The Contribution of Declining Corporate Taxes to Deindustrialization

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Job Market Paper
This version: November 2023
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Abstract

Did the decline in corporate taxation contribute to the declining manufacturing share observed across advanced economies? This article provides causal evidence that the answer is yes. Tax cut explains from 20% to 30% of the observed decline in manufacturing.
I combine longitudinal administrative firm-level data from Germany with 8,000 local tax changes for identification. Using Difference-in-difference estimations, I show that local tax hikes (cuts) increase (decrease) the local manufacturing share. Firm-level results reveal that this is due to wage, employment, firm entry, and labor productivity in the service sector being more responsive to a tax shock than in manufacturing. With this evidence in mind, I calibrate a two-sector model with heterogeneous firms and profit tax to show that, owing to different structural parameters, a corporate tax cut disproportionately benefits service firms, contributing to the sectoral reallocation from manufacturing to service.

***Keywords*—** corporate tax policy, firm-dynamics, productivity, entrepreneurship, structural change
JEL: D22, E62 H25, H71, L26, L60, L80, O47

*I thank Javier Miranda, Matthias Mertens, Xavier D'Haultfoeuille, Mirja Haelbig, Dennis Hutschenreiter, Mélitine Malézieux, Josh Martin, Marc Melitz, Sophie Piton, Anthony Savagar, Vincent Sterk, Tommaso Santini, Merih Sevilir, Simon Wiederhold, and seminar participants at IWH, Bank of England, Paris School of Economics, CEPR Policy Forum, Kent University, Deutsche Bundesbank, German Council of Economic Experts, Applied Economics Conference, International Conference on European Studies for useful feedback and comments. I am grateful to Michael Roßner and Denise Henker for their help with the data. Email: tommaso.bighelli@iwh-halle.de. Website: https://tommasobighelli.com/

1 Introduction

The contribution of industrial output to economic growth has been falling across most advanced economies worldwide. At the same time, the share of the so-called, *tradeable* service sector has increased[1]. While the growth of manufacturing jobs and value-added has been modest, if not declining, the growth in the service sector has been much more rapid, resulting in a reallocation of employment and market shares from manufacturing to service. Existing literature has explored the decline in the manufacturing share, attributing it to factors such as import competition (Acemoglu et al. (2016)), increased activity in the service sector attracting high-skilled labor (Buera and Kaboski (2012)), which in turn stimulates innovation (Delgado and Mills (2020)). Other contributing factors include the technological revolution enabling firms to serve multiple markets (Hsieh and Rossi-Hansberg (2023)) and the increasing offshoring activity by multinational firms (Boehm et al. (2020)).

In this paper, I adopt a different perspective and study another channel. Abstracting from other channels that have also played a significant role, I investigate whether the observed decline in corporate taxation contributed to the reallocation from manufacturing to the service sector. This

[1] I define tradable sector service as in Piton (2021). It includes the following macro-sectors according to Nace Rev.2 classification: Information and Communication; Professional, Scientific and technical activities; Administrative and Support Service activities. For the rest of the paper, if not otherwise specified, this definition of service will apply.

channel is crucial because governments can directly and promptly influence corporate taxes, whereas policies affecting import competition, the supply of high-skilled workers, offshoring, and many other factors affecting sectoral reallocation are typically more complex to implement. Thus, establishing a causal link between corporate taxes and the decline in manufacturing can provide a new tool for those governments seeking to either slow down or accelerate the reallocation from manufacturing to service. Furthermore, this paper introduces yet another channel that, although it was probably not designed for this purpose, contributes to explaining this ongoing trend as a side effect. This article is also part of a recent literature documenting the role of corporate tax cut in some of the observed secular trend (e.g. the decline in labor share, as documented by Kaymak and Schott (2022)).

Similarly to many other developed countries, Germany has also experienced a reallocation of value-added, employment, and output shares from manufacturing to service (left panel of Figure 1). This structural transformation can be attributed to the faster growth of the service sector compared to manufacturing. Concurrently, few fiscal reforms have significantly reduced corporate tax rates (right panel of Figure 1). A distinctive and appealing feature of the German taxation system is that a substantial portion of corporate taxes depends on decisions made at the municipal level, as seen in the right panel of Figure 1, where the difference between the two lines reflects the local taxation. Each year, municipal councils vote on the tax rate for the following year. Among the 11,000 municipalities, every year, approximately 10% of them adjust their tax rate, resulting in a significant number of tax events. Crucially, while municipal councils determine the tax rate, the tax base definition and the liability criteria are established at the federal level and are uniform across all municipalities. This setting is particularly appealing because it allows for a clear distinction between the treatment group - municipalities that change the tax in a given year - and the control group - municipalities that have not yet changed the tax rate or will not change it.

In my analysis, I combine longitudinal administrative firm-level data that I access from the German Federal Statistical Office (Destatis) with data on local business taxes at the municipal level, and I apply an identification approach similar to Fuest et al. (2018). The empirical difference-in-difference analysis at the municipal level shows that a one percentage point (p.p.) increase[2] in local taxes leads to an increase in the employment and revenue manufacturing shares by 1.1% and by 2.3%, respectively. To put this in perspective, considering the average manufacturing share across municipalities, a one p.p. tax change affects the employment (revenue) manufacturing share of the average municipality by approximately 0.6 (1.3) p.p. Simultaneously, this tax change has a noteworthy im-

[2]Although corporate taxes are declining in Germany, the majority of the municipalities *increase* the municipal tax rate. Section 2.1. describes and provides insights on business taxation in Germany.

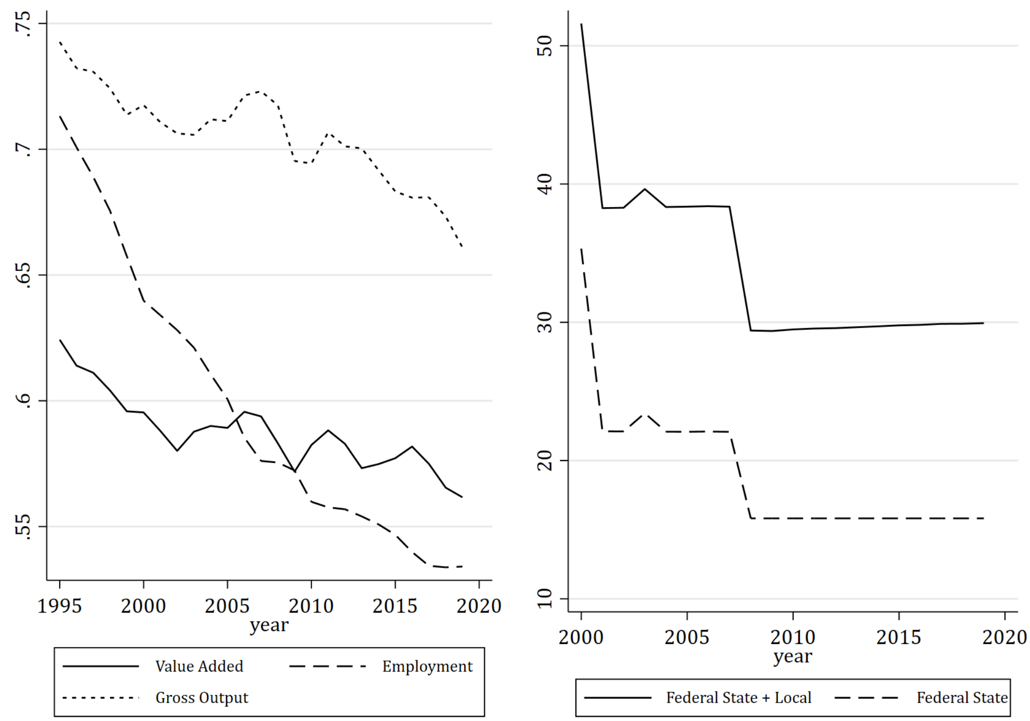

Figure 1. Left Panel: it shows the manufacturing share of value-added employment and gross output. The share is computed as the ratio of the manufacturing value and the manufacturing value plus the tradable service value, where tradeable service includes firms in Information and Communication, Professional, Scientific, and technical activities, and Administrative and Support Service Activities. Source: EU-Klems. Right Panel: it shows Germany's statutory corporate tax rate and the split between Local and Central decisions. Source: OECD.

pact on the number of firms operating in the service sector, leading to a 4% change in the opposite direction. Strikingly, this effect is absent when analyzing the number of firms in the manufacturing sector. In simple terms, assuming symmetric results, a one p.p. tax reduction could stimulate the number of firms in the service sector at the municipal level by increasing the net entry rate. In the firm-level analysis, I show that this is due to firms in the service sector responding more to tax shock than firms in manufacturing. In particular, a one p.p. change in local taxes affects wages, number of employees, and labor productivity of the average firm more in service than in manufacturing.

To show how these different elasticities determine the reallocation from manufacturing to service, I build a quantitative heterogeneous firm-dynamic model by extending the framework of Hopenhayn (1992) and Hopenhayn and Rogerson (1993) to a multi-sector model with taxation to show how a negative corporate tax shock drives the reallocation from manufacturing to service in the long run. Intuitively, a corporate profit tax cut increases the number of entry firms in the market due to higher discounted expected net profits (as documented, among the others, by Sedlacek and Sterk (2019) and Curtis and Decker (2018)). The higher net entry increases labor demand and wages (Neira and Singhania (2022) and Sedlacek and Sterk (2019)), and the higher wages will require that only more productive firms remain in the market. At the same time, the least productive firms will exit (Neira and Singhania (2020)) through a selection process similar to Hopenhayn (1992) and Melitz (2003). In the empirical analysis, I document that all these effects are stronger in service than in manufacturing: i) corporate taxes affect the number of firms operating in service more than the number of firms in manufacturing; ii) at firm-level, average wage and firm number of employees in service react more than wage and number of employees of firms in manufacturing; and iii)) the tax effect on labor productivity is also higher in service than in manufacturing. The ultimate effect of a tax cut is a bigger, more dynamic, and more productive service sector. The calibrated parameters suggest this is due to the service sector's lower entry and adjustment costs, faster capital replacement and different cost structure.

Outline The remainder of the paper is organized as follows. Section 2 gives the institutional background on how corporate taxation works in Germany and related fiscal reforms and describes the data. Section 3 lists a few aggregate facts useful for the analysis and the main intuition. Section 4 presents the empirical methodology, discusses the identification procedure, and shows and comments on the empirical results. Section 5 introduces the model, the calibration procedure, and the quantitative evaluation. Section 6 discussed the mechanisms that, making manufacturing and services reactions different, drive the reallocation. Section 7 concludes.

1.1 Related Literature

This paper builds on three different strands of literature. The first relates to studies investigating the causes behind structural change and sectoral reallocation from manufacturing to service. The second relates to the literature seeking to estimate the effect of corporate taxation on the economy. The third relates to the literature on business dynamism and entrepreneurship.

First, I build on the literature on structural change, complementing the existing work by investigating the role of corporate tax policy. The association between sectoral reallocation, structural change, and growth is first studied in Kuznets (1973). More recent works document the increasing share of service (see e.g. Eckert et al. (2019), Charles et al. (2019) and Fort et al. (2018)) and Buera and Kaboski (2012) investigates the role of higher supply of high-skilled workers in driving the reallocation to service sector that correlates with increase in GDP per capita (Buera et al. (2022)). Along the same line, Ngai and Pissarides (2007) discuss the role of different rates of neutral technological progress across sectors, Moreira (2022) the role of market power and Hutschenreiter et al. (2022) the role of automation. Ding et al. (2022) point to intangible investment in manufacturing firms behind the non-manufacturing employment growth and Comin et al. (2021) discuss the role of non-homothetic preferences. The increasing ability of service firms to scale up production over different local markets has favored productive firms in non-traded service industries as highlighted by Hsieh and Rossi-Hansberg (2023). At the same time, the rise in the service sector is connected with the increasing ability of service firms to participate in international trade (see Ariu et al. (2019) and Baldwin and Freeman (2022)). Among the empirical studies, Delgado et al. (2020) use U.S. firm data and find that the transformation of incumbent manufactur-

ing firms towards Supply Chain Traded service firms contributes to the shift from manufacturing to services.
Although the literature predominantly emphasizes the role of market-related factors, this article uncovers a distinct perspective. It shows that the manufacturing share decline can also be attributed to a specific industrial policy: corporate tax cut. While the decline in corporate taxation was probably not intentionally designed for this purpose, it has significantly contributed to the observed decline in manufacturing share.

Second, I contribute to the literature on corporate taxation and its effect on the economy, starting with the seminal work by Harberger (1962). Several works have documented the negative effect of taxation on various firms economic variables, including innovation (Stantcheva (2021), Akcigit, Grigsby, et al. (2022) and Mukherjee et al. (2017)), income (Patel et al. (2017)) and investment decision (Link et al. (2022), Djankov et al. (2010), Leigh et al. (2019) and Ohrn (2018)). Akcigit, Hanley, and Stantcheva (2022) study the optimal design of corporate taxes. Declining corporate taxation is also responsible for the declining labor share trend (Kaymak and Schott (2022)). Curtis and Decker (2018), Erosa and González (2019), Colciago and Matyska (2023) and Gentry and Hubbard (2000) study the effect of corporate taxes on business dynamism. Using similar data and the same identification approach, Fuest et al. (2018) finds that workers bear one-half of the total tax burden. A recent strand of literature has also used local taxation to investigate spatial misallocation, as documented in Fajgelbaum et al. (2019), Suárez Serrato and Zidar (2016) and Serrato and Zidar (2023). I complement this literature by empirically investigating how these findings differ in the manufacturing and service sectors. My findings align with the evidence that downplays the significance of corporate tax in stimulating economic activities among incumbent firms (Hanappi et al. (2023)), and they support the notion that corporate tax can be especially effective through the selection effect by encouraging the exit of less productive firms (Acemoglu et al. (2018).

