Heterogeneous adjustments of labor markets to automation technologies*

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Abstract

This paper examines the differences in the adjustments of employment and wages to four automation technologies—i.e. robots, communication technology, information technology, and software/database—across 227 regions in 22 European countries from 1995 to 2017. By constructing a measure of technology penetration, we estimate changes in regional labor markets and workers' reallocation between sectors associated with automation technologies. We find that labor market adjustments to automation technologies differ according to: i) the technology which penetrates; ii) the sector of penetration; iii) the sectoral composition of the region; and iv) the technological capabilities of the region. These adjustments are largely driven by the reallocation of low-paid workers across sectors.

Keywords: Automation technology, Labor market, Employment reallocation, Sectoral composition.
JEL Codes: J21, O33, R23.

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1 Introduction

Technologies displace workers by automating part of their tasks. By raising productivity, they also promote economic activity. The (not yet automated) task of determining which effect dominates has become key in social sciences at the dawn of a new economic era with robots and artificial intelligence. As evidence in the literature diverge, the hope of finding a unique answer to that question is a losing battle.[1] At the same time, policymakers are rightly concerned about *how* automation will change the labor market in their area.

Local labor markets have drastically different labor forces that can adapt differently to automation technologies. While in Stuttgart, more than half of workers are employed in the industrial sector, it accounts for less than a third in Andalusia. Is it reasonable for policymakers to expect the same labor market adjustments in those two regions when it comes to the penetration of industrial robots? Nonetheless, labor markets in European regions are not only differentiated by their sectoral composition. Both Brussels and Athens are service-intensive capital cities, although they differ in their technological capabilities. Do productivity gaps also reflect differences in automation adoption between European regions?

This paper examines how automation technologies are associated with changes in employment and wages across 227 regions in 22 European countries from 1995 to 2017. By combining several data sources, we construct a measure of technology penetration at the regional level and at the sectoral level (within regions). We document how regional labor markets adjust to the penetration of robots, communication technology, information technology, and software/database. We break our analysis down at the sectoral level. We decompose the sectoral adjustments to the penetration of automation technologies in each sector. These adjustments are the sum of two mechanisms: the regional productivity effect and the sectoral reallocation effect. The former captures the change in the regional economic activity that follows the technology penetration, while the latter accounts for the resulting workers' reallocation across sectors. We then group regions into clusters which are based on their sectoral composition and level of productivity prior to the period of analysis. We describe the differences between clusters in terms of regional labor market adjustments and workers' reallocation across sectors. Our analysis proceeds in four steps.

First, we combine several data sources to construct our measure of technology penetration. Our sample contains 227 NUTS-2 regions located in 22 European countries over the period 1995–2017. Using the ARDECO database, we have information on the employment-to-population ratio and the average wage at the regional and (within-region) sectoral lev-

[1] See Acemoglu and Restrepo (2018) for the canonical task-based framework with directed technological change. See Aghion et al. (2022) for a comprehensive review that presents the two opposing views in the literature that argue that automation technologies lead to either net creation or net destruction of jobs.

els. We aggregate industries into six broad sectors (i.e. agriculture, industry, construction, market services, financial and business services, and non-market services). We consider four automation technologies: robots, communication technologies, information technologies, and software/database.[2] We use data from the International Federation of Robotics (IFR) for robots and from the EU-KLEMS database (Release 2019) for the three other technologies.[3]

We construct our measure of technology penetration at the (within-region) sectoral level to estimate the regional penetration. Technology stocks are available at the country-sector level. We normalize the technology stock to the country-sector average level of employment (in thousands) between 1990 and 1994. We allocate this country-sector technology stock per thousand workers across regions by using the share of gross fixed capital formation of the region in the country in that sector. We then estimate the regional technology penetration as the average penetration across sectors weighted by the average sectoral composition of employment between 1990 and 1994 in the region.

Second, we analyze how labor markets adjust to the penetration of automation technologies at the regional level. Our baseline empirical specification estimates the change in the employment-to-population ratio and average wage over 10 years according to the changes in the regional penetration of the four automation technologies over the same period. We can interpret our estimates as elasticities since both changes are expressed in logarithms, e.g. the percentage change in regional employment that is associated with a one percent increase in the penetration of robots in the region. We also estimate the same relationship over the 1-year, 5-year, and 15-year horizons.

Third, we break our analysis down at the sectoral level to better understand the underlying changes within regions. We estimate the change in employment (and average wage) in one sector of the region according to the changes in technology penetration in all the sectors of the region. Thus, we allow employment in each sector to be affected in two ways: directly, as the technology penetrates the same sector, that is the *within-sector* adjustment; or indirectly, as the technology penetrates a different sector, which may be associated with adjustments in our sector of interest, that is the *between-sector* adjustment.

We decompose the sectoral adjustments for each sector. These adjustments are the sum of two mechanisms. On the one hand, the regional productivity effect captures the change in

[2]Software serves as a proxy for AI penetration, as shown in Baruffaldi et al. (2020), where they measure its incidence by accounting for the use of AI in open-source software. They show that AI software-related use has dramatically soared since 2013.

[3]IFR data provide the number of installed robots by country and industry since 1993; see Jurkat et al. (2022) for a comprehensive review. EU-KLEMS database provides the net capital stocks (at constant €2015 prices) for communication technology, information technology, and software-database, at the industry level since 1970; see O'Mahony and Timmer (2009) for a comprehensive review. Software and database are regrouped as a unique technology due to data availability.

the regional economic activity that follows the technology penetration. On the other hand, the sectoral reallocation effect accounts for the reallocation of workers between sectors. By considering the change in the sectoral average wage relative to the regional average wage, we are able to determine whether the reallocated workers' are either, on average, low- or high-paid workers.

Fourth, we cluster regions based on their characteristics to look at the heterogeneity in adjustments and workers' reallocation. Regional labor markets are structurally heterogeneous across European countries, implying that the capacity to absorb external shocks is not the same across regions with diverse industrial compositions (Tóth et al. 2022). To account for this, we cluster the 227 regions using the K-means algorithm based on labor market characteristics before the period of analysis. We summarize these characteristics with two dimensions: the sectoral composition of regional employment and the level of productivity. The first dimension accounts for the specialization of the labor force in the region (agriculture, industry, or services). The second dimension accounts for the differences between European regions in terms of technology capabilities.

Our preferred classification has 7 clusters. Three of them are characterized by low-productivity regions that are specialized in services, industry, or agriculture. These clusters include regions mostly located in Eastern Europe (i.e. Bulgaria, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Slovakia, and Slovenia) and some regions from Southern European countries (i.e. Greece, Italy, Portugal, and Spain). The four other clusters include regions that are mostly located in Northern and Western Europe (i.e. Austria, Belgium, Denmark, Finland, France, Germany, Ireland, Netherlands, and Sweden). These latter clusters also distinguish themselves according to the sectoral composition of employment between agriculture, industry, and services—with one cluster characterizing capital cities which are service-intensive regions. Taking advantage of our classification of regions, we re-estimate our baseline specification allowing for cluster-specific labor market adjustments to technology penetration.

Our analysis provides five main results. First, labor market adjustments to automation differ according to the technology. Regional penetration of robots and IT are associated with an increase in employment but a small decrease in wages. CT penetration is associated with a decline in wages, while software and database, however, are associated with higher wages.

Second, the timing of adjustments also depends on the technology. Labor market adjustments to the penetration of both IT and CT gradually intensify over time—i.e. from small in the short run (5 years) to large in the long run (15 years). Conversely, both robot and software-database penetrations display sharp and large adjustments already since the short run.

Third, labor market adjustments depend on the sector through which the automation technology penetrates. Robot adoption in the industry sector seems to complement workers and, thus, serves as an engine for enhancing employment also in other sectors. Conversely, the overall positive relation between IT penetration and employment at the regional level is driven by market services and not by industry—where IT substitutes workers. The large and positive association of software and database penetration with wages is driven by the industrial sector; whereas the non-significant relation with employment at the regional level is due to the increase in industry and the decrease in services that cancel out.

Fourth, the reallocation of workers between sectors also explains a large part of labor dynamics in regions following an increased penetration of automation technologies. These reallocation patterns also depend on the technology and the sector of penetration. For instance, robot (software-database) penetration in the industry is associated with a reallocation of low-paid (high-paid) workers from the service sector to the industry. Conversely, the IT penetration in the industry is associated with a leak of workers from that sector toward service sectors.

Fifth, the between-region heterogeneity in labor market adjustments to automation technologies reflects the differences between European regions in terms of sectoral specialization and technological capabilities. Robot penetration is associated with positive employment changes in regional labor markets, except for service-intensive, low-productive, capital cities. For the three other technologies, there is a clear divide between Southern and Eastern (low-productive) and Northern and Western (high-productive) European regions. Employment in Southern and Eastern regions benefit from the regional penetration of IT and CT—although wages decrease; whereas employment and wages in North and Western regions benefit from the penetration of software and database.

Our work is related to several strands of the literature. The literature on the regional impact of automation technologies remains indecisive regarding the consequences for regional labor markets (Acemoglu and Restrepo 2019, Aghion et al. 2019, Bessen 2019, Aghion et al. 2020, Vries et al. 2020, Webb 2019, Gregory et al. 2022). Empirical studies find heterogeneous results when determining which effect dominates. Using data on the penetration of four different automation technologies in a large number of regions, located in several European countries, we provide new evidence about some of the underlying reasons for such heterogeneity in European labor market adjustments. We find that these differences in adjustments reflect the specialization and the technological capabilities of regions.[4] We thus

[4]Our findings are consistent with Bachmann et al. (2022) who find a stronger positive relationship between robots and worker flows in countries with relatively low labor costs. Labor costs are one dimension of regions' specificities that can be related to technological capabilities.

emphasize the wide divide between Southern and Eastern and Northern and Western European regions in labor market adjustments to automation technologies. Our findings also reveal that different automation technologies lead to different adjustments, thus, emphasizing that robots—although they received most of the attention in this literature—remain a subset of automation technologies and do not summarize the relationship with labor market dynamics for all other technologies.

This paper also makes a methodological contribution to the literature on the measurement of technology penetration at the regional level (Acemoglu and Restrepo 2019, Aghion et al. 2019, Vries et al. 2020, Dauth et al. 2021). The standard approach measures the exposure (i.e. penetration) using a shift-share design based on the industrial structure of employment in the region prior to the period of analysis. This approach assumes that firms in a given industry, have the same propensity to adopt automation technologies in all regions. We contribute to the literature by constructing a measure that allows industries to differ in technology adoption across regions. Taking advantage of our measure, we can look at the dynamics of employment and wages at the sectoral level within regions. Our measure, however, has a drawback. Because we study employment adjustments in different sectors, we cannot derive the usual shift-share design which leverages the employment structure across sectors.

We contribute to the literature on ICT adoption for labor market outcomes (Autor et al. 2003, Spitz-Oener 2006, Goos and Manning 2007, Goos et al. 2009, Autor and Dorn 2013, Goos et al. 2014, Michaels et al. 2014, Cortes et al. 2017). A large part of this literature links ICT adoption to the polarization of employment due to technology-skill complementarity. These studies suggest that ICT adoption shifts the labor demand toward more skilled workers with workers in middling jobs being displaced by these technologies. We add to this literature by disentangling the role of IT and CT to show that the sector through which these technologies penetrate matters. For instance, we find that the penetration of CT in market services is associated with a displacement of less-skilled workers from that sector. However, this pattern is not observed in the industry.[5] The polarization pattern observed in the industrial sector is related to the penetration of IT in that sector which substitutes workers.

Lastly, we contribute to the literature on the determinants of regional disparities in economic performance (Charlot et al. 2015, Fontagné and Santoni 2018, Xiao et al. 2018, Marchand et al. 2020, Aloi et al. 2021, Evenhuis et al. 2021). Disparities between European regions have increased since mid-2000, with respect to both GDP and employment (Ehrlich and Overman 2020). Several studies link growing inequalities across regions to diverging

[5]Our findings on CT are consistent with Akerman et al. (2015) showing that broadband internet worsens labor market outcomes of unskilled workers due to their substitution in executing routine tasks.

capacity to innovate and attract skilled labor (Lee and Rodriguez-Pose 2012,Iammarino et al. 2019, Boschma 2022). Differences in the quality of institutions also play a role in explaining the recent labor productivity slowdown through the long-term returns of human capital and innovation (Rodriguez-Pose and Cataldo 2014, Rodríguez-Pose and Ganau 2021). We contribute to this literature by showing that divergences in automation technologies adoption are related to either the differences in sectoral composition when the regional penetration occurs through services (i.e. agriculture-, industry-, or service-intensive regions); or differences in technological capabilities when the penetration occurs through the industry (i.e. high- or low-productivity regions).

The paper is organized as follows. Section 2 presents the data and our measure of technology penetration. Section 3 estimates the relation between labor market adjustments and technology penetration at the regional level. In Section 4, we describe the sectoral adjustments. We present our decomposition to account for workers' reallocation between sectors. In Section 5, we cluster regions based on their sectoral composition and level of productivity. We then present the heterogeneity in adjustments and reallocation between clusters. In Section 6, we discuss the regularities across different technologies, industries, and regions. Section 7 concludes.

2 Data

2.1 Sample

Our sample contains 227 NUTS-2 regions from 22 European countries between 1995 and 2017.[6] We define sectors (of economic activities) according to the sections of the NACE Rev.2 classification. As the classification has changed from Rev. 1.1 to Rev. 2 in 2008, we aggregate sections accordingly to have consistent sectors; see Table A.1 and A.2 in the appendix for more details.

We consider six sectors as the result of the aggregation. Agriculture (A) corresponds to activities that relate to agriculture, forestry, and fishing. Industry (B-E) refers to manufacturing, mining and quarrying, utilities; except Construction (F) which is a sector in itself. Market Services (G-J) encompass service activities such as wholesale and retail trade, accommodation and food service activities, transportation and storage, along with information and communication. Financial & Business Services (K-N) correspond to financial and insurance activities; real estate activities; professional, scientific, technical, administration and

[6]The set of countries are (in alphabetical order): Austria, Belgium, Bulgaria, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Netherlands, Poland, Portugal, Slovakia, Slovenia, Spain, and Sweden.

support service activities. Lastly, Non-Market Services (O-U) regroup all other services such as public administration and defense, education, human health and social work activities; and any other service activities.

2.2 Variables

Labor market. We consider two labor market outcomes: employment-to-population ratio and average wage. Both are derived from the ARDECO database and are available at the NUTS-2 level.

Employment-to-population ratio—which corresponds to the total number of employed persons aged 15-64 (L) divided by the total population in the region (N)—is derived at both the regional and (within-region) sectoral levels, i.e. respectively $l_r = L_r/N_r$ and $l_{ri} = L_{ri}/N_r$, where r is the region and i is the sector.

Average wage refers to the average yearly wage per worker (in thousands €2015) and is derived as the total compensation (C) divided by the level of employment (L). It is also derived at both the regional and (within-region) sectoral levels, i.e. respectively $W_r = C_r/L_r$ and $W_{ri} = C_{ri}/L_{ri}$.

Automation technology. We consider four different, although related, automation technologies:

1. Robot: "programmed actuated mechanism with a degree of autonomy to perform locomotion, manipulation or positioning" (ISO 8373:2021);
2. Communication technology: "specific tools, systems, computer programs, etc., used to transfer information among project stakeholders" (ISO 24765:2017);
3. Information technology: "resources required to acquire, process, store and disseminate information" (ISO 24765:2017);

4a. Computer software: "computer programs, procedures and possibly associated documentation and data pertaining to the operation of a computer system" (ISO 24765:2017);

4b. Database: "collection of interrelated data stored together in one or more computerized files" (ISO 24765:2017).

We consider software (4a) and Database (4b) as one technology due to data availability.

To measure the stock of robots, we use the number of robots currently in use in each sector at the country level provided by the International Federation of Robotics (IFR); see Jurkat et al. (2022) for a comprehensive review. Robots are present in only three sectors out of six: Industry (B-E), Construction (F), and Non-Market Services (O-U). About 30%

of the robots are not classified. We allocate them proportionally according to the share of each sector in the total number of robots in the country.[7]

To measure the stock of ICT, we use the EU-KLEMS database (Release 2019) which provides data on communication equipment (i.e. communication technology), computing equipment (i.e. information technology), and computer software and databases (i.e. software-database), for each sector at the country level; see O'Mahony and Timmer (2009) for a comprehensive review. Our measures of these technology stocks are the net capital stock (at constant €2015 prices) which is derived from the national accounts.[8]

Other variables. We use the Gross Fixed Capital Formation (GFCF) from the ARDECO database which is available at the country-sector and region-sector levels. This is defined as the acquisitions of produced tangible and intangible assets that are used in the production process for more than one year less disposals of fixed assets. The variable is measured in millions of €2015.

We include two additional control variables to separate the role of technological change from other confounding factors. First, we control for changes in final domestic demand using the real consumption index from the Inter-Country Input-Output database.[9] Technologies can generate economies of scale which translate into a reduction in prices that stimulates product demand. Consequently, this increase in the aggregate demand stimulates labor demand (Bessen 2019).

Second, we account for changes in imports from China using the OECD Trade in Value Added database.[10] Increasing penetration of trade with emerging consequences has detrimental consequences on employment in manufacturing (Autor et al. 2013, Autor et al. 2015). Both control variables are computed at the regional level.

[7]We follow the literature to allocate the unclassified ones across the three sectors (see Acemoglu and Restrepo 2020). Although others do not allocate the unclassified robots (see Graetz and Michaels 2018, Dauth et al. 2021), we decide to include them to have a consistent measure of robots once we aggregate our measure of technology penetration across sectors. As described by Jurkat et al. (2022), the share of unclassified robots sharply decreases over time. Moreover, for some countries, the availability of robots by sector starts later. For these cases, we impute robot stocks backward by applying the average share of sectoral robots for the years for which there is data available to the total stock (in the same spirit as Graetz and Michaels 2018). Results are robust to more complex imputation methods that account for the relative trend in robot stock in each sector.

[8]For some countries, the technology stocks are available at the regional level but not at the sectoral (within region) level. We thus recover them by allocating the technology stocks at the regional level to the sectors within the region. To do so, we use the share of the sector in the regional gross fixed capital formation. This imputation concerns five countries: Bulgaria, Hungary, Ireland, Poland, and Portugal. Despite the imputation, technology stocks of six countries are only available from 2000 onward—i.e. Bulgaria, Estonia, Poland, Portugal, Slovakia, and Slovenia.

[9]OECD (2021), OECD Inter-Country Input-Output Database, http://oe.cd/icio. Release: November 2019.

[10]OECD (2021), OECD Trade in Value Added Database, http://oe.cd/tiva. Release: November 2021.

As we cluster regions, in Section 5, based on the level of labor productivity, we construct a measure of the latter as the ratio between the gross value added and the total number of employed persons aged 15-64 in a given region.

2.3 Technology penetration

Prior work that computes the technology penetration focuses on robots per worker. Although we extend the set of technologies by also looking at CT, IT and software-database in our work, we compare our measure with this literature. The standard approach is to predict the robot penetration in local labor markets by applying a shift-share design (see Acemoglu and Restrepo 2019, Aghion et al. 2019, Dauth et al. 2021). They allocate the change in robots according to the industrial structure of employment in the region before the period of analysis. The underlying assumption is that regions that are more specialized in industries in which robot adoption has been larger at the national level, should also be the regions with the larger rate of adoption.

We propose a measure that differs from theirs for two reasons. First, the latter assumption usually made in the literature implies that firms in industry i have the same propensity to adopt automation technologies in all regions. However, adoption rates differ substantially *between* countries for a given industry (see, for instance, Jurkat et al. 2022 for robot adoption) but also across regions *within* countries (Leigh et al. 2022).

Second, we need to allocate automation technologies at the (within-region) sectoral level to look at the sectoral adjustments. We cannot use the shift-share design at this level of analysis since such a design exploits the local sectoral structure to build penetration at the regional level.

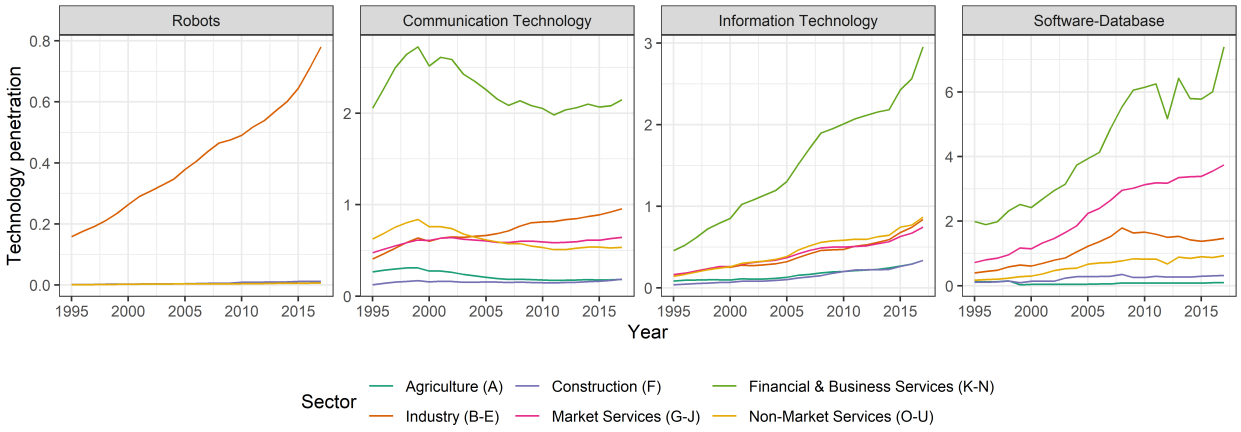
To overcome these limitations, we assume that firms in industry i are more likely to adopt automation technologies in a region that shows higher capital investment. We construct the Gross Fixed Capital Formation (GFCF) share at the regional level as the ratio between the sectoral GFCF in the region and the sectoral GFCF in the country of that region.

We define the penetration of technology K in sector i in region r in country c in year t as:

$$K_{rit} = \frac{Tech_{cit}}{\bar{L}_{ci}} \times \frac{GFCF_{rit}}{GFCF_{cit}}, \tag{1}$$

where $Tech_{cit}$ is the technology stock in sector i in the country in the current year (as described in Section 2.2), $\bar{L}_{ci}$ is the average level of employment in the sector in the country

Figure 1: Technology penetration by sectors



Notes: This figure presents the dynamics of the average sectoral penetration of robots, communication technology, information technology, and software-database, in Agriculture (A), Industry (B-E), Construction (F), Market Services (G-J), Financial & Business Services (K-N) and Non-Market Services (O-U), which is aggregated across regions. The x-axis corresponds to the year and the y-axis corresponds to the technology penetration. Column panels refer to technologies.

between 1990 and 1994,[11] and $GFCF_{rit}/GFCF_{cit}$ is the regional share of the national gross fixed capital formation in sector i.[12]

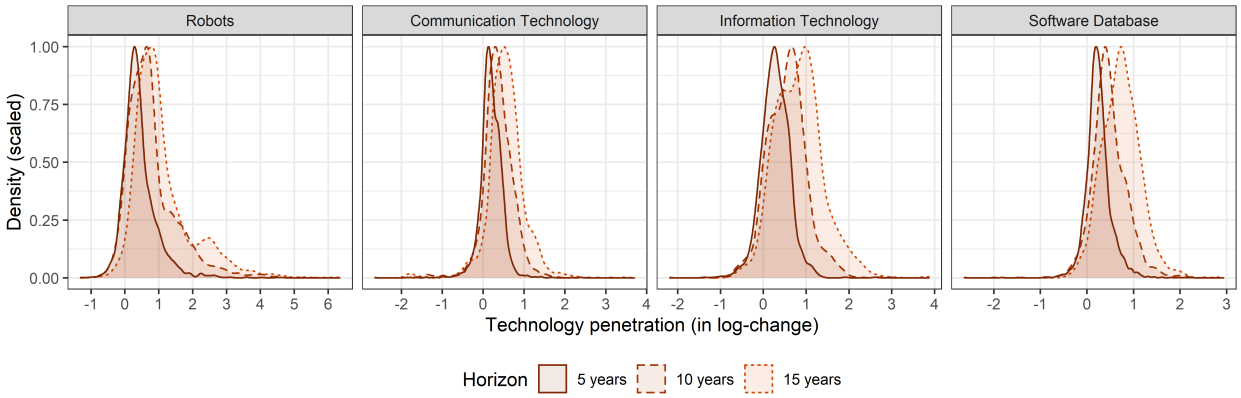
Figure 1 presents the average technology penetration by sectors from 1995 to 2017 which is aggregated across all regions. Although there exist some robots in Construction (F) and Non-Market Services (G-J), Industry (B-E) is the most robot-intensive sector. The penetration of robots in Industry (B-E) multiplied by almost 4 between 1995 to 2017 and does not slow down after the financial crisis. Communication technology varies across sectors. The penetration increases for Industry (B-E) on average across regions, while it decreases for Financial & Business Services (K-N) after the beginning of the 2000s, and is relatively constant for the other sectors during the whole period. Information technology follows a different pattern from the previous two technologies. The penetration increases in all sectors, especially in Financial & Business Services (K-N), slowing down only for a few years after the 2008 financial crisis. The penetration of software and database displays a pattern close to IT. There is a large increase in Financial and Business Services (K-N) and Market Services (G-J), but a slowdown in Industry (B-E) after the 2008 financial crisis.

We define the regional penetration of technology K as in the literature by considering differences across sectors. We compute it as the average penetration across sectors—from Equation (1)—weighted by the sectoral share of employment in the region before the period

[11] Employment data are not available for every year between 1990 and 1994 for three countries: Czech Republic (available since 1993), Germany (since 1991), and Poland (since 1992). For those, we take the average with the available years. Employment data are only available since 1995 for four other countries: Bulgaria, Hungary, Slovakia, and Slovenia. For those, we use the level of employment in 1995.

[12] Considering that investment in digital automation technologies is part of the capital investment.

Figure 2: Distributions of changes in technology penetration



Notes: This figure presents the distributions of the changes in the penetration of robots, communication technology, information technology, and software-database, at the regional level. The x-axis corresponds to the technology penetration (in log-change) and the y-axis corresponds to the scaled density. Column panels refer to technologies. Time horizons range from 5 to 15 years and correspond to the window of the log-change of variables.

of analysis. Thus,

$$K_{rt} = \sum_i \frac{\bar{L}_{ri}}{\bar{L}_r} K_{rit} \tag{2}$$

where $\bar{L}_{ri}$ is the average level of employment in sector i in region r between 1990 and 1994, $\bar{L}_r$ is the average level of employment in region r over the same period, and K_{rit} is the (within-region) sectoral penetration from Equation (1). Table B.6 in the appendix presents the summary statistics of technology penetration at the regional level.

2.4 Technology penetration over time horizons

We define the change in the technology penetration between the year t and $t+h$ such that:

$$\Delta K_{t+h} = \log K_{t+h} - \log K_t,$$

where h is the horizon that corresponds to the window of the change. Figure 2 presents the distributions of the change in technology penetration at the regional level for different time horizons: 5, 10, and 15 years.

For all automation technologies, the distribution of changes in technology penetration shifts to the right-hand side of the panel as the horizon—i.e. the window of the log-change—increases. This indicates that, on average, changes in technology penetration increase over time. Distributions for robots are more skewed which suggests that few regions are overly exposed.

Table 1 presents the change in technology penetration at the regional level. The average

Table 1: Summary statistics – Change in technology penetration at the regional level

	Robots			Comm. Tech.			Info. Tech.			Soft. Data.			
h	Q2	Mean	SD	Q2	Mean	SD	Q2	Mean	SD	Q2	Mean	SD	N
5	0.43	0.90	2.85	0.21	0.29	0.48	0.34	0.43	0.62	0.27	0.38	0.51	3901
10	0.99	2.94	9.63	0.47	0.64	0.86	0.81	1.05	1.62	0.61	0.92	1.19	2766
15	1.58	5.71	20.55	0.78	1.09	1.64	1.36	1.92	2.84	1.16	1.55	1.80	1631

Notes: This table presents the summary statistics of the growth rate of technology penetration of robots, information technology, communication technology, and software-database, at the regional level for the 227 NUTS-2 regions according to time horizon h. Technology penetration is a measure of the allocation of technologies across regions. Data are from the IFR database for robots and EU-KLEMS (Release 2019) for the three other technologies.

region faces a 294% growth in robot penetration over the 10-year horizon while the median growth rate is about 99%. The latter indicates that the technology penetration doubled for more than half of the regions in 10 years. The median growth rates of the penetration of the three other automation technologies are 47% for communication technology, 81% for information technology, and 61% for software and database. For all four technologies, we also notice a widening of regional differences, as the width of the distribution around the mean increases.

3 Labor markets adjustments to technology penetration

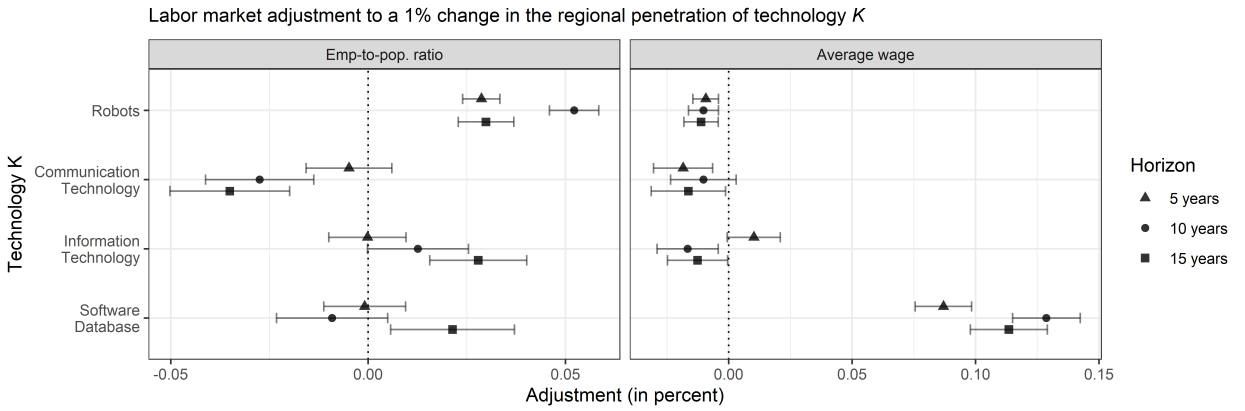
We start by looking at the relationship between labor market outcomes and technology penetration at the regional level. We estimate the regional labor market adjustments in the employment-to-population ratio and average wage associated with changes in the regional penetration of technologies over different time horizons:

$$\Delta Y_{r,t+h} = \alpha_h + \sum_K \beta_h^K \Delta K_{r,t+h} + X\psi + u_{r,t+h}, \tag{3}$$

where $\Delta Y_{r,t+h}$ is the log-change in the outcome variable Y between t and $t+h$ in the region r, $\Delta K_{r,t+h}$ is the log-change in the regional penetration of technology K over the same period in the same region, X are control variables including trade exposure, final demand, and region and time fixed effects, and $u_{r,t+h}$ is the error term. Log-difference estimates can be interpreted as elasticities—i.e. the percentage change in the outcome variable Y that is associated with a 1% change in the penetration to technology K.

