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TECHNEQUALITY partners

ROA Universiteit Maastricht

TiU Stichting Katholieke Universiteit Brabant

UOXF The Chancelor, Masters and Scholars of the University of Oxford

CE Cambridge Econometrics Ltd.

SOFI Stockholms University

WZB Wissenschaftszentrum Berlin für Sozialforschung GGmBH

EUI European University Institute

TU Tallinn University

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Description of deliverable (100 words)

Deliverable 5.2 aims to describe the effects of taxation that result from robot and ICT adoption in Europe. This is also the second deliverable of Work Package 5 (D.5.2).

Decomposing taxes by source (labor, capital, sales), we analyze the impact of automation (1) on tax revenues, (2) the structure of taxation, and (3) identify channels of impact in 19 EU countries during 1995-2016. Robots and Information and Communication Technologies (ICT) are different technologies designed to automate manual (robots) or cognitive tasks (ICT).

Until 2007, robot diffusion led to decreasing factor and tax income, and a shift from taxes on capital to goods. ICTs changed the structure of taxation from capital to labor. We find decreasing employment, but increasing wages and labor income. After 2008, robots have no effect but we find an ICT-induced increase in capital income, a rise of services, but no effect on taxation. Automation goes through different phases with different economic impacts which affect the amount and structure of taxes. Whether automation erodes taxation depends (a) on the technology type, (b) the stage of diffusion and (c) local conditions.

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Automation and taxation: An empirical assessment in Europe

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Until 2007, robot diffusion was associated with decreasing factor and tax income, and a shift from taxes on capital to goods. ICTs coincided with changes in the structure of taxation from capital to labor. We find decreasing employment, but increasing wages and labor income. After 2008, we do not find an effect for robots but observe an ICT-induced increase in capital income, a rise of services, but no effect on taxation. Automation goes through different phases with different economic impacts which affect the amount and structure of taxes. Whether automation is negatively related to taxation depends (a) on the technology type, (b) the stage of diffusion and (c) local conditions.

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Contents

1. Introduction

Does the diffusion of automation technologies (ATs) erode the tax basis? Taxes on labor contribute a major share of public revenues. When ATs diffuse and replace labor at a large scale, the tax basis might be significantly undermined. This argument is put forward to support that a robot tax is needed to ensure the sustainability of public finances [Kovacev, 2020, Süssmuth et al., 2020, Acemoglu et al., 2020, Rebelo et al., 2019]. However, the impact of automation is complex, including many second-order effects. In addition, governments receive taxes from multiple sources other than labor which in turn might be affected by ATs [cf. Atkinson, 2019]. Until now, there is limited empirical evidence on the nexus between automation and public revenues. This study aims to fill this gap. Even though we are not providing causal evidence, we report empirical interactions between automation, production and their link to taxation that help understand the complex relationship between taxes and automation.

We focus on three interdependent effects of automation: (1) The *replacement effect* refers to all effects on factor demand and remuneration when human labor is replaced by sophisticated machinery able to do tasks currently performed by humans [Brynjolfsson and McAfee, 2014, Frey and Osborne, 2017, Korinek and Stiglitz, 2017, Acemoglu and Restrepo, 2020b, Arntz et al., 2016, Nedelkoska and Quintini, 2018, Gregory et al., 2018]. (2) The *reinstatement effect* refers to the creation of new tasks and occupations, and the reallocation of labor within and across industries [Acemoglu and Restrepo, 2019, Blanas et al., 2019, Bessen, 2019, Bessen et al., 2020, Dauth et al., 2018]. (3) The *real income effect* refers to: (a) real income changes when reduced production costs affect prices; and (b) changes in factor revenues (from capital and labor) [Acemoglu and Restrepo, 2019, Graetz and Michaels, 2018, Aghion et al., 2017, Korinek and Stiglitz, 2017]. Specifically, adoption lags may slow down the realization of productivity gains [Bessen, 2019, Acemoglu and Restrepo, 2019] and their impact on prices may be moderated if the unequal distribution of gains is a driver of market concentration [Barkai, 2020].

Total tax revenue is composed of taxes from different sources (e.g. wages, financial income, property, profits, goods, etc.) and each one of them can be affected by automation. Moreover, tax systems are complex and non-linear with different production entities and individuals taxed differently, and various exemptions in place.

Tax revenues are a function of production, factor use, income and private expenditures [cf. OECD, 2019]. The overall impact of automation on production, factor use, distribution and employment is ambiguous and differs across regions and time. We study the impact of automation on aggregate tax revenues and on their composition in 19 European countries during 1995-2016. In a stylized model, we decompose tax revenues by source and link the three effects (replacement, reinstatement, real income) to taxation. The model serves as conceptual framework to address three research question:

1. *What is the relationship between automation and aggregate tax revenues at the country level in absolute terms and in relation to GDP?*
2. *What is the relationship between automation and the composition of taxes by source distinguishing between taxes on labor, capital and goods?*
3. *How can these interactions be traced back to the three effects through which automation affects economic production?*

A major challenge when addressing these questions is the complexity of tax systems and technological change that make it difficult to link the microeconomic impact of automation to macroeconomic consequences and aggregate taxation. We use tax data from the OECD [2020] that allows a cross-country comparison and compile three tax accounts representing taxes on labor, capital and goods. The effects of automation occur at the disaggregate firm and industry level when changes in production technology induce changes in factor demand, employees' incomes and the level and composition of output. We study these effects using macro- and industry level EUKLEMS [2019] data.[1]

To map technological and economic change at the micro-level to aggregate taxation, we apply a sequential procedure based on country and industry level regressions. First, we make a correlation analysis at the country level to explore interactions between automation and taxation. Second, we examine the link between the structure economic production and different taxes. Next, we analyze the prevalence of the replacement, reinstatement and real-income effect. Finally, we argue how these effects explain the observations made in the first step.

We find that the impact of automation depends on the technology type and the phase of diffusion. During the early phase (1995-2007), robots are negatively associated with aggregate tax revenues. The diffusion of robots was accompanied with decreasing factor income from capital and labor, and a shift from capital taxes to taxes on goods. After 2008, we do not observe any significant relationship between robots and aggregate factor markets and taxation, but observe a weak expansion of aggregate output.

Information and Communication Technologies (ICT) diffusion exhibit different effects. Until 2007, we do not observe any significant relation between total revenues and ICT diffusion, but observe an increasing demand for labor in automating industries. At the country level, ICT diffusion is negatively associated with employment, but wages, capital prices and aggregate labor income increased accompanied with an expansion of output. We observe a change in the structure of taxation from capital to labor. After 2008, ICT

[1] In SI.1, we provide additional results at the sub-national (NUTS2) level showing the impact of automation on firm level labor demand and corporate taxation. Due to data limitations, firm level analyses can draw only a partial picture of the impact of automation on taxation, but the findings illustrate regional heterogeneity of impacts.

diffusion had a positive association with aggregate income correlated with rising capital revenues. We also find an increasing employment share of the service sector. We do not observe any effect on total tax revenues but a decreasing share of the taxes on goods.

AT diffusion goes through different phases with different associations with the amount and structure of tax revenues. Labor offsetting during the early phase of automation is compensated by the creation of new jobs in later phases. These processes are accompanied with structural change in the industrial composition. Given our observations, concerns about the sustainability of fiscal revenues appear short-sighted when only looking at the early phases of automation.

Our study is subject to two major limitations. First, the split into an early and late phase of diffusion coincides with the financial crisis 2007/08 which is motivated by the concern that taxation could affected by fiscal policy reforms in response to the crisis. To address the concern that the crisis might also have affected the technological dynamics, we include — in addition to country, time and industry fixed effects (FE) — public finance related controls and GDP growth rates. We check the robustness by splitting the sample of European countries into different groups (East, North, South).

Second, our approach is blind to the distributional consequences of automation. Tax burdens differ across individuals, firms and whole industries. Here, we focus at aggregate income effects and their relation to taxation, but we offer a short discussion of wage inequality across industries and its relation to taxation.

Despite these limitations, our analysis reveals a series of new insights: First, we empirically examine the link between the structure of production and taxation. It is a long-lived debate to which extent technological change alters distribution of factor income [e.g. Karabarbounis and Neiman, 2014, Barkai, 2020]. Our analysis links the debate on factor shares to fiscal policy.

Second, our analysis highlights technological heterogeneity at different stages of the diffusion process: ICT and robots exhibit different relationships with production and taxation. A technology that is labor replacing in one industry can be a driver of (lagged) job creation in another.

To the best of our knowledge, this is the first study that empirically asks whether policy makers should be concerned about the impact of automation on public finances. We find: It depends (a) on the type of technology that is considered, (b) on the stage of diffusion, and (c) on local conditions. We provide structural arguments that enable a better understanding of locally specific conditions, the economic impacts of automation and macro-level effects on taxation.

The remainder of this paper is structured as follows: In the next section, we provide an overview of the automation literature and the empirical reality of taxation. In Section

3, we introduce a conceptual model. In Section 4, we describe our empirical strategy and the data. Section 5 summarizes the results. In Section 6, we link our empirical to the research question. Section 7 concludes.

2. Background and related literature

2.1. The economic impact of automation

We focus on three interdependent effects of automation, namely (1) the *replacement*, (2) the *reinstatement*, and (3) the *real income effect*.

2.1.1. The replacement effect

The replacement effect is the substitution of human labor by machines when technological progress enables machines to perform tasks that were previously performed by human workers [Acemoglu and Restrepo, 2018a]. The number of jobs susceptible to automation differs across occupations and industries. Estimates range between zero and perfect substitution [Arntz et al., 2016, Frey and Osborne, 2017, Nedelkoska and Quintini, 2018, Hawksworth et al., 2018, Webb, 2020].

Labor replacement may lead to lower employment and wages. This can be partially offset by an increase in demand for non-routine tasks and new jobs in expanding sectors which is dependent on substitution elasticities and capital accumulation [Acemoglu and Restrepo, 2019, 2020b, 2018b,a]. Acemoglu and Restrepo [2020b] argue that current trends indicate that the creation of new tasks is insufficient leading to a declining labor share, rising inequality and negative effects on productivity growth.

Empirical results on net labor replacement effect are ambiguous: Gregory et al. [2018] confirm the replacement of routine labor, but also find an increasing product demand associated with growth in net employment and highlight the unequal distribution of gains from technological progress. Graetz and Michaels [2018] find automation to be associated with a lower share of low skilled labor, while Aghion et al. [2019] find that innovation-intensive firms pay higher wage premia for low skill occupations which might reduce income inequality. Differentiating by demographics and task-content, Blanas et al. [2019] observe switches from routine to non-routine jobs and find robot diffusion to be associated with decreasing employment of low skill jobs, but rising income shares of high and medium skilled labor. For Germany, Dauth et al. [2018] document occupational changes of employees within the same workplace, but do not find an effect on total output in industries with high robot use. Job losses in manufacturing were offset by job creation in services.

Overall, the consensus in the literature to date is that employees performing automatable tasks are susceptible to replacement by machinery. However, it remains controversial whether and to what extent the occupation-specific replacement affects aggregate factor incomes and distribution when coupled with the simultaneous reinstatement of new tasks and occupations within and across industries.

2.1.2. The reinstatement effect

Historically, job replacement by automation was often compensated by aggregate growth and the emergence of new tasks [Acemoglu and Restrepo, 2019, Autor, 2015, Aghion et al., 2017, Bessen, 2019]. This effect is heterogeneous across sectors. Changes in the labor share arise from labor substitution, the reinstatement of new tasks, changes in the task composition and productivity growth Acemoglu and Restrepo [2019]. Observed effects are determined by substitution elasticities: workers only benefit if machines are complementary to human labor and changes in relative wages are sensitive to the elasticity of labor supply [Autor, 2015]. The creation of new jobs induced by positive income effects is contingent on the income elasticity of final demand [Bessen, 2019].

Productivity growth and the creation of new tasks may be slowed down if skill mismatches arise from labor market frictions [Acemoglu and Restrepo, 2019, 2020b]. Arntz et al. [2016] argue that the sluggish diffusion of ATs facilitates the adaptation of employees to learn new tasks. They argue that the replacement effect is likely overstated because an increasing demand for new technologies leads to the creation of new jobs. ATs are capital-intensive and require firms to invest in capital which may offset labor replacements [Acemoglu and Restrepo, 2019].

Learning new tasks facilitates the transition of employees across industries Bessen [2019]. Empirically, the reallocation of employment across industries and of tasks within the same firm is shown by Gregory et al. [2018], Dauth et al. [2018], Bessen et al. [2020]. Bessen et al. [2020] also find faster employment and revenue growth among automating firms compared to non-automating.

In short, the reinstatement effect potentially offsets sector-specific negative employment effects at the aggregate level. Empirically, it remains unclear whether the net of job displacement and reinstatement is positive or negative in the current wave of automation.

2.1.3. The real income effect

Automation may boost productivity growth. This can lead to lower output prices and leverage economic growth through increasing final demand. Final demand is contingent on real income, i.e. nominal income over prices. Both may be affected by automation.

Graetz and Michaels [2018] empirically observe increasing productivity and falling output prices when robots diffuse. Acemoglu and Restrepo [2018a] highlight two channels of productivity improvements: (1) machinery may replace less cost-effective labor and (2) incremental technological progress may increase productivity in automated tasks with positive effects on wages. Increasing productivity leads to lower production costs and output prices. Gregory et al. [2018] document that final demand increases in response to declining prices of tradable goods which have a positive spillover effect on local demand for some non-tradable low-tech goods. In turn, this may result in positive effects on local employment and income. In this context, Bessen [2019] highlights the important role of the price elasticity of consumption, where price induced demand increases may offset negative employment effects of labor replacing automation.

Whether productivity induced cost reductions are transmitted to consumers as lower prices is contingent on market competition. In this regard, the unequal distribution of productivity gains across industries and firms comes hand in hand with increased market concentration [Autor et al., 2020, Bormans and Theodorakopoulos, 2020, Andrews et al., 2015, 2016]. Specifically, Barkai [2020] finds that the increases observed in profit shares since the 80s are more pronounced in industries with higher market concentration.

Final demand can also be stimulated by increasing income. Acemoglu and Restrepo [2018a] argue that automation is naturally associated with higher capital intensity similar to other historical events (e.g. industrialization). In turn, higher capital intensity is associated with higher equilibrium wages [see also Huang et al., 2019].

Moreover, Moll et al. [2019] look at the income distribution beyond labor and study the effect of automation on wealth and income from rental rates of capital. They show that capital ownership matters. Therefore, automation can be a driver of increasing returns to wealth which may exacerbate income inequality.

Overall, while it is less controversial in the literature that ATs are associated with productivity gains, it remains unclear whether and how they affect prices, income and final consumption.

2.2. Taxation in Europe

Taxes are *"compulsory, unrequited payments to general government"* [OECD, 2019]. On average, among the 19 European countries covered by our study, the total tax revenue accounted for 37.3% of GDP in 2016 ranging between 23.4% in Ireland and 45.7% in Denmark.[2] Over time, the average tax-to-GDP-ratio weakly fluctuated around 36.44%

[2]When excluding residual taxes (with code 6000), as done in our analysis, total taxes account for 37% of GDP. Our analysis includes 19 European countries: Austria (AT); Belgium (BE); Czech Republic (CZ); Germany (DE); Denmark (DK); Spain (ES); Finland (FI); France (FR); Greece (GR); Ireland (IE); Italy (IT); Lithuania (LT); Latvia (LV); the Netherlands (NL); Portugal (PT); Sweden(SE); Slovenia (SI); Slovakia (SK); and the United Kingdom (UK). The data presented here is based on the Global Revenue Statistics Database provided by the OECD [2020].

in 1995 and 37% in 2016, while the ratio was the lowest during the financial crises (e.g. 34.65% in 2009).

Taxes can be classified by the base of the tax. For example, taxes are imposed on income from labor, profits and capital gains, on property and on the trade of goods and services. Compulsory Social Security Contributions (SSC) can equally be considered as tax revenues [OECD, 2019, A.2]. Here, we look at three broad groups of taxes, namely (1) taxes imposed on labor (T^l) including SSC, (2) taxes on capital (T^k) including taxes on profits and property, and (3) taxes on goods and services (T^y). These groups differ by their linkage to the structure of production reflected in the labor share, capital share and aggregate consumption. Taken together, i.e. $T = T^l + T^k + T^y$, the three groups cover more than 99.9% of total tax revenue in our sample of 19 European countries in year 2016.

On average, taxes on labor accounted for 11.8% of GDP and 31.6% of total taxation, taxes on capital for 13.3% of GDP and 35.1% of total taxation, and taxes on goods for 12% of GDP and 32.5% of total taxation in 2016 in our sample.[3]

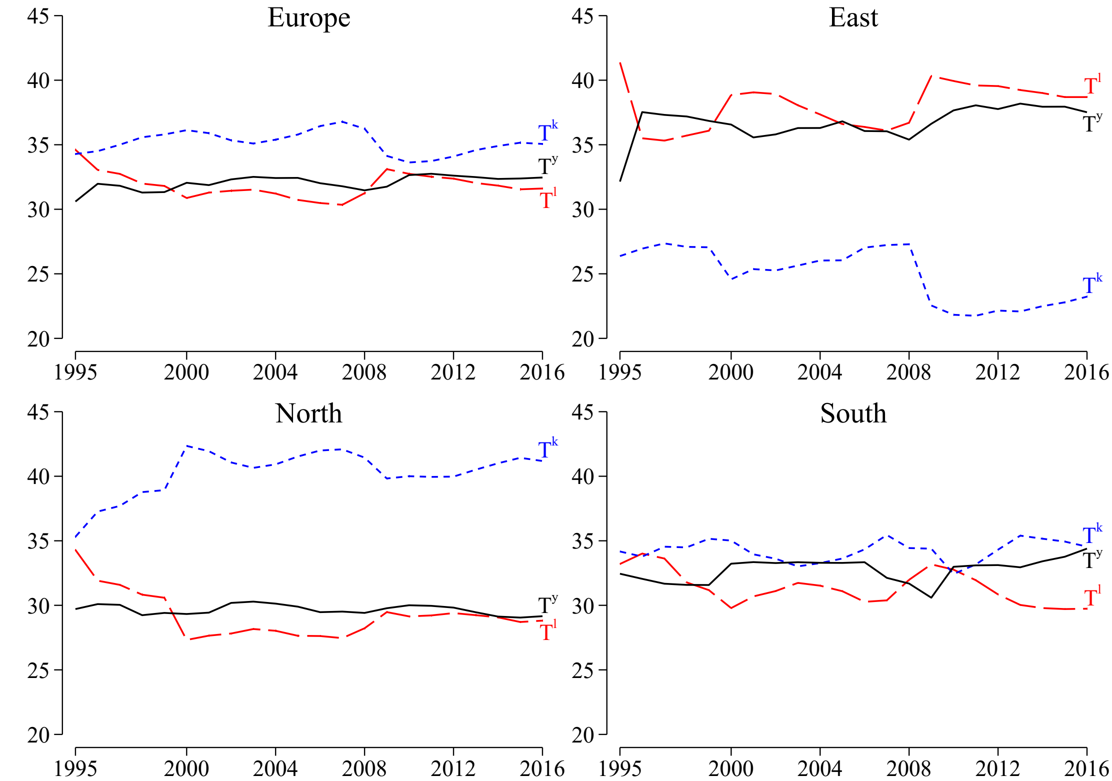
Countries differ by the structure of taxation, i.e. the relative tax contribution of different sources. Figure 1 shows how the structure of taxation evolved over time in Europe and in different regions. The figure illustrates differences between Eastern and Northern Europe: Eastern countries receive most of their tax revenues from taxes on labor and goods, each accounting for roughly 37.5% percent of total tax revenues while taxes on capital contribute only 25%. In Northern Europe, capital taxation contributes the most by a share of roughly 40%, while taxes on labor and goods contribute roughly 30% each. The differences across different sources are much lower in Southern countries, all ranging between 30-35%.

Countries also differ by tax administration, i.e. whether taxes are collected at the central or sub-national (state or local governmental) level. For countries organized on a federal basis, the share of taxes raised at the sub-national level tends to be higher compared to unitary countries [OECD, 2019].

The cross-country heterogeneity in the levels, structure and organization of taxation is driven by a multitude of economic, structural, institutional and social factors which have emerged historically across nations [Kiser and Karceski, 2017, Hettich and Winer, 2005, Castro and Camarillo, 2014]. Among other, empirical measures for such determinants include per-capita GDP, the industrial structure and economic specialization, civil liberties and governmental efficiency, public and financial policies, trade, exchange rates and foreign direct investment (FDI), public expenditures and education [Castro and Camarillo,

[3] These numbers are similar to the OECD average where T including (excluding) residual taxes accounted for 34.4% (34.2%) of GDP, T^l for 9.5% of GDP and 27.2% of total taxation, T^k for 13.6% of GDP and 39.6% of total taxation, and T^y for 11% of GDP and 32.5% of total taxation in 2016.

Figure 1: Structure of taxation - average across Europe and regional groups



Notes: T^l, T^k and T^y is the country group average tax on labor, capital, and goods, respectively, as % of total taxation. The sample includes 19 European countries for the period 1995-2016 which covers three regional groups: East (CZ, LT, LV, SI, and SK); North (AT, BE, DE, DK, FI, FR, IE, NL, SE and UK); and South (ES, GR, IT, and PT).

2014, Castañeda Rodríguez, 2018].

2.2.1. Taxation and automation

For policy makers, two questions related to the nexus of automation and taxation matter: (1) How do existing tax systems influence AT adoption decisions and the emergent path of economic development? (2) Does automation affect tax revenues such that policy makers should care about their financial capacity (taking adoption decisions as given)? The majority of the existing literature on automation and taxation addresses question (1) taking as given that tax revenues suffice to finance essential public services. To the best of our knowledge, we are the first to study question (2).

Existing studies on the nexus of automation and taxation mostly take an optimal taxation perspective. For example, Acemoglu et al. [2020] argue that the US tax system is biased in favor of capital which leads to a sub-optimal reduction of the labor share for "marginally automated jobs". Applying the optimal taxation framework by Diamond and Mirrlees [1971] to a task-based model calibrated on US tax rates, the authors show how a tax reform could raise the labor share. Similarly, Süssmuth et al. [2020] analyze the impact of US taxation on the functional distribution of income and find that distributional changes (in favor of the capital share) can be partly attributed to labor and capital tax reforms during 1974-2008. They argue that changes in relative taxes also affect the use of robots.

Other authors propose a robot tax to cope with the negative effects of automation on employment and income equality. In a theoretical study based on the current tax system in the US, Rebelo et al. [2019] show how a robot tax can be used to reduce inequality but at the cost of efficiency losses. Gasteiger and Prettner [2017] provide a theoretical analysis of a robot tax in overlapping generations model and show how it could raise per capita capital stock with positive long-run growth effects. Kovacev [2020] argues theoretically that the robot-induced replacement of labor could lead to decreasing income taxes and higher transfer payment. A robot tax is analyzed as an instrument to offset the negative effect on public finances. From a law-and-economics perspective, he shows how a robot tax could be implemented while keeping the disincentives for innovation minimal.

Theoretical studies on robot taxes argue that these taxes can be used to reduce inequality and to secure public revenues. However, it remains controversial whether automation really undermines governments' capacity to raise taxes. On that end, Atkinson [2019] argues that the empirical evidence of a jobless future is poor since many studies ignore important second-order effects. Moreover, even if firms adopt robots they still pay taxes on profits, sales and wages of workers doing non-automated jobs which might increase with robot adoption.

Until now, empirical evidence on the actual relationship between automation and tax revenues is lacking and we aim to fill this gap. Overall, while optimal taxation studies focus on the impact of tax systems on the structure of production, we take the opposite perspective and look at the impact of economic change on taxation.

3. A conceptual model

3.1. Tax revenues

Taxes can be grouped into three parts that are differently linked to production. Total tax revenue in country c is given by:

$$T_c = \underbrace{t_c^l \cdot w_c L_c}_{\substack{\text{Taxes on labor} \\ T_c^l}} + \underbrace{t_c^k \cdot r_c K_c}_{\substack{\text{Taxes on capital} \\ T_c^k}} + \underbrace{t_c^y \cdot p_c Q_c}_{\substack{\text{Taxes on goods} \\ T_c^y}} \tag{1}$$

where $L_c = \sum_{i \in I_c} L_{i,c}$ is aggregate labor given by the sum of labor employed in industries $i \in I_c$ that are located in country c, $K_c = \sum_{i \in I_c} K_{i,c}$ is the stock of fixed production capital including ATs (i.e. industrial robots and ICT) and $p_c Q_c = \sum_{i \in I_c} p_{i,c} Q_{i,c}$ is aggregate demand. Wages, prices for capital and prices for goods are given by w_c, r_c and p_c, respectively. The tax rates t_c^l, t_c^k, t_c^y are imposed on labor income, capital income and final demand, respectively.

3.2. Production technology

Automation changes firms' production technology. This can have an impact on industry level factor demand (labor and capital) and productivity when firm-specific production processes and industrial organization change. In a generic form, the production function of industry i is written as:

$$y_{i,c} = f_{i,c}(K_{i,c}, L_{i,c}, A_{i,c}) \tag{2}$$

with $K_{i,c}$ and $L_{i,c}$ as capital and labor whose demand depends on wages $w_{i,c}$ and capital prices $r_{i,c}$. The capital stock $K_{i,c}$ is composed of different types of capital, i.e. $K_{i,c} = K_{i,c}^n + K_{i,c}^a$ where $K_{i,c}^n$ is non-automation capital and $K_{i,c}^a = ICT_{i,c} + R_{i,c}$ is automation capital with $R_{i,c}$ as industrial robots and $ICT_{i,c}$ as ICTs.[4] Both, robots and ICT, are measures of automation, but capture different concepts. Industrial robots are pure ATs designed to automate manual tasks performed by human workers. ICT capital is more

[4]Note that $ICT_{i,c}$ and $R_{i,c}$ are not necessarily disjoint.

general and can be used for various cognitive tasks complementing or substituting human labor. We assume that all types of capital are rented at the same price $r_{i,c}$.

Production technologies differ across industries and countries leading to different input shares. Production functions are empirically not observable. But we observe industry level factor inputs, factor costs and output and can draw inference about the relationships between inputs, outputs and the price responsiveness of factor demand. Moreover, by the definition of a production function, we assume $\frac{\partial f_{i,c}}{\partial L_{i,c}} \geq 0$, $\frac{\partial f_{i,c}}{\partial K_{i,c}} \geq 0$, $\frac{\partial f_{i,c}}{\partial A_{i,c}} \geq 0$, i.e. the quantity of output is non-decreasing in the quantity of inputs and in the level of productivity. Moreover, ceteris paribus we expect factor demand to be negatively related to factor prices, i.e. $\frac{\partial L_{i,c}}{\partial w_{i,c}} \leq 0$ and $\frac{\partial K_{i,c}}{\partial r_{i,c}} \leq 0$.

3.3. Final demand

Final demand is given by the aggregation across firms:

$$p_c Q_c = \sum_{i \in I_c} p^s_{i,c} q_{i,c}(p_{i,c}, Y_c) \tag{3}$$

where $p_{i,c} = (1 + t^y) \cdot p^s_{i,c}$ is i's consumer price including consumption taxes t^y, $p^s_{i,c}$ is i's supply price, and $q_{i,c}(p_{i,c}, Y_c)$ is industry level demand which is a function of the price and income Y_c in region c with $\frac{\partial q_{i,c}}{\partial p_{i,c}} \leq 0$ and $\frac{\partial q_{i,c}}{\partial Y_c} \geq 0$. Assuming market closure, income is composed of labor income $w_c L_c$, capital income $r_c K_c$ minus tax payments, i.e.

$$Y_c = (1 - t^l_c) \cdot w_c L_c + (1 - t^k) \cdot r_c K_c. \tag{4}$$

In this stylized representation, we neglect trade, inter-regional transfers, savings, and household and firm heterogeneity.

3.4. The effects of automation

Automation indirectly affects tax revenues through changes in production technology that translate into changes in factor use, market shares, and final demand.

Formally, the aggregate effect on tax revenue is given by the differential

$$\begin{aligned} dT_c = t^l_c \cdot \left(\frac{\partial w_c}{\partial K^a_c} L_c + w_c \frac{\partial L_c}{\partial K^a_c} \right) + t^k_c \cdot \left(\frac{\partial r_c}{\partial K^a_c} K_c + r_c \frac{\partial K_c}{\partial K^a_c} \right) \\ + t^Y \cdot \left(\frac{\partial P_c}{\partial K^a_c} Q_c + P_c \frac{\partial Q_c}{\partial K^a_c} \right) \end{aligned} \tag{5}$$

where $K^a_c = R_c + ICT_c$, with $R_c = \sum_{i \in I_c} R_{i,c}$ and $ICT_c = \sum_{i \in I_c} ICT_{i,c}$.

We study the effect of automation on production and taxation along the replacement, reinstatement and real-income effect. Even if the differentiation between these effects is not perfectly clear-cut, we simplify the analysis and assume the replacement and reinstatement effect to be mainly reflected in a changing factor demand, while the real income effect to be reflected in final demand and prices. We next discuss these effects in detail.

3.4.1. The replacement effect

In automating industries, i.e. in industries characterized by $K^a_{i,c} > 0$, employees are potentially replaced by machinery, i.e. $\frac{\partial L_{i,c}}{\partial K^a_{i,c}} < 0$ for $i \in \{j | K^a_{j,c} > 0\}$. However, the effect on wages in industry i can go either way, i.e. $\frac{\partial w_{i,c}}{\partial K^a_{i,c}} \lesseqgtr 0$: On the one hand the replacement effect exerts downward pressure on wages paid for jobs that can be automated. On the other, automation may complement non-automatable labor which increases productivity with a positive effect on wages and leads to a polarization of wage income. The net impact of the replacement effect on the labor income in industry i depends on the extent to which potential wage increases for non-automatable jobs offset the replacement of automatable jobs, while we expect a negative sign if the replacement dominates reinstatement in industry i, i.e. $\frac{\partial (w_{i,c} L_{i,c})}{\partial K^a_{i,c}} < 0$.

Ceteris paribus, i.e. in the absence of the reinstatement and real-income effect, the replacement effect has a negative impact on total and on labor taxes in particular, provided that the net effect on the wage bill is negative and taxes are sufficiently non-progressive. If labor taxes are progressive, taxes on labor and wage polarization are positively related.

3.4.2. The reinstatement effect

Reinstatement effects occur at different levels of analysis. Within automating industries, automation may induce occupational changes driven by two effects: (1) efficiency gains may release resources available for other processes, and (2) automation may require complementary labor inputs to operate the machinery. This effect can be reinforced if automation stimulates capital accumulation which may also have a positive effect on labor demand.

The reinstatement effect can also occur as a spillover at the aggregate level when productivity growth reduces prices or increases in incomes lead to market growth and/or changing market shares and sizes of other industries. This can induce the reinstatement of labor in other industries and a cross-industrial reallocation of labor.

Ceteris paribus, the reinstatement effect positively affects labor demand in automating industries and at the country level, i.e. $\frac{\partial L_{i,c}}{\partial K^a_{i,c}} > 0, i \in \{j | K^a_{j,c} > 0\}$ and $\frac{\partial L_c}{\partial K^a_c} > 0$. Dependent on wage heterogeneity within and across industries, the reinstatement effect can have ambiguous effects on industry and country level average wages. However, it has a positive effect on aggregate labor income, i.e. $\frac{\partial w_c L_c}{\partial K_c^a} > 0$.

3.4.3. The real income effect

The real income effect is an indirect, composite effect resulting from both the replacement and reinstatement of labor, and the impact of automation on capital accumulation, productivity and prices. This effect is composed of changes in nominal income and consumer prices. The direction of the total effect of automation on aggregate nominal income depends on the relative contribution of the different mechanisms, $\frac{\partial (w_c L_c + r_c K_c)}{\partial K_c^a} \lesseqgtr 0$.

The second part of the real income effect is a productivity induced change in the aggregate price level. Productivity has a negative effect on unit production costs. ATs increase productivity, i.e. $\frac{\partial A_{i,c}}{\partial K_{i,c}^a} \geq 0$ assuming rational AT adoption decisions, which leads to price reductions when lower unit production costs are passed through to consumers, i.e. $\frac{\partial p_{i,c}}{\partial A_{i,c}} \leq 0$ and $\frac{\partial p_{i,c}}{\partial K_{i,c}^a} \leq 0$. In turn, this increases real disposable income, i.e. $\frac{\partial Y_c^r}{\partial K_{i,c}^a} \geq 0$ where $Y_c^r = (1 - t^l) \frac{w_c}{p_c} L_c + (1 - t^k) \frac{r_c}{p_c} K_c$ and $\frac{\partial p_c}{\partial p_{i,c}} \geq 0$ and $\frac{\partial p_{i,c}}{\partial K_{i,c}^a} \leq 0$.

Dependent on the income elasticity of demand, an increase in real income may induce an increase in consumption which reinforces the reinstatement effect with positive feedback on labor and capital income.

4. Empirical approach and data

4.1. Overview

Real-world tax systems are more complex and as suggested by the stylized decomposition there are three main blocks of tax income, i.e. T_c^l, T_c^k and T_c^y, that are linearly linked to aggregate economic accounts. Tax revenues are raised through different channels with many non-linearities arising from diverse threshold levels and exemptions. Uniform, linear, macroeconomic tax rates t_c^l, t_c^k and t_c^y as used in equation (1) do not exist. Moreover, data on taxation is only available at the country level, while tax burdens are heterogeneous across households, firms, and industries. In return, many of the effects of automation occur at the industry or firm level. Therefore, to analyze the effect of automation on taxation, we use an indirect procedure. Empirically, we observe aggregate tax revenues ($T_{c,t}$, $T_{c,t}^l$, $T_{c,t}^k$ and $T_{c,t}^y$), have measures for the key economic variables ($w_{c,t}$, $L_{c,t}$, $r_{c,t}$, $K_{c,t}$, $p_{c,t}$, $Q_{c,t}$), and can derive indicators for the economic structure at different time periods t.

Table 1: Overview of three key effects of automation on economic production

Effect	Description	Indicators
Replacement	Substitution of labor. Decreasing labor demand and wages. Unclear side effects on net capital accumulation, prices and depreciation.	$\frac{\partial L_{i,c}}{\partial K^a_{i,c}}$, $\frac{\partial w_{i,c}}{\partial K^a_{i,c}}$, $\frac{\partial r_{i,c}}{\partial K^a_{i,c}}$, $\frac{\partial K_{i,c}}{\partial K^a_{i,c}}$ where $K^a_{i,c} = R_{i,c} + ICT_{i,c}$ and $i \in \{j \mid K^a_{j,c} > 0\}$.
Reinstatement	Productivity gains from automation reinstate labor demand in other and newly emerging economic activities. Increasing labor demand and wages.	$\frac{\partial L_c}{\partial K^a_c}$, $\frac{\partial w_c}{\partial K^a_c}$, $\frac{\partial r_c}{\partial K^a_c}$, $\frac{\partial K_c}{\partial K^a_c}$, $\frac{\partial Services_c}{\partial K^a_c}$.
Real income	Productivity gains reduce unit production costs and prices of final goods, and increase aggregate demand. Distortions in market structure and competition, and an unequal distribution of income gains may undermine this effect.	$\frac{\partial A_c}{\partial K^a_c}$, $\frac{\partial p_c}{\partial K^a_c}$, $\frac{\partial Q_c}{\partial K^a_c}$, $\frac{\partial HHI_c}{\partial K^a_c}$.

Our procedure consists of the following steps: First, we establish prerequisites that motivate the subsequent steps. This includes testing for statistically significant correlations between taxes and automation. In turn, this allows us to examine the empirical link between different types of taxes and economic variables. Second, we step-wise test the prevalence of the three effects: replacement, reinstatement and real income; summarized in Table 1. We study how income, output, prices and structural indicators at the macroeconomic and industry level are related to automation. Finally, we argue how the three effects help explain the impact of automation on taxation and in turn help us answer the three research questions introduced in Section 1.

4.2. Data

We combine different data sets at different aggregation levels with varying coverage in terms of countries, industries and time. After merging the data as described below, we end up with two samples. The first sample is a country level panel data set covering the whole economy, i.e. from agriculture to public sectors, for 19 European countries during 1995-2016.[5]

The second sample is an industry level panel data set covering only automation-intensive industries. We classify industries as automation-intensive when information on the use of robots exists, since the data coverage of industries is endogenous. Specifically, only

[5] The sample is unbalanced since data are missing for: Lithuania, Latvia and the United Kingdom during the first sample year, i.e. 1995; and Denmark, Portugal, Slovenia and Slovakia for the period 1995-1999.

significant customers of industrial robots are reported [IFR, 2020]. Overall, this data covers the same set of countries and years as the country level data excluding Portugal due to missing information. The industries classified as automation-intensives include: agriculture; mining and quarrying; 10 manufacturing industries; electricity, gas and water supply; construction; and education, and research and development.[6]

4.2.1. Sources of tax revenue

Taxes are part of our country level data and compiled on the basis of the Global Revenue Statistics Database of the OECD [2020]. We use the OECD terminology to define the tax aggregates as follows:

- $T^l_{c,t}$—taxes on labor are the sum of *Social security contributions (2000)* and *Taxes on payroll and workforce (3000)*;
- $T^k_{c,t}$—taxes on capital are the sum of *Taxes on income, profits and capital gains (1000)* and *Taxes on property (4000)*;[7]
- and $T^y_{c,t}$—taxes on goods given by *Taxes on goods and services (5000)*,

where the numbers in parentheses indicate the tax code from the OECD tax classification system [OECD, 2019, A.1].[8]

To describe the impact on tax revenues, we use taxes measured in national currency. To put this in relation to production, we look at taxes measured as percentage of GDP. For an analysis on the structure of taxation, we use tax data measured as percentage of total taxation.

4.2.2. Economic variables

Empirical proxies for factor income and consumption at the country level are aggregates of NACE Rev. 2 (ISIC Rev. 4) industry level data from the EUKLEMS database [EUKLEMS, 2019, Stehrer et al., 2019, Adarov et al., 2019]. We use

- *LAB* for $w_{c,t}L_{c,t} = \sum_{i \in I_c} w_{i,c,t}L_{i,c,t}$,

[6] The sample is unbalanced since certain country industry year combinations are missing. Generally, the industry and year coverage is rather limited for Eastern European countries i.e. Estonia, Lithuania, Latvia, Slovenia and Slovakia. Details on the coverage are provided in the Appendix (Table A.2).

[7] We include property taxes as part of capital taxes because: (1) they consist largely of taxes on corporate property; and (2) we interpret property as part of the productive capital that is used to provide economic services to final consumers. This interpretation also holds for the majority of private property taxes. For example, taxes on houses are one of the most significant parts of property taxes. Housing is a service consumed by households even if private housing is not traded on the market. This interpretation is not applicable to other components of property taxes (e.g. taxes on gifts). However, tax revenues raised from these residual accounts are negligibly small. The total block of property taxes accounts on average for $< 2\%$ of GDP. Checks excluding all 4000-taxes confirm that this does not alter the results.

[8] In this analysis, we ignore residual taxes (6000) which, on average across OECD countries, account for approximately 0.2% of GDP and 0.6% of total taxation.

- CAP for $r_{c,t}K_{c,t} = \sum_{i \in I_c} r_{i,c,t}K_{i,c,t}$,
- and GO for $p_{c,t}Q_{c,t} = \sum_{i \in I_c} p_{i,c,t}Q_{i,c,t}$.[9]

where $w_{i,c,t}$, $r_{i,c,t}$ and $p_{i,c,t}$, are computed by dividing the respective variables measured in values to their volumes.[10]

Automation may lead to industrial restructuring. To measure this, we construct two structural indicators using industry level data. First, we compute the service sector market share: $Services_{c,t} = \frac{\sum_{i \in I_c^s} p_{i,c,t}Q_{i,c,t}}{\sum_{i \in I_c} p_{i,c,t}Q_{i,c,t}}$, where I_c^s is the set of service industries in c.[11] Second, we compute as a measure of industrial concentration the Hirschmann-Herfindahl index on the basis of industry shares in total production, i.e. $HHI_{c,t} = \sum_{i \in I_c} \left(\frac{p_{i,c,t}Q_{i,c,t}}{p_{c,t}Q_{c,t}} \right)^2$.

For an indicator of cross-industrial wage inequality, we use industry level data on wages to calculate the country level Gini coefficient as follows: $Gini^w_{c,t} = \frac{\sum_{i=1}^{I_c}(2i - I_c - 1)w_{i,c,t}}{I_c \sum_{i=1}^{I_c} w_{i,c,t}}$, where I_c is the total number of industries in country c and i is now the rank of industry level wages in ascending order. Analogously, we compute $Gini^L_{c,t}$ which measures the distribution of employment across industries. A higher level of $Gini^w_{c,t}$ ($Gini^L_{c,t}$) indicates a more unequal distribution of wage (labor) across industries.

To examine the impact of automation on productivity, we use industry level data to calculate labor productivity $LProd_{c,t}$ as the share of gross output volumes over the total number of hours worked. We also estimate total factor productivity $TFP_{c,t}$ as the residual from an OLS regression of gross output volumes on a translog production function of volumes of capital, labor (hours worked) and material inputs [cf. Stehrer et al., 2019].

In the tax regressions, we additionally control for determinants of taxation identified in the literature [e.g. Castro and Camarillo, 2014, Castañeda Rodríguez, 2018]. We include GDP growth and different indicators of public finances sourced from Eurostat [2020a], such as: government consolidated gross debt as % of GDP ($Debt^{\%GDP}_{c,t}$); net government lending/borrowing as % of GDP ($Lending^{\%GDP}_{c,t}$); government interest payments on debt as % of GDP ($Interest^{\%GDP}_{c,t}$); and public gross fixed capital formation as % of GDP ($GovInv^{\%GDP}_{c,t}$). We capture the role of trade by including the period average exchange rate ($XRate_{c,t}$) from the OECD [2020] data set. Robustness checks including additonal controls, such as: effective tax rates, and import and export rates are provided in SI.2.3.

[9] LAB is computed as the compensation of employees in current prices of national currency in million times the ratio of total hours worked by persons engaged over total hours worked by employees, which assumes that in each industry the self-employed receive the same hourly wage as the employees. CAP is the capital compensation calculated as the value added minus labor compensation. Note that we use the value of the capital stock as proxy for the rate of return to capital. GO is the gross output in current prices of national currency in million.

[10] Specifically, we source from EUKLEMS $L_{c,t} = \sum_{i \in I_c} L_{i,c,t}$, $K_{c,t} = \sum_{i \in I_c} K_{i,c,t}$ and $Q_{c,t} = \sum_{i \in I_c} Q_{i,c,t}$ as the number of hours worked in million (H_EMPE), the net capital stock volume of all assets in million (Kq_GFCF), and the gross output volume in million (GO_Q). Similarly, we construct country level $w_{c,t}$, $r_{c,t}$ and $p_{c,t}$ by dividing the corresponding country level aggregates in values by volumes $L_{c,t}$, $K_{c,t}$ and $Q_{c,t}$, respectively.

[11] We define service industries as NACE Rev. 2 (ISIC Rev. 4) 2-digit codes 45-99 or 1-digit codes G-U.

4.2.3. Measuring automation

We use two measures for automation calculated on the basis of: (1) the number of operational industrial robots per industry; and (2) the capital stock of ICT including computer software and databases.

The data on industrial robots is from the International Federation of Robotics (IFR) [IFR, 2020]. An industrial robot is defined as *"automatically controlled, reprogrammable, multipurpose manipulator [...] for industrial applications"* [IFR, 2020].[12] The IFR provides data on deliveries and stocks of industrial robots at the industry level. Industrial robots are a measure of automation because they can readily replace humans in the execution of specific tasks [see Graetz and Michaels, 2018, de Vries et al., 2020, Acemoglu and Restrepo, 2020a, Faber, 2020].

To measure the extent to which robots became part of an industry's production technology, we construct the *robot density* measure as the number of operational robots over the number of hours worked by human labor in industry i, i.e. $R_{i,c,t} = \frac{\#Robots_{i,c,t}}{L_{i,c,t}}$. For the country level analysis, we compute $R_{c,t} = \frac{\sum_{i \in I_c} \#Robots_{i,c,t}}{\sum_{i \in I_c} L_{i,c,t}}$.

As a second automation indicator, we use the *ICT-intensity* measured as net ICT capital stock per hour worked $L_{i,c,t}$. The data on ICT capital is taken from EUKLEMS [2019] and given by the sum of net capital stock volumes of computing equipment (Kq_IT), communications equipment (Kq_CT), and computer software and databases (Kq_Soft_DB). It includes both tangible (hardware) and intangible (data bases and software) ICTs.

The coverage of industries differs for data on robots and ICT. Data on ICT covers the whole economy, except for all industries in Portugal and certain industries and/or years in Eastern European countries. Robot data are available for other countries than those in the ICT data set, but reported only for the following industries: agriculture; mining and quarrying; 10 manufacturing industry groups; electricity, gas and water supply; construction; and education, and research and development (see Table A.2).

We include these two types of automation to potentially account for two different AT types. Robots and ICTs can be distinguished by the type of task they can execute: robots are designed to perform manual tasks, while ICT has a stronger link to cognitive tasks. While robots are pure ATs that execute a clearly defined task previously performed by humans, it is less clear whether this also applies to ICTs. ICTs can be flexibly applied for many different tasks and, at to some extent, these tasks do not have a clear analogue in the range of tasks that can be executed by humans.

In our analysis, we introduce both diffusion measures simultaneously and as an interaction term. Robot-ICT interaction captures complementarities between the two ATs or

[12] This definition follows the ISO norm 8373 `https://www.iso.org/obp/ui/#iso:std:iso:8373:ed-2:v1:en`.

otherwise stated the depth of automation, i.e. the extent to which both, manual and cognitive tasks, are performed by machinery. Concerns about multicollinearity can be ruled out since we find a very low correlation between both measures (with a correlation coefficient of 22% for all countries in the sample and with 34%, 19% and 63% for Eastern, Northern and Southern European countries, respectively.

5. Results

5.1. Prerequisites

Before analyzing the channels through which automation affects the economy, we describe empirically the nexus between taxation, macroeconomic aggregates and automation.

5.1.1. Taxation and automation

We begin with a correlation analysis by regressing country level tax revenues on automation measures:

$$\Theta_{c,t} \sim \beta^R R_{c,t} + \beta^{ICT} ICT_{c,t} + \beta^{RICT} R_{c,t} \cdot ICT_{c,t} + \beta^z Z_{c,t} + \epsilon_{c,t} \tag{6}$$

where $\Theta_{c,t} \in \{T_{c,t}, T^l_{c,t}, T^k_{c,t}, T^y_{c,t}\}$ measured in (1) levels, i.e. in logs of billions of national currency, (2) in percentage share of GDP and (3) in percentage share of total taxation. We control for country and time FE and a series of macroeconomic variables $Z_{c,t}$.[13] To allow the error term to be correlated both across countries and over time, we cluster standard errors at the country and time dimension.

Results using all 19 European countries in the sample are presented in Table 2 for various time periods (Panels A-C). In the first block of columns, we see the association of automation with taxes measured in logarithmic national currency units. The second block shows the relationship with taxes measured in percentage GDP. The last block shows the impact on the structure of taxation, i.e. on taxes as share of total taxation.

For the full period (Panel A), we observe a negative relationship between robots an total tax revenues and taxes on labor in absolute terms and as share in total taxation. Until 2007 (Panel B), robot diffusion was also associated with a decline in capital taxation

[13]This include: GDP growth, gross output share of service industries; Herfindahl-Hirschman Index based on the gross output shares of macro-sectors; government consolidated gross debt as % of GDP; government interest payable as % of GDP; net government lending/borrowing as % of GDP; gross fixed capital formation as % of GDP; and period average exchange rate. All regressions for Taxes in ln of national currency also include the ln of gross output value (pQ). For more details over the construction of these variables, see Section 4.2.2.

increasing the share of taxes on goods. After 2008 (Panel C), we do not find any significant correlation between robots and taxes.