Third, this paper also relates to the literature on firm dynamism and reallocation. I extend to a two sectors model the standard quantitative heterogeneous firms model developed by Hopenhayn (1992) and Hopenhayn and Rogerson (1993) and including taxes as in Sedlacek and Sterk (2019). This theoretical literature complements several theoretical and empirical studies documenting the secular declining trend in business dynamism in the U.S. (see among the others Decker et al. (2016) and Decker et al. (2017), De Ridder (2023) and Morazzoni (2023)) and in Europe (Biondi et al. (2022) and De Haas et al. (2022)).

This study also relates to various discussions on tax policy reforms (see Slattery and Zidar (2020) and Zidar (2019)). While I only focus on the decline of *statutory* corporate taxation, the decline of *effective* corporate tax is even more pronounced as a consequence of firms profits shifting behavior and documented in several studies[3]. Therefore, the results of this study can be seen as a conservative estimate of the effect of taxation on manufacturing decline, which can be even more substantial. I also complement a broader literature on industrial policy which includes, among the others, Criscuolo et al. (2019), Dechezleprêtre et al. (2016), Aiginger and Rodrik (2020) and Liu (2019). I connect with the vast literature documenting the link between policy distortions and misallocation (see Bartelsman et al. (2013), Hsieh and Klenow (2009), Dias et al. (2020)), input factor flexibility (Cunat and Melitz (2012)), market size and aggregate productivity (Melitz and Ottaviano (2008) and Bilbiie et al. (2012)) and employment reallocation (Davis and Haltiwanger (1992)).

Finally, this paper falls in the literature applying difference-in-difference method to estimate causal evidences. Recent works have shown that two-way-fixed effects estimators are biased in those cases where treatment is heterogeneous, not binary, not absorbing, and not staggered (see Callaway and Sant'Anna (2021), De Chaisemartin and d'Haultfoeuille (2022b) and Goodman-Bacon (2021)). They show that when there is heterogeneity in the treatment effect, the trend among early-treated units constitutes a poor counterfactual for the trend among late-treated units. Since the treatment

[3] See among the others Ferrari et al. (2022), Davies et al. (2018), and Martin et al. (2022)

in this paper falls exactly in these critical cases, I apply the method proposed by De Chaisemartin and d'Haultfoeuille (2020).

2 Data and Institutional Context

2.1 Firm Taxation in Germany

Germany has two taxes on business income: the corporate income tax (*Kortperschaftsteuer*) and the local business tax (*Gewerbesteuer*). In this paper, I will focus only on the local business tax (henceforth LBT) as it amounts to a larger share of the burden on firms (in 2018, it amounted to 1.6% of the German GDP and around 7% of the total tax revenue).

The LBT applies to the operating profits of both corporate and non-corporate firms. The LBT is the product of a uniform tax rate (τ_{fed}, which currently amounts to 3.5 %), common across all the municipalities, and a municipal tax rate (Hebesatz) which is set by municipal council every year in December (τ_{mun}). Consequently, each of the over 11,000 municipalities in Germany can potentially have a different tax rate. Notably, the uniform tax rate, τ_{fed}, the tax base definition, and the liability criteria are set at the federal level. Hence, the municipal tax rate is the only difference among municipalities. There is high variability in the municipal tax rates over time as, on average, 10% of the municipalities change the local tax rate every year, and most adjustments are upward. At the same time, changes in the uniform tax rate, τ_{fed}, are much rarer as they imply a national fiscal reform. During the period considered, τ_{fed} changed only once, in 2008, from 5.0% to 3.5%. Consequently, the long-run corporate tax decline is given by the cut of τ_{fed} in 2008, and it allows me to study the long-run macroeconomic effect of a policy tax cut using a calibrated model (Section 5). At the same time, the year-to-year variation in τ_{mun} provides a perfect setting to empirically study the short-run micro-mechanisms of a tax cut as it allows a clear distinction between treated firms and control [4].

Therefore, the German tax system represents a perfect case study to estimate the effect of tax changes on firm dynamics for at least three reasons. First, municipal councils vote for the next year's taxes every year in December; firms are typically surprised by the tax change, and there is little room for any anticipation effect[5]. Secondly, in contrast to other markets such as the United States, where counties have the freedom to modify the local tax rate, the tax base definition, and deductability criteria, the sole distinction in tax codes among municipalities lies in the municipal tax rate. This is important as it allows us to identify a *pure* tax shock that is not influenced by other changes in the local tax code.

[4] Since 2004, municipalities have been obliged to set a minimum rate of 2%. However, this reform had a minor effect as the majority of municipalities already levied more than that threshold.

[5] Link et al. (2022) show that the media coverage of LBT changes is around 8-10 times higher in December than in the other months of the year. This confirms that tax changes come really as a shock for firms.

Regarding multi-plant firms, firms with plants in more than one municipality face a tax rate computed as the weighted average of each municipal factor using the payroll in each municipality as weight. I drop those firms from the final sample to exclude the noise introduced by within-firm payroll adjustments to reduce the final tax rate, at the same time, the econometric assumption relies on group exogeneity, which would be violated in the presence of multi-plant firms. The exclusion of multi-plant firms could introduce some bias, as single-plant firms are typically smaller and more vulnerable to shocks. I address this issue in appendix D.1. where I replicate the main results including also multi-plants firms and aggregating all the plants of each firm into the head firm, while the results are slightly lower in magnitude, they are substantially in line with the main results using only single plants.

The last concern is related to municipalities that change boundaries over time. Those municipalities are mainly concentrated in the former East Germany, and dropping them would introduce a strong selection bias as East Germany has undergone a deep structural transformation after the reunification. I apply a transcoding algorithm to solve this issue to ensure a consistent municipal boundaries definition over time.

Figure 2 shows the average local business taxes among municipalities obtained by multiplying τ_{fed} and τ_{mun}. On average, most municipalities increase the τ_{mun} as seen by the positive slope before and after the 2008 re-

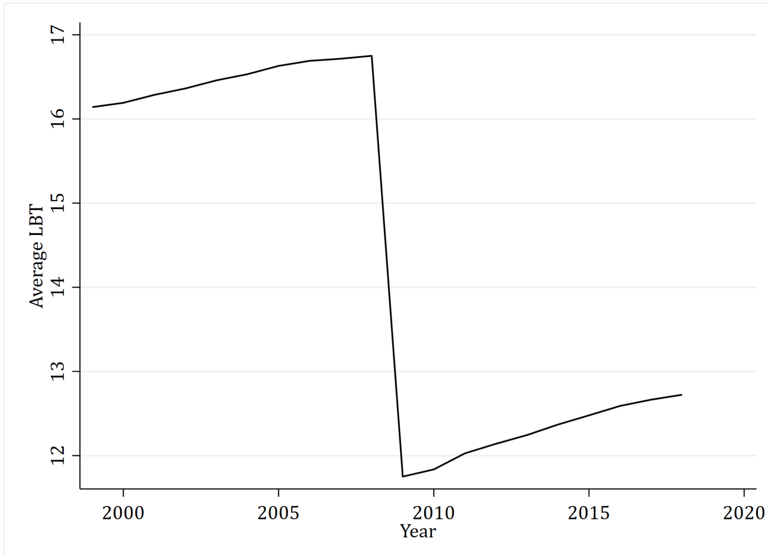

Figure 2. Average local business tax obtained as the product of the federal factor and the municipal factor averaged across municipalities.

form that, by cutting τ_{fed}, significantly dropped the LBT. Out of 11,000 municipalities, on average, every year, 1,231 change taxes (panel A of Table 1). In most cases, this is an increasing change. The average τ_{mun} is between 3.79% and 4.06%, and the average increase is 0.23%. Municipalities change taxes quite frequently; on average, between 2003 and 2018, each municipality change taxes 1.8 times. However, no municipalities have changed taxes yearly; the maximum number of changes per municipality is 13, and a relatively high number, around 15%, never change τ_{mun}.

Big cities tend to have a higher than the average τ_{mun} (panel B of Table 1), and, on average, cities in the West tax higher than cities in the East (Figure 3). Section 4.1. shows that municipal tax rates are correlated with some local aggregate economic factors but do not correlate with the local share of manufacturing. This finding is extremely relevant for the identification as it excludes endogeneity between manufacturing share and local taxes.

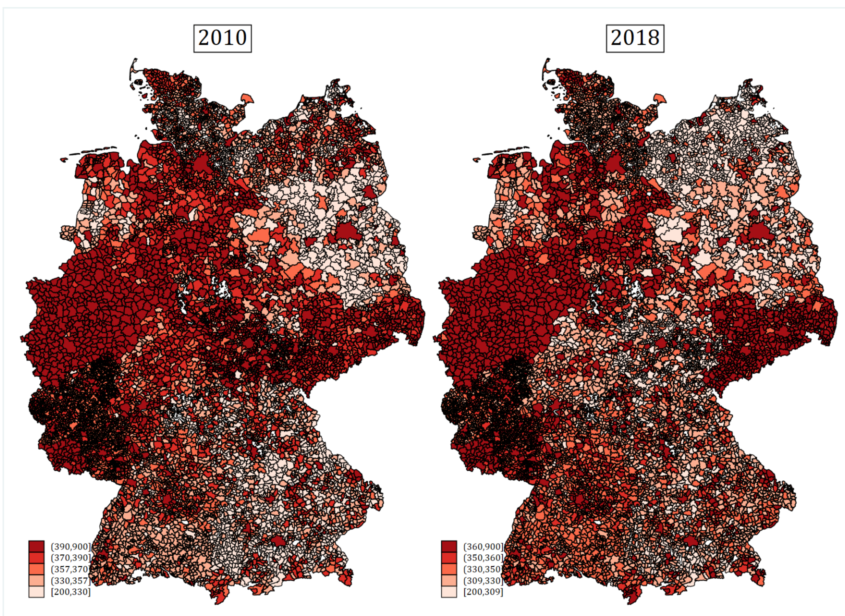

Figure 3. Municipal tax factors in 2010 and 2018.

2.2 Data Description

I combine several administrative firm-level dataset available on request at the Research Data Center of the German Federal Statistical Office[6] with

[6]Namely the source is: RDC of the Federal Statistical Offices of the German Federal States *AFiD-Panel Industrieunternehmen* (DOI: 10.21242/42221.2018.00.01.1.1.0), *AFiD-Panel Strukturerhebung im Dienstleistungs-bereich* (DOI: 10.21242/47415.2020.00.01.1.1.0), *AFidD-Panel Unternehmenreg-*

Table I. Local Business Taxes: average statistics

Panel A: Local Business Tax: aggregate statistics	
Number of municipalities	11,003
Average number municipalities changing taxes	1,231
Average number municipalities increasing taxes	1,137
Average increase of τ_{mun}	0.23
Average number of tax changes per municipality	1.80
Maximum number of tax changes per municipality	13
Number of municipalities that never change the taxes	1,618

Panel B: Local Business Tax over time: average and bigger cities

	2003			2010			2018		
	τ_{fed}	τ_{mun}	LBT	τ_{fed}	τ_{mun}	LBT	τ_{fed}	τ_{mun}	LBT
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Min	5	1	5	3.5	2	7	3.5	2	7
Max	5	6	30	3.5	6	21	3.5	6	21
W - Average	5	3.79	18.95	3.5	3.86	13.51	3.5	4.07	14.25
Berlin	5	4.1	20.5	3.5	4.1	14.35	3.5	4.1	14.35
Cologne	5	4.5	22.5	3.5	4.5	15.75	3.5	4.75	16.62
Düsseldorf	5	4.55	22.75	3.5	4.4	15.4	3.5	4.4	15.4
Frankfurt Main	5	4.9	24.5	3.5	4.6	16.1	3.5	4.6	16.1
Hamburg	5	4.7	23.5	3.5	4.7	16.45	3.5	4.7	16.45
Munich	5	4.9	24.5	3.5	4.9	17.15	3.5	4.9	17.15

Note: Table I shows several statistics of the Local Business Tax. Panel A indicates the number of municipalities in Germany, how many of them change the taxes on average during the period 2003-2018, how many increase, and the average increase. The bottom three lines indicate how frequent tax changes are in the period considered, how many times change the taxes in those municipalities that change the most, and how many municipalities never change the taxes. Panel B indicates the Local Business Tax rate and its two components in some of the bigger German cities in the first, mid, and last year of the sample.

publicly available data on local business tax rate at the municipal level and

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ister (DOI: 10.21242/52121.2019.00.01.1.1.0 and DOI: 10.21242/52111.2012.00.01.1.1.0). Data can be requested here county data on population, unemployment rate, and GDP per capita. All the firm-level dataset are longitudinal and can be merged through anonimized firm identifier.