Figure 3 summarizes the relationship between labor market outcomes and technology penetration at the regional level by displaying the estimated β_h^K coefficients from Equation

Figure 3: Regional labor market adjustments to technology penetration



Notes: This figure presents the labor market adjustments at the regional level of the employment-to-population ratio and average wage to a 1% change in the regional penetration of robots, communication technology, information technology, and software & database. The x-axis corresponds to the adjustment (in percent) and the y-axis corresponds to the technology. Column panels refer to labor market outcomes. Time horizons range from 5 to 15 years and correspond to the window of the log-difference of variables in the regression. Figure E.1 in the appendix presents the figure for the 1-year horizon. Table D.1 in the appendix presents the regressions. Coefficients are reported with a 95% confidence interval and can be interpreted as elasticities since they are obtained using linear regressions with variables in log-difference. Control variables include imports from China (in log-difference), real consumption index (in log-difference), and region and time fixed effects.

(3) with 95% confidence intervals. Although we estimate the relationship over all the time horizons that range from 1 to 15 years, we only report the results for the 5-year, 10-year, and 15-year horizons. We refer to them as respectively the short run, the medium run, and the long run.

Penetration of robots at the regional level tends to be correlated with good prospects in terms of employment at the cost of a small but statistically significant and persistent decline in the average wage. For instance, over a 10-year horizon—which provides the largest estimates for employment—a 1% increase in robots is associated with an increase of 0.052 % in the employment-to-population ratio but a decrease of 0.009 % in the average yearly wage. The median growth rate of robot penetration is about 99% over the 10-year horizon in our sample. This indicates that robot penetration has been multiplied by (at least) two for half of the regions, corresponding to an increase of (at least) 5.2 % in the regional employment-to-population ratio and a decrease of (at least) 0.9 % in the average wage. Since the distribution of change in robot penetration is skewed, the penetration of robots has been multiplied by four for the average region in our sample over this horizon, hence, indicating that the latter figures are double for the average region.

Contrary to robots, the penetration of communication technology seems to be labor-saving as the level of employment declines in the medium to long run as the technology penetrates the region. Over the 10-year horizon, the employment-to-population ratio elasticity is about 0.027. For a region with the median CT penetration (47%), it corresponds

to a decline of 1.3 % in regional the employment-to-population ratio. Contrary to the other technologies, wages move in the same direction as employment. Although we do not observe any significant change in the average wage over the 10-year horizon, the short and long-run estimates are significantly negative although small.

The adjustments to IT penetration show a similar direction as those observed for robots, i.e. an increase in employment and a decline in the average wage. Nevertheless, there are some differences in the timing of adjustment and in the magnitude of the coefficients. The effect on employment is greater for the 15-year horizon, while the effect on wages reaches a peak for the 10-year horizon. In the medium run, the employment-to-population ratio and average-wage elasticities reach respectively the values of 0.013 and -0.017. For a region with a median IT penetration (81%), this corresponds to an increase in the regional employment-to-population ratio of 1.1 % and a decline in the average wage of 1.4 %.

A penetration of software and database is associated with large changes in wages without major implications for employment in the short and medium run. The average wage elasticity is about 0.087 in the short run, before rising to 0.129 in the medium run and 0.114 in the long run. The elasticity of the employment-to-population ratio becomes positive only in the long run. For a region with the median penetration over the 10-year horizon (61%), this corresponds to a 7.9 % rise in the average wage.

To summarize, average regional labor market adjustments to automation technologies differ in two dimensions. On the one hand, the *direction of adjustment* depends on the technology. On average, regional labor markets tend to benefit from investments in software and database through an associated increase in wages. Robot and IT investments complement regional employment but this is accompanied by a small decrease in wages. CT has the most detrimental implications for employment with a moderate decline in wages. The different role of CT, though, may depend on its overall decline associated with an increase in employment and wages.

On the other hand, the *timing of adjustment* also depends on the technology. Labor markets depict gradual employment adjustments to the penetration of ICT from the short to the long run. Conversely, robots and software-database show sharp and large adjustments already in the short run—in terms of employment for robots and wages for software-database. These differences in timing may be due to their different level of maturity, potential applications, and labor force adaptation.

These patterns provide an overview of the relationship between labor markets and technology penetration at the regional level. However, the penetration of these technologies differs substantially across sectors (see Figure 1) and across regions with similar sectoral compositions (see Section 5). For instance, robots are largely used in industry while ICT

and software-database are more widespread in the services sectors. Yet, these results are aggregated at the regional level and may conceal sector-specific patterns along with inter-dependencies between sectors.

4 Sectoral adjustments and workers' reallocation between sectors

In this section, we break our analysis down to the (within-region) sectoral level to better understand the different adjustments of employment and wages for different technologies. We proceed in two steps. First, we distinguish adjustments that are due to the penetration of automation technologies within the sector from those that are due to the penetration through other sectors in the region. Second, we decompose these adjustments into two effects for both employment and wages: the *sectoral reallocation effect*, and the *regional adjustment effect*. We focus our analysis on the 10-year horizon for the remaining of the paper; we report results for the other time horizons in the online appendix. Due to the small share of workers in Agriculture (A) and Construction (F), we follow the literature and focus on the sectoral reallocation effects in the industry and the three service sectors—i.e. we report the results for Agriculture (A) and Construction (F) in the appendix.

4.1 Empirical specification

Technology penetration can affect sectors in two ways: either directly with adjustments of labor market outcomes to technology penetration that occurs in the same sector, that is the *within-sector* adjustment, or indirectly with adjustments relating to the penetration in another sector, that is the *between-sector* adjustment.

We estimate sectoral adjustments separately for the six sectors j:

$$\Delta Y_{rj,t+10} = \alpha_j + \underbrace{\sum_K \gamma_{jj}^K \Delta K_{rj,t+10}}_{\text{Within-sector adjustment}} + \underbrace{\sum_K \sum_{i \neq j} \gamma_{ji}^K \Delta K_{ri,t+10}}_{\text{Between-sector adjustment}} + X\psi + u_{rj,t+10}, \qquad (4)$$

where $\Delta Y_{rj,t+10}$ is the log-change in the outcome variable Y between t and $t+10$ in sector j in region r, $\Delta K_{ri,t+10}$ is the log-change in the penetration of technology K over the same period in sector i—which may differ from sector j—in the same region, X are control variables including trade exposure, final demand, region and time fixed effects, and $u_{rj,t+10}$ is the error term.

Estimated coefficients γ_{jj}^K and γ_{ji}^K from Equation (4) can be interpreted as elasticities:

γ_{jj}^K corresponds to the *within*-sector adjustment—i.e. the adjustment in sector j to a one percent increase in the penetration of technology K in that sector—while γ_{ji}^K corresponds to the *between*-sector adjustment—i.e. the adjustment in sector j to a one percent increase in the penetration of technology K in sector $i \neq j$.

4.2 Decomposition

We decompose both the employment-to-population ratio and average wage sectoral adjustments as the sum of the *sectoral reallocation effect* and the *regional adjustment effect*. For the employment-to-population ratio, the former effect captures the reallocation of employment from other sectors to sector i that follows the penetration of an automation technology K in sector j. For the average wage, the former effect captures the relative change in wage i relative to the regional average. The latter effect corresponds to the regional adjustment in employment or wages that follows the penetration of an automation technology K in sector j. This effect captures the adjustment that is common to all sectors.

To derive the decomposition of the employment-to-population ratio, we start with the identity

$$l_{ri} \equiv s_{ri} \times l_r,$$

where $l_{ri} \equiv L_{ri}/N_r$ is the employment-to-population ratio in sector i, $s_{ri} \equiv L_{ri}/L_r$ is the employment share of that sector in region r, and $l_r \equiv L_r/N_r$ is the employment-to-population ratio in the region. Taking the logarithm and differentiating over time, we obtain that

$$\Delta l_{ri} = \Delta s_{ri} + \Delta l_r, \tag{5}$$

where all terms are estimated using the specification from Equation (4).

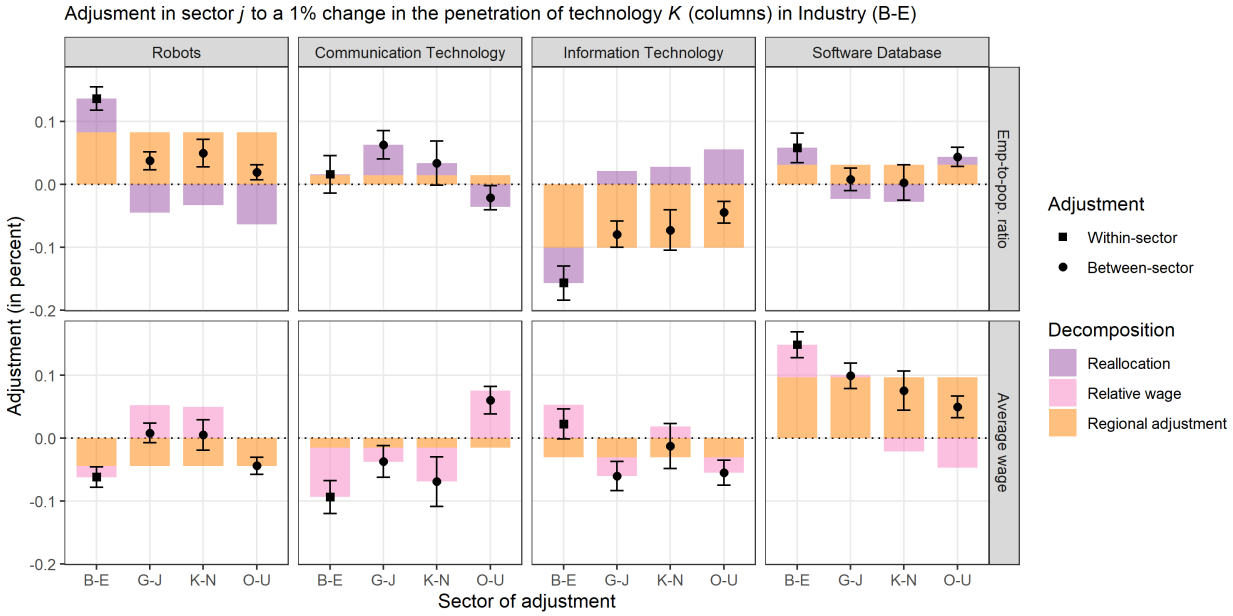
For the average wage, the decomposition is analogous. We consider the identity $W_{ri} \equiv w_{ri} \times W_r$, where W_{ri} is the average wage in sector i, $w_{ri} \equiv W_{ri}/W_r$ is the average wage of sector i relative to the average wage in the region. In the remaining of the paper, we refer to this latter ratio as the relative wage of sector i. Taking the logarithm and differentiating over time yields

$$\Delta W_{ri} = \Delta w_{ri} + \Delta W_r, \tag{6}$$

where all terms are also estimated using the specification from Equation (4).

Since the average wage is defined as total compensation divided by employment, the change in relative wage of sector i can be written as the difference between the change in the relative compensation of sector i and the change in the employment share, namely, $\Delta w_{ri} \equiv \Delta c_{ri} - \Delta s_{ri}$, where $c_{ri} \equiv C_{ri}/C_r$ with C being the total compensation and $\Delta s_{ri} \equiv$

Figure 4: Decomposition of the sectoral adjustments to technology penetration in Industry (B-E)



Notes: This figure presents the decomposition of sectoral adjustments of the employment-to-population ratio and average wage in Industry (B-E), Market Services (G-J), Financial & Business Services (K-N), and Non-Market Services (O-U), to a 1% change in the penetration of robots, communication technology, information technology, and software & database, in Industry (B-E). The time horizon is 10 years and corresponds to the window of the log-change of variables in the regression. The x-axis corresponds to the sector of adjustment and the y-axis corresponds to the adjustment (in percent). Column panels refer to the technology and row panels to the adjusted variable. Coefficients are reported with a 95% confidence interval and can be interpreted as elasticities since they are obtained using linear regressions with variables in log difference. Control variables include imports from China (in log-change), real consumption expenditure (in log-change), and region and time fixed effects. Tables D.2, D.4, and D.5, in the appendix, present the regressions of, respectively, the regional employment-to-population ratio, the sectoral employment-to-population ratio, and sectoral employment share, from which the coefficients are derived. Tables D.3, D.6, and D.7, in the appendix, present the regressions of the adjustments of, respectively, the regional average wage, the sectoral average wage, and the sectoral relative wage, from which the coefficients are derived.

L_{ri}/L_r. Thus, the relative wage of the sector increases along with the employment share if the increase in the relative compensation offsets the one in the employment share.

4.3 Results

Figure 4 shows the sectoral adjustments to the penetration of the four automation technologies in the industrial sector. Column panels refer to technologies. Row panels show the outcome variables. These adjustments are either within-sector when the sectoral adjustment occurs in the industry or between-sector when the sectoral adjustment occurs in the three other service sectors.

The decomposition distinguishes between two effects. The regional adjustment effect captures the overall effect of the technology penetration in the industry on regional employment or regional average wage. The sectoral reallocation effect indicates how the sectoral employment (or average wage) changes relative to the regional employment (or average wage). We

describe the results by technology.

For robots, results are reported in the first column panels. Robots are mainly used in industry: this is where we observe the largest changes in employment and wages—with elasticities of about 0.136 and −0.062 respectively. For a region with the median change in robot penetration in the industry (95%), it means an increase in employment of 12.9% and a decline of 5.9% in wages for the industrial sector.

For employment in the industrial sector, 61% of the increase is due to the increase in overall economic activity at the regional level, while the remaining 39% is due to the reallocation of workers from service sectors to industry. The increase in the overall economic activity linked to investment in robots in the industry is associated with an increase in employment also in the three service sectors. However, the reallocation toward industry partially offsets the regional economic increase—with Non-Market Services (O-U) experiencing the smallest increase in employment.

Wages in the industrial sector follow the negative regional trend observed at the regional level (Figure 3). 71% of the decline is due to the absolute downward adjustment in wages that the region faces despite the overall increase in employment. There are two potential explanations—although not mutually exclusives—for such a pattern: the boost in economic activity creates new jobs mainly in low-wage occupations (across all sectors) and/or regions that invest in robots attract more workers than they generate vacancies for. The decline in the relative wage for the industry seems to indicate that service workers who move to the industrial sector are those at the bottom of the wage distribution. The increases in the relative wages of both Market Services (G-J) and Financial & Business Services (K-N)—which do not experience an overall reduction in wages—seem to point toward this direction. However, this relative difference represents only 29% of the reduction in wages in the industry, thus explaining only a small part of the decrease in regional wages.

For communication technology, results are reported in the second-column panels. While we observe a steady increase in CT penetration in industry (see Figure 1), this is not related to any employment change in the sector. Instead, we find a significant wage decline with an elasticity of −0.093. For a region with the median change in CT penetration in the industry (49%), it means a decline of 4.6% in the average wage in industry.

For employment, regional adjustments are very small. This suggests that CT penetration in industry is not complementary to employment such as robot penetration. The only noticeable pattern is the reallocation of workers from the Non-Market Services (O-U) toward the Market Services (G-J) that follows the penetration of CT in the industrial sector. This may be related to outsourcing of communication activities from industry to specialized service providers in industry J (information and communication).

For wages in the industrial sector, 83% of the decline is due to the fall of the sectoral wage relative to the regional wage. Since there is no reallocation from or toward industry, the decline in wages gives support to the hypothesis that part of the communication activities is outsourced. Outsourcing does not change employment locally but pushes downward pressure on wages in the sector. The decline in the relative wage of Market Services (G-J) and the rise in the one of Non-Market Services (O-U) suggests that the downward pressure happens as low-paid workers in the public sector reallocate toward the private sector.

For information technology, results are reported in the third-column panels. On average, IT increases in the industry at similar rates as robots but is associated with symmetrical sectoral adjustments. The employment elasticity is -0.157 while the average wage elasticity is 0.022 although not significant. For a region with the median change in IT penetration in the industry (80%), it means a decline in industrial employment of 12.6% but a non-significant increase in wages.

For employment in the industrial sector, 63% of the decline is due to the shrinking overall economic activity at the regional level, while the remaining 37% is due to the reallocation of workers toward the service sectors. For service sectors, this reallocation from industry does not compensate the negative regional adjustment due to the industrial penetration of IT. As for robots, Non-Market Services (O-U) are the least affected as they are the largest recipient of the reallocation. But this is not sufficient for Non-Market Services (O-U) to contrast the overall fall in employment associated with IT investment in industry.

For wages in the industrial sector, the decline of the regional wage associated with IT penetration is offset by the increase in the relative wage within the sector. We observe opposite changes in relative sectoral wages in two out of three service sectors. This suggests that workers who reallocate from industry toward market (G-J) and non-market (O-U) service sectors tend to lie at the bottom of the wage distribution.

For software and database, we report results in the fourth column panels. The penetration of this technology in industry steadily increases until the 2008 crisis and declined afterward (see Figure 1). Although this pattern is not associated with significant changes in regional employment (Figure 3), we do observe an increase in employment within industry. Such a technology penetration is also associated with an increase in the average wage in the industrial sector. Employment-to-population ratio and average wage elasticities are, respectively, 0.058 and 0.148. For a region with the median change in software-database penetration in the industry (58%), it corresponds to a 3.4% increase in employment and a raise of 8.6% in the average wage.

For employment in the industrial sector, about one-half of the increase is due to the regional overall increase whereas the other half is due to the reallocation of workers from

the service sectors. This pattern is similar to the one observed with industrial robot penetration. However, for both Market Services (G-J) and Financial & Business Services (K-N) the reallocation effect dampens the positive regional adjustment effect, hence, leading to no changes in employment.

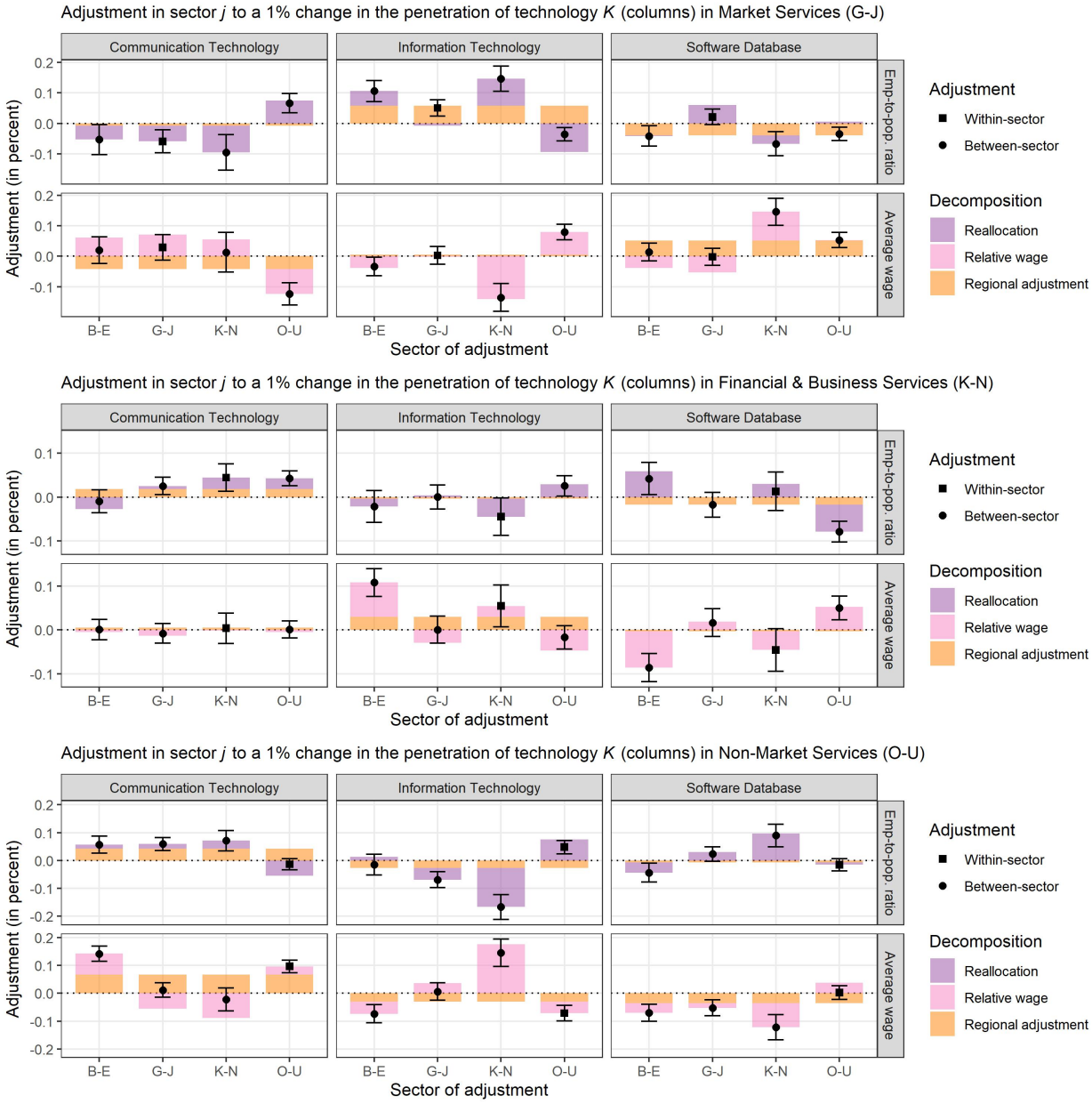
For wages in the industrial sector, the raise is due for 64% to the increase in the regional wage, while the remaining 36% comes from the increase in the wage in industry relative to the regional wage. Both service sectors from which employment reallocates to the industry have few changes in their relative wages. This pattern suggests that the penetration of software & database in the industry attracts high-skill workers from either other sectors and/or from outside the region.

Figure 5 shows the sectoral adjustments to the penetration of CT, IT, and software-database in service sectors. We do not include robots as this technology is not pervasive in these sectors (see Figure 1). Each panel of the figure refers to the technology penetration in one of the three service sectors. The structure of the figure and the decomposition are similar to the one just discussed for the penetration of technologies in industry (Figure 4). We describe the results by technology.

For communication technology, we report results in the first column panels. The direction of labor adjustments differs depending on the sector in which the investment occurs. We observe an increase in regional employment when the investment occurs in Financial & Business Services (K-N). We observe a small increase in all service sectors, but not in industry, where the regional increase is compensated by a reallocation of employment towards the service sectors. Turning to Non-Market services (O-U), the reallocation from this sector to all other services offsets the slight increase in regional employment, meaning that there is no significant change in employment in the public sector. CT penetration in Market Services (G-J) is instead associated with a decline in employment in that sector mostly driven by the reallocation of low-paid workers from the private sectors (B-E, G-J, and K-N) toward the public service sector (O-U). Overall, we observe little variation in wages, except for the public service sector (O-U).

For information technology, we report results in the second column panels. Unlike what we observed for industry, IT penetration in Market Services (G-J) is associated with an economic activity boost at the regional level for all sectors. However, the penetration of IT in this sector is associated with a reallocation from public services toward either industry or financial and business services. These reallocated workers tend to be—on average—at the bottom of the wage distribution as the relative wage increases in the public sector but decreases in the other two sectors. IT penetration in Financial & Business Services (K-N) or Non-Market Services (O-U) is followed by a reallocation of low-paid workers from the former

Figure 5: Decomposition of sectoral adjustments to technology penetration in service sectors



Notes: This figure presents the decomposition of sectoral adjustments of the employment-to-population ratio and average wage in Industry (B-E), Market Services (G-J), Financial & Business Services (K-N), and Non-Market Services (O-U), to a 1% change in the penetration of communication technology (CT), information technology (IT), software & database (SDB) in Market Services (G-J), Financial & Business Services (K-N), and Non-Market Services (O-U). The time horizon is 10 years and corresponds to the window of the log-change of variables in the regression. The x-axis corresponds to the sector of penetration and the y-axis corresponds to the adjustment (in percent). Column panels refer to the technology and row panels to the adjusted variable. Coefficients are reported with a 95% confidence interval and can be interpreted as elasticities since they are obtained using linear regressions with variables in log difference. Control variables include imports from China (in log-change), real consumption expenditure (in log-change), and region and time fixed effects. Tables D.2, D.4, and D.5, in the appendix, present the regressions of, respectively, the regional employment-to-population ratio, the sectoral employment-to-population ratio, and sectoral employment share, from which the coefficients are derived. Tables D.3, D.6, and D.7, in the appendix, present the regressions of the adjustments of, respectively, the regional average wage, the sectoral average wage, and the sectoral relative wage, from which the coefficients are derived.

to the latter. In the first case, IT seems to displace workers which find work in the public service sector. In the latter case, IT investment attracts low-paid workers from the Financial & Business Services (K-N) and Market Services (G-J).

For software and database, we report results in the third column panels. Unlike what we observe for industry, investment in software and database in all service sectors is associated with a regional decrease in employment. This decrease is largest for Market Services (G-J) and smallest for Non-Market Services (O-U). In the case of Market Services (G-J), the reallocation of workers compensates for that loss by attracting low-paid workers from the Financial & Business services. In the case of Non-Market Services (O-U) the reallocation only occurs in the other sectors: employment reallocates from the industrial sector toward the two other service sectors. In the case of Financial & Business Services (K-N) sectors, we observe a reallocation of workers away from the public service sector toward the sector of penetration and industry. Those reallocation patterns do not benefit workers' wages.

To summarize, Figures 4 and 5 show that regional labor market adjustments depend on the sector of penetration. This result adds to the fact that different automation technologies have diverse implications for regional labor markets. Regional labor adjustments to different technologies, when positive or negative, are likely to be driven by specific sectors; when non-significant, they are likely to hide opposite dynamics in different sectors.

Most labor adjustments in European regions still occur in relation to investment in automation technologies in the industry despite the secular decrease in the relative share of employment in that sector. Adjustment patterns in industry are also more likely to follow a clear pattern. Different automation technologies are associated with different labor adjustments within sectors.

For instance, robot adoption in the industry sector seems to complement workers, and serves as an engine for enhancing employment also in other sectors. Nonetheless, the changes at the regional levels (from Fig. 3) are mainly driven by the changes within the industry. Other sectors benefit from the overall increase in economic activity, but regions become more specialized in industry as workers reallocate from services.

On the contrary, the overall positive relation between IT penetration and employment at the regional level (Fig. 3) is driven by market services and not by industry—where the technology substitutes workers. The substitution effect of IT in industry is associated with reduced employment also in services, with only a small share of employees in industry finding employment in any of the service sectors. Overall, we find little structural change from industry to services in association with an investment in IT in any sector. In fact, IT in the private sector mainly has a reallocation effect among the service sectors. Apart from the market services where some new jobs are created: financial sectors create redundant

workers who move to the public sector, while the public sector makes it more attractive to work there for low-paid workers.

Industry is also responsible for the large and positive association between an increased penetration of software and database and wages at the regional level (Fig. 3). Whereas the non-significant relation with employment at the regional level is due to the increase in industry and the decreases in services that cancel out.

Lastly, the potential outsourcing of activities and jobs observed for CT at the regional level (Fig. 3) is mainly related to the reallocation of workers across sectors with different employment shares, rather than by regional adjustments in employment.

Workers' reallocation between sectors explains a large part of labor dynamics in regions following an increased penetration of automation technologies. Robot penetration in the industry sector is associated with a reallocation of low-paid workers from the service sectors toward the industry in the region. CT penetration in services is associated with low-paid workers' reallocation across service sectors. IT penetration in the industry is associated with a reallocation of low-paid workers from industry toward service sectors. Software-database penetration in the industry sector is associated with a reallocation of high-paid workers from the service sectors and/or outside the region.

5 Heterogeneity of technology penetration between European regions

In this section, we account for the heterogeneity between European regions, including within countries. Previous studies pull together regions with critical structural differences. European regions differ in terms of sectoral specialization, technological capabilities, and skills.[13] On the one hand, workers in regions with a lower endowment of technological capabilities and skills may find it harder to adjust to technology penetration.[14] On the other hand, because the penetration of automation technologies is not equal across all sectors, and employment and wages adjust differently to penetration within the same sectors and in other sectors in the same region (Section 4), labor markets are likely to adjust differently to different tech-

[13]Technological capabilities, from a macro perspective, can be understood as a combination of physical investment, human capital—i.e. skills and training needs to engage in a process of technological change—, and technological efforts—i.e. availability of basic scientific knowledge, spending in research and development, patenting activities, among others (Lall 1992). Wirkierman et al. (2021) show that such differences in the stock of capabilities, coupled with trade interdependence between regions, explain the divergence between European regions in terms of (high-tech) employment and wages.

[14]We know from the literature that different groups of workers benefit differently from technological change within countries and regions (e.g. Graetz and Michaels 2018, Lee and Clarke 2019), and regions with different shares of routine workers benefit differently from technological change (e.g. Ciarli et al. 2018).

nologies, depending on whether regions are specialized in industry, services or agriculture. We proceed in three steps. First, we group European regions into clusters based on their sectoral specialization and labor productivity. Second, we reassess labor market adjustments to automation technology penetration for the different clusters. Third, we replicate the exercise for sectoral adjustments.

5.1 Clusters of European regions

We cluster the 227 regions according to their economic structure before the period of analysis, that is, between 1990 and 1994. We consider two dimensions: the sectoral specialization of the region and its technological capabilities. The former dimension refers to the sectoral composition, i.e. the share of employment in Agriculture (A), Industry (B-E + F), and Service (K-N + G-J + O-U). This is consistent with the allocation of automation technologies—which are available at the country-sector level—to regions based on the sector specialization—i.e. using the methodology described in Section 2.3. We proxy the latter dimension by the level of labor productivity, which is measured as the gross value added per worker. In this way, we have a dimension to distinguish between two regions—such as capital cities—that would be both service-intensive with one more productive than the other, e.g. Paris (Île-de-France) versus Sofia (Sofia City).

There is a trade-off in terms of the clustering of variables. On the one hand, more variables can depict a better picture of the regional economic structure. On the other, adding variables reduces the number of countries in the sample because several small countries may not have available statistics on these variables. Although our two dimensions do not reflect the fine details of the economic structure in the region, we believe they convey significant information regarding the aim of the clustering.[15]

We standardize the four clustering variables. First, we standardize the employment shares of sectors at the country level. Second, we standardize our labor productivity measure over the entire sample.