Continuing, we observe a weak negative correlation between ICT diffusion and total tax revenues. Here, the decline in taxes comes at the cost of capital taxes while we observe an increasing share of taxes on labor, but this is only significant in the period prior to 2007. After 2008, ICT diffusion is negatively associated with the share of taxes on goods.

Next, the depth of automation exhibits a positive relationship with total tax revenues and taxes on capital and goods in absolute terms and relative to GDP, while it is negatively related to the share of labor taxes.

Table 2: Taxation and automation

	Taxes in ln of nat. currency				Taxes as % of GDP				Taxes as % of total tax		
	$lnT_{c,t}$	$lnT^l_{c,t}$	$lnT^k_{c,t}$	$lnT^y_{c,t}$	$T_{c,t}$	$T^l_{c,t}$	$T^k_{c,t}$	$T^y_{c,t}$	$T^l_{c,t}$	$T^k_{c,t}$	$T^y_{c,t}$
Panel A: full period 1995-2016											
$R_{c,t}$	-0.026*	-0.051**	0.005	-0.021	0.093	-0.292	0.358	0.026	-0.955	0.758	-0.092
	(0.014)	(0.022)	(0.042)	(0.020)	(0.467)	(0.233)	(0.363)	(0.199)	(0.635)	(0.898)	(0.621)
$ICT_{c,t}$	-0.042***	-0.081	-0.101***	-0.024	-1.359**	0.225	-1.499**	-0.085	1.689	-2.103*	0.596
	(0.013)	(0.107)	(0.033)	(0.022)	(0.529)	(0.383)	(0.602)	(0.196)	(1.001)	(1.110)	(0.694)
$R * ICT_{c,t}$	0.018**	0.023	0.044**	0.027**	0.405	-0.262	0.492*	0.176	-1.068***	0.812*	0.201
	(0.007)	(0.039)	(0.016)	(0.012)	(0.257)	(0.161)	(0.248)	(0.131)	(0.292)	(0.451)	(0.407)
R^2	0.999	.998	.998	.999	.966	.984	.974	.904	.982	.971	.939
N	395	395	395	395	395	395	395	395	395	395	395
Panel B: sub-period 1995-2007											
$R_{c,t}$	-0.064**	-0.145*	-0.121***	-0.010	-0.916	-0.294	-0.872**	0.250	-0.122	-1.903**	1.189**
	(0.022)	(0.073)	(0.034)	(0.031)	(0.635)	(0.263)	(0.380)	(0.247)	(0.507)	(0.637)	(0.536)
$ICT_{c,t}$	-0.005	-0.132	-0.069	-0.001	0.804	0.909**	-0.573	0.468**	1.671*	-2.274*	0.250
	(0.025)	(0.158)	(0.052)	(0.024)	(0.709)	(0.331)	(0.633)	(0.208)	(0.800)	(1.184)	(0.569)
$R * ICT_{c,t}$	0.003	0.047	0.010	0.007	-0.602	-0.178	-0.216	-0.208*	0.101	0.250	-0.002
	(0.019)	(0.056)	(0.033)	(0.014)	(0.638)	(0.259)	(0.424)	(0.115)	(0.327)	(0.633)	(0.536)
R^2	0.999	.998	.999	0.999	.975	.986	.983	.943	.99	.985	.964
N	224	224	224	224	224	224	224	224	224	224	224
Panel C: sub-period 2008-2016											
$R_{c,t}$	0.004	0.012	0.028	-0.022	0.520	0.300	0.262	-0.041	0.301	0.426	-0.699
	(0.020)	(0.023)	(0.059)	(0.027)	(0.807)	(0.362)	(0.540)	(0.338)	(0.787)	(1.210)	(0.940)
$ICT_{c,t}$	-0.016	-0.005	-0.012	-0.041	-0.971	-0.196	0.112	-0.886	-0.205	1.693*	-1.520
	(0.034)	(0.045)	(0.028)	(0.061)	(0.838)	(0.520)	(0.235)	(0.610)	(0.911)	(0.790)	(0.887)
$R * ICT_{c,t}$	-0.006	0.004	-0.001	-0.012	0.112	-0.099	0.122	0.089	0.204	-0.459	0.221
	(0.023)	(0.022)	(0.039)	(0.035)	(0.857)	(0.343)	(0.573)	(0.365)	(0.530)	(0.626)	(0.415)
R^2	0.999	0.999	.999	0.999	.983	.994	.989	.949	.991	.987	.966
N	171	171	171	171	171	171	171	171	171	171	171

Notes: $*p < 0.05$, $**p < 0.01$, $***p < 0.001$. Regression results of aggregate flows of tax revenues on different automation measures for 19 European countries during the period 1995-2016. All regressions use country level data and include: GDP growth, gross output share of service industries; Herfindahl-Hirschman Index based on the gross output shares of macro-sectors; government consolidated gross debt as % of GDP; government interest payable as % of GDP; net government lending/borrowing as % of GDP; gross fixed capital formation as % of GDP; period average exchange rate; and country (c) and year (t) fixed effects. All regressions for Taxes in ln of national currency also include the ln of gross output value (pQ). Standard errors are clustered both at the country and year level.

To control for regional differences, we split the sample into Eastern, Northern and

Southern Europe which differ by tax systems, their industrial structure and the extent to which countries were hit by the financial crisis.[14] The results are shown in B.1.1.

In Eastern Europe, we find that while robot diffusion is negatively associated with taxes on labor and goods no effects are present for ICT. The depth of automation is positively correlated with taxes on capital and goods and it is associated with a shift from taxation of labor to capital. Until 2007, the effect of $R * ICT_{c,t}$ on capital taxation is opposite, i.e. negative.

In Northern Europe, we observe a negative correlation between robot diffusion and the depth of automation and labor taxes. Until 2007, robot diffusion and automation depth exhibit a negative impact on total tax revenues and capital taxation and after 2008 on taxes on goods. Conversely, ICT diffusion is positively related to labor taxation at the expense of taxes on capital.

In Southern Europe, we find robots to be negatively correlated with total tax revenues and taxes on goods measured as percentage GDP. Prior to 2007, we see a negative relationship between robots and labor taxation and after 2008 with capital taxation. ICTs exhibit a negative association with labor taxation and we observe an increasing share of goods taxation.

5.1.2. Taxation and production

To identify the determinants taxation, we run a regression of taxes measured in logs of national currency, percentage GDP and percentage of total taxation on a sample of country level economic and public finance indicators. The results for the period 1995-2016 are shown in Table 3. Again, we provide additional results on various country sub-groups in B.1.2.

We observe a strong positive relationship between the wage bill $wL_{c,t}$ and all taxes measured in national currencies. Capital income exhibits a weak positive correlation with taxes on labor and aggregate consumption with taxes on goods.

In the latter two blocks of columns showing the results for taxes as percentage of GDP and the structure of taxation, we use factor income shares as regressors, i.e. dividing $wL_{c,t}$ and $rK_{c,t}$ by GDP. We find factor income shares (both $wL_{c,t}$ and $rK_{c,t}$) to be negatively correlated with total tax revenues and taxes on goods. The last block of columns shows the relationship between factor shares and the structure of taxation: We observe both the share of labor and capital taxation to be positively correlated with factor income shares at the expense of taxes on goods. These observations are robust across different regions and sub-periods (see B.1.2).

[14] Descriptive statistics and time series plots illustrating the regional peculiarities can be found in the Appendix A.2 and A.3.1.

Labor taxes in absolute terms, in relation to GDP and as share in total taxation exhibit a positive correlation with the market share of services $Services_{c,t}$. This pattern holds for the majority of sub-periods and regions. In other sub-samples, we additionally find a negative association of the services share with taxes on capital and goods. Northern Europe is an exception where we observe a weakly significant opposite relationship.

Table 3: Taxation and the structure of production

	Taxes in ln of nat. currency				Taxes as % of GDP				Taxes as % of total tax		
	ln $T_{c,t}$	ln $T^l_{c,t}$	ln $T^k_{c,t}$	ln$T^y_{c,t}$	$T_{c,t}$	$T^l_{c,t}$	$T^k_{c,t}$	$T^y_{c,t}$	$T^l_{c,t}$	$T^k_{c,t}$	$T^y_{c,t}$
$R_{c,t}$	-0.019*	-0.039*	0.013	-0.014	-0.056	-0.323	0.322	-0.055	-0.922	0.801	-0.202
	(0.010)	(0.019)	(0.040)	(0.021)	(0.421)	(0.226)	(0.357)	(0.127)	(0.598)	(0.905)	(0.515)
$ICT_{c,t}$	-0.061***	-0.093	-0.122***	-0.047*	-1.620***	0.022	-1.794**	0.152	1.291	-2.695**	1.457**
	(0.011)	(0.095)	(0.038)	(0.024)	(0.544)	(0.353)	(0.641)	(0.165)	(0.903)	(1.118)	(0.608)
$R*ICT_{c,t}$	0.022***	0.022	0.048**	0.031**	0.429	-0.199	0.589**	0.040	-0.893**	1.067**	-0.196
	(0.005)	(0.034)	(0.017)	(0.012)	(0.290)	(0.153)	(0.269)	(0.077)	(0.363)	(0.429)	(0.291)
$wL_{c,t}$	0.593***	0.721*	0.661**	0.626***	-0.457***	0.051	0.122	-0.630***	0.560**	0.799**	-1.392***
	(0.164)	(0.345)	(0.280)	(0.150)	(0.156)	(0.111)	(0.133)	(0.094)	(0.245)	(0.377)	(0.253)
$rK_{c,t}$	0.097	0.260	0.119	0.069	-0.656***	-0.022	0.025	-0.659***	0.508**	0.715**	-1.315***
	(0.090)	(0.256)	(0.162)	(0.091)	(0.135)	(0.088)	(0.105)	(0.073)	(0.178)	(0.262)	(0.216)
$pQ_{c,t}$	0.205	-0.066	0.128	0.238							
	(0.246)	(0.561)	(0.378)	(0.220)							
$GDPgrowth_{c,t}$	-0.001	-0.003	0.005	-0.002	0.004	-0.031	0.039	-0.004	-0.109	0.135	-0.004
	(0.001)	(0.003)	(0.003)	(0.002)	(0.039)	(0.026)	(0.027)	(0.016)	(0.076)	(0.086)	(0.040)
$Services_{c,t}$	-0.003	0.011	-0.014	-0.015**	-0.026	0.151*	-0.129	-0.047	0.513**	-0.371	-0.169
	(0.004)	(0.013)	(0.010)	(0.007)	(0.091)	(0.080)	(0.099)	(0.042)	(0.235)	(0.273)	(0.111)
$HHI_{c,t}$	-0.886	2.203	-3.399	-2.793***	-13.553	24.999*	-27.689	-10.863	90.046**	-73.312	-16.057
	(0.575)	(1.771)	(2.073)	(0.840)	(17.702)	(13.563)	(18.820)	(7.968)	(42.454)	(58.541)	(24.486)
$Debt^{\%GDP}_{c,t}$	0.002***	0.000	0.004**	0.002***	0.051***	-0.005	0.038***	0.018***	-0.062**	0.061	-0.007
	(0.000)	(0.001)	(0.001)	(0.001)	(0.012)	(0.007)	(0.013)	(0.004)	(0.024)	(0.036)	(0.012)
$Interest^{\%GDP}_{c,t}$	-0.008	0.004	-0.021	-0.012*	-0.324	-0.050	-0.171	-0.103**	0.298	-0.266	0.211
	(0.007)	(0.008)	(0.015)	(0.006)	(0.191)	(0.091)	(0.155)	(0.044)	(0.257)	(0.391)	(0.156)
$Lending^{\%GDP}_{c,t}$	0.005***	-0.002	0.004	0.006**	0.116***	0.012	0.071*	0.033***	-0.029	0.047	-0.032
	(0.001)	(0.004)	(0.004)	(0.002)	(0.028)	(0.019)	(0.036)	(0.011)	(0.065)	(0.084)	(0.040)
$GovInv^{\%GDP}_{c,t}$	0.007	0.009	0.004	-0.003	-0.001	0.020	0.039	-0.060	0.055	-0.021	-0.182
	(0.006)	(0.009)	(0.015)	(0.006)	(0.193)	(0.106)	(0.154)	(0.062)	(0.274)	(0.333)	(0.221)
$XRate_{c,t}$	-0.004***	-0.004	-0.004	-0.008***	-0.089**	-0.002	-0.075*	-0.012	0.101	-0.090	0.042
	(0.001)	(0.006)	(0.003)	(0.002)	(0.036)	(0.028)	(0.038)	(0.011)	(0.067)	(0.081)	(0.034)
R^2	0.999	.998	.999	.999	.973	.985	.975	.96	.983	.972	.956
N	395	395	395	395	395	395	395	395	395	395	395

Notes: *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$. Regression results to examine the link between tax aggregation and economic production for 19 European countries during the period 1995-2016. All regressions use country level data and include: GDP growth ($GDPgrowth_{c,t}$); share of gross output produced in service industries ($Services_{c,t}$); Herfindahl-Hirschman Index based on the gross output shares of macro-sectors ($HHI_{c,t}$); government consolidated gross debt as % of GDP ($Debt^{\%GDP}_{c,t}$); government interest payable as % of GDP ($Interest^{\%GDP}_{c,t}$); net government lending/borrowing as % of GDP ($Lending^{\%GDP}_{c,t}$); gross fixed capital formation as % of GDP ($GovInv^{\%GDP}_{c,t}$); period average exchange rate ($XRate_{c,t}$); and country (c) and year (t) fixed effects. For the first block (Taxes in ln of national currency), $wL_{c,t}$, $rK_{c,t}$ and $pQ_{c,t}$ are expressed as the natural logarithm (ln) while for the last two blocks they are expressed as % of GDP. Standard errors are clustered both at the country and year level.

High indebtedness and higher deficits are positively related to taxes in absolute terms and measured in percentage GDP. Net lending as percentage GDP is positively correlated with all taxes except from labor taxes which are negatively related to deficits.

We find a higher exchange rate $XRate_{c,t}$ (i.e. US$ per Euro) to be negatively related to taxes on capital, goods and in total measured in absolute terms and as percentage of GDP. We also observe a higher exchange rate to be positively related to the relative tax contribution of labor at the cost of taxes on capital. This relationship is opposite in Southern European countries.[15]

5.2. The impact of automation on economic production

5.2.1. The replacement effect

We test for the replacement effect running the following regressions

$$X_{i,c,t} \sim \beta^R R_{i,c,t} + \beta^{ICT} ICT_{i,c,t} + \beta^{RICT} R_{i,c,t} \cdot ICT_{i,c,t} + \epsilon_{i,c,t} \tag{7}$$

where $X_{i,c,t} \in \{wL_{i,c,t}, w_{i,c,t}, L_{i,c,t}, rK_{i,c,t}, r_{i,c,t}, K_{i,c,t}\}$ and i is an industry in the subset of automation-intensive industries (see 4.2.3 and Table A.1). We control for country industry, country year and industry year FE. Standard errors are two-way clustered at the country-industry and year level.

Results on the replacement effect are shown in Table 4. Additional findings on country subsets are available in B.2. In total, we find weak support for the replacement effect in automation-intensive industries when robots diffuse, i.e. we observe decreasing employment aligned with increasing wages. The effects offset such that we do not find a significant effect on the wage bill $wL_{i,c,t}$. The replacement effect is even stronger when robots and ICT are adopted simultaneously captured by $R * ICT_{i,c,t}$. ICT diffusion is weakly positively associated with $wL_{i,c,t}$ driven by both, increasing employment $L_{i,c,t}$ and wages $w_{i,c,t}$. After 2008, we do not observe significant effects on labor market outcomes in automation-intensive industries. We also do not see that automation has any significant impact on capital accumulation and valuation for all periods and sub-periods.

In Eastern Europe, we find robots and $R * ICT_{i,c,t}$ to coincide with capital accumulation and labor replacement reflected in lower employment. The effects on capital prices are ambiguous: ICT ($R * ICT_{i,c,t}$) exhibits negative (positive) correlations with $r_{i,c,t}$. These relationships are more prevalent before 2007.

In Northern Europe we observe a weak positive association of ICT and robots with wages and a negative one with employment. The negative employment effect dominates for robots and the positive wage effect for ICT. These observations are only weakly significant. Capital markets in Northern Europe are only weakly affected. Moreover, we observe a

[15]Note that the exchange rate varies across European countries only in the time dimension since the EU's Exchange Rate Mechanism aims to keep exchange rate fluctuations between the Euro and other European currencies flat (see also https://stats.oecd.org/glossary/detail.asp?ID=3055). Hence, $XRate_{c,t}$ captures the competitiveness of European countries on global markets but can not be interpreted as an indicator for within-European trade.

positive association between capital accumulation and robots and the automation depth $R * ICT_{i,c,t}$ prior to 2007.

In Southern Europe, both, robots and ICT diffusion, are associated with increasing wages and less employment while the employment effect is less significant and the wage effect dominates in quantitative terms, i.e. we find a positive correlation with $wL_{i,c,t}$. $R * ICT_{i,c,t}$ is negatively associated with employment while this effect is strongest in the period after 2008. We also find a negative relationship between the capital bill $rK_{i,c,t}$ and automation (see B.2).

Table 4: The replacement effect

	ln $wL_{i,c,t}$	ln $w_{i,c,t}$	ln $L_{i,c,t}$	ln $rK_{i,c,t}$	ln $r_{i,c,t}$	ln $K_{i,c,t}$
Panel A: full period 1995-2016						
$R_{i,c,t}$	-0.031	0.026**	-0.057**	-0.053	-0.011	0.008
	(0.031)	(0.010)	(0.027)	(0.036)	(0.007)	(0.027)
$ICT_{i,c,t}$	0.020	0.005	0.015	0.026	-0.001	0.028
	(0.012)	(0.005)	(0.013)	(0.026)	(0.010)	(0.023)
$R * ICT_{i,c,t}$	-0.007	0.005**	-0.012**	0.003	-0.004	0.006
	(0.005)	(0.002)	(0.005)	(0.009)	(0.002)	(0.007)
R^2	.997	.996	.994	.972	.927	.996
N	4898	4898	4898	4843	4803	4803
Panel B: sub-period 1995-2007						
$R_{i,c,t}$	-0.006	0.016*	-0.022	0.005	-0.002	0.020
	(0.028)	(0.008)	(0.027)	(0.050)	(0.005)	(0.021)
$ICT_{i,c,t}$	0.026**	0.005	0.021*	0.001	0.001	0.029
	(0.010)	(0.005)	(0.010)	(0.027)	(0.010)	(0.017)
$R * ICT_{i,c,t}$	0.002	0.001	0.001	-0.003	-0.000	0.008
	(0.005)	(0.002)	(0.005)	(0.015)	(0.003)	(0.008)
R^2	.998	.997	.996	.975	.94	.998
N	2827	2827	2827	2790	2777	2777
Panel C: sub-period 2008-2016						
$R_{i,c,t}$	-0.034	0.013	-0.047*	-0.021	-0.004	-0.021
	(0.027)	(0.012)	(0.023)	(0.043)	(0.004)	(0.020)
$ICT_{i,c,t}$	-0.033	0.016	-0.049	-0.100	-0.006	-0.036
	(0.027)	(0.010)	(0.027)	(0.095)	(0.005)	(0.053)
$R * ICT_{i,c,t}$	-0.012	0.000	-0.012	0.028	-0.003*	0.011
	(0.010)	(0.004)	(0.009)	(0.020)	(0.002)	(0.009)
R^2	.999	.998	.998	.985	.918	.999
N	2070	2070	2070	2052	2025	2025

Notes: *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$. Regression results to test the replacement effect for 19 European countries during the period 1995-2016. All regressions use industry level data for the subset of industries susceptible to automation, defined as industries were the use of industrial robots is prevalent (see Appendix Table A.1). All regressions include: country industry (*ci*); country year (*ct*); and industry year (*it*) fixed effects. All regressions are weighted by the base-sample-year share of each industry's number of hours worked to country-wide hours worked. Standard errors are clustered both at the country-industry and year level.

5.2.2. The reinstatement effect

We test the reinstatement effect empirically with the following country level regressions

$$Y_{c,t} \sim \beta^R R_{c,t} + \beta^{ICT} ICT_{c,t} + \beta^{RICT} R_{c,t} \cdot ICT_{c,t} + \beta^z Z_{c,t} + \epsilon_{c,t} \tag{8}$$

where $Y_{c,t} \in \{w_{c,t}, L_{c,t}, r_{c,t}, K_{c,t}, HHI_{c,t}, Services_{c,t}, Gini^L_{c,t}, Gini^w_{c,t}\}$. The main effects of interest are those of automation on country level labor market outcomes $w_{c,t}$ and $L_{c,t}$. We also examine whether automation is a driver of capital accumulation ($K_{c,t}$ and $r_{c,t}$). Using $HHI_{c,t}$ and $Gini^L_{c,t}$ we test whether automation is related with industrial concentration of output and labor. $Services_{c,t}$ measures the cross-industrial reallocation of output to services. With $Gini^w_{c,t}$ we evaluate potential effects on cross-industrial wage inequality. The regressions include the same set of country level controls $Z_{c,t}$ as in equation (6), and country and year FE. We use two-way clustered standard errors at the country and year level. Regression results are shown in Table 5 and in B.2 for different country subsets.

We observe that robots and the depth of automation exhibit a negative association with wages and a positive correlation with employment which is only significant for $R * ICT_{c,t}$. We find the opposite for ICT diffusion which is associated with a positive effect on wages and a negative on employment. We also find robots to be negatively related to the accumulation and valuation of capital, while ICT exhibits a positive association with capital prices but a negative and statistically insignificant correlation with the capital stock. After 2008, the effects of ATs on factor markets become insignificant. Interestingly, while results for Eastern and Northern Europe align, the findings for Southern Europe are slightly different. specifically, we find ICT to coincide with capital accumulation and associated with more employment, while the effect of robots on employment and wages is negative before 2007 but positive afterwards.

For the full sample, the use of industrial robots is negatively related to the market share of services while the impact of ICT differs across periods: Prior to 2007, we observe ICT diffusion is negatively related to $Services_{c,t}$ but positively after 2008. This is also reflected in an ICT-related increase of the employment share of services after 2008. Prior to 2007, we find ICT diffusion to be accompanied with industrial concentration $HHI_{c,t}$ while we observe the opposite after 2008. For the full period, we find both robot and ICT diffusion to be associated with an increase in cross-industrial wage inequality measured by $Gini^w_{c,t}$.

In Eastern Europe, we find ICT to be negatively related to the share of the service sector which is less significant after 2008. In Northern Europe, ICT diffusion is strongly positively correlated with the share of services but also with cross-industrial wage inequality. In Southern Europe, the ICT-induced rise of services is significant in all periods while robots exhibit the opposite effect.

Table 5: The reinstatement effect

	$\ln w_{c,t}$	$\ln L_{c,t}$	$\ln r_{c,t}$	$\ln K_{c,t}$	$HHI_{c,t}$	$Services_{c,t}$	$Gini^L_{c,t}$	$Gini^w_{c,t}$
Panel A: full period 1995-2016								
$R_{c,t}$	-0.128***	-0.006	-0.088***	-0.056**	0.003	-0.941***	0.002	0.032***
	(0.032)	(0.016)	(0.031)	(0.026)	(0.003)	(0.269)	(0.004)	(0.009)
$ICT_{c,t}$	0.168***	-0.092**	0.077	-0.006	-0.001	0.527	-0.004	0.038***
	(0.049)	(0.040)	(0.047)	(0.069)	(0.004)	(1.008)	(0.009)	(0.013)
$R * ICT_{c,t}$	-0.075***	0.035**	-0.032	-0.004	0.000	0.212	0.003	-0.008
	(0.023)	(0.016)	(0.022)	(0.037)	(0.003)	(0.464)	(0.005)	(0.006)
R^2	.995	.999	.907	.999	.918	.973	.713	.762
N	395	395	395	395	395	395	395	395
Panel B: sub-period 1995-2007								
$R_{c,t}$	-0.145***	-0.040	-0.084**	-0.065**	0.002	-1.539***	-0.010	0.011
	(0.040)	(0.023)	(0.029)	(0.026)	(0.005)	(0.497)	(0.007)	(0.011)
$ICT_{c,t}$	0.301***	-0.142***	0.141***	-0.049*	0.016***	-2.427**	-0.007	0.018
	(0.052)	(0.023)	(0.040)	(0.024)	(0.005)	(1.107)	(0.013)	(0.017)
$R * ICT_{c,t}$	-0.141***	0.040***	-0.065**	0.017	-0.009**	1.215*	-0.001	-0.006
	(0.032)	(0.011)	(0.023)	(0.015)	(0.003)	(0.607)	(0.006)	(0.010)
R^2	.998	.999	.923	0.999	.958	.98	.781	.878
N	224	224	224	224	224	224	224	224
Panel C: sub-period 2008-2016								
$R_{c,t}$	-0.034	0.018	-0.039	-0.004	0.014**	-1.635**	0.004	0.009*
	(0.027)	(0.019)	(0.028)	(0.023)	(0.005)	(0.562)	(0.005)	(0.004)
$ICT_{c,t}$	0.011	0.008	0.046	0.100*	-0.011**	2.054	-0.000	0.006
	(0.018)	(0.035)	(0.036)	(0.047)	(0.004)	(1.161)	(0.006)	(0.007)
$R * ICT_{c,t}$	-0.032**	0.002	-0.036	-0.038	0.004	-0.467	-0.001	0.008
	(0.013)	(0.021)	(0.024)	(0.034)	(0.003)	(0.726)	(0.003)	(0.005)
R^2	.999	0.999	.822	0.999	.967	.988	.936	.948
N	171	171	171	171	171	171	171	171

Notes: *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$. Regression results to test the reinstatement effect for 19 European countries during the period 1995-2016. All regressions include: GDP growth, government consolidated gross debt as % of GDP; government interest payable as % of GDP; net government lending/borrowing as % of GDP; gross fixed capital formation as % of GDP; period average exchange rate; value added TFP–calculated as the residual from an OLS regression of value-added volumes (VA) on a translog production function including capital volumes (K) and total number of hours worked (L); and country (c) and year (t) fixed effects. Standard errors are clustered both at the country and year level.

5.2.3. The real income effect

To evaluate the real income effect of automation on: (1) aggregate factor earnings, and (2) productivity and prices, and to test whether this is associated with aggregate market expansion reflected in aggregate output and sales, we run the following regressions:

$$Y_{c,t} \sim \beta^R R_{c,t} + \beta^{ICT} ICT_{c,t} + \beta^{RICT} R_{c,t} \cdot ICT_{c,t} + \beta^z Z_{c,t} + \epsilon_{c,t} \qquad (9)$$

where $Y_{c,t} \in \{wL_{c,t}, rK_{c,t}, (wL_{c,t} + rK_{c,t}), pQ_{c,t}, Q_{c,t}, p_{c,t}, LProd_{c,t}, TFP_{c,t}\}$. In line with equation (1), we control for the same set of country level controls $Z_{c,t}$, include country and year FE, and use two-way clustered standard errors at the country and year level. The results are presented in Table 6. Sub-sample results are available in B.2.

For the full sample and the subset of Eastern European countries, we find that robot diffusion is significantly negatively correlated with factor incomes, both capital and labor, with aggregate output and prices. Prior to 2007, we observe robot diffusion to be accompanied with a contraction in output quantities, which is reversed after 2008. The effects of robot diffusion on factor incomes and the total value of aggregate output are insignificant after 2008. The depth of automation exhibits roughly the same effects as for robots, but these are less significant.

For ICT diffusion, we observe a positive relation with labor income and labor productivity. Prior to 2007, we additionally observe a weakly significant correlation with the value of aggregate output, and after 2008, we find a positive effect on capital income.

In Northern Europe, only labor income appears to be negatively associated with robot diffusion. In Southern Europe, we find that robot adoption is significantly positively correlated with capital income while this effect is moderated by the depth of automation.

We also observe a negative relationship between the use of industrial robots and prices for final goods and the value of aggregate output. Prior to 2007, we find robots to be associated with a contraction of aggregate output by quantity while we observe an expansion after 2007. The relationship between robot adoption and output quantity varies across different groups of countries. In Southern and Eastern Europe, we find robots to be weakly associated with an output expansion which appears to be driven by the post-2008 period. In Northern Europe, we find prices to be negatively related to the use of industrial robots.

We do not observe significant effects of ICT adoption on factor and goods markets for the majority of country groups. Only in Southern Europe and prior to 2007, ICT diffusion appears to be associated with an output expansion by volume and value, increasing prices and capital income. In Northern Europe, we observe a positive correlation between ICT diffusion and labor productivity driven by the period prior to 2007. In Eastern Europe, we find TFP to be negatively related to robot and ICT adoption, but positively related to the depth of automation. These effects are weekly significant after 2008. In Southern Europe, we observe only weak effects of ATs on productivity and find only a weakly significant positive effect of robots on labor productivity.

Table 6: The real income effect

	$\ln wL_{c,t}$	$\ln rK_{c,t}$	$\ln (wL + rK)_{c,t}$	$\ln pQ_{c,t}$	$\ln Q_{c,t}$	$\ln p_{c,t}$	$\ln LProd_{c,t}$	$\ln TFP_{c,t}$
Panel A: full period 1995-2016								
$R_{c,t}$	-0.131***	-0.133**	-0.139***	-0.113**	0.009	-0.099***	-0.006	-0.004
	(0.039)	(0.047)	(0.042)	(0.040)	(0.029)	(0.029)	(0.019)	(0.014)
$ICT_{c,t}$	0.068	-0.062	0.015	0.017	0.026	-0.019	0.093**	-0.046
	(0.057)	(0.058)	(0.055)	(0.049)	(0.032)	(0.044)	(0.033)	(0.030)
$R * ICT_{c,t}$	-0.033	0.005	-0.019	-0.026	-0.016	0.016	-0.049**	0.027**
	(0.036)	(0.035)	(0.036)	(0.035)	(0.026)	(0.021)	(0.022)	(0.012)
R^2	.997	.996	.997	.997	.999	.916	.998	.869
N	395	395	395	395	309	309	309	309
Panel B: sub-period 1995-2007								
$R_{c,t}$	-0.193***	-0.147***	-0.180***	-0.133***	-0.060***	-0.114***	-0.017	0.009
	(0.038)	(0.041)	(0.037)	(0.038)	(0.015)	(0.023)	(0.011)	(0.011)
$ICT_{c,t}$	0.126***	-0.034	0.059	0.096*	0.015	0.014	0.142***	-0.091***
	(0.040)	(0.066)	(0.049)	(0.054)	(0.018)	(0.047)	(0.031)	(0.028)
$R * ICT_{c,t}$	-0.074**	-0.048	-0.060*	-0.085**	-0.010	-0.015	-0.061**	0.058***
	(0.028)	(0.038)	(0.032)	(0.035)	(0.015)	(0.027)	(0.020)	(0.015)
R^2	.999	.998	.999	.999	0.999	.946	.999	.929
N	224	224	224	224	174	174	174	174
Panel C: sub-period 2008-2016								
$R_{c,t}$	-0.008	-0.035	-0.025	-0.006	0.066**	-0.033**	0.028	-0.003
	(0.030)	(0.039)	(0.024)	(0.025)	(0.026)	(0.014)	(0.026)	(0.010)
$ICT_{c,t}$	0.047	0.127*	0.083*	0.069	0.039	0.029	0.013	0.020***
	(0.034)	(0.061)	(0.037)	(0.054)	(0.029)	(0.020)	(0.022)	(0.002)
$R * ICT_{c,t}$	-0.029	-0.063	-0.048	-0.049	-0.018	-0.026*	-0.016	-0.002
	(0.030)	(0.040)	(0.029)	(0.035)	(0.026)	(0.013)	(0.019)	(0.009)
R^2	.999	.999	0.999	0.999	0.999	.875	0.999	.978
N	171	171	171	171	135	135	135	135

Notes: *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$. Regression results to test the real income effect for 19 European countries during the period 1995-2016. Labor productivity is measured as the share of gross output volumes (Q) over the total number of hours worked. TFP is calculated as the residual from an OLS regression of gross output volumes (Q) on a translog production function including capital volumes (K), total number of hours worked (L) and intermediate input volumes (M). All regressions include: GDP growth, government consolidated gross debt as % of GDP; government interest payable as % of GDP; net government lending/borrowing as % of GDP; gross fixed capital formation as % of GDP; period average exchange rate; and country (c) and year (t) fixed effects. Standard errors are clustered both at the country and year level.

6. Discussion

Generally, we observe taxes to be negatively related to automation, but the driving mechanisms differ across each type of AT and phases of diffusion: Robot diffusion is accompanied with a shift from the taxation of labor to goods. In contrast, for ICT diffusion we find an increase in labor taxes at the expense of capital taxes prior to 2007 and at the expense of taxes on goods post-2008. After 2008, the impact of automation on taxation is, if anything, weekly significant. For this period, we also observe statistically weaker and qualitatively different effects of ATs on factor incomes and the structure of production. As shown in Section 5.1.2, factor revenues are an important determinant of absolute and relative flows of tax revenues. Before digging deeper into a discussion about the economic effects and their relation to taxes, it should be emphasized that the sample size for the post-2008 period is smaller. In addition, the years right after the financial crisis might exhibit distorting patterns of production and fiscal policies that potentially undermine the capacity to capture economic regularities.

6.1. Summarizing the effects of automation

We find weak support for a robot-induced replacement effect occurring in AT-intensive industries which is stronger when robots and ICT diffuse simultaneously. The replacement is accompanied by rising wages which may indicate complementarities between non-automated jobs and robots. Job losses and wage increases balance and we do not find a significant effect on industry level labor income. The diffusion of ICT has a different relationship: prior to 2007, it exhibits a positive employment effect without any effect on wages.

For country level labor markets, we find robot diffusion and the depth of automation to have a negative relationship with wages and a weakly significant positive one on labor demand. We observe for ICT: increasing wages but negative effects on employment.

These findings are opposite to the replacement effect and may arise from changes in the industry composition: While we find partial evidence for robot-induced labor replacement in AT-intensive industries, we observe the reinstatement of labor in other industries accompanied by decreasing average wages. The opposite holds for ICTs which are labor replacing at the aggregate level until 2007.

One explanation for the discrepancy between industry level and country level results is a composition effect when some industries grow while others shrink. We find support for this effect: robot diffusion has a negative association with the market share of services, while the impact of ICT remains ambiguous. Prior to 2007, it exhibits a negative association which is mainly driven by Eastern European countries, but the opposite is observed after 2008 in Northern and Southern Europe.[16]

Whether a technology complements or substitutes labor depends on the extent to which human workers have the capacity to make effective use of it. Robots and ICT differ by the types of tasks that can be automated or complemented: manual (robots) and cognitive (ICT). One explanation for the net labor replacing effect of ICT in the pre-2007 period

[16] In additional robustness checks that are not presented here for the sake of brevity we observe the employment share of services to increase significantly after 2008.

is that this capacity was insufficiently trained in the early phase of digitization. After 2008, ICT diffusion is associated with an increasing role of services benefiting from an increasing complementarity between human labor and ICT driving the reinstatement of labor in emerging industries.[17]

In contrast, robots are designed to automate well-defined manual tasks of human workers. It is not surprising to observe a labor replacing effect in automating industries. The depth of automation captures the extent to which both, manual and cognitive tasks, are automated. We find that the depth of automation has a positive effect on total employment which seems to arise from a cross-sector redistribution reflected in a rising output share of services.

The relationship between automation and labor taxation differs across technologies: robots exhibit a negative and ICT a positive impact, even if only weakly significant. This matches with the finding that robots (ICT) have a negative (positive) association with labor revenue. However, it should be noted that labor tax revenues are not necessarily linearly dependent on the wage bill and dependent on the progressiveness of taxation. Labor replacing but wage inequality-increasing technological change can even positively affect tax revenues from labor. For both ATs we observe wage inequality to increase. In SI.2.4, we show that wage inequality is positively related to taxes on labor at the expense of taxes on goods. However, it is beyond the scope of this work to explore the nexus of inequality, automation and taxation further.

We have also explored how real income may be affected by automation. Until 2007, we find that robots and automation depth to have a association with factor earnings. ICT exhibits a positive relation to labor income until 2007 and a positive relation to capital income after 2008. Nominal income is only one part of the real income effect: Prices are negatively correlated with robot diffusion over the full period. After 2008, this is accompanied with an increase in the volume of aggregate output. Theory suggests that productivity gains reduce production costs reflected in lower output prices. For robot diffusion, we confirm a negative price effect but do not find any effect on productivity. ICT adoption has a positive association with labor productivity, but we do not find any significant effect on prices.

In total, the real income effect of robot diffusion is negative: nominal incomes decrease which is only partially compensated by lower output prices. Aggregate output measured as a proxy for final demand decreases. For ICT diffusion, we find support for a positive real income effect reflected by increasing nominal income and an expansion of aggregate output, but these effects differ across regions and sub-periods. Moreover, we observe a

[17] Of course, technological complementarity is not only contingent on the appropriate skill sets of human labor, but depends also on the technical maturity of ICT being tied to its users needs.

positive productivity effect but this effect is not transmitted to reduced consumer prices.

6.2. Answering the research questions

Now, we return to the research questions outlined in Section 1:

1. *What is the effect of automation on aggregate tax revenues at the country level in absolute terms and in relation to GDP?*
2. *What is the effect of automation on the composition of taxes by source distinguishing between taxes on labor, capital and goods?*
3. *How can these effects be traced back to the three effects through which automation affects economic production?*

Different types of technology affect the economy and taxation differently at different stages of their diffusion process.

Industrial robots as pure automation technology exhibit a negative relationship with aggregate tax revenues. This effect is strongest in the period until 2007 when robot diffusion was accompanied with labor replacement in automating industries, decreasing capital and labor incomes, decreasing wages, capital prices and capital stocks, and a negative impact on aggregate consumption. At this time, aggregate tax revenues decreased which was driven by lower tax revenues raised from capital. A shift from capital taxation towards the taxation of goods occurred. We also observed a negative relationship with labor taxes, though less significant.

The second period, after 2008, is different: While industrial robots are still labor replacing in automating industries, we can not find any significant effect on aggregate factor earnings, but we find prices for final goods to decrease and aggregate demand in volumes to rise. Aggregate consumption in values is not significantly affected and the same holds for taxation: tax revenues measured in levels and in percentage of GDP along with the structure of taxation are not significantly affected during this period. Looking at the full period of time, robot diffusion was accompanied by a shift from labor taxation towards other sources.

We observe a different relationship between ICT diffusion and taxation. Again, the effects differ across different phases of diffusion. Prior to 2007, ICT diffusion was associated with a shift from capital to labor taxation and a weak increase in taxes on goods. In this period, ICT diffusion was accompanied with an increasing labor demand and wage bill in automating industries. At the country level, the overall effect on labor income was positive and reflected both wage increases along with declines in employment. We observe decreasing country level capital income, though not significant. We also find evidence for a weak increase in aggregate demand. These effects taken together offer an explanation for the shift from capital taxes towards an increasing relative importance of taxes on labor and goods.

After 2008, we observe a different pattern: capital taxes increased at the expense of taxes on goods while tax revenues from labor were unaffected. This is in line with our observations at the economic side: we do not observe any significant relationship between ICT and labor income, but instead capital income to be rising.

The results of our study suggest that it is not possible to derive a universally valid answer to the three research questions: Technology diffusion is an inherently dynamic process with different phases of early take-off, wide-spread adoption and technological maturation. In our analysis, we have shown that the economic effects differ across different stages of the diffusion process. Moreover, these effects differ across different types of ATs. A technology can be labor replacing at an early stage of diffusion, but labor reinstating at a later phase. We observe similar differences across time for the impact of ATs on capital valuation, real income and consumption which are all key economic determinants of the level and structure of taxation.

7. Conclusion

In this study, we explore the effects of automation on taxation. We introduce a stylized theoretical framework that decomposes tax revenues into three broader sources of taxation distinguishing between taxes on labor, capital and consumption. We link these sources to economic production and identify three economic effects of automation. This provides the theoretical basis to draw a link from micro level AT adoption decisions to aggregate flows tax revenues. In contrast to existing studies on automation and taxation, we do not look at the impact of taxes on firms' adoption decisions. Instead, we are the first who study empirically the relationship between automation and tax revenues taking adoption decisions as given.

We find partial support for a robot-induced replacement effect. On the other hand, ICT technologies appear to be labor reinstating, reflected through increasing labor incomes which in turn constitute an important source of taxes. We observe a structural break between the periods prior and past to the financial crisis: after 2008, the labor replacing effects of automation diminish and service industries gain market share. We argue that this can be explained by a new phase of ICT diffusion shifting from a labor replacing to a labor complementing technology. The effects on taxation differ across regions but can be attributed to the heterogeneous impacts of automation on local factor markets and industry composition.

Before concluding, we need to emphasize a few limitations of our work. First, tax systems are complex systems and have been subject to reform policies prior and past to the financial crisis. The financial crisis in 2008 was a key driver of many structural reforms that might follow different political paradigms compared to those prior to the crisis. These policy changes are difficult to control for, especially in a set of heterogeneous countries with diverse cultures of taxation that evolved differently over decades. We cope with these peculiarities by splitting our analysis into different periods of time and looking at different groups of countries in separation.

A second limitation related to the tax data is the notion of endogeneity: we do not know to what extent automation and its economic impact are affected by particular tax rules. This problem can not be solved straightforwardly, but there is no clear reason to assume that automation decisions are affected differently from taxation compared to all other forms of capital investments.

Lastly, our analysis only briefly discussed any distributional effects. Conceptually, we have implicitly assumed a linear relationship between country level wage and capital income, consumption and taxation. However, households with different income levels consume and save differently, and employees earning different wages face different tax rates. Our results suggest that automation increases cross-industry wage inequality and point to the progressiveness of labor taxation. Inequality is a major issue in the literature on the economic effects of automation, but an in-depth analysis under this context is left for future study.

Summing up, our study suggests that the nexus between taxation and automation is complex and requires a careful monitoring of the economic side effects of technological change. Preceding studies argued that policy makers should be concerned about the sustainability of public finances when intelligent machinery replaces labor and undermines the basis of taxation. Our study is the first to explore the empirical basis of this claim. Overall, our findings suggest that there is no strong empirical evidence supporting that tax revenues are negatively affected by ATs in the long run.

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A. Descriptives and data

A.1. Data

Table A.1: List of NACE Rev.2 (ISIC Rev.4) industry groups in industry level data.

Industry aggregation:		
EUKLEMS	IFR	Description of industries in IFR dataset
01t03	01t03	A-B-Agriculture, forestry, fishing
05t09	05t09	C-Mining and quarrying
10t12	10t12	10-12-Food and beverages
13t15	13t15	13-15-Textiles
16t18	16	16-Wood and furniture
16t18	17t18	17-18-Paper
19t21	19t20	20-21-other chemical products n.e.c.
19t21	21	19-Pharmaceuticals, cosmetics
22t23	22	22-Rubber and plastic products (non-automotive)
22t23	23	23-Glass, ceramics, stone, mineral products (non-auto
24t25	24	24-Basic metals
24t25	25	25-Metal products (non-automotive)
26t27	26t27	26-27-Electrical/electronics
28	28	28-Industrial machinery
29t30	29	29-Automotive
29t30	30	30-Other vehicles
31t33	32	91-All other manufacturing branches
35t39	35t39	E-Electricity, gas, water supply
41t43	41t43	F-Construction
85	85	P-Education/research/development
Rest	Rest	90-All other non-manufacturing branches

Notes: EUKLEMS and IFR refer to the aggregation of NACE Rev.2 (ISIC Rev.4) 2-digit industries considered in the EUKLEMS and IFR data set, respectively. The industry level analysis in this paper is based on the more aggregate EUKLEMS industry aggregation.

Table A.2: Time period coverage of each country industry pair in the industry level sample.

Country	Industry groups based on ISIC Rev.4 (NACE Rev.2) 2-digit codes used in the industry-level sample														
	01t03	05t09	10t12	13t15	16t18	19t21	22t23	24t25	26t27	28	29t30	31t33	35t39	41t43	85
AT	1995-2016	1995-2016	1995-2016	1995-2016	1995-2016	1995-2016	1995-2016	1995-2016	1995-2016	1995-2016	1995-2016	1995-2016	1995-2016	1995-2016	1995-2016
BE	1995-2016	1995-2016	1995-2016	1995-2016	1995-2016	1995-2016	1995-2016	1995-2016	1995-2016	1995-2016	1995-2016	1995-2016	1995-2016	1995-2016	1995-2016
CZ	1995-2016	1995-2016	1995-2016	1995-2016	1995-2016	1995-2016	1995-2016	1995-2016	1995-2016	1995-2016	1995-2016	1995-2016	1995-2016	1995-2016	1995-2016
DE	1995-2016	1995-2016	1995-2016	1995-2016	1995-2016	1995-2016	1995-2016	1995-2016	1995-2016	1995-2016	1995-2016	1995-2016	1995-2016	1995-2016	1995-2016
DK	1995-2016	1995-2016	1995-2016	1995-2016	1995-2016	1995-2016	1995-2016	1995-2016	1995-2016	1995-2016	1995-2016	1995-2016	1995-2016	1995-2016	1995-2016
EE	2000-2016	2000-2016	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	2000-2016	2000-2016	2000-2016
ES	1995-2016	1995-2016	1995-2016	1995-2016	1995-2016	1995-2016	1995-2016	1995-2016	1995-2016	1995-2016	1995-2016	1995-2016	1995-2016	1995-2016	1995-2016
FI	1995-2016	1995-2016	1995-2016	1995-2016	1995-2016	1995-2016	1995-2016	1995-2016	1995-2016	1995-2016	1995-2016	1995-2016	1995-2016	1995-2016	1995-2016
FR	1995-2016	1995-2016	1995-2016	1995-2016	1995-2016	1995-2016	1995-2016	1995-2016	1995-2016	1995-2016	1995-2016	1995-2016	1995-2016	1995-2016	1995-2016
GR	1995-2016	1995-2016	1995-2016	1995-2016	1995-2016	1995-2016	1995-2016	1995-2016	1995-2016	1995-2016	1995-2016	1995-2016	1995-2016	1995-2016	1995-2016
IT	1995-2016	1995-2016	1995-2016	1995-2016	1995-2016	1995-2016	1995-2016	1995-2016	1995-2016	1995-2016	1995-2016	1995-2016	1995-2016	1995-2016	1995-2016
LT	1995-2016	1995-2016	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	1995-2016	1995-2016	1995-2016
LV	1995-2016	2000-2016	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	2000-2016	1995-2016	2000-2016
NL	1995-2016	1995-2016	1995-2016	1995-2016	1995-2016	1995-2016	1995-2016	1995-2016	1995-2016	1995-2016	1995-2016	1995-2016	1995-2016	1995-2016	1995-2016
SE	1995-2016	1995-2016	1995-2016	1995-2016	1995-2016	1995-2016	1995-2016	1995-2016	1995-2016	1995-2016	1995-2016	1995-2016	1995-2016	1995-2016	1995-2016
SI	2000-2016	2000-2016	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	2000-2016	2000-2016	2000-2016
SK	2000-2016	2000-2016	2000-2016	2000-2016	2000-2016	2000-2016	2000-2016	2000-2016	2000-2016	2000-2016	2000-2016	2000-2016	2000-2016	2000-2016	2000-2016
UK	2007-2016	1995-2016	1995-2016	1995-2016	1995-2016	1995-2016	1995-2016	1995-2016	1995-2016	1995-2016	1995-2016	1995-2016	1995-2016	1995-2016	1995-2016

Notes: This table presents the year coverage across countries and industries for the industry level sample used in the analysis. Industries refer to groupings of NACE Rev.2 (ISIC Rev.4) 2-digit industry codes and are discussed in detail in Table A.1.