Business Register[7]**.** The business register includes the full population of German plants and firms. The units of observation are establishments, and for each establishment, there is information regarding which enterprise it belongs. For each establishment, the information available includes birth and death year, location, number of employees, turnover, and economic activity classification (NACE Rev. 2). This is the only dataset that includes all the firms independently on their employment size. I use the business register to compute firm age, firm entry and exit[8]. At the same time, I observe firm size and job-creation and destruction rate. From this dataset, I also compute some aggregate statistics at the municipal level, such as the total number of firms by sector, total number of employees, and employment and output sector share.

Manufacturing sector [9]**.** The units of observation are firms and plants with at least 20 employees. For each of them, I observe, among the others, turnover, number of employees, investments, value-added, intermediate input, and wage. The observations are available yearly for the period

[7] I use this dataset to compute the following tables: II (Panel C), III, VI, VII, IX,

[8] Firm-entry is the registration year of the firm. Firm-exit is the dissolving year. If the dissolving year is not available, I assume a firm is dissolved if it is not active for three consecutive years.

[9] I use this dataset to compute the following tables: II (Panel A and B), III,V, VIII, X

1999-2018. For most of the variables, the coverage is the full population of German firms with at least 20 employees and this makes this dataset the best option available to study the German manufacturing sector[10].

[10]This dataset has been extensively used to study market power (see Mertens (2020) and Mertens (2022)), energy-shock impact (Mertens et al. (2022)) and minimum-wage effect (Haelbig et al. (2023)).

Table II. Descriptive Statistics

Panel A: Only firms with more than 20 Employees

	Manufacturing		**Service**	
	Mean	Median	Mean	Median
	(1)	(2)	(3)	(4)
Revenue (in 1000s)	44,828	7,729	17,168	3,566
Employment	179.41	59	120.96	42
Wage per Empl. (in 1000s)	37.09	35.90	36.05	33.23
Value Added per Empl. (in 1000s)	53.68	46.58	59.39	47.33
Firm Age	27.87	16	19.21	10

Panel B: Only firms with more than 20 Employees - aggregates

	Manufacturing	**Service**
	(1)	(2)
Job Creation Rate	0.033	0.069
Job Destruction Rate	-0.030	-0.052
VA per Emp of exiting firms	14.60	18.70

Panel C: Full Population of Firms

	Manufacturing		**Service**	
	Mean	Median	Mean	Median
	(1)	(2)	(3)	(4)
Revenue (in 1000s)	3,801	506	2,024	291
Employment	20.7	5	8	3
Age	23.10	14	15.09	7

Note: Table II shows several descriptive statistics. In Panel A, they are computed only among firms with more than 20 employees. Value Added is computed as the difference between revenues and intermediate input. Employment refers to the number of employees in headcount at the end of the year. In Panel B, the Job Creation Rate and Job Destruction rate are computed as in Davis and Haltiwanger (1992) and weighted at sector level. In Panel C, indicators are computed using also firms with less than 20 employees. Only single-plant firms are included. In the Appendix, Table B.1. provides statistics that include also multi-plant firms.

Service sector [11]**.** Data on the service sector is a representative stratified[12] sample covering 15% of the firms with a turnover of at least 17.5 thousand euro. It includes turnover, number of employees, investments, value-added, intermediate input, wage and salaries of firms in the following economic sectors: transportation and storage, information and communication, professional, scientific and technical activities, administrative and support service activities according to NACE Rev. 2 classification[13]. To make this sample comparable with manufacturing, I exclude firms with less than 20 employees and I apply inverse probability weighting to ensure the representativeness of the sample.

Others. I complement these datasets with local tax rates data at the municipal level, publicly available from the Federal Statistical Office of Germany, and with aggregate data on unemployment rate and total population at the county level. I also collect a few other aggregated variables from OECD Data Statistics, Eurostat, CompNet dataset, and EU-KLEMS[14].

Sample definition. When not explicitly indicated, I conduct the main econometric analysis using the Manufacturing and Service databases combined with information on firm-entry and exit taken from the business reg-

[11] I use this dataset to compute the following tables: II (Panel A and B), III,V, VIII, X

[12] Data are stratified at state, 4-digits industry, and sales level.

[13] Namely sectors J,M,N of the NACE Rev.2 classification.

[14] See Bighelli et al. (2023) and Haug et al. (2022) for a description of the CompNet dataset and Corrado et al. (2022) for a description of EU-KLEMS.

isters. I drop multi-plants from the main sample. The reason is twofold: first, the presence of firms with establishments in multiple municipalities would bias the econometric estimation by invalidating the group exogeneity assumption. Second, it would introduce a channel, the intra-firm adjustment in response to tax shock, that is not directly observable and would distort the results. However, this can potentially introduce some bias, as single-plant firms are typically smaller and more vulnerable to shocks. In appendix D.1., I address this issue and I replicate the main results including also multi-plants firms, results are robust and only slightly attenuated. Finally, each establishment is allocated to one economic sector following the NACE classification. NACE classification changed in 2008, and I follow Mertens (2022) to transcode economic sectors and obtain a time-consistent definition of manufacturing and service. I also apply an outliers routine to winsorize extreme values of firm' value added and number of employees. Finally, I drop municipalities with less than 5 firms in both manufacturing and service and less 100 employees in total.

Table II provides an overview of some firm-level variables computed using both datasets. Firms in manufacturing are, on average, bigger and pay higher salaries than firms in the service sector. However, the service sector is more productive and more dynamic than manufacturing. Moreover, the value-added of firms in their last year of activity is higher in the service sector. This evidence suggests that the productivity threshold that selects the firms surviving in the market is higher in the service sector.

Finally, Table III provides statistics on employment and turnover share of manufacturing and service across German municipalities.

Table III. Average statistics on Manufacturing and Service share

	Manufacturing	Service	Other sectors
Employment share all firms market economy	31.17%	23.41%	45.42%
Revenue share all firms market economy	35.24%	23.58%	41.18%
Employment share all firms selected sectors	54.32%	45.68%	
Revenue share all firms selected sectors	56.58%	43.42%	
Employment share 20+ firms market economy	41.21%	22.38%	36.41%
Revenue share 20+ market economy	42.94%	24.16%	32.90%
Employment share 20+ firms selected sectors	60.85%	40.15%	
Revenue share 20+ selected sectors	62.41%	43.59%	

Note: Table III shows the mean of the manufacturing and sector employment and revenue shares across municipalities. The first two lines indicate the shares over all the market economy. The third and fourth lines indicate the shares computed only among the selected sectors: manufacturing and tradeable service. The bottom four lines indicate the shares computed only using firms with more than 20 employees.

3 Facts on Manufacturing, Service and Taxes

In this section, I briefly present a few key aggregate facts on Manufacturing, Service, and Taxes that provide insight into the reallocation between manufacturing and service. I also state some hypotheses on how the reallocation works that will guide the empirical and the quantitative analysis. Moreover, when possible, I show how these trends look in other countries. While a cross-country comparison is beyond the scope of this paper, it is interesting to observe that these facts are common in other advanced economies.

Fact 1. Corporate tax rates have decreased in advanced economies.

Table IV shows the Statutory Corporate Tax Rates on profits in advanced countries in 2001 and 2018. All the selected countries have decreased the corporate tax rate in the last two decades. Different liability criteria and different rules in defining taxable income make it difficult to compare the tax rates across countries and over time. However, many studies investigating effective tax rates (Dyreng et al. (2017) and Drake et al. (2020)) have confirmed that tax rates have undoubtedly decreased in the last decades.

Table IV. Statutory Corporate Tax Rates

Country	2001	2018	Δ
Belgium	40.2	29.6	-10.6
Canada	40.5	26.6	- 13.9
China	33	25	-8
Denmark	30	22	- 8
Finland	29	20	-9
France	36.4	34.4	-2
Germany	38.3	29.9	-8.4
Ireland	20	12.5	-7.5
Italy	40.3	27.8	-12.5
Japan	40.9	29.7	-11.2
Luxembourg	37.5	24.9	-12.6
Netherlands	35	25	-10
Norway	28	22	-6
Portugal	35.2	31.5	-3.7
Spain	35	25	-10
Sweden	28	21.4	-6.6
United Kingdom	30	19	-11
United States	39.3	25.9	-13.4

Fact 2. Business dynamism in Service is higher and relatively increasing.

While several studies have documented decreasing business dynamism in advanced economies, and it is undoubtedly the case for many sectors of the economy, business dynamism has been on the rise in the Service sector relatively to Manufacturing, as illustrated in Figure 4. While the number of firms in Service is around 10% higher in 2019 than in 2008, it consistently drops in Manufacturing (top-left panel). Similarly, the churn rate, computed as the sum of the entry and exit rates, has always been higher in the Service sector, and the difference with manufacturing increased in the last years (top-right panel). This can be seen also in the two graphs at the bottom. The firm-entry and firm-exit rates in Manufacturing have always been diminishing for most of the last decade.

Hypothesis 1 *Business dynamism in Service is more elastic to tax shock than in Manufacturing*

In the following sections, I show the causal relationship between tax shock and business dynamism in service, and I will relate this to lower entry and adjustment costs in the Service sector.

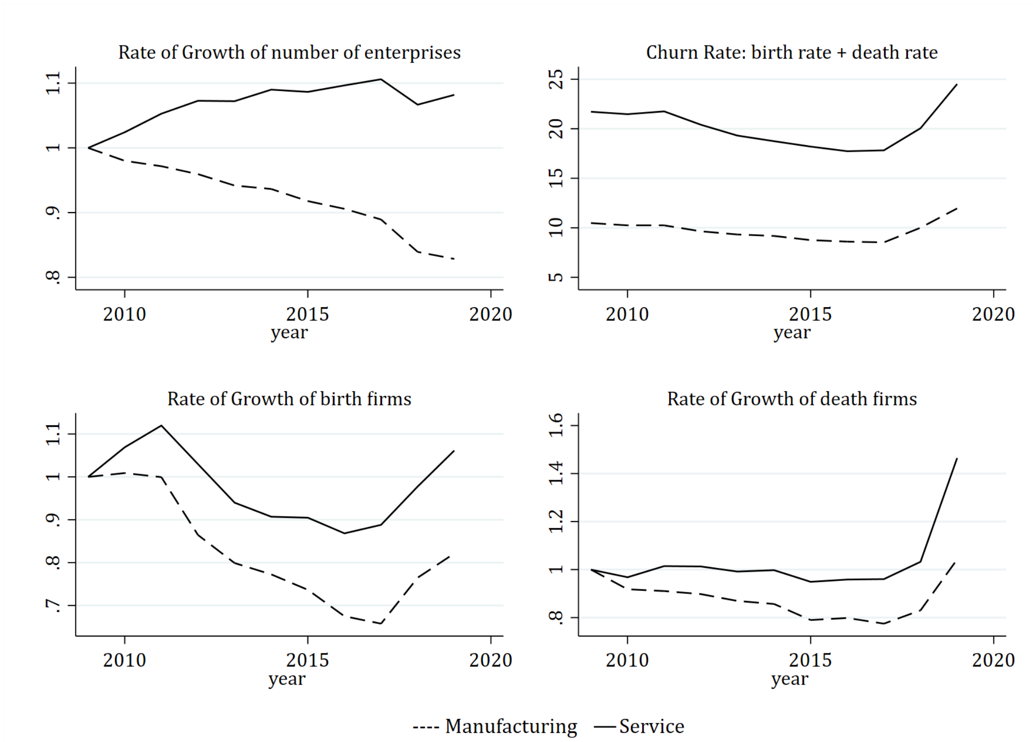

Figure 4. The figure shows the rate of growth of number of employees (top-left), the rate of growth of birth firms (bottom-left), and the rate of growth of death firms (bottom-right) as change with respect to base year 2008. The top-right panel shows the churn rate computed as the sum of the birth rate and death rate. Source: Eurostat Structural Business Statistics

Fact 3. The average Wage in Service has increased.

While average wages in Germany are higher in manufacturing than in service, they increased more in the latter than in the former, as seen in Figure 5. In section 5, I argue that the higher labor demand consequent to the higher entry rate in service contributed to this difference. Moreover, in section 4, I show that wages in service are more responsive to tax shock than in manufacturing.

Hypothesis 2 *Wages in Service are more responsive to tax shock than in Manufacturing*

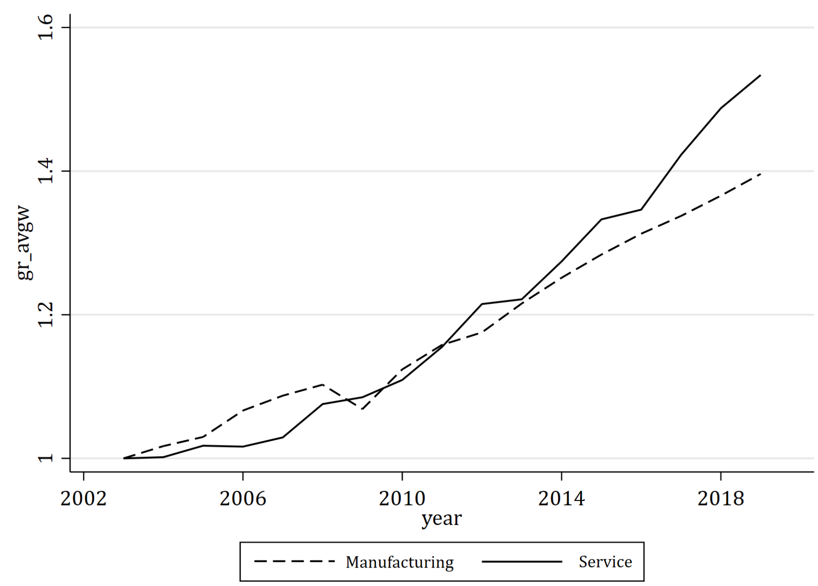

Figure 5. The Figure shows the growth of employees' total compensation with respect to the base year in Manufacturing and Service. Source: EU-Klems.