We start by looking at principal components to understand in which dimensions the regions differ the most. Table 2 shows the eigenvectors of the principal component analysis. The first principal component (PC1) primarily reflects the difference between regions with a high share of employment in agriculture and/or industry versus service. As the productivity-related element is negative, it captures the fact that service-intensive regions also tend to be the most productive ones. The second principal component (PC2) distinguishes be-

[15]While productivity might seem a synthetic measure of technological capabilities of the regions, our distinction between low- and high-productive areas is consistent with the taxonomy elaborated by Capello and Lenzi (2013).

Table 2: Principal components

	Principal Component (PC)			
	PC1	PC2	PC3	PC4
Productivity	-0.26	0.72	0.64	0.01
Share of Agriculture in Emp.	0.47	-0.40	0.63	0.46
Share of Industry in Emp.	0.50	0.54	-0.42	0.54
Share of Service in Emp.	-0.68	-0.16	-0.11	0.70
Standard deviation	1.34	1.02	0.90	0.27
Proportion of Variance	0.48	0.28	0.22	0.02
Cumulative Proportion	0.48	0.76	0.98	1.00

Notes: This table presents eigenvectors of the principal components analysis. The eigenvectors refer to the columns from PC1 to PC4. Variables of clustering include productivity and the employment shares of agriculture (A), industry (B-E and F), and service (K-N, G-J, and O-U).

tween industry-intensive and agriculture-intensive regions. In addition, it also captures that productivity—after being correlated with services—is also associated with industry-intensive regions. The third principal component (PC3) completes the circle by differentiating agriculture-intensive regions. The fact that the productivity element of the vector is greater for industry and agriculture reflects that there is much more distance between low- and high-productive regions in agriculture and industry than in services as service-intensive regions tend to be capital cities. Those three principal components can explain 98 percent of the variance. The last principal component (PC4) acts as a residual.

We classify the 227 regions into k clusters $S = \{S_1, ..., S_k\}$ by minimizing the within-cluster sum of squares such that:

$$\arg\min_{S} \sum_{i=1}^{k} \sum_{X \in S_i} \|X - \mu_i\|^2, \tag{7}$$

where X contains the standardized clustering variables and μ_i is the mean of points in S_i.

Our preferred classification has 7 clusters.[16] Table 3 describes the clusters and their centers—i.e. the within-cluster averages. Differences in productivity split the sample into two

[16]We select our preferred classification based on three metrics: the Within-cluster Sum of Squares (WSS), the Akaike Information Criterion (AIC), and the Bayesian Information Criterion (BIC). Figure C.1 in the appendix shows the goodness-of-fit based on these metrics for sets ranging from 1 to 15. Both WSS and the AIC are strictly decreasing. We thus consider sets that are in the neighborhood of the minimum of the BIC. This suggests sets ranging from 7 to 9, with 8 being the minimum. Although the clustering with 8 clusters lies at the minimum of BIC, we prefer the classification with only 7 clusters. The rationale is that both cluster specifications mostly differentiate on the basis of the service-intensive clusters. The 8-cluster specification makes three clusters out of clusters 1 and 2 by generating an in-between additional k-mean. To facilitate the interpretation of the results, without any loss in the meaning, we prefer to consider the one with the lowest number of clusters, hence, the set with 7 clusters.

Table 3: Clusters and K-means

	Cluster	N	K-means			
			Agriculture	Industry	Service	Productivity
1	Service intensive (High)	25	-1.30	-1.32	1.70	0.94
2	Service/Agriculture (High)	30	0.25	-0.81	0.64	0.57
3	Industry intensive (High)	61	-0.37	0.86	-0.57	0.58
4	Agriculture/Industry (High)	42	1.01	0.21	-0.64	0.35
5	Service intensive (Low)	19	-0.97	-0.43	1.23	-1.10
6	Industry intensive (Low)	31	-0.01	0.62	-0.30	-1.48
7	Agriculture intensive (Low)	19	1.27	-0.78	-0.75	-1.26

Notes: This table presents the clusters, the number of regions in them, and their within-cluster average in clustering variables. N is the number of regions in the cluster. All clustering variables are expressed in standard deviation. Agriculture, Industry, and Service refer to the share of regional employment in these sectors which are standardized at the country level, whereas productivity corresponds to the gross value added per worker which is standardized over the entire sample.

groups of clusters, namely, those with high productivity (clusters 1 to 4) and low productivity (clusters 5 to 7).

Among the high-productive clusters (High): clusters 1 and 2 correspond to service-intensive regions. Cluster 1 contains 23 regions that specialize in service activities of higher value added (e.g. KIBS) whereas the 32 regions in cluster 2 are more rural as they have also a significant share of their economic activities in agriculture and service activities are likely of lower value added (e.g. hospitality). Cluster 3 is the largest cluster with 61 regions that are industry-intensive. Cluster 4 brings together 42 regions that are primarily into agriculture but with significant industrial economic activity.

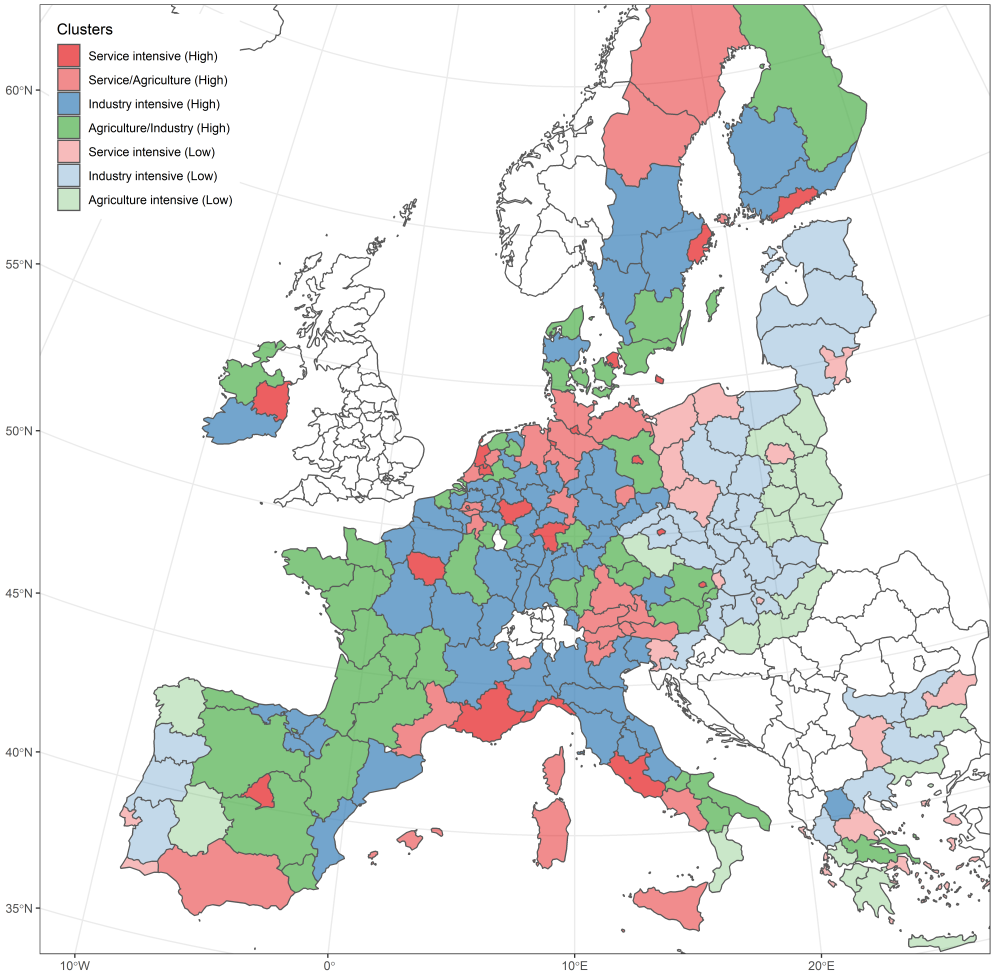
The classification of low-productivity clusters straightforwardly reflects the sectoral composition. Cluster 5 regroups 19 service-intensive regions, cluster 6 contains 31 industry-intensive regions, and cluster 7 refers to the 19 remaining agriculture-intensive regions.

Figure 6 displays the geographical distribution of clusters. This map delivers three main results which corroborate the consistency of the clustering.

First, the productivity dimension of clusters reflects the Northern-Western versus Southern-Eastern economic division in Europe. For instance, all regions in France and Netherlands lie in the high-productive clusters while Bulgarian and Czech regions belong to the low-productive ones. In addition, some regions of Southern Europe are also included among the low-productive regions such as Galicia, Calabria, most of the Greek regions, and Portugal.

Second, capital cities all lie in service-related clusters, although the same productivity division applies. For instance, Île de France and Berlin are service-intensive regions with high productivity, while Área Metropolitana de Lisboa and the Capital City of Warsaw are also service-intensive but with low productivity.

Figure 6: Regional clusters



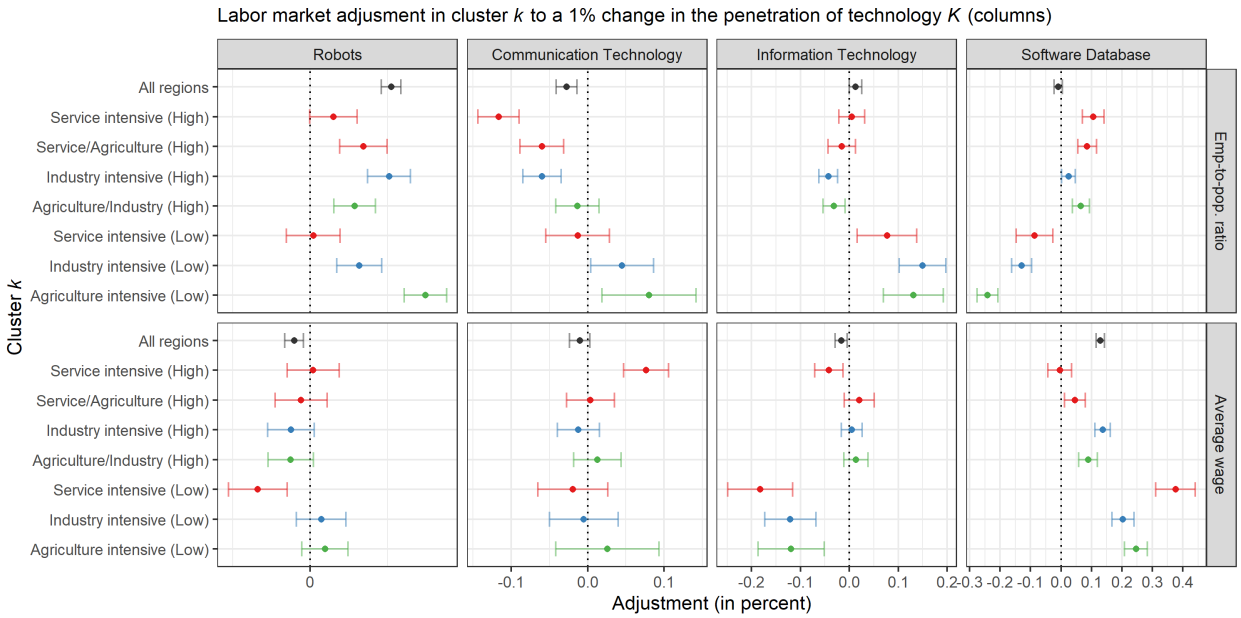
Notes: This figure presents the geographical distribution of clusters. These clusters are obtained using the K-means algorithm. The set of clustering variables contains the employment shares in agriculture, industry, and service standardized at the country level and the productivity, expressed in gross value added per worker, standardized over the entire sample.

Third, regions within countries are alike to their neighbors, showing a spatial coherence of the clustering. For instance, Northern Italy is industry-intensive while the South is mostly agriculture related. Another example is France where the economic activity in the West is more oriented toward agriculture and industry, while the North and East are instead industry-intensive.

5.2 Labor market adjustments

We investigate the heterogeneity in the relationship between labor markets and technology penetration at the regional level. To do so, we interact cluster fixed effects with technology

Figure 7: Heterogeneity in regional adjustments to technology penetration



Notes: This figure presents the adjustments at the regional level of the employment-to-population ratio and the average wage to a 1% change in the regional penetration of robots, communication technology, information technology, and software & database, according to the cluster in which the region belongs. Time horizon is 10 years and corresponds to the window of the log-change of variables in the regression. Clusters are (from top to bottom): Service intensive regions (with High productivity), Service/Agriculture intensive regions (with High productivity), Industry intensive regions (with High productivity), Agriculture/Industry intensive regions (with High productivity), Service intensive regions (with Low productivity), Industry intensive regions (with Low productivity), and Agriculture intensive regions (with Low productivity). Clusters are obtained with K-means. The set of clustering variables contains the employment shares in agriculture, industry, and service, standardized at the country level and the productivity, expressed in gross value added per worker, standardized over the entire sample. The x-axis corresponds to the adjustment (in percent) and the y-axis corresponds to the cluster. Row panels refer to the adjusted variables and column panels refer to technologies. Coefficients are reported with a 95% confidence interval and can be interpreted as elasticities since they are obtained using linear regressions with variables in log difference. Control variables include imports from China (in log-change), real consumption expenditure (in log-change), and region and cluster-specific time fixed effects. Table D.8, in the appendix, report the coefficients from the regression.

penetration in the baseline specification. Thus, we estimate the following regression:

$$\Delta Y_{rk,t+10} = \alpha + \sum_{k} \sum_{K} \beta_k^K \Delta K_{rk,t+10} \times \kappa_k + X\psi + u_{rk,t+10}, \tag{8}$$

where $\Delta Y_{rk,t+10}$ is the log-change in the outcome variable Y between t and $t+10$ in the region r which belongs to cluster k, $\Delta K_{rk,t+10}$ is the log-change in the regional penetration of technology K over the same period in the same region, X are control variables including trade exposure, final demand, region and cluster-time fixed effects, and $u_{rk,t+10}$ is the error term. We consider cluster-time fixed effects to control for structural changes that could be cluster-specific.

Figure 7 summarizes the relationship between the labor market outcomes and technology penetration at the regional level for each cluster. Column panels refer to technologies. Row panels are the adjusted variables.

The positive association between robot penetration and the employment-to-population ratio at the regional level—discussed in Figure 3—is confirmed for all regions, except for those specialized mainly in services such as capital cities. Industry-intensive regions experience the highest increase in employment among high-productivity regions, although differences between clusters are not statistically significant. While agriculture-intensive regions do so among low-productivity regions—with elasticities of respectively 0.051 and 0.074. For a region with the median change in robot penetration in the former cluster (60%), it corresponds to an increase in employment of 3.1%. In the latter cluster, the average change is about 438% which suggests an increase of 32.4% in employment. The negative association between robot penetration and wages at the regional level—discussed in Figure 3—is instead confirmed only for low-productive regions specialized in services such as Eastern European capital cities. To simplify, in regions that experience an increase in employment, there is no significant variation in wages associated with the penetration of robots. Instead, in service regions that do not experience such an increase in employment, higher penetration is associated with lower wages after 10 years.

Penetration of CT shows a clear divide between high- and low-productivity regions with respect to the employment-to-population ratio. The negative association with employment observed when all regions are pulled together is driven by the high-productivity regions. Although the high-productivity service-intensive regions experience the largest decline in employment in association with a higher penetration of CT, they are the only regions that experience an increase in the average wage. For a region in that cluster with the median change in CT (53%), we observe a negative change in employment of 6.1% and a positive change in wages of 4%.

Penetration of IT also depicts a productivity-based division between European regions. More productive North and Western European regions tend to be associated with no or few negative changes in employment and wages for the regional IT penetration, whereas less productive South and Eastern European regions experience positive (negative) changes in employment (wages). For the median change in IT penetration in industry-intensive regions with low productivity (90%), it corresponds to a raise in the employment-to-population ratio of 13.5% with a decline in the regional average wage of -10.9%.

On average, penetration of software-database at the regional level is associated with no changes in employment but large positive changes in wages—when we pull all the European regions together. Looking at the heterogeneity indicates two composition effects. First, high-productivity regions experience positive changes in employment, whereas low-productivity ones face negative changes in employment. Second, low-productivity regions drive the positive regional wage change with large elasticities—especially in service-intensive regions. The

positive wage association with high-productivity regions is relatively low and non-significant for high-productivity capital cities.

To summarize, we observe sizable heterogeneity across regions in terms of both employment and wage adjustments to automation technologies. Robot penetration at the regional level is almost always associated with positive changes in employment—i.e. except for capital cities. As for the rest of the automation technologies, there is a regularity suggesting a clear divide between South and Eastern (low productive) and North and Western (high productive) European regions. Software and database penetration at the regional level is associated with positive changes in both employment and wages for North and Western regions, but with large negative employment adjustments and large positive wage adjustments in South and Eastern regions. Both older technologies—information and communication technologies—have no or negative association with employment in the North and Western European regions, but a significant and positive association with employment in South and Eastern regions. However, these regions also experience a reduction in wages – not seen in North and Western regions.

Such a pattern may emphasize the distinction between North and Western regions that already went through the golden age of ICTs—and in which ICTs do not foster employment—versus South and Eastern regions that are catching up in ICT stock—i.e. for which the penetration of these technologies is faster and generates net employment. Nonetheless, high-productive regions are already ahead of the technological frontier, hence, more concerned over the potential implications of advanced robotics and AI on employment.

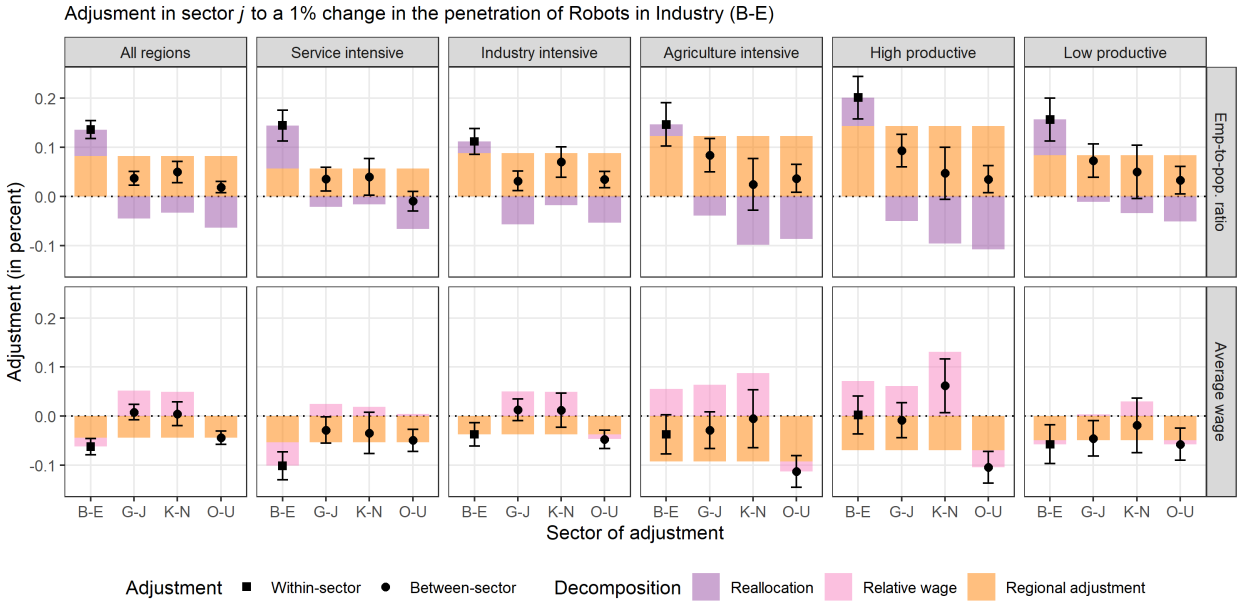
5.3 Sectoral adjustments

We look at the heterogeneity of sectoral adjustments to technology penetration according to the *initial sectoral composition* and the *initial level of productivity* of the region. Due to the relatively small size of clusters, we regroup clusters according to both dimensions using the classification from Table 3. For the *initial sectoral composition* of the region, we define three groups: Service-intensive (clusters 1 + 2 + 5), Industry-intensive (clusters 3 + 6), and Agriculture-intensive (clusters 4 + 7). For the *initial level of productivity* of the region, we define two groups: High-productive (clusters 1 to 4) and low-productive (clusters 5 to 7).

We estimate the adjustments according to both clustering dimensions separately for the six sectors j with the following specification:

$$\Delta Y_{rkj,t+10} = \alpha_j + \sum_k \sum_K \sum_i \gamma^K_{k,ji} \Delta K_{ri,t+10} \times \kappa_k + X\psi + u_{rj,t+10}, \tag{9}$$

Figure 8: Decomposition of the sectoral adjustments to the penetration of robots in Industry (B-E) by clusters



Notes: This figure presents the decomposition of sectoral adjustments of the employment-to-population ratio and average wage in Industry (B-E), Market Services (G-J), Financial & Business Services (K-N), and Non-Market Services (O-U), to a 1% change in the penetration of robots in Industry (B-E) according to the initial sectoral composition and the initial level of productivity of the region. The time horizon is 10 years and corresponds to the window of the log-change of variables in the regression. The x-axis corresponds to the sector of penetration and the y-axis corresponds to the adjustment (in percent). Column panels refer to the type of cluster and row panels to the adjusted variable. Coefficients are reported with a 95% confidence interval and can be interpreted as elasticities since they are obtained using linear regressions with variables in log difference. Control variables include imports from China (in log-change), real consumption expenditure (in log-change), and region and time fixed effects.

where $\Delta Y_{rj,t+10}$ is the log-change in the outcome variable Y between t and $t+10$ in sector j in region r which belongs to cluster k, $\Delta K_{ri,t+10}$ is the log-change in the penetration of technology K over the same period in sector i in the same region, X are control variables including trade exposure, final demand, region, cluster-time fixed effects, and $u_{rj,t+10}$ is the error term. Note that we control for the initial level of productivity when estimating Equation (9) with clusters being the initial sectoral composition and vice-versa. For reasons of space, we focus on the adjustments in one sector for each automation technology. We report the decomposition of the sectoral adjustments in the other sectors in the online appendix, and we summarize across-clusters regularities with respect to technologies and sectors in the next section.

We start with the penetration of industrial robots. Figure 8 shows the sectoral adjustments to the penetration of robots in Industry (B-E) according to clusters. We focus on the industry as this is where most of the investment in robots occurs. The positive regional adjustment of employment and the negative regional adjustment of wages are consistent across all clusters, although there are important differences. The regional increase in employment is

observed mainly in industry-, agriculture-intensive clusters, and in high-productivity clusters. In service-intensive regions, the increase in employment associated with a higher penetration of robots in Industry (B-E) is driven by a larger reallocation toward this sector from services, whereas this reallocation effect is moderated in industry- and agriculture-intensive regions. Service-intensive and low-productivity clusters undergo a structural change toward industry, in those regions where industry invests in robots.

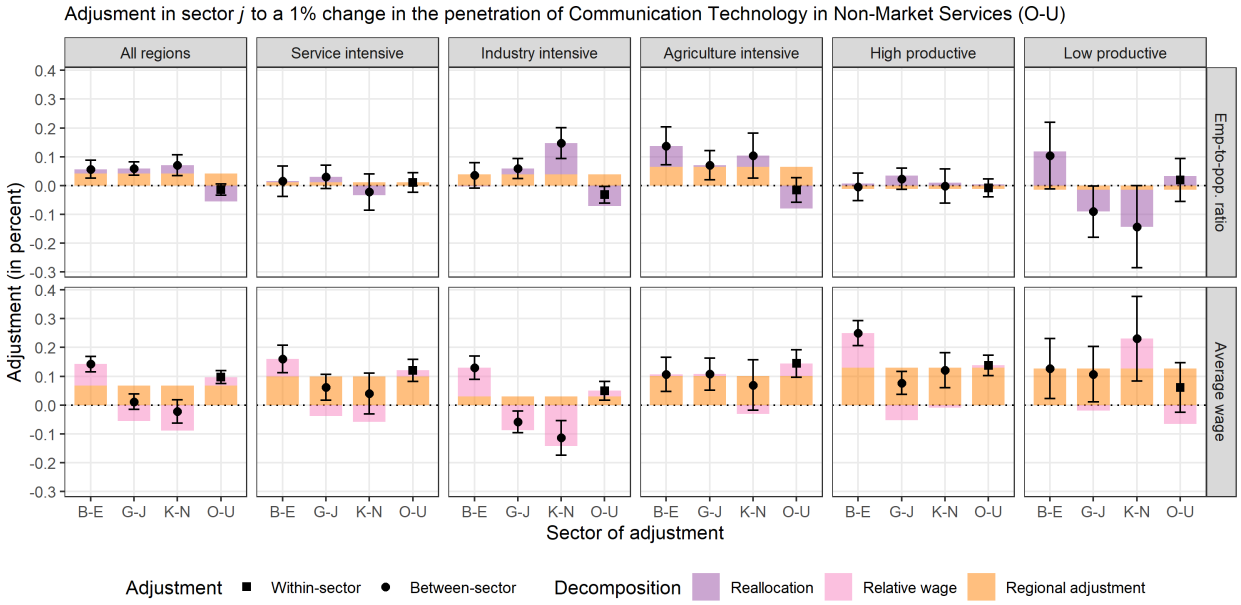
As noted earlier, most of the decline in wages is observed in service-intensive regions, particularly those with lower productivity. We also find that in those regions two sectors drive the wage reduction: Industry (B-E) itself and Mon-Market Services (O-U). In low-productive regions (with any specialization) this is due entirely to a regional reduction in wages across all sectors. In service-intensive regions (including high and low-productivity ones) the reduction observed in industry is split between the regional effect and the reallocation of low-paid workers from the private service sectors to industry. As the relative wage in Industry (B-E) instead increases in agriculture-intensive regions, it suggests that the reallocated workers have greater wages than those initially present in the sector. This may highlight a reallocation of high-skill workers toward the industry.

We first focus on the penetration of ICTs through the public service sector, where we observe most of the reallocation of workers. For communication technology, Figure 9 shows the sectoral adjustments to the penetration in Non-Market Services (O-U). Regional adjustments indicate that the positive association of the average wage (at the regional level) with the CT penetration through the public service sector is consistent across all sectors, whereas the positive association with employment is limited to the industry- and agriculture-intensive clusters. For the full sample, the reallocation occurs from the sector of penetration toward the three other productive sectors. There is heterogeneity regarding these reallocation patterns with respect to the cluster. Workers are mostly reallocated toward the Financial & Business Services (K-N) in industry-intensive regions, whereas they are reallocated toward the Industry (B-E) in agriculture-intensive regions. In low-productivity regions, the CT penetration in Non-Market Services (O-U) generates reallocation across the productive sectors, mostly from services toward the industry.

For information technology, Figure 10 shows the sectoral adjustments to the penetration in Non-Market Services (O-U). IT penetration in Non-Market Services (O-U) suggests that low-paid workers from the Financial & Business Services (K-N) reallocate toward the public service sector. This pattern is more pronounced for industry-, agriculture-intensive, and high-productivity regions. Service-intensive and low-productivity regions, however, experience a negative regional adjustment in wages.

Lastly, we look at the penetration of software and database through the Market Services

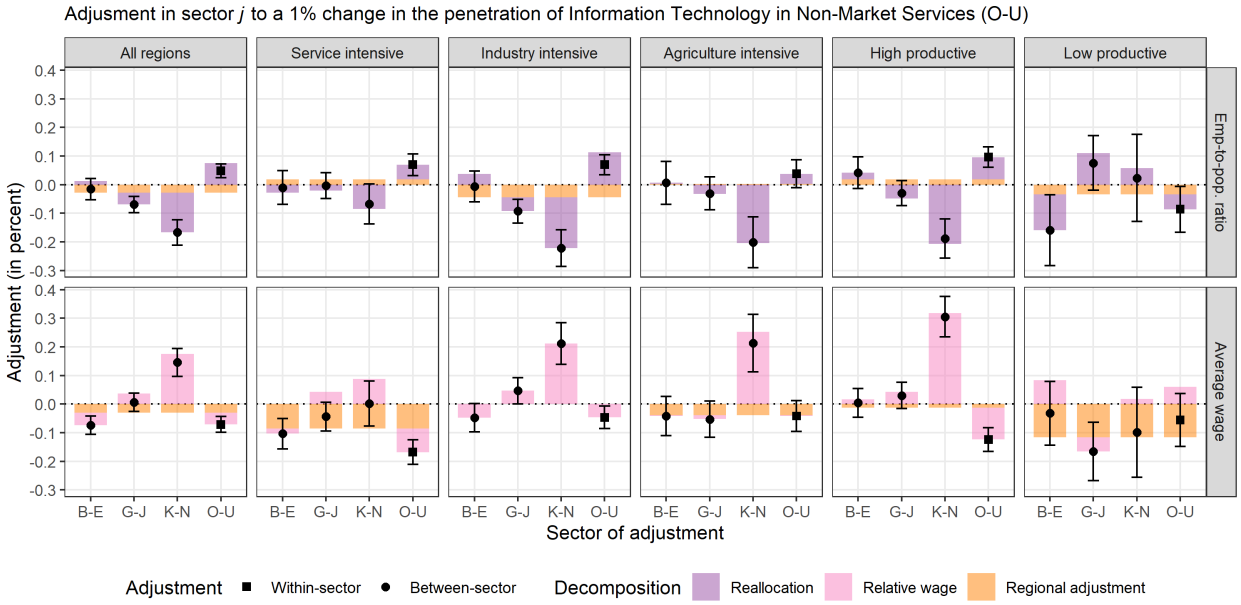
Figure 9: Decomposition of the sectoral adjustments to the penetration of communication technology in Non-Market Services (O-U) by clusters



Notes: This figure presents the decomposition of sectoral adjustments of the employment-to-population ratio and average wage in Industry (B-E), Market Services (G-J), Financial & Business Services (K-N), and Non-Market Services (O-U), to a 1% change in the penetration of communication technology in Non-Market Services (O-U) according to the initial sectoral composition and the initial level of productivity of the region. The time horizon is 10 years and corresponds to the window of the log-change of variables in the regression. The x-axis corresponds to the sector of penetration and the y-axis corresponds to the adjustment (in percent). Column panels refer to the type of cluster and row panels to the adjusted variable. Coefficients are reported with a 95% confidence interval and can be interpreted as elasticities since they are obtained using linear regressions with variables in log difference. Control variables include imports from China (in log-change), real consumption expenditure (in log-change), and region and time fixed effects.