A.2. Descriptive statistics

Table A.3: Descriptive statistics for all countries and country groups (East, North, South)

	% of GDP				% of total tax			Production			GDP	Services		% of GDP				Gini	
	T	T^l	T^k	T^y	T^l	T^k	T^y	wL	rK	pQ	$growth$	pQ	HHI	$Debt$	$Interest$	$Lending$	$GovInv$	w	L
All																			
Mean	36	12	13	12	32	35	32	530	330	1830	2.3	57	.13	63	2.8	-3	3.5	.16	.51
St.Dev.	5.8	4.2	5.2	1.5	10	10	5.2	578	414	2212	3.5	6.8	.026	34	1.8	3.7	1	.049	.029
Min	23	.29	4.6	6.9	.6	17	23	2.5	1.7	8.7	-15	41	.082	8.5	.4	-32	1.5	.081	.41
Median	35	12	12	11	33	32	31	209	120	715	2.3	57	.13	58	2.6	-2.6	3.6	.15	.51
Max	49	19	33	16	45	69	44	2307	1978	10831	25	71	.19	181	11	6.9	7.7	.4	.6
East																			
Mean	32	12	7.8	12	38	25	37	369	314	1733	3.5	50	.15	32	1.4	-3.5	4	.18	.53
St.Dev.	3.2	2.6	1.2	1.2	5.7	4	3.5	698	592	3313	4.4	5.8	.027	16	.71	3	1.1	.065	.037
Min	27	7.7	4.6	9.9	26	17	30	2.5	1.7	8.7	-15	41	.093	8.5	.4	-15	1.5	.11	.41
Median	31	13	8	11	40	24	37	18	10	67	3.6	50	.15	28	1.3	-2.8	4	.16	.53
Max	38	16	9.8	15	45	34	44	2307	1978	10831	12	63	.19	83	4	1.4	7.7	.4	.6
North																			
Mean	39	12	16	12	29	40	30	656	379	2078	2.3	60	.12	64	2.8	-1.9	3.2	.15	.52
St.Dev.	5.8	5.3	5.1	1.6	12	10	3.7	567	371	1849	3	5.1	.023	23	1.4	3.7	.84	.042	.02
Min	23	.29	9.8	7.5	.6	23	24	30	19	114	-8.1	48	.082	24	.5	-32	1.6	.081	.47
Median	41	14	15	11	32	39	29	410	195	1294	2.2	60	.12	62	2.7	-1.9	3.3	.14	.52
Max	49	19	33	16	45	69	40	2166	1710	7618	25	71	.18	131	9	6.9	5.3	.31	.57
South																			
Mean	34	11	12	11	31	34	33	397	223	1302	1.1	58	.12	1.0e+02	4.6	-5.1	3.7	.16	.49
St.Dev.	3.7	1.6	2.7	1.6	3.4	3.8	6.2	325	180	1094	3	5.6	.019	35	2.1	3.4	1.1	.03	.023
Min	28	7.9	7.5	6.9	25	26	23	49	34	157	-10	49	.084	36	1.6	-15	1.5	.12	.46
Median	33	11	11	11	31	35	30	318	157	927	1.6	57	.12	104	4.4	-4.6	3.7	.15	.49
Max	42	14	17	15	40	42	44	969	549	3267	5.8	70	.16	181	11	2.1	5.9	.24	.55

Notes: This table shows the main descriptives (mean, standard deviation, minimum, median, maximum) of the core variables included in the regression analyses. Further information about the data is provided in the main article (mainly Section 4). The upper panel shows the statistics of the full data covering all 19 European countries during the period 1995-2016. The lower panels show the within-country group statistics for Eastern, Northern and Southern Europe.

Table A.4: Descriptive statistics for Eastern European countries (by country)

	% of GDP				% of total tax			Production			GDP	Services		% of GDP				Gini	
	T	T^l	T^k	T^y	T^l	T^k	T^y	wL	rK	pQ	$growth$	pQ	HHI	$Debt$	$Interest$	$Lending$	$GovInv$	w	L
CZ																			
Mean	33	15	8.1	11	44	24	32	1590	1357	7499	2.7	46	.17	28	1.1	-3.6	4.8	.15	.53
St.Dev.	.75	.21	.67	.5	.75	1.7	1.5	484	384	2403	2.8	1.1	.012	11	.16	2.7	.94	.0064	.0046
Min	32	14	7	9.9	41	21	30	737	703	3451	-4.7	44	.15	12	.8	-12	3.2	.14	.52
Median	33	15	8	11	44	24	32	1668	1403	7916	2.6	46	.17	28	1.1	-3	4.7	.15	.54
Max	35	15	9.2	12	45	27	34	2307	1978	10831	6.8	49	.19	44	1.4	.7	7.7	.16	.54
LT																			
Mean	29	10	7.6	12	35	26	39	11	9.9	41	4.3	51	.14	26	1.3	-3.2	3.6	.18	.53
St.Dev.	1.7	1.3	1.9	.79	5	5.5	1.7	4.5	4.5	17	5.3	2.8	.011	10	.43	3.3	1	.049	.016
Min	27	7.7	4.6	11	28	17	36	4.8	3.9	19	-15	44	.12	14	.7	-12	2.3	.12	.5
Median	29	10	8.3	11	32	28	40	12	9.4	42	5.2	51	.14	23	1.3	-2.8	3.6	.17	.54
Max	33	13	9.8	13	42	33	42	19	16	66	11	56	.16	43	2	.2	5.4	.27	.55
LV																			
Mean	29	8.9	8.4	12	31	29	40	7.4	6	30	4.2	59	.1	23	1	-2.2	3.7	.25	.5
St.Dev.	1.1	.81	.46	.86	2.5	1.8	2	3.9	2.8	15	6	1.8	.0095	15	.46	2.7	1.5	.098	.064
Min	27	7.9	7.6	10	26	26	37	2.5	1.7	8.7	-14	55	.093	8.5	.4	-9.6	1.5	.13	.41
Median	29	8.7	8.4	12	30	29	40	8.1	6.9	35	5.7	59	.1	14	.9	-1.4	3.7	.22	.48
Max	31	10	9.6	14	35	34	44	13	9.4	49	12	63	.13	48	1.8	1.4	6	.4	.6
SI																			
Mean	37	15	8	14	41	22	37	21	7.6	62	2.2	51	.15	42	2	-3.9	4.2	.12	.56
St.Dev.	.55	.53	.7	.57	1.1	1.7	1.9	4.1	1.7	13	3.4	2.1	.0098	22	.67	3.4	.57	.0078	.014
Min	36	14	6.9	13	39	19	35	12	4.1	36	-7.5	49	.13	22	1.1	-15	3.1	.11	.55
Median	37	15	7.9	14	40	21	37	23	8	69	3.2	50	.14	27	1.9	-2.8	4.1	.12	.56
Max	38	16	9.2	15	43	25	40	25	9.5	76	7	54	.16	83	3.2	0	5.1	.14	.58
SK																			
Mean	31	13	6.7	11	42	22	36	27	27	137	3.9	44	.18	44	2.1	-4.7	3.7	.19	.51
St.Dev.	1.9	.98	.61	.73	1.6	1	1.8	7.9	7.2	39	3.6	1.5	.012	8.8	.9	2.9	.77	.017	.0091
Min	28	11	5.7	9.9	39	20	33	15	13	73	-5.5	41	.15	29	1.3	-13	2.9	.16	.48
Median	31	13	6.5	11	43	22	36	30	29	143	4.5	44	.18	43	1.8	-3.1	3.6	.19	.51
Max	34	14	7.5	12	44	23	39	39	35	193	11	46	.19	55	4	-2.1	6.4	.21	.52

Notes: This table shows the main descriptives (mean, standard deviation, minimum, median, maximum) of the core variables included in the regression analyses for each Eastern European country during the period 1995-2016. Further information about the data is provided in the main article (mainly Section 4).

Table A.5: Descriptive statistics for Northern European countries (by country)

	% of GDP				% of total tax			Production			GDP	Services		% of GDP				Gini	
	T	T^l	T^k	T^y	T^l	T^k	T^y	wL	rK	pQ	$growth$	pQ	HHI	$Debt$	$Interest$	$Lending$	$GovInv$	w	L
AT																			
Mean	42	17	13	12	40	30	28	154	79	470	1.8	56	.12	72	3.1	-2.7	3	.16	.51
St.Dev.	1	.44	.61	.37	.86	1	.56	29	21	122	1.6	.92	.0029	8	.51	1.4	.37	.0037	.007
Min	40	16	11	11	39	28	27	112	46	290	-3.8	54	.11	64	2.1	-6.1	2.4	.15	.5
Median	42	17	13	12	40	30	29	150	83	471	2	57	.12	68	3.1	-2.5	3	.16	.51
Max	43	18	14	13	43	32	29	206	112	646	3.7	58	.13	85	4	-.7	3.9	.16	.52
BE																			
Mean	43	14	19	11	32	43	25	177	106	649	1.9	60	.13	106	5.1	-2.1	2.2	.21	.56
St.Dev.	.76	.35	.59	.18	.71	.8	.53	37	24	149	1.4	1.9	.01	12	1.9	1.8	.19	.054	.0088
Min	42	13	17	10	31	41	24	121	70	417	-2	56	.12	87	2.7	-5.4	1.9	.15	.55
Median	43	14	19	11	32	43	25	174	111	651	1.8	60	.13	105	4.3	-2.3	2.1	.2	.56
Max	45	14	20	11	33	44	26	232	147	868	3.8	63	.15	131	9	.2	2.6	.31	.57
DE																			
Mean	35	14	11	10	39	32	29	1452	726	4339	1.4	57	.15	67	2.7	-2.1	2.2	.12	.53
St.Dev.	.98	.43	.78	.25	1.3	1.4	.72	196	139	780	2	1	.0063	8.5	.66	2.4	.18	.0037	.0036
Min	34	13	10	9.7	36	30	27	1192	528	3185	-5.7	55	.14	55	1.2	-9.4	1.9	.12	.52
Median	35	14	11	10	39	32	28	1385	712	4284	1.6	56	.15	65	2.8	-2.1	2.2	.12	.53
Max	37	15	13	11	41	35	30	1864	984	5657	4.2	59	.16	82	3.5	1.2	2.6	.13	.53
DK																			
Mean	46	.39	30	15	.85	66	33	972	505	2970	1.3	66	.096	42	2.1	.64	3.2	.094	.52
St.Dev.	1.1	.17	1.1	.51	.37	1.3	1.2	136	82	469	2	2	.0033	6.7	.75	2.8	.44	.01	.0052
Min	45	.29	29	15	.6	64	30	738	405	2206	-4.9	63	.09	27	1.1	-3.5	2.6	.081	.51
Median	46	.33	30	15	.73	65	33	1030	493	3093	1.3	65	.096	44	1.9	.1	3	.091	.51
Max	48	.88	33	16	1.9	69	35	1174	648	3610	3.9	68	.1	52	3.7	5	3.9	.12	.53
FI																			
Mean	43	12	17	14	28	40	31	95	48	307	2.3	53	.15	47	2.1	.54	3.8	.11	.51
St.Dev.	1.5	.66	1.3	.61	1.3	2.2	1.2	21	11	74	3.2	3.2	.02	8.9	1	3.5	.29	.015	.013
Min	41	11	16	12	25	37	29	59	27	178	-8.1	48	.12	33	1.1	-5.9	3.3	.096	.5
Median	43	12	17	14	28	41	32	95	51	320	2.8	52	.16	45	1.6	.3	3.9	.11	.51
Max	46	14	21	14	31	46	33	123	63	396	6.3	59	.18	64	4.1	6.9	4.4	.14	.53
FR																			
Mean	42	18	13	11	40	31	25	1077	505	3095	1.6	64	.11	73	2.8	-3.7	3.9	.16	.49
St.Dev.	1.3	.86	1.4	.51	1.9	2.8	1.2	210	92	623	1.4	2.2	.0081	15	.46	1.5	.22	.017	.0051
Min	40	17	9.8	10	38	23	24	754	337	2061	-2.9	61	.095	56	1.8	-7.2	3.4	.14	.49
Median	42	17	14	11	40	32	25	1088	533	3197	1.8	64	.11	65	2.8	-3.6	3.9	.16	.49
Max	44	19	15	12	45	33	28	1381	611	3895	3.9	68	.12	98	3.6	-1.3	4.3	.2	.51
IE																			
Mean	29	4.4	14	11	15	47	37	73	64	318	5.7	58	.14	61	2.5	-3.2	3.1	.18	.5
St.Dev.	2.4	.59	1.2	1.4	2.6	1.8	2.3	24	34	123	6.2	5.1	.017	32	1.3	8.2	.97	.035	.017
Min	23	3.7	11	7.5	12	44	33	30	19	114	-5.1	51	.12	24	1	-32	1.8	.13	.47
Median	28	4.1	14	11	14	48	37	84	63	342	5.5	55	.14	57	2.4	-.35	3.3	.18	.5
Max	32	5.5	15	13	20	50	40	103	152	561	25	67	.18	120	5.1	4.9	5.3	.28	.53
NL																			
Mean	36	14	11	11	38	31	30	333	158	1026	2	63	.11	58	2.6	-2.1	3.8	.12	.54
St.Dev.	1	.88	.56	.21	1.8	1.3	.94	71	38	245	2.1	1.6	.0035	8.8	1.2	2.3	.24	.0088	.0046
Min	34	12	10	10	35	28	29	209	90	594	-3.7	60	.099	43	1.2	-8.7	3.5	.11	.53
Median	36	14	11	11	38	32	30	333	170	1045	2.1	63	.11	59	2.1	-1.8	3.8	.12	.54
Max	38	15	12	11	41	33	32	430	205	1360	5	66	.11	73	5.1	1.2	4.3	.14	.55
SE																			
Mean	45	15	18	12	32	40	27	1480	1179	5397	2.6	61	.13	49	2.3	-.12	4.3	.11	.53
St.Dev.	2.1	.48	2	.25	1.2	2.5	1.5	389	285	1346	2.3	2.5	.012	11	1.5	2.2	.27	.0049	.0089
Min	42	14	16	12	30	36	25	901	746	3334	-4.3	58	.1	37	.5	-7	3.9	.096	.51
Median	45	15	18	12	33	40	27	1440	1193	5448	3	60	.13	47	1.7	0	4.3	.11	.53
Max	49	16	22	13	34	44	29	2166	1710	7618	6	66	.15	69	5.2	3.3	5.1	.12	.54
UK																			
Mean	32	5.8	16	10	18	49	32	825	448	2429	2.2	68	.089	55	2.4	-3.8	2.4	.18	.5
St.Dev.	.96	.35	.86	.46	.84	1.6	1.8	203	89	573	1.8	2.6	.0083	21	.48	3.1	.52	.016	.0087
Min	29	5.1	14	9.1	17	47	29	485	335	1527	-4.1	62	.082	34	1.8	-10	1.6	.15	.49
Median	32	6	16	10	19	49	32	858	463	2508	2.4	69	.085	43	2.4	-3.1	2.5	.18	.5
Max	33	6.2	17	11	20	52	36	1147	609	3329	5	71	.11	87	3.1	1.4	3.3	.2	.52

Notes: This table shows the main descriptives (mean, standard deviation, minimum, median, maximum) of the core variables included in the regression analyses for each Northern European country during the period 1995-2016. Further information about the data is provided in the main article (mainly Section 4).

Table A.6: Descriptive statistics for Southern European countries (by country)

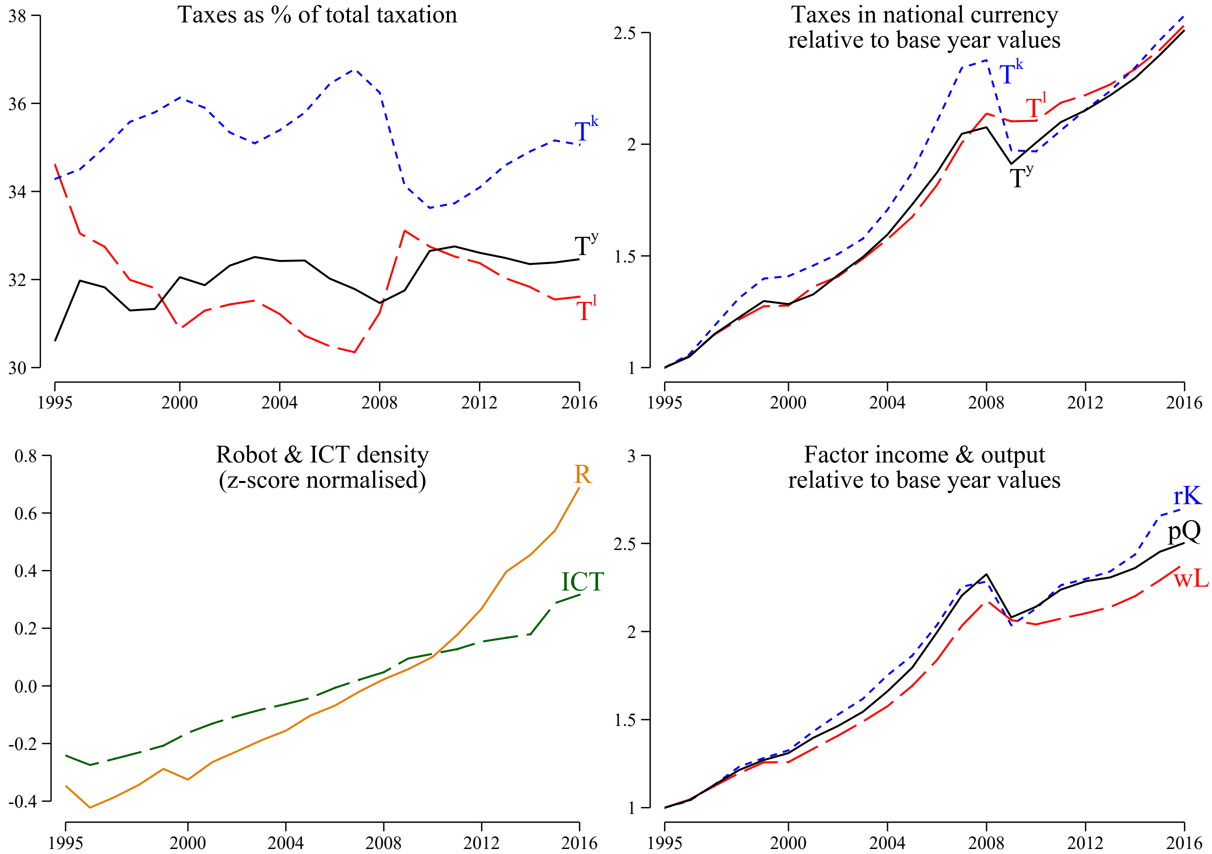
	% of GDP				% of total tax			Production			GDP	Services		% of GDP				Gini	
	T	T^l	T^k	T^y	T^l	T^k	T^y	wL	rK	pQ	$growth$	pQ	HHI	$Debt$	$Interest$	$Lending$	$GovInv$	w	L
ES																			
Mean	33	12	12	9.3	35	36	28	506	283	1650	2.2	53	.13	63	2.9	-3.9	3.8	.15	.49
St.Dev.	1.6	.2	1.1	.78	1.7	1.8	1.8	129	86	482	2.5	3.3	.01	21	1.1	4.1	.89	.0074	.017
Min	30	11	11	6.9	32	34	23	286	139	811	-3.8	49	.11	36	1.6	-11	2	.14	.46
Median	33	12	12	9.5	35	36	29	553	314	1890	3	51	.13	61	2.9	-4.1	3.9	.15	.5
Max	36	12	15	10	40	42	31	664	387	2253	5.2	59	.14	101	5	2.1	5.2	.16	.51
GR																			
Mean	32	10	9.8	12	32	30	38	94	62	282	.84	66	.09	126	5.9	-7.5	4.5	.17	.48
St.Dev.	2.7	.65	1.2	1.3	1.9	2	2.1	25	13	68	4.4	3.2	.0034	33	2.1	3.4	1.1	.023	.0097
Min	28	9	7.5	11	28	26	35	49	36	157	-10	60	.084	97	3.2	-15	2.5	.14	.46
Median	32	11	9.7	12	32	31	37	95	63	288	2.5	66	.091	106	5.2	-6.5	4.7	.17	.48
Max	39	11	12	15	35	35	41	131	85	386	5.8	70	.098	181	11	.5	5.9	.24	.49
IT																			
Mean	39	13	16	11	30	38	27	826	459	2747	.66	56	.14	116	5.8	-3.4	2.9	.14	.48
St.Dev.	1.7	.74	.75	.53	1.5	1	.91	134	72	469	2	2	.01	11	2.1	1.4	.36	.0077	.015
Min	37	11	14	10	29	37	25	582	308	1838	-5.3	52	.12	104	3.9	-7.2	2.3	.12	.46
Median	39	13	16	11	30	39	26	872	487	2941	1.3	56	.14	115	4.8	-3	2.9	.14	.48
Max	42	14	17	12	34	41	28	969	549	3267	3.8	59	.16	135	11	-1.3	3.7	.15	.5
PT																			
Mean	31	8.5	10	13	27	31	41	93	51	302	.54	58	.11	91	3.5	-5.5	3.6	.21	.52
St.Dev.	1.5	.38	1	.54	.86	1.9	1.9	6.7	9.8	28	2.1	2.2	.0067	30	.89	2.5	1.1	.011	.017
Min	29	7.9	8.8	12	25	29	37	78	34	245	-4.1	54	.097	54	2.6	-11	1.5	.19	.5
Median	31	8.5	9.8	13	27	32	41	93	54	309	.79	58	.11	76	3	-5.1	3.7	.22	.52
Max	34	9.1	12	14	29	35	44	102	66	338	3.8	61	.13	133	4.9	-1.9	5.3	.23	.55

Notes: This table shows the main descriptives (mean, standard deviation, minimum, median, maximum) of the core variables included in the regression analyses for each Southern European country during the period 1995-2016. Further information about the data is provided in the main article (mainly Section 4).

A.3. Time series

A.3.1. Time series of key variables

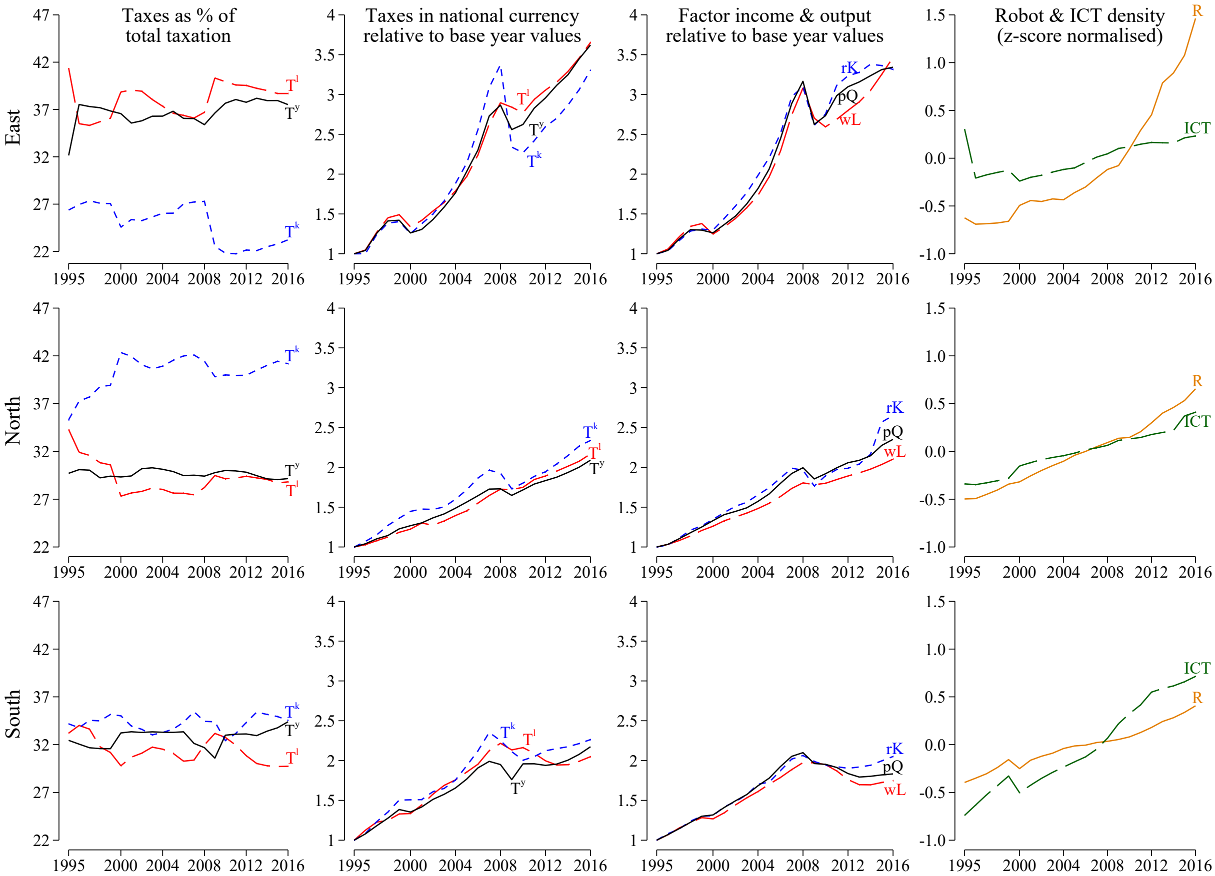
Figure A.1: Time series of key variables (averaged across countries)



Source: Author's calculations based on IFR, EUKLEMS and Global Revenue Statistics Database of OECD.
Notes: Each time series represents the average value of the respective variable across all 19 European countries considered in the country level sample. $T^l_{c,t}$, $T^k_{c,t}$ and $T^y_{c,t}$ refer to taxes on labor, capital and goods, respectively. R and ICT capture the robot and ICT intensity as the ratio of the number of operational robots and ICT capital, respectively, over the number of hours worked in the economy. wL, rK and pQ is labor compensation, capital compensation and the value of gross output, respectively. For the two left panels, i.e. taxes in national currency and factor income & output, the country level values of each variable considered are indexed relative to their base year values. For the bottom-left panel R and ICT are z-score normalized by subtracting the sample mean and dividing by the standard deviation of the sample. The sample includes 19 European countries: AT; BE; CZ; DE; DK; ES; FI; FR; GR; IE; IT; LT; LV; NL; PT; SE; SI; SK; and UK, for the period 1995-2016, but is unbalanced since data are not reported for LT, LV and UK in 1995, and DK, PT, SI and SK in 1995-1999. For more details over the country level sample and construction of variables, see section 4.2.1.

A.3.2. Time series of key variables by region

Figure A.2: Time series of key variables by regional groups (averaged across countries)



Source: Author's calculations based on IFR, EUKLEMS and Global Revenue Statistics Database of OECD.
Notes: Each time series represents the average value of the respective variable across all countries considered within each regional group in the country level sample. $T^l_{c,t}$, $T^k_{c,t}$ and $T^y_{c,t}$ refer to taxes on labor, capital and goods, respectively. R and ICT capture the robot and ICT intensity as the ratio of the number of operational robots and ICT capital, respectively, over the number of hours worked in the economy. wL, rK and pQ is labor compensation, capital compensation and the value of gross output, respectively. For all graphs in the second and third column, i.e. taxes in national currency and factor income & output, the country level values of each variable considered are indexed relative to their base year values. For all graphs in the last column, R and ICT are z-score normalized by subtracting the sample mean and dividing by the standard deviation of the sample. The sample includes 19 European countries: AT; BE; CZ; DE; DK; ES; FI; FR; GR; IE; IT; LT; LV; NL; PT; SE; SI; SK; and UK, for the period 1995-2016, but is unbalanced since data are not reported for LT, LV and UK in 1995, and DK, PT, SI and SK in 1995-1999. The regional groups are: East (CZ, LT, LV, SI, and SK); North (AT, BE, DE, DK, FI, FR, IE, NL, SE and UK); and South (ES, GR, IT, and PT). For more details over the country level sample and construction of variables, see section 4.2.1.

B. Additional regression results

B.1. Prerequisites

B.1.1. Taxation and automation by region and period

Table B.7: Taxation and automation in Eastern Europe

	Taxes in ln of nat. currency				Taxes as % of GDP				Taxes as % of total tax		
	$lnT_{c,t}$	$lnT^l_{c,t}$	$lnT^k_{c,t}$	$lnT^y_{c,t}$	$T_{c,t}$	$T^l_{c,t}$	$T^k_{c,t}$	$T^y_{c,t}$	$T^l_{c,t}$	$T^k_{c,t}$	$T^y_{c,t}$
Panel A: full period 1995-2016											
$R_{c,t}$	-0.030	-0.042**	0.037	-0.062*	-0.294	-0.220	0.468	-0.542**	-0.568	2.044*	-1.416**
	(0.029)	(0.012)	(0.056)	(0.029)	(0.553)	(0.218)	(0.404)	(0.181)	(0.807)	(0.924)	(0.457)
$ICT_{c,t}$	0.024	0.096*	-0.063	-0.001	2.337	1.701*	0.154	0.482	2.672	-1.343	-1.310
	(0.048)	(0.040)	(0.083)	(0.075)	(1.205)	(0.793)	(0.479)	(0.442)	(1.634)	(0.913)	(1.443)
$R * ICT_{c,t}$	0.009	-0.019	0.024	0.033	-0.100	-0.405*	0.081	0.224	-1.171**	0.368	0.807
	(0.009)	(0.010)	(0.014)	(0.018)	(0.278)	(0.178)	(0.106)	(0.114)	(0.380)	(0.179)	(0.395)
R^2	0.999	0.999	.999	0.999	.948	.977	.845	.901	.962	.917	.909
N	97	97	97	97	97	97	97	97	97	97	97
Panel B: sub-period 1995-2007											
$R_{c,t}$	-0.022	-0.037	-0.014	0.000	-0.524	-0.123	0.115	-0.516	0.291	0.541	-0.861**
	(0.022)	(0.032)	(0.030)	(0.021)	(0.504)	(0.153)	(0.102)	(0.270)	(0.245)	(0.278)	(0.198)
$ICT_{c,t}$	0.031	0.030	-0.044	0.060	3.108	1.105	0.295	1.709	0.068	-1.872	1.833
	(0.115)	(0.139)	(0.085)	(0.152)	(1.653)	(1.233)	(0.779)	(1.208)	(2.888)	(2.125)	(3.833)
$R * ICT_{c,t}$	-0.002	0.013	-0.029	-0.002	-0.432	0.073	-0.346*	-0.159	0.679	-0.599	-0.031
	(0.018)	(0.022)	(0.020)	(0.024)	(0.232)	(0.172)	(0.132)	(0.204)	(0.508)	(0.363)	(0.725)
R^2	0.999	0.999	0.999	0.999	.973	.991	.9	.913	.99	.962	.932
N	52	52	52	52	52	52	52	52	52	52	52
Panel C: sub-period 2008-2016											
$R_{c,t}$	0.008	0.018	0.076	-0.047	1.161	0.526	0.733	-0.099	0.048	1.712	-1.633
	(0.013)	(0.039)	(0.056)	(0.023)	(0.969)	(0.408)	(0.528)	(1.063)	(1.804)	(1.217)	(1.768)
$ICT_{c,t}$	0.143	0.036	0.285*	0.184*	1.163	-0.387	1.146***	0.404	-3.195	3.875*	-0.952
	(0.078)	(0.122)	(0.105)	(0.077)	(3.117)	(1.413)	(0.150)	(1.616)	(5.180)	(1.700)	(2.422)
$R * ICT_{c,t}$	-0.011	0.028	-0.018	-0.036	0.960	0.316	0.152	0.492	-0.167	-0.307	0.526
	(0.018)	(0.030)	(0.052)	(0.033)	(0.565)	(0.200)	(0.190)	(0.434)	(0.349)	(0.672)	(0.507)
R^2	0.999	0.999	.999	0.999	.977	.982	.932	.936	.959	.949	.944
N	45	45	45	45	45	45	45	45	45	45	45

Notes: $*p < 0.05$, $**p < 0.01$, $***p < 0.001$. Regression results of aggregate flows of tax revenues on different automation measures for Eastern European countries during the period 1995-2016. All regressions use country level data and include: GDP growth, gross output share of service industries; Herfindahl-Hirschman Index based on the gross output shares of macro-sectors; government consolidated gross debt as % of GDP; government interest payable as % of GDP; net government lending/borrowing as % of GDP; gross fixed capital formation as % of GDP; period average exchange rate; and country (c) and year (t) fixed effects. All regressions for Taxes in ln of national currency also include the ln of gross output value (pQ).

Table B.8: Taxation and automation in Northern Europe

	Taxes in ln of nat. currency				Taxes as % of GDP				Taxes as % of total tax		
	$lnT_{c,t}$	$lnT^l_{c,t}$	$lnT^k_{c,t}$	$lnT^y_{c,t}$	$T_{c,t}$	$T^l_{c,t}$	$T^k_{c,t}$	$T^y_{c,t}$	$T^l_{c,t}$	$T^k_{c,t}$	$T^y_{c,t}$
Panel A: full period 1995-2016											
$R_{c,t}$	-0.025	0.023	-0.010	-0.020	0.684	-0.368**	0.875*	0.177	-1.376***	1.165	0.098
	(0.021)	(0.043)	(0.032)	(0.029)	(0.437)	(0.137)	(0.451)	(0.264)	(0.402)	(0.711)	(0.622)
$ICT_{c,t}$	-0.007	-0.255	-0.159**	0.084	-0.254	1.247***	-2.716***	1.215*	3.084**	-5.947***	2.706*
	(0.028)	(0.220)	(0.052)	(0.049)	(1.217)	(0.337)	(0.637)	(0.658)	(0.959)	(1.052)	(1.346)
$R * ICT_{c,t}$	-0.012	0.140	0.062	-0.050	-0.603	-0.974***	1.139*	-0.768	-1.696***	2.971***	-1.140
	(0.017)	(0.128)	(0.037)	(0.035)	(0.773)	(0.131)	(0.511)	(0.434)	(0.509)	(0.897)	(0.923)
R^2	0.999	.997	.998	.999	.974	.995	.974	.956	.994	.984	.942
N	214	214	214	214	214	214	214	214	214	214	214
Panel B: sub-period 1995-2007											
$R_{c,t}$	-0.046**	0.103	-0.128***	-0.001	-1.067*	0.250	-1.635***	0.318	1.408	-3.054**	1.448
	(0.016)	(0.076)	(0.032)	(0.031)	(0.488)	(0.451)	(0.472)	(0.361)	(0.945)	(0.963)	(1.203)
$ICT_{c,t}$	-0.012	-0.962*	-0.078	0.027	-0.049	0.428	-1.121	0.644	1.328	-2.963	1.794
	(0.035)	(0.452)	(0.076)	(0.074)	(1.200)	(0.927)	(1.203)	(0.711)	(2.125)	(1.933)	(2.591)
$R * ICT_{c,t}$	0.018	0.557**	0.026	-0.015	0.278	0.384	0.200	-0.306	0.707	0.512	-1.251
	(0.023)	(0.238)	(0.046)	(0.046)	(0.790)	(0.585)	(0.739)	(0.485)	(1.334)	(1.190)	(1.659)
R^2	0.999	.997	.999	0.999	.988	.995	.986	.972	.995	.989	.965
N	124	124	124	124	124	124	124	124	124	124	124
Panel C: sub-period 2008-2016											
$R_{c,t}$	-0.007	-0.043	0.018	-0.068***	0.100	0.186	0.904	-0.989***	1.499	0.953	-2.605***
	(0.029)	(0.071)	(0.083)	(0.020)	(1.358)	(0.462)	(0.926)	(0.221)	(1.020)	(1.508)	(0.719)
$ICT_{c,t}$	0.073	0.381	0.075	0.043	-1.555	-0.462	-0.876	-0.217	-0.792	-0.192	0.506
	(0.063)	(0.250)	(0.157)	(0.033)	(1.830)	(0.545)	(1.597)	(0.275)	(1.947)	(2.511)	(1.597)
$R * ICT_{c,t}$	-0.051*	-0.153	-0.082	-0.057***	-1.586**	-0.222	-0.434	-0.930***	1.782	-0.727	-0.890
	(0.027)	(0.143)	(0.084)	(0.011)	(0.672)	(0.442)	(0.433)	(0.211)	(1.419)	(1.385)	(0.528)
R^2	0.999	0.999	.999	0.999	.989	.998	.992	.985	.997	.995	.977
N	90	90	90	90	90	90	90	90	90	90	90

Notes: $*p < 0.05$, $**p < 0.01$, $***p < 0.001$. Regression results of aggregate flows of tax revenues on different automation measures for Northern European countries during the period 1995-2016. All regressions use country level data and include: GDP growth, gross output share of service industries; Herfindahl-Hirschman Index based on the gross output shares of macro-sectors; government consolidated gross debt as % of GDP; government interest payable as % of GDP; net government lending/borrowing as % of GDP; gross fixed capital formation as % of GDP; period average exchange rate; and country (c) and year (t) fixed effects. All regressions for Taxes in ln of national currency also include the ln of gross output value (pQ).

Table B.9: Taxation and automation in Southern Europe

	Taxes in ln of nat. currency				Taxes as % of GDP				Taxes as % of total tax		
	$lnT_{c,t}$	$lnT^l_{c,t}$	$lnT^k_{c,t}$	$lnT^y_{c,t}$	$T_{c,t}$	$T^l_{c,t}$	$T^k_{c,t}$	$T^y_{c,t}$	$T^l_{c,t}$	$T^k_{c,t}$	$T^y_{c,t}$
Panel A: full period 1995-2016											
$R_{c,t}$	-0.158	-0.173	0.020	-0.272	-5.660**	-2.091	-0.575	-2.994	-2.005	3.854	-5.622
	(0.068)	(0.126)	(0.105)	(0.132)	(1.758)	(1.250)	(0.990)	(1.281)	(3.209)	(2.798)	(3.480)
$ICT_{c,t}$	-0.032	-0.084*	-0.006	-0.022	-0.708	-0.719**	0.120	-0.109	-1.770**	1.216	0.158
	(0.018)	(0.028)	(0.045)	(0.032)	(0.302)	(0.148)	(0.290)	(0.239)	(0.454)	(0.703)	(0.946)
$R * ICT_{c,t}$	0.011	0.020	-0.054	0.076	0.773	0.376	-0.420	0.817*	0.270	-2.347**	2.533*
	(0.032)	(0.037)	(0.055)	(0.040)	(0.426)	(0.353)	(0.182)	(0.291)	(0.762)	(0.677)	(0.877)
R^2	0.999	.999	.999	.999	.971	.967	.972	.959	.955	.935	.971
N	83	83	83	83	83	83	83	83	83	83	83
Panel B: sub-period 1995-2007											
$R_{c,t}$	-0.428**	-0.388	-0.784	-0.182	-12.186**	-2.540	-8.536*	-1.111	3.842	-11.378	8.483
	(0.125)	(0.245)	(0.380)	(0.242)	(3.262)	(2.450)	(2.830)	(2.351)	(3.875)	(7.832)	(8.293)
$ICT_{c,t}$	-0.140	-0.236**	-0.280	0.098	-5.795*	-3.293**	-3.255	0.753	-4.770**	-5.327	7.326
	(0.077)	(0.066)	(0.155)	(0.091)	(2.388)	(1.021)	(1.796)	(1.118)	(1.385)	(4.020)	(3.980)
$R * ICT_{c,t}$	-0.013	-0.071	0.023	-0.034	1.345*	-0.057	1.199*	0.203	-1.695	1.470	-0.860
	(0.030)	(0.045)	(0.060)	(0.038)	(0.423)	(0.436)	(0.493)	(0.444)	(0.789)	(1.588)	(1.445)
R^2	0.999	0.999	0.999	0.999	.981	.976	.99	.975	.981	.981	.992
N	47	47	47	47	47	47	47	47	47	47	47
Panel C: sub-period 2008-2016											
$R_{c,t}$	-0.329*	-0.152	-0.546	-0.194	-11.876**	-1.525	-7.294*	-3.057	6.052	-9.334	4.973
	(0.139)	(0.117)	(0.384)	(0.267)	(3.600)	(1.220)	(2.476)	(1.657)	(3.201)	(4.689)	(6.883)
$ICT_{c,t}$	0.039	-0.006	0.046	0.091**	1.605	0.025	0.735	0.845**	-2.092*	-0.063	1.298
	(0.031)	(0.024)	(0.076)	(0.028)	(0.893)	(0.198)	(0.796)	(0.228)	(0.881)	(1.872)	(1.178)
$R * ICT_{c,t}$	-0.066*	-0.094*	-0.084	-0.004	-1.393	-0.727	-0.705	0.039	-0.550	-0.199	1.862
	(0.021)	(0.039)	(0.047)	(0.058)	(0.703)	(0.346)	(0.465)	(0.494)	(1.159)	(1.370)	(2.353)
R^2	0.999	0.999	0.999	0.999	.992	.994	.99	.993	.986	.974	.993
N	36	36	36	36	36	36	36	36	36	36	36

Notes: *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$. Regression results of aggregate flows of tax revenues on different automation measures for Southern European countries during the period 1995-2016. All regressions use country level data and include: GDP growth, gross output share of service industries; Herfindahl-Hirschman Index based on the gross output shares of macro-sectors; government consolidated gross debt as % of GDP; government interest payable as % of GDP; net government lending/borrowing as % of GDP; gross fixed capital formation as % of GDP; period average exchange rate; and country (c) and year (t) fixed effects. All regressions for Taxes in ln of national currency also include the ln of gross output value (pQ).

Table B.10: Taxation and the structure of production before 2007 in whole Europe

	Taxes in ln of nat. currency				Taxes as % of GDP				Taxes as % of total tax		
	ln $T_{c,t}$	ln $T^l_{c,t}$	ln $T^k_{c,t}$	ln$T^y_{c,t}$	$T_{c,t}$	$T^l_{c,t}$	$T^k_{c,t}$	$T^y_{c,t}$	$T^l_{c,t}$	$T^k_{c,t}$	$T^y_{c,t}$
$R_{c,t}$	-0.040*	-0.078	-0.108***	0.020	-0.683*	-0.223	-0.830**	0.370**	-0.104	-1.984**	1.315**
	(0.021)	(0.049)	(0.031)	(0.032)	(0.382)	(0.185)	(0.377)	(0.132)	(0.480)	(0.730)	(0.459)
$ICT_{c,t}$	-0.042	-0.163	-0.110*	-0.008	-0.856	0.275	-1.269	0.138	0.967	-2.616	0.873
	(0.027)	(0.123)	(0.057)	(0.028)	(0.701)	(0.468)	(0.760)	(0.187)	(1.024)	(1.510)	(0.997)
$R * ICT_{c,t}$	0.008	0.036	0.019	0.000	0.083	0.053	-0.025	0.054	0.254	0.170	0.107
	(0.017)	(0.045)	(0.031)	(0.016)	(0.567)	(0.267)	(0.415)	(0.092)	(0.423)	(0.681)	(0.624)
$wL_{c,t}$	0.540**	1.383**	0.331	0.593***	-0.588**	-0.129	0.058	-0.517***	0.187	0.578*	-0.940***
	(0.213)	(0.495)	(0.302)	(0.137)	(0.223)	(0.138)	(0.165)	(0.088)	(0.262)	(0.314)	(0.287)
$rK_{c,t}$	-0.032	0.288	-0.120	0.162	-0.887***	-0.249*	-0.086	-0.552***	0.033	0.474*	-0.757**
	(0.129)	(0.343)	(0.158)	(0.110)	(0.232)	(0.138)	(0.153)	(0.070)	(0.258)	(0.262)	(0.286)
$pQ_{c,t}$	0.485	-0.671	0.726*	0.290							
	(0.304)	(0.801)	(0.385)	(0.213)							
$GDPgrowth_{c,t}$	-0.001	-0.007	-0.002	0.004	0.001	-0.063	0.008	0.056*	-0.155	-0.049	0.180*
	(0.002)	(0.004)	(0.003)	(0.003)	(0.049)	(0.038)	(0.033)	(0.027)	(0.092)	(0.078)	(0.089)
$Services_{c,t}$	0.001	-0.024	-0.014	-0.001	-0.088	0.146	-0.231*	-0.002	0.574**	-0.594**	-0.016
	(0.004)	(0.028)	(0.009)	(0.005)	(0.142)	(0.104)	(0.119)	(0.028)	(0.200)	(0.254)	(0.140)
$HHI_{c,t}$	-1.002	-1.847	-2.840***	-1.663	-46.114	14.996	-44.451**	-16.658*	90.039**	-69.920**	-5.931
	(0.694)	(2.807)	(0.842)	(0.960)	(31.257)	(20.870)	(14.942)	(7.923)	(33.816)	(23.348)	(39.046)
$Debt^{\%GDP}_{c,t}$	0.001	0.004*	0.002	-0.000	0.035*	0.015	0.015	0.006	0.008	0.009	-0.029
	(0.001)	(0.002)	(0.001)	(0.001)	(0.018)	(0.011)	(0.015)	(0.008)	(0.025)	(0.033)	(0.031)
$Interest^{\%GDP}_{c,t}$	-0.004	-0.006	0.002	-0.007*	0.154	-0.077	0.199	0.032	-0.152	0.464	0.250
	(0.007)	(0.012)	(0.010)	(0.004)	(0.179)	(0.134)	(0.114)	(0.066)	(0.308)	(0.290)	(0.279)
$Lending^{\%GDP}_{c,t}$	0.004	-0.005	0.007	0.000	0.136	0.020	0.099	0.017	-0.026	0.094	-0.081
	(0.003)	(0.006)	(0.006)	(0.002)	(0.079)	(0.033)	(0.072)	(0.012)	(0.081)	(0.123)	(0.068)
$GovInv^{\%GDP}_{c,t}$	-0.005	-0.019	0.014	-0.018*	-0.063	0.039	-0.002	-0.100	-0.080	0.245	-0.330
	(0.008)	(0.011)	(0.012)	(0.009)	(0.201)	(0.125)	(0.161)	(0.069)	(0.261)	(0.316)	(0.300)
$XRate_{c,t}$	-0.005***	-0.007	-0.010**	-0.005**	-0.121**	0.003	-0.117**	-0.008	0.156*	-0.207**	0.095**
	(0.001)	(0.006)	(0.003)	(0.002)	(0.048)	(0.033)	(0.045)	(0.011)	(0.080)	(0.083)	(0.037)
R^2	0.999	.998	.999	0.999	.982	.988	.984	.972	.99	.986	.969
N	224	224	224	224	224	224	224	224	224	224	224

Notes: *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$. Regression results to examine the link between tax aggregation and economic production for 19 European countries during the period 1995-2007. All regressions use country level data and include: GDP growth ($GDPgrowth_{c,t}$); share of gross output produced in service industries ($Services_{c,t}$); Herfindahl-Hirschman Index based on the gross output shares of macro-sectors ($HHI_{c,t}$); government consolidated gross debt as % of GDP ($Debt^{\%GDP}_{c,t}$); government interest payable as % of GDP ($Interest^{\%GDP}_{c,t}$); net government lending/borrowing as % of GDP ($Lending^{\%GDP}_{c,t}$); gross fixed capital formation as % of GDP ($GovInv^{\%GDP}_{c,t}$); period average exchange rate ($XRate_{c,t}$); and country (c) and year (t) fixed effects. For the first block, $wL_{c,t}$, $rK_{c,t}$ and $pQ_{c,t}$ are expressed as the natural logarithm (ln) while for the last two blocks they are expressed as % of GDP.

