highlighted the importance of intangible assets over tangible ones.

To demonstrate how VC TFP could provide us with a deeper understanding of productivity developments, we also studied how the removal of global investment barriers have affected value chains. To examine how the emergence of China as a pivotal new player in value chains has impacted the value chains of EU15 industries, we focused on bilateral investment treaties between China and EU countries.

Our findings from the event study analysis indicate that these agreements have led to an increase in VC TFP in the market sector. In more detail, considering manufacturing industries, it seems that this increase in VC TFP comes from the final producer industry, whereas considering market services, the increase in VC TFP results from both the final producer industry and even more clearly from the rest of the value chain. Furthermore, the results show that the value added of the final producer industry increased after the event but the share of domestic value added of the chain remained virtually unchanged, indicating that bilateral treaties were beneficial for the EU15 countries, but also more broadly for the chains.

We also find that after the event business related intangibles increased in the final producer industry, whereas tangible investments responded less. Together with the results from the dynamic panel regression, this finding suggests that the increase in VC TFP is strongly linked to the business-related intangibles in the final producer industry.

Looking ahead, further research should focus on leveraging new global datasets to unravel the complex productivity patterns within global value chains (GVCs). While OECD and KLEMS data have proven valuable, more comprehensive and granular datasets could offer deeper insights into the factors influencing productivity in various sectors. In particular, it is important to further analyze the coordination failures in EU value chains that have resulted in weak productivity dynamics throughout these chains.

Moreover, examining the effects of the recent slowdown in globalization and the growing risk of trade wars on productivity dynamics will be crucial. This research could help policymakers understand the implications of geopolitical shifts and devise strategies to mitigate potential adverse effects on global value chains. Exploring the role of intangible investments in fostering productivity growth, especially in the context of evolving global trade relationships, will be essential to fully grasp the future trajectory of value chain productivity. It is particularly important to understand whether the emphasis on intangibles remains resilient in the era of geopolitical tensions.

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Appendix

The value-added composition

In this Appendix, we examine the value-added composition in our value-chain data. The results can be found in Table 10. This analysis focuses on manufacturing, market services, other services, and the construction and utilities sector. The value-added breakdown includes the contributions from the final producer (the final producer) and other industries.[21]

Between 1995 and 2017, the final producer industry accounted for about 56.5% of the value-added in the value chain, with the majority originating from the domestic part of the chain. Market services contributed 25.7% of the value-added, manufacturing 8.4%, and final production 4.5%. The data reveals consistent organization across sectors, with the final producer industry's share being the largest, varying between 40% and 76%. The highest shares were found in other services, while the lowest were in manufacturing. The role of market services in value added also remains consistently high, with the highest share (outside the final producer industry) in the manufacturing sector.

From 1995 to 2017, the most significant change has been the increase in the private service sector's value-added share, which rose by 4.2 percentage points. Meanwhile, the shares of the final industry, manufacturing, and the final sector decreased by roughly the same amount. This change predominantly occurred in the foreign part of the value chain, as shown in Table 13. Professional, scientific, technical, administrative, support service activities, financial, insurance, and trade activities contributed significantly to the increase in the services sector.

[21] Manufacturing includes all manufacturing activities (ISIC class C). Utilities and Construction encompasses utilities (such as electricity, gas, steam, and air conditioning supply), water supply, sewerage, waste management, and remediation activities, as well as construction (ISIC class D-F). Market Services include wholesale and retail trade, transportation and storage, accommodation and food service activities, information and communication, financial and insurance activities, real estate activities, professional, scientific and technical activities, and administrative and support service activities (ISIC class G-N). Other Services cover public administration and defense, education, human health and social work activities, arts, entertainment and recreation, other service activities, activities of households as employers, and activities of extraterritorial organizations and bodies (ISIC class O-U). We also include agriculture, forestry, fishing, and mining activities (ISIC class A, B) as provider of inputs

	Average	Manufacturing	Market services	Other services	Util. & construction
Final industry	56.5 %	40.4 %	57.7 %	76.1 %	52.1 %
Manufacturing	8.4 %	12.7 %	6.4 %	4.2 %	10.4 %
Market services	25.7 %	32.7 %	28.6 %	15.1 %	26.5 %
Other services	1.8 %	1.7 %	2.0 %	1.3 %	2.1 %
Final	4.5 %	8.1 %	2.5 %	1.2 %	6.2 %
Util. & construct.	3.0 %	4.1 %	2.7 %	2.2 %	2.8 %