(G-J) which is the sector experiencing the largest change. Figure 11 shows the sectoral adjustments to the penetration of software & database in Market Services (G-J) according to clusters. Regional adjustments suggest that the positive regional wage effect of software-database penetration in Market Services (G-J) is consistent across all clusters. For the full sample, this penetration indicates a reallocation across productive service sectors, i.e. from the Financial & Business Services (K-N) toward the sector of penetration. This reallocation pattern is, however, heterogeneous across clusters. In service-intensive regions, high-paid workers from the Industry (B-E) also reallocate toward the sector of penetration in addition to the low-paid workers from Financial & Business Services (K-N). In industry-intensive regions, only workers from the financial and business sector reallocate. In the agriculture-intensive regions, workers attracted to the sector of penetration are either high-paid workers from the industry or low-paid workers in the public sector.

Figure 10: Decomposition of the sectoral adjustments to the penetration of information technology in Non-Market Services (O-U) by clusters



Notes: This figure presents the decomposition of sectoral adjustments of the employment-to-population ratio and average wage in Industry (B-E), Market Services (G-J), Financial & Business Services (K-N), and Non-Market Services (O-U), to a 1% change in the penetration of information technology in Non-Market Services (O-U) according to the initial sectoral composition and the initial level of productivity of the region. The time horizon is 10 years and corresponds to the window of the log-change of variables in the regression. The x-axis corresponds to the sector of penetration and the y-axis corresponds to the adjustment (in percent). Column panels refer to the type of cluster and row panels to the adjusted variable. Coefficients are reported with a 95% confidence interval and can be interpreted as elasticities since they are obtained using linear regressions with variables in log difference. Control variables include imports from China (in log-change), real consumption expenditure (in log-change), and region and time fixed effects.

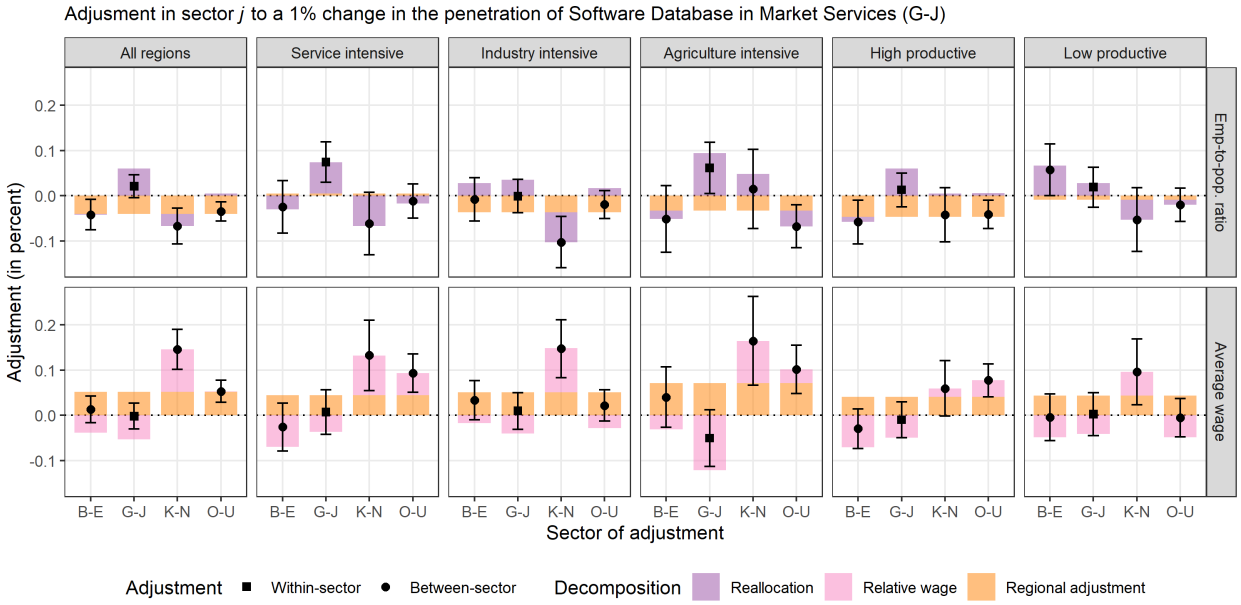
6 Discussion of regularities across different technologies, industries, and regions

Decomposing for different technologies, in different sectors and regions, we find considerable heterogeneity in labor adjustments. Some of these require further investigation. A number of regularities emerge from the more detailed results on specific technologies/sectors/regions. We summarize them here.

First, across different regions, technologies and industries, we find that European regional labor markets adjust to increased penetration of automation technology more in relation to employment than to wages. Or, in other words, we observe significant changes in wages only in a few combinations of regions-technologies-industries. While we observe significant variations in employment across regions-technologies-industries, some of which we have discussed in detail in the paper.

Second, across technologies and industries, most labor market adjustments have occurred

Figure 11: Decomposition of the sectoral adjustments to the penetration of software & database in Market Services (G-J) by clusters



Notes: This figure presents the decomposition of sectoral adjustments of the employment-to-population ratio and average wage in Industry (B-E), Market Services (G-J), Financial & Business Services (K-N), and Non-Market Services (O-U), to a 1% change in the penetration of software & database in Market Services (G-J) according to the initial sectoral composition and the initial level of productivity of the region. The time horizon is 10 years and corresponds to the window of the log-change of variables in the regression. The x-axis corresponds to the sector of penetration and the y-axis corresponds to the adjustment (in percent). Column panels refer to the type of cluster and row panels to the adjusted variable. Coefficients are reported with a 95% confidence interval and can be interpreted as elasticities since they are obtained using linear regressions with variables in log difference. Control variables include imports from China (in log-change), real consumption expenditure (in log-change), and region and time fixed effects.

in high-productive regions (Northern and Western Europe), for both employment and wages. We observe significant changes in employment or wages in low-productive regions, but only in a small combination of technologies and industries, possibly because investment in automation technologies is lower in these regions. The high/low productivity divide also explains most of the variation across different regions in industry, with past specialization being less relevant to explain heterogeneous outcomes. For the three service sectors, instead, the initial specialization is more relevant, as most of the heterogeneity in labor market adjustments across regions is explained by their past specialization in services.

Third and related, in high-productive Northern and Western regions, labor market adjustments are more likely to be positive than negative (for both employment and wages) across technologies and sectors. Conversely, in low-productive Southern and Eastern regions, negative adjustments are more common. In high-productive regions, automation has a higher probability of completing workers than in low-productive regions—where there is a higher probability of replacing workers. More research is needed to disentangle those differences.

Fourth, three main regularities emerge in relation to the different technologies. i) Robots—which are used mainly in industry—are associated with a positive increase in employment, both within the industry and in other sectors. All regions experience an increase in employment, except for low-productive and service-intensive regions where the employment-to-population ratio falls. These are also the only regions that experience a reduction in the average regional wage associated with robot investment. ii) Information and communication technologies are associated with different labor market adjustments. IT is associated with a decrease in employment in industry following investment in industry, and indirectly in most other industries. Whereas CT is associated with changes in employment and wages only in services (but not in industry) and tends to be associated with indirect positive spillovers on employment in other sectors. iii) Increased penetration in software and databases is followed by an increase in wages in the same sector only in industry, but not in the service sector. Most other sectors adjust their wages after the penetration through industry.

Fifth, three regularities emerge in relation to different sectors. i) Employment in industry increases following an increase in robots or software-database investment, whereas it decreases following an increase in ICT investment. ii) In the case of market services, adjustments in employment exhibit an opposite pattern within the industry of investment and in other industries. For example, increased penetration of software and databases in market services is associated with an increase in employment in that sector (especially in service-intensive regions) but a decrease in employment in other sectors (especially in high-productive regions). With respect to wages, we find no significant changes for workers within market services following an increased penetration of any automation technology in market services, although we do find significant changes in most other sectors for all technologies. iii) In the case of financial and business services and non-market services, the adjustments are largely heterogeneous across technologies and regions, showing no common pattern along any of the two dimensions.

7 Conclusion

This paper examines the labor market adjustments to automation technologies in 227 regions located in 22 European countries. We combine several data sources to measure the penetration of robots, communication technologies, information technologies, and software/database. We analyze how employment and wages change when these technologies penetrate at the regional and (within-region) sectoral levels. We decompose the sectoral adjustments to account for workers' reallocation between sectors. By clustering regions based on their specialization and technology capabilities, we provide evidence of the roots of the

observed heterogeneity in labor market and sectoral adjustments to automation technologies.

Although our data do not allow us to establish causality, they provide compelling evidence of the reasons behind the differences between European regions regarding labor market adjustments to automation technologies.

First, we find that labor market adjustments to automation differ according to the technology. This result suggests that, although robot has become the most analyzed automation technology in the literature, it remains a subset of automation technologies and do not necessarily represent the relationship for all other technologies. We also find that the timing of adjustments to automation technologies also differs. Both most recent technologies (i.e. robots and AI) tend to have much more contemporaneous effects compared to ICT.

Second, our results suggest that regional changes in employment and wages are driven by sectoral penetration of technologies. In particular, robot penetration in the industry is associated with positive employment changes. For ICT and Software & Database, we find different implications depending on whether they penetrate through industry or services sectors. Our results also suggest substantial employment reallocation between sectors, mostly of low-paid workers. This result, however, does not take into account inflow and outflow from other regions. A limit that we intend to address in future work.

Third, we find that specialization and technology capabilities of European regions are key drivers of labor market adjustments and sectoral reallocation of workers. We emphasize a wide divide between South and Eastern, and North and Western European regions; but also between service-intensive and industry/agriculture-intensive regions.

These results offer implications to policymakers. Local public policies aiming at making automation technologies beneficial for all workers should account for labor market specificities in terms of workforce specialization and technology capabilities of the region. The role of the public service sector in employment should not be neglected. Often put aside to assess the consequences of automation on employment, we argue that this sector does react to technology penetration in other sectors and often serves as a recipient for reallocated workers. Reallocated workers tend to be at the bottom of the wage distribution and likely at the bottom of the skill distribution too. Such a pattern suggests that reallocated workers' training is key in enhancing sectoral, hence regional, labor productivity after automation technology penetration.

Finally, this paper opens up three new avenues for research. First, labor market adjustments seem to find their roots in regions' characteristics such as sectoral specialization and productivity. Institutions are potential drivers of both in the long run, thus of labor market adjustments. Second, since our approach focuses on sectoral employment, we believe that access to better data in terms of occupations and skills would help in having a better

understanding of workers' reallocation. Third, although we partially account for migration through population changes as we consider the employment-to-population ratio, we do not consider workers' reallocation between regions as a consequence of automation technologies. These are questions that we intend to pursue in future work.

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Appendices

A Data

This appendix reports, in Table A.1, the aggregation of NACE sections used in the analysis. Table A.2 presents the overview of both revisions of the NACE classification and the correspondence.

Table A.1: Sectors of economic activities and NACE sections

	Sector	NACE Rev. 2	NACE Rev. 1.1
A	Agriculture	A	A, B
B-E	Industry	B, C, D, E	C, D, E
F	Construction	F	F
G-J	Market Services	G, I, H, J	G, H, I
K-N	Financial Business Services	K, L, M, N	J, K
O-U	Non-Market Services	O, P, Q, R, S, T, U	L, M, N, O, P, Q

Notes: This table presents the classification of sectors used in the analysis. This classification is derived from the NACE classifications such to be compatible across the two versions Rev. 1.1 and Rev. 2. Table A.2 summarizes both NACE classifications in the appendix.

Table A.2: Overview of NACE classifications

NACE Rev. 2		NACE Rev. 1.1	
A	Agriculture, forestry and fishing	A	Agriculture, hunting and forestry
		B	Fishing
B	Mining and quarrying	C	Mining and quarrying
C	Manufacturing	D	Manufacturing
D	Electricity, gas, steam and air conditioning supply	E	Electricity, gas and water supply
E	Water supply, sewerage, waste management and remediation activities		
F	Construction	F	Construction
G	Wholesale and retail trade; repair of motor vehicles and motorcycles	G	Wholesale and retail trade: repair of motor vehicles, motorcycles and personal and household goods
I	Accommodation and food service activities	H	Hotels and restaurants
H	Transportation and storage	I	Transport, storage and communications
J	Information and communication		
K	Financial and insurance activities	J	Financial intermediation
L	Real estate activities	K	Real estate, renting and business activities
M	Professional, scientific and technical activities		
N	Administrative and support service activities		
O	Public administration and defence; compulsory social security	L	Public administration and defence; compulsory social security
P	Education	M	Education
Q	Human health and social work activities	N	Health and social work
R	Arts, entertainment and recreation	O	Other community, social and personal services activities
S	Other service activities		
T	Activities of households as employers; undifferentiated goods- and services-producing activities of households for own use	P	Activities of private households as employers and undifferentiated production activities of private households
U	Activities of extraterritorial organisations and bodies	Q	Extraterritorial organisations and bodies

Notes: This table presents the correspondence between the two revisions (Rev. 2. and Rev. 1.1) of the NACE classification.

B Descriptive statistics

This appendix reports, in Table B.1, the summary statistics of the adjusted variables at the regional level. Tables B.2 and B.3 report the summary statistics of, respectively, the employment-to-population ratio and the average wage, at the sectoral (within-region) level. Tables B.4 and B.5 report the summary statistics of, respectively, the employment-to-population ratio and the average wage, at the regional level for each cluster. Table B.6 reports the summary statistics of the technology penetration at the regional level. Tables B.7 to B.10 report the summary statistics at the sectoral level of the penetration of, respectively, robots, communication technology, information technology, and software & database. Tables B.11 and B.12 report the summary statistics of the change in the technology penetration at, respectively, the regional and sectoral levels.

Table B.1: Summary statistics – Adjusted variables at the regional level

Variable	Year	Mean	SD	Min	Q1	Q2	Q3	Max	N
Emp.	1995	724.2	641.9	14.4	317.5	562.3	934.5	5435.2	227
	2000	768.0	698.7	15.9	342.5	574.7	962.6	5856.4	227
	2005	793.6	735.8	17.7	362.8	591.2	998.2	5903.4	227
	2010	813.0	751.4	17.4	364.1	605.7	1026.8	6032.6	227
	2015	824.9	761.6	18.2	365.5	616.9	1022.7	6232.3	227
Wage	1995	23.4	11.6	1.8	11.4	27.0	31.9	51.0	226
	2000	25.0	11.8	2.3	13.7	28.8	33.7	54.4	227
	2005	26.1	11.8	2.7	14.9	28.8	35.2	56.3	227
	2010	27.3	12.1	3.1	15.8	29.6	36.2	58.1	227
	2015	27.7	12.5	3.8	14.8	30.2	37.5	58.1	227
Prod.	1995	44.9	19.0	8.0	26.9	51.2	57.2	83.9	221
	2000	47.2	20.3	5.6	29.8	53.3	61.8	91.4	227
	2005	50.1	20.6	6.7	34.1	55.5	64.7	96.4	227
	2010	51.5	20.5	7.8	33.2	56.3	65.3	103.8	227
	2015	53.2	22.0	8.6	32.7	57.4	65.8	162.1	227

Notes: This table presents the summary statistics of the employment-to-population ratio (Emp.), the average wage (Wage), and the labor productivity (Prod.) at the regional level for the 227 NUTS-2 regions every 5 years from 1995 to 2015. Data are from the ARDECO database. Outcomes variables are the level of employment (Emp.) in thousands, the average yearly wage (Wage) in thousands €2015, and the average yearly gross value added per worker (Prod.) in thousands €2015. Missing values come from data availability. The average yearly wage in Saarland (DEC0) cannot be calculated at the regional level as the compensation of employees is missing for the sector Agriculture (A) until 2000. The average yearly productivity per worker cannot be computed for the 6 regions of Bulgaria in 1995 as the gross value added is not available.

Table B.2: Summary statistics – Employment-to-population ratio at the sectoral level

Sector	Year	Mean	SD	Min	Q1	Q2	Q3	Max	N
A	1995	53.4	66.2	0.2	15.6	30.7	66.0	432.4	227
	2000	48.7	63.3	0.3	14.1	26.9	54.6	430.3	227
	2005	42.5	53.5	0.1	11.9	23.1	49.3	332.9	227
	2010	37.7	46.5	0.1	11.0	21.7	44.5	280.4	226
	2015	35.7	43.2	0.1	11.0	21.1	43.4	317.5	226
B-E	1995	155.7	151.2	0.3	56.5	124.3	193.6	1191.3	227
	2000	152.2	145.8	0.5	56.7	122.0	187.2	1110.5	227
	2005	144.1	137.9	0.8	55.0	113.6	180.8	1151.0	227
	2010	133.3	126.0	0.4	50.1	104.8	174.0	1033.4	227
	2015	132.4	125.2	0.4	47.4	103.0	173.7	972.7	227
F	1995	51.7	47.6	0.3	20.0	36.1	63.9	302.7	227
	2000	53.9	50.4	0.5	21.0	40.3	68.6	309.8	227
	2005	58.2	59.6	0.7	24.0	42.9	70.0	419.5	227
	2010	56.9	50.6	0.6	24.2	46.1	71.5	328.0	227
	2015	51.0	43.3	1.0	22.7	41.5	65.4	317.6	227
G-J	1995	181.9	180.1	5.8	76.2	129.6	228.6	1602.5	227
	2000	199.2	202.6	5.9	83.0	139.0	248.8	1788.3	227
	2005	211.1	216.8	6.8	87.2	150.4	264.2	1841.3	227
	2010	220.3	223.8	6.8	89.7	154.2	276.1	1878.5	227
	2015	224.6	227.3	7.0	91.2	155.3	277.6	1933.1	227
K-N	1995	82.0	114.1	0.7	21.1	48.7	102.3	1205.5	227
	2000	96.7	134.5	0.9	25.0	56.3	117.2	1438.9	227
	2005	109.1	147.2	1.0	28.5	63.5	132.7	1510.5	227
	2010	122.3	156.9	1.3	34.4	73.6	155.5	1533.6	227
	2015	131.2	168.4	1.5	37.2	79.2	161.4	1645.7	227
O-U	1995	199.4	184.9	3.7	85.1	149.2	249.6	1698.0	227
	2000	217.4	202.9	4.4	87.9	154.4	272.0	1812.6	227
	2005	228.6	212.6	5.4	93.6	160.0	279.9	1780.9	227
	2010	242.7	227.4	5.9	102.0	176.8	309.5	1875.1	227
	2015	250.1	234.3	6.2	102.5	183.2	321.1	1922.1	227

Notes: This table presents the summary statistics of employment-to-population ratio at the sectoral level for the 227 NUTS-2 regions every 5 years from 1995 to 2015. Data are from the ARDECO database. Missing values come from data availability.

Table B.3: Summary statistics – Average wage at the sectoral level

Sector	Year	Mean	SD	Min	Q1	Q2	Q3	Max	N
A	1995	4.1	3.7	0.1	1.4	3.5	5.6	20.6	226
	2000	5.1	4.0	0.2	1.9	4.2	7.1	18.6	227
	2005	6.9	5.5	0.2	2.7	5.8	9.5	32.3	227
	2010	7.9	5.5	0.3	3.5	7.2	11.0	33.4	226
	2015	9.0	6.1	0.5	4.6	8.1	11.9	37.0	226
B-E	1995	26.7	13.7	2.0	15.3	29.8	36.3	78.8	227
	2000	29.8	14.7	4.1	16.0	32.8	39.9	63.9	227
	2005	33.1	16.0	3.7	19.8	37.2	44.1	69.9	227
	2010	36.2	16.9	4.4	21.5	39.7	48.2	73.5	227
	2015	37.4	18.1	4.9	18.3	40.6	51.0	82.8	227
F	1995	29.2	17.3	1.5	12.7	28.8	41.9	76.5	227
	2000	28.8	16.2	2.7	13.0	28.7	42.7	66.9	227
	2005	27.2	15.5	2.4	11.3	27.6	40.3	62.3	227
	2010	26.1	14.9	2.3	11.7	28.3	36.2	83.8	227
	2015	24.7	12.8	3.9	12.7	26.9	34.4	52.1	227
G-J	1995	21.2	11.3	1.5	11.4	22.5	29.2	51.4	227
	2000	22.5	11.1	2.0	12.9	24.0	31.0	54.0	227
	2005	22.9	11.3	2.5	13.6	22.9	31.5	56.9	227
	2010	23.9	11.9	2.6	15.1	23.6	32.8	60.5	227
	2015	24.5	12.2	3.1	14.6	24.1	33.8	62.1	227
K-N	1995	25.3	12.1	1.7	15.5	26.2	34.3	58.3	227
	2000	25.7	11.6	3.2	15.1	27.6	33.4	62.5	227
	2005	25.4	11.8	3.9	15.9	25.0	34.2	61.1	227
	2010	25.9	12.8	4.7	16.0	25.0	34.2	76.2	227
	2015	26.3	13.0	4.5	15.0	25.6	36.4	66.6	227
O-U	1995	26.4	11.6	2.3	19.5	29.3	34.2	54.3	227
	2000	27.4	11.3	3.6	19.8	31.0	33.9	61.4	227
	2005	28.5	10.6	4.9	22.5	30.8	35.2	52.7	227
	2010	29.7	11.1	5.6	23.0	32.0	36.2	57.3	227
	2015	29.7	11.1	6.4	20.8	32.2	37.5	59.5	227

Notes: This table presents the summary statistics of the yearly average wage at the sectoral level for the 227 NUTS-2 regions every 5 years from 1995 to 2015. Data are from the ARDECO database. The average yearly wage is in thousands €2015. Missing values come from data availability. The average yearly wage in Saarland (DEC0) cannot be calculated at the regional level as the compensation of employees is missing for the sector Agriculture (A) until 2000.

Table B.4: Summary statistics – Employment-to-population ratio at the regional level by cluster

Cluster	Year	Mean	SD	Min	Q1	Q2	Q3	Max	N
Service (High)	1995	1059.0	1120.8	20.2	495.6	791.0	1634.7	5435.2	25
	2000	1175.2	1217.7	24.9	639.8	828.8	1618.2	5856.4	25
	2005	1231.7	1261.8	26.6	646.1	870.1	1557.1	5903.4	25
	2010	1279.0	1294.5	27.2	667.8	934.1	1691.8	6032.6	25
	2015	1326.2	1329.4	28.1	663.9	988.7	1851.1	6232.3	25
Ser./Agr. (High)	1995	630.7	624.4	14.4	179.3	328.7	941.6	2128.5	30
	2000	683.8	690.4	15.9	185.0	399.5	990.8	2421.7	30
	2005	717.2	749.8	17.7	187.0	435.1	996.9	2950.0	30
	2010	734.6	751.8	17.4	188.5	461.5	1030.8	2932.2	30
	2015	743.6	753.0	18.2	191.8	461.6	1076.3	2774.9	30
Industry (High)	1995	886.7	701.9	101.9	474.4	655.3	1077.7	4063.2	61
	2000	953.2	766.3	100.5	505.4	696.1	1080.2	4274.6	61
	2005	984.4	822.7	99.0	516.1	701.5	1078.8	4579.2	61
	2010	1004.2	830.9	103.3	524.1	710.1	1121.8	4622.0	61
	2015	1013.7	830.7	95.8	523.2	739.4	1203.5	4626.9	61
Agr./Ind. (High)	1995	524.4	329.1	79.9	270.7	497.4	620.3	1269.2	42
	2000	562.2	352.9	83.7	282.8	537.8	664.7	1379.2	42
	2005	583.8	364.2	88.4	285.5	547.7	739.6	1442.9	42
	2010	598.3	377.2	92.3	288.5	573.6	737.3	1491.2	42
	2015	603.3	387.1	94.8	281.6	563.2	711.0	1534.4	42
Service (Low)	1995	564.5	440.6	24.6	221.7	430.0	897.5	1505.2	19
	2000	590.0	473.3	30.2	238.2	397.0	934.9	1595.1	19
	2005	623.1	506.5	33.2	265.7	442.7	1020.4	1799.9	19
	2010	664.9	543.2	35.8	256.7	445.0	1194.3	1823.8	19
	2015	675.4	541.1	44.7	238.8	464.4	1171.1	1649.5	19
Industry (Low)	1995	695.6	396.1	117.2	423.8	569.0	860.6	1831.4	31
	2000	682.7	395.0	128.3	448.0	527.0	836.9	1751.6	31
	2005	678.0	375.4	132.2	443.5	529.0	757.2	1718.3	31
	2010	673.4	385.2	134.5	393.4	545.0	774.8	1788.7	31
	2015	679.8	371.3	126.3	434.8	568.0	831.1	1756.6	31
Agriculture (Low)	1995	557.3	337.9	115.8	283.0	463.5	737.4	1352.0	19
	2000	542.9	319.8	128.1	301.3	455.7	684.2	1315.8	19
	2005	548.2	316.3	136.3	296.4	448.0	714.5	1238.4	19
	2010	559.8	330.8	130.1	285.2	470.0	740.8	1255.5	19
	2015	563.3	347.7	116.0	281.1	469.7	712.7	1260.1	19

Notes: This table presents the summary statistics of employment-to-population ratio at the regional level by cluster for the 227 NUTS-2 regions every 5 years from 1995 to 2015. Data are from the ARDECO database. Missing values come from data availability.

Table B.5: Summary statistics – Average wage at the regional level by cluster

Cluster	Year	Mean	SD	Min	Q1	Q2	Q3	Max	N
Service (High)	1995	35.0	8.0	11.4	31.6	36.5	39.1	51.0	25
	2000	36.4	8.6	13.6	31.5	35.7	40.6	54.4	25
	2005	37.0	9.1	16.9	30.1	37.0	41.5	56.3	25
	2010	38.7	9.7	18.2	31.9	37.3	44.9	58.1	25
	2015	39.1	9.7	20.1	32.2	38.8	43.8	58.1	25
Ser./Agr. (High)	1995	29.5	4.8	19.9	26.6	29.8	32.8	41.3	30
	2000	31.5	5.6	21.2	28.4	31.9	34.4	44.6	30
	2005	32.0	6.1	21.6	28.0	32.7	35.8	46.2	30
	2010	33.4	7.0	23.4	28.4	34.0	38.1	49.0	30
	2015	33.9	7.3	22.2	29.1	35.3	38.7	50.0	30
Industry (High)	1995	30.1	5.0	14.7	26.3	31.3	33.5	40.1	60
	2000	31.4	5.0	14.8	27.3	32.5	35.0	41.9	61
	2005	32.4	5.5	21.2	27.4	33.6	36.5	44.3	61
	2010	33.6	5.8	19.4	28.8	34.5	38.0	46.3	61
	2015	34.4	6.5	15.7	29.4	35.2	39.0	47.1	61
Agr./Ind. (High)	1995	27.4	5.5	11.2	24.1	28.6	30.8	38.3	42
	2000	29.8	5.7	14.6	26.6	30.7	33.0	41.1	42
	2005	31.0	6.4	15.5	27.4	32.8	33.8	44.1	42
	2010	32.0	6.5	16.0	28.0	33.3	35.4	45.4	42
	2015	32.6	7.6	12.8	29.6	35.0	36.5	46.9	42
Service (Low)	1995	9.9	4.8	2.6	6.7	9.1	12.4	21.1	19
	2000	11.4	5.1	2.8	8.1	10.6	14.3	23.1	19
	2005	13.2	5.7	3.2	8.9	13.5	17.3	23.3	19
	2010	14.6	6.3	3.6	10.2	13.5	18.5	28.3	19
	2015	14.5	6.0	4.4	11.1	12.9	17.9	29.1	19
Industry (Low)	1995	6.9	2.7	2.1	5.2	7.0	8.4	12.3	31
	2000	8.1	2.9	2.3	6.6	8.1	8.8	13.8	31
	2005	9.5	3.3	2.7	7.4	9.8	10.7	15.9	31
	2010	10.5	3.4	3.1	9.2	10.5	12.2	18.1	31
	2015	11.0	3.2	3.8	10.3	11.6	12.4	18.0	31
Agriculture (Low)	1995	8.3	5.5	1.8	4.5	7.5	8.7	20.7	19
	2000	9.7	5.8	2.6	5.9	7.8	10.5	22.1	19
	2005	11.0	5.6	3.2	6.0	10.3	12.9	21.8	19
	2010	11.7	5.9	4.0	6.8	10.0	13.6	23.6	19
	2015	11.4	5.4	4.7	7.7	10.5	12.1	23.5	19

Notes: This table presents the summary statistics of the yearly average wage at the regional level by cluster for the 227 NUTS-2 regions every 5 years from 1995 to 2015. Data are from the ARDECO database. The average yearly wage is in thousands €2015. Missing values come from data availability. The average yearly wage in Saarland (DEC0) cannot be calculated at the regional level as the compensation of employees is missing for the sector Agriculture (A) until 2000.

Table B.6: Summary statistics – Technology penetration at the regional level

Technology	Year	Mean	SD	Min	Q1	Q2	Q3	Max	N
Robots	1995	0.0	0.1	0	0	0.0	0.0	0.3	227
	2000	0.1	0.1	0	0	0.0	0.1	0.5	227
	2005	0.1	0.1	0	0	0.0	0.1	0.7	227
	2010	0.1	0.1	0	0	0.1	0.1	0.9	227
	2015	0.2	0.2	0	0	0.1	0.2	1.3	227
Comm. Tech.	1995	0.5	2.9	0	0	0.0	0.1	39.9	227
	2000	0.8	4.1	0	0	0.0	0.1	54.6	227
	2005	0.7	3.1	0	0	0.0	0.2	38.4	227
	2010	0.7	2.7	0	0	0.0	0.2	33.4	227
	2015	0.7	2.8	0	0	0.0	0.2	34.9	227
Info. Tech	1995	0.1	0.5	0	0	0.0	0.0	5.7	227
	2000	0.3	1.1	0	0	0.0	0.1	13.4	227
	2005	0.4	1.5	0	0	0.0	0.1	17.8	227
	2010	0.6	2.4	0	0	0.0	0.2	29.7	227
	2015	0.8	3.3	0	0	0.0	0.2	41.3	227
Soft. Data.	1995	0.5	2.0	0	0	0.0	0.1	24.8	227
	2000	0.8	2.9	0	0	0.1	0.2	34.5	227
	2005	1.4	5.7	0	0	0.1	0.3	70.7	227
	2010	2.0	8.6	0	0	0.1	0.4	108.3	227
	2015	2.0	9.1	0	0	0.1	0.4	116.1	227

Notes: This table presents the summary statistics of technology penetration of robots, information technology, communication technology, and software-database, at the regional level for the 227 NUTS-2 regions every 5 years from 1995 to 2015. Data are from the IFR database for robots and EU-KLEMS (Release 2019) for the three other technologies. Technology penetration is a measure of the allocation of technologies across regions. Missing values come from data availability as EU-KLEMS data for regions in Bulgaria, Estonia, Poland, Portugal, Slovakia, and Slovenia, are only available since 2000.