B.1.2. Taxation and economic production by region and period

Table B.11: Taxation and the structure of production after 2008 in whole Europe

	Taxes in ln of nat. currency				Taxes as % of GDP				Taxes as % of total tax		
	ln $T_{c,t}$	ln $T^l_{c,t}$	ln $T^k_{c,t}$	ln$T^y_{c,t}$	$T_{c,t}$	$T^l_{c,t}$	$T^k_{c,t}$	$T^y_{c,t}$	$T^l_{c,t}$	$T^k_{c,t}$	$T^y_{c,t}$
$R_{c,t}$	-0.012	0.015	0.016	-0.058	0.210	0.233	0.196	-0.220	0.479	0.439	-0.901
	(0.023)	(0.025)	(0.059)	(0.034)	(0.758)	(0.405)	(0.539)	(0.238)	(0.925)	(0.956)	(0.776)
$ICT_{c,t}$	0.019	-0.007	0.017	0.026	0.280	-0.118	0.137	0.261***	-1.274	0.519	0.731
	(0.036)	(0.050)	(0.034)	(0.056)	(0.466)	(0.623)	(0.318)	(0.058)	(1.056)	(0.753)	(0.657)
$R * ICT_{c,t}$	-0.020	-0.000	-0.016	-0.035	-0.149	-0.131	0.098	-0.117	0.399	-0.302	-0.135
	(0.024)	(0.031)	(0.039)	(0.033)	(0.647)	(0.376)	(0.605)	(0.095)	(0.595)	(0.736)	(0.535)
$wL_{c,t}$	0.403***	0.339	0.539*	0.375***	-0.662***	0.039	0.087	-0.788***	0.715*	1.091*	-1.795***
	(0.075)	(0.193)	(0.284)	(0.094)	(0.182)	(0.070)	(0.232)	(0.085)	(0.342)	(0.572)	(0.343)
$rK_{c,t}$	0.017	0.235	0.146	-0.242**	-0.718***	0.013	0.058	-0.789***	0.722**	1.013**	-1.728***
	(0.064)	(0.130)	(0.151)	(0.075)	(0.146)	(0.032)	(0.181)	(0.089)	(0.253)	(0.412)	(0.306)
$pQ_{c,t}$	0.204	0.099	0.202	0.248*							
	(0.122)	(0.351)	(0.327)	(0.128)							
$GDPgrowth_{c,t}$	0.000	-0.003	0.000	0.004**	-0.084	-0.048	-0.024	-0.012	-0.077	0.041	0.031
	(0.002)	(0.003)	(0.004)	(0.002)	(0.059)	(0.032)	(0.031)	(0.007)	(0.063)	(0.082)	(0.049)
$Services_{c,t}$	-0.000	0.019**	0.009	-0.021**	0.219	0.127*	0.112	-0.020	0.200	0.037	-0.252
	(0.005)	(0.007)	(0.013)	(0.008)	(0.188)	(0.066)	(0.153)	(0.047)	(0.234)	(0.294)	(0.161)
$HHI_{c,t}$	-0.850	1.508	-0.386	-3.682**	16.968	14.520	-2.496	4.943	16.206	-22.266	3.475
	(0.705)	(1.067)	(2.189)	(1.346)	(22.773)	(13.039)	(17.292)	(9.459)	(36.421)	(49.622)	(34.892)
$Debt^{\%GDP}_{c,t}$	-0.001	-0.002*	0.001	-0.001	0.045**	-0.003	0.022	0.026***	-0.042	0.023	0.022
	(0.001)	(0.001)	(0.003)	(0.001)	(0.014)	(0.008)	(0.013)	(0.007)	(0.027)	(0.032)	(0.015)
$Interest^{\%GDP}_{c,t}$	0.012	0.020*	-0.036	0.041***	-0.797**	-0.051	-0.409**	-0.336**	0.644**	-0.561	-0.133
	(0.008)	(0.010)	(0.036)	(0.011)	(0.274)	(0.075)	(0.161)	(0.130)	(0.231)	(0.371)	(0.325)
$Lending^{\%GDP}_{c,t}$	0.003**	0.001	0.008**	0.001	0.092*	0.011	0.074**	0.007	-0.050	0.130**	-0.088*
	(0.001)	(0.001)	(0.003)	(0.002)	(0.042)	(0.013)	(0.030)	(0.012)	(0.030)	(0.046)	(0.041)
$GovInv^{\%GDP}_{c,t}$	0.004	0.023*	-0.003	-0.004	0.132	0.111	0.086	-0.064	0.366	-0.074	-0.280
	(0.005)	(0.012)	(0.016)	(0.009)	(0.193)	(0.092)	(0.153)	(0.045)	(0.224)	(0.255)	(0.258)
$XRate_{c,t}$	0.008	-0.004	0.014	0.020**	0.027	-0.042	0.052	0.017	-0.247	0.292	-0.046
	(0.007)	(0.011)	(0.013)	(0.008)	(0.246)	(0.108)	(0.227)	(0.050)	(0.205)	(0.302)	(0.197)
R^2	0.999	0.999	.999	0.999	.986	.994	.989	.984	.992	.989	.982
N	171	171	171	171	171	171	171	171	171	171	171

Notes: $*p < 0.05$, $**p < 0.01$, $***p < 0.001$. Regression results to examine the link between tax aggregation and economic production for 19 European countries during the period 2008-2016. All regressions use country level data and include: GDP growth ($GDPgrowth_{c,t}$); share of gross output produced in service industries ($Services_{c,t}$); Herfindahl-Hirschman Index based on the gross output shares of macro-sectors ($HHI_{c,t}$); government consolidated gross debt as % of GDP ($Debt^{\%GDP}_{c,t}$); government interest payable as % of GDP ($Interest^{\%GDP}_{c,t}$); net government lending/borrowing as % of GDP ($Lending^{\%GDP}_{c,t}$); gross fixed capital formation as % of GDP ($GovInv^{\%GDP}_{c,t}$); period average exchange rate ($XRate_{c,t}$); and country (c) and year (t) fixed effects. For the first block, $wL_{c,t}$, $rK_{c,t}$ and $pQ_{c,t}$ are expressed as the natural logarithm (ln) while for the last two blocks they are expressed as % of GDP.

Table B.12: Taxation and the structure of production in Eastern Europe

	Taxes in ln of nat. currency				Taxes as % of GDP				Taxes as % of total tax		
	ln $T_{c,t}$	ln $T^l_{c,t}$	ln $T^k_{c,t}$	ln$T^y_{c,t}$	$T_{c,t}$	$T^l_{c,t}$	$T^k_{c,t}$	$T^y_{c,t}$	$T^l_{c,t}$	$T^k_{c,t}$	$T^y_{c,t}$
$R_{c,t}$	-0.017	-0.036*	0.054	-0.047	0.100	-0.285	0.570	-0.185***	-1.207	2.046*	-0.763
	(0.021)	(0.014)	(0.052)	(0.029)	(0.471)	(0.206)	(0.362)	(0.038)	(0.583)	(0.817)	(0.473)
$ICT_{c,t}$	-0.008	0.120	-0.173	-0.035	1.197	1.918	-0.509	-0.211	4.590*	-2.596	-1.982
	(0.049)	(0.076)	(0.108)	(0.057)	(1.598)	(0.998)	(0.793)	(0.316)	(1.737)	(1.548)	(1.592)
$R * ICT_{c,t}$	0.011	-0.024	0.033	0.034**	-0.164	-0.402*	0.153	0.085	-1.084**	0.666*	0.411
	(0.008)	(0.014)	(0.017)	(0.012)	(0.276)	(0.164)	(0.125)	(0.049)	(0.286)	(0.257)	(0.221)
$wL_{c,t}$	0.421*	0.266	0.454	0.486*	-0.645*	0.085	0.098	-0.828***	0.995**	0.891*	-1.936***
	(0.162)	(0.148)	(0.351)	(0.201)	(0.243)	(0.096)	(0.177)	(0.053)	(0.296)	(0.361)	(0.271)
$rK_{c,t}$	-0.053	0.210	-0.466*	-0.047	-0.765**	0.112	-0.034	-0.843***	1.208**	0.548	-1.801***
	(0.128)	(0.228)	(0.173)	(0.144)	(0.265)	(0.144)	(0.157)	(0.046)	(0.312)	(0.277)	(0.291)
$pQ_{c,t}$	0.557	0.557	0.574	0.587*							
	(0.267)	(0.323)	(0.533)	(0.255)							
$GDPgrowth_{c,t}$	-0.000	-0.005	-0.006	0.008*	-0.143	-0.100*	-0.036	-0.007	-0.116	-0.014	0.118
	(0.003)	(0.004)	(0.007)	(0.003)	(0.070)	(0.040)	(0.038)	(0.015)	(0.066)	(0.061)	(0.074)
$Services_{c,t}$	0.010	0.050**	-0.044	0.010	0.178*	0.393***	-0.229**	0.014	1.149***	-0.938**	-0.229
	(0.009)	(0.011)	(0.022)	(0.013)	(0.065)	(0.054)	(0.079)	(0.024)	(0.193)	(0.213)	(0.126)
$HHI_{c,t}$	-0.181	7.356***	-9.693***	-0.809	3.429	58.719**	-56.126***	0.836	203.464***	-203.918***	-1.281
	(0.969)	(1.417)	(1.936)	(1.831)	(21.374)	(13.088)	(11.241)	(3.604)	(26.785)	(20.504)	(25.856)
$Debt^{\%GDP}_{c,t}$	0.001	-0.002	-0.001	0.006	-0.039	-0.056	0.010	0.007	-0.117**	0.066	0.054
	(0.001)	(0.003)	(0.003)	(0.004)	(0.066)	(0.028)	(0.041)	(0.006)	(0.041)	(0.083)	(0.074)
$Interest^{\%GDP}_{c,t}$	0.000	0.048	-0.026	-0.037	0.596	0.866*	-0.339	0.068	1.894**	-1.557	-0.345
	(0.009)	(0.027)	(0.047)	(0.055)	(0.901)	(0.338)	(0.576)	(0.111)	(0.496)	(1.200)	(0.965)
$Lending^{\%GDP}_{c,t}$	0.003	0.002	0.010*	0.000	0.048	-0.004	0.064	-0.012	-0.066	0.173	-0.102
	(0.002)	(0.003)	(0.005)	(0.003)	(0.069)	(0.052)	(0.042)	(0.014)	(0.082)	(0.105)	(0.096)
$GovInv^{\%GDP}_{c,t}$	0.013	0.015	0.031	-0.001	0.413	0.227	0.180	0.006	0.180	0.241	-0.403
	(0.012)	(0.015)	(0.022)	(0.016)	(0.199)	(0.160)	(0.100)	(0.053)	(0.294)	(0.264)	(0.368)
$XRate_{c,t}$	-0.001	0.004*	-0.004	-0.004	-0.016	0.036	-0.033	-0.019	0.154**	-0.106	-0.054
	(0.003)	(0.002)	(0.005)	(0.004)	(0.085)	(0.029)	(0.043)	(0.028)	(0.051)	(0.083)	(0.036)
R^2	0.999	0.999	.999	0.999	.962	.978	.867	.986	.973	.931	.958
N	97	97	97	97	97	97	97	97	97	97	97

Notes: *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$. Regression results to examine the link between tax aggregation and economic production for Eastern European countries during the period 1995-2016. All regressions use country level data and include: GDP growth ($GDPgrowth_{c,t}$); share of gross output produced in service industries ($Services_{c,t}$); Herfindahl-Hirschman Index based on the gross output shares of macro-sectors ($HHI_{c,t}$); government consolidated gross debt as % of GDP ($Debt^{\%GDP}_{c,t}$); government interest payable as % of GDP ($Interest^{\%GDP}_{c,t}$); net government lending/borrowing as % of GDP ($Lending^{\%GDP}_{c,t}$); gross fixed capital formation as % of GDP ($GovInv^{\%GDP}_{c,t}$); period average exchange rate ($XRate_{c,t}$); and country (c) and year (t) fixed effects. For the first block (Taxes in ln of national currency), $wL_{c,t}$, $rK_{c,t}$ and $pQ_{c,t}$ are expressed as the natural logarithm (ln) while for the last two blocks they are expressed as % of GDP.

Table B.13: Taxation and the structure of production in Eastern Europe before 2007

	Taxes in ln of nat. currency				Taxes as % of GDP				Taxes as % of total tax		
	ln $T_{c,t}$	ln $T^l_{c,t}$	ln $T^k_{c,t}$	ln$T^y_{c,t}$	$T_{c,t}$	$T^l_{c,t}$	$T^k_{c,t}$	$T^y_{c,t}$	$T^l_{c,t}$	$T^k_{c,t}$	$T^y_{c,t}$
$R_{c,t}$	0.028	0.027	0.030	0.041	0.636	0.319	0.512**	-0.194	0.526	0.849*	-1.412**
	(0.014)	(0.020)	(0.031)	(0.028)	(0.305)	(0.169)	(0.136)	(0.157)	(0.309)	(0.316)	(0.351)
$ICT_{c,t}$	-0.115	-0.126	-0.345**	0.058	-3.927*	-1.601	-2.148	-0.178	-1.438	-3.874	5.382
	(0.094)	(0.095)	(0.111)	(0.069)	(1.804)	(1.014)	(1.122)	(0.556)	(2.688)	(2.122)	(2.791)
$R * ICT_{c,t}$	0.019	0.037*	0.012	0.001	0.519*	0.465**	0.023	0.031	0.960*	-0.196	-0.722
	(0.012)	(0.017)	(0.016)	(0.014)	(0.205)	(0.134)	(0.158)	(0.075)	(0.425)	(0.370)	(0.342)
$wL_{c,t}$	0.967***	1.277***	0.543**	1.008**	0.095	0.312*	0.444***	-0.661***	0.830*	1.407***	-2.253***
	(0.167)	(0.164)	(0.142)	(0.276)	(0.188)	(0.144)	(0.084)	(0.062)	(0.342)	(0.186)	(0.193)
$rK_{c,t}$	0.240	0.382	-0.256	0.516***	-0.277	0.146	0.280***	-0.703***	0.683*	1.185***	-1.880***
	(0.115)	(0.215)	(0.154)	(0.082)	(0.178)	(0.129)	(0.054)	(0.053)	(0.311)	(0.135)	(0.181)
$pQ_{c,t}$	-0.111	-0.819*	0.508*	0.016							
	(0.242)	(0.335)	(0.227)	(0.266)							
$GDPgrowth_{c,t}$	0.004	0.004	-0.002	0.010**	0.080	0.043	0.009	0.028	0.053	-0.039	-0.018
	(0.003)	(0.003)	(0.006)	(0.003)	(0.080)	(0.025)	(0.038)	(0.030)	(0.053)	(0.071)	(0.048)
$Services_{c,t}$	0.006	0.011	-0.018	0.022	0.171	0.317***	-0.144	-0.002	0.930***	-0.712**	-0.200
	(0.006)	(0.007)	(0.020)	(0.016)	(0.088)	(0.037)	(0.083)	(0.039)	(0.120)	(0.185)	(0.102)
$HHI_{c,t}$	-0.522	0.092	-3.379	1.359	-23.448	25.836	-36.984***	-12.300*	128.158*	-109.586***	-21.499
	(1.423)	(2.304)	(1.994)	(1.762)	(21.753)	(22.306)	(3.717)	(4.547)	(50.501)	(16.102)	(30.946)
$Debt^{\%GDP}_{c,t}$	0.009	0.008	0.017**	0.006	0.286**	0.111*	0.150**	0.024	0.054	0.222*	-0.267*
	(0.005)	(0.005)	(0.006)	(0.006)	(0.082)	(0.051)	(0.042)	(0.018)	(0.102)	(0.092)	(0.110)
$Interest^{\%GDP}_{c,t}$	-0.042	-0.013	-0.045	-0.072	-1.060	-0.202	-0.619	-0.239	0.204	-0.820	0.503
	(0.027)	(0.037)	(0.064)	(0.064)	(0.562)	(0.298)	(0.346)	(0.132)	(0.569)	(0.750)	(0.650)
$Lending^{\%GDP}_{c,t}$	0.001	0.002	-0.003	0.003	0.019	0.021	-0.013	0.010	0.042	-0.065	0.027
	(0.002)	(0.004)	(0.004)	(0.005)	(0.047)	(0.044)	(0.026)	(0.014)	(0.126)	(0.080)	(0.091)
$GovInv^{\%GDP}_{c,t}$	-0.008	-0.003	-0.017	-0.009	-0.244**	-0.052	-0.176***	-0.016	0.053	-0.372**	0.308
	(0.005)	(0.004)	(0.010)	(0.010)	(0.080)	(0.087)	(0.037)	(0.041)	(0.263)	(0.132)	(0.183)
$XRate_{c,t}$	-0.001	0.004	-0.002	-0.005	0.004	0.071***	-0.036	-0.032*	0.251**	-0.126**	-0.121***
	(0.002)	(0.002)	(0.004)	(0.006)	(0.046)	(0.013)	(0.021)	(0.014)	(0.059)	(0.040)	(0.024)
R^2	0.999	0.999	0.999	0.999	.985	.994	.947	.992	.993	.986	.989
N	52	52	52	52	52	52	52	52	52	52	52

Notes: $*p < 0.05$, $**p < 0.01$, $***p < 0.001$. Regression results to examine the link between tax aggregation and economic production for Eastern European countries during the period 1995-2007. All regressions use country level data and include: GDP growth ($GDPgrowth_{c,t}$); share of gross output produced in service industries ($Services_{c,t}$); Herfindahl-Hirschman Index based on the gross output shares of macro-sectors ($HHI_{c,t}$); government consolidated gross debt as % of GDP ($Debt^{\%GDP}_{c,t}$); government interest payable as % of GDP ($Interest^{\%GDP}_{c,t}$); net government lending/borrowing as % of GDP ($Lending^{\%GDP}_{c,t}$); gross fixed capital formation as % of GDP ($GovInv^{\%GDP}_{c,t}$); period average exchange rate ($XRate_{c,t}$); and country (c) and year (t) fixed effects. For the first block (Taxes in ln of national currency), $wL_{c,t}$, $rK_{c,t}$ and $pQ_{c,t}$ are expressed as the natural logarithm (ln) while for the last two blocks they are expressed as % of GDP.

Table B.14: Taxation and the structure of production in Eastern Europe after 2008

	Taxes in ln of nat. currency				Taxes as % of GDP				Taxes as % of total tax		
	ln $T_{c,t}$	ln $T^l_{c,t}$	ln $T^k_{c,t}$	ln$T^y_{c,t}$	$T_{c,t}$	$T^l_{c,t}$	$T^k_{c,t}$	$T^y_{c,t}$	$T^l_{c,t}$	$T^k_{c,t}$	$T^y_{c,t}$
$R_{c,t}$	0.007	0.025	0.038	-0.041	1.096*	0.497	0.731	-0.131**	0.037	1.763	-1.672**
	(0.014)	(0.036)	(0.051)	(0.027)	(0.471)	(0.254)	(0.438)	(0.046)	(0.710)	(1.210)	(0.566)
$ICT_{c,t}$	0.114	0.086	0.310***	0.094	1.952	1.232	0.648	0.072	0.726	1.541**	-2.565**
	(0.074)	(0.093)	(0.053)	(0.092)	(2.608)	(0.839)	(0.689)	(0.694)	(0.834)	(0.379)	(0.674)
$R * ICT_{c,t}$	-0.012	0.034	-0.046	-0.034	0.396	0.417**	-0.020	-0.001	0.800	-0.350	-0.408
	(0.014)	(0.021)	(0.037)	(0.026)	(0.266)	(0.106)	(0.201)	(0.104)	(0.395)	(0.622)	(0.346)
$wL_{c,t}$	0.099	-0.107	-0.515	0.393	-1.203**	0.182**	-0.354	-1.032***	1.966**	-0.048	-1.939***
	(0.059)	(0.121)	(0.377)	(0.189)	(0.282)	(0.043)	(0.273)	(0.088)	(0.536)	(0.635)	(0.143)
$rK_{c,t}$	-0.188	0.609	-1.684*	-0.218	-1.076**	0.430***	-0.428	-1.078***	2.558**	-0.406	-2.177***
	(0.173)	(0.354)	(0.750)	(0.351)	(0.308)	(0.042)	(0.304)	(0.098)	(0.595)	(0.727)	(0.211)
$pQ_{c,t}$	0.572	0.567	2.668*	-0.217							
	(0.303)	(0.397)	(1.032)	(0.576)							
$GDPgrowth_{c,t}$	0.002	-0.008	0.013	0.006	-0.171*	-0.127*	-0.032	-0.012	-0.159	0.021	0.130
	(0.003)	(0.006)	(0.009)	(0.006)	(0.068)	(0.058)	(0.065)	(0.009)	(0.143)	(0.181)	(0.073)
$Services_{c,t}$	0.015*	0.064***	0.012	-0.019	0.472	0.608***	-0.152	0.016	1.360**	-0.748	-0.624
	(0.006)	(0.010)	(0.032)	(0.020)	(0.316)	(0.040)	(0.277)	(0.052)	(0.367)	(0.658)	(0.313)
$HHI_{c,t}$	-0.116	4.020***	-1.969	-2.229	16.404	22.740*	-20.945	14.609	68.966**	-98.584*	28.860
	(0.582)	(0.838)	(2.267)	(1.604)	(26.332)	(9.184)	(16.827)	(8.089)	(23.681)	(44.890)	(20.729)
$Debt^{\%GDP}_{c,t}$	-0.001	-0.006*	0.007	-0.001	-0.080	-0.087*	0.014	-0.006	-0.167*	0.111	0.047
	(0.001)	(0.003)	(0.005)	(0.003)	(0.038)	(0.037)	(0.037)	(0.011)	(0.065)	(0.107)	(0.047)
$Interest^{\%GDP}_{c,t}$	-0.025	0.087	-0.183	-0.021	0.309	1.023	-1.076	0.362	2.743*	-3.513	0.976
	(0.027)	(0.065)	(0.131)	(0.048)	(0.670)	(0.642)	(0.627)	(0.183)	(1.138)	(1.756)	(0.790)
$Lending^{\%GDP}_{c,t}$	0.004	-0.003	0.019**	0.002	0.054	-0.041	0.102*	-0.007	-0.193	0.290*	-0.097
	(0.002)	(0.005)	(0.006)	(0.002)	(0.042)	(0.051)	(0.041)	(0.012)	(0.148)	(0.122)	(0.053)
$GovInv^{\%GDP}_{c,t}$	0.020*	0.016	0.019	0.015	0.669***	0.342**	0.382**	-0.055	0.156	0.833*	-0.936**
	(0.008)	(0.013)	(0.028)	(0.019)	(0.112)	(0.098)	(0.115)	(0.080)	(0.454)	(0.362)	(0.272)
$XRate_{c,t}$	-0.001	-0.036**	0.034	0.012	-0.572**	-0.515**	-0.017	-0.039	-0.874**	0.409	0.439**
	(0.006)	(0.013)	(0.027)	(0.014)	(0.131)	(0.144)	(0.126)	(0.059)	(0.310)	(0.390)	(0.124)
R^2	0.999	0.999	0.999	0.999	.989	.992	.946	.995	.987	.956	.987
N	45	45	45	45	45	45	45	45	45	45	45

Notes: *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$. Regression results to examine the link between tax aggregation and economic production for Eastern European countries during the period 2008-2016. All regressions use country level data and include: GDP growth ($GDPgrowth_{c,t}$); share of gross output produced in service industries ($Services_{c,t}$); Herfindahl-Hirschman Index based on the gross output shares of macro-sectors ($HHI_{c,t}$); government consolidated gross debt as % of GDP ($Debt^{\%GDP}_{c,t}$); government interest payable as % of GDP ($Interest^{\%GDP}_{c,t}$); net government lending/borrowing as % of GDP ($Lending^{\%GDP}_{c,t}$); gross fixed capital formation as % of GDP ($GovInv^{\%GDP}_{c,t}$); period average exchange rate ($XRate_{c,t}$); and country (c) and year (t) fixed effects. For the first block (Taxes in ln of national currency), $wL_{c,t}$, $rK_{c,t}$ and $pQ_{c,t}$ are expressed as the natural logarithm (ln) while for the last two blocks they are expressed as % of GDP.

Table B.15: Taxation and the structure of production in Northern Europe

	Taxes in ln of nat. currency				Taxes as % of GDP				Taxes as % of total tax		
	ln $T_{c,t}$	ln $T^l_{c,t}$	ln $T^k_{c,t}$	ln$T^y_{c,t}$	$T_{c,t}$	$T^l_{c,t}$	$T^k_{c,t}$	$T^y_{c,t}$	$T^l_{c,t}$	$T^k_{c,t}$	$T^y_{c,t}$
$R_{c,t}$	-0.010	0.038	0.003	-0.009	0.520	-0.407**	0.826*	0.101	-1.355**	1.220*	0.024
	(0.015)	(0.029)	(0.031)	(0.022)	(0.344)	(0.134)	(0.392)	(0.136)	(0.428)	(0.620)	(0.449)
$ICT_{c,t}$	-0.038	-0.255	-0.178**	0.065	-1.883	0.671**	-3.503***	0.949	2.665***	-6.157***	3.256*
	(0.030)	(0.158)	(0.068)	(0.052)	(1.047)	(0.259)	(0.853)	(0.587)	(0.673)	(1.556)	(1.490)
$R * ICT_{c,t}$	-0.007	0.113	0.059	-0.049	0.193	-0.735***	1.455**	-0.527	-1.636***	2.901**	-1.114
	(0.015)	(0.089)	(0.043)	(0.037)	(0.515)	(0.109)	(0.533)	(0.379)	(0.412)	(1.044)	(0.963)
$wL_{c,t}$	0.770***	1.435***	0.799**	0.637***	-0.114	0.155	0.260	-0.530**	0.634	0.778	-1.313**
	(0.162)	(0.257)	(0.345)	(0.169)	(0.234)	(0.142)	(0.243)	(0.198)	(0.358)	(0.496)	(0.515)
$rK_{c,t}$	0.114*	0.630	0.214*	0.141	-0.523**	0.004	0.053	-0.579***	0.507*	0.699	-1.130**
	(0.056)	(0.448)	(0.111)	(0.093)	(0.197)	(0.114)	(0.206)	(0.176)	(0.274)	(0.403)	(0.445)
$pQ_{c,t}$	-0.027	-0.935	-0.288	0.064							
	(0.183)	(0.629)	(0.399)	(0.256)							
$GDPgrowth_{c,t}$	0.001	-0.003	0.002	0.000	0.069	-0.017	0.053	0.032**	-0.095**	0.080	0.008
	(0.001)	(0.003)	(0.003)	(0.001)	(0.045)	(0.016)	(0.037)	(0.011)	(0.037)	(0.052)	(0.042)
$Services_{c,t}$	0.001	-0.001	0.006	-0.013*	0.096	0.074	0.074	-0.053	0.094	0.143	-0.293
	(0.004)	(0.017)	(0.011)	(0.006)	(0.181)	(0.065)	(0.179)	(0.053)	(0.208)	(0.259)	(0.173)
$HHI_{c,t}$	0.278	-0.451	1.923	-3.190***	27.954	20.964*	25.742	-18.753	20.983	42.126	-69.404**
	(0.734)	(2.704)	(1.870)	(0.831)	(28.332)	(10.884)	(30.160)	(12.425)	(37.826)	(41.410)	(26.447)
$Debt^{\%GDP}_{c,t}$	-0.000	-0.000	0.000	-0.000	0.026	-0.006	0.029	0.003	-0.025	0.031	0.001
	(0.001)	(0.002)	(0.002)	(0.001)	(0.028)	(0.010)	(0.022)	(0.006)	(0.015)	(0.035)	(0.029)
$Interest^{\%GDP}_{c,t}$	0.001	0.019	0.006	-0.001	-0.284	-0.044	-0.218	-0.022	0.191	-0.167	-0.014
	(0.011)	(0.020)	(0.024)	(0.008)	(0.418)	(0.133)	(0.345)	(0.081)	(0.259)	(0.396)	(0.331)
$Lending^{\%GDP}_{c,t}$	0.005**	-0.006	0.010**	0.003	0.141*	-0.009	0.144**	0.006	-0.115**	0.239***	-0.114*
	(0.002)	(0.004)	(0.004)	(0.002)	(0.064)	(0.018)	(0.059)	(0.009)	(0.039)	(0.071)	(0.052)
$GovInv^{\%GDP}_{c,t}$	0.026*	-0.027	0.050*	0.016	0.399	-0.024	0.655	-0.232*	-0.227	1.165*	-0.865**
	(0.013)	(0.020)	(0.025)	(0.015)	(0.527)	(0.090)	(0.525)	(0.110)	(0.259)	(0.623)	(0.380)
$XRate_{c,t}$	0.011	0.114	-0.001	0.000	0.410	0.403***	-0.040	0.047	0.668*	-0.492	-0.210
	(0.007)	(0.063)	(0.022)	(0.005)	(0.295)	(0.086)	(0.379)	(0.083)	(0.332)	(0.614)	(0.293)
R^2	0.999	.997	.998	.999	.981	.996	.976	.979	.994	.984	.958
N	214	214	214	214	214	214	214	214	214	214	214

Notes: $*p < 0.05$, $**p < 0.01$, $***p < 0.001$. Regression results to examine the link between tax aggregation and economic production for Northern European countries during the period 1995-2016. All regressions use country level data and include: GDP growth ($GDPgrowth_{c,t}$); share of gross output produced in service industries ($Services_{c,t}$); Herfindahl-Hirschman Index based on the gross output shares of macro-sectors ($HHI_{c,t}$); government consolidated gross debt as % of GDP ($Debt^{\%GDP}_{c,t}$); government interest payable as % of GDP ($Interest^{\%GDP}_{c,t}$); net government lending/borrowing as % of GDP ($Lending^{\%GDP}_{c,t}$); gross fixed capital formation as % of GDP ($GovInv^{\%GDP}_{c,t}$); period average exchange rate ($XRate_{c,t}$); and country (c) and year (t) fixed effects. For the first block (Taxes in ln of national currency), $wL_{c,t}$, $rK_{c,t}$ and $pQ_{c,t}$ are expressed as the natural logarithm (ln) while for the last two blocks they are expressed as % of GDP.

Table B.16: Taxation and the structure of production in Northern Europe before 2007

	Taxes in ln of nat. currency				Taxes as % of GDP				Taxes as % of total tax		
	ln $T_{c,t}$	ln $T^l_{c,t}$	ln $T^k_{c,t}$	ln$T^y_{c,t}$	$T_{c,t}$	$T^l_{c,t}$	$T^k_{c,t}$	$T^y_{c,t}$	$T^l_{c,t}$	$T^k_{c,t}$	$T^y_{c,t}$
$R_{c,t}$	-0.029*	0.155	-0.108***	0.015	-1.238**	0.168	-1.711***	0.305	1.307	-3.084***	1.583
	(0.014)	(0.088)	(0.033)	(0.028)	(0.497)	(0.435)	(0.452)	(0.276)	(0.901)	(0.862)	(0.980)
$ICT_{c,t}$	-0.029	-0.972**	-0.096	0.028	-0.699	0.181	-1.303	0.423	1.127	-2.800	1.892
	(0.029)	(0.414)	(0.087)	(0.062)	(1.229)	(0.828)	(1.210)	(0.669)	(1.887)	(1.911)	(2.252)
$R * ICT_{c,t}$	0.005	0.545*	0.012	-0.016	0.021	0.183	-0.048	-0.115	0.328	0.126	-0.537
	(0.019)	(0.256)	(0.047)	(0.037)	(0.735)	(0.428)	(0.725)	(0.433)	(1.065)	(1.237)	(1.338)
$wL_{c,t}$	0.849***	1.770***	0.958**	0.467**	0.011	0.201	0.340	-0.530*	0.577	0.861	-1.295*
	(0.131)	(0.520)	(0.312)	(0.175)	(0.317)	(0.165)	(0.326)	(0.241)	(0.369)	(0.569)	(0.667)
$rK_{c,t}$	0.164**	0.825	0.199	0.289**	-0.307	0.044	0.190	-0.540**	0.374	0.782	-1.009
	(0.066)	(0.480)	(0.127)	(0.097)	(0.277)	(0.157)	(0.292)	(0.229)	(0.349)	(0.507)	(0.635)
$pQ_{c,t}$	-0.022	-1.659**	0.032	-0.042							
	(0.155)	(0.641)	(0.285)	(0.316)							
$GDPgrowth_{c,t}$	0.002	0.002	0.009	-0.002	0.069	-0.054	0.052	0.070*	-0.141	0.005	0.097
	(0.003)	(0.007)	(0.007)	(0.005)	(0.092)	(0.075)	(0.072)	(0.032)	(0.132)	(0.108)	(0.143)
$Services_{c,t}$	0.012	-0.041	0.012	0.006	0.495	0.157	0.244	0.095	0.028	0.081	-0.145
	(0.007)	(0.028)	(0.017)	(0.007)	(0.271)	(0.122)	(0.231)	(0.052)	(0.281)	(0.325)	(0.215)
$HHI_{c,t}$	1.499	-9.179	2.189	-0.169	71.433	27.183	50.057	-5.807	-0.314	61.421	-60.457*
	(1.053)	(5.482)	(2.593)	(1.314)	(45.398)	(15.405)	(39.647)	(9.460)	(37.820)	(46.879)	(32.779)
$Debt^{\%GDP}_{c,t}$	-0.001	0.000	0.005	-0.005**	-0.001	-0.038	0.026	0.012	-0.094	0.065	0.036
	(0.001)	(0.006)	(0.003)	(0.002)	(0.030)	(0.029)	(0.019)	(0.015)	(0.059)	(0.038)	(0.057)
$Interest^{\%GDP}_{c,t}$	0.016	0.026	-0.010	0.032*	0.428	0.324	0.279	-0.176	0.780	0.153	-0.832
	(0.013)	(0.064)	(0.027)	(0.016)	(0.318)	(0.303)	(0.208)	(0.142)	(0.647)	(0.409)	(0.533)
$Lending^{\%GDP}_{c,t}$	0.005	-0.007	0.008	0.000	0.175	-0.015	0.193	-0.002	-0.105	0.273	-0.139
	(0.004)	(0.008)	(0.010)	(0.002)	(0.144)	(0.041)	(0.138)	(0.022)	(0.090)	(0.207)	(0.135)
$GovInv^{\%GDP}_{c,t}$	-0.005	0.025	-0.020	-0.001	-0.349	0.052	-0.037	-0.364**	0.520	0.427	-0.742*
	(0.014)	(0.056)	(0.024)	(0.022)	(0.406)	(0.261)	(0.230)	(0.116)	(0.416)	(0.327)	(0.347)
$XRate_{c,t}$	-0.001	0.142**	-0.037	0.001	0.006	0.479***	-0.489	0.016	1.100***	-1.123*	0.021
	(0.005)	(0.061)	(0.021)	(0.007)	(0.185)	(0.118)	(0.278)	(0.057)	(0.334)	(0.519)	(0.226)
R^2	0.999	.997	.999	0.999	.99	.995	.986	.982	.995	.99	.973
N	124	124	124	124	124	124	124	124	124	124	124

Notes: $*p < 0.05$, $**p < 0.01$, $***p < 0.001$. Regression results to examine the link between tax aggregation and economic production for Northern European countries during the period 1995-2007. All regressions use country level data and include: GDP growth ($GDPgrowth_{c,t}$); share of gross output produced in service industries ($Services_{c,t}$); Herfindahl-Hirschman Index based on the gross output shares of macro-sectors ($HHI_{c,t}$); government consolidated gross debt as % of GDP ($Debt^{\%GDP}_{c,t}$); government interest payable as % of GDP ($Interest^{\%GDP}_{c,t}$); net government lending/borrowing as % of GDP ($Lending^{\%GDP}_{c,t}$); gross fixed capital formation as % of GDP ($GovInv^{\%GDP}_{c,t}$); period average exchange rate ($XRate_{c,t}$); and country (c) and year (t) fixed effects. For the first block (Taxes in ln of national currency), $wL_{c,t}$, $rK_{c,t}$ and $pQ_{c,t}$ are expressed as the natural logarithm (ln) while for the last two blocks they are expressed as % of GDP.

Table B.17: Taxation and the structure of production in Northern Europe after 2008

	Taxes in ln of nat. currency				Taxes as % of GDP				Taxes as % of total tax		
	ln $T_{c,t}$	ln $T^l_{c,t}$	ln $T^k_{c,t}$	ln$T^y_{c,t}$	$T_{c,t}$	$T^l_{c,t}$	$T^k_{c,t}$	$T^y_{c,t}$	$T^l_{c,t}$	$T^k_{c,t}$	$T^y_{c,t}$
$R_{c,t}$	-0.040	-0.035	-0.044	-0.113***	-0.380	-0.444	0.835	-0.771*	0.308	1.115	-1.714
	(0.035)	(0.070)	(0.093)	(0.016)	(1.170)	(0.532)	(1.209)	(0.381)	(1.779)	(2.310)	(1.162)
$ICT_{c,t}$	0.065	0.350	0.049	0.049	0.256	0.198	-0.395	0.454*	-0.410	-1.120	1.275
	(0.065)	(0.213)	(0.140)	(0.045)	(1.942)	(0.955)	(1.562)	(0.207)	(1.832)	(2.363)	(1.669)
$R * ICT_{c,t}$	-0.081***	-0.141	-0.137**	-0.103***	-2.181***	-0.736	-0.554	-0.892**	0.944	-0.477	-0.426
	(0.023)	(0.139)	(0.041)	(0.010)	(0.346)	(0.561)	(0.621)	(0.373)	(1.626)	(1.743)	(0.926)
$wL_{c,t}$	0.553**	-0.152	1.026	0.779***	-0.264	0.295**	-0.120	-0.439*	0.882	0.208	-1.054*
	(0.197)	(0.453)	(0.674)	(0.176)	(0.228)	(0.122)	(0.249)	(0.197)	(0.651)	(0.609)	(0.468)
$rK_{c,t}$	0.098	0.234	0.270	-0.005	-0.515**	0.140	-0.179	-0.476**	0.676	0.325	-1.008**
	(0.054)	(0.136)	(0.158)	(0.073)	(0.212)	(0.093)	(0.190)	(0.164)	(0.477)	(0.394)	(0.402)
$pQ_{c,t}$	-0.007	-0.632*	-0.382	0.234*							
	(0.163)	(0.282)	(0.460)	(0.112)							
$GDPgrowth_{c,t}$	0.000	-0.004*	0.000	0.002	-0.003	0.008	-0.011	-0.000	0.015	0.009	-0.014
	(0.001)	(0.002)	(0.002)	(0.001)	(0.027)	(0.014)	(0.018)	(0.008)	(0.022)	(0.033)	(0.027)
$Services_{c,t}$	-0.002	-0.020**	0.028	-0.023	0.565*	-0.018	0.643***	-0.060	-0.292	1.005***	-0.668**
	(0.006)	(0.008)	(0.020)	(0.013)	(0.253)	(0.057)	(0.185)	(0.088)	(0.222)	(0.222)	(0.267)
$HHI_{c,t}$	-0.201	-0.261	4.752	-4.684**	86.496*	-3.083	108.736**	-19.157	-40.405	152.757***	-103.938*
	(0.878)	(1.794)	(2.753)	(1.726)	(44.466)	(10.372)	(37.341)	(14.741)	(32.674)	(32.947)	(52.118)
$Debt^{\%GDP}_{c,t}$	-0.000	-0.001	-0.001	-0.000	0.002	0.008	0.004	-0.010	0.035*	-0.011	-0.024
	(0.001)	(0.001)	(0.002)	(0.001)	(0.026)	(0.007)	(0.017)	(0.007)	(0.017)	(0.019)	(0.017)
$Interest^{\%GDP}_{c,t}$	0.020	0.019	0.017	0.060***	0.289	-0.177	0.025	0.442**	-0.502	-0.565*	0.955***
	(0.012)	(0.019)	(0.019)	(0.015)	(0.324)	(0.139)	(0.099)	(0.159)	(0.469)	(0.259)	(0.255)
$Lending^{\%GDP}_{c,t}$	0.003*	-0.002*	0.008**	-0.001	0.097	-0.016	0.120**	-0.006	-0.092*	0.220***	-0.118***
	(0.001)	(0.001)	(0.003)	(0.002)	(0.055)	(0.014)	(0.041)	(0.011)	(0.046)	(0.046)	(0.032)
$GovInv^{\%GDP}_{c,t}$	0.027*	0.056	0.057*	0.012	1.291*	-0.155	1.368**	0.078	-0.638	1.356*	-0.684
	(0.012)	(0.041)	(0.029)	(0.011)	(0.595)	(0.170)	(0.583)	(0.099)	(0.565)	(0.608)	(0.547)
$XRate_{c,t}$	0.025	-0.071	0.064	0.041	1.343	0.349*	0.662	0.332*	-0.482	0.945	-0.347
	(0.026)	(0.042)	(0.054)	(0.027)	(0.975)	(0.164)	(0.899)	(0.150)	(0.525)	(0.918)	(0.629)
R^2	0.999	0.999	.999	0.999	.992	.998	.992	.994	.998	.995	.985
N	90	90	90	90	90	90	90	90	90	90	90

Notes: *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$. Regression results to examine the link between tax aggregation and economic production for Northern European countries during the period 2008-2016. All regressions use country level data and include: GDP growth ($GDPgrowth_{c,t}$); share of gross output produced in service industries ($Services_{c,t}$); Herfindahl-Hirschman Index based on the gross output shares of macro-sectors ($HHI_{c,t}$); government consolidated gross debt as % of GDP ($Debt^{\%GDP}_{c,t}$); government interest payable as % of GDP ($Interest^{\%GDP}_{c,t}$); net government lending/borrowing as % of GDP ($Lending^{\%GDP}_{c,t}$); gross fixed capital formation as % of GDP ($GovInv^{\%GDP}_{c,t}$); period average exchange rate ($XRate_{c,t}$); and country (c) and year (t) fixed effects. For the first block (Taxes in ln of national currency), $wL_{c,t}$, $rK_{c,t}$ and $pQ_{c,t}$ are expressed as the natural logarithm (ln) while for the last two blocks they are expressed as % of GDP..

Table B.18: Taxation and the structure of production in Southern Europe

	Taxes in ln of nat. currency				Taxes as % of GDP				Taxes as % of total tax		
	ln $T_{c,t}$	ln $T^l_{c,t}$	ln $T^k_{c,t}$	ln$T^y_{c,t}$	$T_{c,t}$	$T^l_{c,t}$	$T^k_{c,t}$	$T^y_{c,t}$	$T^l_{c,t}$	$T^k_{c,t}$	$T^y_{c,t}$
$R_{c,t}$	-0.089	-0.021	-0.083	-0.119	-2.639	-0.113	-1.396	-1.130	0.936	-1.106	-0.403
	(0.067)	(0.053)	(0.133)	(0.166)	(1.458)	(0.454)	(1.262)	(0.553)	(1.185)	(3.073)	(2.338)
$ICT_{c,t}$	-0.012	-0.021	0.027	-0.045	-0.476	-0.412	0.032	-0.096	-1.057*	0.827	0.230
	(0.018)	(0.035)	(0.045)	(0.027)	(0.370)	(0.240)	(0.254)	(0.146)	(0.404)	(0.582)	(0.770)
$R * ICT_{c,t}$	-0.017	-0.044	-0.015	0.016	-0.231	-0.523	-0.108	0.400	-1.465*	-0.686	1.309
	(0.035)	(0.032)	(0.081)	(0.048)	(0.564)	(0.277)	(0.599)	(0.173)	(0.518)	(0.989)	(0.943)
$wL_{c,t}$	0.474	1.449**	0.816	-0.577	-0.522	0.204	0.054	-0.780***	1.207***	0.830	-2.059**
	(0.228)	(0.404)	(0.509)	(0.271)	(0.370)	(0.127)	(0.270)	(0.113)	(0.193)	(0.444)	(0.468)
$rK_{c,t}$	0.032	0.291	0.798	-0.833**	-0.726*	-0.031	0.126	-0.821***	0.691**	1.169**	-2.196**
	(0.134)	(0.163)	(0.373)	(0.212)	(0.236)	(0.068)	(0.190)	(0.124)	(0.207)	(0.340)	(0.447)
$pQ_{c,t}$	0.371	-0.715	-0.531	2.045***							
	(0.362)	(0.526)	(0.928)	(0.284)							
$GDPgrowth_{c,t}$	-0.001	0.006*	-0.013	0.006	-0.061	0.089**	-0.129	-0.022	0.295*	-0.314*	0.075
	(0.002)	(0.002)	(0.007)	(0.004)	(0.088)	(0.026)	(0.063)	(0.028)	(0.099)	(0.121)	(0.113)
$Services_{c,t}$	-0.004	-0.017	-0.032	0.038*	-0.480	-0.057	-0.212	-0.211**	0.268	-0.312	-0.260
	(0.008)	(0.013)	(0.023)	(0.015)	(0.273)	(0.122)	(0.180)	(0.050)	(0.254)	(0.277)	(0.252)
$HHI_{c,t}$	-0.676	-2.176	-0.745	1.953	-68.953	-33.946	-4.902	-30.105	-56.626	3.487	-47.370
	(2.259)	(3.393)	(4.358)	(3.691)	(61.669)	(37.106)	(62.160)	(25.849)	(70.218)	(97.698)	(124.679)
$Debt^{\%GDP}_{c,t}$	0.000	0.000	-0.000	0.001	0.017	0.007	-0.012	0.022**	-0.011	-0.043	0.042
	(0.002)	(0.001)	(0.004)	(0.001)	(0.030)	(0.016)	(0.020)	(0.005)	(0.024)	(0.036)	(0.038)
$Interest^{\%GDP}_{c,t}$	0.015	0.026**	-0.007	0.020	0.196	0.374*	0.157	-0.334*	1.037***	0.241	-0.709
	(0.011)	(0.008)	(0.027)	(0.014)	(0.291)	(0.119)	(0.112)	(0.118)	(0.132)	(0.212)	(0.344)
$Lending^{\%GDP}_{c,t}$	0.009	0.002	0.019	0.007	0.195	0.009	0.210*	-0.024	-0.184*	0.400*	-0.284
	(0.007)	(0.004)	(0.009)	(0.009)	(0.123)	(0.042)	(0.089)	(0.030)	(0.075)	(0.132)	(0.162)
$GovInv^{\%GDP}_{c,t}$	0.009	0.011	0.021	-0.008	0.221	0.193	0.373	-0.345**	0.377	0.835	-1.038
	(0.009)	(0.014)	(0.024)	(0.023)	(0.469)	(0.185)	(0.305)	(0.099)	(0.217)	(0.550)	(0.474)
$XRate_{c,t}$	0.419	-0.144	1.882	-0.328	6.553	-2.304	16.370	-7.514	-6.859	58.045**	-33.208
	(0.541)	(0.819)	(0.971)	(0.239)	(18.145)	(8.853)	(10.138)	(4.234)	(11.312)	(14.966)	(21.609)
R^2	0.999	0.999	.999	.999	.976	.978	.973	.986	.973	.948	.984
N	83	83	83	83	83	83	83	83	83	83	83

Notes: $*p < 0.05$, $**p < 0.01$, $***p < 0.001$. Regression results to examine the link between tax aggregation and economic production for Southern European countries during the period 1995-2016. All regressions use country level data and include: GDP growth ($GDPgrowth_{c,t}$); share of gross output produced in service industries ($Services_{c,t}$); Herfindahl-Hirschman Index based on the gross output shares of macro-sectors ($HHI_{c,t}$); government consolidated gross debt as % of GDP ($Debt^{\%GDP}_{c,t}$); government interest payable as % of GDP ($Interest^{\%GDP}_{c,t}$); net government lending/borrowing as % of GDP ($Lending^{\%GDP}_{c,t}$); gross fixed capital formation as % of GDP ($GovInv^{\%GDP}_{c,t}$); period average exchange rate ($XRate_{c,t}$); and country (c) and year (t) fixed effects. For the first block (Taxes in ln of national currency), $wL_{c,t}$, $rK_{c,t}$ and $pQ_{c,t}$ are expressed as the natural logarithm (ln) while for the last two blocks they are expressed as % of GDP.