Due to the relatively higher wages, the least productive firms are forced to quit the market. This selection mechanism works more in Service where there is higher business dynamism and higher wage response, and it translates into higher firm productivity in the Service sector.

Hypothesis 3 *Firm Productivity in Service is more responsive to tax shock than in Manufacturing*

Fact 4. Manufacturing share in the economy decreases.

Figure 4 shows that the share of workers employed in manufacturing is declining in advanced economies. The trend is negative also in countries with a traditionally big manufacturing sector, like Germany. It is true both in absolute numbers and in share. In the period 2000-2018, the number of workers employed in manufacturing dropped by 2% in Germany, 35% in UK, and 26% in the US. At the same time, the number of employees in the service increased, respectively by 54%, 53% and 45%. The same holds for value-added and gross output[15]. These numbers suggest that results for Germany, given its historically massive manufacturing sector can represent a good lower bound for estimating the effect of taxes on sector reallocation.

At the same time, there is another descriptive statistic that suggests a relationship between tax cuts and manufacturing decline in Germany as well as in other countries. As described in section 3, Germany implemented a substantial tax cut in 2008 (-9%). To see what happened in other

[15] For value-added, in manufacturing it increased by 36% in Germany, 3% in UK and 27% in US, while in service it increased, respectively, by: 75%, 234%, and 241%. For gross output, in manufacturing it increased by 31% in Germany, 18% in UK and 20% in US, while in service it increased, respectively, by 76%, 228% and 202%.

advanced countries, I select three countries that implemented a substantial tax cut around the same period, and three that did not implement any tax reform. For each of these two groups of countries, I observe the dynamic of the manufacturing share in the period 2004-2007, which I compare with the period after the tax cut, 2008-2011. The countries that implemented a tax cut experienced a decline of manufacturing share of double size, compared to those that did not implement[16][17].

Hypothesis 4 ***Tax cut contributes to Manufacturing decline***

[16]Namely, I include in the tax-cutting group Italy, Spain, and United Kingdom. In the 2008-2011 period, they had a lower tax rate of about 4.2 percentage points compared with the 2004-2007 period, and, among the two periods, they faced a decline in manufacturing of, on average 5.2 percentage points. The non-tax-cutting group includes France, United States and Belgium. In the period 2004-2011, they did not implement any tax cut, and in 2008-2011 they face an average decline of manufacturing share of only 2.5 compared to 2003-2007.

[17]In the Appendix, Figure C.4. shows the cross-country correlation between the country change in the effective tax rate and the change in the country's manufacturing share: a higher decline in the effective tax rate correlates with stronger manufacturing share decline.

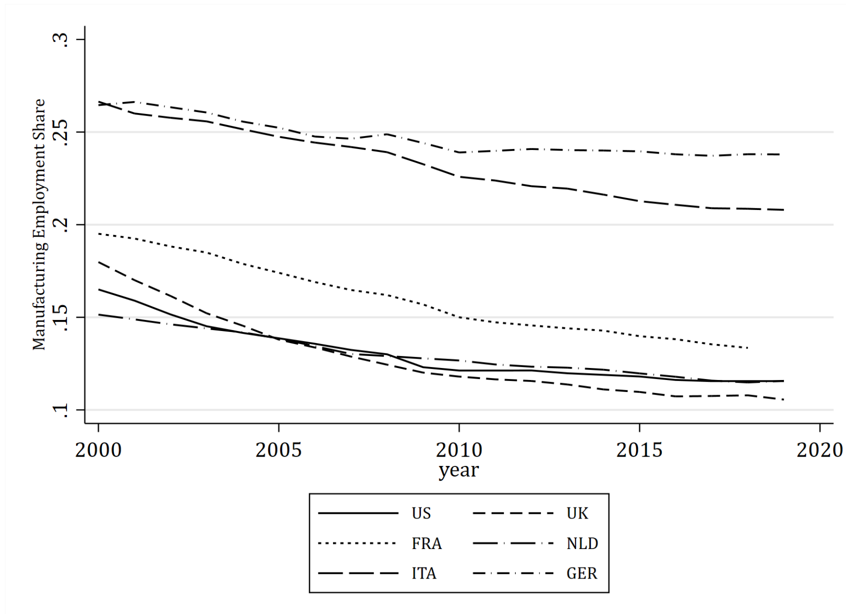

Figure 6. The Figure shows the employment manufacturing share computed as the number of employees in manufacturing divided by the total market economy in six selected countries. Source: EU-Klems.

4 Empirical Estimation

This section outlines the main econometric specification, discusses the identification assumptions and threats, and presents the main results. Before entering the main econometric analysis, I dig deeper into how municipalities decide to change the LBT municipal factor. The main identifying assumption is that municipalities do not set the local factor in response to the municipal manufacturing share. The following subsection validates this assumption.

4.1 Determinants of Municipal Tax rate Changes

In Table V, I run a set of fixed effect estimations to understand how municipal aggregate variables correlate with local tax rates changes. The coefficients of interest are log(MAN) and log(SER), indicating how the municipal employment manufacturing or service share affects the change of local taxes[18]. Table V shows that, when regressing the logarithm of manufacturing share on the logarithm of the municipal tax rates, manufacturing share is not significant. In other words, municipal manufacturing and service share do not correlate with the change in municipal tax. Therefore, we can exclude that municipalities set the tax rates in response to the manufacturing share. They rather adjust the local taxes in response to aggregate variables like aggregate productivity, unemployment rate, and municipality size.

[18] Appendix D replicates these table using Sales Manufacturing share and Sales Service share.

Table V. Manufacturing Share and Fixed Effect Estimation

	$\mathbf{log(}\tau_{m,c,t+1}\mathbf{)}$			
	(1)	(2)	(3)	(4)
$\log(\text{MAN}_{m,c,t})$	0.0001	0.0002	0.0001	0.0002
	(0.0005)	(0.0005)	(0.0005)	0.0005)
$\log(\text{SER}_{m,c,t})$	0.00008		0.00008	
	(0.0004)		(0.0004)	
$\log(\text{EMP}_{m,c,t})$	0.0019	0.0017		
	(0.0025)	(0.0022)		
$\log(\text{Avg EMP}_{m,c,t})$	-0.0037	-0.0027	-0.0017	-0.0010
	(0.0024)	(0.0021)	(0.0014)	(0.0012)
$\log(\text{LP}_{m,c,t})$	-0.0015*	-0.0015**	-0.0015*	-0.0016**
	(0.0008)	(0.0007)	(0.0008)	(0.0007)
$\log(\text{Avg Age}_{m,c,t})$	0.0006	-0.0005	-0.0006	-0.0005
	(0.00067)	(0.00062)	(0.00067)	(0.0006)
$\log(\text{POP}_{c,t})$	-0.158***	-0.151***	-0.158***	-0.151***
	(0.02385)	(0.0229)	(0.0238)	(0.0229)
$\log(\text{Un. Rate}_{c,t})$	-0.008**	-0.0094**	- 0.0085 **	-0.0094**
	(0.004)	(0.0039)	(0.004)	(0.0039)
Land-Year FE	Yes	Yes	Yes	Yes
Municipality FE	Yes	Yes	Yes	Yes
N	60,152	60,152	60,152	60,152
Cluster SE	Municipality	Municipality	Municipality	Municipality

Note: Table V shows the results of the association of municipal corporate taxes on a few aggregate variables at the local level. The sample includes single plant firms with more than 20 employees. Standard Errors clustered at municipal level.

4.2 Econometric Specification

Having established that municipalities don't set the tax rate in response to manufacturing share, I can proceed with the main econometric estimation of the effect of corporate taxes. I estimate the main econometric specifications at the municipal and firm level as in equations (1) and (2), respectively:

$$logY_{m,t} = \alpha_{m,t} + \beta\tau_{m,t-1} + \psi_{k,t} + \epsilon_{m,t} \tag{1}$$

$$logY_{i,m,t} = \alpha_{m,t} + \alpha_{i,t} + \beta\tau_{m,t-1} + \psi_{k,t} + \epsilon_{i,m,t} \tag{2}$$

Where τ is the lagged corporate tax rate of the municipality, i indicates firm, and m indicates municipality. ψ includes a set of controls at the county level, including population and unemployment rate. I estimate equation (1) at the municipal level, and I use the employment manufacturing share and, separately for manufacturing and service, the total number of firms as the dependent variable. I estimate equation (2) at firm-level and, separately, for manufacturing and service using wages, firm size, and labor productivity as outcome variables. Standard errors are clustered at the municipal level.

Results are estimated using De Chaisemartin and d'Haultfoeuille (2020) approach. They show that the standard way to estimate average treatment effect (ATE) using linear regressions with period and group fixed effects yields biased estimations when the treatment is not binary, heterogeneous, and units can move in and out of treatment status. The treatment in this paper falls in all these cases. It is heterogeneous, as each municipality can increase the tax rate by any magnitude. The effect is also heterogeneous as the response may vary by the local conditions of the municipality. Moreover, the treatment is not staggered as municipalities can move in and out of it as they can be treated multiple times (but also never).

To be valid and draw causal inference, the estimator needs to satisfy a set of seven identifying assumptions, namely: a balanced panel of groups, sharp design, independent groups, strong exogeneity, and common trends for the potential outcome with treatment, existence of a stable group, mean independence between a group's outcome and other groups treatment, existence of a stable group for the placebo tests. Let's briefly discuss all of them. My estimation is clearly a sharp design, and I have a balanced panel of groups as no municipalities appear or disappear over time, and in the few cases where it happens, I apply the transcoding procedure described in section 2.1. I test the common trend assumption in every equation by using placebo estimation. In other words, I compare treated and control outcome evolution before the treatment changes. The common trend assumption requires that the placebo should not be different from zero. Contrarily to the staggered adoption design, in my case, I have a non-absorbing treatment (e.g. municipalities that increase the taxes in t but not in t+1 are not considered treated in t+1), it requires that the common trend assumption needs to hold for every pair of consecutive periods. I also have a stable group in every period as well as in every placebo estimation, which means that for every pair of consecutive time periods, t and t+1, I have at least a municipality that increases and a municipality that does not increase the taxes and a municipality that increases the taxes in both t and t+1 and a municipality that increase only in t but not in t+1. Independent Groups assumption requires that the potential outcomes and treatments of different groups be independent (but allows for them to be correlated over time within group). The exclusion from the sample of those firms that have plants in multiple municipalities strengthens this assumption as well as the inclusion of fixed effects, particularly those at time and state level as in Appendix C. Finally, Table V excludes the possibility of endogeneity and reverse causality between the treatment and the outcome.

If these assumptions are satisfied, the estimator generalizes the standard DID estimator with two groups, two periods, and binary treatment to a situation with many groups, many periods, and non-binary and non-absorbing treatment. It compares groups two by two based on the same initial value of treatment, and it computes a DID estimator for each pair of consecutive time periods. Then, the ATE is equal to the average of those DIDs across all pairs of consecutive time periods and across all treatment values. All the specifications include group and time-fixed effects. For each regression at the municipal level, I include time fixed effect interacted with a categorical variable indicating within municipality average firm number of employees. In this way, I obtain an estimator that is equal to a weighted average of ATEs within the same size categorical variable, which are unbiased even if groups experience differential trends, provided that all groups within each size group experience parallel trends. In the firm-level regression, I use directly a categorical variable for the number of employees. Appendix C includes a battery of robustness checks. I estimate all the equations with time-fixed effect interacted with categorical variable clustering municipalities by municipal size and another version where I don't include any interaction of time-fixed effect.

4.3 Municipal level results

Table VI shows the result of the difference-in-difference estimation of the effect of an increase in the municipal corporate tax rate on the municipal number of firms. The sample includes all the firms of all size. I estimate this regression twice, once only for firms in manufacturing and once only for firms in service. Results show that a 1 p.p. increase in the municipal tax rate decreases the municipal number of firms in the service sector in the following period by 4%. At the same time, it does not affect the number of firms in manufacturing. In the last two lines of Table VI, I run a placebo estimator for one and two periods before the tax shock. All the placebo coefficients are not significant, confirming the parallel trend assumption. These results provide causal evidence validating **Hypothesis**

1 that business dynamism in service is more responsive to tax shock than in manufacturing, particularly through entry rate.

Table VI. Effect of taxes on Municipal Number of Firms

	Dependent variable: Number of Firms$_{m,t+1}$	
	Manufacturing	Service
	(1)	(2)
$\tau^{mun}_{m,t}$	0.002	-0.0041***
	(0.008)	(0.00144)
N	51,645	51,645
Cluster	Municipality	Municipality
Placebo 1	-0.0002	-0.0004
	(0.0004)	(0.00099)
Placebo 2	0.0009	0.0002
	(0.0055)	(0.0002)

Note: Table VI shows the result of the difference-in-difference estimation of equation (1) with the municipal number of firms in manufacturing and service as outcome variables. The sample includes all single plant firms of all size, aggregated at municipal level. Standard error clustered at the municipal level. The estimation is computed using the approach developed by De Chaisemartin and d'Haultfoeuille (2020) and De Chaisemartin and d'Haultfoeuille (2022a).