Table B.7: Summary statistics – Robot penetration at the sectoral level

Sector	Year	Mean	SD	Min	Q1	Q2	Q3	Max	N
A	1995	0.0	0.0	0	0.0	0.0	0.0	0.0	227
	2000	0.0	0.0	0	0.0	0.0	0.0	0.0	227
	2005	0.0	0.0	0	0.0	0.0	0.0	0.0	227
	2010	0.0	0.0	0	0.0	0.0	0.0	0.0	227
	2015	0.0	0.0	0	0.0	0.0	0.0	0.0	227
B-E	1995	0.2	0.2	0	0.0	0.1	0.2	1.2	227
	2000	0.3	0.3	0	0.0	0.2	0.3	1.7	227
	2005	0.4	0.5	0	0.0	0.2	0.5	2.7	227
	2010	0.5	0.6	0	0.1	0.3	0.6	3.8	227
	2015	0.6	0.8	0	0.1	0.3	0.8	4.5	227
F	1995	0.0	0.0	0	0.0	0.0	0.0	0.0	227
	2000	0.0	0.0	0	0.0	0.0	0.0	0.1	227
	2005	0.0	0.0	0	0.0	0.0	0.0	0.1	227
	2010	0.0	0.0	0	0.0	0.0	0.0	0.3	227
	2015	0.0	0.0	0	0.0	0.0	0.0	0.3	227
G-J	1995	0.0	0.0	0	0.0	0.0	0.0	0.0	227
	2000	0.0	0.0	0	0.0	0.0	0.0	0.0	227
	2005	0.0	0.0	0	0.0	0.0	0.0	0.0	227
	2010	0.0	0.0	0	0.0	0.0	0.0	0.0	227
	2015	0.0	0.0	0	0.0	0.0	0.0	0.0	227
K-N	1995	0.0	0.0	0	0.0	0.0	0.0	0.0	227
	2000	0.0	0.0	0	0.0	0.0	0.0	0.0	227
	2005	0.0	0.0	0	0.0	0.0	0.0	0.0	227
	2010	0.0	0.0	0	0.0	0.0	0.0	0.0	227
	2015	0.0	0.0	0	0.0	0.0	0.0	0.0	227
O-U	1995	0.0	0.0	0	0.0	0.0	0.0	0.0	227
	2000	0.0	0.0	0	0.0	0.0	0.0	0.0	227
	2005	0.0	0.0	0	0.0	0.0	0.0	0.0	227
	2010	0.0	0.0	0	0.0	0.0	0.0	0.1	227
	2015	0.0	0.0	0	0.0	0.0	0.0	0.1	227

Notes: This table presents the summary statistics of the penetration of robots at the sectoral level for the 227 NUTS-2 regions every 5 years from 1995 to 2015. Data are from the IFR database. Technology penetration is a measure of the allocation of technologies across regions.

Table B.8: Summary statistics – Information technology penetration at the sectoral level

Sector	Year	Mean	SD	Min	Q1	Q2	Q3	Max	N
A	1995	0.1	0.3	0	0	0.0	0.0	1.7	190
	2000	0.1	0.4	0	0	0.0	0.0	3.2	227
	2005	0.1	0.5	0	0	0.0	0.0	3.7	227
	2010	0.2	0.9	0	0	0.0	0.0	5.7	227
	2015	0.3	1.1	0	0	0.0	0.0	7.1	227
B-E	1995	0.1	0.4	0	0	0.0	0.0	2.6	190
	2000	0.3	0.7	0	0	0.0	0.1	4.2	227
	2005	0.3	1.0	0	0	0.0	0.1	8.0	227
	2010	0.5	1.5	0	0	0.0	0.1	10.9	227
	2015	0.7	2.1	0	0	0.0	0.1	14.1	227
F	1995	0.0	0.1	0	0	0.0	0.0	1.2	190
	2000	0.1	0.2	0	0	0.0	0.0	2.8	227
	2005	0.1	0.6	0	0	0.0	0.0	9.1	227
	2010	0.2	0.8	0	0	0.0	0.1	6.8	227
	2015	0.3	0.9	0	0	0.0	0.0	6.3	227
G-J	1995	0.2	0.7	0	0	0.0	0.0	8.4	190
	2000	0.3	1.0	0	0	0.0	0.1	10.7	227
	2005	0.4	1.2	0	0	0.0	0.1	11.9	227
	2010	0.5	1.6	0	0	0.0	0.2	16.4	227
	2015	0.6	2.5	0	0	0.0	0.2	30.9	227
K-N	1995	0.5	1.8	0	0	0.0	0.1	20.8	190
	2000	0.9	3.6	0	0	0.1	0.3	43.3	227
	2005	1.3	5.7	0	0	0.1	0.4	66.5	227
	2010	2.0	9.2	0	0	0.1	0.5	110.9	227
	2015	2.4	11.5	0	0	0.1	0.5	143.1	227
O-U	1995	0.1	0.5	0	0	0.0	0.0	4.5	190
	2000	0.3	1.2	0	0	0.0	0.1	16.4	227
	2005	0.4	1.5	0	0	0.0	0.1	16.8	227
	2010	0.6	2.2	0	0	0.0	0.1	23.0	227
	2015	0.7	3.0	0	0	0.0	0.1	32.7	227

Notes: This table presents the summary statistics of the penetration of information technology at the sectoral level for the 227 NUTS-2 regions every 5 years from 1995 to 2015. Data are EU-KLEMS (Release 2019). Technology penetration is a measure of the allocation of technologies across regions. Missing values come from data availability as EU-KLEMS data for regions in Bulgaria, Estonia, Poland, Portugal, Slovakia, and Slovenia, are only available since 2000.

Table B.9: Summary statistics – Communication technology penetration at the sectoral level

Sector	Year	Mean	SD	Min	Q1	Q2	Q3	Max	N
A	1995	0.3	1.2	0	0	0.0	0.0	12.0	190
	2000	0.3	1.4	0	0	0.0	0.0	13.0	227
	2005	0.2	1.0	0	0	0.0	0.0	7.9	227
	2010	0.2	0.8	0	0	0.0	0.0	6.4	227
	2015	0.2	0.7	0	0	0.0	0.0	5.6	227
B-E	1995	0.4	1.3	0	0	0.0	0.1	8.9	190
	2000	0.6	2.1	0	0	0.0	0.1	14.1	227
	2005	0.7	2.4	0	0	0.0	0.1	17.2	227
	2010	0.8	3.0	0	0	0.0	0.1	24.6	227
	2015	0.9	3.2	0	0	0.0	0.1	27.4	227
F	1995	0.1	0.7	0	0	0.0	0.0	8.1	190
	2000	0.2	0.9	0	0	0.0	0.0	11.3	227
	2005	0.2	1.3	0	0	0.0	0.0	19.6	227
	2010	0.1	0.7	0	0	0.0	0.0	7.7	227
	2015	0.2	0.6	0	0	0.0	0.0	4.4	227
G-J	1995	0.5	2.1	0	0	0.0	0.2	25.4	190
	2000	0.6	2.1	0	0	0.0	0.3	24.6	227
	2005	0.6	1.7	0	0	0.0	0.3	17.0	227
	2010	0.6	1.7	0	0	0.1	0.4	18.4	227
	2015	0.6	2.1	0	0	0.1	0.4	26.1	227
K-N	1995	2.1	12.4	0	0	0.0	0.1	144.9	190
	2000	2.5	14.6	0	0	0.0	0.1	176.1	227
	2005	2.3	12.3	0	0	0.1	0.2	143.2	227
	2010	2.1	10.3	0	0	0.1	0.3	124.5	227
	2015	2.1	9.9	0	0	0.1	0.4	120.8	227
O-U	1995	0.6	3.1	0	0	0.0	0.0	31.3	190
	2000	0.8	4.9	0	0	0.0	0.1	66.8	227
	2005	0.6	3.1	0	0	0.0	0.1	36.2	227
	2010	0.5	2.4	0	0	0.0	0.1	25.9	227
	2015	0.5	2.4	0	0	0.0	0.1	27.6	227

Notes: This table presents the summary statistics of the penetration of communication technology at the sectoral level for the 227 NUTS-2 regions every 5 years from 1995 to 2015. Data are from EU-KLEMS (Release 2019). Technology penetration is a measure of the allocation of technologies across regions. Missing values come from data availability as EU-KLEMS data for regions in Bulgaria, Estonia, Poland, Portugal, Slovakia, and Slovenia, are only available since 2000.

Table B.10: Summary statistics – Software and database penetration at the sectoral level

Sector	Year	Mean	SD	Min	Q1	Q2	Q3	Max	N
A	1995	0.1	0.6	0	0.0	0.0	0.0	6.0	190
	2000	0.0	0.1	0	0.0	0.0	0.0	1.1	227
	2005	0.0	0.2	0	0.0	0.0	0.0	1.6	227
	2010	0.1	0.3	0	0.0	0.0	0.0	2.1	227
	2015	0.1	0.3	0	0.0	0.0	0.0	2.8	227
B-E	1995	0.4	0.9	0	0.0	0.1	0.2	4.7	190
	2000	0.6	1.8	0	0.0	0.1	0.3	12.3	227
	2005	1.2	4.0	0	0.0	0.1	0.3	34.7	227
	2010	1.7	6.2	0	0.0	0.1	0.3	51.1	227
	2015	1.4	4.7	0	0.0	0.1	0.4	35.7	227
F	1995	0.1	0.4	0	0.0	0.0	0.0	4.0	190
	2000	0.1	0.5	0	0.0	0.0	0.1	4.6	227
	2005	0.3	2.1	0	0.0	0.0	0.1	30.8	227
	2010	0.3	1.0	0	0.0	0.0	0.1	10.4	227
	2015	0.3	1.0	0	0.0	0.0	0.1	7.6	227
G-J	1995	0.7	2.9	0	0.0	0.0	0.1	32.4	190
	2000	1.1	4.2	0	0.0	0.1	0.2	43.4	227
	2005	2.2	8.8	0	0.0	0.1	0.3	94.9	227
	2010	3.1	12.1	0	0.0	0.1	0.5	131.8	227
	2015	3.4	15.1	0	0.0	0.1	0.5	178.5	227
K-N	1995	2.0	8.0	0	0.0	0.1	0.4	87.2	190
	2000	2.4	9.2	0	0.0	0.2	0.6	102.5	227
	2005	3.9	16.8	0	0.1	0.2	0.8	191.9	227
	2010	6.1	28.4	0	0.1	0.3	1.0	340.5	227
	2015	5.8	25.7	0	0.1	0.3	1.2	314.4	227
O-U	1995	0.2	0.4	0	0.0	0.0	0.1	3.6	190
	2000	0.3	1.1	0	0.0	0.0	0.1	15.0	227
	2005	0.7	2.8	0	0.0	0.1	0.2	32.4	227
	2010	0.8	3.1	0	0.0	0.1	0.2	33.3	227
	2015	0.9	3.5	0	0.0	0.1	0.2	39.2	227

Notes: This table presents the summary statistics of the penetration of software-database, at the sectoral level for the 227 NUTS-2 regions every 5 years from 1995 to 2015. Data are from EU-KLEMS (Release 2019). Technology penetration is a measure of the allocation of technologies across regions. Missing values come from data availability as EU-KLEMS data for regions in Bulgaria, Estonia, Poland, Portugal, Slovakia, and Slovenia, are only available since 2000.

Table B.11: Summary statistics – Change in technology penetration at the regional level (in clusters)

		Robots			Comm. Tech.			Info. Tech.			Soft. Data.			
Cluster	h	Q2	Mean	SD	Q2	Mean	SD	Q2	Mean	SD	Q2	Mean	SD	N
All regions	5	0.43	0.90	2.85	0.21	0.29	0.48	0.34	0.43	0.62	0.27	0.38	0.51	3901
	10	0.99	2.94	9.63	0.47	0.64	0.86	0.81	1.05	1.62	0.61	0.92	1.19	2766
	15	1.58	5.71	20.55	0.78	1.09	1.64	1.36	1.92	2.84	1.16	1.55	1.80	1631
Service intensive (High)	5	0.43	0.75	2.79	0.22	0.33	0.44	0.42	0.53	0.54	0.32	0.38	0.33	450
	10	1.05	1.86	3.62	0.53	0.70	0.72	1.10	1.33	1.17	0.74	0.89	0.60	325
	15	1.78	3.62	6.34	0.93	1.25	1.25	1.99	2.60	2.39	1.39	1.56	0.91	200
Service/Agriculture (High)	5	0.33	0.41	0.55	0.22	0.33	0.81	0.32	0.46	0.96	0.27	0.37	0.66	540
	10	0.76	0.92	1.00	0.44	0.72	1.57	0.76	1.08	1.88	0.65	0.81	1.10	390
	15	1.34	1.58	1.51	0.81	1.29	3.25	1.15	2.10	4.59	1.23	1.41	1.71	240
Industry intensive (High)	5	0.29	0.54	3.04	0.19	0.24	0.26	0.31	0.37	0.42	0.22	0.27	0.28	1098
	10	0.60	1.47	9.47	0.39	0.51	0.49	0.66	0.83	0.86	0.46	0.59	0.63	793
	15	0.99	2.87	21.88	0.66	0.88	0.86	1.11	1.47	1.51	0.81	0.97	0.75	488
Agriculture/Industry (High)	5	0.34	0.68	4.12	0.19	0.25	0.26	0.35	0.41	0.41	0.25	0.31	0.34	751
	10	0.68	1.92	14.25	0.41	0.53	0.46	0.81	0.95	0.86	0.56	0.70	0.67	541
	15	1.16	3.68	31.67	0.72	0.90	0.79	1.52	1.73	1.50	1.00	1.20	0.94	331
Service intensive (Low)	5	1.16	1.89	2.36	0.37	0.41	0.66	0.35	0.42	0.60	0.43	0.57	0.70	287
	10	5.12	7.37	10.18	0.92	0.98	1.04	0.88	1.03	1.04	0.99	1.53	1.74	192
	15	10.23	14.26	17.54	1.46	1.75	1.92	1.35	1.87	2.18	2.15	2.94	2.96	97
Industry intensive (Low)	5	1.27	1.67	1.77	0.27	0.27	0.51	0.35	0.50	0.86	0.31	0.50	0.65	473
	10	4.74	6.54	9.07	0.64	0.66	0.90	0.90	1.44	3.53	1.01	1.38	1.69	318
	15	10.66	12.52	10.54	1.13	1.16	1.50	1.61	2.65	4.97	1.83	2.48	2.64	163
Agriculture intensive (Low)	5	1.13	1.57	2.05	0.23	0.31	0.50	0.41	0.44	0.56	0.40	0.59	0.79	302
	10	4.38	6.23	7.35	0.62	0.75	0.75	0.97	1.10	0.98	1.09	1.66	2.08	207
	15	10.89	14.95	19.58	0.80	1.17	1.28	1.46	1.83	1.74	1.92	2.83	3.24	112

Notes: This table presents the summary statistics of the growth rate of technology penetration of robots, information technology, communication technology, and software-database, at the regional level for each cluster of the 227 NUTS-2 regions according to time horizon h. Data are from the IFR database for robots and EU-KLEMS (Release 2019) for the three other technologies. Technology penetration is a measure of the allocation of technologies across regions. Missing values come from data availability as EU-KLEMS data for regions in Bulgaria, Estonia, Poland, Portugal, Slovakia, and Slovenia, are only available since 2000.

Table B.12: Summary statistics – Change in the technology penetration at the sectoral level

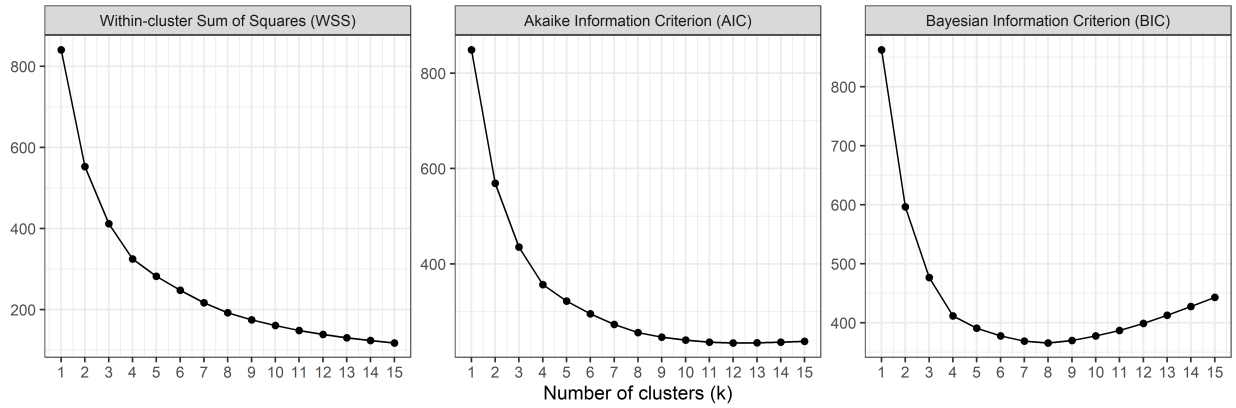
		Robots			Comm. Tech.			Info. Tech.			Soft. Data.			
h	Sector	Q2	Mean	SD	Q2	Mean	SD	Q2	Mean	SD	Q2	Mean	SD	N
5	A				0.19	0.32	0.89	0.25	0.53	1.64	0.18	0.44	1.19	2727
	B-E	0.42	0.73	0.99	0.21	0.34	0.70	0.23	0.36	0.70	0.25	0.37	0.71	2727
	F	0.84	14.95	86.65	0.17	0.41	0.97	0.33	0.63	1.35	0.17	0.39	1.06	2727
	G-J				0.19	0.28	0.62	0.32	0.51	0.93	0.35	0.52	0.78	2727
	K-N				0.26	0.34	0.51	0.29	0.42	0.68	0.24	0.33	0.51	2727
	O-U	0.39	4.94	44.39	0.24	0.29	0.42	0.37	0.42	0.55	0.25	0.34	0.61	2727
10	A				0.44	0.74	1.87	0.62	1.06	2.38	0.44	0.93	1.79	1902
	B-E	0.95	2.21	3.27	0.49	0.78	1.21	0.51	0.80	1.13	0.58	0.84	1.41	1902
	F	2.94	57.46	210.00	0.33	1.08	2.42	0.71	1.71	2.88	0.43	0.80	1.38	1902
	G-J				0.37	0.62	1.07	0.69	1.20	1.89	0.80	1.21	1.65	1902
	K-N				0.64	0.83	0.99	0.63	1.07	1.50	0.57	0.74	0.86	1902
	O-U	0.84	10.66	72.33	0.57	0.73	0.81	0.92	1.14	1.28	0.56	0.80	1.27	1902
15	A				0.66	1.14	1.96	0.96	1.68	2.92	0.87	1.67	3.47	1087
	B-E	1.58	4.25	6.85	0.76	1.24	1.66	0.73	1.30	1.83	0.94	1.31	1.82	1087
	F	6.52	267.45	760.82	0.45	1.88	4.53	1.07	3.00	4.97	0.72	1.22	1.89	1087
	G-J				0.55	1.01	1.84	1.02	2.14	3.51	1.49	2.08	2.05	1087
	K-N				1.03	1.46	1.69	1.04	2.03	3.22	0.97	1.27	1.40	1087
	O-U	1.43	16.10	83.30	0.89	1.20	1.25	1.51	2.05	2.35	0.92	1.27	1.58	1087

Notes: This table presents the summary statistics of the growth rate of technology penetration of robots, information technology, communication technology, and software-database, at the regional level by sector for the 227 NUTS-2 regions according to time horizon h. Data are from the IFR database for robots and EU-KLEMS (Release 2019) for the three other technologies. Technology penetration is a measure of the allocation of technologies across regions. Missing values come from data availability as EU-KLEMS data for regions in Bulgaria, Estonia, Poland, Portugal, Slovakia, and Slovenia, are only available since 2000.

C Clustering

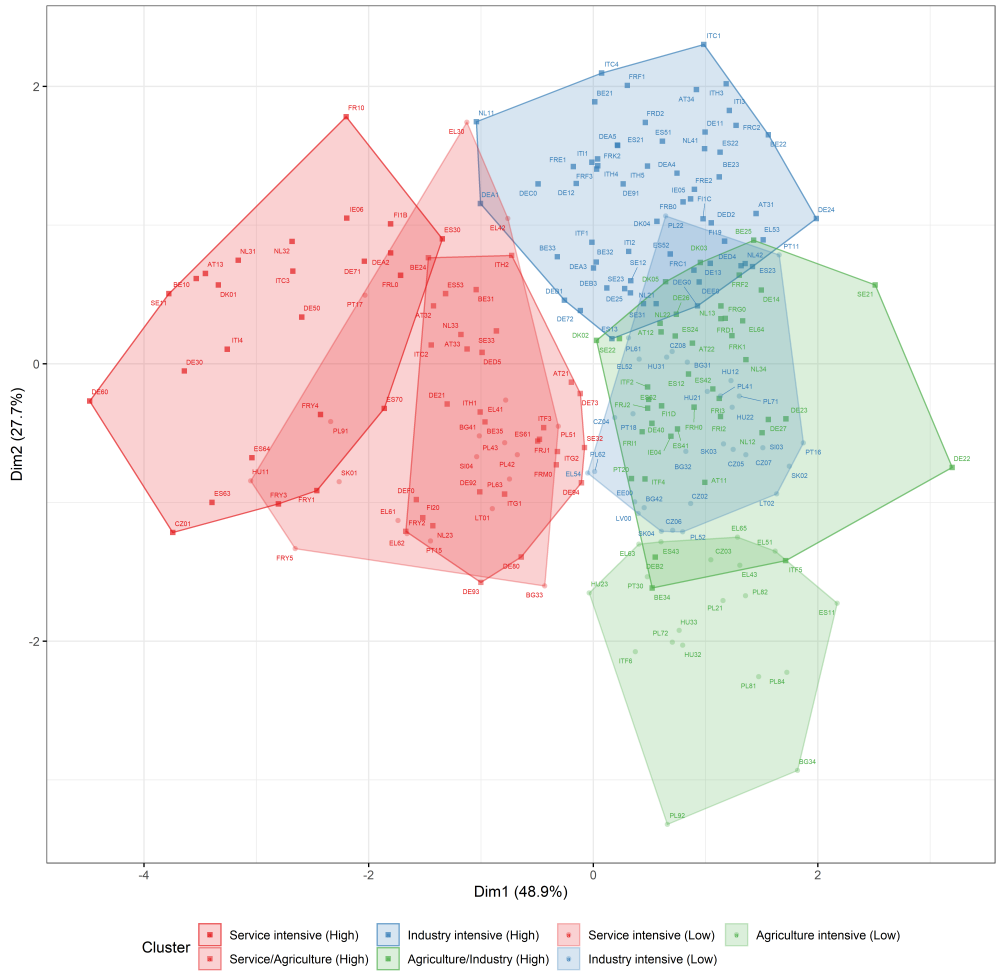
This appendix reports, in Figure C.1, the goodness of fit of the classification of regions using the K-means algorithm. Figure C.2 reports the regional clusters on the first two principal components derived from the K-means.

Figure C.1: Goodness-of-fit



Notes: This figure presents the goodness-of-fit of the K-means clustering for several cluster numbers ranging from 1 to 15. The goodness-of-fit is reported using three metrics: the Within-cluster Sum of Squares (WSS), the Akaike Information Criterion (AIC), and the Bayesian Information Criterion (BIC).

Figure C.2: Regional clusters and the first two principal components



Notes: This figure presents the seven clusters on the first two principal components from the K-means algorithm. The set of clustering variables contains the share of the three sectors (i.e. agriculture, industry, and service).

D Regression tables

This appendix reports, in Table D.1, the labor market adjustments to regional technology penetration. Tables D.2 to D.7 report the adjustments to sectoral technology penetration of, respectively, the regional employment-to-population ratio, the regional average wage, the sectoral employment-to-population ratio, the sectoral employment share, the sectoral average wage, and the relative sectoral wage. Table D.8 presents the labor market adjustments to regional technology penetration by cluster.

Table D.1: Labor market adjustments to regional technology penetration

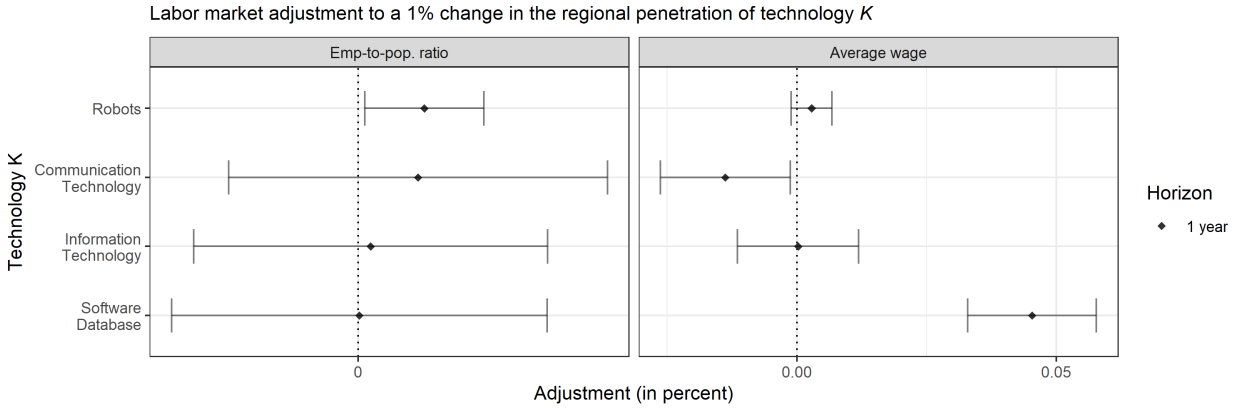
	Linear regression - Dep. var.: in logarithm							
	$h = 1$		$h = 5$		$h = 10$		$h = 15$	
	(Emp.)	(Wage)	(Emp.)	(Wage)	(Emp.)	(Wage)	(Emp.)	(Wage)
Intercept	0.007	0.013**	0.105***	0.113***	−0.025	−0.035*	0.068***	0.042**
	(0.005)	(0.006)	(0.014)	(0.015)	(0.019)	(0.019)	(0.020)	(0.020)
Robots	0.004**	0.003	0.029***	−0.009***	0.052***	−0.010***	0.030***	−0.011***
	(0.002)	(0.002)	(0.002)	(0.003)	(0.003)	(0.003)	(0.004)	(0.004)
Comm. Tech.	0.003	−0.014**	−0.005	−0.019***	−0.027***	−0.010	−0.035***	−0.016**
	(0.005)	(0.006)	(0.006)	(0.006)	(0.007)	(0.007)	(0.008)	(0.008)
Info. Tech.	0.001	0.000	−0.000	0.010*	0.013*	−0.017***	0.028***	−0.013**
	(0.005)	(0.006)	(0.005)	(0.005)	(0.007)	(0.006)	(0.006)	(0.006)
Soft. Data.	0.000	0.045***	−0.001	0.087***	−0.009	0.129***	0.021***	0.114***
	(0.005)	(0.006)	(0.005)	(0.006)	(0.007)	(0.007)	(0.008)	(0.008)
Imports	0.010***	−0.001	0.027***	−0.008*	0.031***	0.025***	−0.026***	−0.003
	(0.003)	(0.004)	(0.004)	(0.004)	(0.006)	(0.006)	(0.005)	(0.005)
Cons. Exp.	0.133***	0.202***	0.249***	0.243***	0.264***	0.137***	0.307***	0.171***
	(0.010)	(0.012)	(0.012)	(0.013)	(0.018)	(0.018)	(0.021)	(0.021)
R^2	0.228	0.226	0.467	0.521	0.618	0.780	0.814	0.930
Adj. R^2	0.185	0.182	0.430	0.487	0.579	0.758	0.781	0.917
Num. obs.	4602	4597	3718	3713	2613	2608	1513	1508

Notes: $^{***}p < 0.01$; $^{**}p < 0.05$; $^{*}p < 0.1$. Standard errors between parentheses. This table summarizes the coefficients from the estimated linear regressions of adjustments of the regional employment-to-population ratio (Emp.) and regional average wage per worker (Wage) to a 1% change in the regional penetration of robots, communication technology, information technology, and software & database. Controls variables include imports from China (in log-difference), real consumption index (in log-difference), and region and time fixed effects. Time horizon is $h = 1$.

E Additional figures

This appendix reports, in Figure E.1, the regional labor market adjustments to technology penetration over the 1-year horizon.

Figure E.1: Regional labor market adjustments to technology penetration (1-year horizon)



Notes: This figure presents the labor market adjustments at the regional level of employment and the average wage to a 1% change in the regional penetration of robots, communication technology, information technology, and software & database. The x-axis corresponds to the adjustment (in percent) and the y-axis corresponds to the technology. Column panels refer to labor market outcomes. Time horizons is 1 year and correspond to the window of the log-difference of variables in the regression. Coefficients are reported with a 95% confidence interval and can be interpreted as elasticities since they are obtained using linear regressions with variables in log-difference. Controls variables include imports from china (in log-difference), real consumption index (in log-difference), and region and time fixed effects. Table D.1 in the appendix presents the regressions. Figure 3 presents the figure for 5-year, 10-year, and 15-year horizons.