Table B.19: Taxation and the structure of production in Southern Europe before 2007

	Taxes in ln of nat. currency				Taxes as % of GDP				Taxes as % of total tax		
	ln $T_{c,t}$	ln $T^l_{c,t}$	ln $T^k_{c,t}$	ln$T^y_{c,t}$	$T_{c,t}$	$T^l_{c,t}$	$T^k_{c,t}$	$T^y_{c,t}$	$T^l_{c,t}$	$T^k_{c,t}$	$T^y_{c,t}$
$R_{c,t}$	-0.388**	-0.259	-0.565*	-0.385*	-10.997**	-1.285	-7.763**	-1.949**	6.488**	-9.874	5.615
	(0.111)	(0.119)	(0.201)	(0.123)	(3.270)	(1.477)	(2.375)	(0.587)	(1.157)	(4.882)	(4.968)
$ICT_{c,t}$	-0.102	-0.115	-0.131	-0.046	-5.088	-1.759	-1.620	-1.709**	-0.710	-0.848	0.456
	(0.090)	(0.101)	(0.200)	(0.080)	(2.961)	(0.975)	(2.275)	(0.412)	(0.657)	(4.096)	(3.753)
$R * ICT_{c,t}$	-0.015	-0.076	0.120**	-0.115*	1.376*	-0.163	1.013*	0.525**	-2.062***	0.881	-0.030
	(0.034)	(0.050)	(0.036)	(0.041)	(0.553)	(0.270)	(0.421)	(0.141)	(0.324)	(1.002)	(0.913)
$wL_{c,t}$	0.132	0.412	2.065*	-1.803**	-0.542	-0.092	0.365	-0.815**	0.311	1.501*	-1.843*
	(0.370)	(0.542)	(0.761)	(0.456)	(0.388)	(0.190)	(0.270)	(0.153)	(0.263)	(0.535)	(0.641)
$rK_{c,t}$	-0.166	-0.556*	0.610	-0.439*	-0.938*	-0.439**	0.213	-0.713**	-0.346	1.323**	-1.353*
	(0.176)	(0.176)	(0.431)	(0.144)	(0.306)	(0.121)	(0.212)	(0.127)	(0.207)	(0.401)	(0.471)
$pQ_{c,t}$	0.260	0.109	-1.056	0.923*							
	(0.555)	(0.623)	(1.547)	(0.333)							
$GDPgrowth_{c,t}$	-0.003	0.004	-0.018*	0.006	-0.174	0.023	-0.167	-0.029	0.242*	-0.343	0.159
	(0.006)	(0.007)	(0.007)	(0.008)	(0.097)	(0.035)	(0.094)	(0.084)	(0.100)	(0.222)	(0.256)
$Services_{c,t}$	-0.004	0.015	-0.099*	0.060**	-0.529	0.027	-0.706*	0.149	0.642	-1.386*	1.077*
	(0.014)	(0.021)	(0.039)	(0.015)	(0.502)	(0.221)	(0.270)	(0.110)	(0.283)	(0.503)	(0.417)
$HHI_{c,t}$	-10.445	-6.114	-30.324**	3.208	-348.658*	-68.918	-293.377**	13.637	124.267*	-613.334**	396.704**
	(4.584)	(4.367)	(7.599)	(3.817)	(146.418)	(50.586)	(79.913)	(32.846)	(49.023)	(121.922)	(95.655)
$Debt^{\%GDP}_{c,t}$	-0.008	-0.008	-0.003	-0.016**	-0.109	-0.015	-0.078	-0.015	0.050	-0.146	0.048
	(0.005)	(0.005)	(0.007)	(0.005)	(0.064)	(0.022)	(0.051)	(0.011)	(0.030)	(0.103)	(0.090)
$Interest^{\%GDP}_{c,t}$	0.003	0.017	-0.031	0.013	0.037	0.209	-0.133	-0.039	0.675	-0.371	0.708
	(0.013)	(0.015)	(0.027)	(0.014)	(0.472)	(0.155)	(0.319)	(0.107)	(0.310)	(0.663)	(0.465)
$Lending^{\%GDP}_{c,t}$	0.016	0.011	0.025	0.011	0.444	0.096	0.352*	-0.004	-0.114	0.654*	-0.367
	(0.008)	(0.011)	(0.013)	(0.007)	(0.248)	(0.118)	(0.134)	(0.056)	(0.119)	(0.206)	(0.218)
$GovInv^{\%GDP}_{c,t}$	0.012	0.034	-0.035	0.019	0.203	0.361	-0.066	-0.092	0.959*	-0.048	-0.131
	(0.017)	(0.027)	(0.037)	(0.018)	(0.605)	(0.291)	(0.272)	(0.145)	(0.343)	(0.576)	(0.545)
$XRate_{c,t}$	0.840	0.028	2.373**	0.564	10.241	-7.190	22.429**	-4.998	-25.622*	73.655***	-33.538*
	(0.487)	(0.515)	(0.735)	(0.500)	(13.471)	(6.928)	(5.940)	(3.275)	(10.534)	(9.454)	(11.738)
R^2	0.999	0.999	0.999	0.999	.986	.988	.991	.99	.989	.986	.995
N	47	47	47	47	47	47	47	47	47	47	47

Notes: $*p < 0.05$, $**p < 0.01$, $***p < 0.001$. Regression results to examine the link between tax aggregation and economic production for Southern European countries during the period 1995-2007. All regressions use country level data and include: GDP growth ($GDPgrowth_{c,t}$); share of gross output produced in service industries ($Services_{c,t}$); Herfindahl-Hirschman Index based on the gross output shares of macro-sectors ($HHI_{c,t}$); government consolidated gross debt as % of GDP ($Debt^{\%GDP}_{c,t}$); government interest payable as % of GDP ($Interest^{\%GDP}_{c,t}$); net government lending/borrowing as % of GDP ($Lending^{\%GDP}_{c,t}$); gross fixed capital formation as % of GDP ($GovInv^{\%GDP}_{c,t}$); period average exchange rate ($XRate_{c,t}$); and country (c) and year (t) fixed effects. For the first block (Taxes in ln of national currency), $wL_{c,t}$, $rK_{c,t}$ and $pQ_{c,t}$ are expressed as the natural logarithm (ln) while for the last two blocks they are expressed as % of GDP.

Table B.20: Taxation and the structure of production in Southern Europe after 2008

	Taxes in ln of nat. currency				Taxes as % of GDP				Taxes as % of total tax		
	ln $T_{c,t}$	ln $T^l_{c,t}$	ln $T^k_{c,t}$	ln$T^y_{c,t}$	$T_{c,t}$	$T^l_{c,t}$	$T^k_{c,t}$	$T^y_{c,t}$	$T^l_{c,t}$	$T^k_{c,t}$	$T^y_{c,t}$
$R_{c,t}$	-0.384	-0.332*	-0.773	0.062	-10.053*	-1.729	-7.012	-1.312	3.044	-10.847	9.006
	(0.181)	(0.130)	(0.419)	(0.185)	(3.567)	(0.982)	(3.203)	(0.992)	(2.594)	(6.833)	(5.686)
$ICT_{c,t}$	0.051	0.039	0.079	0.047	0.967	0.238	0.572	0.157	-0.634	0.393	-0.536
	(0.048)	(0.022)	(0.095)	(0.049)	(1.198)	(0.213)	(1.010)	(0.137)	(0.755)	(2.124)	(0.919)
$R * ICT_{c,t}$	-0.053	-0.041	-0.048	-0.054	-1.513	-0.467	-0.835	-0.210	0.350	-0.226	0.865
	(0.038)	(0.031)	(0.079)	(0.038)	(0.715)	(0.274)	(0.588)	(0.154)	(0.931)	(1.509)	(0.824)
$wL_{c,t}$	0.351	0.605	2.436	-2.242*	-0.958	0.042	-0.119	-0.882***	1.396	0.829	-1.927
	(0.485)	(0.397)	(1.097)	(0.830)	(0.656)	(0.208)	(0.629)	(0.126)	(0.771)	(1.287)	(1.010)
$rK_{c,t}$	0.267	0.867*	1.109**	-1.243**	-1.066	0.170	-0.188	-1.048***	1.903*	0.859	-2.508**
	(0.169)	(0.308)	(0.256)	(0.368)	(0.666)	(0.117)	(0.627)	(0.072)	(0.688)	(1.270)	(0.728)
$pQ_{c,t}$	0.398	0.008	-2.175	3.413**							
	(0.601)	(0.311)	(1.465)	(0.977)							
$GDPgrowth_{c,t}$	-0.002	-0.012	0.006	0.005	-0.109	-0.081	-0.016	-0.012	-0.175	0.080	0.102
	(0.005)	(0.006)	(0.014)	(0.007)	(0.161)	(0.069)	(0.099)	(0.040)	(0.091)	(0.127)	(0.237)
$Services_{c,t}$	-0.006	-0.011	-0.034	0.025	-0.167	-0.129	-0.038	0.000	-0.289	-0.201	0.350
	(0.017)	(0.015)	(0.034)	(0.024)	(0.271)	(0.088)	(0.263)	(0.081)	(0.297)	(0.505)	(0.424)
$HHI_{c,t}$	-4.953*	-5.104	-2.218	-7.507***	-31.593	-47.814*	6.422	9.798	-150.883	-4.442	100.503
	(1.729)	(2.725)	(5.155)	(1.202)	(71.039)	(16.303)	(76.111)	(13.611)	(118.158)	(154.686)	(52.185)
$Debt^{\%GDP}_{c,t}$	-0.000	-0.000	0.000	-0.003*	-0.017	-0.017	-0.024	0.024**	-0.049*	-0.053	0.105
	(0.001)	(0.002)	(0.002)	(0.001)	(0.039)	(0.013)	(0.027)	(0.004)	(0.018)	(0.047)	(0.047)
$Interest^{\%GDP}_{c,t}$	0.000	-0.031	-0.021	0.072*	-0.283	0.003	0.167	-0.452**	0.437	0.659	-1.002
	(0.006)	(0.022)	(0.032)	(0.029)	(0.204)	(0.125)	(0.193)	(0.094)	(0.300)	(0.483)	(0.427)
$Lending^{\%GDP}_{c,t}$	0.003	0.003	0.005	-0.000	0.023	0.013	0.029	-0.019	0.020	0.044	-0.108
	(0.002)	(0.003)	(0.005)	(0.003)	(0.056)	(0.020)	(0.059)	(0.018)	(0.064)	(0.159)	(0.085)
$GovInv^{\%GDP}_{c,t}$	-0.011	-0.023	-0.027	0.015	-0.037	-0.132	0.125	-0.030	-0.398	-0.108	0.289
	(0.009)	(0.018)	(0.033)	(0.022)	(0.136)	(0.124)	(0.220)	(0.075)	(0.367)	(0.689)	(0.312)
R^2	0.999	0.999	0.999	0.999	.994	.995	.99	.999	.993	.975	.996
N	36	36	36	36	36	36	36	36	36	36	36

Notes: *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$. Regression results to examine the link between tax aggregation and economic production for Southern European countries during the period 2008-2016. All regressions use country level data and include: GDP growth ($GDPgrowth_{c,t}$); share of gross output produced in service industries ($Services_{c,t}$); Herfindahl-Hirschman Index based on the gross output shares of macro-sectors ($HHI_{c,t}$); government consolidated gross debt as % of GDP ($Debt^{\%GDP}_{c,t}$); government interest payable as % of GDP ($Interest^{\%GDP}_{c,t}$); net government lending/borrowing as % of GDP ($Lending^{\%GDP}_{c,t}$); gross fixed capital formation as % of GDP ($GovInv^{\%GDP}_{c,t}$); period average exchange rate ($XRate_{c,t}$); and country (c) and year (t) fixed effects. For the first block (Taxes in ln of national currency), $wL_{c,t}$, $rK_{c,t}$ and $pQ_{c,t}$ are expressed as the natural logarithm (ln) while for the last two blocks they are expressed as % of GDP.

B.2. The economic impact of automation by region and period

B.2.1. Eastern Europe

Table B.21: The replacement effect in Eastern Europe

	$\ln wL_{i,c,t}$	$\ln w_{i,c,t}$	$\ln L_{i,c,t}$	$\ln rK_{i,c,t}$	$\ln r_{i,c,t}$	$\ln K_{i,c,t}$
Panel A: full period 1995-2016						
$R_{i,c,t}$	-0.012	0.031	-0.043***	0.036	0.002	-0.029
	(0.022)	(0.019)	(0.014)	(0.023)	(0.003)	(0.031)
$ICT_{i,c,t}$	0.014	-0.006	0.021	0.021	-0.012***	0.043*
	(0.020)	(0.021)	(0.013)	(0.023)	(0.002)	(0.022)
$R * ICT_{i,c,t}$	-0.009	0.010	-0.019***	0.004	0.002**	-0.016
	(0.007)	(0.007)	(0.004)	(0.007)	(0.001)	(0.009)
R^2	.998	.997	.992	.985	.99	.998
N	909	909	909	909	814	814
Panel B: sub-period 1995-2007						
$R_{i,c,t}$	-0.038	-0.029	-0.009	-0.017	-0.004	-0.009
	(0.043)	(0.037)	(0.029)	(0.053)	(0.002)	(0.022)
$ICT_{i,c,t}$	0.008	-0.011	0.019	-0.000	-0.007***	0.043***
	(0.043)	(0.034)	(0.030)	(0.042)	(0.002)	(0.013)
$R * ICT_{i,c,t}$	0.030	0.057	-0.027	0.055	0.009*	-0.004
	(0.056)	(0.045)	(0.035)	(0.069)	(0.004)	(0.043)
R^2	.998	.997	.992	.984	.993	.998
N	459	459	459	459	409	409
Panel C: sub-period 2008-2016						
$R_{i,c,t}$	0.010	0.017	-0.007	-0.038	0.005	-0.002
	(0.016)	(0.016)	(0.010)	(0.041)	(0.004)	(0.015)
$ICT_{i,c,t}$	-0.013	-0.003	-0.010	0.072	0.001	0.011
	(0.017)	(0.019)	(0.018)	(0.058)	(0.009)	(0.043)
$R * ICT_{i,c,t}$	0.001	0.006	-0.005	-0.018	0.004**	-0.007
	(0.007)	(0.007)	(0.003)	(0.016)	(0.002)	(0.009)
R^2	.999	.999	.997	.992	.976	0.999
N	450	450	450	450	405	405

Notes: *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$. Regression results to test the replacement effect for Eastern European countries during the period 1995-2016. All regressions use industry level data for the subset of industries susceptible to automation, defined as industries were the use of industrial robots is prevalent (see Appendix Table A.1). All regressions include: country industry (*ci*); country year (*ct*); and industry year (*it*) fixed effects. All regressions are weighted by the base-sample-year share of each industry's number of hours worked to country-wide hours worked.

Table B.22: The reinstatement effect in Eastern Europe

	ln $w_{c,t}$	ln $L_{c,t}$	ln $r_{c,t}$	ln $K_{c,t}$	$HHI_{c,t}$	$Services_{c,t}$	$Gini^L_{c,t}$	$Gini^w_{c,t}$
Panel A: full period 1995-2016								
$R_{c,t}$	-0.145***	0.053**	-0.113***	0.023	0.003	0.216	0.027	0.057*
	(0.018)	(0.015)	(0.022)	(0.017)	(0.002)	(0.394)	(0.016)	(0.026)
$ICT_{c,t}$	0.274**	-0.064	0.232**	-0.023	0.009	-5.645**	-0.018	0.008
	(0.090)	(0.040)	(0.068)	(0.034)	(0.009)	(1.662)	(0.038)	(0.058)
$R * ICT_{c,t}$	-0.030*	0.005	-0.013	-0.012*	-0.002	0.522	0.002	-0.011
	(0.013)	(0.008)	(0.009)	(0.005)	(0.002)	(0.317)	(0.005)	(0.011)
R^2	.999	.998	.948	0.999	.945	.978	.767	.825
N	97	97	97	97	97	97	97	97
Panel B: sub-period 1995-2007								
$R_{c,t}$	-0.118*	-0.021	-0.039	-0.048**	-0.006*	0.102	0.027	0.055**
	(0.045)	(0.014)	(0.054)	(0.016)	(0.003)	(0.405)	(0.020)	(0.019)
$ICT_{c,t}$	0.596***	-0.165***	0.279	-0.043	0.040**	-10.135***	0.021	0.128
	(0.107)	(0.027)	(0.135)	(0.060)	(0.014)	(1.581)	(0.047)	(0.066)
$R * ICT_{c,t}$	-0.094**	0.028***	-0.035	0.012	-0.005	1.121**	-0.006	-0.024*
	(0.022)	(0.002)	(0.034)	(0.011)	(0.003)	(0.377)	(0.006)	(0.010)
R^2	.999	.999	.947	0.999	.98	.991	.824	.933
N	52	52	52	52	52	52	52	52
Panel C: sub-period 2008-2016								
$R_{c,t}$	-0.057*	0.025	-0.031	0.007	0.006	-1.018	0.004	0.006
	(0.025)	(0.026)	(0.023)	(0.026)	(0.004)	(0.502)	(0.004)	(0.008)
$ICT_{c,t}$	0.158	0.182**	0.000	0.112	-0.019	-1.852	0.013	-0.033*
	(0.114)	(0.057)	(0.080)	(0.100)	(0.017)	(1.968)	(0.013)	(0.015)
$R * ICT_{c,t}$	-0.031***	-0.020	-0.038	-0.022	0.007***	-0.810**	0.001	0.007*
	(0.006)	(0.030)	(0.018)	(0.021)	(0.001)	(0.212)	(0.002)	(0.003)
R^2	0.999	.999	.883	0.999	.985	.995	.988	.909
N	45	45	45	45	45	45	45	45

Notes: *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$. Regression results to test the reinstatement effect for Eastern European countries during the period 1995-2016. All regressions include: GDP growth, government consolidated gross debt as % of GDP; government interest payable as % of GDP; net government lending/borrowing as % of GDP; gross fixed capital formation as % of GDP; period average exchange rate; value added TFP–calculated as the residual from an OLS regression of value-added volumes (VA) on a translog production function including capital volumes (K) and total number of hours worked (L); and country (c) and year (t) fixed effects.

Table B.23: The real income effect in Eastern Europe

	ln $wL_{c,t}$	ln $rK_{c,t}$	ln $(wL + rK)_{c,t}$	ln $pQ_{c,t}$	ln $Q_{c,t}$	ln $p_{c,t}$	ln $LProd_{c,t}$	ln $TFP_{c,t}$
Panel A: full period 1995-2016								
$R_{c,t}$	-0.106***	-0.059	-0.086**	-0.084	0.059**	-0.090***	-0.009	-0.002
	(0.021)	(0.044)	(0.029)	(0.041)	(0.018)	(0.013)	(0.019)	(0.011)
$ICT_{c,t}$	-0.016	-0.186	-0.098	-0.026	-0.007	-0.198**	0.049	-0.185**
	(0.061)	(0.113)	(0.067)	(0.102)	(0.038)	(0.050)	(0.035)	(0.048)
$R * ICT_{c,t}$	0.010	0.022	0.016	0.008	-0.016	0.036*	-0.024	0.026*
	(0.014)	(0.028)	(0.018)	(0.025)	(0.009)	(0.014)	(0.011)	(0.011)
R^2	.999	.999	.999	.999	0.999	.983	0.999	.933
N	97	97	97	97	76	76	76	76
Panel B: sub-period 1995-2007								
$R_{c,t}$	-0.181*	-0.040	-0.130*	-0.106	-0.063*	-0.089	-0.055	-0.032*
	(0.066)	(0.038)	(0.052)	(0.063)	(0.023)	(0.046)	(0.028)	(0.013)
$ICT_{c,t}$	0.138	-0.542***	-0.126	-0.106	-0.031	-0.151	0.144	-0.241**
	(0.134)	(0.117)	(0.117)	(0.160)	(0.064)	(0.093)	(0.080)	(0.043)
$R * ICT_{c,t}$	0.000	0.102**	0.045	0.052	0.013	0.021	-0.020	0.043**
	(0.034)	(0.034)	(0.033)	(0.045)	(0.013)	(0.018)	(0.016)	(0.010)
R^2	.999	.999	.999	.999	0.999	.99	0.999	.988
N	52	52	52	52	40	40	40	40
Panel C: sub-period 2008-2016								
$R_{c,t}$	-0.032	0.006	-0.016	0.012	0.072**	-0.022	0.019	-0.018*
	(0.036)	(0.040)	(0.031)	(0.036)	(0.022)	(0.010)	(0.016)	(0.006)
$ICT_{c,t}$	0.292	0.093	0.164	0.157	0.089	-0.019	-0.065	0.017
	(0.161)	(0.124)	(0.109)	(0.098)	(0.112)	(0.033)	(0.116)	(0.019)
$R * ICT_{c,t}$	-0.080*	-0.062**	-0.069*	-0.057*	-0.021	-0.016	-0.006	-0.013*
	(0.032)	(0.019)	(0.026)	(0.022)	(0.009)	(0.008)	(0.017)	(0.005)
R^2	0.999	0.999	0.999	0.999	0.999	.917	0.999	.985
N	45	45	45	45	36	36	36	36

Notes: *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$. Regression results to test the real income effect for Eastern European countries during the period 1995-2016. Labor productivity is measured as the share of gross output volumes (Q) over the total number of hours worked. TFP is calculated as the residual from an OLS regression of gross output volumes (Q) on a translog production function including capital volumes (K), total number of hours worked (L) and intermediate input volumes (M). All regressions include: GDP growth, government consolidated gross debt as % of GDP; government interest payable as % of GDP; net government lending/borrowing as % of GDP; gross fixed capital formation as % of GDP; period average exchange rate; and country (c) and year (t) fixed effects.

B.2.2. Northern Europe

Table B.24: The replacement effect in Northern Europe

	$\ln wL_{i,c,t}$	$\ln w_{i,c,t}$	$\ln L_{i,c,t}$	$\ln rK_{i,c,t}$	$\ln r_{i,c,t}$	$\ln K_{i,c,t}$
Panel A: full period 1995-2016						
$R_{i,c,t}$	-0.006	0.007	-0.013	-0.012	-0.010	0.057
	(0.036)	(0.009)	(0.033)	(0.047)	(0.010)	(0.037)
$ICT_{i,c,t}$	0.006	0.004	0.002	0.029	0.001	0.007
	(0.013)	(0.004)	(0.013)	(0.020)	(0.013)	(0.015)
$R * ICT_{i,c,t}$	-0.002	0.005*	-0.007	0.009	-0.004	0.014*
	(0.008)	(0.002)	(0.008)	(0.012)	(0.003)	(0.008)
R^2	.997	.998	.997	.947	.901	.994
N	2958	2958	2958	2925	2958	2958
Panel B: sub-period 1995-2007						
$R_{i,c,t}$	0.041	0.010	0.031	0.096	0.002	0.071***
	(0.031)	(0.007)	(0.027)	(0.076)	(0.007)	(0.023)
$ICT_{i,c,t}$	0.008	0.001	0.007	0.004	0.002	0.019
	(0.009)	(0.005)	(0.011)	(0.034)	(0.015)	(0.017)
$R * ICT_{i,c,t}$	0.003	-0.001	0.004	-0.001	-0.001	0.010
	(0.009)	(0.003)	(0.008)	(0.024)	(0.004)	(0.007)
R^2	.998	.999	.998	.953	.92	.998
N	1742	1742	1742	1718	1742	1742
Panel C: sub-period 2008-2016						
$R_{i,c,t}$	-0.053**	-0.005	-0.048**	0.003	0.000	-0.023
	(0.022)	(0.012)	(0.020)	(0.074)	(0.004)	(0.023)
$ICT_{i,c,t}$	-0.060	0.024	-0.085*	-0.165	-0.011	-0.086
	(0.041)	(0.015)	(0.038)	(0.128)	(0.006)	(0.080)
$R * ICT_{i,c,t}$	-0.011	-0.001	-0.010	0.052	-0.002	0.022
	(0.014)	(0.006)	(0.012)	(0.036)	(0.002)	(0.013)
R^2	.999	.999	.999	.971	.918	.998
N	1215	1215	1215	1206	1215	1215

Notes: *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$. Regression results to test the replacement effect for Northern European countries during the period 1995-2016. All regressions use industry level data for the subset of industries susceptible to automation, defined as industries were the use of industrial robots is prevalent (see Appendix Table A.1). All regressions include: country industry (*ci*); country year (*ct*); and industry year (*it*) fixed effects. All regressions are weighted by the base-sample-year share of each industry's number of hours worked to country-wide hours worked.

Table B.25: The reinstatement effect in Northern Europe

	$\ln w_{c,t}$	$\ln L_{c,t}$	$\ln r_{c,t}$	$\ln K_{c,t}$	$HHI_{c,t}$	$Services_{c,t}$	$Gini^L_{c,t}$	$Gini^w_{c,t}$
Panel A: full period 1995-2016								
$R_{c,t}$	-0.078***	-0.036**	-0.134***	-0.034*	0.006	-0.883***	0.001	-0.003
	(0.012)	(0.011)	(0.028)	(0.018)	(0.003)	(0.229)	(0.004)	(0.008)
$ICT_{c,t}$	0.170**	-0.070	0.034	0.046	0.004	1.564	0.025	0.103**
	(0.061)	(0.040)	(0.116)	(0.073)	(0.009)	(1.811)	(0.014)	(0.034)
$R * ICT_{c,t}$	-0.070*	0.036	-0.013	0.004	-0.005	0.289	-0.015	-0.050**
	(0.035)	(0.029)	(0.068)	(0.050)	(0.007)	(0.979)	(0.010)	(0.021)
R^2	.999	0.999	.945	.999	.919	.96	.935	.92
N	214	214	214	214	214	214	214	214
Panel B: sub-period 1995-2007								
$R_{c,t}$	-0.037	-0.026	-0.083**	0.023	0.014***	-1.947**	0.002	-0.012
	(0.023)	(0.020)	(0.033)	(0.019)	(0.004)	(0.746)	(0.003)	(0.008)
$ICT_{c,t}$	0.055	-0.053	0.082	-0.102	-0.010	1.579	0.008	0.099***
	(0.053)	(0.037)	(0.097)	(0.072)	(0.008)	(1.827)	(0.009)	(0.023)
$R * ICT_{c,t}$	0.022	0.007	-0.006	0.077*	0.006	-1.217	-0.004	-0.034**
	(0.027)	(0.024)	(0.051)	(0.036)	(0.004)	(0.804)	(0.005)	(0.013)
R^2	.999	0.999	.955	0.999	.963	.971	.987	.966
N	124	124	124	124	124	124	124	124
Panel C: sub-period 2008-2016								
$R_{c,t}$	0.032*	-0.041	-0.017	-0.031	0.007	-0.329	0.010*	0.012**
	(0.017)	(0.041)	(0.041)	(0.021)	(0.005)	(0.721)	(0.005)	(0.005)
$ICT_{c,t}$	-0.001	0.038	-0.048	0.068	-0.039**	7.653**	-0.009	-0.013
	(0.010)	(0.052)	(0.074)	(0.052)	(0.013)	(2.442)	(0.006)	(0.010)
$R * ICT_{c,t}$	0.015**	0.000	0.033	0.050	0.017***	-2.464*	-0.003	0.020*
	(0.006)	(0.035)	(0.058)	(0.030)	(0.005)	(1.164)	(0.005)	(0.009)
R^2	0.999	0.999	.877	0.999	.966	.983	.961	.974
N	90	90	90	90	90	90	90	90

Notes: *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$. Regression results to test the reinstatement effect for Northern European countries during the period 1995-2016. All regressions include: GDP growth, government consolidated gross debt as % of GDP; government interest payable as % of GDP; net government lending/borrowing as % of GDP; gross fixed capital formation as % of GDP; period average exchange rate; value added TFP–calculated as the residual from an OLS regression of value-added volumes (VA) on a translog production function including capital volumes (K) and total number of hours worked (L); and country (c) and year (t) fixed effects.

Table B.26: The real income effect in Northern Europe

	$\ln wL_{c,t}$	$\ln rK_{c,t}$	$\ln (wL + rK)_{c,t}$	$\ln pQ_{c,t}$	$\ln Q_{c,t}$	$\ln p_{c,t}$	$\ln LProd_{c,t}$	$\ln TFP_{c,t}$
Panel A: full period 1995-2016								
$R_{c,t}$	-0.158***	-0.140	-0.166**	-0.141**	-0.029	-0.051***	-0.000	0.029**
	(0.038)	(0.078)	(0.058)	(0.052)	(0.019)	(0.006)	(0.015)	(0.011)
$ICT_{c,t}$	0.117	-0.038	0.068	0.064	-0.002	0.025**	0.068*	-0.005
	(0.077)	(0.077)	(0.083)	(0.071)	(0.037)	(0.010)	(0.034)	(0.030)
$R * ICT_{c,t}$	-0.071	-0.029	-0.066	-0.076	-0.001	-0.022**	-0.043*	0.030
	(0.055)	(0.069)	(0.065)	(0.058)	(0.021)	(0.008)	(0.020)	(0.018)
R^2	.998	.993	.997	.997	0.999	.992	0.999	.885
N	214	214	214	214	171	171	171	171
Panel B: sub-period 1995-2007								
$R_{c,t}$	-0.059*	0.021	-0.025	-0.003	-0.034	-0.045***	0.015	0.018
	(0.029)	(0.062)	(0.036)	(0.039)	(0.022)	(0.008)	(0.015)	(0.010)
$ICT_{c,t}$	-0.019	-0.189	-0.093	-0.084	0.029	0.019	0.061	-0.025
	(0.094)	(0.168)	(0.116)	(0.114)	(0.056)	(0.013)	(0.045)	(0.016)
$R * ICT_{c,t}$	0.038	0.055	0.053	0.045	-0.011	-0.012	-0.007	0.028**
	(0.051)	(0.077)	(0.057)	(0.057)	(0.034)	(0.009)	(0.025)	(0.009)
R^2	.999	.997	.999	.999	0.999	.992	0.999	.92
N	124	124	124	124	99	99	99	99
Panel C: sub-period 2008-2016								
$R_{c,t}$	0.001	-0.082	-0.061	-0.093	0.025	-0.005	-0.003	0.017
	(0.030)	(0.115)	(0.062)	(0.055)	(0.027)	(0.019)	(0.020)	(0.012)
$ICT_{c,t}$	0.041	-0.008	0.019	0.018	0.028	0.023	-0.041*	0.038**
	(0.051)	(0.171)	(0.094)	(0.070)	(0.018)	(0.018)	(0.021)	(0.016)
$R * ICT_{c,t}$	0.020	0.020	0.014	-0.025	0.030	-0.035**	0.015	0.015
	(0.034)	(0.105)	(0.067)	(0.046)	(0.021)	(0.012)	(0.019)	(0.014)
R^2	0.999	.998	.999	0.999	0.999	.962	0.999	.989
N	90	90	90	90	72	72	72	72

Notes: $*p < 0.05$, $**p < 0.01$, $***p < 0.001$. Regression results to test the real income effect for Northern European countries during the period 1995-2016. Labor productivity is measured as the share of gross output volumes (Q) over the total number of hours worked. TFP is calculated as the residual from an OLS regression of gross output volumes (Q) on a translog production function including capital volumes (K), total number of hours worked (L) and intermediate input volumes (M). All regressions include: GDP growth, government consolidated gross debt as % of GDP; government interest payable as % of GDP; net government lending/borrowing as % of GDP; gross fixed capital formation as % of GDP; period average exchange rate; and country (c) and year (t) fixed effects.

B.2.3. Southern Europe

Table B.27: The replacement effect in Southern Europe

	ln $wL_{i,c,t}$	ln $w_{i,c,t}$	ln $L_{i,c,t}$	ln $rK_{i,c,t}$	ln $r_{i,c,t}$	ln $K_{i,c,t}$
Panel A: full period 1995-2016						
$R_{i,c,t}$	-0.017	0.079*	-0.096	-0.239	-0.033***	-0.036
	(0.072)	(0.041)	(0.073)	(0.186)	(0.010)	(0.052)
$ICT_{i,c,t}$	0.068***	0.035	0.033	-0.065	0.011**	0.020
	(0.016)	(0.024)	(0.022)	(0.064)	(0.005)	(0.012)
$R * ICT_{i,c,t}$	0.023	0.014	0.010	0.067	0.015***	-0.050**
	(0.024)	(0.012)	(0.024)	(0.062)	(0.005)	(0.020)
R^2	.996	.967	.995	.952	.987	.997
N	981	981	981	959	981	981
Panel B: sub-period 1995-2007						
$R_{i,c,t}$	0.026	0.052**	-0.026	-0.085*	-0.007	-0.003
	(0.020)	(0.022)	(0.023)	(0.046)	(0.006)	(0.029)
$ICT_{i,c,t}$	0.090*	0.097	-0.007	-0.378	-0.009	0.054
	(0.042)	(0.062)	(0.045)	(0.232)	(0.008)	(0.036)
$R * ICT_{i,c,t}$	-0.013	-0.017**	0.005	-0.048*	0.004*	-0.017*
	(0.009)	(0.007)	(0.007)	(0.025)	(0.002)	(0.009)
R^2	.998	.97	.998	.959	.992	.999
N	576	576	576	563	576	576
Panel C: sub-period 2008-2016						
$R_{i,c,t}$	-0.068	0.184	-0.252	-0.710	-0.055	-0.052
	(0.159)	(0.131)	(0.151)	(0.547)	(0.035)	(0.084)
$ICT_{i,c,t}$	0.084**	0.048	0.036	0.114	0.029**	0.036
	(0.029)	(0.029)	(0.033)	(0.097)	(0.013)	(0.023)
$R * ICT_{i,c,t}$	0.099*	0.007	0.092	0.202	0.025*	-0.103**
	(0.053)	(0.031)	(0.052)	(0.140)	(0.011)	(0.041)
R^2	.998	.972	.998	.978	.874	.999
N	405	405	405	396	405	405

Notes: $*p < 0.05$, $**p < 0.01$, $***p < 0.001$. Regression results to test the replacement effect for Southern European countries during the period 1995-2016. All regressions use industry level data for the subset of industries susceptible to automation, defined as industries were the use of industrial robots is prevalent (see Appendix Table A.1). All regressions include: country industry (ci); country year (ct); and industry year (it) fixed effects. All regressions are weighted by the base-sample-year share of each industry's number of hours worked to country-wide hours worked.

Table B.28: The reinstatement effect in Southern Europe

	$\ln w_{c,t}$	$\ln L_{c,t}$	$\ln r_{c,t}$	$\ln K_{c,t}$	$HHI_{c,t}$	$Services_{c,t}$	$Gini^L_{c,t}$	$Gini^w_{c,t}$
Panel A: full period 1995-2016								
$R_{c,t}$	-0.163	-0.034	0.018	-0.084**	0.017*	-3.596*	-0.012	-0.021
	(0.083)	(0.040)	(0.061)	(0.019)	(0.005)	(1.304)	(0.010)	(0.030)
$ICT_{c,t}$	0.030	0.043**	-0.044*	0.099***	0.001	0.712	-0.000	0.002
	(0.015)	(0.013)	(0.017)	(0.006)	(0.001)	(0.355)	(0.004)	(0.005)
$R * ICT_{c,t}$	0.034	-0.064**	-0.031*	-0.031***	-0.008**	0.944*	-0.011	0.010
	(0.017)	(0.014)	(0.010)	(0.005)	(0.002)	(0.401)	(0.006)	(0.007)
R^2	.997	0.999	.982	0.999	.987	.995	.953	.926
N	83	83	83	83	83	83	83	83
Panel B: sub-period 1995-2007								
$R_{c,t}$	-0.181*	-0.053	-0.054	-0.111**	-0.011	-0.455	0.018	-0.118
	(0.058)	(0.057)	(0.090)	(0.031)	(0.007)	(2.112)	(0.021)	(0.080)
$ICT_{c,t}$	-0.018	-0.015	-0.000	0.045***	-0.018**	2.840	-0.010	-0.082
	(0.046)	(0.030)	(0.061)	(0.007)	(0.005)	(1.340)	(0.011)	(0.037)
$R * ICT_{c,t}$	0.014	-0.048*	-0.012	-0.019*	-0.001	0.353	-0.017*	0.018
	(0.016)	(0.018)	(0.030)	(0.007)	(0.001)	(0.359)	(0.006)	(0.017)
R^2	.998	0.999	.989	0.999	.997	.997	.976	.945
N	47	47	47	47	47	47	47	47
Panel C: sub-period 2008-2016								
$R_{c,t}$	0.262***	0.112	0.309*	0.101*	-0.006	0.011	-0.007	0.017
	(0.041)	(0.050)	(0.105)	(0.042)	(0.007)	(2.620)	(0.011)	(0.033)
$ICT_{c,t}$	0.006	-0.050	-0.110**	0.031*	-0.003	1.791*	-0.003	0.005
	(0.011)	(0.032)	(0.033)	(0.012)	(0.001)	(0.643)	(0.004)	(0.008)
$R * ICT_{c,t}$	0.022	0.015	-0.004	0.019	-0.004	0.394	-0.008*	0.010
	(0.012)	(0.027)	(0.034)	(0.009)	(0.004)	(0.684)	(0.003)	(0.008)
R^2	0.999	0.999	.946	0.999	.99	.996	.992	.976
N	36	36	36	36	36	36	36	36

Notes: $*p < 0.05$, $**p < 0.01$, $***p < 0.001$. Regression results to test the reinstatement effect for Southern European countries during the period 1995-2016. All regressions include: GDP growth, government consolidated gross debt as % of GDP; government interest payable as % of GDP; net government lending/borrowing as % of GDP; gross fixed capital formation as % of GDP; period average exchange rate; value added TFP–calculated as the residual from an OLS regression of value-added volumes (VA) on a translog production function including capital volumes (K) and total number of hours worked (L); and country (c) and year (t) fixed effects.

Table B.29: The real income effect in Southern Europe

	ln $wL_{c,t}$	ln $rK_{c,t}$	ln $(wL + rK)_{c,t}$	ln $pQ_{c,t}$	ln $Q_{c,t}$	ln $p_{c,t}$	ln $LProd_{c,t}$	ln $TFP_{c,t}$
Panel A: full period 1995-2016								
$R_{c,t}$	-0.193	0.176**	-0.055	0.010	-0.008	-0.036	0.039	0.056
	(0.140)	(0.040)	(0.082)	(0.045)	(0.041)	(0.041)	(0.022)	(0.021)
$ICT_{c,t}$	0.055	0.092**	0.070**	0.097***	0.092	0.084**	0.027	-0.006
	(0.023)	(0.021)	(0.013)	(0.015)	(0.053)	(0.019)	(0.033)	(0.016)
$R * ICT_{c,t}$	-0.017	-0.162**	-0.071*	-0.103***	-0.078*	0.009	-0.021	-0.016
	(0.038)	(0.030)	(0.023)	(0.014)	(0.018)	(0.014)	(0.016)	(0.009)
R^2	.999	.999	.999	0.999	0.999	.998	.999	.994
N	83	83	83	83	61	61	61	61
Panel B: sub-period 1995-2007								
$R_{c,t}$	-0.275***	0.129	-0.122*	-0.130*	-0.242	0.045	-0.122	-0.013
	(0.038)	(0.141)	(0.039)	(0.051)	(0.170)	(0.087)	(0.208)	(0.079)
$ICT_{c,t}$	-0.073	0.297**	0.064	0.078**	0.060*	0.022	0.033	-0.048*
	(0.050)	(0.063)	(0.043)	(0.024)	(0.017)	(0.013)	(0.029)	(0.014)
$R * ICT_{c,t}$	-0.035*	-0.075	-0.050**	-0.047**	0.002	-0.040	0.042	-0.009
	(0.013)	(0.036)	(0.014)	(0.012)	(0.064)	(0.034)	(0.081)	(0.029)
R^2	0.999	0.999	0.999	0.999	0.999	0.999	0.999	.999
N	47	47	47	47	34	34	34	34
Panel C: sub-period 2008-2016								
$R_{c,t}$	0.292*	0.366*	0.315**	0.303*	0.340**	0.123	0.121	0.066*
	(0.110)	(0.122)	(0.084)	(0.098)	(0.059)	(0.070)	(0.063)	(0.018)
$ICT_{c,t}$	-0.029	-0.058	-0.040	-0.051	-0.113*	0.076	-0.028	-0.017
	(0.035)	(0.033)	(0.020)	(0.026)	(0.029)	(0.032)	(0.024)	(0.017)
$R * ICT_{c,t}$	0.036	-0.071	-0.005	0.012	-0.022	0.003	-0.006	0.002
	(0.037)	(0.035)	(0.023)	(0.028)	(0.016)	(0.013)	(0.017)	(0.009)
R^2	0.999	0.999	0.999	0.999	0.999	.97	0.999	.997
N	36	36	36	36	27	27	27	27

Notes: $^*p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$. Regression results to test the real income effect for Southern European countries during the period 1995-2016. Labor productivity is measured as the share of gross output volumes (Q) over the total number of hours worked. TFP is calculated as the residual from an OLS regression of gross output volumes (Q) on a translog production function including capital volumes (K), total number of hours worked (L) and intermediate input volumes (M). All regressions include: GDP growth, government consolidated gross debt as % of GDP; government interest payable as % of GDP; net government lending/borrowing as % of GDP; gross fixed capital formation as % of GDP; period average exchange rate; and country (c) and year (t) fixed effects.

SI.1. Analysis at the sub-national level

The impact of automation is heterogeneous across firms, industries and regions. To analyze the impact of automation on aggregate taxation, we would ideally have data that provides a direct link between firm and industry level production accounts and tax payments. But this data does not exist and granular data on firm or industry level tax payments draws only a partial picture: For example, at the firm level we have data on corporate taxes charged on profits and represent a part of aggregate taxes on capital. But we do not know how profits of individual firms or industries affect individual wealth levels and the demand for saving, investment in financial accounts and durable goods (e.g. housing) which all are subject to other kinds of taxation.

We complement the macro level analysis with a region level approach using firm level data provided by Bureau van Dijk Electronic Publishing [2020a] and analyze the nexus between regional patterns of automation, labor demand and corporate tax payments in NUTS2-regions. This analysis draws only a partial picture of economic reality, but illustrates that the impacts of automation are diverse at the granular level. For governments, this understanding is important because — dependent on the country-specific structure of tax administration — locally raised taxes can be decisive to ensure the financing of essential public infrastructure.

SI.1.1. Empirical approach

But as explained in Sec. 2.2, tax revenues are collected at different levels of government administration (central, federal, local). For governments it is also relevant to understand the impact of automation at the local level. To analyze the local effects of automation, we would ideally use regional data on economic production, automation and taxation. Unfortunately, this data is not available in a format that is consistent with the country level analysis introduced above.

As an alternative, we use firm level data being aware that firm level evidence draws only a partial picture of the economic reality. In particular, we rely on the proprietary firm level data set Amadeus, the European counterpart of ORBIS-Global, which is a product of Bureau van Dijk Electronic Publishing [2020a] (BvDEP). The underlying data are firms' financial statements sourced from various national registries (e.g. statistical agencies) and standardized by BvDEP for cross-country comparability.[18]

[18] For more details over the standardization procedure, see the correspondence tables used for each country by Bureau van Dijk Electronic Publishing [2020b]. For the initial data cleaning and preparation procedure we follow Kalemli-Ozcan et al. [2015]. Specifically, we drop firms reporting consolidated accounts, i.e. C1 and C2 codes and, if duplicate, the rest is kept based on the presence of annual reports over local registry filling. We also use annual records over quarters and late calendar months over early months.

For the analysis, we rely on balance sheet information of firms in the European countries where the industry level information on robot- or ICT-intensity exist for the period 2008-2016. To cover the largest set of regions across EU possible, we examine the effects of robot- and ICT-intensity separately and, thus, rely on the maximal amount of information available across data sets. More precisely, the sample used to analyze the impact of ICT-intensity ($ICT_{i,c,t}$) covers the same set of countries and industries used in the country and industry level analysis from above. The sample used to analyze the impact of robot-intensity ($R_{i,c,t}$) also includes the following set of countries: Croatia (HR); Hungary (HU); Ireland (IE); Poland (PL); Portugal (PT); and Romania (RO).

For each firm in the data set we retain those reporting strictly positive firm-year values on the number of employees or taxes payed. The latter refers to income tax expenses of the reporting period plus any net deferred tax expenses/income between the current and the previous reporting period. Conclusions drawn from this analysis are limited to a rather specific category of fiscal taxes, i.e. corporate income taxes.

Each firm's primary production activity is based on the NACE Rev.2 (ISIC Rev.4) 2-digit industry code used to merge with the industry level measures on robot- and ICT-intensity. The sample includes the same set of 15 industry groups covered in the industry level sample (see Appendix Table A.1 for a detailed description of the industry codes). Finally, we link firms to the location of economic activity trough the NUTS version 2016 regional classification codes which across the EU and UK cover 281 regions at NUTS 2 and 1348 regions at NUTS 3 level [Eurostat, 2020b]. The sample used in our analysis for the effects of robot (ICT) intensity covers 273 (227) NUTS 2 and 1314 (1127) NUTS 3 regions. For more details over the summary statistics of the firm level sample and variables considered, see Appendix Table SI.13.

ORBIS-Global is widely accepted as one of the best available options in terms of the richness of balance sheet information and cross-country comparability at the expense of incomplete coverage for smaller-sized firms with simplified financial reporting obligations [Bajgar et al., 2020, Kalemli-Ozcan et al., 2015]. Thus, while a large number of micro firms remain unrecorded, the sample manages to cover around 60% of economic activity in terms of employment, on average (see Appendix Table SI.11).[19]

However, it is still crucial to understand the representativeness of the firm level corporate income taxes relative to the economy wide capital and corporate income taxes. Even when we look at the country level sample, we find that corporate taxes on income, profits and capital gains (variable code 1200 in OECD [2019] data set) represent only 22% of total capital taxes T^k, on average across sample-countries (see Appendix Table SI.12). When we focus on the firm level samples we see that, on average, they represent around 20%

[19] For similar evidence see Bormans and Theodorakopoulos [2020].

of the economy-wide corporate taxes on income, profits and capital gains (see Appendix Table SI.12). This gap is mainly driven by the fact that in the firm level samples we only observe firms in the limited sub-set of the 15 industry groupings used in the industry level analysis and not the whole economy. However, even if we observed firm level data for the whole economy the sample will remain underrepresented, in line with the results from above on the coverage on employment. Overall, while the firm level data is helpful in uncovering interesting underlying heterogeneity, any results will capture a very limited part of the aggregate effects.

Using a regression analysis, we estimate the impact of robot $R_{i,c,t}$ and $ICT_{i,c,t}$ intensity on regional labor demand $L_{f,r,i,t}$ and corporate tax payment $T^{\pi}_{f,r,i,t}$. To illustrate the effects, we estimate for each country the following specification

$$Y_{f,r,t} \sim \beta^x_r \cdot \mathbb{1}(r,i)_f \cdot X_{i,c,t} + \epsilon_{r,f,t} \quad \text{(SI.1)}$$

where $Y_{f,r,t} \in \{T^{\pi}_{f,r,t}, L_{f,r,t}\}$, $X_{i,c,t} \in \{R_{i,c,t}, ICT_{i,c,t}\}$ and $i \in I_c$. $\mathbb{1}(r,i)_f$ is a firm-specific dummy variable that equals one if firm f is located in region r and with primary economic activity in industry i.[20] All regressions include firm and NUTS3-region-year FE and are weighted using the same weights as in the industry level analysis, i.e. base-sample-year share of each industry's number of hours worked to country-wide hours worked. For the standard errors, we use multi-way clustering at the industry, region and year level.

Note that we combine data from different levels of aggregation here. In particular, we merge industry-country level data on automation with firm level data where the location of the firm is observed. This way we are able to map the industry-country level to the region-level dimension. However, since we do not directly observe the allocation of robot and ICT-intensity across regions, our estimation strategy assumes that all industries within an country are equally exposed to automation independent of the regional identity. Using this estimation strategy, we capture within-industry technological change and induced reallocation across firms that might be regionally unequally distributed.

We illustrate the effects of ICT and robot adoption at the regional level drawing maps that show the estimated effect β_r on corporate taxes and on local labor demand. Different color codes indicate the size and direction of the expected impact.