Table VII shows the results of the same estimation of a tax increase on the municipal manufacturing share. Manufacturing share is calculated as the share of the municipal sum of employees and revenues divided by the sum of the manufacturing and service sectors. In both cases, manufacturing share *increases* in response to a tax increase. This result suggests that if municipal taxes were the only taxes without the federal component (τ_{fed}), a tax increase could foster manufacturing share, and if we assume a

Table VII. Effect of taxes on Municipal Manufacturing Share

	Dependent variable:	
	Employment Manufacturing Share$_{m,t+1}$	Revenue Manufacturing Share$_{m,t+1}$
	(1)	(2)
$\tau_{m,t}^{mun}$	0.011**	0.023**
	(0.0053)	(0.010)
N	51,645	51,645
Cluster	Municipality	Municipality
Placebo 1	0.0044	0.0051
	(0.0035)	(0.0048)
Placebo 2	-0.0056	-0.0073
	(0.00317)	(0.0041)

Note: Table VII shows the result of regressing equation (1) on the municipal employment manufacturing share (column 1) and the municipal revenue manufacturing share (column 2). Manufacturing shares are computed as the ratio of manufacturing and the sum of manufacturing and service. The sample includes all single plant firms of all size aggregated at municipal level. Standard error clustered at the municipal level. The estimation is computed using the approach developed by De Chaisemartin and d'Haultfoeuille (2020) and De Chaisemartin and d'Haultfoeuille (2022a).

symmetric effect, we conclude that a tax cut will cause a decrease in manufacturing share.

4.4 Firm Level Results

To dig deeper into the micro-mechanisms that cause the link between corporate tax and manufacturing share, I show that the reallocation is due to firms in the service sector being more responsive to tax shock. This finding motivates the entire article: if firms in service were responding to a tax shock the same way as firms in manufacturing, there would not be any room for reallocation. I investigate the responsiveness of firms to tax shock with respect to three outcome variables: average wage, number of employees, and labor productivity, defined as value added per employee. This allows to test the transmission mechanism outlined above that connects the tax shock to the sectoral reallocation.

Table VIII. Effect of taxes to within-firm average wage

	Dependent variable: Average Wage$_{i,m,t+1}$	
	Manufacturing (1)	Service (2)
$\tau_{m,t}^{mun}$	-0.008*	-0.014***
	(0.0044)	(0.0035)
N	183,116	302,945
Cluster	Municipality	Municipality
Placebo 1	-0.0003	-0.026
	(0.041)	(0.035)
Placebo 2	0.047	0.0549
	(0.027)	(0.0691)

Note: Table VIII shows the result of regressing equation (2) on the firm average wage computed as total firm wages divided by the number of employees in headcounts. The regression is estimated separately for manufacturing and service. The sample includes single plant firms with more than 20 employees. Standard error clustered at the municipal level. The estimation is computed using the approach developed by De Chaisemartin and d'Haultfoeuille (2020) and De Chaisemartin and d'Haultfoeuille (2022a).

Table XIII shows that an increase (decrease) in corporate tax decreases (increase) wages. According to Fuest et al. (2018), this mechanism is due to the ability of firms to pass the tax burden to workers. Table XIII reveals this happens more in the service sector. The different sectoral elasticity to tax

Table IX. Effect of taxes on Firm Number of Employees

	Dependent variable: Number of Employees$_{i,m,t+1}$			
	Manufacturing		Service	
	All Firms	Incumbents	All Firms	Incumbents
	(1)	(2)	(3)	(4)
$\tau^{mun}_{m,t}$	0.0044	-0.003*	0.024***	-0.014**
	(0.0224)	(0.0016)	(0.004)	(0.011)
N	1,264,511	1,032,518	3,548,146	2,631,137
Cluster	Municipality	Municipality	Municipality	Municipality
Placebo 1	-0.0032	-0.122	0.0023	-0.0002*
	(0.040)	(0.205)	(0.0000)	(0.0001)
Placebo 2	-0.0002	0.074	0.00091	-0.0001
	(0.131)	(0.071)	(0.0033)	(0.0024)

Note: Table IX shows the result of regressing equation (2) on the firm number of employees in headcounts. The regression is estimated separately for manufacturing and service. Columns 1 and 3 include all the firms in the sector. Columns 2 and 4 exclude firms that entered the sample in the year and firms that will exit the sample in the following year. The sample includes single plant firms with more than 20 employees. Standard error clustered at the municipal level. The estimation is computed using the approach developed by De Chaisemartin and d'Haultfoeuille (2020) and De Chaisemartin and d'Haultfoeuille (2022a).

shock can result from several factors, like different sectoral capital-labor substitability. Jäger et al. (2022) find that workers in manufacturing and bigger firms are usually more covered by collective bargaining contracts, which provides another explanation that contribute to making manufacturing wages less flexible. Moreover, the entry and exit of firms in service necessarily implies a higher share of new employment contracts that make the labor market in service more dynamic and flexible and increase the average response of wages to tax shock.

Table X. Effect of taxes on Labor Productivity

	Dependent variable: Labor Productivity$_{i,m,t+1}$	
	Manufacturing (1)	Service (2)
$\tau_{m,t}^{mun}$	-0.0238*	-0.077***
	(0.0133)	(0.0.0246)
N	183,116	302,945
Cluster	Municipality	Municipality
Placebo 1	-0.0098	-0.145
	(0.046)	(0.23)
Placebo 2	-0.0009	-0.0079
	(0.112)	(0.0231)

Table X shows the results of regressing equation (2) on firm labor productivity computed as value-added per employee. The regression is estimated separately for manufacturing and service. The sample includes single plant firms with more than 20 employees.Standard error clustered at the municipal level. The estimation is computed using the approach developed by De Chaisemartin and d'Haultfoeuille (2020) and De Chaisemartin and d'Haultfoeuille (2022a).

In Table VII, I show that tax hike (cut) causes increase (decrease) of the manufacturing share. It occurs through two distinct channels: firstly, by influencing the sectoral number of firms (hence through the *extensive* margin). And, secondly, by impacting the average size of existing firms (hence through the *intensive* margin).Table VI already investigated the extensive margin establishing a causal link between tax change and net growth of the number of firms. Table IX investigates the intensive margin: how tax change affects the average size of existing firms. Columns (2) and (4) of table IX show the results: tax hike (cut) decrease (increase) the average size of incumbent firms, again firms in the service sector are more responsive than firms in manufacturing to a tax shock. When we consider the effect of tax on the average firm size including also entrants and exits, the coefficients are of the opposite sign. This is not surprising and it has already been investigated by the literature. Decker et al. (2017) finds that tax cut stimulate the entry of firms, and since young firms tend to be smaller than the average, tax cut reduces the average firm size. At the same time, (Acemoglu et al., 2018) find that tax hike may stimulate the exit of smaller firms, with the effect of increasing the average firm size. Overall, the message of Table IX is that a tax cut increases the size of incumbent firms, particularly in the service sector and decrease the average size of all firms because it stimulates the entry of many small firms. Again, these two effects happen more in the service sector.

Finally, the last empirical result is the effect of tax shock on labor productivity computed as value added per employee. Table X shows that the effect of corporate tax shock is higher in service than in manufacturing. And, given what we learned in the previous results, this is mainly given by the larger exit of low-productive firms.

Overall, from the empirical results, we learned that if we assume that tax cuts and tax hikes lead to symmetric outcomes, corporate tax cuts increase the share, the dynamism and the average productivity in the service sector. At the same time, tax cuts do not appear to stimulate much manufacturing sector. These effects combined lead to the sectoral reallocation from manufacturing to service.

5 Model

In this section, I build a general equilibrium model with a heterogeneous mass of firms that endogenously enter and exit the market. The model borrows from Sedlacek and Sterk (2019) that extended the framework developed by Hopenhayn (1992) and Hopenhayn and Rogerson (1993) by including profit tax. I further extend this framework to a two-sector model to study how a corporate tax cut drives the sectoral reallocation. To study the effect of taxes, I simulate the general equilibrium model under two scenarios: the first with a corporate tax rate of 38% and the second with a corporate tax rate of 29%. This tax cut is consistent with the tax cut observed in Germany after the reform of 2008 that, among the others, cuts τ_{fed}. To keep the model simple, I assume that all the municipalities levy the same tax rate, e.g., there is no spatial dimension and no spatial reallocation in the model. As commonly done in the literature investigating on corporate tax incidence started with the seminal paper by Harberger (1962), the economy is closed. This assumption does not necessarily mean that the external sector is ignored, but it means that the external sector is assumed to play the same role under the two simulations with high and low tax. I will discuss the implication of this and other assumptions in section 5.5.

5.1 The Economy

The economy is stationary. Time is discrete. There is a representative household with utility $U(C, N) = lnC - \nu N$.

There are three categories of firms in this economy: two of them include firms producing intermediate inputs: manufacturing and service. The third is a single firm that combines the intermediate inputs (M_t and S_t) to produce a final good Y_t. Firms are owned by the household.

Firms maximize the present value of after-tax profits and operate decreasing returns-to-scale production technologies, denoted by $y = f(k, l, z)$. To simplify the notation, I omit the firm subscript *i*. Productivity, z, is firm-specific and follows a Markov process. Production requires a fixed operational cost c_f, denominated in units of goods. Capital depreciates at a rate δ and I denote investment by $i = k - (1 - \delta)k_{-1}$. Incumbent firms face a cost of capital adjustment given by $\psi(k, k_{-1}) \geq 0$.

At the beginning of a period, a firm chooses whether to exit or to continue. And it already knows its lagged TFP level z_{-1}. If it decides to continue, it learns its current productivity realization and generates a before-tax cash flow given by: $\pi^c = y - wn - i - c_f - \psi(k, k_{-1})$. If the firm exits, it avoids fixed costs, sells its remaining capital, and terminates operation forever. The final, before tax, cash flow is $\pi^x = (1 - \delta)k_{-1} - \psi(0, k_{-1})$.

There is free entry of firms. After paying an entry cost, c_e, an entrant draws its initial lagged value z_{-1} from a distribution. After this, entrants behave as incumbents. Entrants start with zero capital and are exempted from the capital adjustment cost.

For simplicity, I assume that only one firm is producing the final good, which will never leave the market and will never face the competition of an entry firm producing the final good. At the same time, I assume that intermediate input firms cannot change the sector in which they produce during their life: if a firm enters the market operating in manufacturing, it will be a manufacturing firm until it dies.

Firms in the intermediate goods sector are taxed on their business income, calculated as revenues minus operating costs, at a rate τ. Firms can partially deduct labor and capital expenses, the fixed cost of production, and the adjustment costs[19]. This means that those expenses are excluded from the calculation of taxable income and take the form of a depreciation allowance (depreciation equals deduction).

Including the factor cost deduction, tax bills for continuing and exiting firms are:

$$T^c = \tau(y - wn - c_f - \psi(k, k_{-1}) - \delta k) \tag{3}$$

$$T^x = -\tau\psi(0, k_{-1}) \tag{4}$$

[19]For a discussion on the effect of different deduction systems, see Sedlacek and Sterk (2019)

In other words, the taxable income of a continuing firm does not include labor costs and investments, and firms deduct the amount of capital lost in depreciation. If a firm exits, it does not pay any taxes since the final sale of capital is a negative investment excluded from taxable income.
The firm value can be expressed as:

$$V(z_{-1}, k_{-1}) = max\{E\{max_{k,l}\pi^c - T^c + \frac{1}{1+r}V(z,k)\}, \pi^x - T^x\} \quad (5)$$

Firms in the final good sector produce output Y using the following production function where a is the elasticity of substitution between manufacturing and service goods:

$$Y_t = [aM_t^{\frac{\eta-1}{\eta}} + (1-a)S_t^{\frac{\eta-1}{\eta}}]^{\frac{\eta}{\eta-1}} \quad (6)$$

Firms in the manufacturing sector produce a good that combines capital and labor to produce the intermediate input that will serve to produce the final good.

$$M_t = z\Big(k^{\alpha_M} n^{1-\alpha_M}\Big)^\theta \quad (7)$$

Firms in the service sector produce a good that combines capital and labor to produce the intermediate input that will serve to produce the final good.

$$S_t = z\Big(k^{\alpha_S} n^{1-\alpha_S}\Big)^\theta \quad (8)$$

5.2 Parametrization

The parameters of the model are either estimated from aggregate German data or calibrated to match moments of German microdata in the period 2003-2007. Only a few standard parameters are taken from the existing literature.