Table D.2: Regional employment-to-population ratio adjustments to sectoral technology penetration

	Linear regression - Dep. var.: Emp-to-pop. ratio (in log)			
	$(h = 1)$	$(h = 5)$	$(h = 10)$	$(h = 15)$
Intercept	0.003	0.086***	−0.006	0.194***
	(0.005)	(0.016)	(0.023)	(0.033)
Robot penetration				
ROB in (B-E)	0.036***	0.077***	0.083***	0.073***
	(0.005)	(0.004)	(0.006)	(0.008)
ROB in (F)	−0.002***	0.000	−0.003*	−0.008***
	(0.001)	(0.001)	(0.002)	(0.001)
ROB in (O-U)	−0.002**	−0.011***	−0.008***	−0.006***
	(0.001)	(0.002)	(0.002)	(0.002)
Communication Technology penetration				
CT in (A)	−0.002	0.011***	0.004	0.029***
	(0.004)	(0.003)	(0.004)	(0.007)
CT in (B-E)	0.018***	0.025***	0.014	−0.011
	(0.006)	(0.007)	(0.010)	(0.015)
CT in (F)	−0.004	−0.032***	−0.032***	−0.010
	(0.004)	(0.005)	(0.007)	(0.010)
CT in (G-J)	−0.026***	−0.014	−0.008	−0.039**
	(0.009)	(0.011)	(0.016)	(0.017)
CT in (K-N)	−0.012*	0.005	0.018**	−0.048***
	(0.007)	(0.006)	(0.008)	(0.015)
CT in (O-U)	0.022***	0.046***	0.042***	−0.091***
	(0.007)	(0.009)	(0.010)	(0.016)
Information Technology penetration				
IT in (A)	0.007**	0.015***	0.027***	−0.008
	(0.004)	(0.003)	(0.004)	(0.007)
IT in (B-E)	−0.041***	−0.094***	−0.100***	−0.107***
	(0.008)	(0.008)	(0.009)	(0.017)
IT in (F)	0.007**	0.049***	0.066***	0.002
	(0.003)	(0.004)	(0.005)	(0.008)
IT in (G-J)	0.022***	0.043***	0.058***	0.042***
	(0.008)	(0.010)	(0.011)	(0.014)
IT in (K-N)	0.025***	0.019***	−0.003	0.090***
	(0.007)	(0.007)	(0.012)	(0.013)
IT in (O-U)	−0.028***	−0.045***	−0.028**	0.076***
	(0.008)	(0.010)	(0.012)	(0.016)
Software-Database penetration				
SDB in (A)	−0.003	−0.007***	−0.002	−0.011**
	(0.002)	(0.003)	(0.003)	(0.005)
SDB in (B-E)	−0.009	0.018***	0.031***	0.052***
	(0.006)	(0.005)	(0.008)	(0.013)
SDB in (F)	0.003	−0.014***	−0.031***	0.022***
	(0.003)	(0.003)	(0.004)	(0.006)
SDB in (G-J)	0.005	−0.018**	−0.040***	−0.013
	(0.006)	(0.008)	(0.011)	(0.012)
SDB in (K-N)	−0.012*	−0.013*	−0.017	−0.044***
	(0.007)	(0.007)	(0.012)	(0.016)
SDB in (O-U)	0.016***	0.004	−0.007	0.036***
	(0.006)	(0.008)	(0.011)	(0.014)
Imports	0.021***	0.021***	0.027***	−0.058***
	(0.004)	(0.005)	(0.008)	(0.008)
Cons. Exp.	0.074***	0.196***	0.168***	0.144***
	(0.012)	(0.015)	(0.022)	(0.029)
R^2	0.242	0.565	0.775	0.870
Adj. R^2	0.193	0.530	0.749	0.843
Num. obs.	3377	2721	1902	1087

Notes: $^{***}p < 0.01$; $^{**}p < 0.05$; $^{*}p < 0.1$. Standard errors between parentheses. This table summarizes the coefficients from the estimated linear regressions of adjustments of the regional employment-to-population ratio to a 1% change in the sectoral penetration of robots, communication technology, information technology, and software & database, in Agriculture (A), Industry (B-E), Construction (F), Market Services (G-J), Financial & Business Services (K-N), and Non-Market Services (O-U). Controls variables include imports from China (in log-difference), real consumption index (in log-difference), and region and time fixed effects. Time horizons h range from 1 to 15 years and correspond to the window of the log-difference of variables in the regression.

Table D.3: Regional average wage adjustments to sectoral technology penetration

	Linear regression - Dep. var.: Emp-to-pop. ratio (in log)			
	$(h = 1)$	$(h = 5)$	$(h = 10)$	$(h = 15)$
Intercept	0.012**	0.134***	0.000	0.137***
	(0.006)	(0.015)	(0.022)	(0.034)
Robot penetration				
ROB in (B-E)	−0.022***	−0.034***	−0.044***	−0.024***
	(0.005)	(0.004)	(0.006)	(0.008)
ROB in (F)	−0.001	−0.004***	0.005***	−0.006***
	(0.001)	(0.001)	(0.001)	(0.001)
ROB in (O-U)	0.001	0.001	0.006***	0.002
	(0.001)	(0.002)	(0.002)	(0.002)
Communication Technology penetration				
CT in (A)	0.006	−0.014***	−0.014***	0.028***
	(0.004)	(0.003)	(0.004)	(0.007)
CT in (B-E)	0.005	0.007	−0.016*	0.024
	(0.007)	(0.007)	(0.009)	(0.016)
CT in (F)	−0.002	0.014***	−0.008	0.013
	(0.004)	(0.005)	(0.006)	(0.010)
CT in (G-J)	−0.026***	−0.056***	−0.042***	−0.019
	(0.010)	(0.010)	(0.015)	(0.018)
CT in (K-N)	0.029***	0.029***	0.006	−0.017
	(0.007)	(0.006)	(0.008)	(0.015)
CT in (O-U)	−0.007	0.036***	0.067***	−0.106***
	(0.008)	(0.008)	(0.009)	(0.017)
Information Technology penetration				
IT in (A)	0.001	0.014***	0.016***	−0.032***
	(0.004)	(0.003)	(0.004)	(0.007)
IT in (B-E)	−0.011	−0.030***	−0.031***	−0.076***
	(0.009)	(0.007)	(0.008)	(0.018)
IT in (F)	−0.001	−0.016***	−0.008*	−0.015*
	(0.004)	(0.003)	(0.005)	(0.009)
IT in (G-J)	0.011	0.037***	0.005	0.030**
	(0.008)	(0.009)	(0.011)	(0.015)
IT in (K-N)	−0.002	−0.007	0.030***	0.054***
	(0.007)	(0.006)	(0.011)	(0.013)
IT in (O-U)	0.002	−0.001	−0.030***	0.039**
	(0.009)	(0.009)	(0.011)	(0.017)
Software-Database penetration				
SDB in (A)	−0.011***	−0.015***	−0.023***	0.004
	(0.002)	(0.002)	(0.003)	(0.005)
SDB in (B-E)	0.034***	0.055***	0.096***	0.088***
	(0.006)	(0.004)	(0.007)	(0.013)
SDB in (F)	0.004	0.013***	0.019***	0.012*
	(0.003)	(0.003)	(0.004)	(0.006)
SDB in (G-J)	0.021***	0.024***	0.052***	0.006
	(0.006)	(0.007)	(0.010)	(0.013)
SDB in (K-N)	−0.015**	0.001	−0.003	−0.012
	(0.007)	(0.007)	(0.011)	(0.016)
SDB in (O-U)	0.005	−0.013*	−0.036***	0.057***
	(0.007)	(0.008)	(0.010)	(0.014)
Imports	−0.008*	−0.033***	0.004	−0.037***
	(0.005)	(0.005)	(0.007)	(0.008)
Cons. Exp.	0.174***	0.232***	0.120***	0.155***
	(0.013)	(0.014)	(0.021)	(0.031)
R^2	0.266	0.634	0.857	0.952
Adj. R^2	0.218	0.604	0.840	0.941
Num. obs.	3373	2717	1898	1083

Notes: $^{***}p < 0.01$; $^{**}p < 0.05$; $^{*}p < 0.1$. Standard errors between parentheses. This table summarizes the coefficients from the estimated linear regressions of adjustments of the regional average wage to a 1% change in the sectoral penetration of robots, communication technology, information technology, and software & database, in Agriculture (A), Industry (B-E), Construction (F), Market Services (G-J), Financial & Business Services (K-N), and Non-Market Services (O-U). Controls variables include imports from China (in log-difference), real consumption index (in log-difference), and region and time fixed effects. Time horizons h range from 1 to 15 years and correspond to the window of the log-difference of variables in the regression.

Table D.4: Sectoral employment-to-population ratio adjustment to sectoral technology penetration

	Linear regression - Dep. var.: Emp-to-pop. ratio (in log)					
	(A)	(B-E)	(F)	(G-J)	(K-N)	(O-U)
Intercept	−0.241***	−0.176***	−0.398***	0.045	0.140***	0.252***
	(0.067)	(0.037)	(0.069)	(0.028)	(0.044)	(0.024)
Robot penetration						
ROB in (B-E)	0.147***	0.136***	0.222***	0.037***	0.050***	0.019***
	(0.017)	(0.009)	(0.017)	(0.007)	(0.011)	(0.006)
ROB in (F)	−0.010**	−0.005**	−0.005	0.001	−0.002	−0.003**
	(0.004)	(0.002)	(0.004)	(0.002)	(0.003)	(0.002)
ROB in (O-U)	−0.003	−0.015***	−0.057***	−0.012***	0.013***	−0.002
	(0.007)	(0.004)	(0.007)	(0.003)	(0.004)	(0.002)
Communication Technology penetration						
CT in (A)	0.040***	0.026***	−0.030**	−0.000	0.012	−0.003
	(0.011)	(0.006)	(0.012)	(0.005)	(0.007)	(0.004)
CT in (B-E)	−0.218***	0.016	0.227***	0.063***	0.034*	−0.021**
	(0.027)	(0.015)	(0.028)	(0.012)	(0.018)	(0.010)
CT in (F)	−0.021	−0.047***	−0.080***	−0.020**	−0.002	−0.034***
	(0.019)	(0.011)	(0.020)	(0.008)	(0.013)	(0.007)
CT in (G-J)	0.182***	−0.053**	−0.183***	−0.059***	−0.095***	0.067***
	(0.045)	(0.025)	(0.047)	(0.019)	(0.030)	(0.016)
CT in (K-N)	−0.084***	−0.009	−0.079***	0.025**	0.044***	0.043***
	(0.024)	(0.013)	(0.025)	(0.010)	(0.016)	(0.009)
CT in (O-U)	0.160***	0.057***	0.097***	0.059***	0.071***	−0.014
	(0.028)	(0.016)	(0.029)	(0.012)	(0.019)	(0.010)
Information Technology penetration						
IT in (A)	0.009	0.034***	0.094***	0.014***	0.007	0.034***
	(0.012)	(0.006)	(0.012)	(0.005)	(0.008)	(0.004)
IT in (B-E)	0.088***	−0.157***	−0.423***	−0.079***	−0.073***	−0.045***
	(0.025)	(0.014)	(0.026)	(0.011)	(0.016)	(0.009)
IT in (F)	0.029**	0.073***	0.209***	0.043***	0.061***	0.044***
	(0.014)	(0.008)	(0.015)	(0.006)	(0.009)	(0.005)
IT in (G-J)	−0.046	0.106***	0.277***	0.051***	0.147***	−0.036***
	(0.032)	(0.018)	(0.033)	(0.013)	(0.021)	(0.011)
IT in (K-N)	0.073**	−0.021	0.030	0.000	−0.045**	0.026**
	(0.033)	(0.018)	(0.034)	(0.014)	(0.022)	(0.012)
IT in (O-U)	0.010	−0.015	−0.161***	−0.069***	−0.167***	0.048***
	(0.034)	(0.019)	(0.035)	(0.014)	(0.023)	(0.012)
Software-Database penetration						
SDB in (A)	0.053***	−0.033***	0.012	0.002	0.008	−0.017***
	(0.010)	(0.005)	(0.010)	(0.004)	(0.006)	(0.003)
SDB in (B-E)	−0.023	0.058***	0.046**	0.008	0.003	0.044***
	(0.022)	(0.012)	(0.022)	(0.009)	(0.014)	(0.008)
SDB in (F)	−0.012	−0.019***	−0.110***	−0.029***	−0.059***	−0.008**
	(0.011)	(0.006)	(0.012)	(0.005)	(0.007)	(0.004)
SDB in (G-J)	−0.113***	−0.042**	−0.050	0.021	−0.067***	−0.034***
	(0.031)	(0.017)	(0.032)	(0.013)	(0.020)	(0.011)
SDB in (K-N)	−0.059*	0.042**	0.113***	−0.018	0.013	−0.079***
	(0.034)	(0.019)	(0.035)	(0.014)	(0.022)	(0.012)
SDB in (O-U)	−0.147***	−0.044**	0.093***	0.023*	0.090***	−0.015
	(0.031)	(0.017)	(0.032)	(0.013)	(0.021)	(0.011)
Imports	−0.005	0.067***	0.076***	0.033***	0.046***	−0.019**
	(0.023)	(0.012)	(0.023)	(0.009)	(0.015)	(0.008)
Cons. Exp.	0.061	0.187***	0.811***	0.091***	0.083**	0.164***
	(0.064)	(0.036)	(0.066)	(0.027)	(0.042)	(0.023)
R^2	0.777	0.837	0.867	0.757	0.783	0.730
Adj. R^2	0.751	0.818	0.851	0.728	0.758	0.698
Num. obs.	1897	1902	1902	1902	1902	1902

Notes: $^{***}p < 0.01$; $^{**}p < 0.05$; $^{*}p < 0.1$. Standard errors between parentheses. This table summarizes the coefficients from the estimated linear regressions of adjustments of the sectoral employment-to-population ratio in Agriculture (A), Industry (B-E), Construction (F), Market Services (G-J), Financial & Business Services (K-N), and Non-Market Services (O-U), to a 1% change in the sectoral penetration of robots, communication technology, information technology, and software & database, in Agriculture (A), Industry (B-E), Construction (F), Market Services (G-J), Financial & Business Services (K-N), and Non-Market Services (O-U) over the 10-year horizon. Controls variables include imports from China (in log-difference), real consumption index (in log-difference), and region and time fixed effects. Time horizon is $h = 10$ years and corresponds to the window of the log-difference of variables in the regression.

Table D.5: Sectoral employment share adjustment to sectoral technology penetration

	Linear regression - Dep. var.: Employment share (in log)					
	(A)	(B-E)	(F)	(G-J)	(K-N)	(O-U)
Intercept	−0.234***	−0.171***	−0.393***	0.051***	0.145***	0.258***
	(0.063)	(0.029)	(0.058)	(0.019)	(0.038)	(0.021)
Robot penetration						
ROB in (B-E)	0.064***	0.053***	0.139***	−0.045***	−0.033***	−0.063***
	(0.016)	(0.007)	(0.015)	(0.005)	(0.010)	(0.005)
ROB in (F)	−0.007*	−0.002	−0.002	0.004***	0.001	−0.000
	(0.004)	(0.002)	(0.004)	(0.001)	(0.002)	(0.001)
ROB in (O-U)	0.004	−0.008***	−0.049***	−0.005**	0.021***	0.006***
	(0.006)	(0.003)	(0.006)	(0.002)	(0.004)	(0.002)
Communication Technology penetration						
CT in (A)	0.036***	0.022***	−0.033***	−0.004	0.008	−0.006*
	(0.011)	(0.005)	(0.010)	(0.003)	(0.006)	(0.003)
CT in (B-E)	−0.232***	0.001	0.212***	0.048***	0.019	−0.036***
	(0.025)	(0.012)	(0.024)	(0.008)	(0.015)	(0.008)
CT in (F)	0.012	−0.014*	−0.048***	0.012**	0.030***	−0.002
	(0.018)	(0.008)	(0.017)	(0.006)	(0.011)	(0.006)
CT in (G-J)	0.189***	−0.045**	−0.176***	−0.051***	−0.088***	0.075***
	(0.042)	(0.020)	(0.039)	(0.013)	(0.026)	(0.014)
CT in (K-N)	−0.103***	−0.027***	−0.097***	0.007	0.026*	0.025***
	(0.022)	(0.010)	(0.021)	(0.007)	(0.014)	(0.007)
CT in (O-U)	0.119***	0.015	0.055**	0.018**	0.029*	−0.055***
	(0.026)	(0.012)	(0.025)	(0.008)	(0.016)	(0.009)
Information Technology penetration						
IT in (A)	−0.018*	0.007	0.067***	−0.013***	−0.019***	0.008**
	(0.011)	(0.005)	(0.010)	(0.003)	(0.007)	(0.004)
IT in (B-E)	0.188***	−0.056***	−0.322***	0.021***	0.028**	0.056***
	(0.023)	(0.011)	(0.022)	(0.007)	(0.014)	(0.008)
IT in (F)	−0.037***	0.008	0.143***	−0.022***	−0.005	−0.021***
	(0.013)	(0.006)	(0.012)	(0.004)	(0.008)	(0.004)
IT in (G-J)	−0.104***	0.048***	0.219***	−0.008	0.089***	−0.094***
	(0.030)	(0.014)	(0.028)	(0.009)	(0.018)	(0.010)
IT in (K-N)	0.076**	−0.018	0.033	0.004	−0.042**	0.029***
	(0.031)	(0.014)	(0.029)	(0.009)	(0.019)	(0.010)
IT in (O-U)	0.038	0.012	−0.134***	−0.042***	−0.140***	0.075***
	(0.032)	(0.015)	(0.030)	(0.010)	(0.019)	(0.011)
Software-Database penetration						
SDB in (A)	0.055***	−0.031***	0.014	0.003	0.010*	−0.015***
	(0.009)	(0.004)	(0.008)	(0.003)	(0.006)	(0.003)
SDB in (B-E)	−0.054***	0.027***	0.015	−0.023***	−0.028**	0.013*
	(0.020)	(0.009)	(0.019)	(0.006)	(0.012)	(0.007)
SDB in (F)	0.019*	0.012**	−0.079***	0.002	−0.028***	0.023***
	(0.011)	(0.005)	(0.010)	(0.003)	(0.006)	(0.003)
SDB in (G-J)	−0.073**	−0.002	−0.010	0.061***	−0.027	0.005
	(0.029)	(0.013)	(0.027)	(0.009)	(0.017)	(0.009)
SDB in (K-N)	−0.042	0.059***	0.130***	−0.000	0.030	−0.062***
	(0.032)	(0.015)	(0.029)	(0.010)	(0.019)	(0.010)
SDB in (O-U)	−0.140***	−0.037***	0.101***	0.031***	0.097***	−0.008
	(0.029)	(0.014)	(0.027)	(0.009)	(0.018)	(0.010)
Imports	−0.032	0.040***	0.049**	0.006	0.019	−0.045***
	(0.021)	(0.010)	(0.020)	(0.006)	(0.013)	(0.007)
Cons. Exp.	−0.106*	0.019	0.643***	−0.077***	−0.085**	−0.004
	(0.060)	(0.028)	(0.056)	(0.018)	(0.036)	(0.020)
R^2	0.811	0.817	0.866	0.778	0.750	0.788
Adj. R^2	0.789	0.796	0.851	0.753	0.721	0.763
Num. obs.	1897	1902	1902	1902	1902	1902

Notes: $^{***}p < 0.01$; $^{**}p < 0.05$; $^{*}p < 0.1$. Standard errors between parentheses. This table summarizes the coefficients from the estimated linear regressions of adjustments of the sectoral employment share in Agriculture (A), Industry (B-E), Construction (F), Market Services (G-J), Financial & Business Services (K-N), and Non-Market Services (O-U), to a 1% change in the sectoral penetration of robots, communication technology, information technology, and software & database, in Agriculture (A), Industry (B-E), Construction (F), Market Services (G-J), Financial & Business Services (K-N), and Non-Market Services (O-U) over the 10-year horizon. Controls variables include imports from China (in log-difference), real consumption index (in log-difference), and region and time fixed effects. Time horizon is $h = 10$ years and corresponds to the window of the log-difference of variables in the regression.

Table D.6: Sectoral average wage adjustment to sectoral technology penetration

	Linear regression - Dep. var.: Average wage (in log)					
	(A)	(B-E)	(F)	(G-J)	(K-N)	(O-U)
Intercept	1.348***	0.214***	−0.296***	0.040	−0.075	−0.165***
	(0.099)	(0.033)	(0.062)	(0.032)	(0.049)	(0.027)
Robot penetration						
ROB in (B-E)	−0.051**	−0.062***	−0.093***	0.008	0.005	−0.044***
	(0.025)	(0.008)	(0.016)	(0.008)	(0.012)	(0.007)
ROB in (F)	−0.003	0.003	0.020***	−0.000	0.006*	0.008***
	(0.006)	(0.002)	(0.004)	(0.002)	(0.003)	(0.002)
ROB in (O-U)	−0.053***	0.013***	0.060***	0.016***	0.002	−0.007***
	(0.010)	(0.003)	(0.006)	(0.003)	(0.005)	(0.003)
Communication Technology penetration						
CT in (A)	−0.047***	−0.034***	0.032***	−0.028***	−0.012	−0.005
	(0.017)	(0.006)	(0.011)	(0.005)	(0.008)	(0.005)
CT in (B-E)	0.124***	−0.093***	−0.106***	−0.037***	−0.069***	0.060***
	(0.040)	(0.013)	(0.025)	(0.013)	(0.020)	(0.011)
CT in (F)	−0.086***	0.090***	0.013	−0.032***	−0.082***	−0.027***
	(0.028)	(0.009)	(0.018)	(0.009)	(0.014)	(0.008)
CT in (G-J)	0.165**	0.020	−0.126***	0.029	0.013	−0.123***
	(0.067)	(0.022)	(0.042)	(0.021)	(0.033)	(0.019)
CT in (K-N)	0.056	0.001	0.081***	−0.008	0.004	0.001
	(0.035)	(0.012)	(0.022)	(0.011)	(0.018)	(0.010)
CT in (O-U)	−0.243***	0.142***	0.198***	0.012	−0.022	0.097***
	(0.042)	(0.014)	(0.026)	(0.013)	(0.021)	(0.012)
Information Technology penetration						
IT in (A)	0.065***	−0.002	0.036***	0.027***	0.027***	0.007
	(0.017)	(0.006)	(0.011)	(0.005)	(0.008)	(0.005)
IT in (B-E)	−0.338***	0.022*	0.091***	−0.060***	−0.013	−0.055***
	(0.037)	(0.012)	(0.023)	(0.012)	(0.018)	(0.010)
IT in (F)	0.031	−0.053***	−0.082***	0.012*	0.001	0.012**
	(0.021)	(0.007)	(0.013)	(0.007)	(0.010)	(0.006)
IT in (G-J)	−0.060	−0.034**	0.010	0.003	−0.135***	0.080***
	(0.047)	(0.015)	(0.029)	(0.015)	(0.023)	(0.013)
IT in (K-N)	0.025	0.108***	0.081***	0.001	0.055**	−0.017
	(0.049)	(0.016)	(0.031)	(0.016)	(0.024)	(0.014)
IT in (O-U)	0.007	−0.074***	−0.209***	0.006	0.146***	−0.071***
	(0.050)	(0.017)	(0.032)	(0.016)	(0.025)	(0.014)
Software-Database penetration						
SDB in (A)	−0.033**	0.020***	−0.062***	−0.020***	−0.019***	−0.019***
	(0.014)	(0.005)	(0.009)	(0.005)	(0.007)	(0.004)
SDB in (B-E)	0.295***	0.148***	0.115***	0.099***	0.075***	0.049***
	(0.032)	(0.011)	(0.020)	(0.010)	(0.016)	(0.009)
SDB in (F)	0.024	−0.035***	0.108***	0.020***	0.090***	0.004
	(0.017)	(0.005)	(0.010)	(0.005)	(0.008)	(0.005)
SDB in (G-J)	−0.106**	0.013	0.120***	−0.002	0.146***	0.053***
	(0.045)	(0.015)	(0.029)	(0.015)	(0.023)	(0.013)
SDB in (K-N)	−0.068	−0.086***	−0.195***	0.017	−0.046*	0.050***
	(0.050)	(0.016)	(0.031)	(0.016)	(0.025)	(0.014)
SDB in (O-U)	0.180***	−0.070***	−0.005	−0.052***	−0.122***	0.002
	(0.046)	(0.015)	(0.029)	(0.015)	(0.023)	(0.013)
Imports	0.086***	0.010	−0.027	−0.007	−0.027*	0.008
	(0.033)	(0.011)	(0.021)	(0.011)	(0.017)	(0.009)
Cons. Exp.	0.231**	0.207***	−0.066	0.045	−0.075	0.128***
	(0.094)	(0.031)	(0.060)	(0.030)	(0.047)	(0.026)
R^2	0.710	0.866	0.615	0.701	0.651	0.790
Adj. R^2	0.677	0.850	0.571	0.667	0.610	0.766
Num. obs.	1893	1902	1902	1902	1902	1902

Notes: $^{***}p < 0.01$; $^{**}p < 0.05$; $^{*}p < 0.1$. Standard errors between parentheses. This table summarizes the coefficients from the estimated linear regressions of adjustments of the sectoral average wage in Agriculture (A), Industry (B-E), Construction (F), Market Services (G-J), Financial & Business Services (K-N), and Non-Market Services (O-U), to a 1% change in the sectoral penetration of robots, communication technology, information technology, and software & database, in Agriculture (A), Industry (B-E), Construction (F), Market Services (G-J), Financial & Business Services (K-N), and Non-Market Services (O-U) over the 10-year horizon. Controls variables include imports from China (in log-difference), real consumption index (in log-difference), and region and time fixed effects. Time horizon is $h = 10$ years and corresponds to the window of the log-difference of variables in the regression.

Table D.7: Relative sectoral wage adjustment to sectoral technology penetration

	Linear regression - Dep. var.: Relative wage (in log)					
	(A)	(B-E)	(F)	(G-J)	(K-N)	(O-U)
Intercept	1.347***	0.213***	−0.299***	0.038*	−0.075*	−0.166***
	(0.095)	(0.028)	(0.058)	(0.023)	(0.041)	(0.024)
Robot penetration						
ROB in (B-E)	−0.007	−0.018**	−0.049***	0.052***	0.049***	0.000
	(0.024)	(0.007)	(0.015)	(0.006)	(0.010)	(0.006)
ROB in (F)	−0.008	−0.002	0.015***	−0.006***	0.001	0.002
	(0.006)	(0.002)	(0.004)	(0.001)	(0.003)	(0.002)
ROB in (O-U)	−0.059***	0.006**	0.054***	0.010***	−0.005	−0.014***
	(0.010)	(0.003)	(0.006)	(0.002)	(0.004)	(0.002)
Communication Technology penetration						
CT in (A)	−0.032**	−0.020***	0.046***	−0.013***	0.003	0.010**
	(0.016)	(0.005)	(0.010)	(0.004)	(0.007)	(0.004)
CT in (B-E)	0.139***	−0.078***	−0.091***	−0.022**	−0.054***	0.075***
	(0.039)	(0.011)	(0.023)	(0.009)	(0.017)	(0.010)
CT in (F)	−0.079***	0.098***	0.021	−0.024***	−0.074***	−0.019***
	(0.027)	(0.008)	(0.017)	(0.007)	(0.012)	(0.007)
CT in (G-J)	0.208***	0.062***	−0.084**	0.071***	0.055**	−0.081***
	(0.064)	(0.019)	(0.039)	(0.015)	(0.028)	(0.016)
CT in (K-N)	0.050	−0.005	0.076***	−0.013*	−0.002	−0.005
	(0.034)	(0.010)	(0.021)	(0.008)	(0.015)	(0.009)
CT in (O-U)	−0.311***	0.075***	0.132***	−0.055***	−0.089***	0.030***
	(0.040)	(0.012)	(0.024)	(0.010)	(0.017)	(0.010)
Information Technology penetration						
IT in (A)	0.049***	−0.018***	0.020**	0.011***	0.011	−0.009**
	(0.016)	(0.005)	(0.010)	(0.004)	(0.007)	(0.004)
IT in (B-E)	−0.308***	0.053***	0.121***	−0.029***	0.018	−0.025***
	(0.035)	(0.010)	(0.021)	(0.008)	(0.015)	(0.009)
IT in (F)	0.039*	−0.045***	−0.073***	0.021***	0.009	0.020***
	(0.020)	(0.006)	(0.012)	(0.005)	(0.009)	(0.005)
IT in (G-J)	−0.065	−0.039***	0.005	−0.002	−0.140***	0.075***
	(0.045)	(0.013)	(0.027)	(0.011)	(0.019)	(0.011)
IT in (K-N)	−0.005	0.078***	0.050*	−0.029***	0.025	−0.047***
	(0.047)	(0.014)	(0.028)	(0.011)	(0.020)	(0.012)
IT in (O-U)	0.038	−0.044***	−0.179***	0.037***	0.176***	−0.041***
	(0.048)	(0.014)	(0.029)	(0.012)	(0.021)	(0.012)
Software-Database penetration						
SDB in (A)	−0.009	0.044***	−0.039***	0.003	0.004	0.005
	(0.014)	(0.004)	(0.008)	(0.003)	(0.006)	(0.003)
SDB in (B-E)	0.198***	0.052***	0.021	0.003	−0.021	−0.047***
	(0.031)	(0.009)	(0.019)	(0.007)	(0.013)	(0.008)
SDB in (F)	0.006	−0.055***	0.089***	0.001	0.071***	−0.015***
	(0.016)	(0.005)	(0.010)	(0.004)	(0.007)	(0.004)
SDB in (G-J)	−0.159***	−0.039***	0.069***	−0.053***	0.094***	0.001
	(0.044)	(0.013)	(0.026)	(0.010)	(0.019)	(0.011)
SDB in (K-N)	−0.064	−0.083***	−0.193***	0.019*	−0.043**	0.053***
	(0.048)	(0.014)	(0.029)	(0.011)	(0.021)	(0.012)
SDB in (O-U)	0.215***	−0.035***	0.029	−0.017	−0.087***	0.038***
	(0.044)	(0.013)	(0.027)	(0.011)	(0.019)	(0.011)
Imports	0.083***	0.007	−0.030	−0.010	−0.031**	0.005
	(0.032)	(0.009)	(0.019)	(0.008)	(0.014)	(0.008)
Cons. Exp.	0.110	0.088***	−0.184***	−0.074***	−0.194***	0.008
	(0.091)	(0.027)	(0.055)	(0.022)	(0.039)	(0.023)
R^2	0.709	0.756	0.647	0.757	0.750	0.653
Adj. R^2	0.675	0.728	0.607	0.728	0.721	0.612
Num. obs.	1893	1898	1898	1898	1898	1898

Notes: $^{***}p < 0.01$; $^{**}p < 0.05$; $^{*}p < 0.1$. Standard errors between parentheses. This table summarizes the coefficients from the estimated linear regressions of adjustments of the relative sectoral wage in Agriculture (A), Industry (B-E), Construction (F), Market Services (G-J), Financial & Business Services (K-N), and Non-Market Services (O-U), to a 1% change in the sectoral penetration of robots, communication technology, information technology, and software & database, in Agriculture (A), Industry (B-E), Construction (F), Market Services (G-J), Financial & Business Services (K-N), and Non-Market Services (O-U) over the 10-year horizon. Controls variables include imports from China (in log-difference), real consumption index (in log-difference), and region and time fixed effects. Time horizon is $h = 10$ years and corresponds to the window of the log-difference of variables in the regression.