[20]Since we drop firms reporting consolidated accounts, we account for any double counting that could possibly arise from subsidiary firms integrating their statements to the national of international headquarter. However, we cannot control for such a possibility for multi-plant firms, due to the absence of data at such granular level.

SI.1.2. Results

In the preceding analysis, we observed that the economic effects of automation can be heterogeneous across different groups of countries. This indicates that local conditions matter. Now, we explore regional heterogeneity at the sub-national level.

In Fig. SI.11, we show the regional effects of automation at the level of NUTS2 regions. The figures on top (Fig. SI.12a and SI.12b) show the effects on local labor demand that is captured by the firms in our sample. The figures at the bottom illustrate the correlation between automation and corporate tax revenues (Fig. SI.12c and SI.12d). On the left (right) hand side, we show the estimated effects of robot (ICT) adoption. The colors indicate the scale of the effect where green color indicates positive and red color negative estimated effects. Additional plots at the NUTS3 and at the country level aggregated from firm level data are available in the Appendix SI.1.4.2.

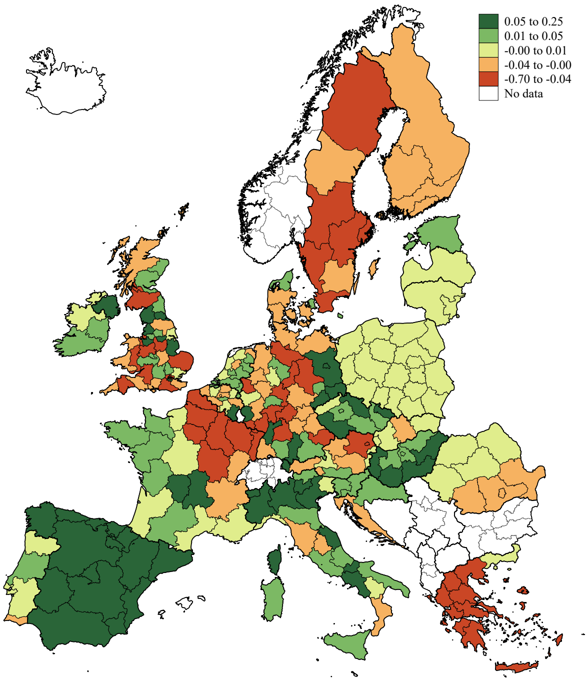
Visually, indicated by the similar coloring patterns comparing the map at the top with its analog at the bottom, it can be seen that in most regions the effects of automation on labor and taxation point into the same direction: When ATs exhibit a negative association with employment, we also observe a negative impact with corporate tax payments. Few exceptions at the local level exist where we find an opposite pattern of correlation. For example, in Alentejo (Portugal, PT18) and in Corse (France, FR83) the impact of robots on labor is negatively correlated with its impact on corporate taxes. In parts of Ireland and many regions of the UK, we observe generally a negative correlation between the effect of robots on tax revenues and on labor as indicated by opposite coloring codes for each NUTS regions, i.e. robots have a negative impact on labor but a positive impact on corporate tax payments and vice versa.

We also observe that the impact of robots compared to ICT differs across regions and countries. For example, we observe robots to have a positive impact on labor and taxation in Italy, but we find a negative impact of ICT. The opposite pattern holds true for parts of Greece where ICT tends to exhibit a positive effect, but robots a negative one.

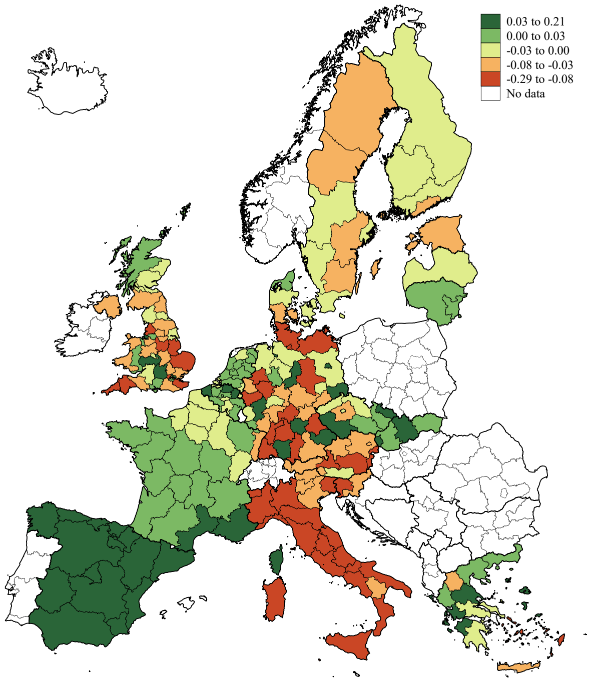
Generally, we find that most regions in Spain, France and the Baltic countries to be the beneficiaries of automation: Both, robots and ICT diffusion, exhibit positive effects on regional labor demand and corporate taxation. The estimated effects draw a mixed picture of Germany and the UK: Some regions exhibit strong negative, others strong positive impacts. In Sweden and Finland, we find negative effects of robot diffusion on both, labor and taxes, and mixed effects of ICT.

Figure SI.11: Automation at the sub-national level (NUTS2 regions)

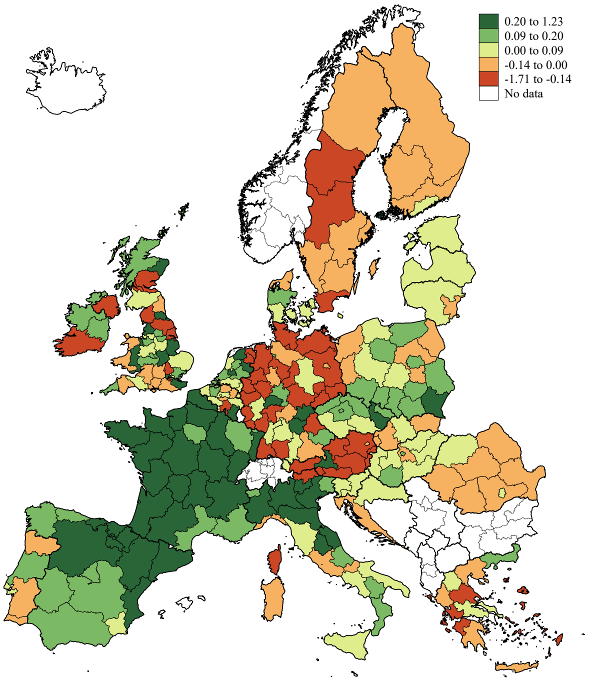
(a) Labor & robots



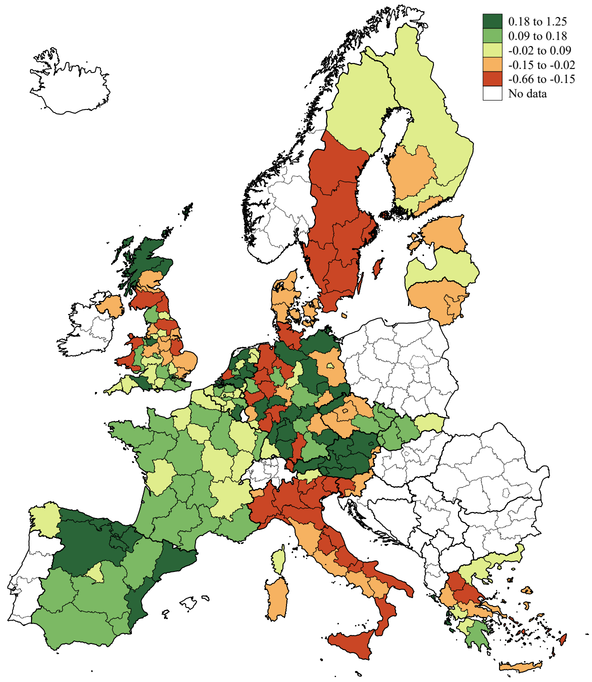
(b) Labor & ICT



(c) Taxes & robots



(d) Taxes & ICT



Source: Author's calculations based on ORBIS Global, IFR and EUKLEMS data sets.
Notes: Each map presents the point estimates from regressing for each country separately the ln of the firm level corporate income tax ($Taxes$) and number of employees (L), respectively, on the industry level robot (R) or ICT intensity interacted with a full set of NUTS2 version 2016-regional dummies. All regressions include firm and NUTS3 version 2016-region-year fixed effects and are weighted using the same weights as in the industry level analysis, i.e. base-sample-year share of each industry's number of hours worked to country-wide hours worked. The estimated effects are plotted with 2 shades of green and red for two groups of positive and negative values, respectively, with the darker colors representing stronger effects. Regions with no data are left blank. Panels (a) and (c) cover 273 NUTS2 regions, while panels (b) and (d) cover 227 NUTS2 regions.

SI.1.3. Discussion and insights

Our analysis at the sub-national (NUTS2) level underlines the heterogeneity of impacts in two regards: (1) The linkage between economic outcomes, taxes to automation, and (2) the relationship between economic outcomes and tax payments differ across regions. Limited to corporate taxation in the period 2008-2016 and covering only a subset of industries and firms, we find that automation is positively correlated with employment in some regions, while negatively in others. In most regions, we find a positive correlation between employment and taxes: Hence, when the net of the replacement and reinstatement effect is employment increasing, corporate tax payments tend to be higher. However, this relationship is reverse for some of the regions in our analysis. Note that the sub-national analysis draws only a partial picture of the aggregate reality: Due to data limitations, we cover only corporate tax payments of a subset of firms drawn from a subset of industries. Corporate tax payments are a subset of capital taxes and represent only a fraction of total taxation. Hence, the results can not be extrapolated to the flows of aggregate taxation.

SI.1.4. Additional information on firm level data

SI.1.4.1. Data and descriptives

Table SI.11: Representativeness of employment in ORBIS vs. EUKLEMS data

Country	(1)	(2)	(3)	(4)	(5)
	Total employment			Employment share %	
	EUKLEMS	R-sample	ICT-sample	R-sample	ICT-sample
AT	1,254,090	932,795	932,795	74.38	74.38
BE	1,130,893	784,687	784,687	69.39	69.39
CZ	2,080,420	1,283,846	1,283,846	61.71	61.71
DE	12,381,000	8,997,709	8,997,709	72.67	72.67
DK	733,000	297,891	297,891	40.64	40.64
EE	241,000	57,452	10,524	23.84	4.37
ES	4,787,000	1,572,781	1,572,781	32.86	32.86
FI	705,900	824,132	824,132	116.75	116.75
FR	6,386,000	1,508,347	1,508,347	23.62	23.62
GR	777,160	49,835	49,835	6.41	6.41
HR	545,340	291,881	N/A	53.52	N/A
HU	1,495,220	536,044	N/A	35.85	N/A
IE	472,790	677,391	N/A	143.28	N/A
IT	6,534,000	4,614,803	4,614,803	70.63	70.63
LT	495,570	482,602	294,167	97.38	59.36
LV	291,860	113,203	113,203	38.79	38.79
NL	1,654,000	1,610,159	1,610,159	97.35	97.35
PL	5,863,800	1,313,027	N/A	22.39	N/A
PT	1,389,160	598,185	N/A	43.06	N/A
RO	2,907,400	1,470,350	N/A	50.57	N/A
SE	1,489,000	1,352,279	1,352,279	90.82	90.82
SI	325,680	155,516	53,275	47.75	16.36
SK	821,310	436,482	436,482	53.14	53.14
UK	6,433,010	4,806,876	4,806,876	74.72	74.72
Mean	2,549,775	1,448,678	1,641,322	60.06	55.78

Notes: Columns (1), (2) and (3) show the total number of employees in EUKLEMS, R-sample and ICT-sample, respectively, for each country in the last sample period, i.e. 2016. R- and ICT-sample refer to the firm level ORBIS sample when robot- and ICT-density is reported, respectively. Columns (4) and (5) report the employment shares in % covered by the firm level sample relative to the aggregate data in EUKLEMS, i.e. the ratio of (2) over (1) and (3) over (1), respectively. All samples cover the same 15 industry-groupings used in the analysis and discussed in detail in Appendix Table A.1.

Table SI.12: Representativeness of corporate taxes in ORBIS firm level samples vs. OECD country level data.

Country	(1)	(2)	(3)	(4)	(5)
	Aggregate Tax			Tax share (Sample Tax/$T_c^{k,corp}$)%	
	T_c^k	$T_c^{k,corp}$	$T_c^k/T_c^{k,corp}$	R-sample	ICT-sample
AT	44	8	19.18	N/A	N/A
BE	81	15	18.03	39.61	39.61
CZ	385	179	46.40	0.16	0.16
DE	410	62	15.23	N/A	N/A
DK	641	60	9.32	7.62	7.62
EE	2	0	21.88	4.37	4.12
ES	133	25	18.97	35.34	35.34
FI	36	5	13.33	30.52	30.52
FR	331	45	13.70	19.10	19.10
GR	21	4	20.43	3.16	3.16
HU	3,076	831	27.02	0.10	N/A
IE	31	7	23.56	1.06	N/A
IT	275	36	13.19	27.11	27.11
LT	2	1	27.26	3.90	N/A
LV	2	0	18.61	N/A	N/A
NL	85	24	27.96	7.32	7.32
PL	150	34	22.81	6.84	N/A
PT	21	6	27.49	35.85	N/A
SE	744	121	16.20	1.36	1.36
SI	3	1	21.35	1.31	N/A
SK	6	3	46.77	31.92	31.92
UK	311	53	17.12	56.61	56.61
Mean	309	69	22.08	16.49	20.30

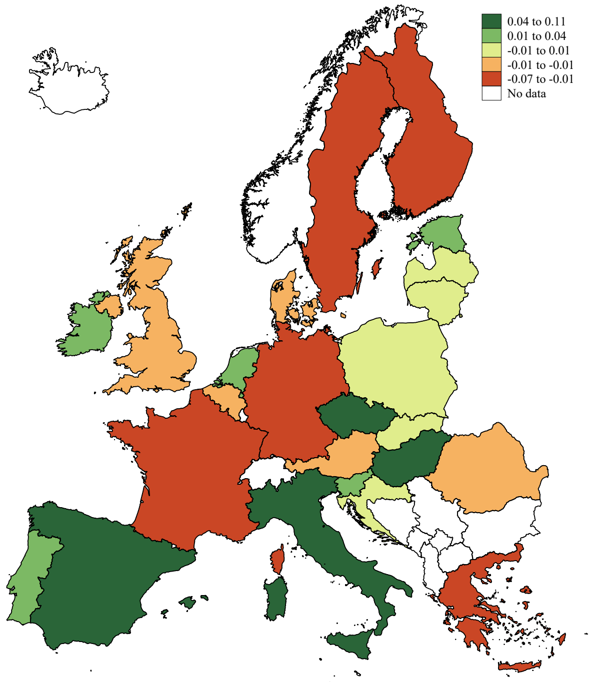
Notes: Column (1) shows the total tax on capital T^k in billions of national currency for each country in the last sample period, i.e. 2016. Column (2) is a sub-category of column (1) capturing corporate taxes on income, profits and capital gains $T^{k,corp}$ (with variable code 1200 in OECD [2019] data set). Column (3) is the ratio of (1) over (2) in %. Columns (4) and (5) capture the share of total taxes reported in the R- and ICT-sample used in the analysis, respectively, over (2) in %. R- and ICT-sample refer to the firm level ORBIS sample when robot- and ICT-density is reported, respectively. The aggregate taxes cover the whole economy while the firm level samples cover the 15 industry-groupings discussed in detail in Appendix Table A.1.

Table SI.13: Summary statistics for firm level sample

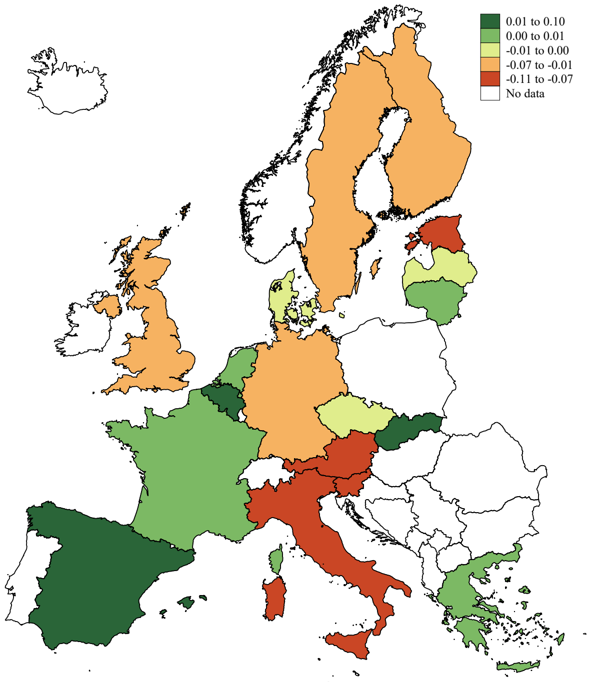
	R-sample		ICT-sample	
	$L_{f,i,t}$	$T^{\dagger}_{f,i,t}$	$L_{f,i,t}$	$T^{\dagger}_{f,i,t}$
Mean	23	321	26	409
St.Dev.	838	30,453	985	35,244
Min	1	.001	1	.001
Median	4	5.2	3	8
Max	855,492	24,474,986	855,492	24,474,986
# Observations	16,261,216	8,095,653	11,391,818	6,019,433
# Firms	4,385,360	1,964,694	3,245,827	1,478,475
# Countries	24	24	18	18
# NUTS2 regions	273	273	227	227
# NUTS3 regions	1,310	1,314	1,119	1,123

Notes: † refers to values in thousands for the Mean, St.Dev., Min, Median, and Max. This table presents the summary statistics on the firm level corporate income tax ($T_{f,i,t}$) and number of employees ($L_{f,i,t}$) for 2 different samples. R- and ICT-sample refer to samples with non-missing values of industry level robot- and ICT-intensity, respectively. The ICT-sample covers the following 18 countries: AT; BE; CZ; DE; DK; EE; ES; FI; FR; GR; IT; LT; LV; NL; SE; SI; SK; and UK, while the R-sample covers 6 additional countries: HR; HU; IE; PL; PT; and RO. Both samples cover the same set of 15 industry groups included in the industry level analysis—for more details see Appendix Table A.1.

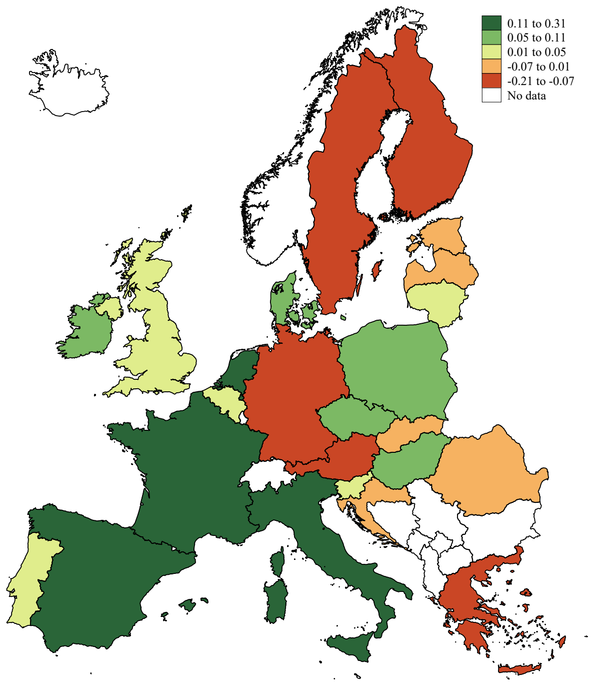
SI.1.4.2. Additional results



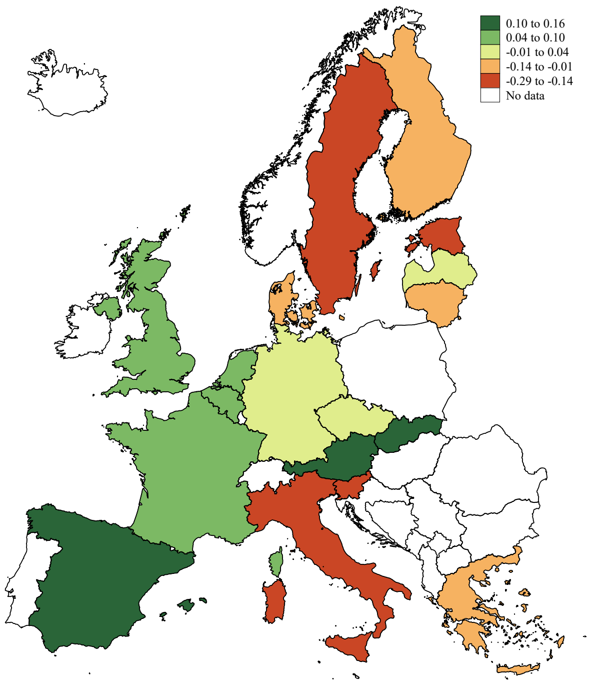
(a) Labor & robots



(b) Labor & ICT



(c) Taxes & robots

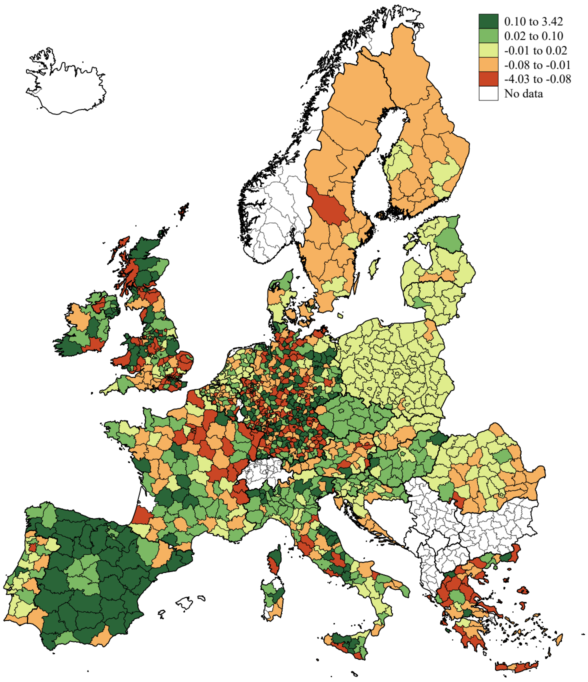


(d) Taxes & ICT

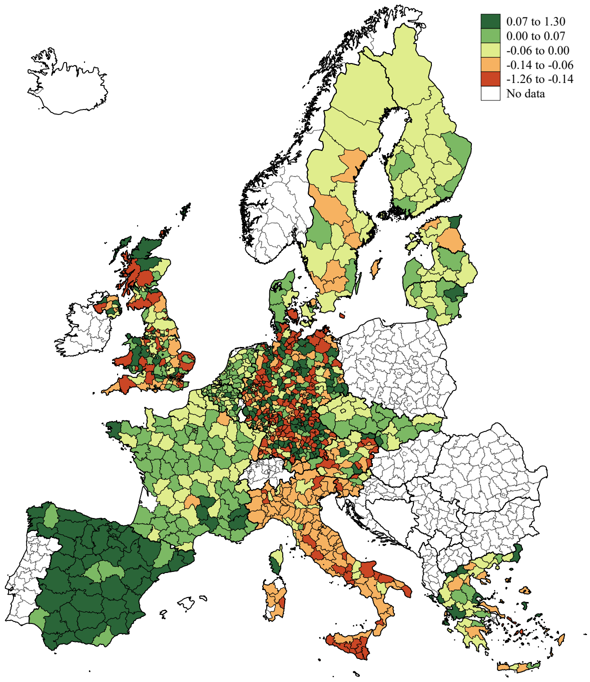
Figure SI.13: automation at the national level (NUTS0 regions)

Source: Author's calculations based on ORBIS Global, IFR and EUKLEMS data sets.

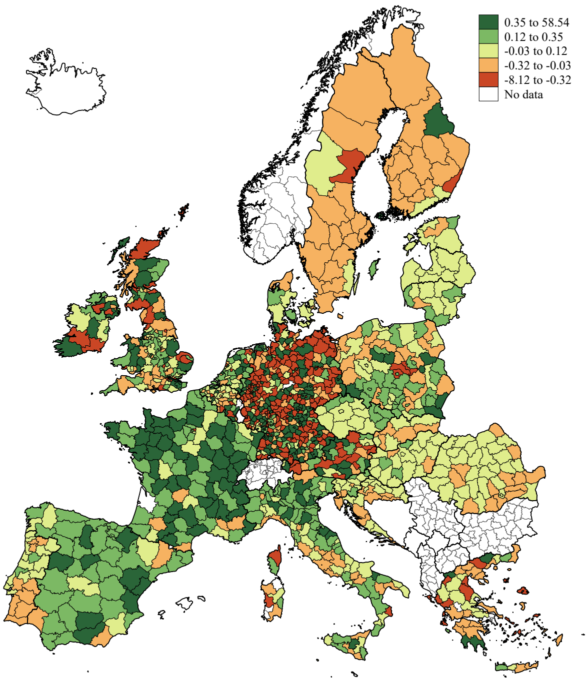
Notes: Each map presents the point estimates from regressing for each country separately the ln of the firm level corporate income tax ($Taxes$) and number of employees (L), respectively, on the industry level robot (R) or ICT intensity. All regressions include firm and NUTS3 version 2016-region-year fixed effects and are weighted using the same weights as in the industry level analysis, i.e. base-sample-year share of each industry's number of hours worked to country-wide hours worked. The estimated effects are plotted with 2 shades of green and red for two groups of positive and negative values, respectively, with the darker colors representing stronger effects. Regions with no data are left blank.



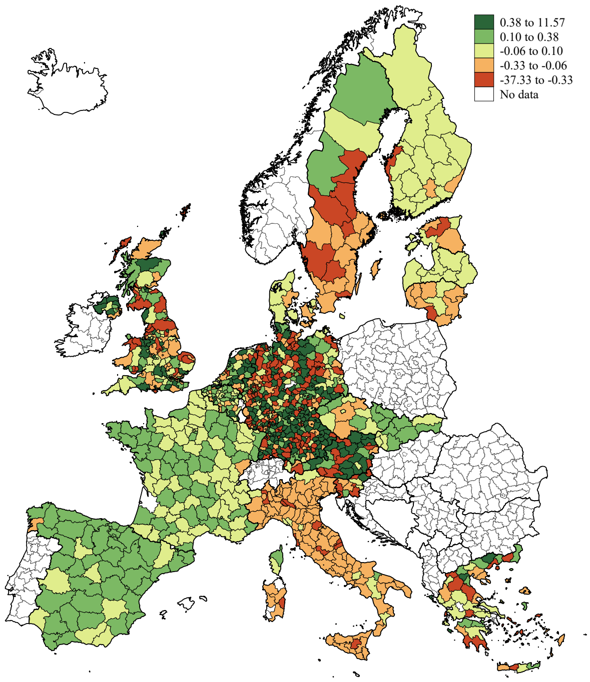
(a) Labor & robots



(b) Labor & ICT



(c) Taxes & robots



(d) Taxes & ICT

Figure SI.14: automation at the sub-national level (NUTS3 regions)

Source: Author's calculations based on ORBIS Global, IFR and EUKLEMS data sets.

Notes: Each map presents the point estimates from regressing for each country separately the ln of the firm level corporate income tax ($Taxes$) and number of employees (L), respectively, on the industry level robot (R) or ICT intensity interacted with a full set of NUTS3 version 2016-regional dummies. All regressions include firm and NUTS3 version 2016-region-year fixed effects and are weighted using the same weights as in the industry level analysis, i.e. base-sample-year share of each industry's number of hours worked to country-wide hours worked. The estimated effects are plotted with 2 shades of green and red for two groups of positive and negative values, respectively, with the darker colors representing stronger effects. Regions with no data are left blank. Panels (a), (b), (c) and (d) cover 1310, 1119, 1314, and 1123 NUTS3 regions, respectively.

SI.2. Robustness checks

In this section, we provide the results of a series of robustness checks.

First, we make sure that our results are not driven by changes in the tax system. Unfortunately, comprehensive data that covers the whole range of different taxes, that is consistent across our sample of countries and covers a reasonable number of years is not available. We are only able to proxy tax reforms using data on corporate taxation that cover a smaller period of time but all countries in our sample. We use two different data sources.

In SI.2.1, we repeat all baseline country level regressions and include as an additional control the corporate tax rate ($CRT_{c,t}$) sourced from KPMG.[21] This data are only available between 2003-2016 and only the results for the period after 2008 are comparable with the baseline analysis.

Next, in SI.2.2 we repeat all baseline country level regressions and include as an additional control the effective tax rate ($ERT_{c,t}$) sourced from Eurostat.[22] The ETR variable is only available between 2006-2016 and again, only the results for the period after 2008 are comparable with the baseline analysis.

Another concern regarding the robustness of our results may arise from the impact of trade. In our baseline, we only controlled for the exchange rate which does not or only poorly vary across different European countries. To capture the country specific impact of trade, we repeat all baseline country level regressions and include as additional controls the countrylevel imports ($Imports^{\%GDP}_{c,t}$) and exports ($Exports^{\%GDP}_{c,t}$) as percentage of GDP sourced from the OECD National Accounts Database.[23] The results are shown in Table SI.2.3.

Finally, to explore the nexus between distribution and taxation, we examine the progressiveness of taxation (Table SI.2.4). To do so, we rely on the same empirical specification used to understand the determinants of taxation, but now our regressions include as an additional control the Gini coefficient from the industry level distribution of labor in terms of hours worked ($Gini^{L}_{c,t}$) sourced from Eurostat.

[21] The data were sourced from the KPMG website: https://home.kpmg/xx/en/home/services/tax/tax-tools-and-resources/tax-rates-online.html

[22] This is the Effective Average Tax Rate (ETR) for large corporations in non-financial sector, computed at corporate level, for average asset composition and funding sources, using the Devereux/Griffith methodology. The data are available in Eurostat: https://ec.europa.eu/taxation_customs/business/economic-analysis-taxation/data-taxation_en

[23] The data are available in OECD: https://stats.oecd.org/viewhtml.aspx?datasetcode=NAAG&lang=en#

SI.2.1. Controlling for changes in corporate taxation using KPMG data

SI.2.1.1. Taxation and automation

Table SI.24: Taxation and automation

	Taxes in ln of nat. currency				Taxes as % of GDP				Taxes as % of total tax		
	$lnT_{c,t}$	$lnT^l_{c,t}$	$lnT^k_{c,t}$	$lnT^y_{c,t}$	$T_{c,t}$	$T^l_{c,t}$	$T^k_{c,t}$	$T^y_{c,t}$	$T^l_{c,t}$	$T^k_{c,t}$	$T^y_{c,t}$
Panel A: full period 2003-2016											
$R_{c,t}$	-0.005	-0.036	0.053	-0.018	0.385	-0.282	0.709	-0.041	-1.219	1.776	-0.572
	(0.014)	(0.029)	(0.068)	(0.023)	(0.548)	(0.329)	(0.556)	(0.272)	(0.974)	(1.583)	(1.025)
$ICT_{c,t}$	-0.074**	-0.045	-0.069	-0.111	-2.269**	-0.229	-0.934	-1.105	0.847	0.311	-1.458
	(0.033)	(0.041)	(0.046)	(0.070)	(0.891)	(0.612)	(0.607)	(0.678)	(1.323)	(1.885)	(1.667)
$R*ICT_{c,t}$	0.029*	0.013	0.028	0.064*	0.788	-0.195	0.367	0.616*	-1.005	-0.050	1.145
	(0.016)	(0.019)	(0.036)	(0.032)	(0.479)	(0.341)	(0.417)	(0.306)	(0.760)	(1.120)	(0.864)
R^2	0.999	0.999	.999	.999	.975	.991	.983	.922	.988	.979	.947
N	266	266	266	266	266	266	266	266	266	266	266
Panel B: sub-period 2003-2007											
$R_{c,t}$	-0.093**	-0.090	-0.018	-0.027	-0.049	-0.322	0.130	0.143	-0.402	0.238	0.343
	(0.026)	(0.044)	(0.040)	(0.056)	(1.179)	(0.859)	(0.619)	(0.775)	(1.749)	(1.316)	(2.180)
$ICT_{c,t}$	-0.086	-0.131*	-0.133	-0.154	-1.682	1.421	-1.659	-1.444	5.631	-2.457	-2.845
	(0.088)	(0.058)	(0.152)	(0.136)	(1.625)	(0.812)	(1.821)	(1.090)	(3.356)	(4.002)	(2.591)
$R*ICT_{c,t}$	-0.026	-0.008	-0.058	0.042	-1.416	-0.813**	-0.853	0.249	-1.044	-1.044	2.114
	(0.026)	(0.020)	(0.063)	(0.042)	(0.775)	(0.282)	(0.970)	(0.485)	(1.111)	(1.783)	(1.084)
R^2	0.999	0.999	0.999	0.999	.994	.998	.996	.981	.998	.996	.989
N	95	95	95	95	95	95	95	95	95	95	95
Panel C: sub-period 2008-2016											
$R_{c,t}$	0.001	0.008	0.018	-0.020	0.253	0.228	0.113	-0.088	0.335	0.241	-0.576
	(0.018)	(0.024)	(0.057)	(0.029)	(0.716)	(0.352)	(0.514)	(0.365)	(0.880)	(1.284)	(0.980)
$ICT_{c,t}$	-0.019	-0.010	-0.023	-0.039	-0.988	-0.201	0.102	-0.889	-0.203	1.681	-1.512
	(0.030)	(0.045)	(0.029)	(0.063)	(0.669)	(0.466)	(0.330)	(0.571)	(0.933)	(1.053)	(1.023)
$R*ICT_{c,t}$	0.001	0.012	0.021	-0.016	0.435	-0.013	0.302	0.145	0.163	-0.236	0.072
	(0.021)	(0.026)	(0.037)	(0.036)	(0.727)	(0.322)	(0.580)	(0.348)	(0.586)	(0.746)	(0.529)
R^2	0.999	0.999	.999	0.999	.985	.994	.989	.95	.991	.988	.966
N	171	171	171	171	171	171	171	171	171	171	171

Notes: $*\ p < 0.05$, $**\ p < 0.01$, $***\ p < 0.001$. Regression results of aggregate flows of tax revenues on different automation measures for 19 European countries during the period 2003-2016. All regressions use country level data and include: GDP growth, gross output share of the service sector in total economy; Herfindahl-Hirschman Index computed based on the gross-output shares of macro-sectors; government consolidated gross debt as % of GDP; government interest payable as % of GDP; net government lending/borrowing as % of GDP; gross fixed capital formation as % of GDP; period average exchange rate; corporate tax rate; and country (c) and year (t) fixed effects. All regressions in Panel A also include the ln of gross-output value (pQ).

SI.2.1.2. Taxation and economic production

Table SI.25: Taxation and the structure of economic production for the period 2003-2016

	Taxes in ln of nat. currency				Taxes as % of GDP				Taxes as % of total tax		
	ln $T_{c,t}$	ln $T^l_{c,t}$	ln $T^k_{c,t}$	ln$T^y_{c,t}$	$T_{c,t}$	$T^l_{c,t}$	$T^k_{c,t}$	$T^y_{c,t}$	$T^l_{c,t}$	$T^k_{c,t}$	$T^y_{c,t}$
$R_{c,t}$	-0.017	-0.035	0.035	-0.040*	0.109	-0.313	0.664	-0.242	-0.959	1.846	-0.924
	(0.012)	(0.024)	(0.052)	(0.022)	(0.603)	(0.339)	(0.499)	(0.144)	(1.002)	(1.183)	(0.665)
$ICT_{c,t}$	-0.039	-0.044	-0.009	-0.055	-0.849	-0.116	-1.039	0.305	-0.291	-1.442	1.492
	(0.026)	(0.039)	(0.056)	(0.061)	(0.906)	(0.581)	(0.711)	(0.217)	(1.427)	(1.538)	(0.904)
$R*ICT_{c,t}$	0.012	0.012	-0.001	0.040	0.157	-0.242	0.439	-0.040	-0.514	0.836	-0.252
	(0.012)	(0.017)	(0.032)	(0.029)	(0.507)	(0.316)	(0.470)	(0.105)	(0.841)	(1.020)	(0.549)
$wL_{c,t}$	0.504***	0.083	0.999**	0.467**	-0.541***	-0.018	0.232	-0.755***	0.320	1.467**	-1.774***
	(0.113)	(0.201)	(0.344)	(0.206)	(0.174)	(0.125)	(0.175)	(0.059)	(0.422)	(0.542)	(0.225)
$rK_{c,t}$	0.062	0.059	0.215	-0.137	-0.639***	-0.035	0.170	-0.774***	0.439	1.300***	-1.743***
	(0.088)	(0.133)	(0.199)	(0.107)	(0.169)	(0.090)	(0.159)	(0.060)	(0.303)	(0.400)	(0.243)
$pQ_{c,t}$	0.205	0.652*	-0.529	0.440							
	(0.184)	(0.310)	(0.472)	(0.256)							
$GDPgrowth_{c,t}$	-0.002	-0.004	0.005	-0.002	-0.054*	-0.046	0.005	-0.013	-0.135	0.130	0.014
	(0.001)	(0.003)	(0.004)	(0.003)	(0.027)	(0.030)	(0.028)	(0.008)	(0.092)	(0.089)	(0.027)
$Services_{c,t}$	-0.009	0.017***	-0.017	-0.018	-0.061	0.075	-0.166	0.030	0.337	-0.496	0.139
	(0.006)	(0.005)	(0.011)	(0.011)	(0.104)	(0.070)	(0.128)	(0.030)	(0.253)	(0.350)	(0.146)
$HHI_{c,t}$	-1.603*	1.883*	-2.855	-2.940*	-25.520	11.880	-46.480*	9.081	52.987	-120.853	60.639
	(0.759)	(0.892)	(2.068)	(1.455)	(19.482)	(11.633)	(26.239)	(6.067)	(50.566)	(76.131)	(37.107)
$Debt^{\%GDP}_{c,t}$	0.001	-0.002**	0.003	0.001	0.056***	-0.013	0.046**	0.022**	-0.091**	0.091*	0.003
	(0.001)	(0.001)	(0.002)	(0.001)	(0.012)	(0.009)	(0.016)	(0.008)	(0.038)	(0.046)	(0.020)
$Interest^{\%GDP}_{c,t}$	0.007	0.032***	-0.027	0.011	-0.758***	0.054	-0.502**	-0.310**	0.962**	-0.871*	-0.180
	(0.009)	(0.009)	(0.029)	(0.021)	(0.208)	(0.138)	(0.187)	(0.116)	(0.420)	(0.451)	(0.335)
$Lending^{\%GDP}_{c,t}$	0.005**	-0.000	0.009**	0.005	0.133**	0.003	0.114**	0.016	-0.100**	0.205***	-0.103**
	(0.002)	(0.002)	(0.003)	(0.004)	(0.054)	(0.015)	(0.038)	(0.010)	(0.037)	(0.060)	(0.044)
$GovInv^{\%GDP}_{c,t}$	0.006	0.024*	0.005	-0.003	-0.052	0.032	-0.032	-0.052	0.283	-0.273	-0.068
	(0.007)	(0.012)	(0.016)	(0.013)	(0.198)	(0.097)	(0.178)	(0.044)	(0.238)	(0.365)	(0.228)
$XRate_{c,t}$	0.002	-0.005	0.018***	-0.007	0.134	0.018	0.123**	-0.007	-0.149	0.305*	-0.148*
	(0.003)	(0.004)	(0.005)	(0.005)	(0.083)	(0.066)	(0.056)	(0.015)	(0.159)	(0.153)	(0.075)
$CTR_{c,t}$	0.001	0.005**	0.003	-0.004*	0.074	0.055**	0.014	0.005	0.100	-0.031	-0.066
	(0.002)	(0.002)	(0.004)	(0.002)	(0.055)	(0.023)	(0.044)	(0.015)	(0.062)	(0.093)	(0.059)
R^2	0.999	0.999	.999	.999	.979	.991	.983	.978	.988	.982	.972
N	266	266	266	266	266	266	266	266	266	266	266

Notes: $*\, p < 0.05$, $**\, p < 0.01$, $***\, p < 0.001$. Regression results to establish the link between tax aggregation and economic production for 19 European countries during the period 2003-2016. All regressions use country level data and include: GDP growth ($GDPgrowth_{c,t}$), share of gross output produced in service industries ($Services_{c,t}$); the Herfindahl-Hirschman Index computed based on the gross-output shares of macro-sectors ($HHI_{c,t}$); government consolidated gross debt as % of GDP ($Debt^{\%GDP}_{c,t}$); government interest payable as % of GDP ($Interest^{\%GDP}_{c,t}$); net government lending/borrowing as % of GDP ($Lending^{\%GDP}_{c,t}$); gross fixed capital formation as % of GDP ($GovInv^{\%GDP}_{c,t}$); period average exchange rate ($XRate_{c,t}$); corporate tax rate ($CTR_{c,t}$); and country (c) and year (t) fixed effects. For the first block, $wL_{c,t}$, $rK_{c,t}$ and $pQ_{c,t}$ are expressed as the natural logarithm (ln) while for the last two blocks they are expressed as % of GDP.

Table SI.26: Taxation and the structure of economic production for the period 2003-2007

	Taxes in ln of nat. currency				Taxes as % of GDP				Taxes as % of total tax		
	ln $T_{c,t}$	ln $T^l_{c,t}$	ln $T^k_{c,t}$	ln$T^y_{c,t}$	$T_{c,t}$	$T^l_{c,t}$	$T^k_{c,t}$	$T^y_{c,t}$	$T^l_{c,t}$	$T^k_{c,t}$	$T^y_{c,t}$
$R_{c,t}$	-0.053	-0.061	0.001	0.039	0.241	-0.112	-0.449	0.802	-0.529	-1.326	1.911
	(0.030)	(0.036)	(0.056)	(0.059)	(1.198)	(0.886)	(0.562)	(0.581)	(1.709)	(0.990)	(1.333)
$ICT_{c,t}$	-0.073	-0.102*	-0.148	-0.129	-1.664	1.558	-2.081	-1.141	5.689	-3.419	-2.078
	(0.071)	(0.046)	(0.173)	(0.109)	(1.624)	(0.862)	(2.196)	(0.679)	(3.694)	(4.545)	(2.254)
$R * ICT_{c,t}$	-0.032	-0.019	-0.053	0.031	-1.479	-0.833**	-0.806	0.159	-1.003	-0.881	1.911*
	(0.021)	(0.011)	(0.067)	(0.034)	(0.925)	(0.274)	(0.973)	(0.229)	(1.247)	(1.603)	(0.727)
$wL_{c,t}$	0.501*	0.559**	0.022	0.869***	-0.509*	-0.082	0.122	-0.548***	0.373	0.739**	-1.197***
	(0.193)	(0.129)	(0.413)	(0.168)	(0.226)	(0.087)	(0.156)	(0.068)	(0.195)	(0.255)	(0.218)
$rK_{c,t}$	0.149	-0.183	0.395*	0.196	-0.473	-0.114	0.232	-0.591***	0.327	0.955**	-1.320***
	(0.106)	(0.131)	(0.161)	(0.135)	(0.229)	(0.085)	(0.154)	(0.050)	(0.172)	(0.224)	(0.190)
$pQ_{c,t}$	0.233	0.254	0.732	-0.089							
	(0.275)	(0.248)	(0.556)	(0.305)							
$GDPgrowth_{c,t}$	-0.003	-0.001	-0.013*	0.005	-0.229***	-0.077**	-0.138*	-0.014	-0.005	-0.221	0.200*
	(0.002)	(0.002)	(0.005)	(0.006)	(0.048)	(0.020)	(0.055)	(0.026)	(0.073)	(0.128)	(0.093)
$Services_{c,t}$	0.007	-0.002	0.005	0.014	0.192	-0.048	0.141	0.099	-0.150	0.031	0.097
	(0.007)	(0.008)	(0.013)	(0.009)	(0.265)	(0.109)	(0.126)	(0.083)	(0.193)	(0.189)	(0.107)
$HHI_{c,t}$	-1.525	-2.531*	-1.455	-0.672	-37.785	-29.406	-10.359	1.980	-57.172	-4.554	48.919*
	(1.220)	(1.087)	(2.014)	(1.712)	(43.344)	(15.599)	(24.832)	(11.571)	(26.997)	(38.101)	(22.124)
$Debt^{\%GDP}_{c,t}$	-0.002	-0.003*	-0.001	0.001	-0.096	-0.037	-0.038	-0.022	-0.043	0.017	0.020
	(0.001)	(0.001)	(0.003)	(0.002)	(0.051)	(0.023)	(0.040)	(0.015)	(0.039)	(0.077)	(0.049)
$Interest^{\%GDP}_{c,t}$	0.028**	0.062***	0.036	-0.049	1.507**	0.801***	0.675	0.031	1.075	0.367	-1.302
	(0.008)	(0.013)	(0.038)	(0.027)	(0.461)	(0.171)	(0.453)	(0.220)	(0.577)	(0.849)	(0.626)
$Lending^{\%GDP}_{c,t}$	0.015**	-0.001	0.024**	0.014*	0.391*	-0.026	0.377**	0.040	-0.352**	0.599**	-0.263
	(0.004)	(0.003)	(0.006)	(0.006)	(0.149)	(0.037)	(0.126)	(0.033)	(0.120)	(0.175)	(0.136)
$GovInv^{\%GDP}_{c,t}$	0.012	0.009	0.020	-0.007	0.346	-0.137	0.455	0.028	-0.616	0.829*	-0.253
	(0.012)	(0.012)	(0.018)	(0.018)	(0.280)	(0.110)	(0.226)	(0.094)	(0.415)	(0.362)	(0.265)
$XRate_{c,t}$	-0.010	-0.024**	0.003	-0.011	-0.146	0.052	-0.105	-0.093	0.207	-0.039	-0.124
	(0.008)	(0.007)	(0.015)	(0.013)	(0.156)	(0.115)	(0.188)	(0.073)	(0.396)	(0.394)	(0.212)
$CTR_{c,t}$	0.002	-0.001	0.006	0.000	0.120*	0.018	0.078	0.024*	-0.043	0.095	-0.043
	(0.002)	(0.001)	(0.004)	(0.002)	(0.055)	(0.020)	(0.045)	(0.011)	(0.072)	(0.083)	(0.040)
R^2	0.999	0.999	0.999	0.999	.995	.998	.996	.992	.998	.996	.994
N	95	95	95	95	95	95	95	95	95	95	95

Notes: $* p < 0.05$, $** p < 0.01$, $*** p < 0.001$. Regression results to establish the link between tax aggregation and economic production for 19 European countries during the period 2003-2007. All regressions use country level data and include: GDP growth ($GDPgrowth_{c,t}$), share of gross output produced in service industries ($Services_{c,t}$); the Herfindahl-Hirschman Index computed based on the gross-output shares of macro-sectors ($HHI_{c,t}$); government consolidated gross debt as % of GDP ($Debt^{\%GDP}_{c,t}$); government interest payable as % of GDP ($Interest^{\%GDP}_{c,t}$); net government lending/borrowing as % of GDP ($Lending^{\%GDP}_{c,t}$); gross fixed capital formation as % of GDP ($GovInv^{\%GDP}_{c,t}$); period average exchange rate ($XRate_{c,t}$); corporate tax rate ($CTR_{c,t}$); and country (c) and year (t) fixed effects. For the first block, $wL_{c,t}$, $rK_{c,t}$ and $pQ_{c,t}$ are expressed as the natural logarithm (ln) while for the last two blocks they are expressed as % of GDP.