Table XI. Model parameters

Parameter	Moment/Source	Manufacturing	Service	Source
discount rate	interest rate	0.04	0.04	external
capital share	1-comp/va	0.33	0.37	estimated
span of control	Basu and Fernald (1997)	0.90	0.90	external
depreciation rate	$1 + \frac{i-k}{k_{-1}}$	0.08	0.14	estimated
mean of TFP shocks	avg. firm size	0.178	0.249	calibrated
autocorrelation of TFP shocks	autocorr. inv. rate	0.409	0.417	calibrated
SD of TFP shocks	sd inv. rate	0.12	0.081	calibrated
Mean of cost shocks	avg. exit rate	2.6	1.96	calibrated
dispersion of cost shocks	death rate 5 y.o. firms	1.2	3.291	calibrated
non-convex adjustment cost	inaction rate	0.0012	0.00098	calibrated
convex adjustment cost	avg. inv rate	0.44	0.403	calibrated
entry cost	entrants=1	1.90	1.70	calibrated

Discount rate and span of control parameters are set as standard in the literature. Capital share is computed using aggregated data from EU

Klems and equals one minus the labor share computed as employees' compensation and value-added ratio. I compute the depreciation rate using the standard Perpetual Inventory Method using aggregate data on capital and investments from EU Klems. The other parameters are internally calibrated using the simulated method of moments. I set the parameters to match moments taken from the German business register, therefore including the entire population of firms, and validated using Eurostat concerning employment, age, entry, and exit of firms. For the calibration requiring investment data, I use the manufacturing and service samples described in section 2.

As in Sedlacek and Sterk (2019) and common in the literature, the mean of TFP shocks is set to match the average firm size of German firms, and autocorrelation and standard deviation of TFP shocks to match the autocorrelation and standard deviation of investment rates. The mean and dispersion of cost shocks are set to match the average exit rate and the death rate of 5-year-old firms. The entry costs are set to normalize the mass of entrants to 1. I calibrate capital adjustment cost assuming they take the functional form as in Cooper and Haltiwanger (2006): $\psi(k, k_{-1}) = \Gamma_0 + \frac{\Gamma_1}{2}\left(\frac{i}{k_{-1}}\right)^2 k_{-1}$ where Γ_0 and Γ_1 are set to match the investment inaction rate and the average investment rate.

The model parameters show already some structural differences between service and manufacturing. First, the depreciation rate is higher in service, which suggests that capital in the service sector is replaced faster than in manufacturing. Second, the entry and adjustment costs are higher in manufacturing than in service.

5.3 Model Performance and Validation

Overall, the model captures the targeted statistics fairly well. Table XII shows that investment moments, inaction, exit rates, and average size from the model are close to their data counterpart. The model closely replicates the average exit rate observed in the data while it underestimates the relative exit rate in manufacturing, defined as the ratio between the average exit rate of one and five year old firms. In other words, according to the model, one year old and five year old firms have the same exit rates in manufacturing, while in the date the former is higher than the latter. I don't find this discrepancy too worrisome as the model still replicates well the aggregate exit rate.

Table XII. Targeted Statistics

Target	Data	Model
Investment Rate Mean Manufacturing	0.06	0.08
Investment Rate Mean Service	0.17	0.21
Investment SD Manufacturing	0.34	0.36
Investment SD Service	0.43	0.38
Investment Autocorr. Manufacturing	0.10	0.10
Investment Autocorr. Service	0.22	0.17
Inaction Rate Manufacturing	0.11	0.10
Inaction Rate Service	0.07	0.05
Average Exit Rate Manufacturing	0.036	0.04
Average Exit Rate Service	0.039	0.046
Relative[20] Exit Rate Manufacturing	1.97	1
Relative Exit Rate Service	2.3	2.1
Average Size Manufacturing	21	22
Average Size Service	8	6

Before quantitatively evaluating the across steady-state analysis of a reduction of τ from 38% to 29%, I show how this cut affects the size and age distribution and how it matches with the data. Table XIII shows the

[20] Relative exit rate is the ratio between average exit rate of 1 and 5 years old firms.

number of firms by size and age category, respectively. The data refer to the period 2003-2007, hence before the tax cut, and the table reports the results of the simulation both before and after the tax cut. The goal of this table is twofold. First, by comparing columns 1-2 and 4-5, the table shows that model replicates fairly well the age and size distribution both in manufacturing and service. And second, by comparing columns 2-3 and 5-6, the model provides insights on how the tax cut changes the shape of the distributions. It is important to observe that, to identify the effect of the tax cut, column 3 and 6 are the result of the simulation using pre-tax data, and the new, lower, tax rate is the only difference between columns 2-3 and 5-6[21]. As expected, a reduction in profit tax increase the share of both small and young firms, particularly in the service sector. Overall, the tax cut reduces the share of big firms, particularly in the service sector (Panel A) and this is due to the higher entry of young firms (Panel B).

5.4 Quantitative analysis

I finally evaluate the quantitative effect of a tax cut from $\tau = 0.38$ to $\tau = 0.29$. This scenario is consistent with the tax reform implemented in Germany in 2008. To do this I run a simulation under the two τ scenarios, and I compare the two equilibrium of the economy. Figure 7 and Figure 8 show how few key variables change behave after the tax cut in manu-

[21] To further assess how the model fits with the data, Table E.1. in the Appendix shows that the model replicates well also the age and the size distribution observed after the tax cut reform.

Table XIII. Size and age distributions

Panel A: Size Distribution

	Manufacturing			Service		
	Data pre	Model pre	Model after	Data pre	Model pre	Model after
	(1)	(2)	(3)	(4)	(5)	(6)
0-9	62.77	69.97	71.17	80.84	79.99	83.61
10-19	19.15	13.01	13.18	5.59	8.00	9.33
20-49	8.14	8.34	8.11	3.16	5.74	4.94
50-249	7.89	7.76	6.85	9.98	5.63	2.12
250+	2.05	0.92	0.69	0.43	0.64	0.32

Panel B: Age Distribution

	Manufacturing			Service		
	Data pre	Model pre	Model after	Data pre	Model pre	Model after
	(1)	(2)	(3)	(4)	(5)	(6)
<1	2.96	2.38	3.79	4.91	5.13	8.06
1-5	17.93	22.91	24.10	27.63	30.21	35.17
6-10	13.43	14.10	13.6	20.13	19.19	20.11
10-15	13.02	11.35	10.90	15.67	19.21	19.06
15+	52.66	50.26	47.61	31.66	26.26	17.60

Note: Table XIII shows the age and size distributions. Columns 1 and 4 indicate the number of firms observed in the data before the tax cut reform, for each category. Columns 2 and 5 indicate the number of firms in each category resulting from the model simulation with the tax rate pre-reform. Columns 3 and 6 indicate the number of firms in each category resulting from the model simulation with the tax rate post-reform.

facturing and services, by firm age. Figure 7 shows the average effects of the reduction in profit tax by firm age on aggregate output, average firm size growth and TFP growth. A permanent corporate tax cut increases the aggregate output and decreases the average firm size given the entry of many small firms. These results are not surprising and common in the literature (similar evidence are found in Mertens and Ravn (2013), Sedlacek and Sterk (2019) and Neira and Singhania (2020)). However, the average firm size decrease reflects the higher number of entering firms after the tax cut. It also implies higher labor demand that increases the real wages, making incumbent firms hire less. These two effects, combined with the higher entry rate and the relative higher wage increase in service, make service firms contract more than manufacturing firms.

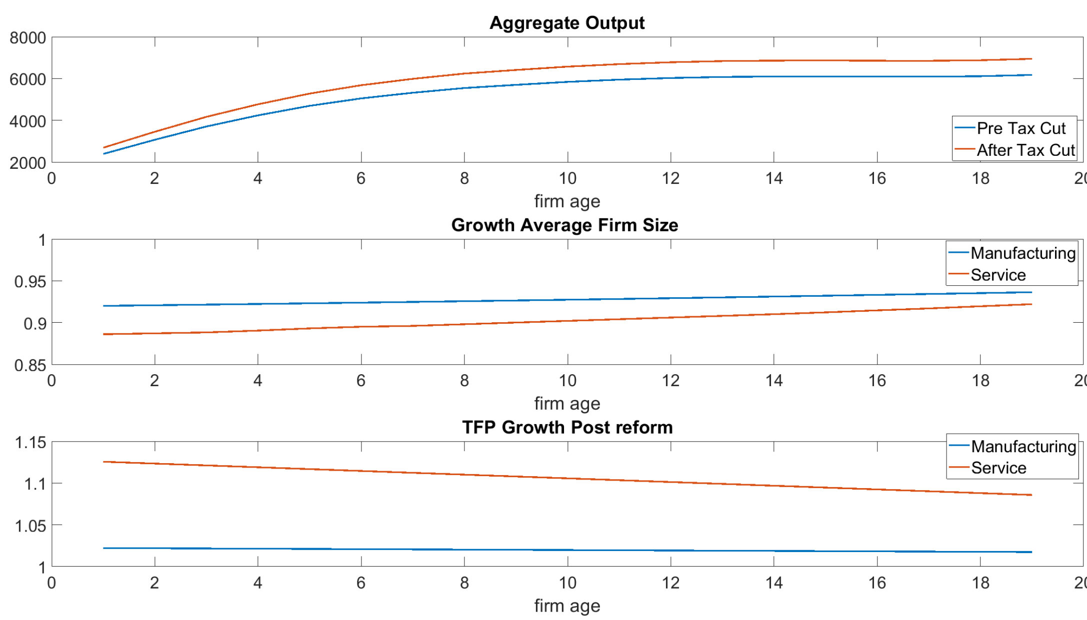

Figure 7. The Figure shows the results of the model simulation under the two tax cut scenarios, for manufacturing and services by firm age.

The higher level of wages will make less productive firms exit the market. As the effect of wages is higher in service, due to higher entry which increases labor demand, this selection effect works more than in manufacturing as can be seen in the top panels of Figure 8, and makes TFP increase more in service (bottom panel of Figure 7).

Therefore, the overall effect of a corporate tax cut is: i. a more dynamic service sector with a positive net growth of firms; and ii. a more productive service sector. These two effects dominate the average firm-size decrease in service and contribute to accelerating the rise of employment and turnover in service leading to the final effect, which is a lower share of manufacturing in the economy (bottom panels of Figure 8).

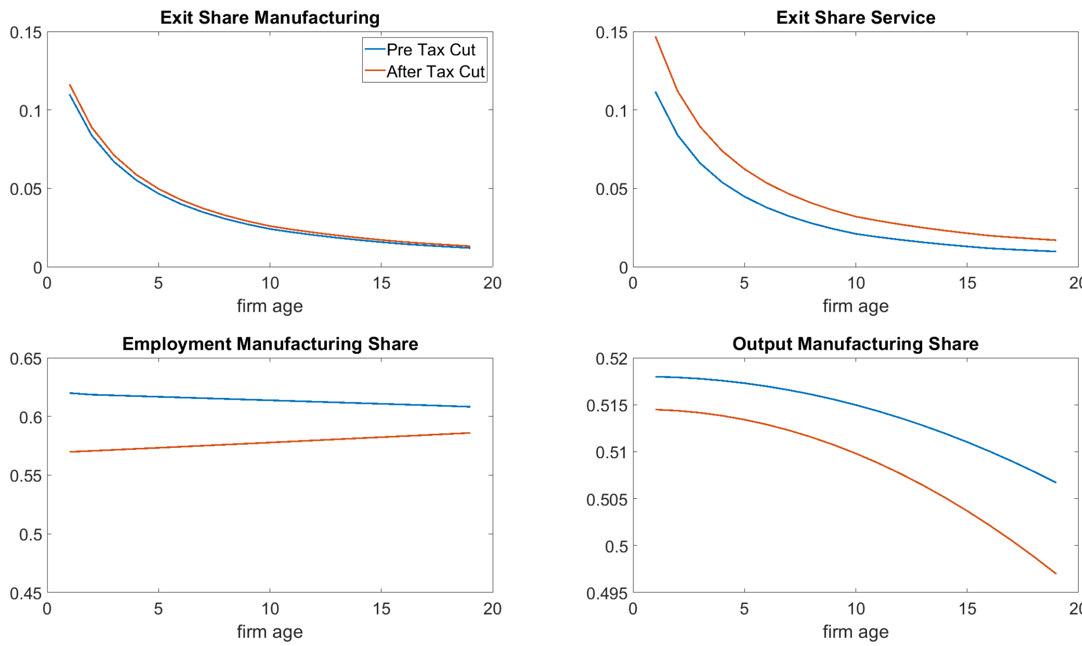

Figure 8. The Figure shows the results of the model simulation under the two tax cut scenarios, for manufacturing and services by firm age.

Overall, the model predicts that the tax cut has led to a contraction of 3.3 p.p. in the manufacturing employment share and 1 p.p. in the manufacturing turnover share which account for, respectively, 34% and 23% of the drop in manufacturing share observed in the data in the period 2003-2018. While these numbers may look small compared to other channels that contributed to the reallocation to service, they are not. Indeed, they suggest that there is room for governments to directly affect the reallocation from manufacturing to service, because, contrary to the other causes studied by the literature, the government can directly intervene to change corporate taxes. The results of this paper shed light on one of the side consequences of corporate tax decline, although tax cuts were not probably specifically designed to foster sectoral reallocation, they disproportionally advantaged firms in the service sector and this has contributed to deindustrialization.

6 Mechanisms

The model results highlight that corporate tax cuts are one of the factors contributing to the sectoral reallocation from manufacturing to services. The first empirical part of this article shows this is due to the different responsiveness of firms in manufacturing and service to tax changes. In this section, I briefly discuss some of the mechanisms that make the firm's reaction different across sectors. Namely, I discuss the following mechanisms: difference in the cost structure, in the capital replacement rate, and in the entry and adjustment costs.