Table 10: Value-added composition for manufacturing, market services, other services, and construction and utilities sector (columns), as well as unweighted averages

	Average	Manufacturing	Market services	Other services	Util. & construction
Final industry	-1.6	-3.7	-1.2	-1.4	-0.2
Manufacturing	-1.1	-0.1	-1.4	-0.6	-2.4
Market services	4.2	4.7	3.7	2.5	6.0
Other services	0.5	0.7	0.4	0.6	0.4
Final	-2.1	-2.1	-0.9	-0.7	-4.6
Util. & construct.	0.0	0.5	-0.7	-0.4	0.8

Table 11: Value-added composition changes 1995-2017 for manufacturing, market services, other services, and construction and utilities sector (columns), as well as unweighted averages, percentage points

		Average	Manufacturing	Market services	Other services	Util. & construction
Final industry	dom	55.3 %	37.5 %	55.8 %	76.0 %	51.7 %
	for	1.3 %	2.9 %	1.9 %	0.0 %	0.4 %
Manufacturing	dom	4.3 %	5.8 %	3.4 %	2.2 %	5.8 %
	for	4.1 %	6.8 %	3.0 %	2.0 %	4.6 %
Market services	dom	15.8 %	17.6 %	18.8 %	10.4 %	16.5 %
	for	9.9 %	15.0 %	9.8 %	4.7 %	10.0 %
Other services	dom	1.4 %	1.1 %	1.6 %	1.1 %	1.7 %
	for	0.4 %	0.6 %	0.4 %	0.1 %	0.4 %
Final	dom	1.1 %	2.3 %	0.5 %	0.3 %	1.3 %
	for	3.4 %	5.9 %	2.0 %	0.8 %	4.9 %
Util. & construct.	dom	2.3 %	2.8 %	2.2 %	2.0 %	2.3 %
	for	0.6 %	1.3 %	0.5 %	0.3 %	0.5 %
Total	dom	80.2 %	67.2 %	82.3 %	92.0 %	79.3 %
	for	19.7 %	32.4 %	17.7 %	8.0 %	20.7 %

Table 12: Foreign and domestic value-added decomposition for manufacturing, market services, other services, and construction and utilities sector (columns)

Examples of productivity growth individual industries

Next, we show corollaries with the previous literature and expand their examples with further data.

The results can be found in Table 14.

		Average	Manufacturing	Market services	Other services	Util. & construction
Final industry	dom	-2.0	-3.6	-2.7	-1.4	-0.1
	for	0.4	0.0	1.6	0.0	-0.1
Manufacturing	dom	-1.0	-0.6	-1.1	-0.4	-2.0
	for	-0.1	0.4	-0.2	-0.2	-0.4
Market services	dom	-0.5	-1.3	-1.4	0.0	0.8
	for	4.7	6.0	5.1	2.6	5.2
Other services	dom	0.3	0.5	0.1	0.5	0.3
	for	0.2	0.3	0.3	0.1	0.2
Final	dom	-0.4	-0.3	-0.2	-0.2	-0.8
	for	-1.7	-1.9	-0.7	-0.5	-3.8
Util. & construct.	dom	0.0	0.4	-0.7	-0.4	0.7
	for	0.1	0.1	0.1	0.0	0.0
Total	dom	-3.5	-4.9	-6.1	-2.0	-1.0

Table 13: Foreign and domestic value-added composition changes 1995-2017 for manufacturing, market services, other services, and construction and utilities sector (columns), percentage points

First, we revisit the German automotive industry discussed by Timmer (2017). It provides an interesting example of international value chains, as the sector depends extensively on globally produced components, such as engines, braking systems, energy inputs, and various business services like logistics and marketing. Another example is the construction industry (Table 14, row 4). Recently, Kuusi et al. (2022) demonstrated that the traditional focus on the construction industry is restrictive for understanding productivity growth in construction activities.