Table SI.27: Taxation and the structure of economic production after 2008

	Taxes in ln of nat. currency				Taxes as % of GDP				Taxes as % of total tax		
	ln $T_{c,t}$	ln $T^l_{c,t}$	ln $T^k_{c,t}$	ln$T^y_{c,t}$	$T_{c,t}$	$T^l_{c,t}$	$T^k_{c,t}$	$T^y_{c,t}$	$T^l_{c,t}$	$T^k_{c,t}$	$T^y_{c,t}$
$R_{c,t}$	-0.018	0.010	0.002	-0.057	-0.160	0.136	-0.001	-0.295	0.538	0.206	-0.763
	(0.021)	(0.033)	(0.057)	(0.035)	(0.665)	(0.487)	(0.530)	(0.246)	(0.979)	(1.001)	(0.814)
$ICT_{c,t}$	0.016	-0.009	0.010	0.027	0.374	-0.094	0.187	0.280*	-1.290	0.579	0.696
	(0.029)	(0.049)	(0.032)	(0.056)	(0.385)	(0.559)	(0.417)	(0.142)	(1.127)	(0.871)	(0.570)
$R * ICT_{c,t}$	-0.012	0.008	0.006	-0.036	0.161	-0.049	0.263	-0.053	0.349	-0.107	-0.251
	(0.021)	(0.038)	(0.035)	(0.033)	(0.565)	(0.364)	(0.610)	(0.094)	(0.658)	(0.793)	(0.456)
$wL_{c,t}$	0.422***	0.358*	0.588*	0.372***	-0.632**	0.046	0.103	-0.782***	0.710*	1.109*	-1.806***
	(0.076)	(0.179)	(0.279)	(0.097)	(0.219)	(0.072)	(0.245)	(0.088)	(0.342)	(0.578)	(0.349)
$rK_{c,t}$	0.015	0.233*	0.140	-0.241**	-0.719***	0.013	0.058	-0.789***	0.722**	1.012**	-1.728***
	(0.057)	(0.117)	(0.126)	(0.075)	(0.164)	(0.036)	(0.184)	(0.089)	(0.253)	(0.413)	(0.309)
$pQ_{c,t}$	0.232*	0.128	0.277	0.244*							
	(0.121)	(0.341)	(0.329)	(0.125)							
$GDPgrowth_{c,t}$	0.001	-0.003	0.001	0.004*	-0.065	-0.043	-0.014	-0.008	-0.080	0.053	0.024
	(0.001)	(0.003)	(0.004)	(0.002)	(0.054)	(0.028)	(0.029)	(0.006)	(0.060)	(0.077)	(0.050)
$Services_{c,t}$	-0.005	0.015***	-0.003	-0.020**	-0.019	0.064	-0.014	-0.069	0.238	-0.113	-0.163
	(0.004)	(0.003)	(0.009)	(0.008)	(0.137)	(0.039)	(0.135)	(0.048)	(0.179)	(0.256)	(0.172)
$HHI_{c,t}$	-1.604**	0.748	-2.381	-3.581**	-20.289	4.725	-22.330	-2.684	22.175	-45.780	17.390
	(0.576)	(0.850)	(1.618)	(1.309)	(13.480)	(9.234)	(13.544)	(8.849)	(25.596)	(41.651)	(32.746)
$Debt^{\%GDP}_{c,t}$	-0.001	-0.002*	0.002	-0.001	0.040**	-0.004	0.019	0.025***	-0.041	0.020	0.024
	(0.001)	(0.001)	(0.003)	(0.001)	(0.014)	(0.008)	(0.015)	(0.007)	(0.028)	(0.035)	(0.017)
$Interest^{\%GDP}_{c,t}$	0.019**	0.027	-0.018	0.040**	-0.298	0.080	-0.144	-0.234	0.564	-0.247	-0.319
	(0.006)	(0.024)	(0.035)	(0.013)	(0.253)	(0.110)	(0.185)	(0.137)	(0.384)	(0.497)	(0.345)
$Lending^{\%GDP}_{c,t}$	0.002	0.000	0.005*	0.001	0.042	-0.002	0.047	-0.003	-0.042	0.099*	-0.070
	(0.001)	(0.002)	(0.003)	(0.002)	(0.034)	(0.012)	(0.027)	(0.009)	(0.030)	(0.046)	(0.043)
$GovInv^{\%GDP}_{c,t}$	0.002	0.021	-0.009	-0.004	0.049	0.089	0.041	-0.081	0.380	-0.127	-0.249
	(0.005)	(0.013)	(0.015)	(0.009)	(0.205)	(0.090)	(0.158)	(0.052)	(0.229)	(0.258)	(0.254)
$XRate_{c,t}$	0.007	-0.006	0.010	0.020**	-0.043	-0.060	0.015	0.002	-0.236	0.248	-0.021
	(0.006)	(0.014)	(0.011)	(0.008)	(0.200)	(0.111)	(0.215)	(0.045)	(0.232)	(0.309)	(0.181)
$CTR_{c,t}$	0.004**	0.004	0.012*	-0.001	0.231**	0.061	0.123*	0.047**	-0.037	0.146	-0.086
	(0.002)	(0.007)	(0.006)	(0.002)	(0.079)	(0.039)	(0.059)	(0.019)	(0.098)	(0.118)	(0.065)
R^2	0.999	0.999	.999	0.999	.988	.995	.989	.985	.992	.989	.983
N	171	171	171	171	171	171	171	171	171	171	171

Notes: $* \, p < 0.05$, $** \, p < 0.01$, $*** \, p < 0.001$. Regression results to establish the link between tax aggregation and economic production for 19 European countries during the period 2008-2016. All regressions use country level data and include: GDP growth ($GDPgrowth_{c,t}$), share of gross output produced in service industries ($Services_{c,t}$); the Herfindahl-Hirschman Index computed based on the gross-output shares of macro-sectors ($HHI_{c,t}$); government consolidated gross debt as % of GDP ($Debt^{\%GDP}_{c,t}$); government interest payable as % of GDP ($Interest^{\%GDP}_{c,t}$); net government lending/borrowing as % of GDP ($Lending^{\%GDP}_{c,t}$); gross fixed capital formation as % of GDP ($GovInv^{\%GDP}_{c,t}$); period average exchange rate ($XRate_{c,t}$); corporate tax rate ($CTR_{c,t}$); and country (c) and year (t) fixed effects. For the first block, $wL_{c,t}$, $rK_{c,t}$ and $pQ_{c,t}$ are expressed as the natural logarithm (ln) while for the last two blocks they are expressed as % of GDP.

SI.2.1.3. The reinstatement effect

Table SI.28: The reinstatement effect

	ln $w_{c,t}$	ln $L_{c,t}$	ln $r_{c,t}$	ln $K_{c,t}$	$HHI_{c,t}$	$Services_{c,t}$	$Gini^L_{c,t}$	$Gini^w_{c,t}$
Panel A: full period 2003-2016								
$R_{c,t}$	-0.091*	0.014	-0.105**	-0.005	0.009**	-1.151***	0.018*	0.037**
	(0.043)	(0.019)	(0.039)	(0.023)	(0.003)	(0.342)	(0.009)	(0.016)
$ICT_{c,t}$	-0.036	0.003	-0.047	0.091	-0.018***	4.974***	0.014	0.057*
	(0.072)	(0.043)	(0.075)	(0.069)	(0.005)	(0.962)	(0.017)	(0.027)
$R * ICT_{c,t}$	-0.007	-0.001	0.006	-0.048	0.008**	-1.697***	-0.005	-0.021
	(0.036)	(0.019)	(0.039)	(0.037)	(0.003)	(0.474)	(0.008)	(0.013)
R^2	.998	.999	.846	.999	.951	.982	.836	.781
N	266	266	266	266	266	266	266	266
Panel B: sub-period 2003-2007								
$R_{c,t}$	-0.275**	-0.123**	-0.222**	-0.091*	0.019	-4.158*	-0.013*	0.033
	(0.095)	(0.041)	(0.073)	(0.037)	(0.011)	(1.531)	(0.006)	(0.042)
$ICT_{c,t}$	-0.102	-0.071	-0.005	-0.139	-0.044**	8.827**	0.007	0.022
	(0.158)	(0.042)	(0.109)	(0.091)	(0.013)	(3.086)	(0.010)	(0.036)
$R * ICT_{c,t}$	-0.060	-0.005	-0.055	0.004	0.009	-1.477*	-0.002	-0.007
	(0.055)	(0.008)	(0.039)	(0.037)	(0.004)	(0.535)	(0.005)	(0.013)
R^2	.999	0.999	.939	0.999	.991	.995	.975	.958
N	95	95	95	95	95	95	95	95
Panel C: sub-period 2008-2016								
$R_{c,t}$	-0.033	0.034	-0.021	-0.007	0.012**	-1.730***	0.004	0.008*
	(0.028)	(0.021)	(0.025)	(0.024)	(0.004)	(0.505)	(0.006)	(0.004)
$ICT_{c,t}$	0.011	0.009	0.046	0.100*	-0.011**	2.052	-0.000	0.006
	(0.019)	(0.037)	(0.039)	(0.045)	(0.004)	(1.162)	(0.006)	(0.007)
$R * ICT_{c,t}$	-0.033**	-0.009	-0.047*	-0.036	0.005*	-0.407	-0.001	0.009
	(0.013)	(0.025)	(0.025)	(0.033)	(0.003)	(0.723)	(0.003)	(0.005)
R^2	.999	0.999	.85	0.999	.969	.988	.936	.948
N	171	171	171	171	171	171	171	171

Notes: $* \ p < 0.05$, $** \ p < 0.01$, $*** \ p < 0.001$. Regression results to test the reinstatement effect for 19 European countries during the period 2003-2016. All regressions include: GDP growth, government consolidated gross debt as % of GDP; government interest payable as % of GDP; net government lending/borrowing as % of GDP; gross fixed capital formation as % of GDP; period average exchange rate; value added TFP–calculated as the residual from an OLS regression of value-added volumes (VA) on a translog production function including capital volumes (K) and total number of hours worked (L); corporate tax rate; and country (c) and year (t) fixed effects.

SI.2.1.4. The real-income effect

Table SI.29: The real income effect

	ln $wL_{c,t}$	ln $rK_{c,t}$	ln $(wL + rK)_{c,t}$	ln $pQ_{c,t}$	ln $Q_{c,t}$	ln $p_{c,t}$	ln $LProd_{c,t}$	ln $TFP_{c,t}$
Panel A: full period 2003-2016								
$R_{c,t}$	-0.050	-0.065*	-0.062*	-0.044	0.083***	-0.074**	0.052	-0.001
	(0.038)	(0.032)	(0.030)	(0.033)	(0.026)	(0.029)	(0.031)	(0.009)
$ICT_{c,t}$	-0.025	0.031	-0.001	-0.020	0.007	-0.043	-0.008	0.006
	(0.102)	(0.051)	(0.080)	(0.091)	(0.057)	(0.051)	(0.039)	(0.019)
$R * ICT_{c,t}$	-0.009	-0.023	-0.018	-0.012	-0.013	0.018	-0.005	-0.001
	(0.048)	(0.031)	(0.041)	(0.046)	(0.031)	(0.029)	(0.025)	(0.005)
R^2	.999	.998	.999	.999	0.999	.884	.999	.953
N	266	266	266	266	210	210	210	210
Panel B: sub-period 2003-2007								
$R_{c,t}$	-0.482**	-0.238*	-0.393**	-0.328**	-0.122	-0.308**	0.007	-0.037
	(0.153)	(0.091)	(0.116)	(0.118)	(0.081)	(0.089)	(0.093)	(0.026)
$ICT_{c,t}$	-0.165	-0.152	-0.163	-0.146	-0.007	-0.054	0.009	-0.135*
	(0.181)	(0.155)	(0.164)	(0.168)	(0.081)	(0.111)	(0.132)	(0.051)
$R * ICT_{c,t}$	-0.031	-0.014	-0.017	-0.029	-0.021	-0.056	-0.025	0.018
	(0.059)	(0.055)	(0.056)	(0.052)	(0.046)	(0.039)	(0.053)	(0.016)
R^2	.999	0.999	0.999	0.999	0.999	.938	0.999	.985
N	95	95	95	95	75	75	75	75
Panel C: sub-period 2008-2016								
$R_{c,t}$	0.008	-0.031	-0.013	0.005	0.063**	-0.027*	0.019	-0.004
	(0.033)	(0.046)	(0.026)	(0.028)	(0.023)	(0.013)	(0.022)	(0.011)
$ICT_{c,t}$	0.048	0.128*	0.084*	0.070	0.043	0.023	0.023	0.020***
	(0.039)	(0.062)	(0.040)	(0.058)	(0.024)	(0.027)	(0.014)	(0.003)
$R * ICT_{c,t}$	-0.040	-0.065	-0.055	-0.056	-0.016	-0.029	-0.011	-0.002
	(0.035)	(0.038)	(0.031)	(0.039)	(0.024)	(0.017)	(0.012)	(0.009)
R^2	.999	.999	0.999	0.999	0.999	.891	0.999	.978
N	171	171	171	171	135	135	135	135

Notes: $* \ p < 0.05$, $** \ p < 0.01$, $*** \ p < 0.001$. Regression results to test the real income effect for 19 European countries during the period 2003-2016. Labor productivity is measured as the share of gross-output volumes (Q) over the total number of hours worked. TFP is calculated as the residual from an OLS regression of gross-output volumes (Q) on a translog production function including capital volumes (K), total number of hours worked (L) and intermediate input volumes (M). All regressions include: GDP growth, government consolidated gross debt as % of GDP; government interest payable as % of GDP; net government lending/borrowing as % of GDP; gross fixed capital formation as % of GDP; period average exchange rate; corporate tax rate; and country (c) and year (t) fixed effects.

SI.2.2. Controlling for changes in corporate taxation using Eurostat data

SI.2.2.1. Taxation and automation

Table SI.210: Taxation and automation

	Taxes in ln of nat. currency				Taxes as % of GDP				Taxes as % of total tax		
	$lnT_{c,t}$	$lnT^l_{c,t}$	$lnT^k_{c,t}$	$lnT^y_{c,t}$	$T_{c,t}$	$T^l_{c,t}$	$T^k_{c,t}$	$T^y_{c,t}$	$T^l_{c,t}$	$T^k_{c,t}$	$T^y_{c,t}$
Panel A: full period 2006-2016											
$R_{c,t}$	0.011	-0.018	0.061	-0.005	0.700	-0.116	0.669	0.147	-1.165	1.545	-0.383
	(0.009)	(0.029)	(0.067)	(0.020)	(0.495)	(0.344)	(0.531)	(0.254)	(1.108)	(1.574)	(0.875)
$ICT_{c,t}$	-0.036	-0.011	-0.038	-0.077	-1.706**	0.076	-0.600	-1.181	1.258	0.602	-2.054
	(0.025)	(0.032)	(0.045)	(0.063)	(0.665)	(0.477)	(0.647)	(0.668)	(1.194)	(1.964)	(1.459)
$R * ICT_{c,t}$	0.011	-0.003	0.028	0.036	0.637	-0.427	0.507	0.557	-1.463	0.316	1.149
	(0.014)	(0.010)	(0.041)	(0.038)	(0.467)	(0.296)	(0.578)	(0.389)	(0.866)	(1.303)	(0.987)
R^2	0.999	0.999	.999	.999	.979	.993	.985	.932	.988	.982	.955
N	209	209	209	209	209	209	209	209	209	209	209
Panel B: sub-period 2006-2007											
$R_{c,t}$	-0.157	0.136	-0.410	0.226	-0.824	-1.136	-3.342	3.654	-2.008	-8.762	10.468
	(0.056)	(0.095)	(0.168)	(0.255)	(1.140)	(1.027)	(2.295)	(1.734)	(2.783)	(5.745)	(5.076)
$ICT_{c,t}$	-1.772	-1.600	-1.380	-2.587	-31.601	-9.570	-2.047	-19.984	-1.939	26.188	-29.429
	(0.341)	(0.443)	(1.079)	(1.343)	(12.556)	(6.256)	(15.185)	(12.986)	(19.822)	(35.241)	(37.088)
$R * ICT_{c,t}$	0.256	0.356	0.057	0.505	3.067	1.690	-2.740	4.116	2.727	-9.776	7.925
	(0.071)	(0.082)	(0.238)	(0.259)	(2.150)	(1.289)	(3.211)	(2.503)	(3.800)	(7.878)	(7.441)
R^2	0.999	0.999	0.999	0.999	0.999	0.999	.999	.995	0.999	.999	.996
N	38	38	38	38	38	38	38	38	38	38	38
Panel C: sub-period 2008-2016											
$R_{c,t}$	0.006	0.013	0.033	-0.023	0.582	0.314	0.309	-0.041	0.284	0.496	-0.757
	(0.017)	(0.020)	(0.052)	(0.027)	(0.647)	(0.332)	(0.429)	(0.335)	(0.779)	(1.125)	(0.859)
$ICT_{c,t}$	-0.015	-0.005	-0.012	-0.041	-0.911	-0.182	0.158	-0.887	-0.221	1.760	-1.575
	(0.030)	(0.048)	(0.032)	(0.062)	(0.682)	(0.476)	(0.370)	(0.611)	(0.921)	(1.127)	(1.105)
$R * ICT_{c,t}$	0.000	0.009	0.016	-0.013	0.336	-0.046	0.294	0.088	0.144	-0.206	0.013
	(0.021)	(0.026)	(0.039)	(0.035)	(0.757)	(0.317)	(0.593)	(0.370)	(0.542)	(0.759)	(0.599)
R^2	0.999	0.999	.999	0.999	.985	.994	.99	.95	.991	.988	.968
N	171	171	171	171	171	171	171	171	171	171	171

Notes: $* \ p < 0.05$, $** \ p < 0.01$, $*** \ p < 0.001$. Regression results of aggregate flows of tax revenues on different automation measures for 19 European countries during the period 2006-2016. All regressions use country level data and include: GDP growth, gross output share of the service sector in total economy; Herfindahl-Hirschman Index computed based on the gross-output shares of macro-sectors; government consolidated gross debt as % of GDP; government interest payable as % of GDP; net government lending/borrowing as % of GDP; gross fixed capital formation as % of GDP; period average exchange rate; effective tax rate; and country (c) and year (t) fixed effects. All regressions in Panel A also include the ln of gross-output value (pQ).

SI.2.2.2. Taxation and economic production

Table SI.211: Taxation and the structure of economic production for the period 2006-2016

	Taxes in ln of nat. currency				Taxes as % of GDP				Taxes as % of total tax		
	ln $T_{c,t}$	ln $T^l_{c,t}$	ln $T^k_{c,t}$	ln$T^y_{c,t}$	$T_{c,t}$	$T^l_{c,t}$	$T^k_{c,t}$	$T^y_{c,t}$	$T^l_{c,t}$	$T^k_{c,t}$	$T^y_{c,t}$
$R_{c,t}$	-0.006	-0.013	0.032	-0.036	0.247	-0.159	0.540	-0.135	-0.729	1.527	-0.818
	(0.009)	(0.025)	(0.051)	(0.023)	(0.548)	(0.336)	(0.483)	(0.170)	(1.020)	(1.138)	(0.603)
$ICT_{c,t}$	-0.003	-0.020	0.018	-0.022	-0.322	0.146	-0.635	0.168**	0.078	-0.991	0.722
	(0.025)	(0.025)	(0.043)	(0.064)	(0.628)	(0.509)	(0.740)	(0.057)	(1.394)	(1.523)	(0.500)
$R*ICT_{c,t}$	-0.003	-0.002	0.001	0.017	0.098	-0.449	0.559	-0.012	-1.016	1.082	-0.060
	(0.014)	(0.009)	(0.034)	(0.039)	(0.487)	(0.300)	(0.604)	(0.067)	(0.964)	(1.140)	(0.416)
$wL_{c,t}$	0.386***	0.131	0.826**	0.298	-0.546***	0.008	0.265	-0.818***	0.377	1.595***	-1.945***
	(0.095)	(0.206)	(0.342)	(0.194)	(0.155)	(0.106)	(0.157)	(0.051)	(0.417)	(0.477)	(0.156)
$rK_{c,t}$	-0.006	0.159	0.103	-0.247**	-0.646***	-0.010	0.174	-0.810***	0.496	1.352***	-1.830***
	(0.079)	(0.134)	(0.132)	(0.101)	(0.153)	(0.062)	(0.148)	(0.061)	(0.303)	(0.350)	(0.182)
$pQ_{c,t}$	0.265	0.528	-0.237	0.401							
	(0.157)	(0.352)	(0.446)	(0.274)							
$GDPgrowth_{c,t}$	-0.000	-0.005	0.005	0.001	-0.072	-0.060	0.003	-0.015*	-0.158	0.142	0.016
	(0.002)	(0.004)	(0.005)	(0.003)	(0.043)	(0.034)	(0.029)	(0.007)	(0.098)	(0.093)	(0.040)
$Services_{c,t}$	-0.011**	0.019***	-0.019	-0.023**	-0.104	0.103	-0.234*	0.027	0.456	-0.640*	0.174
	(0.004)	(0.006)	(0.012)	(0.009)	(0.133)	(0.076)	(0.124)	(0.045)	(0.266)	(0.320)	(0.155)
$HHI_{c,t}$	-2.244***	1.716*	-3.764*	-3.828**	-31.582	15.468	-54.769**	7.719	68.551	-135.375*	63.282*
	(0.524)	(0.856)	(1.982)	(1.354)	(21.053)	(12.587)	(21.255)	(8.382)	(50.792)	(64.781)	(31.537)
$Debt^{\%GDP}_{c,t}$	-0.001	-0.002	0.002	-0.001	0.049***	-0.011	0.034**	0.026***	-0.075*	0.058	0.019
	(0.001)	(0.001)	(0.002)	(0.001)	(0.013)	(0.009)	(0.015)	(0.008)	(0.038)	(0.040)	(0.015)
$Interest^{\%GDP}_{c,t}$	0.017**	0.019*	-0.014	0.036**	-0.648**	-0.001	-0.243	-0.405**	0.646***	-0.230	-0.492
	(0.007)	(0.009)	(0.030)	(0.015)	(0.237)	(0.098)	(0.155)	(0.139)	(0.198)	(0.340)	(0.358)
$Lending^{\%GDP}_{c,t}$	0.004**	0.000	0.007**	0.003	0.110**	0.010	0.084**	0.016	-0.059	0.142**	-0.081*
	(0.002)	(0.001)	(0.003)	(0.003)	(0.045)	(0.012)	(0.035)	(0.010)	(0.044)	(0.051)	(0.041)
$GovInv^{\%GDP}_{c,t}$	0.002	0.024	-0.002	-0.007	0.030	0.122	-0.003	-0.088*	0.463*	-0.258	-0.207
	(0.006)	(0.013)	(0.019)	(0.011)	(0.248)	(0.082)	(0.190)	(0.048)	(0.247)	(0.350)	(0.240)
$XRate_{c,t}$	0.005	0.002	0.014*	-0.000	0.100	0.093	0.027	-0.020	0.137	0.055	-0.188*
	(0.004)	(0.003)	(0.006)	(0.010)	(0.126)	(0.078)	(0.141)	(0.026)	(0.224)	(0.253)	(0.100)
$ETR_{c,t}$	0.003*	0.003	0.012**	-0.003	0.136	0.036	0.120*	-0.020	-0.035	0.214**	-0.198**
	(0.002)	(0.002)	(0.005)	(0.002)	(0.076)	(0.023)	(0.055)	(0.019)	(0.045)	(0.094)	(0.082)
R^2	0.999	0.999	.999	0.999	.982	.993	.985	.982	.989	.985	.979
N	209	209	209	209	209	209	209	209	209	209	209

Notes: $*\,p < 0.05$, $**\,p < 0.01$, $***\,p < 0.001$. Regression results to establish the link between tax aggregation and economic production for 19 European countries during the period 2006-2016. All regressions use country level data and include: GDP growth ($GDPgrowth_{c,t}$), share of gross output produced in service industries ($Services_{c,t}$); the Herfindahl-Hirschman Index computed based on the gross-output shares of macro-sectors ($HHI_{c,t}$); government consolidated gross debt as % of GDP ($Debt^{\%GDP}_{c,t}$); government interest payable as % of GDP ($Interest^{\%GDP}_{c,t}$); net government lending/borrowing as % of GDP ($Lending^{\%GDP}_{c,t}$); gross fixed capital formation as % of GDP ($GovInv^{\%GDP}_{c,t}$); period average exchange rate ($XRate_{c,t}$); effective tax rate ($ETR_{c,t}$); and country (c) and year (t) fixed effects. For the first block, $wL_{c,t}$, $rK_{c,t}$ and $pQ_{c,t}$ are expressed as the natural logarithm (ln) while for the last two blocks they are expressed as % of GDP.

Table SI.212: Taxation and the structure of economic production for the period 2006-2007

	Taxes in ln of nat. currency				Taxes as % of GDP				Taxes as % of total tax		
	ln $T_{c,t}$	ln $T^l_{c,t}$	ln $T^k_{c,t}$	ln$T^y_{c,t}$	$T_{c,t}$	$T^l_{c,t}$	$T^k_{c,t}$	$T^y_{c,t}$	$T^l_{c,t}$	$T^k_{c,t}$	$T^y_{c,t}$
$R_{c,t}$	-0.130	0.091	-0.212	0.241	-0.653	-0.652	-1.990	1.988	-0.882	-4.258	4.623
	(0.077)	(0.087)	(0.190)	(0.341)	(1.362)	(0.868)	(1.728)	(0.421)	(2.690)	(3.608)	(2.115)
$ICT_{c,t}$	-1.777	-1.453	-1.905	-2.026	-32.988	-13.633	-19.156	-0.199	-11.824	-28.743	37.544
	(0.374)	(0.627)	(1.281)	(1.668)	(15.777)	(5.174)	(18.371)	(3.157)	(18.784)	(36.950)	(21.266)
$R * ICT_{c,t}$	0.242	0.369	-0.011	0.461	3.152	1.988	0.597	0.567	3.611	0.448	-3.467
	(0.068)	(0.097)	(0.225)	(0.283)	(2.760)	(1.092)	(3.229)	(0.682)	(3.582)	(6.787)	(4.054)
$wL_{c,t}$	0.257	-0.548	2.317	-0.332	-0.002	0.011	0.784	-0.797**	0.084	2.344	-2.479*
	(0.159)	(0.410)	(0.976)	(1.187)	(0.187)	(0.117)	(0.210)	(0.055)	(0.339)	(0.507)	(0.338)
$rK_{c,t}$	0.058	-0.058	0.291	0.189	-0.048	-0.110	0.823	-0.761**	-0.170	2.341	-2.190
	(0.126)	(0.198)	(0.424)	(0.633)	(0.211)	(0.122)	(0.230)	(0.058)	(0.342)	(0.502)	(0.357)
$pQ_{c,t}$	0.683	2.303	-2.801	1.531							
	(0.279)	(0.667)	(1.689)	(2.142)							
$GDPgrowth_{c,t}$	0.001	0.002	0.001	0.004	-0.059	0.031	-0.086	-0.004	0.153	-0.164	-0.019
	(0.002)	(0.004)	(0.008)	(0.011)	(0.088)	(0.049)	(0.098)	(0.023)	(0.141)	(0.205)	(0.131)
$Services_{c,t}$	0.009	0.024	-0.002	0.008	0.535	0.247	0.099	0.189	0.160	-0.373	0.272
	(0.006)	(0.006)	(0.014)	(0.019)	(0.128)	(0.081)	(0.149)	(0.049)	(0.222)	(0.335)	(0.242)
$HHI_{c,t}$	3.890	11.662	-5.720	5.183	157.071	50.836	37.749	68.485*	-3.095	-115.108	151.384
	(0.876)	(3.166)	(6.610)	(7.433)	(42.720)	(32.530)	(41.817)	(10.407)	(88.895)	(119.139)	(70.229)
$Debt^{\%GDP}_{c,t}$	0.003	-0.009	0.012	0.003	0.004	-0.085	0.122	-0.033	-0.195	0.298	-0.109
	(0.002)	(0.002)	(0.005)	(0.008)	(0.092)	(0.028)	(0.090)	(0.016)	(0.068)	(0.175)	(0.131)
$Interest^{\%GDP}_{c,t}$	0.064	0.326*	-0.227	0.101	2.715	1.799	-0.248	1.163	2.579	-3.566	1.624
	(0.035)	(0.043)	(0.110)	(0.171)	(0.642)	(0.707)	(0.810)	(0.204)	(2.071)	(2.308)	(0.957)
$Lending^{\%GDP}_{c,t}$	0.007	-0.042	0.062	-0.017	0.153	-0.125	0.487	-0.208	-0.490	1.208	-0.752
	(0.007)	(0.009)	(0.019)	(0.031)	(0.189)	(0.087)	(0.212)	(0.047)	(0.259)	(0.441)	(0.287)
$GovInv^{\%GDP}_{c,t}$	0.040	0.033	0.036	0.022	1.160	0.127	0.648	0.385	-0.685	0.061	0.928
	(0.007)	(0.022)	(0.045)	(0.053)	(0.369)	(0.236)	(0.352)	(0.083)	(0.628)	(0.885)	(0.581)
$XRate_{c,t}$	-0.184	-0.139	-0.214	-0.174	-3.514	-1.482	-2.058	0.025	-1.215	-2.795	3.640
	(0.038)	(0.063)	(0.123)	(0.169)	(1.538)	(0.512)	(1.766)	(0.282)	(1.832)	(3.512)	(1.986)
$ETR_{c,t}$	-0.020	-0.001	-0.036	-0.012	-0.368	-0.023	-0.400	0.055	0.208	-0.721	0.495
	(0.003)	(0.006)	(0.013)	(0.017)	(0.134)	(0.057)	(0.139)	(0.024)	(0.163)	(0.273)	(0.175)
R^2	0.999	0.999	0.999	0.999	0.999	0.999	0.999	0.999	0.999	0.999	.999
N	38	38	38	38	38	38	38	38	38	38	38

Notes: $* \, p < 0.05$, $** \, p < 0.01$, $*** \, p < 0.001$. Regression results to establish the link between tax aggregation and economic production for 19 European countries during the period 2006-2007. All regressions use country level data and include: GDP growth ($GDPgrowth_{c,t}$), share of gross output produced in service industries ($Services_{c,t}$); the Herfindahl-Hirschman Index computed based on the gross-output shares of macro-sectors ($HHI_{c,t}$); government consolidated gross debt as % of GDP ($Debt^{\%GDP}_{c,t}$); government interest payable as % of GDP ($Interest^{\%GDP}_{c,t}$); net government lending/borrowing as % of GDP ($Lending^{\%GDP}_{c,t}$); gross fixed capital formation as % of GDP ($GovInv^{\%GDP}_{c,t}$); period average exchange rate ($XRate_{c,t}$); effective tax rate ($ETR_{c,t}$); and country (c) and year (t) fixed effects. For the first block, $wL_{c,t}$, $rK_{c,t}$ and $pQ_{c,t}$ are expressed as the natural logarithm (ln) while for the last two blocks they are expressed as % of GDP.

Table SI.213: Taxation and the structure of economic production after 2008

	Taxes in ln of nat. currency				Taxes as % of GDP				Taxes as % of total tax		
	ln $T_{c,t}$	ln $T^l_{c,t}$	ln $T^k_{c,t}$	ln$T^y_{c,t}$	$T_{c,t}$	$T^l_{c,t}$	$T^k_{c,t}$	$T^y_{c,t}$	$T^l_{c,t}$	$T^k_{c,t}$	$T^y_{c,t}$
$R_{c,t}$	-0.010	0.017	0.022	-0.059	0.281	0.251	0.253	-0.223	0.461	0.526	-0.976
	(0.022)	(0.024)	(0.051)	(0.033)	(0.618)	(0.459)	(0.432)	(0.236)	(0.915)	(0.812)	(0.655)
$ICT_{c,t}$	0.018	-0.007	0.016	0.026	0.305	-0.112	0.157	0.260***	-1.280	0.550	0.705
	(0.032)	(0.052)	(0.035)	(0.057)	(0.478)	(0.584)	(0.473)	(0.056)	(1.107)	(0.878)	(0.527)
$R*ICT_{c,t}$	-0.014	0.005	0.001	-0.037	0.075	-0.075	0.276	-0.126	0.345	-0.030	-0.369
	(0.022)	(0.034)	(0.037)	(0.033)	(0.623)	(0.363)	(0.628)	(0.093)	(0.605)	(0.772)	(0.450)
$wL_{c,t}$	0.405***	0.340	0.544*	0.374***	-0.650***	0.041	0.096	-0.788***	0.712*	1.104*	-1.807***
	(0.069)	(0.188)	(0.265)	(0.097)	(0.182)	(0.076)	(0.222)	(0.085)	(0.339)	(0.558)	(0.337)
$rK_{c,t}$	0.022	0.239*	0.158	-0.243**	-0.704***	0.016	0.070	-0.790***	0.718**	1.030**	-1.743***
	(0.055)	(0.118)	(0.114)	(0.073)	(0.143)	(0.037)	(0.169)	(0.088)	(0.249)	(0.391)	(0.297)
$pQ_{c,t}$	0.213*	0.107	0.228	0.245*							
	(0.104)	(0.345)	(0.278)	(0.130)							
$GDPgrowth_{c,t}$	0.001	-0.003	0.001	0.004**	-0.076	-0.046	-0.018	-0.012	-0.078	0.051	0.023
	(0.001)	(0.004)	(0.004)	(0.002)	(0.058)	(0.030)	(0.032)	(0.008)	(0.063)	(0.086)	(0.051)
$Services_{c,t}$	-0.003	0.017***	0.000	-0.020**	0.093	0.096	0.013	-0.015	0.231	-0.115	-0.121
	(0.004)	(0.004)	(0.010)	(0.008)	(0.128)	(0.054)	(0.121)	(0.042)	(0.209)	(0.255)	(0.147)
$HHI_{c,t}$	-1.495**	0.959	-2.165	-3.485**	-9.118	8.083	-23.212*	6.010	22.479	-53.927	30.678
	(0.581)	(1.071)	(1.885)	(1.305)	(14.731)	(11.543)	(12.337)	(8.701)	(29.795)	(43.342)	(34.744)
$Debt^{\%GDP}_{c,t}$	-0.001	-0.002*	0.001	-0.001	0.041**	-0.004	0.019	0.026***	-0.041	0.018	0.026*
	(0.001)	(0.001)	(0.003)	(0.001)	(0.014)	(0.010)	(0.013)	(0.008)	(0.028)	(0.032)	(0.014)
$Interest^{\%GDP}_{c,t}$	0.017**	0.024	-0.022	0.040***	-0.550*	0.010	-0.213	-0.346**	0.585*	-0.262	-0.390
	(0.006)	(0.018)	(0.034)	(0.011)	(0.287)	(0.107)	(0.162)	(0.141)	(0.269)	(0.401)	(0.353)
$Lending^{\%GDP}_{c,t}$	0.003*	0.001	0.006*	0.001	0.073*	0.006	0.059*	0.008	-0.045	0.107**	-0.068
	(0.001)	(0.002)	(0.003)	(0.002)	(0.036)	(0.011)	(0.028)	(0.013)	(0.028)	(0.042)	(0.042)
$GovInv^{\%GDP}_{c,t}$	0.002	0.021	-0.009	-0.004	0.052	0.091	0.022	-0.061	0.386	-0.172	-0.196
	(0.005)	(0.011)	(0.017)	(0.009)	(0.203)	(0.094)	(0.159)	(0.041)	(0.237)	(0.291)	(0.254)
$XRate_{c,t}$	0.007	-0.005	0.011	0.020**	-0.018	-0.053	0.017	0.018	-0.237	0.238	-0.000
	(0.006)	(0.012)	(0.011)	(0.009)	(0.223)	(0.104)	(0.220)	(0.050)	(0.212)	(0.298)	(0.178)
$ETR_{c,t}$	0.004*	0.003	0.011*	-0.001	0.156*	0.038	0.124*	-0.006	-0.037	0.189*	-0.162*
	(0.002)	(0.004)	(0.005)	(0.002)	(0.080)	(0.039)	(0.054)	(0.021)	(0.051)	(0.093)	(0.086)
R^2	0.999	0.999	.999	0.999	.988	.994	.99	.984	.992	.989	.984
N	171	171	171	171	171	171	171	171	171	171	171

Notes: $*\, p < 0.05$, $**\, p < 0.01$, $***\, p < 0.001$. Regression results to establish the link between tax aggregation and economic production for 19 European countries during the period 2008-2016. All regressions use country level data and include: GDP growth ($GDPgrowth_{c,t}$), share of gross output produced in service industries ($Services_{c,t}$); the Herfindahl-Hirschman Index computed based on the gross-output shares of macro-sectors ($HHI_{c,t}$); government consolidated gross debt as % of GDP ($Debt^{\%GDP}_{c,t}$); government interest payable as % of GDP ($Interest^{\%GDP}_{c,t}$); net government lending/borrowing as % of GDP ($Lending^{\%GDP}_{c,t}$); gross fixed capital formation as % of GDP ($GovInv^{\%GDP}_{c,t}$); period average exchange rate ($XRate_{c,t}$); effective tax rate ($ETR_{c,t}$); and country (c) and year (t) fixed effects. For the first block, $wL_{c,t}$, $rK_{c,t}$ and $pQ_{c,t}$ are expressed as the natural logarithm (ln) while for the last two blocks they are expressed as % of GDP.

SI.2.2.3. The reinstatement effect

Table SI.214: The reinstatement effect

	ln $w_{c,t}$	ln $L_{c,t}$	ln $r_{c,t}$	ln $K_{c,t}$	$HHI_{c,t}$	$Services_{c,t}$	$Gini^L_{c,t}$	$Gini^w_{c,t}$
Panel A: full period 2006-2016								
$R_{c,t}$	-0.046	0.016	-0.051	-0.006	0.010**	-1.255**	0.014	0.028
	(0.027)	(0.022)	(0.028)	(0.025)	(0.004)	(0.475)	(0.008)	(0.016)
$ICT_{c,t}$	0.026	0.015	0.024	0.130*	-0.013**	3.418**	0.005	0.031
	(0.032)	(0.042)	(0.050)	(0.064)	(0.005)	(1.121)	(0.011)	(0.022)
$R * ICT_{c,t}$	-0.041**	-0.007	-0.035	-0.065	0.006*	-1.013	-0.000	-0.005
	(0.017)	(0.022)	(0.027)	(0.041)	(0.003)	(0.574)	(0.005)	(0.010)
R^2	.999	.999	.825	0.999	.961	.984	.876	.78
N	209	209	209	209	209	209	209	209
Panel B: sub-period 2006-2007								
$R_{c,t}$	-0.600	-0.036	-0.619	-0.018	-0.000	5.246	0.033	0.169
	(0.196)	(0.031)	(0.148)	(0.049)	(0.004)	(2.788)	(0.013)	(0.100)
$ICT_{c,t}$	0.004	-0.584	-1.016	-0.348	0.126	-47.101	-0.174	0.763
	(0.906)	(0.262)	(0.697)	(0.465)	(0.035)	(20.932)	(0.091)	(0.395)
$R * ICT_{c,t}$	-0.124	0.090	0.192	-0.036	-0.028	10.816	0.038	-0.084
	(0.154)	(0.055)	(0.125)	(0.087)	(0.007)	(3.456)	(0.018)	(0.071)
R^2	0.999	0.999	.993	0.999	0.999	.999	.998	.99
N	38	38	38	38	38	38	38	38
Panel C: sub-period 2008-2016								
$R_{c,t}$	-0.033	0.019	-0.036	-0.005	0.014**	-1.612**	0.004	0.009*
	(0.027)	(0.019)	(0.023)	(0.023)	(0.004)	(0.550)	(0.005)	(0.004)
$ICT_{c,t}$	0.008	0.005	0.038	0.103**	-0.010**	1.990	-0.000	0.006
	(0.020)	(0.037)	(0.038)	(0.044)	(0.004)	(1.181)	(0.006)	(0.007)
$R * ICT_{c,t}$	-0.035*	-0.002	-0.044	-0.035	0.005*	-0.535	-0.001	0.008
	(0.015)	(0.023)	(0.026)	(0.032)	(0.003)	(0.704)	(0.003)	(0.005)
R^2	.999	0.999	.846	0.999	.971	.988	.936	.948
N	171	171	171	171	171	171	171	171

Notes: $*\ p < 0.05$, $**\ p < 0.01$, $***\ p < 0.001$. Regression results to test the reinstatement effect for 19 European countries during the period 2006-2016. All regressions include: GDP growth, government consolidated gross debt as % of GDP; government interest payable as % of GDP; net government lending/borrowing as % of GDP; gross fixed capital formation as % of GDP; period average exchange rate; value added TFP–calculated as the residual from an OLS regression of value-added volumes (VA) on a translog production function including capital volumes (K) and total number of hours worked (L); effective tax rate; and country (c) and year (t) fixed effects.

SI.2.2.4. The real-income effect

Table SI.215: The real income effect

	ln $wL_{c,t}$	ln $rK_{c,t}$	ln $(wL + rK)_{c,t}$	ln $pQ_{c,t}$	ln $Q_{c,t}$	ln $p_{c,t}$	ln $LProd_{c,t}$	ln $TFP_{c,t}$
Panel A: full period 2006-2016								
$R_{c,t}$	-0.013	-0.062*	-0.039*	-0.026	0.074***	-0.051***	0.035	0.001
	(0.022)	(0.029)	(0.021)	(0.025)	(0.019)	(0.015)	(0.024)	(0.007)
$ICT_{c,t}$	0.069	0.102*	0.084*	0.069	0.063*	0.015	0.020	0.026***
	(0.048)	(0.055)	(0.044)	(0.061)	(0.032)	(0.022)	(0.024)	(0.002)
$R * ICT_{c,t}$	-0.056*	-0.054	-0.061*	-0.061	-0.038	-0.022	-0.019	-0.006
	(0.030)	(0.033)	(0.028)	(0.036)	(0.026)	(0.013)	(0.018)	(0.006)
R^2	.999	.999	.999	.999	0.999	.896	0.999	.976
N	209	209	209	209	165	165	165	165
Panel B: sub-period 2006-2007								
$R_{c,t}$	-0.787	-0.629	-0.717	-0.475	-0.295	-0.507	-0.282	-0.115
	(0.290)	(0.168)	(0.219)	(0.181)	(0.156)	(0.181)	(0.150)	(0.043)
$ICT_{c,t}$	-0.026	-2.421	-1.044	-0.775	1.087	-0.910	-0.263	0.882
	(1.376)	(1.015)	(1.129)	(0.901)	(0.745)	(0.775)	(0.588)	(0.371)
$R * ICT_{c,t}$	-0.042	0.190	0.078	0.054	-0.219	0.120	0.073	-0.179
	(0.213)	(0.145)	(0.165)	(0.135)	(0.138)	(0.134)	(0.097)	(0.074)
R^2	0.999	0.999	0.999	0.999	0.999	.977	0.999	.999
N	38	38	38	38	30	30	30	30
Panel C: sub-period 2008-2016								
$R_{c,t}$	-0.008	-0.035	-0.024	-0.006	0.069***	-0.034**	0.030	-0.003
	(0.031)	(0.040)	(0.023)	(0.025)	(0.020)	(0.012)	(0.022)	(0.010)
$ICT_{c,t}$	0.046	0.127*	0.082*	0.069	0.050**	0.025	0.021	0.022***
	(0.035)	(0.062)	(0.038)	(0.054)	(0.019)	(0.023)	(0.017)	(0.003)
$R * ICT_{c,t}$	-0.031	-0.063	-0.050	-0.050	-0.012	-0.028	-0.012	-0.001
	(0.032)	(0.039)	(0.030)	(0.036)	(0.020)	(0.015)	(0.013)	(0.010)
R^2	.999	.999	0.999	0.999	0.999	.886	0.999	.979
N	171	171	171	171	135	135	135	135

Notes: $* \ p < 0.05$, $** \ p < 0.01$, $*** \ p < 0.001$. Regression results to test the real income effect for 19 European countries during the period 2006-2016. Labor productivity is measured as the share of gross-output volumes (Q) over the total number of hours worked. TFP is calculated as the residual from an OLS regression of gross-output volumes (Q) on a translog production function including capital volumes (K), total number of hours worked (L) and intermediate input volumes (M). All regressions include: GDP growth, government consolidated gross debt as % of GDP; government interest payable as % of GDP; net government lending/borrowing as % of GDP; gross fixed capital formation as % of GDP; period average exchange rate; effective tax rate; and country (c) and year (t) fixed effects.

SI.2.3. Controlling for trade

SI.2.3.1. Taxation and automation

Table SI.216: Taxation and automation

	Taxes in ln of nat. currency				Taxes as % of GDP				Taxes as % of total tax		
	$lnT_{c,t}$	$lnT^l_{c,t}$	$lnT^k_{c,t}$	$lnT^y_{c,t}$	$T_{c,t}$	$T^l_{c,t}$	$T^k_{c,t}$	$T^y_{c,t}$	$T^l_{c,t}$	$T^k_{c,t}$	$T^y_{c,t}$
Panel A: full period 1995-2016											
$R_{c,t}$	-0.022	-0.048**	0.017	-0.024	0.150	-0.270	0.405	0.015	-0.938	0.842	-0.166
	(0.014)	(0.022)	(0.043)	(0.017)	(0.438)	(0.206)	(0.346)	(0.188)	(0.632)	(0.875)	(0.542)
$ICT_{c,t}$	-0.040***	-0.079	-0.094***	-0.027	-1.234***	0.281	-1.401**	-0.114	1.733	-1.922*	0.428
	(0.011)	(0.108)	(0.031)	(0.018)	(0.421)	(0.375)	(0.517)	(0.186)	(1.027)	(1.042)	(0.591)
$R * ICT_{c,t}$	0.015**	0.021	0.037**	0.028**	0.285	-0.311*	0.395*	0.201	-1.105***	0.637	0.358
	(0.007)	(0.038)	(0.015)	(0.011)	(0.229)	(0.157)	(0.195)	(0.123)	(0.313)	(0.399)	(0.354)
R^2	0.999	.998	.998	.999	.968	.985	.975	.906	.982	.972	.942
N	395	395	395	395	395	395	395	395	395	395	395
Panel B: sub-period 1995-2007											
$R_{c,t}$	-0.067***	-0.135*	-0.127***	-0.008	-0.949	-0.302	-0.890**	0.243	-0.102	-1.927**	1.200**
	(0.022)	(0.065)	(0.036)	(0.030)	(0.652)	(0.273)	(0.384)	(0.243)	(0.512)	(0.648)	(0.517)
$ICT_{c,t}$	-0.005	-0.103	-0.076	-0.001	0.669	0.903**	-0.648	0.415*	1.838**	-2.406*	0.254
	(0.024)	(0.138)	(0.053)	(0.025)	(0.722)	(0.351)	(0.644)	(0.223)	(0.809)	(1.254)	(0.690)
$R * ICT_{c,t}$	0.002	0.032	0.013	0.007	-0.539	-0.181	-0.180	-0.178	0.004	0.319	0.005
	(0.019)	(0.050)	(0.035)	(0.015)	(0.641)	(0.272)	(0.433)	(0.134)	(0.348)	(0.684)	(0.612)
R^2	0.999	.998	.999	0.999	.975	.987	.983	.943	.99	.985	.964
N	224	224	224	224	224	224	224	224	224	224	224
Panel C: sub-period 2008-2016											
$R_{c,t}$	0.004	0.009	0.030	-0.022	0.472	0.263	0.286	-0.077	0.178	0.600	-0.753
	(0.020)	(0.018)	(0.058)	(0.028)	(0.801)	(0.355)	(0.547)	(0.346)	(0.820)	(1.212)	(0.981)
$ICT_{c,t}$	-0.011	-0.017	0.018	-0.036	-1.071	-0.265	0.199	-1.006	-0.272	2.047***	-1.770**
	(0.037)	(0.042)	(0.039)	(0.065)	(0.769)	(0.466)	(0.236)	(0.547)	(0.914)	(0.514)	(0.746)
$R * ICT_{c,t}$	-0.011	0.011	-0.031	-0.015	0.254	-0.000	0.008	0.246	0.344	-0.961*	0.541
	(0.022)	(0.021)	(0.027)	(0.036)	(0.800)	(0.292)	(0.511)	(0.365)	(0.412)	(0.456)	(0.400)
R^2	0.999	0.999	.999	0.999	.984	.995	.989	.953	.992	.988	.967
N	171	171	171	171	171	171	171	171	171	171	171

Notes: $* \ p < 0.05$, $** \ p < 0.01$, $*** \ p < 0.001$. Regression results of aggregate flows of tax revenues on different automation measures for 19 European countries during the period 1995-2016. All regressions use country level data and include: GDP growth, gross output share of the service sector in total economy; Herfindahl-Hirschman Index computed based on the gross-output shares of macro-sectors; government consolidated gross debt as % of GDP; government interest payable as % of GDP; net government lending/borrowing as % of GDP; gross fixed capital formation as % of GDP; period average exchange rate; imports as % of GDP; exports as % of GDP; and country (c) and year (t) fixed effects. All regressions in Panel A also include the ln of gross-output value (pQ).