One of the main structural difference between manufacturing and services is the capital intensity. While manufacturing is traditionally more capital-intensive, the service sector is traditionally more labor-intensive. This difference also results in a different cost structure among the two sectors; manufacturing, being a capital-intensive sector, tends to have relatively higher fixed cost, while service sector, being more labor-intensive, tends to have relatively higher variable costs. As the corporate tax on profits can be seen as a further variable cost, it is not surprising that firms in the service sector are more responsive to tax changes. At the same time, it is unsurprising that service firms, with relatively more variable and less fixed costs, are more flexible and adjust more to a tax change, as seen in section 4. Along the same line, table XI shows that the depreciation rate is higher in service than in manufacturing. In other words, service firms replace capital more often than manufacturing firms. According to the findings of this paper, the corporate tax cut, by reducing the cost of capital, does not benefit firms with relatively higher capital stock (manufacturing) but, instead, benefits those firms that replace capital more often (service). Finally, according to Table XI's calibrated parameters, manufacturing has higher entry and adjustment costs. Lower adjustment costs make service firms more flexible and more responsive to adjust production factors in response to a tax change. At the same time, entry costs are all those upfront costs, investment and startup costs that potential entrepreneurs have to face. The tax cut, by increasing the expected future profits, attracts more firms to the market, and this effect is larger to the sector with lower entry costs.

One of the channels not discussed in this paper is the role of the rest of the world. In the model, I assume that the foreign sector plays the same role under high or lower tax scenarios. However, corporate tax rates is one of the ways countries use to attract foreign business group to open plants within the country. A simple cross-country analysis reveals that the average increase of Outward FDI stock between 2008 and 2011 is 13% in those countries that had a corporate tax cut in the same period, and 58% in those countries that did not cut the tax[22]. In other words, tax cuts may reduce the offshoring activity of firms in countries that cut the taxes. However, it is not clear whether it affects more manufacturing or the service sector. On the one hand, most of German Outward FDI's stock is typically in the service sector, and only one-third in manufacturing. On the other hand, half of the jobs provided by German branches abroad are attributable to the manufacturing sector[23]. I leave a deeper investigation of how the foreign sector affects the result of this paper to future research.

7 Conclusion

This study contributes to the literature investigating the structural reallocation from manufacturing to service. Corporate tax cut explains around 34% and 23% of the decline in employment and revenue share of manufacturing observed in Germany in 2003-2018. Firm-level analysis shows this

[22] I run this analysis across two groups of countries of similar structure and level and I compute the rate of growth of Outward FDI Stocks for the period 2008-2011. The first group includes countries that, in the period 2008-2011 did not implement a tax cut and includes U.S. (FDI Growth 45%), France (33%), Ireland (96%). The second group includes countries that in the period 2008-2011 implemented a corporate tax cut reform, and includes: Germany (14%), Italy (17%), and Netherlands (10%). Source: OECD FDI Data.

[23] See Bundesbank Press Release

is due to firms in the service sector being more responsive to tax shock than firms in manufacturing. Hence, tax cuts disproportionally advantage firms in the service sector, which expands while manufacturing shrinks. The quantitative evaluation suggests this is due to structural differences in the cost structure, the capital replacement rate, and the entry and adjustment costs. This article has several policy implications. First, it sheds light on how corporate tax policy stimulates firms differently across sectors and how it has consequences for sectoral reallocation. Secondly, this article suggests tax cuts might not necessarily be the right policy tool if the policy goal is to stimulate activity in the manufacturing sector. On the other hand, a corporate tax cut could work well in those countries interested in fostering the transition toward a service economy.

One limitation of the quantitative evaluation presented in this paper regards how the labor market is modeled. The evidence suggests that workers' skills are increasingly sector-specific, as is likely the case for labor frictions. Hence, extending the analysis and including endogenous participation and matching frictions on the labor market would interesting to study how the tax shock affects labor reallocation from manufacturing to service. In addition to this, as discussed, the model is based on a closed economy which does not incorporate interaction with the external sector and its implications on the effect of tax on reallocation. At the same time, the empirical analysis relies on the assumption that tax hikes and tax cuts have a symmetric effect, while there might exist mechanisms against this assumption. Another caveat is that some empirical results are based on samples including only firms with more than 20 employees. While they account for most of economic activity, omitting small firms can still be a source of bias. I leave all these topics for future research.

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Appendix

A Further data description

Data on Taxation. Data on local business taxes are publicly available on the website of the Federal Statistics of Germany. Since the German reunification in 1990, there have been a number of reforms that change the boundaries of municipalities. In order to recover the temporally consistent territorial boundaries necessary to run the longitudinal analysis, I apply the transcoding algoritm described in Kauffmann (2015), Kauffmann (2017), and Austria (2013) and the tables available here.

German Longitudinal Data. Data can be accessed on site and upon request at the Research Data Centre of the Federal Statistical office of Germany. Further information on data access and requests are available at https://www.forschungsdatenzentrum.de/en/request. The specific modules I use are:

- *AFiD-Panel Industrieunternehmen* (DOI: 10.21242/42221.2018.00.01.1.1.0)
- *AFiD-Panel Strukturerhebung im Dienstleistungs-bereich* (DOI: 10.21242/47415.2020.00.01.1.1
- *AFiD-Panel Unternehmenregister* (DOI: 10.21242/52121.2019.00.01.1.1.0 and DOI: 10.21242/52111.2012.00.01.1.1.0)

- *Investitionserhebung im Bereich Verarbeitendes Gewerbe, Bergbau und Gewinnung von Steinen und Erden*
- *Panel der Kostenstrukturerhebung im Bereich Verarbeiten- des Gewerbe, Bergbau und Gewinnung von Steinen und Erden*

Variable definitions.

- *Unit of observation:* single plant firms.
- *Municipality:* Lowest administrative level in Germany, classified according numerical codes AGS at 8 digits.
- *Economic sectors:* Four-digit industry indicator variable. Each firm-plant is assigned to industry in which it generates most of its value added. The economic sector is defined following NACE Rev 2. classification for years after 2008. For years before 2008 the economic sector is defined following NACE Rev 1.1. and reclassified into NACE Rev 2. Manufacturing sector is defined as all firms belonging to 4-digit industries from 1000 to 3399. Service sector includes all firms in the industries 5800-6399, 6900-7599, 7700-8299.
- *L:* Number of employees in headcounts.
- *W:* Within firm average real wage, defined as gross salary before taxes + other social expenses, divided by the number of employees

and deflated using 2-digit industry-level deflator supplied by the statistical office of Germany.

- *R:* Total real revenue, defined as total gross output deflated using 2-digit industry-level deflator supplied by the statistical office of Germany.

- *M:* Real intermediate input, defined expenditures for raw materials, energy, intermediate services, goods for resale, renting, temporary agency workers and contracted work supplied by other firms deflated using 2-digit industry-level deflator.

- *VA:* Value added, defined as real revenues minus real intermediate input.

- *LP:* Labor productivity, defined as real value added divided by number of employees.

B Additional Statistics

Table B.1. Descriptive Statistics

Panel A: Only firms with more than 20 Employees				
	Manufacturing		**Service**	
	Mean	Median	Mean	Median
	(1)	(2)	(3)	(4)
Revenue (in 1000s)	77,125	15,121	23,056	4,564
Employment	279,11	105	137	45
Wage per Empl. (in 1000s)	38.84	36.27	38.12	33.46
Value Added per Empl. (in 1000s)	59.15	48.58	62.12	47.83
Firm Age	29.11	17	20.02	10

Panel B: Only firms with more than 20 Employees - aggregates		
	Manufacturing	**Service**
	(1)	(2)
Job Creation Rate	0.031	0.062
Job Destruction Rate	-0.029	-0.051
VA per Emp of exiting firms	16.30	18.90

Panel C: Full Population of Firms				
	Manufacturing		**Service**	
	Mean	Median	Mean	Median
	(1)	(2)	(3)	(4)
Revenue (in 1000s)	6,735	791	2,191	296
Employment	31.7	7	9	3
Age	24.20	14	15.23	7

Note: Table B.1 shows several descriptive statistics. In Panel A, they are computed only among firms with more than 20 employees. Value Added is computed as the difference between revenues and intermediate input. Employment refers to the number of employees in headcount at the end of the year. In Panel B, the Job Creation Rate and Job Destruction rate are computed as in Davis and Haltiwanger (1992) and weighted at sector level. In Panel C, indicators are computed using also firms with less than 20 employees. Firms with multiple plants included.

Table B.2. Value-Added Share by age and size category in Manufacturing

Age \ Size	20-49	50-249	>250	Total
0-4	0.0018	0.0133	0.0266	0.041
>5	0.066	0.373	0.5200	0.959
Total	0.068	0.386	0.5466	1

Table B.2. shows the share of value added generated by each size and age category. Only firms with more than 20 employees are included.

Table B.3. Employment Share by age and size category in Manufacturing

Age \ Size	20-49	50-249	>250	Total
0-4	0.002	0.0145	0.0294	0.046
>5	0.079	0.391	0.484	0.954
Total	0.081	0.405	0.513	1

Table B.3. shows the share of employees in each size and age category. Only firms with more than 20 employees are included.

Table B.4. Value-Added Share by age and size category in Service

Age \ Size	20-49	50-249	>250	Total
0-4	0.017	0.028	0.0304	0.085
>5	0.311	0.447	0.157	0.915
Total	0.328	0.475	0.187	1

Table B.4. shows the share of value added generated by each size and age category. Only firms with more than 20 employees are included.

Table B.5. Employment Share by age and size category in Service

Age \ Size	20-49	50-249	>250	Total
0-4	0.010	0.025	0.025	0.06
>5	0.142	0.325	0.472	0.94
Total	0.152	0.35	0.497	1

Table B.5. shows the share of employees in each size and age category. Only firms with more than 20 employees are included.

C Additional Figures

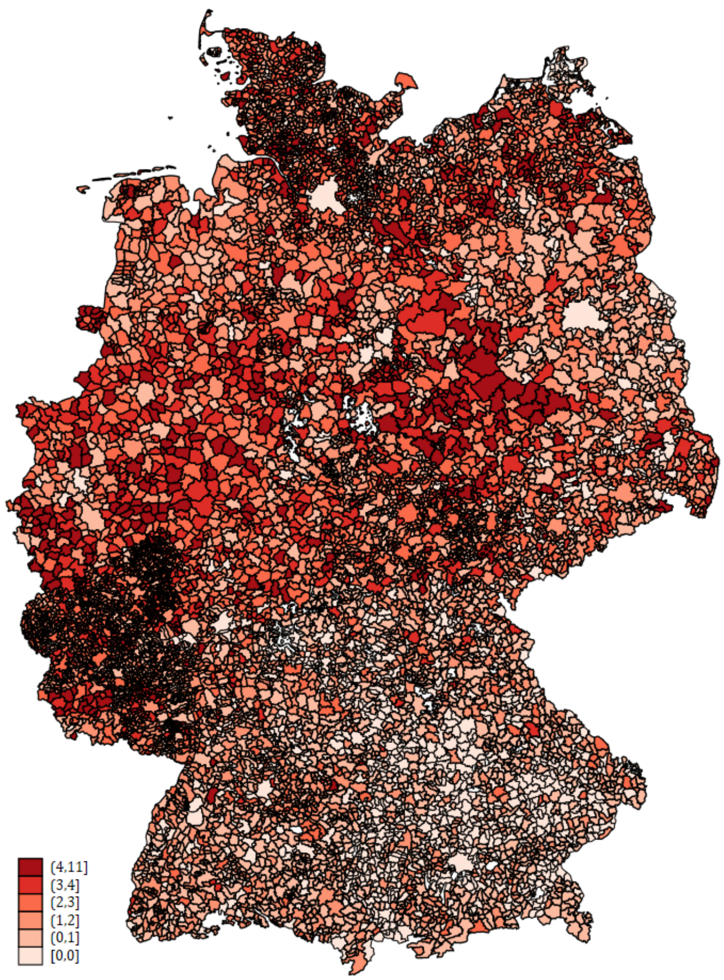

Figure C.1. The figure shows the number of tax increase per municipality during the period 2003-2018.