Overall, a detailed examination of the data raises confidence that our measures of VC TFP are consistent with the previous literature. In the German automotive industry, we confirm that a major part of the productivity growth originates from outside the industry. TFP growth contribution from outside the German industry itself was 1.5 percentage points (pps) while the industry's own contribution was only 0.8 pps. The contribution of inputs was 3.7 pps, which constituted 62% of all productivity growth. When comparing to Timmer (2017), it is notable that the observed output growth was moderately different. In our data, the average output growth in the industry was 6% per year compared to 5% per year in the previous work. However, the input contributions were quite similar, with our estimate at 3.7 pps versus 4 pps in Timmer (2017). Thus, the higher output growth observed in our data is attributed to higher TFP growth. According to our findings, the share of final industry TFP growth was only 38%, whereas it was 74% in Timmer's article. Thus, it appears that the higher TFP results from higher foreign sector contribution.

While we report similar findings with the previous literature, our dataset also allows us to extend the approach. We find that the German automotive industry has experienced lower output growth (2.3%) in the subsequent years from 2008 to 2017 (Table 14, row 2). Input growth has been substantially lower, and TFP growth, especially in the rest of the value chain, has slowed considerably. Thus, it seems that Germany has been less able to reap benefits from the value chains in the post-2008 period. The benefits of globalization have not been as strong as before. When considering the entire European sector, we find a decline in output growth in the 2008-2017 period, resulting from decreasing use of inputs (Table 14, row 3). Despite the nascent growth period, the VC TFP growth has been almost as high as in Germany.

Using an alternative dataset[22], we revisit the findings of Kuusi et al. (2022) regarding the construction sector. Again, we also provide similar findings. In Table 14, we show that VC TFP presents a more positive view of productivity growth compared to the traditional industry-based measurements. VC TFP growth has been faster in the upstream part of the sector, while the industry's contribution is negative.

This finding is intuitive. The construction industry typically involves on-site work, whereas industrializing construction, particularly through prefabrication, aims to reduce these on-site activities. Technological advancements in construction largely focus on increasing the amount of work performed in an upstream factory setting rather than on-site, with these components then being delivered to the construction site for easier installation or assembly.

	Output growth	Input cont.	VC TFP	Final TFP	Other VC TFP
German automot. 95-07	6.0 %	3.7	2.4	0.8	1.5
German automot. 08-17	2.3 %	1.0	1.3	0.9	0.3
European automot. 08-17	-0.1 %	-1.3	1.2	0.4	0.8
European constr. 95-17	0.5 %	0.6	-0.1	-0.3	0.2

Table 14: corollaries with the previous literature and expanding their examples: The automotives manufacturing (C19) and construction (F)

[22] Kuusi et al. (2022) use the WIOD dataset

Robustness of the event study analysis

It seems that the effect on VC TFP is not very heterogeneous. When each group is examined separately, the results are rather similar, even for the sample of only manufacturing industries or market services. Except for a few exceptions, the pre-event coefficients are insignificant. Moreover, while there are some differences in magnitude, the coefficient in all groups reflects a similar upward pattern after the event as the aggregated coefficients. However, when examined separately the post-event coefficients are not statistically significant, while a clearly larger share of the mass of the confidence intervals is positive.

Recall that Callaway and Sant'Anna (2021)'s approach requires a large number of clusters for the inference to be valid. We only have 15 clusters in our baseline specification. However, it would be more adequate to cluster the standard errors at the policy-level (country-level) instead of country-industry level. If we do cluster at the policy-level the post-event coefficients are insignificant at the 0.05 level. However, the confidence bands are located clearly more on the positive side. Furthermore, if we utilize the method by Borusyak et al. (2024) or the traditional "two-way fixed effects" the results are very similar to our baseline results.

If we alter the event window to its maximum, 13 years before and after the event, we notice that the post-event coefficients after year 7 are on average 0.13. Also, the pre-event coefficients before year 7 are seemingly close to zero. It also seems as if the last post-event coefficients (years 9 to 13) would start to stabilize somewhere around 0.13, compared to the upward-trend present in the first post-event coefficients (years 1 to 8).

Given that we have rather few control and treated countries, it is possible that the observations from one influential country would be responsible for the results. It would then be quite doubtful whether the BITs agreements caused these results or something else that happened within this country at the same time that the BITs agreements entered into force. Considering VC TFP, we test for influential countries by leaving one country at a time out of the sample. We find that each time the results stay roughly the same, and while the significances and magnitudes somewhat change, the coefficients draw a rather similar pattern in each case.

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