SI.2.3.2. Taxation and economic production

Table SI.217: Taxation and the structure of economic production

	Taxes in ln of nat. currency				Taxes as % of GDP				Taxes as % of total tax		
	ln $T_{c,t}$	ln $T^l_{c,t}$	ln $T^k_{c,t}$	ln$T^y_{c,t}$	$T_{c,t}$	$T^l_{c,t}$	$T^k_{c,t}$	$T^y_{c,t}$	$T^l_{c,t}$	$T^k_{c,t}$	$T^y_{c,t}$
$R_{c,t}$	-0.017*	-0.038*	0.024	-0.020	0.000	-0.298	0.372	-0.075	-0.897	0.899	-0.296
	(0.010)	(0.019)	(0.042)	(0.017)	(0.379)	(0.198)	(0.341)	(0.122)	(0.604)	(0.897)	(0.448)
$ICT_{c,t}$	-0.060***	-0.091	-0.113***	-0.054**	-1.490***	0.101	-1.690***	0.098	1.362	-2.471**	1.227**
	(0.011)	(0.095)	(0.038)	(0.019)	(0.456)	(0.354)	(0.539)	(0.131)	(0.947)	(0.984)	(0.454)
$R * ICT_{c,t}$	0.020***	0.021	0.040**	0.035***	0.317	-0.255	0.491**	0.081	-0.946**	0.871**	-0.003
	(0.005)	(0.034)	(0.017)	(0.010)	(0.242)	(0.152)	(0.213)	(0.067)	(0.410)	(0.364)	(0.254)
$wL_{c,t}$	0.554***	0.736**	0.677**	0.546***	-0.457***	0.042	0.128	-0.626***	0.553**	0.801**	-1.387***
	(0.158)	(0.348)	(0.304)	(0.107)	(0.147)	(0.106)	(0.113)	(0.086)	(0.229)	(0.350)	(0.214)
$rK_{c,t}$	0.064	0.278	0.155	-0.019	-0.646***	-0.022	0.036	-0.660***	0.509***	0.732***	-1.328***
	(0.095)	(0.265)	(0.184)	(0.074)	(0.126)	(0.083)	(0.091)	(0.068)	(0.166)	(0.249)	(0.191)
$pQ_{c,t}$	0.292	-0.093	0.127	0.384**							
	(0.248)	(0.589)	(0.446)	(0.156)							
$GDPgrowth_{c,t}$	-0.001	-0.003	0.005*	-0.001	0.000	-0.039	0.039	-0.000	-0.114	0.131	0.005
	(0.001)	(0.003)	(0.003)	(0.002)	(0.045)	(0.027)	(0.027)	(0.014)	(0.071)	(0.078)	(0.037)
$Services_{c,t}$	-0.002	0.011	-0.012	-0.014**	-0.001	0.161*	-0.107	-0.055	0.524**	-0.327	-0.210*
	(0.004)	(0.014)	(0.011)	(0.006)	(0.093)	(0.078)	(0.106)	(0.041)	(0.235)	(0.287)	(0.101)
$HHI_{c,t}$	-0.433	2.449	-1.428	-3.792***	15.645	40.383**	-2.741	-21.997**	104.190**	-22.533	-66.533***
	(0.540)	(1.883)	(1.975)	(1.041)	(22.087)	(14.718)	(20.198)	(9.127)	(46.604)	(58.539)	(22.957)
$Debt^{\%GDP}_{c,t}$	0.001***	0.000	0.004**	0.002***	0.049***	-0.005	0.035**	0.018***	-0.063**	0.057	-0.004
	(0.000)	(0.001)	(0.001)	(0.001)	(0.013)	(0.008)	(0.013)	(0.004)	(0.025)	(0.036)	(0.012)
$Interest^{\%GDP}_{c,t}$	-0.009	0.004	-0.020	-0.014**	-0.277	-0.020	-0.134	-0.123**	0.325	-0.186	0.127
	(0.007)	(0.009)	(0.015)	(0.006)	(0.190)	(0.090)	(0.153)	(0.046)	(0.236)	(0.387)	(0.141)
$Lending^{\%GDP}_{c,t}$	0.005***	-0.002	0.004	0.006**	0.114***	0.012	0.068	0.034**	-0.030	0.043	-0.029
	(0.001)	(0.004)	(0.004)	(0.002)	(0.035)	(0.019)	(0.041)	(0.012)	(0.060)	(0.092)	(0.050)
$GovInv^{\%GDP}_{c,t}$	0.008	0.009	0.002	-0.001	0.044	0.032	0.084	-0.072	0.068	0.059	-0.252
	(0.005)	(0.010)	(0.015)	(0.007)	(0.189)	(0.102)	(0.163)	(0.064)	(0.291)	(0.346)	(0.194)
$XRate_{c,t}$	-0.005***	-0.004	-0.006*	-0.007***	-0.107***	-0.010	-0.091***	-0.006	0.093	-0.121	0.072**
	(0.001)	(0.006)	(0.003)	(0.002)	(0.032)	(0.029)	(0.030)	(0.011)	(0.066)	(0.074)	(0.030)
$Imports^{\%GDP}_{c,t}$	-0.002	0.001	0.001	-0.005*	0.006	0.025	-0.008	-0.012	0.019	0.007	-0.024
	(0.002)	(0.002)	(0.005)	(0.002)	(0.054)	(0.022)	(0.053)	(0.014)	(0.066)	(0.092)	(0.047)
$Exports^{\%GDP}_{c,t}$	0.000	-0.001	-0.005	0.005**	-0.064	-0.048*	-0.046	0.030**	-0.041	-0.109	0.119***
	(0.001)	(0.002)	(0.005)	(0.002)	(0.053)	(0.025)	(0.045)	(0.013)	(0.069)	(0.087)	(0.034)
R^2	0.999	.998	.999	.999	.974	.986	.976	.962	.983	.973	.96
N	395	395	395	395	395	395	395	395	395	395	395

Notes: $* \, p < 0.05$, $** \, p < 0.01$, $*** \, p < 0.001$. Regression results to establish the link between tax aggregation and economic production for 19 European countries during the period 1995-2016. All regressions use country level data and include: GDP growth ($GDPgrowth_{c,t}$), share of gross output produced in service industries ($Services_{c,t}$); the Herfindahl-Hirschman Index computed based on the gross-output shares of macro-sectors ($HHI_{c,t}$); government consolidated gross debt as % of GDP ($Debt^{\%GDP}_{c,t}$); government interest payable as % of GDP ($Interest^{\%GDP}_{c,t}$); net government lending/borrowing as % of GDP ($Lending^{\%GDP}_{c,t}$); gross fixed capital formation as % of GDP ($GovInv^{\%GDP}_{c,t}$); period average exchange rate ($XRate_{c,t}$); imports as % of GDP ($Imports^{\%GDP}_{c,t}$); exports as % of GDP ($Exports^{\%GDP}_{c,t}$); and country (c) and year (t) fixed effects. For the first block, $wL_{c,t}$, $rK_{c,t}$ and $pQ_{c,t}$ are expressed as the natural logarithm (ln) while for the last two blocks they are expressed as % of GDP.

Table SI.218: Taxation and the structure of economic production before 2007

	Taxes in ln of nat. currency				Taxes as % of GDP				Taxes as % of total tax		
	ln $T_{c,t}$	ln $T^l_{c,t}$	ln $T^k_{c,t}$	ln$T^y_{c,t}$	$T_{c,t}$	$T^l_{c,t}$	$T^k_{c,t}$	$T^y_{c,t}$	$T^l_{c,t}$	$T^k_{c,t}$	$T^y_{c,t}$
$R_{c,t}$	-0.040*	-0.068	-0.110***	0.020	-0.683	-0.220	-0.836**	0.372**	-0.067	-2.006**	1.321**
	(0.021)	(0.049)	(0.033)	(0.032)	(0.384)	(0.183)	(0.381)	(0.131)	(0.478)	(0.750)	(0.447)
$ICT_{c,t}$	-0.040	-0.155	-0.108*	-0.008	-0.838	0.311	-1.257	0.109	1.106	-2.633	0.789
	(0.028)	(0.121)	(0.057)	(0.028)	(0.727)	(0.477)	(0.778)	(0.197)	(1.018)	(1.544)	(1.064)
$R*ICT_{c,t}$	0.006	0.028	0.018	0.000	0.061	0.012	-0.043	0.093	0.110	0.176	0.216
	(0.018)	(0.040)	(0.032)	(0.017)	(0.586)	(0.284)	(0.421)	(0.106)	(0.443)	(0.711)	(0.668)
$wL_{c,t}$	0.543**	1.354**	0.342	0.589***	-0.571**	-0.099	0.079	-0.551***	0.265	0.598*	-1.035***
	(0.208)	(0.466)	(0.303)	(0.140)	(0.196)	(0.133)	(0.155)	(0.071)	(0.238)	(0.320)	(0.279)
$rK_{c,t}$	-0.045	0.114	-0.096	0.153	-0.874***	-0.227	-0.068	-0.579***	0.076	0.499*	-0.832**
	(0.133)	(0.248)	(0.163)	(0.116)	(0.217)	(0.139)	(0.149)	(0.056)	(0.260)	(0.273)	(0.289)
$pQ_{c,t}$	0.492	-0.425	0.678	0.307							
	(0.302)	(0.656)	(0.419)	(0.221)							
$GDPgrowth_{c,t}$	0.000	-0.000	-0.002	0.004	0.014	-0.041	0.021	0.033	-0.090	-0.040	0.114
	(0.002)	(0.005)	(0.004)	(0.003)	(0.043)	(0.041)	(0.037)	(0.027)	(0.100)	(0.081)	(0.088)
$Services_{c,t}$	0.000	-0.028	-0.015	-0.001	-0.095	0.130	-0.235*	0.010	0.510**	-0.582**	0.017
	(0.004)	(0.029)	(0.009)	(0.005)	(0.145)	(0.098)	(0.118)	(0.033)	(0.177)	(0.252)	(0.129)
$HHI_{c,t}$	-0.797	-3.341	-2.237	-1.844*	-43.233	18.272	-37.764**	-23.740*	82.205***	-53.537	-25.672
	(0.639)	(4.059)	(2.036)	(0.916)	(26.259)	(16.166)	(14.351)	(11.889)	(25.705)	(38.658)	(36.698)
$Debt^{\%GDP}_{c,t}$	0.001	0.004	0.002	-0.000	0.034	0.013	0.014	0.007	0.003	0.009	-0.025
	(0.001)	(0.002)	(0.001)	(0.001)	(0.019)	(0.012)	(0.015)	(0.009)	(0.027)	(0.033)	(0.033)
$Interest^{\%GDP}_{c,t}$	-0.005	-0.010	0.002	-0.007*	0.146	-0.091	0.190	0.047	-0.186	0.454	0.294
	(0.008)	(0.011)	(0.010)	(0.004)	(0.173)	(0.132)	(0.110)	(0.068)	(0.313)	(0.289)	(0.269)
$Lending^{\%GDP}_{c,t}$	0.004	-0.003	0.007	0.000	0.137	0.023	0.099	0.015	-0.010	0.089	-0.087
	(0.003)	(0.005)	(0.006)	(0.002)	(0.084)	(0.033)	(0.079)	(0.010)	(0.082)	(0.130)	(0.088)
$GovInv^{\%GDP}_{c,t}$	-0.003	-0.005	0.013	-0.018*	-0.057	0.056	-0.009	-0.104	0.037	0.194	-0.344
	(0.008)	(0.010)	(0.016)	(0.009)	(0.239)	(0.137)	(0.208)	(0.063)	(0.303)	(0.397)	(0.296)
$XRate_{c,t}$	-0.005**	-0.005	-0.010**	-0.005**	-0.123**	0.001	-0.122**	-0.003	0.163*	-0.220**	0.110**
	(0.002)	(0.006)	(0.004)	(0.002)	(0.053)	(0.036)	(0.053)	(0.011)	(0.088)	(0.097)	(0.049)
$Imports^{\%GDP}_{c,t}$	-0.002	-0.018	0.001	-0.001	-0.015	-0.032	-0.007	0.024	-0.139	0.027	0.069
	(0.003)	(0.011)	(0.006)	(0.003)	(0.075)	(0.034)	(0.062)	(0.030)	(0.093)	(0.096)	(0.068)
$Exports^{\%GDP}_{c,t}$	0.000	0.012	-0.002	0.001	-0.001	0.005	-0.013	0.008	0.073	-0.050	0.021
	(0.002)	(0.010)	(0.007)	(0.003)	(0.068)	(0.038)	(0.059)	(0.027)	(0.087)	(0.112)	(0.089)
R^2	0.999	.998	.999	0.999	.982	.988	.984	.974	.99	.986	.97
N	224	224	224	224	224	224	224	224	224	224	224

Notes: $*\, p < 0.05$, $**\, p < 0.01$, $***\, p < 0.001$. Regression results to establish the link between tax aggregation and economic production for 19 European countries during the period 1995-2007. All regressions use country level data and include: GDP growth ($GDPgrowth_{c,t}$), share of gross output produced in service industries ($Services_{c,t}$); the Herfindahl-Hirschman Index computed based on the gross-output shares of macro-sectors ($HHI_{c,t}$); government consolidated gross debt as % of GDP ($Debt^{\%GDP}_{c,t}$); government interest payable as % of GDP ($Interest^{\%GDP}_{c,t}$); net government lending/borrowing as % of GDP ($Lending^{\%GDP}_{c,t}$); gross fixed capital formation as % of GDP ($GovInv^{\%GDP}_{c,t}$); period average exchange rate ($XRate_{c,t}$); imports as % of GDP ($Imports^{\%GDP}_{c,t}$); exports as % of GDP ($Exports^{\%GDP}_{c,t}$); and country (c) and year (t) fixed effects. For the first block, $wL_{c,t}$, $rK_{c,t}$ and $pQ_{c,t}$ are expressed as the natural logarithm (ln) while for the last two blocks they are expressed as % of GDP.

Table SI.219: Taxation and the structure of economic production after 2008

	Taxes in ln of nat. currency				Taxes as % of GDP				Taxes as % of total tax		
	ln $T_{c,t}$	ln $T^l_{c,t}$	ln $T^k_{c,t}$	ln$T^y_{c,t}$	$T_{c,t}$	$T^l_{c,t}$	$T^k_{c,t}$	$T^y_{c,t}$	$T^l_{c,t}$	$T^k_{c,t}$	$T^y_{c,t}$
$R_{c,t}$	-0.012	0.014	0.019	-0.058*	0.150	0.168	0.241	-0.258	0.274	0.693	-0.947
	(0.022)	(0.022)	(0.063)	(0.030)	(0.787)	(0.386)	(0.548)	(0.233)	(0.903)	(0.966)	(0.776)
$ICT_{c,t}$	0.022	-0.022	0.046	0.031	0.247	-0.213	0.231	0.229**	-1.469*	0.799	0.689
	(0.036)	(0.042)	(0.042)	(0.059)	(0.422)	(0.552)	(0.297)	(0.091)	(0.771)	(0.479)	(0.641)
$R*ICT_{c,t}$	-0.023	0.012	-0.042	-0.037	-0.099	-0.021	-0.004	-0.074	0.647*	-0.645	-0.082
	(0.023)	(0.025)	(0.033)	(0.036)	(0.593)	(0.321)	(0.544)	(0.090)	(0.293)	(0.534)	(0.489)
$wL_{c,t}$	0.433***	0.197	0.642	0.494***	-0.628**	0.095	0.039	-0.762***	0.857**	0.902*	-1.764***
	(0.100)	(0.267)	(0.418)	(0.143)	(0.232)	(0.092)	(0.209)	(0.092)	(0.313)	(0.439)	(0.329)
$rK_{c,t}$	0.033	0.163	0.202	-0.183**	-0.694***	0.056	0.021	-0.770***	0.829**	0.870**	-1.705***
	(0.072)	(0.125)	(0.235)	(0.069)	(0.183)	(0.075)	(0.164)	(0.091)	(0.293)	(0.336)	(0.292)
$pQ_{c,t}$	0.124	0.482	-0.211	-0.013							
	(0.189)	(0.474)	(0.719)	(0.205)							
$GDPgrowth_{c,t}$	0.001	-0.004	0.002	0.005***	-0.089	-0.054	-0.019	-0.015*	-0.094	0.064	0.027
	(0.001)	(0.002)	(0.004)	(0.001)	(0.053)	(0.030)	(0.031)	(0.007)	(0.054)	(0.065)	(0.052)
$Services_{c,t}$	-0.001	0.020*	0.011	-0.023**	0.193	0.081	0.153	-0.040	0.088	0.188	-0.276
	(0.005)	(0.009)	(0.013)	(0.010)	(0.196)	(0.075)	(0.163)	(0.047)	(0.235)	(0.287)	(0.185)
$HHI_{c,t}$	-0.599	0.238	2.578	-3.518*	2.585	-7.504	15.706	-5.617	-41.965	54.074	-9.381
	(0.831)	(1.998)	(2.746)	(1.884)	(34.614)	(16.779)	(28.147)	(11.123)	(49.692)	(54.626)	(40.365)
$Debt^{\%GDP}_{c,t}$	-0.001	-0.002*	0.001	-0.001	0.041**	-0.006	0.023	0.024***	-0.052	0.035	0.019
	(0.001)	(0.001)	(0.002)	(0.001)	(0.015)	(0.007)	(0.016)	(0.006)	(0.031)	(0.036)	(0.018)
$Interest^{\%GDP}_{c,t}$	0.014*	0.012	-0.023	0.046***	-0.776**	-0.019	-0.436**	-0.321**	0.729**	-0.673	-0.114
	(0.007)	(0.009)	(0.026)	(0.012)	(0.276)	(0.078)	(0.178)	(0.120)	(0.244)	(0.370)	(0.320)
$Lending^{\%GDP}_{c,t}$	0.003**	0.001	0.008*	0.001	0.094**	0.014	0.072*	0.009	-0.042	0.120*	-0.087*
	(0.001)	(0.002)	(0.004)	(0.002)	(0.038)	(0.011)	(0.036)	(0.009)	(0.042)	(0.058)	(0.044)
$GovInv^{\%GDP}_{c,t}$	0.004	0.025*	-0.006	-0.005	0.180	0.151	0.064	-0.035	0.514*	-0.250	-0.246
	(0.006)	(0.012)	(0.020)	(0.009)	(0.178)	(0.087)	(0.144)	(0.058)	(0.253)	(0.339)	(0.240)
$XRate_{c,t}$	0.008	-0.003	0.015	0.018*	0.030	-0.055	0.069	0.015	-0.260*	0.317	-0.049
	(0.007)	(0.010)	(0.013)	(0.008)	(0.239)	(0.088)	(0.214)	(0.044)	(0.125)	(0.258)	(0.186)
$Imports^{\%GDP}_{c,t}$	0.002	-0.007*	0.009	0.004	-0.042	-0.029	0.011	-0.024	-0.120	0.138	-0.028
	(0.002)	(0.003)	(0.010)	(0.002)	(0.037)	(0.028)	(0.044)	(0.018)	(0.096)	(0.117)	(0.070)
$Exports^{\%GDP}_{c,t}$	-0.002	0.007**	-0.012	-0.003	0.058	0.061**	-0.040	0.037	0.195	-0.241	0.044
	(0.003)	(0.003)	(0.011)	(0.004)	(0.074)	(0.025)	(0.070)	(0.024)	(0.128)	(0.166)	(0.078)
R^2	0.999	0.999	.999	0.999	.986	.995	.989	.985	.992	.989	.982
N	171	171	171	171	171	171	171	171	171	171	171

Notes: $*\,p < 0.05$, $**\,p < 0.01$, $***\,p < 0.001$. Regression results to establish the link between tax aggregation and economic production for 19 European countries during the period 2008-2016. All regressions use country level data and include: GDP growth ($GDPgrowth_{c,t}$), share of gross output produced in service industries ($Services_{c,t}$); the Herfindahl-Hirschman Index computed based on the gross-output shares of macro-sectors ($HHI_{c,t}$); government consolidated gross debt as % of GDP ($Debt^{\%GDP}_{c,t}$); government interest payable as % of GDP ($Interest^{\%GDP}_{c,t}$); net government lending/borrowing as % of GDP ($Lending^{\%GDP}_{c,t}$); gross fixed capital formation as % of GDP ($GovInv^{\%GDP}_{c,t}$); period average exchange rate ($XRate_{c,t}$); imports as % of GDP ($Imports^{\%GDP}_{c,t}$); exports as % of GDP ($Exports^{\%GDP}_{c,t}$); and country (c) and year (t) fixed effects. For the first block, $wL_{c,t}$, $rK_{c,t}$ and $pQ_{c,t}$ are expressed as the natural logarithm (ln) while for the last two blocks they are expressed as % of GDP.

SI.2.3.3. The reinstatement effect

Table SI.220: The reinstatement effect

	ln $w_{c,t}$	ln $L_{c,t}$	ln $r_{c,t}$	ln $K_{c,t}$	$HHI_{c,t}$	$Services_{c,t}$	$Gini^L_{c,t}$	$Gini^w_{c,t}$
Panel A: full period 1995-2016								
$R_{c,t}$	-0.141***	-0.003	-0.082**	-0.067***	0.001	-0.799**	0.001	0.034***
	(0.023)	(0.017)	(0.031)	(0.020)	(0.002)	(0.278)	(0.005)	(0.009)
$ICT_{c,t}$	0.155***	-0.090**	0.085*	-0.018	-0.003	0.648	-0.005	0.040***
	(0.049)	(0.042)	(0.042)	(0.057)	(0.003)	(0.989)	(0.009)	(0.013)
$R * ICT_{c,t}$	-0.060***	0.032*	-0.040*	0.010	0.002	0.085	0.004	-0.011
	(0.015)	(0.018)	(0.019)	(0.025)	(0.001)	(0.427)	(0.005)	(0.007)
R^2	.996	.999	.915	.999	.967	.976	.727	.783
N	395	395	395	395	395	395	395	395
Panel B: sub-period 1995-2007								
$R_{c,t}$	-0.145***	-0.041*	-0.083***	-0.065**	0.002	-1.436**	-0.008	0.013
	(0.038)	(0.019)	(0.025)	(0.025)	(0.002)	(0.510)	(0.008)	(0.009)
$ICT_{c,t}$	0.303***	-0.129***	0.170***	-0.053**	0.010***	-1.510	0.004	0.034*
	(0.052)	(0.017)	(0.045)	(0.023)	(0.002)	(0.905)	(0.011)	(0.018)
$R * ICT_{c,t}$	-0.141***	0.032***	-0.082***	0.019	-0.005***	0.674	-0.008	-0.016
	(0.033)	(0.009)	(0.025)	(0.014)	(0.001)	(0.491)	(0.006)	(0.011)
R^2	.998	.999	.93	0.999	.982	.984	.797	.888
N	224	224	224	224	224	224	224	224
Panel C: sub-period 2008-2016								
$R_{c,t}$	-0.026	0.045*	-0.014	-0.009	0.006*	-0.820	0.004	0.005
	(0.029)	(0.022)	(0.026)	(0.024)	(0.003)	(0.526)	(0.005)	(0.006)
$ICT_{c,t}$	0.008	-0.005	0.038	0.095**	-0.009**	1.797	-0.002	0.007
	(0.020)	(0.029)	(0.042)	(0.036)	(0.004)	(1.189)	(0.005)	(0.007)
$R * ICT_{c,t}$	-0.033*	0.000	-0.042*	-0.029	0.006**	-0.662	0.000	0.010**
	(0.015)	(0.018)	(0.022)	(0.028)	(0.003)	(0.711)	(0.002)	(0.004)
R^2	.999	0.999	.85	0.999	.984	.99	.94	.952
N	171	171	171	171	171	171	171	171

Notes: $* \ p < 0.05$, $** \ p < 0.01$, $*** \ p < 0.001$. Regression results to test the reinstatement effect for 19 European countries during the period 1995-2016. All regressions include: GDP growth, government consolidated gross debt as % of GDP; government interest payable as % of GDP; net government lending/borrowing as % of GDP; gross fixed capital formation as % of GDP; period average exchange rate; value added TFP–calculated as the residual from an OLS regression of value-added volumes (VA) on a translog production function including capital volumes (K) and total number of hours worked (L); imports as % of GDP; exports as % of GDP; and country (c) and year (t) fixed effects.

SI.2.3.4. The real-income effect

Table SI.221: The real income effect

	ln $wL_{c,t}$	ln $rK_{c,t}$	ln $(wL + rK)_{c,t}$	ln $pQ_{c,t}$	ln $Q_{c,t}$	ln $p_{c,t}$	ln $LProd_{c,t}$	ln $TFP_{c,t}$
Panel A: full period 1995-2016								
$R_{c,t}$	-0.142***	-0.153***	-0.155***	-0.129***	-0.006	-0.112***	-0.028*	-0.005
	(0.030)	(0.036)	(0.031)	(0.029)	(0.020)	(0.024)	(0.014)	(0.013)
$ICT_{c,t}$	0.057	-0.079	0.000	0.002	0.019	-0.026	0.081**	-0.047
	(0.049)	(0.048)	(0.046)	(0.040)	(0.028)	(0.044)	(0.029)	(0.030)
$R * ICT_{c,t}$	-0.021	0.023	-0.003	-0.009	-0.005	0.022	-0.037**	0.026**
	(0.027)	(0.026)	(0.025)	(0.024)	(0.017)	(0.021)	(0.014)	(0.012)
R^2	.998	.997	.998	.998	.999	.925	.999	.871
N	395	395	395	395	309	309	309	309
Panel B: sub-period 1995-2007								
$R_{c,t}$	-0.197***	-0.145***	-0.181***	-0.136***	-0.060***	-0.113***	-0.018	0.009
	(0.042)	(0.042)	(0.038)	(0.038)	(0.013)	(0.022)	(0.013)	(0.012)
$ICT_{c,t}$	0.132***	-0.042	0.060	0.100*	0.014	0.026	0.127***	-0.081***
	(0.039)	(0.055)	(0.043)	(0.047)	(0.016)	(0.037)	(0.030)	(0.024)
$R * ICT_{c,t}$	-0.077**	-0.044	-0.060**	-0.087**	-0.008	-0.023	-0.048**	0.050***
	(0.026)	(0.029)	(0.027)	(0.031)	(0.017)	(0.021)	(0.021)	(0.011)
R^2	.999	.998	.999	.999	0.999	.948	.999	.935
N	224	224	224	224	174	174	174	174
Panel C: sub-period 2008-2016								
$R_{c,t}$	0.034	-0.056	-0.012	0.005	0.065***	-0.019	-0.002	0.002
	(0.035)	(0.062)	(0.033)	(0.024)	(0.017)	(0.016)	(0.017)	(0.008)
$ICT_{c,t}$	0.023	0.131*	0.071*	0.052	0.029*	0.021	0.023*	0.020**
	(0.039)	(0.058)	(0.038)	(0.041)	(0.013)	(0.022)	(0.012)	(0.006)
$R * ICT_{c,t}$	-0.033	-0.052	-0.044	-0.038	-0.006	-0.025	-0.009	-0.006
	(0.030)	(0.031)	(0.026)	(0.025)	(0.015)	(0.013)	(0.010)	(0.009)
R^2	.999	.999	0.999	0.999	0.999	.898	0.999	.982
N	171	171	171	171	135	135	135	135

Notes: $* \ p < 0.05$, $** \ p < 0.01$, $*** \ p < 0.001$. Regression results to test the real income effect for 19 European countries during the period 1995-2016. Labor productivity is measured as the share of gross-output volumes (Q) over the total number of hours worked. TFP is calculated as the residual from an OLS regression of gross-output volumes (Q) on a translog production function including capital volumes (K), total number of hours worked (L) and intermediate input volumes (M). All regressions include: GDP growth, government consolidated gross debt as % of GDP; government interest payable as % of GDP; net government lending/borrowing as % of GDP; gross fixed capital formation as % of GDP; period average exchange rate; imports as % of GDP; exports as % of GDP; and country (c) and year (t) fixed effects.

SI.2.4. The progressiveness of taxation

Table SI.222: Taxation and the structure of economic production

	Taxes in ln of nat. currency				Taxes as % of GDP				Taxes as % of total tax		
	$\ln T_{c,t}$	$\ln T^l_{c,t}$	$\ln T^k_{c,t}$	$\ln T^y_{c,t}$	$T_{c,t}$	$T^l_{c,t}$	$T^k_{c,t}$	$T^y_{c,t}$	$T^l_{c,t}$	$T^k_{c,t}$	$T^y_{c,t}$
$R_{c,t}$	-0.016	-0.039*	0.016	-0.007	-0.001	-0.320	0.319	0.000	-0.996	0.798	-0.140
	(0.010)	(0.019)	(0.041)	(0.020)	(0.439)	(0.237)	(0.362)	(0.126)	(0.634)	(0.910)	(0.543)
$ICT_{c,t}$	-0.057***	-0.092	-0.118***	-0.039	-1.559**	0.026	-1.797***	0.213	1.209	-2.698**	1.526**
	(0.013)	(0.098)	(0.038)	(0.025)	(0.553)	(0.368)	(0.622)	(0.174)	(0.936)	(1.083)	(0.671)
$R * ICT_{c,t}$	0.021***	0.022	0.047**	0.030**	0.416	-0.200	0.590**	0.026	-0.876**	1.068**	-0.210
	(0.006)	(0.034)	(0.017)	(0.012)	(0.295)	(0.153)	(0.268)	(0.080)	(0.365)	(0.422)	(0.302)
$wL_{c,t}$	0.575***	0.718*	0.647**	0.592***	-0.454***	0.052	0.122	-0.627***	0.555**	0.799**	-1.388***
	(0.167)	(0.357)	(0.274)	(0.151)	(0.157)	(0.111)	(0.135)	(0.094)	(0.245)	(0.380)	(0.253)
$rK_{c,t}$	0.087	0.259	0.111	0.050	-0.652***	-0.022	0.025	-0.655***	0.503**	0.715**	-1.311***
	(0.089)	(0.261)	(0.160)	(0.089)	(0.137)	(0.088)	(0.107)	(0.074)	(0.180)	(0.265)	(0.217)
$pQ_{c,t}$	0.233	-0.062	0.149	0.290							
	(0.249)	(0.577)	(0.368)	(0.231)							
$GDPgrowth_{c,t}$	-0.001	-0.003	0.006	-0.002	0.010	-0.031	0.038	0.002	-0.117	0.135	0.002
	(0.001)	(0.003)	(0.003)	(0.002)	(0.039)	(0.026)	(0.029)	(0.014)	(0.077)	(0.087)	(0.041)
$Services_{c,t}$	-0.003	0.011	-0.014	-0.014*	-0.026	0.151*	-0.129	-0.047	0.513**	-0.371	-0.169
	(0.004)	(0.014)	(0.010)	(0.007)	(0.092)	(0.080)	(0.099)	(0.041)	(0.235)	(0.273)	(0.109)
$HHI_{c,t}$	-0.903	2.201	-3.412	-2.824***	-14.113	24.969*	-27.662	-11.420	90.799**	-73.283	-16.685
	(0.582)	(1.763)	(2.088)	(0.843)	(17.909)	(13.689)	(19.071)	(7.985)	(43.113)	(58.868)	(24.721)
$Debt^{\%GDP}_{c,t}$	0.002***	0.000	0.004**	0.002***	0.052***	-0.005	0.038***	0.019***	-0.064**	0.061	-0.006
	(0.000)	(0.001)	(0.001)	(0.001)	(0.012)	(0.008)	(0.013)	(0.004)	(0.025)	(0.036)	(0.014)
$Interest^{\%GDP}_{c,t}$	-0.009	0.004	-0.021	-0.013**	-0.329	-0.050	-0.171	-0.108**	0.305	-0.266	0.206
	(0.007)	(0.008)	(0.015)	(0.006)	(0.191)	(0.090)	(0.156)	(0.046)	(0.262)	(0.392)	(0.160)
$Lending^{\%GDP}_{c,t}$	0.005***	-0.002	0.004	0.005**	0.114***	0.012	0.071*	0.031***	-0.027	0.047	-0.034
	(0.001)	(0.004)	(0.004)	(0.002)	(0.028)	(0.019)	(0.036)	(0.010)	(0.067)	(0.084)	(0.040)
$GovInv^{\%GDP}_{c,t}$	0.007	0.009	0.003	-0.005	-0.012	0.020	0.039	-0.071	0.070	-0.021	-0.194
	(0.005)	(0.009)	(0.015)	(0.006)	(0.193)	(0.103)	(0.159)	(0.059)	(0.283)	(0.339)	(0.227)
$XRate_{c,t}$	-0.004***	-0.004	-0.004	-0.007***	-0.087**	-0.002	-0.075*	-0.010	0.098	-0.090	0.045
	(0.001)	(0.006)	(0.003)	(0.002)	(0.035)	(0.028)	(0.037)	(0.011)	(0.068)	(0.080)	(0.034)
$Gini^w_{c,t}$	-0.123	-0.018	-0.095	-0.231*	-1.661	-0.089	0.080	-1.653	2.233	0.087	-1.862
	(0.080)	(0.146)	(0.145)	(0.132)	(2.991)	(1.480)	(1.773)	(1.370)	(3.329)	(3.287)	(3.623)
R^2	0.999	.998	.999	.999	.973	.985	.975	.961	.983	.972	.957
N	395	395	395	395	395	395	395	395	395	395	395

Notes: $* \, p < 0.05$, $** \, p < 0.01$, $*** \, p < 0.001$. Regression results to establish the link between tax aggregation and economic production for 19 European countries during the period 1995-2016. All regressions use country level data and include: GDP growth ($GDPgrowth_{c,t}$), share of gross output produced in service industries ($Services_{c,t}$); the Herfindahl-Hirschman Index computed based on the gross-output shares of macro-sectors ($HHI_{c,t}$); government consolidated gross debt as % of GDP ($Debt^{\%GDP}_{c,t}$); government interest payable as % of GDP ($Interest^{\%GDP}_{c,t}$); net government lending/borrowing as % of GDP ($Lending^{\%GDP}_{c,t}$); gross fixed capital formation as % of GDP ($GovInv^{\%GDP}_{c,t}$); period average exchange rate ($XRate_{c,t}$); Gini index from the industry level distribution of hourly wage ($Gini^w_{c,t}$); and country (c) and year (t) fixed effects. For the first block, $wL_{c,t}$, $rK_{c,t}$ and $pQ_{c,t}$ are expressed as the natural logarithm (ln) while for the last two blocks they are expressed as % of GDP.

Table SI.223: Taxation and the structure of economic production before 2007

	Taxes in ln of nat. currency				Taxes as % of GDP				Taxes as % of total tax		
	ln $T_{c,t}$	ln $T^l_{c,t}$	ln $T^k_{c,t}$	ln$T^y_{c,t}$	$T_{c,t}$	$T^l_{c,t}$	$T^k_{c,t}$	$T^y_{c,t}$	$T^l_{c,t}$	$T^k_{c,t}$	$T^y_{c,t}$
$R_{c,t}$	-0.040*	-0.077	-0.107***	0.019	-0.693*	-0.231	-0.835*	0.372**	-0.119	-1.993**	1.335**
	(0.020)	(0.049)	(0.030)	(0.032)	(0.385)	(0.185)	(0.384)	(0.133)	(0.471)	(0.789)	(0.470)
$ICT_{c,t}$	-0.042	-0.162	-0.109*	-0.008	-0.750	0.356	-1.223	0.117	1.133	-2.522*	0.664
	(0.025)	(0.124)	(0.052)	(0.027)	(0.684)	(0.465)	(0.702)	(0.173)	(0.999)	(1.381)	(0.951)
$R*ICT_{c,t}$	0.012	0.047	0.028	-0.001	0.075	0.047	-0.029	0.056	0.242	0.163	0.123
	(0.017)	(0.044)	(0.031)	(0.018)	(0.559)	(0.259)	(0.411)	(0.092)	(0.409)	(0.679)	(0.603)
$wL_{c,t}$	0.445*	1.155**	0.140	0.613***	-0.602**	-0.140	0.052	-0.514***	0.165	0.566*	-0.913***
	(0.220)	(0.484)	(0.297)	(0.179)	(0.225)	(0.140)	(0.157)	(0.087)	(0.265)	(0.302)	(0.284)
$rK_{c,t}$	-0.068	0.200	-0.194	0.170	-0.887***	-0.249	-0.086	-0.552***	0.034	0.474*	-0.758**
	(0.128)	(0.319)	(0.149)	(0.127)	(0.242)	(0.143)	(0.156)	(0.069)	(0.263)	(0.266)	(0.294)
$pQ_{c,t}$	0.641*	-0.292	1.044**	0.255							
	(0.310)	(0.739)	(0.365)	(0.297)							
$GDPgrowth_{c,t}$	-0.001	-0.006	-0.001	0.004	0.013	-0.054	0.013	0.054*	-0.137	-0.038	0.157*
	(0.002)	(0.004)	(0.003)	(0.003)	(0.045)	(0.036)	(0.037)	(0.026)	(0.091)	(0.082)	(0.083)
$Services_{c,t}$	0.002	-0.023	-0.013	-0.001	-0.116	0.124	-0.244*	0.004	0.529**	-0.619**	0.040
	(0.003)	(0.027)	(0.009)	(0.005)	(0.143)	(0.104)	(0.133)	(0.031)	(0.208)	(0.279)	(0.144)
$HHI_{c,t}$	-1.141	-2.182	-3.120***	-1.632	-53.009	9.721	-47.469**	-15.260*	79.200**	-76.069**	7.733
	(0.686)	(2.773)	(0.898)	(0.948)	(31.000)	(20.654)	(17.061)	(7.347)	(33.558)	(25.963)	(35.039)
$Debt^{\%GDP}_{c,t}$	0.001	0.005*	0.003**	-0.000	0.042*	0.020	0.018	0.004	0.019	0.015	-0.042
	(0.001)	(0.003)	(0.002)	(0.001)	(0.021)	(0.012)	(0.018)	(0.008)	(0.026)	(0.038)	(0.033)
$Interest^{\%GDP}_{c,t}$	-0.006	-0.009	-0.001	-0.007	0.149	-0.081	0.197	0.033	-0.160	0.459	0.260
	(0.007)	(0.011)	(0.009)	(0.004)	(0.178)	(0.131)	(0.113)	(0.065)	(0.300)	(0.285)	(0.273)
$Lending^{\%GDP}_{c,t}$	0.003	-0.006	0.006	0.000	0.131	0.016	0.097	0.018	-0.033	0.090	-0.072
	(0.003)	(0.006)	(0.006)	(0.002)	(0.080)	(0.033)	(0.074)	(0.013)	(0.084)	(0.129)	(0.070)
$GovInv^{\%GDP}_{c,t}$	-0.008	-0.026	0.008	-0.017*	-0.073	0.031	-0.006	-0.098	-0.095	0.236	-0.311
	(0.008)	(0.015)	(0.014)	(0.009)	(0.192)	(0.117)	(0.162)	(0.071)	(0.255)	(0.330)	(0.283)
$XRate_{c,t}$	-0.005**	-0.007	-0.009**	-0.005**	-0.119**	0.005	-0.116**	-0.009	0.160*	-0.205**	0.091**
	(0.002)	(0.006)	(0.003)	(0.002)	(0.047)	(0.033)	(0.044)	(0.011)	(0.081)	(0.082)	(0.040)
$Gini^w_{c,t}$	-0.276**	-0.667*	-0.560*	0.061	-4.085	-3.125	-1.788	0.828	-6.421	-3.643	8.095
	(0.118)	(0.313)	(0.300)	(0.204)	(3.691)	(2.275)	(3.607)	(1.095)	(4.514)	(7.436)	(4.566)
R^2	0.999	.998	.999	0.999	.982	.988	.984	.973	.99	.986	.97
N	224	224	224	224	224	224	224	224	224	224	224

Notes: $*\,p < 0.05$, $**\,p < 0.01$, $***\,p < 0.001$. Regression results to establish the link between tax aggregation and economic production for 19 European countries during the period 1995-2007. All regressions use country level data and include: GDP growth ($GDPgrowth_{c,t}$), share of gross output produced in service industries ($Services_{c,t}$); the Herfindahl-Hirschman Index computed based on the gross-output shares of macro-sectors ($HHI_{c,t}$); government consolidated gross debt as % of GDP ($Debt^{\%GDP}_{c,t}$); government interest payable as % of GDP ($Interest^{\%GDP}_{c,t}$); net government lending/borrowing as % of GDP ($Lending^{\%GDP}_{c,t}$); gross fixed capital formation as % of GDP ($GovInv^{\%GDP}_{c,t}$); period average exchange rate ($XRate_{c,t}$); Gini index from the industry level distribution of hourly wage ($Gini^w_{c,t}$); and country (c) and year (t) fixed effects. For the first block, $wL_{c,t}$, $rK_{c,t}$ and $pQ_{c,t}$ are expressed as the natural logarithm (ln) while for the last two blocks they are expressed as % of GDP.

Table SI.224: Taxation and the structure of economic production after 2008

	Taxes in ln of nat. currency				Taxes as % of GDP				Taxes as % of total tax		
	ln $T_{c,t}$	ln $T^l_{c,t}$	ln $T^k_{c,t}$	ln$T^y_{c,t}$	$T_{c,t}$	$T^l_{c,t}$	$T^k_{c,t}$	$T^y_{c,t}$	$T^l_{c,t}$	$T^k_{c,t}$	$T^y_{c,t}$
$R_{c,t}$	-0.010	0.013	0.023	-0.056	0.236	0.216	0.242	-0.221	0.408	0.557	-0.946
	(0.022)	(0.025)	(0.060)	(0.030)	(0.794)	(0.481)	(0.585)	(0.240)	(0.807)	(1.017)	(0.798)
$ICT_{c,t}$	0.022	-0.011	0.031	0.030	0.349	-0.164	0.256	0.257***	-1.459	0.828	0.615
	(0.034)	(0.052)	(0.032)	(0.055)	(0.469)	(0.672)	(0.342)	(0.056)	(1.075)	(0.791)	(0.653)
$R*ICT_{c,t}$	-0.016	-0.005	0.001	-0.031	-0.065	-0.186	0.243	-0.122	0.173	0.074	-0.278
	(0.024)	(0.027)	(0.042)	(0.033)	(0.703)	(0.431)	(0.657)	(0.104)	(0.526)	(0.818)	(0.605)
$wL_{c,t}$	0.399***	0.344*	0.522	0.370***	-0.608**	0.003	0.180	-0.791***	0.571	1.331*	-1.886***
	(0.085)	(0.180)	(0.288)	(0.090)	(0.194)	(0.065)	(0.244)	(0.081)	(0.379)	(0.603)	(0.332)
$rK_{c,t}$	0.020	0.232	0.157	-0.239***	-0.669***	-0.019	0.142	-0.792***	0.591*	1.231**	-1.811***
	(0.068)	(0.127)	(0.178)	(0.069)	(0.164)	(0.046)	(0.198)	(0.085)	(0.301)	(0.459)	(0.304)
$pQ_{c,t}$	0.217	0.085	0.253	0.261*							
	(0.137)	(0.325)	(0.348)	(0.120)							
$GDPgrowth_{c,t}$	0.000	-0.003	0.000	0.004**	-0.082	-0.050	-0.020	-0.012	-0.082	0.051	0.028
	(0.001)	(0.003)	(0.004)	(0.002)	(0.064)	(0.031)	(0.035)	(0.007)	(0.059)	(0.083)	(0.055)
$Services_{c,t}$	0.000	0.019**	0.011	-0.020**	0.220	0.126*	0.114	-0.020	0.198	0.041	-0.253
	(0.005)	(0.006)	(0.012)	(0.008)	(0.187)	(0.067)	(0.147)	(0.047)	(0.223)	(0.271)	(0.148)
$HHI_{c,t}$	-0.571	1.222	0.677	-3.414**	20.495	12.182	3.589	4.724	6.745	-6.478	-2.492
	(0.563)	(0.936)	(1.637)	(1.234)	(22.114)	(12.660)	(15.151)	(9.745)	(29.095)	(39.240)	(32.568)
$Debt^{\%GDP}_{c,t}$	-0.001	-0.002**	0.001	-0.001	0.044**	-0.003	0.021	0.026***	-0.040	0.020	0.023
	(0.001)	(0.001)	(0.003)	(0.001)	(0.014)	(0.009)	(0.012)	(0.007)	(0.022)	(0.027)	(0.015)
$Interest^{\%GDP}_{c,t}$	0.015*	0.017*	-0.025	0.044***	-0.700*	-0.115	-0.243	-0.342**	0.385	-0.129	-0.297
	(0.008)	(0.007)	(0.032)	(0.011)	(0.330)	(0.114)	(0.196)	(0.136)	(0.208)	(0.376)	(0.401)
$Lending^{\%GDP}_{c,t}$	0.003*	0.002	0.006	0.000	0.083	0.017	0.059	0.008	-0.026	0.090	-0.073
	(0.001)	(0.002)	(0.003)	(0.002)	(0.048)	(0.018)	(0.036)	(0.011)	(0.038)	(0.056)	(0.045)
$GovInv^{\%GDP}_{c,t}$	0.005	0.022*	0.000	-0.004	0.154	0.096	0.124	-0.066	0.307	0.024	-0.317
	(0.006)	(0.012)	(0.018)	(0.009)	(0.204)	(0.088)	(0.170)	(0.049)	(0.279)	(0.305)	(0.254)
$XRate_{c,t}$	0.006	-0.002	0.007	0.018*	-0.003	-0.022	0.000	0.018	-0.166	0.157	0.005
	(0.008)	(0.009)	(0.016)	(0.008)	(0.269)	(0.126)	(0.251)	(0.053)	(0.204)	(0.335)	(0.213)
$Gini^w_{c,t}$	-0.534	0.546	-2.035	-0.512	-11.923	7.904	-20.568	0.741	31.981	-53.367*	20.169
	(0.391)	(0.700)	(1.449)	(0.338)	(13.351)	(8.440)	(12.519)	(3.255)	(20.372)	(28.630)	(19.228)
R^2	0.999	0.999	.999	0.999	.986	.994	.989	.984	.992	.99	.983
N	171	171	171	171	171	171	171	171	171	171	171

Notes: $*\,p < 0.05$, $**\,p < 0.01$, $***\,p < 0.001$. Regression results to establish the link between tax aggregation and economic production for 19 European countries during the period 2008-2016. All regressions use country level data and include: GDP growth ($GDPgrowth_{c,t}$), share of gross output produced in service industries ($Services_{c,t}$); the Herfindahl-Hirschman Index computed based on the gross-output shares of macro-sectors ($HHI_{c,t}$); government consolidated gross debt as % of GDP ($Debt^{\%GDP}_{c,t}$); government interest payable as % of GDP ($Interest^{\%GDP}_{c,t}$); net government lending/borrowing as % of GDP ($Lending^{\%GDP}_{c,t}$); gross fixed capital formation as % of GDP ($GovInv^{\%GDP}_{c,t}$); period average exchange rate ($XRate_{c,t}$); Gini index from the industry level distribution of hourly wage ($Gini^{w}_{c,t}$); and country (c) and year (t) fixed effects. For the first block, $wL_{c,t}$, $rK_{c,t}$ and $pQ_{c,t}$ are expressed as the natural logarithm (ln) while for the last two blocks they are expressed as % of GDP.