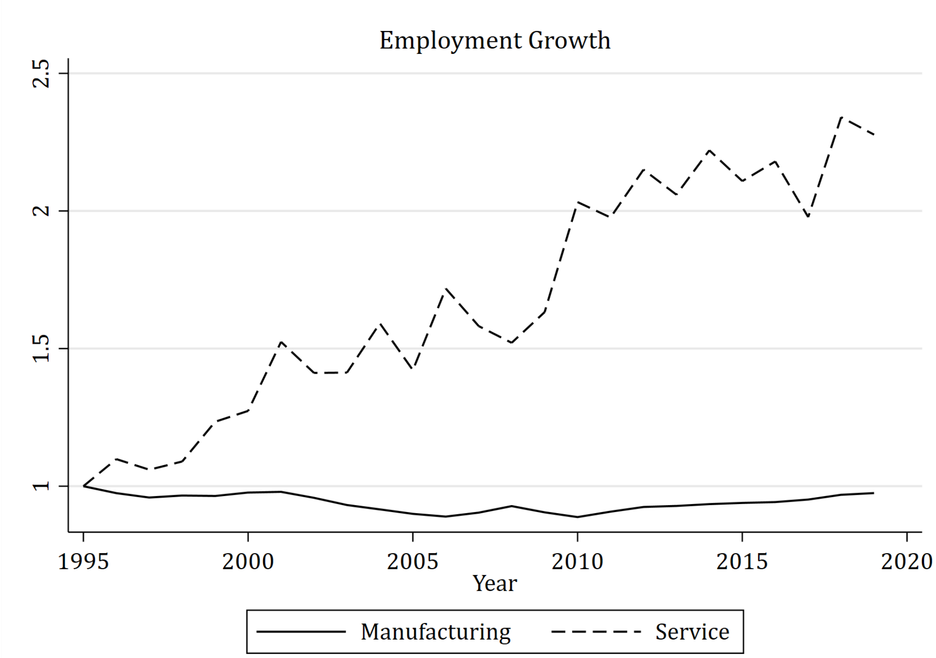

Figure C.2. The Figure shows aggregate rate of growth of employment in Manufacturing and Service in Germany. Growth with respect to base year 1995. Source EU Klems.

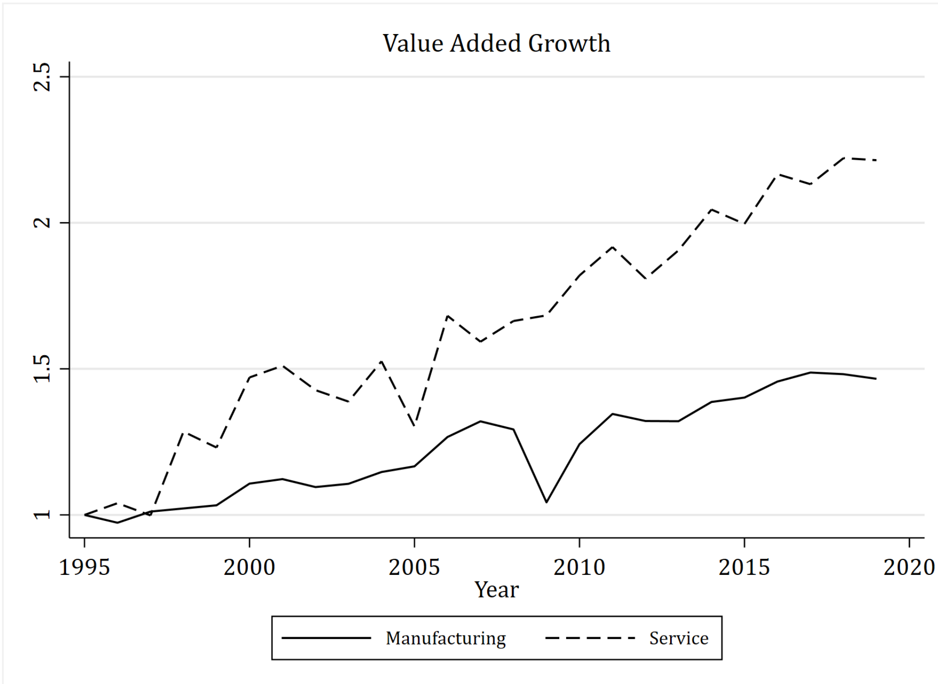

Figure C.3. The Figure shows aggregate rate of growth of value-added in Manufacturing and Service in Germany. Growth with respect to base year 1995. Source EU Klems.

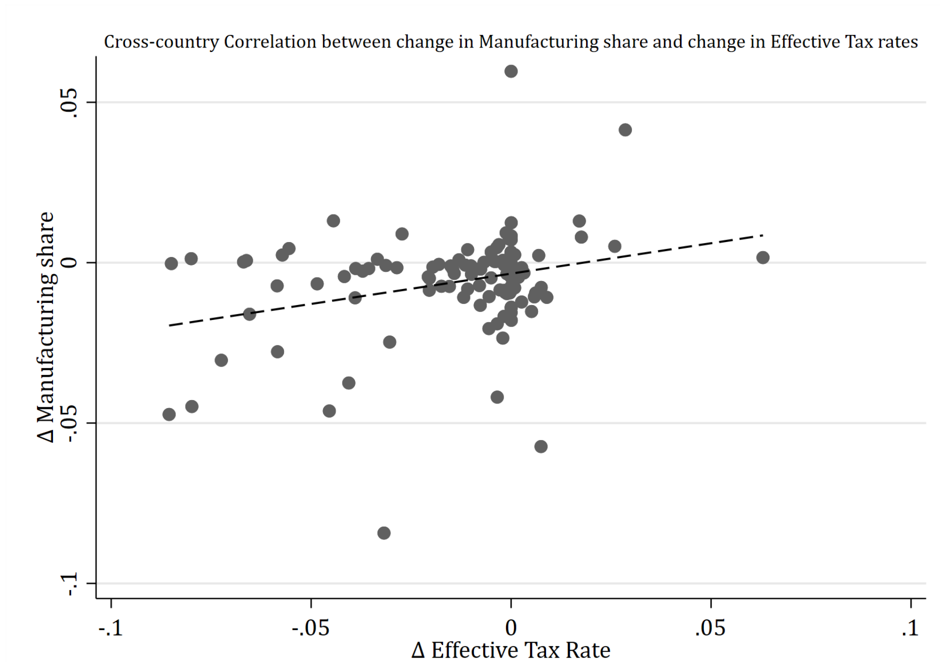

Figure C.4. The Figure shows the cross-country correlation between the change in Manufacturing share and change in the effective tax rate. Each dot represents the country change in effective tax rate and manufacturing share with respect to the year before. Effective tax rate is computed as the country median of the ratio between tax on profits paid by firms and pre-tax income. This ratio is computed across all firms in a given country. The analysis include the following countries and years: Belgium (2000-2020), Croatia (2002-2021), Czech Republic (2005-2020), Denmark (2001-2020), Finland (1999-2020), France (2003-2020), Hungary (2003-2020), Italy (2006-2020), Latvia (2007-2019), Lithuania (2000-2020), Netherlands (2007-2019), Portugal (2004-2020), Slovenia (2002-2021), Spain (2008-2020), Sweden (2003-2020), Switzerland (2009-2020). Source: CompNet 9th Vintage.

D Further Regression Results

D.1 Disentangling entering and exiting

Table D.1.1. Effect of taxes on Firm Number of Employees

	Dependent variable: Number of Employees$_{i,m,t+1}$							
	Manufacturing				Service			
	All Firms	Incumbents	Incumbents + Exit	Incumbent + Entry	All Firms	Incumbents	Incumbents + Exit	Incumbents + Entry
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$\tau_{m,t}^{mun}$	0.0044	-0.003*	0.0037	0.0005	0.024***	-0.014**	0.021**	0.002***
	(0.0224)	(0.0016)	(0.051)	(0.034)	(0.004)	(0.011)	(0.0073)	(0.0003)
N	1,264,511	1,032,518	1,101,254	1,083,764	3,548,146	2,631,137	3,153,149	2,913,251
Cluster	Municipality	Municipality	Municipality	Municipality	Municipality	Municipality	Municipality	Municipality
Placebo 1	-0.0032	-0.122	0.0013	0.0002	0.0023	-0.0002*	0.0023	0.0000
	(0.040)	(0.205)	(0.094)	(0.00017)	(0.0000)	(0.0001)	(0.00005)	(0.000)
Placebo 2	-0.0002	0.074	0.0009	0.00003	0.00091	-0.0001	0.0016	0.000
	(0.131)	(0.071)	(0.0032)	(0.0045)	(0.0033)	(0.0024)	(0.0031)	(0.000)

Note: Table D.1.1. shows the result of regressing equation (2) on the firm number of employees in headcounts. The regression is estimated separately for manufacturing and service. Columns 1 and 3 include all the firms in the sector. Columns 2 and 4 exclude firms that entered the sample in the year and firms that will exit the sample in the following year. The sample includes single plant firms with more than 20 employees. Standard error clustered at the municipal level. The estimation is computed using the approach developed by De Chaisemartin and d'Haultfoeuille (2020) and De Chaisemartin and d'Haultfoeuille (2022a).

D.2 Including Multi-plants firms

Table D.2.1. Effect of taxes to within-firm average wage

	Dependent variable: Average Wage$_{i,m,t+1}$	
	Manufacturing (1)	Service (2)
$\tau^{mun}_{m,t}$	-0.003**	-0.014***
	(0.0015)	(0.037)
N	194,341	319,104
Cluster	Municipality	Municipality
Placebo 1	-0.0001	-0.003
	(0.036)	(0.041)
Placebo 2	0.000	-0.002
	(0.000)	(0.0571)

Note: Table D.2.1. shows the result of regressing equation (2) on the firm average wage computed as total firm wages divided by the number of employees in headcounts. The regression is estimated separately for manufacturing and service. Standard error clustered at the municipal level. Only firms with more than 20 employees are included. The estimation is computed using the approach developed by De Chaisemartin and d'Haultfoeuille (2020) and De Chaisemartin and d'Haultfoeuille (2022a).

Table D.2.2. Effect of taxes on Firm Number of Employees

	Dependent variable: Number of Employees$_{i,m,t+1}$							
	Manufacturing				Service			
	All Firms (1)	Incumbents (2)	Incumbents + Exit (3)	Incumbent + Entry (4)	All Firms (5)	Incumbents (6)	Incumbents + Exit (7)	Incumbents + Entry (8)
$\tau^{mun}_{m,t}$	0.0036	-0.0023	0.0027	0.0015	0.019***	-0.013**	0.016*	0.002**
	(0.0413)	(0.034)	(0.141)	(0.043)	(0.0033)	(0.0071)	(0.0083)	(0.011)
N	1,351,142	1,077,548	1,104,125	1,129,451	3,617,741	2,683,158	3,216,454	3,000,541
Cluster	Municipality	Municipality	Municipality	Municipality	Municipality	Municipality	Municipality	Municipality
Placebo 1	-0.0014	-0.212	0.0007	0.0006	0.0023	-0.0003	0.0041	0.0001
	(0.052)	(0.256)	(0.0z4)	(0.00045)	(0.0000)	(0.0004)	(0.000054)	(0.002)
Placebo 2	-0.0004	0.074	0.0011	0.00007	0.00054	-0.0004	0.0046	0.000
	(0.151)	(0.076)	(0.0052)	(0.0045)	(0.0043)	(0.0074)	(0.071)	(0.000)

Note: Table D.2.2. shows the result of regressing equation (2) on the firm number of employees in headcounts. The regression is estimated separately for manufacturing and service. Columns 1 and 3 include all the firms in the sector. Columns 2 and 4 exclude firms that entered the sample in the year and firms that will exit the sample in the following year. Firms with all size classes included. Standard error clustered at the municipal level. The estimation is computed using the approach developed by De Chaisemartin and d'Haultfoeuille (2020) and De Chaisemartin and d'Haultfoeuille (2022a).

Table D.2.3. Effect of taxes on Labor Productivity

	Dependent variable: Labor Productivity$_{i,m,t+1}$	
	Manufacturing	Service
	(1)	(2)
$\tau_{m,t}^{mun}$	-0.0013	-0.041**
	(0.045)	(0.0.022)
N	184,341	319,104
Cluster	Municipality	Municipality
Placebo 1	-0.0071	-0.112
	(0.049)	(0.43)
Placebo 2	-0.00001	-0.00051
	(0.074)	(0.0341)

Table D.2.3. shows the results of regressing equation (2) on firm labor productivity computed as value-added per employee. The regression is estimated separately for manufacturing and service. Standard error clustered at the municipal level. Only firms with more than 20 employees are included. The estimation is computed using the approach developed by De Chaisemartin and d'Haultfoeuille (2020) and De Chaisemartin and d'Haultfoeuille (2022a).

E Additional Results from the Model

Table E.1. Size and age distributions

Panel A: Size Distribution

	Manufacturing				**Service**			
	Data pre	Model pre	Data after	Model after	Data pre	Model pre	Data after	Model after
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
0-9	62.77	69.97	63.58	64.26	80.84	79.99	85.39	83.36
10-19	19.15	13.01	18.24	17.42	5.59	8.00	5.96	6.23
20-49	8.14	8.34	8.37	9.13	3.16	5.74	5.40	5.61
50-249	7.89	7.74	7.36	7.95	9.98	5.63	1.82	2.84
250+	2.05	0.92	2.06	1.64	0.43	0.64	1.43	1.96

Panel B: Age Distribution

	Manufacturing				**Service**			
	Data pre	Model pre	Data after	Model after	Data pre	Model pre	Data after	Model after
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
<1	2.96	2.38	3.05	3.41	4.91	5.13	6.6	6.23
1-5	17.93	22.91	19.03	18.62	27.63	30.21	29.51	28.41
6-10	13.43	14.10	13.23	14.11	20.13	19.19	20.54	21.18
10-15	13.02	11.35	12.16	11.25	15.67	19.21	13.84	14.21
15+	52.66	50.26	52.53	52.62	31.66	26.26	29.61	29.77

Note: Table E.1. shows the age and size distributions observed in the data before and after the tax reform and how they match with the model simulations. The purpose of this table is purely to assess the performance of the model in replicating the data. Therefore, contrarily to the rest of the paper, column 4 refers to the model simulated using the parameters calibrated with after tax data.