Table D.8: Labor market adjustments to regional technology penetration by clusters

	Linear regression - Dep. var.: in logarithm							
	$h = 1$		$h = 5$		$h = 10$		$h = 15$	
	(Emp.)	(Wage)	(Emp.)	(Wage)	(Emp.)	(Wage)	(Emp.)	(Wage)
Intercept	0.001	0.022***	0.061***	0.116***	−0.161***	0.048**	−0.092***	0.069**
	(0.005)	(0.007)	(0.015)	(0.018)	(0.022)	(0.024)	(0.028)	(0.032)
Robot penetration								
ROB in Service (High)	0.011**	0.002	0.003	0.015**	0.015*	0.002	0.015*	−0.014
	(0.006)	(0.007)	(0.006)	(0.007)	(0.008)	(0.009)	(0.008)	(0.009)
ROB in Ser./Agr. (High)	0.003	−0.003	0.024***	−0.017**	0.034***	−0.006	0.031***	−0.010
	(0.004)	(0.005)	(0.007)	(0.008)	(0.008)	(0.009)	(0.008)	(0.009)
ROB in Industry (High)	0.009*	0.002	0.044***	0.016**	0.051***	−0.012	0.051***	−0.039***
	(0.005)	(0.006)	(0.006)	(0.007)	(0.007)	(0.008)	(0.008)	(0.009)
ROB in Agr./Ind. (High)	0.006	0.000	0.015***	0.008	0.029***	−0.013*	0.023***	−0.019**
	(0.004)	(0.005)	(0.006)	(0.007)	(0.007)	(0.007)	(0.008)	(0.009)
ROB in Service (Low)	−0.004	0.001	0.005	−0.051***	0.002	−0.034***	−0.034***	−0.024*
	(0.004)	(0.005)	(0.006)	(0.007)	(0.009)	(0.010)	(0.011)	(0.013)
ROB in Industry (Low)	−0.004	0.014**	0.034***	−0.013*	0.032***	0.007	−0.006	−0.001
	(0.005)	(0.006)	(0.006)	(0.007)	(0.007)	(0.008)	(0.010)	(0.011)
ROB in Agriculture (Low)	0.005	0.009	0.071***	−0.012*	0.074***	0.010	0.036***	0.030***
	(0.005)	(0.006)	(0.006)	(0.007)	(0.007)	(0.008)	(0.008)	(0.009)
Communication Technology penetration								
CT in Service (High)	−0.000	0.025	−0.073***	0.059***	−0.116***	0.076***	−0.058***	0.037**
	(0.014)	(0.018)	(0.013)	(0.015)	(0.014)	(0.015)	(0.014)	(0.015)
CT in Ser./Agr. (High)	0.006	0.043**	−0.031**	0.033**	−0.060***	0.004	−0.064***	0.050***
	(0.015)	(0.019)	(0.014)	(0.016)	(0.015)	(0.016)	(0.015)	(0.017)
CT in Industry (High)	−0.026**	−0.008	−0.037***	−0.049***	−0.060***	−0.012	−0.059***	−0.032**
	(0.012)	(0.015)	(0.012)	(0.014)	(0.013)	(0.014)	(0.013)	(0.015)
CT in Agr./Ind. (High)	−0.014	0.014	0.012	−0.007	−0.013	0.013	−0.020	−0.001
	(0.013)	(0.015)	(0.013)	(0.015)	(0.014)	(0.016)	(0.014)	(0.016)
CT in Service (Low)	−0.002	−0.037*	−0.005	0.013	−0.013	−0.019	−0.120**	−0.103
	(0.017)	(0.021)	(0.017)	(0.020)	(0.021)	(0.023)	(0.058)	(0.065)
CT in Industry (Low)	0.014	−0.001	0.040***	0.020	0.045**	−0.005	0.035	−0.046
	(0.013)	(0.017)	(0.015)	(0.018)	(0.021)	(0.023)	(0.037)	(0.042)
CT in Agriculture (Low)	0.065***	−0.028	0.093***	0.061**	0.080**	0.026	−0.028	−0.228***
	(0.020)	(0.024)	(0.023)	(0.027)	(0.031)	(0.034)	(0.051)	(0.057)
Information Technology penetration								
IT in Service (High)	0.001	−0.005	−0.008	0.006	0.005	−0.042***	0.055***	−0.058***
	(0.012)	(0.015)	(0.011)	(0.013)	(0.014)	(0.015)	(0.013)	(0.014)
IT in Ser./Agr. (High)	−0.010	0.009	−0.015	0.033**	−0.016	0.020	0.018	−0.112***
	(0.014)	(0.017)	(0.012)	(0.014)	(0.014)	(0.016)	(0.014)	(0.016)
IT in Industry (High)	−0.003	0.025**	−0.025***	0.031***	−0.043***	0.005	−0.002	0.025**
	(0.010)	(0.012)	(0.008)	(0.010)	(0.010)	(0.011)	(0.009)	(0.010)
IT in Agr./Ind. (High)	−0.004	0.022	−0.024**	0.049***	−0.031***	0.013	−0.005	0.009
	(0.012)	(0.014)	(0.010)	(0.011)	(0.011)	(0.013)	(0.010)	(0.011)
IT in Service (Low)	−0.015	0.020	0.007	−0.085***	0.077**	−0.182***	0.023	0.117***
	(0.016)	(0.019)	(0.018)	(0.021)	(0.031)	(0.034)	(0.040)	(0.045)
IT in Industry (Low)	0.003	−0.049***	0.044**	−0.092***	0.150***	−0.121***	−0.014	−0.049
	(0.015)	(0.018)	(0.017)	(0.020)	(0.024)	(0.027)	(0.040)	(0.046)
IT in Agriculture (Low)	−0.012	−0.041*	0.029	−0.090***	0.131***	−0.119***	0.207***	0.029
	(0.017)	(0.021)	(0.021)	(0.025)	(0.031)	(0.034)	(0.049)	(0.056)
Software-Database penetration								
SDB in Service (High)	0.017	−0.015	0.088***	−0.058***	0.106***	−0.004	0.071***	0.069***
	(0.018)	(0.022)	(0.015)	(0.018)	(0.018)	(0.020)	(0.021)	(0.023)
SDB in Ser./Agr. (High)	0.003	−0.028	0.055***	−0.021	0.086***	0.046***	0.053***	0.099***
	(0.016)	(0.020)	(0.014)	(0.017)	(0.016)	(0.017)	(0.019)	(0.022)
SDB in Industry (High)	0.036***	0.001	0.028***	0.071***	0.025**	0.137***	0.021	0.117***
	(0.013)	(0.016)	(0.011)	(0.013)	(0.012)	(0.013)	(0.017)	(0.019)
SDB in Agr./Ind. (High)	0.023	−0.005	0.049***	0.036**	0.065***	0.089***	0.011	0.099***
	(0.015)	(0.018)	(0.013)	(0.015)	(0.014)	(0.016)	(0.015)	(0.017)
SDB in Service (Low)	0.026	0.076***	0.004	0.227***	−0.087***	0.376***	0.105**	0.191***
	(0.017)	(0.021)	(0.018)	(0.021)	(0.031)	(0.033)	(0.041)	(0.046)
SDB in Industry (Low)	0.007	0.078***	−0.035***	0.159***	−0.129***	0.204***	0.027	0.153***
	(0.012)	(0.015)	(0.012)	(0.014)	(0.017)	(0.018)	(0.022)	(0.025)
SDB in Agriculture (Low)	−0.043***	0.103***	−0.143***	0.175***	−0.241***	0.246***	−0.169***	0.246***
	(0.013)	(0.016)	(0.014)	(0.016)	(0.017)	(0.019)	(0.024)	(0.027)
Imports	0.016***	−0.005	0.070***	−0.021***	0.078***	0.008	0.046***	−0.008
	(0.003)	(0.004)	(0.005)	(0.005)	(0.006)	(0.007)	(0.007)	(0.008)
Cons. Exp.	0.158***	0.177***	0.296***	0.157***	0.392***	0.044**	0.332***	0.190***
	(0.011)	(0.014)	(0.013)	(0.015)	(0.017)	(0.019)	(0.019)	(0.021)
R^2	0.303	0.296	0.598	0.595	0.757	0.821	0.887	0.945
Adj. R^2	0.237	0.229	0.554	0.550	0.721	0.795	0.860	0.932
Num. obs.	4602	4597	3718	3713	2613	2608	1513	1508

Notes: $^{***}p < 0.01$; $^{**}p < 0.05$; $^{*}p < 0.1$. Standard errors between parentheses. This table summarizes the coefficients from the estimated linear regressions of adjustments of the regional employment-to-population ratio (Emp.) and regional average wage per worker (Wage) to a 1% change in the regional penetration of robots, communication technology, information technology, and software & database, according to the cluster in which the region belongs. Controls variables include imports from China (in log-difference), real consumption index (in log-difference), and region and time fixed effects. Time horizons h range from 1 to 15 years and correspond to the window of the log-difference of variables in the regression.

Online Appendix

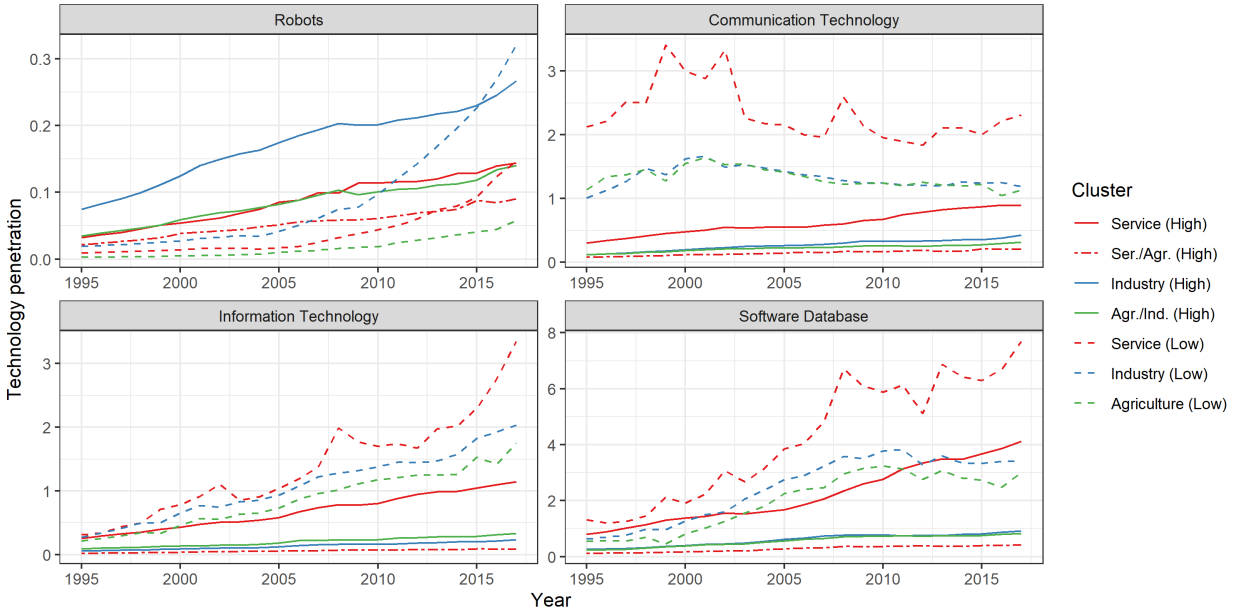
Heterogeneous adjustments of labor markets to automation technologies

Fabien Petit, Florencia Jaccoud and Tommaso Ciarli

F Technology penetration

This appendix reports, in Figure OA.1, the regional penetration of automation technologies for the seven clusters. Figures OA.2 to OA.5 report the sectoral penetration of automation technologies for the seven clusters. Figure OA.6 reports the distributions of changes in technology penetration by cluster.

Figure OA.1: Technology penetration by cluster

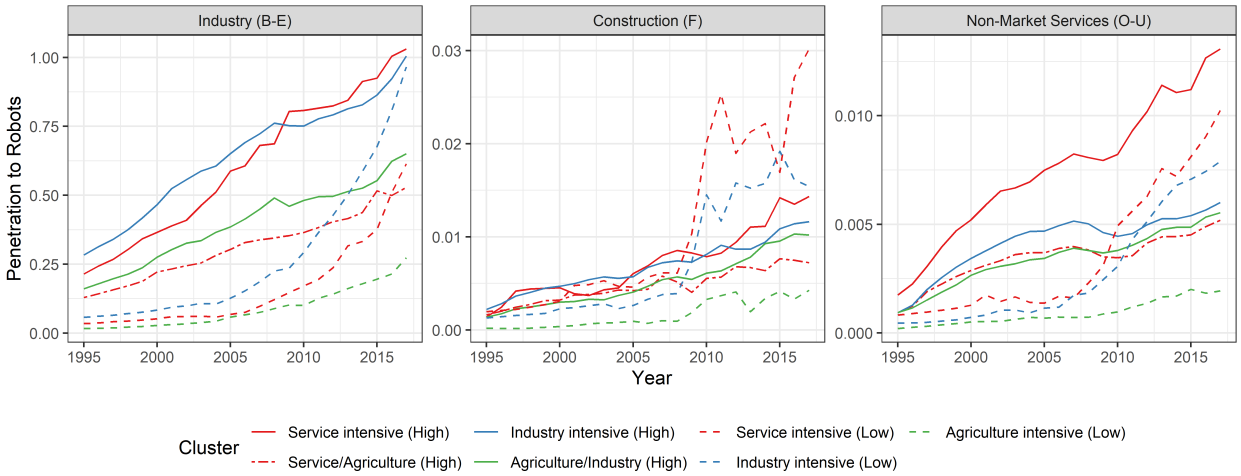


Notes: This figure presents the dynamics of the average regional penetration of robots, communication technology, information technology, and software database, which is aggregated across regions in the same cluster. The x-axis corresponds to the year and the y-axis corresponds to the technology penetration. Column panels refer to technologies.

G Sectoral adjustments

This appendix reports, in Tables OA.1 to OA.6, the employment-to-population ratio adjustment in all the sectors to sectoral technology penetration over different time horizons.

Figure OA.2: Robot penetration by sectors and clusters



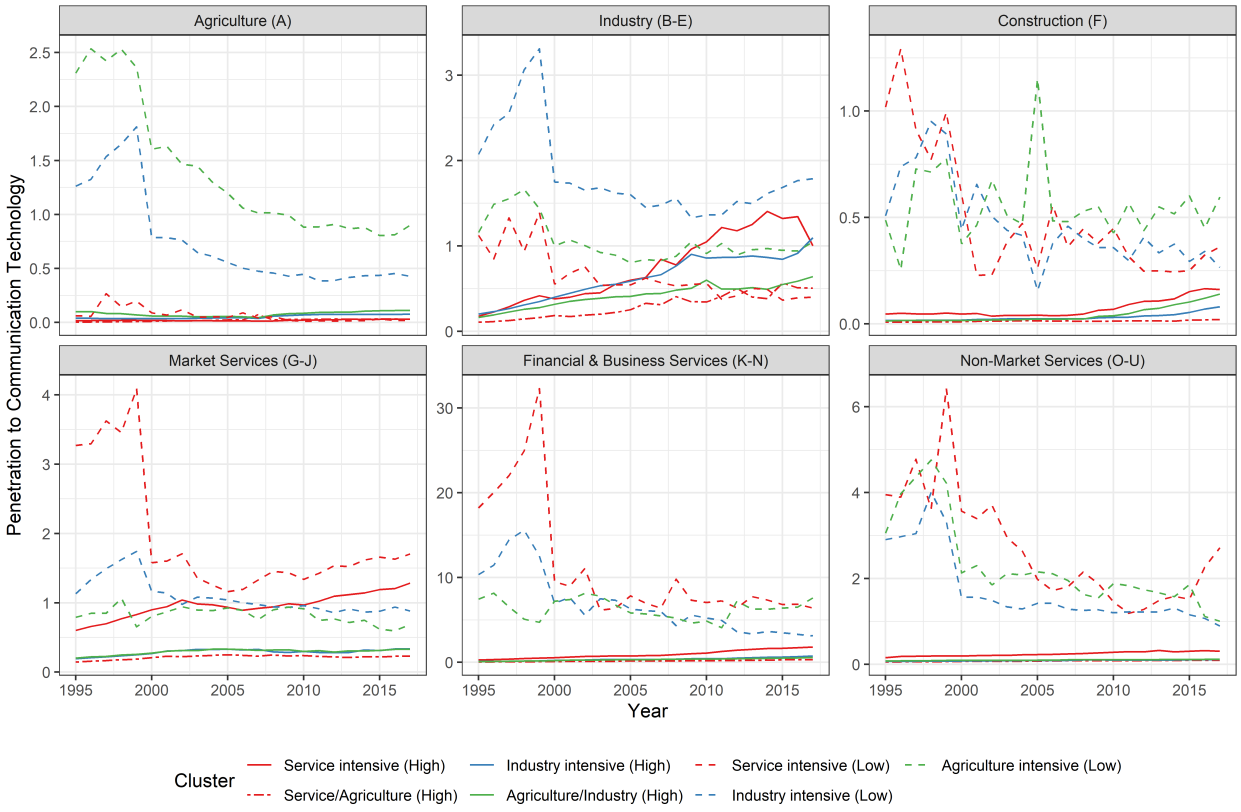
Notes: This figure presents the dynamics of the average penetration of robots in Agriculture (A), Industry (B-E), Construction (F), Market Services (G-J), Financial & Business Services (K-N) and Non-Market Services (O-U), which is aggregated across regions in the same cluster. The x-axis corresponds to the year and the y-axis corresponds to the technology penetration.

Tables OA.7 to OA.12 do so for the sectoral employment share. Tables OA.13 to OA.18 for the average wage per worker. Tables OA.19 to OA.24 for the relative wage.

H Decomposition of the sectoral adjustments

This appendix reports, in Figures OA.8 to OA.10, the decomposition of the sectoral adjustments to the technology penetration in Industry (B-E) of, respectively, CT, IT, and software & database. Figures OA.11 to OA.12 report the decomposition of the sectoral adjustments to the technology penetration in Market Services (G-J) of, respectively, CT and IT. Figures OA.13 to OA.14 report the decomposition of the sectoral adjustments to the technology penetration in Financial & Business Services (K-N) of, respectively, robot, CT, IT, and software & database. Figure OA.16 reports the decomposition of the sectoral adjustments to the technology penetration in Non-Market Services (O-U) of software & database.

Figure OA.3: Communication technology penetration by sectors and clusters

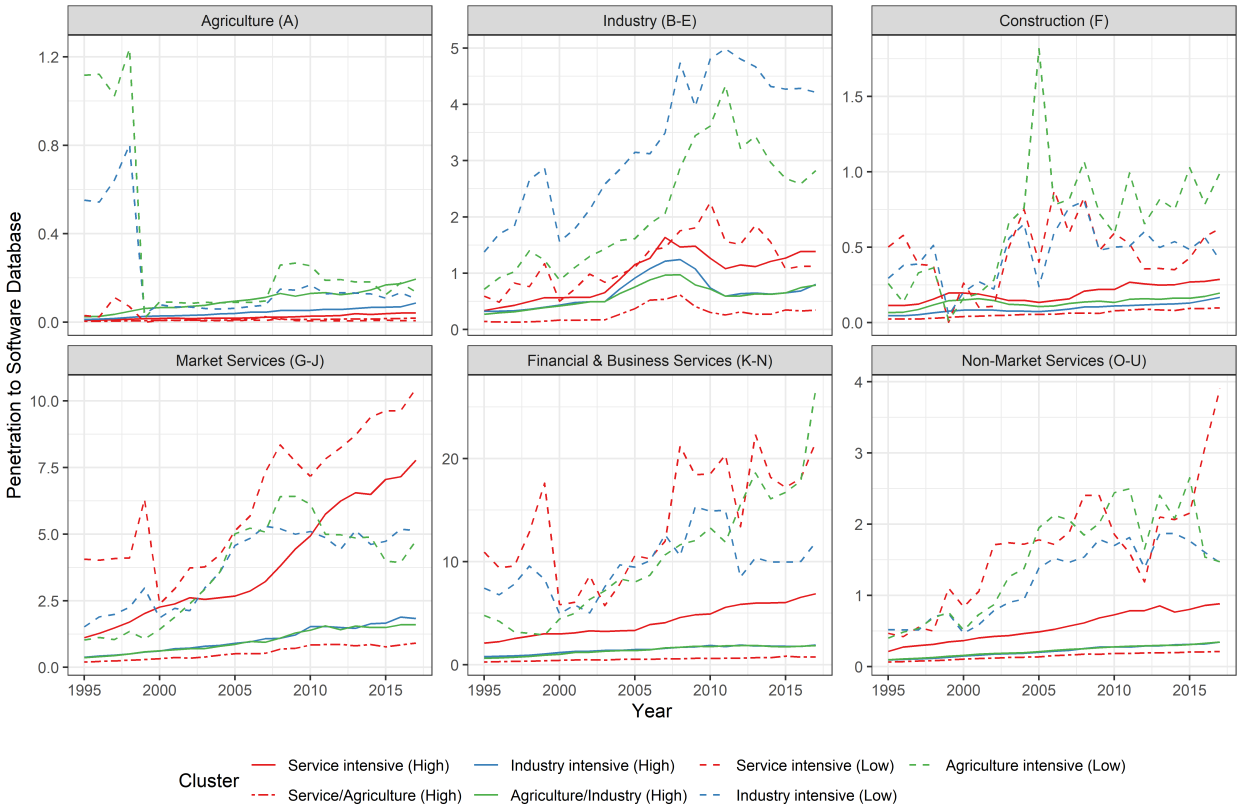


Notes: This figure presents the dynamics of the average penetration of communication technology in Agriculture (A), Industry (B-E), Construction (F), Market Services (G-J), Financial & Business Services (K-N) and Non-Market Services (O-U), which is aggregated across regions in the same cluster. The x-axis corresponds to the year and the y-axis corresponds to the technology penetration.

Figure OA.4: Information technology penetration by sectors and clusters

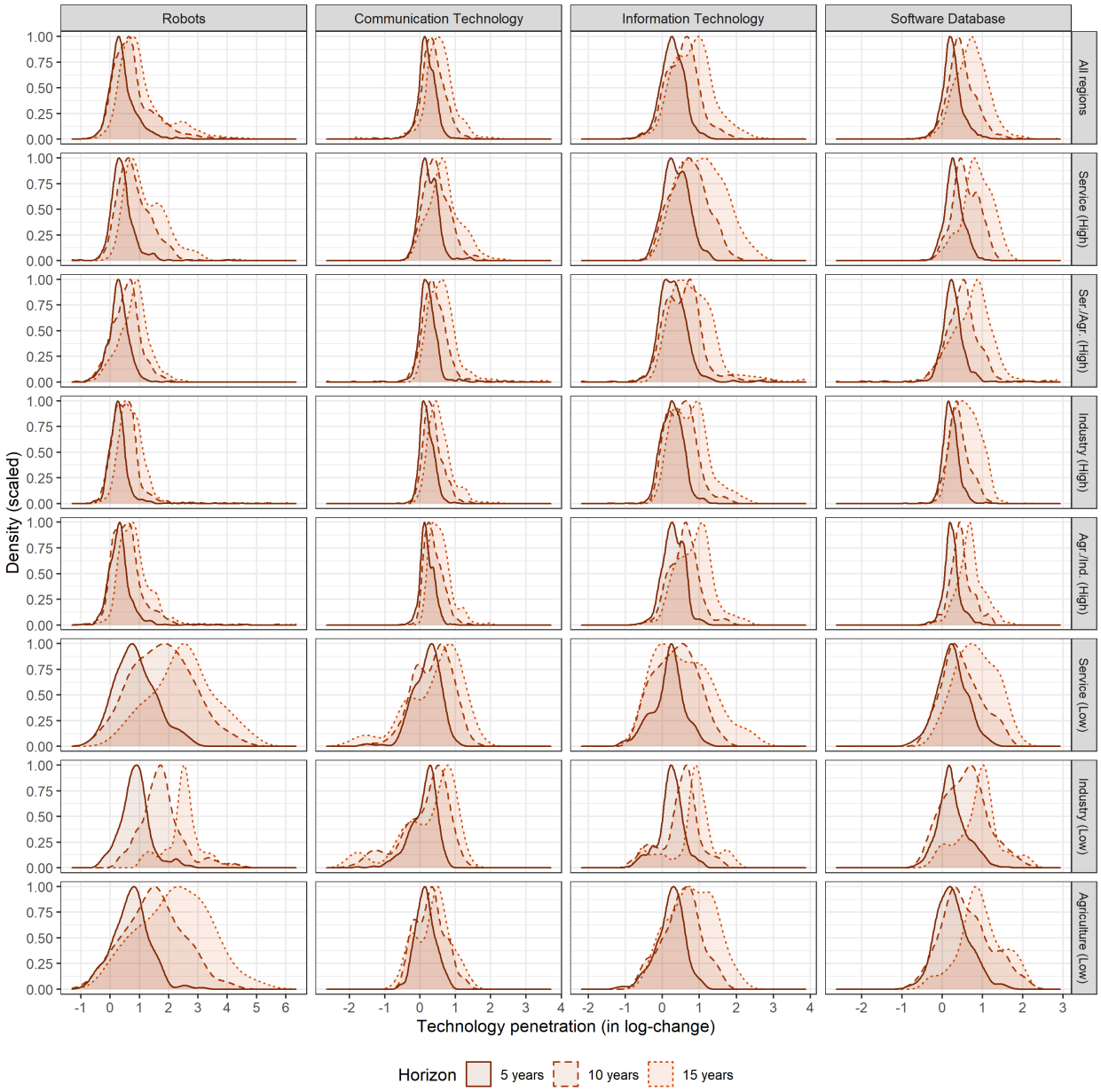
Notes: This figure presents the dynamics of the average penetration of information technology in Agriculture (A), Industry (B-E), Construction (F), Market Services (G-J), Financial & Business Services (K-N) and Non-Market Services (O-U), which is aggregated across regions in the same cluster. The x-axis corresponds to the year and the y-axis corresponds to the technology penetration.

Figure OA.5: Software database penetration by sectors and clusters



Notes: This figure presents the dynamics of the average penetration of software database in Agriculture (A), Industry (B-E), Construction (F), Market Services (G-J), Financial & Business Services (K-N) and Non-Market Services (O-U), which is aggregated across regions in the same cluster. The x-axis corresponds to the year and the y-axis corresponds to the technology penetration.

Figure OA.6: Distributions of changes in technology penetration by cluster



Notes: This figure presents the distributions of the changes in the penetration of robots, communication technology, information technology, and software-database, at the regional level for each cluster. Row panels refer to clusters and column panels refer to technologies. The x-axis corresponds to the technology penetration (in log-change) and the y-axis corresponds to the scaled density. Column panels refer to technologies. Time horizons range from 5 to 15 years and correspond to the window of the log-change of variables.

Table OA.1: Employment-to-population ratio adjustment in Agriculture (A) to sectoral technology penetration

	Linear regression - Dep. var.: Emp-to-pop. ratio (in log)			
	$(h = 1)$	$(h = 5)$	$(h = 10)$	$(h = 15)$
Intercept	−0.008	−0.103**	−0.241***	0.121
	(0.019)	(0.046)	(0.067)	(0.121)
Robot penetration				
ROB in (B-E)	0.086***	0.143***	0.147***	0.033
	(0.017)	(0.013)	(0.017)	(0.030)
ROB in (F)	−0.006**	−0.013***	−0.010**	−0.022***
	(0.003)	(0.004)	(0.004)	(0.005)
ROB in (O-U)	−0.005	−0.015***	−0.003	0.014*
	(0.004)	(0.005)	(0.007)	(0.008)
Communication Technology penetration				
CT in (A)	−0.009	0.031***	0.040***	0.029
	(0.013)	(0.010)	(0.011)	(0.025)
CT in (B-E)	−0.064***	−0.095***	−0.218***	−0.031
	(0.023)	(0.021)	(0.027)	(0.056)
CT in (F)	0.038**	−0.009	−0.021	0.027
	(0.015)	(0.015)	(0.019)	(0.036)
CT in (G-J)	0.035	0.032	0.182***	0.030
	(0.032)	(0.032)	(0.045)	(0.064)
CT in (K-N)	−0.065***	−0.042**	−0.084***	−0.106**
	(0.024)	(0.019)	(0.024)	(0.054)
CT in (O-U)	0.027	0.151***	0.160***	−0.171***
	(0.026)	(0.026)	(0.028)	(0.058)
Information Technology penetration				
IT in (A)	−0.014	0.006	0.009	−0.050*
	(0.013)	(0.010)	(0.012)	(0.026)
IT in (B-E)	0.044	0.059***	0.088***	−0.106*
	(0.028)	(0.023)	(0.025)	(0.062)
IT in (F)	−0.028**	0.017*	0.029**	−0.029
	(0.012)	(0.010)	(0.014)	(0.031)
IT in (G-J)	0.020	0.040	−0.046	0.122**
	(0.028)	(0.028)	(0.032)	(0.052)
IT in (K-N)	0.033	−0.030	0.073**	0.188***
	(0.024)	(0.020)	(0.033)	(0.046)
IT in (O-U)	0.035	−0.017	0.010	0.050
	(0.030)	(0.029)	(0.034)	(0.060)
Software-Database penetration				
SDB in (A)	0.066***	0.034***	0.053***	0.090***
	(0.008)	(0.007)	(0.010)	(0.018)
SDB in (B-E)	−0.075***	−0.135***	−0.023	0.115**
	(0.020)	(0.014)	(0.022)	(0.047)
SDB in (F)	−0.000	−0.006	−0.012	0.014
	(0.011)	(0.010)	(0.011)	(0.022)
SDB in (G-J)	−0.072***	−0.067***	−0.113***	−0.177***
	(0.021)	(0.022)	(0.031)	(0.045)
SDB in (K-N)	0.009	0.041*	−0.059*	−0.150***
	(0.024)	(0.021)	(0.034)	(0.058)
SDB in (O-U)	−0.048**	−0.100***	−0.147***	0.062
	(0.022)	(0.024)	(0.031)	(0.050)
Imports	−0.074***	−0.050***	−0.005	−0.249***
	(0.015)	(0.016)	(0.023)	(0.029)
Cons. Exp.	0.144***	0.076*	0.061	0.008
	(0.042)	(0.044)	(0.064)	(0.107)
R^2	0.147	0.483	0.777	0.896
Adj. R^2	0.091	0.441	0.751	0.874
Num. obs.	3372	2716	1897	1086

Notes: $^{***}p < 0.01$; $^{**}p < 0.05$; $^{*}p < 0.1$. Standard errors between parentheses. This table summarizes the coefficients from the estimated linear regressions of adjustments of the sectoral employment-to-population ratio in Agriculture (A) to a 1% change in the sectoral penetration of robots, communication technology, information technology, and software & database, in Agriculture (A), Industry (B-E), Construction (F), Market Services (G-J), Financial & Business Services (K-N), and Non-Market Services (O-U). Controls variables include imports from China (in log-difference), real consumption index (in log-difference), and region and time fixed effects. Time horizons h range from 1 to 15 years and correspond to the window of the log-difference of variables in the regression.

Table OA.2: Employment-to-population ratio adjustment in Industry (B-E) to sectoral technology penetration

	Linear regression - Dep. var.: Emp-to-pop. ratio (in log)			
	$(h = 1)$	$(h = 5)$	$(h = 10)$	$(h = 15)$
Intercept	0.001	0.009	-0.176^{***}	0.070
	(0.010)	(0.025)	(0.037)	(0.056)
Robot penetration				
ROB in (B-E)	0.041^{***}	0.097^{***}	0.136^{***}	0.071^{***}
	(0.009)	(0.007)	(0.009)	(0.014)
ROB in (F)	-0.004^{***}	0.001	-0.005^{**}	-0.016^{***}
	(0.001)	(0.002)	(0.002)	(0.002)
ROB in (O-U)	-0.008^{***}	-0.021^{***}	-0.015^{***}	-0.011^{***}
	(0.002)	(0.003)	(0.004)	(0.004)
Communication Technology penetration				
CT in (A)	0.011	0.025^{***}	0.026^{***}	0.041^{***}
	(0.007)	(0.005)	(0.006)	(0.012)
CT in (B-E)	0.031^{**}	0.060^{***}	0.016	-0.007
	(0.012)	(0.012)	(0.015)	(0.026)
CT in (F)	-0.009	-0.041^{***}	-0.047^{***}	0.050^{***}
	(0.008)	(0.008)	(0.011)	(0.017)
CT in (G-J)	-0.073^{***}	-0.087^{***}	-0.053^{**}	-0.105^{***}
	(0.017)	(0.017)	(0.025)	(0.030)
CT in (K-N)	-0.036^{***}	-0.023^{**}	-0.009	-0.111^{***}
	(0.013)	(0.010)	(0.013)	(0.025)
CT in (O-U)	0.026^{*}	0.052^{***}	0.057^{***}	-0.178^{***}
	(0.014)	(0.014)	(0.016)	(0.027)
Information Technology penetration				
IT in (A)	0.005	0.019^{***}	0.034^{***}	-0.009
	(0.007)	(0.005)	(0.006)	(0.012)
IT in (B-E)	-0.072^{***}	-0.163^{***}	-0.157^{***}	-0.228^{***}
	(0.015)	(0.012)	(0.014)	(0.029)
IT in (F)	0.007	0.059^{***}	0.073^{***}	-0.037^{**}
	(0.006)	(0.006)	(0.008)	(0.014)
IT in (G-J)	0.066^{***}	0.118^{***}	0.106^{***}	0.152^{***}
	(0.015)	(0.015)	(0.018)	(0.024)
IT in (K-N)	0.042^{***}	0.021^{*}	-0.021	0.185^{***}
	(0.013)	(0.011)	(0.018)	(0.022)
IT in (O-U)	-0.020	-0.039^{**}	-0.015	0.130^{***}
	(0.016)	(0.015)	(0.019)	(0.028)
Software-Database penetration				
SDB in (A)	-0.020^{***}	-0.021^{***}	-0.033^{***}	-0.043^{***}
	(0.004)	(0.004)	(0.005)	(0.008)
SDB in (B-E)	0.011	0.037^{***}	0.058^{***}	0.172^{***}
	(0.011)	(0.008)	(0.012)	(0.022)
SDB in (F)	0.004	-0.013^{**}	-0.019^{***}	-0.000
	(0.006)	(0.005)	(0.006)	(0.010)
SDB in (G-J)	0.012	-0.014	-0.042^{**}	-0.033
	(0.011)	(0.012)	(0.017)	(0.021)
SDB in (K-N)	-0.006	0.021^{*}	0.042^{**}	-0.072^{***}
	(0.013)	(0.011)	(0.019)	(0.027)
SDB in (O-U)	0.004	-0.013	-0.044^{**}	0.042^{*}
	(0.012)	(0.013)	(0.017)	(0.023)
Imports	0.041^{***}	0.060^{***}	0.067^{***}	-0.090^{***}
	(0.008)	(0.009)	(0.012)	(0.014)
Cons. Exp.	0.116^{***}	0.147^{***}	0.187^{***}	0.167^{***}
	(0.023)	(0.024)	(0.036)	(0.050)
R^2	0.248	0.620	0.837	0.941
Adj. R^2	0.199	0.589	0.818	0.928
Num. obs.	3377	2721	1902	1087

Notes: $^{***}p < 0.01$; $^{**}p < 0.05$; $^{*}p < 0.1$. Standard errors between parentheses. This table summarizes the coefficients from the estimated linear regressions of adjustments of the sectoral employment-to-population ratio in Industry (B-E) to a 1% change in the sectoral penetration of robots, communication technology, information technology, and software & database, in Agriculture (A), Industry (B-E), Construction (F), Market Services (G-J), Financial & Business Services (K-N), and Non-Market Services (O-U). Controls variables include imports from China (in log-difference), real consumption index (in log-difference), and region and time fixed effects. Time horizons h range from 1 to 15 years and correspond to the window of the log-difference of variables in the regression.

Table OA.3: Employment-to-population ratio adjustment in Construction (F) to sectoral technology penetration

	Linear regression - Dep. var.: Emp-to-pop. ratio (in log)			
	$(h = 1)$	$(h = 5)$	$(h = 10)$	$(h = 15)$
Intercept	−0.007	0.087*	−0.398***	−0.239***
	(0.018)	(0.047)	(0.069)	(0.092)
Robot penetration				
ROB in (B-E)	0.092***	0.210***	0.222***	0.197***
	(0.016)	(0.013)	(0.017)	(0.023)
ROB in (F)	−0.005**	−0.007*	−0.005	−0.007**
	(0.002)	(0.004)	(0.004)	(0.004)
ROB in (O-U)	−0.010***	−0.031***	−0.057***	−0.015**
	(0.004)	(0.005)	(0.007)	(0.006)
Communication Technology penetration				
CT in (A)	−0.021*	−0.011	−0.030**	0.006
	(0.012)	(0.010)	(0.012)	(0.019)
CT in (B-E)	0.070***	0.138***	0.227***	−0.000
	(0.021)	(0.022)	(0.028)	(0.043)
CT in (F)	−0.013	−0.047***	−0.080***	−0.106***
	(0.013)	(0.015)	(0.020)	(0.028)
CT in (G-J)	−0.062**	−0.119***	−0.183***	0.057
	(0.029)	(0.033)	(0.047)	(0.049)
CT in (K-N)	−0.088***	−0.099***	−0.079***	−0.097**
	(0.022)	(0.019)	(0.025)	(0.041)
CT in (O-U)	0.071***	0.150***	0.097***	−0.037
	(0.024)	(0.027)	(0.029)	(0.044)
Information Technology penetration				
IT in (A)	0.036***	0.061***	0.094***	0.046**
	(0.012)	(0.010)	(0.012)	(0.020)
IT in (B-E)	−0.162***	−0.357***	−0.423***	−0.252***
	(0.026)	(0.023)	(0.026)	(0.047)
IT in (F)	0.041***	0.163***	0.209***	0.180***
	(0.011)	(0.011)	(0.015)	(0.023)
IT in (G-J)	0.078***	0.222***	0.277***	0.117***
	(0.025)	(0.028)	(0.033)	(0.040)
IT in (K-N)	0.122***	0.155***	0.030	0.062*
	(0.022)	(0.021)	(0.034)	(0.035)
IT in (O-U)	−0.079***	−0.192***	−0.161***	0.046
	(0.027)	(0.029)	(0.035)	(0.046)
Software-Database penetration				
SDB in (A)	−0.012*	−0.007	0.012	−0.034**
	(0.007)	(0.008)	(0.010)	(0.013)
SDB in (B-E)	0.009	0.072***	0.046**	0.112***
	(0.018)	(0.014)	(0.022)	(0.036)
SDB in (F)	−0.011	−0.092***	−0.110***	−0.021
	(0.010)	(0.010)	(0.012)	(0.017)
SDB in (G-J)	−0.007	−0.053**	−0.050	−0.181***
	(0.019)	(0.022)	(0.032)	(0.035)
SDB in (K-N)	−0.019	0.020	0.113***	0.090**
	(0.021)	(0.021)	(0.035)	(0.044)
SDB in (O-U)	0.034*	0.053**	0.093***	0.055
	(0.020)	(0.024)	(0.032)	(0.038)
Imports	0.088***	0.089***	0.076***	0.058**
	(0.014)	(0.016)	(0.023)	(0.022)
Cons. Exp.	0.425***	0.844***	0.811***	0.584***
	(0.039)	(0.044)	(0.066)	(0.081)
R^2	0.260	0.698	0.867	0.939
Adj. R^2	0.212	0.673	0.851	0.926
Num. obs.	3377	2721	1902	1087

Notes: $^{***}p < 0.01$; $^{**}p < 0.05$; $^{*}p < 0.1$. Standard errors between parentheses. This table summarizes the coefficients from the estimated linear regressions of adjustments of the sectoral employment-to-population ratio in Construction (F) to a 1% change in the sectoral penetration of robots, communication technology, information technology, and software & database, in Agriculture (A), Industry (B-E), Construction (F), Market Services (G-J), Financial & Business Services (K-N), and Non-Market Services (O-U). Controls variables include imports from China (in log-difference), real consumption index (in log-difference), and region and time fixed effects. Time horizons h range from 1 to 15 years and correspond to the window of the log-difference of variables in the regression.

Table OA.4: Employment-to-population ratio adjustment in Market Services (G-J) to sectoral technology penetration

	Linear regression - Dep. var.: Emp-to-pop. ratio (in log)			
	$(h = 1)$	$(h = 5)$	$(h = 10)$	$(h = 15)$
Intercept	0.002	0.103***	0.045	0.223***
	(0.008)	(0.019)	(0.028)	(0.046)
Robot penetration				
ROB in (B-E)	0.014**	0.046***	0.037***	0.071***
	(0.007)	(0.005)	(0.007)	(0.011)
ROB in (F)	0.001	0.001	0.001	−0.004**
	(0.001)	(0.002)	(0.002)	(0.002)
ROB in (O-U)	−0.002	−0.015***	−0.012***	−0.009***
	(0.002)	(0.002)	(0.003)	(0.003)
Communication Technology penetration				
CT in (A)	0.009*	0.007*	−0.000	0.037***
	(0.005)	(0.004)	(0.005)	(0.010)
CT in (B-E)	0.029***	0.052***	0.063***	−0.025
	(0.009)	(0.009)	(0.012)	(0.021)
CT in (F)	−0.008	−0.014**	−0.020**	−0.000
	(0.006)	(0.006)	(0.008)	(0.014)
CT in (G-J)	−0.049***	−0.055***	−0.059***	−0.016
	(0.013)	(0.013)	(0.019)	(0.024)
CT in (K-N)	0.019*	0.015*	0.025**	−0.016
	(0.010)	(0.008)	(0.010)	(0.020)
CT in (O-U)	0.022**	0.055***	0.059***	−0.036
	(0.011)	(0.011)	(0.012)	(0.022)
Information Technology penetration				
IT in (A)	0.001	0.006	0.014***	−0.015
	(0.005)	(0.004)	(0.005)	(0.010)
IT in (B-E)	−0.030***	−0.078***	−0.079***	−0.063***
	(0.011)	(0.009)	(0.011)	(0.023)
IT in (F)	0.005	0.025***	0.043***	−0.015
	(0.005)	(0.004)	(0.006)	(0.012)
IT in (G-J)	0.024**	0.036***	0.051***	−0.005
	(0.011)	(0.011)	(0.013)	(0.020)
IT in (K-N)	0.010	0.039***	0.000	0.059***
	(0.010)	(0.008)	(0.014)	(0.018)
IT in (O-U)	−0.031**	−0.081***	−0.069***	0.034
	(0.012)	(0.012)	(0.014)	(0.023)
Software-Database penetration				
SDB in (A)	−0.014***	−0.003	0.002	−0.014**
	(0.003)	(0.003)	(0.004)	(0.007)
SDB in (B-E)	−0.010	0.013**	0.008	0.018
	(0.008)	(0.006)	(0.009)	(0.018)
SDB in (F)	0.003	−0.012***	−0.029***	0.022***
	(0.004)	(0.004)	(0.005)	(0.008)
SDB in (G-J)	0.027***	0.027***	0.021	0.021
	(0.008)	(0.009)	(0.013)	(0.017)
SDB in (K-N)	−0.023**	−0.041***	−0.018	−0.043**
	(0.009)	(0.009)	(0.014)	(0.022)
SDB in (O-U)	0.020**	0.034***	0.023*	0.032*
	(0.009)	(0.010)	(0.013)	(0.019)
Imports	0.036***	0.035***	0.033***	0.006
	(0.006)	(0.007)	(0.009)	(0.011)
Cons. Exp.	0.077***	0.141***	0.091***	0.047
	(0.017)	(0.018)	(0.027)	(0.040)
R^2	0.211	0.547	0.757	0.874
Adj. R^2	0.159	0.511	0.728	0.847
Num. obs.	3377	2721	1902	1087

Notes: $^{***}p < 0.01$; $^{**}p < 0.05$; $^{*}p < 0.1$. Standard errors between parentheses. This table summarizes the coefficients from the estimated linear regressions of adjustments of the sectoral employment-to-population ratio in Market Services (G-J) to a 1% change in the sectoral penetration of robots, communication technology, information technology, and software & database, in Agriculture (A), Industry (B-E), Construction (F), Market Services (G-J), Financial & Business Services (K-N), and Non-Market Services (O-U). Controls variables include imports from China (in log-difference), real consumption index (in log-difference), and region and time fixed effects. Time horizons h range from 1 to 15 years and correspond to the window of the log-difference of variables in the regression.

Table OA.5: Employment-to-population ratio adjustment in Fin. & Bus. Services (K-N) to sectoral technology penetration

	Linear regression - Dep. var.: Emp-to-pop. ratio (in log)			
	$(h = 1)$	$(h = 5)$	$(h = 10)$	$(h = 15)$
Intercept	0.011	0.179***	0.140***	0.347***
	(0.012)	(0.029)	(0.044)	(0.075)
Robot penetration				
ROB in (B-E)	0.027**	0.047***	0.050***	0.094***
	(0.011)	(0.008)	(0.011)	(0.018)
ROB in (F)	0.001	0.008***	−0.002	−0.004
	(0.002)	(0.002)	(0.003)	(0.003)
ROB in (O-U)	0.007***	0.010***	0.013***	−0.009*
	(0.003)	(0.003)	(0.004)	(0.005)
Communication Technology penetration				
CT in (A)	−0.002	0.018***	0.012	0.111***
	(0.008)	(0.006)	(0.007)	(0.016)
CT in (B-E)	0.004	0.028**	0.034*	−0.022
	(0.014)	(0.013)	(0.018)	(0.035)
CT in (F)	0.002	−0.021**	−0.002	0.021
	(0.009)	(0.009)	(0.013)	(0.023)
CT in (G-J)	0.008	−0.018	−0.095***	−0.252***
	(0.020)	(0.020)	(0.030)	(0.040)
CT in (K-N)	0.003	0.030**	0.044***	0.011
	(0.015)	(0.012)	(0.016)	(0.033)
CT in (O-U)	0.030*	0.056***	0.071***	−0.007
	(0.016)	(0.016)	(0.019)	(0.036)
Information Technology penetration				
IT in (A)	0.024***	0.017***	0.007	−0.065***
	(0.008)	(0.006)	(0.008)	(0.016)
IT in (B-E)	−0.016	−0.078***	−0.073***	−0.124***
	(0.018)	(0.014)	(0.016)	(0.039)
IT in (F)	0.008	0.060***	0.061***	−0.010
	(0.007)	(0.007)	(0.009)	(0.019)
IT in (G-J)	−0.024	0.045***	0.147***	0.163***
	(0.017)	(0.017)	(0.021)	(0.033)
IT in (K-N)	0.007	−0.036***	−0.045**	−0.002
	(0.015)	(0.013)	(0.022)	(0.029)
IT in (O-U)	−0.100***	−0.129***	−0.167***	0.033
	(0.019)	(0.018)	(0.023)	(0.037)
Software-Database penetration				
SDB in (A)	−0.020***	−0.014***	0.008	−0.031***
	(0.005)	(0.005)	(0.006)	(0.011)
SDB in (B-E)	−0.014	0.015*	0.003	0.041
	(0.012)	(0.009)	(0.014)	(0.029)
SDB in (F)	−0.010	−0.045***	−0.059***	−0.031**
	(0.007)	(0.006)	(0.007)	(0.014)
SDB in (G-J)	0.021	−0.022	−0.067***	0.066**
	(0.013)	(0.014)	(0.020)	(0.028)
SDB in (K-N)	0.006	0.024*	0.013	0.003
	(0.015)	(0.013)	(0.022)	(0.036)
SDB in (O-U)	0.075***	0.076***	0.090***	−0.018
	(0.014)	(0.015)	(0.021)	(0.031)
Imports	0.022**	0.022**	0.046***	−0.018
	(0.009)	(0.010)	(0.015)	(0.018)
Cons. Exp.	0.010	0.208***	0.083**	0.264***
	(0.026)	(0.027)	(0.042)	(0.067)
R^2	0.168	0.568	0.783	0.892
Adj. R^2	0.113	0.533	0.758	0.868
Num. obs.	3377	2721	1902	1087

Notes: $^{***}p < 0.01$; $^{**}p < 0.05$; $^{*}p < 0.1$. Standard errors between parentheses. This table summarizes the coefficients from the estimated linear regressions of adjustments of the sectoral employment-to-population ratio in Financial & Business Services (K-N) to a 1% change in the sectoral penetration of robots, communication technology, information technology, and software & database, in Agriculture (A), Industry (B-E), Construction (F), Market Services (G-J), Financial & Business Services (K-N), and Non-Market Services (O-U). Controls variables include imports from China (in log-difference), real consumption index (in log-difference), and region and time fixed effects. Time horizons h range from 1 to 15 years and correspond to the window of the log-difference of variables in the regression.

Table OA.6: Employment-to-population ratio adjustment in Non-Market Services (O-U) to sectoral technology penetration

	Linear regression - Dep. var.: Emp-to-pop. ratio (in log)			
	$(h = 1)$	$(h = 5)$	$(h = 10)$	$(h = 15)$
Intercept	0.014^{*}	0.167^{***}	0.252^{***}	0.370^{***}
	(0.007)	(0.017)	(0.024)	(0.040)
Robot penetration				
ROB in (B-E)	0.013^{**}	0.028^{***}	0.019^{***}	0.014
	(0.006)	(0.005)	(0.006)	(0.010)
ROB in (F)	-0.002^{*}	0.001	-0.003^{**}	-0.005^{***}
	(0.001)	(0.001)	(0.002)	(0.002)
ROB in (O-U)	0.001	-0.007^{***}	−0.002	−0.001
	(0.001)	(0.002)	(0.002)	(0.003)
Communication Technology penetration				
CT in (A)	−0.002	0.015^{***}	−0.003	0.012
	(0.005)	(0.004)	(0.004)	(0.008)
CT in (B-E)	0.005	−0.011	-0.021^{**}	-0.040^{**}
	(0.008)	(0.008)	(0.010)	(0.019)
CT in (F)	-0.012^{**}	-0.040^{***}	-0.034^{***}	-0.051^{***}
	(0.005)	(0.005)	(0.007)	(0.012)
CT in (G-J)	0.013	0.053^{***}	0.067^{***}	0.049^{**}
	(0.012)	(0.012)	(0.016)	(0.021)
CT in (K-N)	0.003	0.041^{***}	0.043^{***}	−0.025
	(0.009)	(0.007)	(0.009)	(0.018)
CT in (O-U)	0.007	−0.015	−0.014	-0.123^{***}
	(0.010)	(0.010)	(0.010)	(0.019)
Information Technology penetration				
IT in (A)	0.017^{***}	0.014^{***}	0.034^{***}	0.013
	(0.005)	(0.004)	(0.004)	(0.009)
IT in (B-E)	−0.003	-0.035^{***}	-0.045^{***}	0.058^{***}
	(0.010)	(0.008)	(0.009)	(0.021)
IT in (F)	0.002	0.030^{***}	0.044^{***}	0.011
	(0.004)	(0.004)	(0.005)	(0.010)
IT in (G-J)	-0.033^{***}	-0.042^{***}	-0.036^{***}	-0.127^{***}
	(0.010)	(0.010)	(0.011)	(0.017)
IT in (K-N)	0.021^{**}	0.013^{*}	0.026^{**}	0.079^{***}
	(0.009)	(0.008)	(0.012)	(0.015)
IT in (O-U)	-0.031^{***}	0.039^{***}	0.048^{***}	0.112^{***}
	(0.011)	(0.011)	(0.012)	(0.020)
Software-Database penetration				
SDB in (A)	-0.015^{***}	-0.016^{***}	-0.017^{***}	-0.020^{***}
	(0.003)	(0.003)	(0.003)	(0.006)
SDB in (B-E)	−0.012	0.029^{***}	0.044^{***}	-0.033^{**}
	(0.007)	(0.005)	(0.008)	(0.016)
SDB in (F)	0.015^{***}	0.016^{***}	-0.008^{**}	0.048^{***}
	(0.004)	(0.004)	(0.004)	(0.007)
SDB in (G-J)	0.017^{**}	−0.012	-0.034^{***}	0.056^{***}
	(0.008)	(0.008)	(0.011)	(0.015)
SDB in (K-N)	-0.020^{**}	-0.048^{***}	-0.079^{***}	-0.051^{***}
	(0.009)	(0.008)	(0.012)	(0.019)
SDB in (O-U)	0.032^{***}	−0.012	−0.015	0.051^{***}
	(0.008)	(0.009)	(0.011)	(0.017)
Imports	0.009	0.007	-0.019^{**}	-0.051^{***}
	(0.006)	(0.006)	(0.008)	(0.010)
Cons. Exp.	−0.022	0.146^{***}	0.164^{***}	0.184^{***}
	(0.016)	(0.016)	(0.023)	(0.036)
R^2	0.126	0.434	0.730	0.889
Adj. R^2	0.069	0.389	0.698	0.865
Num. obs.	3377	2721	1902	1087

Notes: $^{***}p < 0.01$; $^{**}p < 0.05$; $^{*}p < 0.1$. Standard errors between parentheses. This table summarizes the coefficients from the estimated linear regressions of adjustments of the sectoral employment-to-population ratio in Non-Market Services (O-U) to a 1% change in the sectoral penetration of robots, communication technology, information technology, and software & database, in Agriculture (A), Industry (B-E), Construction (F), Market Services (G-J), Financial & Business Services (K-N), and Non-Market Services (O-U). Controls variables include imports from China (in log-difference), real consumption index (in log-difference), and region and time fixed effects. Time horizons h range from 1 to 15 years and correspond to the window of the log-difference of variables in the regression.

Table OA.7: Employment share adjustment in Agriculture (A) to sectoral technology penetration

	Linear regression - Dep. var.: Employment share (in log)			
	$(h = 1)$	$(h = 5)$	$(h = 10)$	$(h = 15)$
Intercept	−0.011	−0.190***	−0.234***	−0.072
	(0.019)	(0.043)	(0.063)	(0.111)
Robot penetration				
ROB in (B-E)	0.051***	0.066***	0.064***	−0.040
	(0.017)	(0.012)	(0.016)	(0.027)
ROB in (F)	−0.004	−0.013***	−0.007*	−0.014***
	(0.002)	(0.003)	(0.004)	(0.004)
ROB in (O-U)	−0.003	−0.003	0.004	0.020***
	(0.004)	(0.005)	(0.006)	(0.008)
Communication Technology penetration				
CT in (A)	−0.007	0.020**	0.036***	−0.000
	(0.013)	(0.009)	(0.011)	(0.023)
CT in (B-E)	−0.082***	−0.119***	−0.232***	−0.020
	(0.022)	(0.020)	(0.025)	(0.052)
CT in (F)	0.042***	0.023*	0.012	0.037
	(0.014)	(0.014)	(0.018)	(0.034)
CT in (G-J)	0.060*	0.046	0.189***	0.069
	(0.031)	(0.030)	(0.042)	(0.059)
CT in (K-N)	−0.053**	−0.048***	−0.103***	−0.059
	(0.023)	(0.017)	(0.022)	(0.049)
CT in (O-U)	0.006	0.105***	0.119***	−0.080
	(0.025)	(0.024)	(0.026)	(0.054)
Information Technology penetration				
IT in (A)	−0.022*	−0.009	−0.018*	−0.042*
	(0.012)	(0.009)	(0.011)	(0.024)
IT in (B-E)	0.085***	0.152***	0.188***	0.001
	(0.027)	(0.021)	(0.023)	(0.057)
IT in (F)	−0.034***	−0.032***	−0.037***	−0.031
	(0.012)	(0.010)	(0.013)	(0.028)
IT in (G-J)	−0.002	−0.003	−0.104***	0.080*
	(0.027)	(0.026)	(0.030)	(0.048)
IT in (K-N)	0.008	−0.049***	0.076**	0.098**
	(0.023)	(0.019)	(0.031)	(0.043)
IT in (O-U)	0.062**	0.027	0.038	−0.025
	(0.029)	(0.027)	(0.032)	(0.055)
Software-Database penetration				
SDB in (A)	0.068***	0.042***	0.055***	0.101***
	(0.008)	(0.007)	(0.009)	(0.016)
SDB in (B-E)	−0.067***	−0.154***	−0.054***	0.062
	(0.019)	(0.013)	(0.020)	(0.043)
SDB in (F)	−0.003	0.008	0.019*	−0.008
	(0.011)	(0.009)	(0.011)	(0.021)
SDB in (G-J)	−0.076***	−0.049**	−0.073**	−0.164***
	(0.020)	(0.021)	(0.029)	(0.042)
SDB in (K-N)	0.021	0.054***	−0.042	−0.105**
	(0.023)	(0.020)	(0.032)	(0.053)
SDB in (O-U)	−0.064***	−0.105***	−0.140***	0.025
	(0.021)	(0.022)	(0.029)	(0.046)
Imports	−0.094***	−0.070***	−0.032	−0.191***
	(0.014)	(0.015)	(0.021)	(0.027)
Cons. Exp.	0.069*	−0.121***	−0.106*	−0.136
	(0.041)	(0.041)	(0.060)	(0.098)
R^2	0.176	0.557	0.811	0.913
Adj. R^2	0.122	0.522	0.789	0.894
Num. obs.	3372	2716	1897	1086

Notes: $^{***}p < 0.01$; $^{**}p < 0.05$; $^{*}p < 0.1$. Standard errors between parentheses. This table summarizes the coefficients from the estimated linear regressions of adjustments of the sectoral employment share in Agriculture (A) to a 1% change in the sectoral penetration of robots, communication technology, information technology, and software & database, in Agriculture (A), Industry (B-E), Construction (F), Market Services (G-J), Financial & Business Services (K-N), and Non-Market Services (O-U). Controls variables include imports from China (in log-difference), real consumption index (in log-difference), and region and time fixed effects. Time horizons h range from 1 to 15 years and correspond to the window of the log-difference of variables in the regression.

Table OA.8: Employment share adjustment in Industry (B-E) to sectoral technology penetration

	Linear regression - Dep. var.: Employment share (in log)			
	$(h = 1)$	$(h = 5)$	$(h = 10)$	$(h = 15)$
Intercept	−0.002	−0.077***	−0.171***	−0.123***
	(0.009)	(0.019)	(0.029)	(0.048)
Robot penetration				
ROB in (B-E)	0.005	0.020***	0.053***	−0.001
	(0.008)	(0.005)	(0.007)	(0.012)
ROB in (F)	−0.002	0.000	−0.002	−0.008***
	(0.001)	(0.002)	(0.002)	(0.002)
ROB in (O-U)	−0.006***	−0.010***	−0.008***	−0.004
	(0.002)	(0.002)	(0.003)	(0.003)
Communication Technology penetration				
CT in (A)	0.013**	0.013***	0.022***	0.011
	(0.006)	(0.004)	(0.005)	(0.010)
CT in (B-E)	0.013	0.035***	0.001	0.004
	(0.010)	(0.009)	(0.012)	(0.022)
CT in (F)	−0.005	−0.009	−0.014*	0.059***
	(0.007)	(0.006)	(0.008)	(0.014)
CT in (G-J)	−0.047***	−0.073***	−0.045**	−0.067***
	(0.015)	(0.014)	(0.020)	(0.025)
CT in (K-N)	−0.025**	−0.028***	−0.027***	−0.064***
	(0.011)	(0.008)	(0.010)	(0.021)
CT in (O-U)	0.004	0.006	0.015	−0.088***
	(0.012)	(0.011)	(0.012)	(0.023)
Information Technology penetration				
IT in (A)	−0.003	0.004	0.007	−0.001
	(0.006)	(0.004)	(0.005)	(0.010)
IT in (B-E)	−0.031**	−0.069***	−0.056***	−0.121***
	(0.013)	(0.009)	(0.011)	(0.025)
IT in (F)	0.000	0.009**	0.008	−0.039***
	(0.005)	(0.004)	(0.006)	(0.012)
IT in (G-J)	0.043***	0.075***	0.048***	0.110***
	(0.013)	(0.012)	(0.014)	(0.021)
IT in (K-N)	0.017	0.002	−0.018	0.095***
	(0.011)	(0.008)	(0.014)	(0.018)
IT in (O-U)	0.008	0.005	0.012	0.054**
	(0.014)	(0.012)	(0.015)	(0.024)
Software-Database penetration				
SDB in (A)	−0.017***	−0.014***	−0.031***	−0.032***
	(0.004)	(0.003)	(0.004)	(0.007)
SDB in (B-E)	0.020**	0.019***	0.027***	0.119***
	(0.009)	(0.006)	(0.009)	(0.019)
SDB in (F)	0.001	0.001	0.012**	−0.022**
	(0.005)	(0.004)	(0.005)	(0.009)
SDB in (G-J)	0.007	0.003	−0.002	−0.020
	(0.009)	(0.009)	(0.013)	(0.018)
SDB in (K-N)	0.006	0.034***	0.059***	−0.028
	(0.011)	(0.009)	(0.015)	(0.023)
SDB in (O-U)	−0.012	−0.018*	−0.037***	0.005
	(0.010)	(0.010)	(0.014)	(0.020)
Imports	0.020***	0.040***	0.040***	−0.032***
	(0.007)	(0.007)	(0.010)	(0.012)
Cons. Exp.	0.041**	−0.049***	0.019	0.023
	(0.019)	(0.018)	(0.028)	(0.042)
R^2	0.172	0.556	0.817	0.940
Adj. R^2	0.118	0.521	0.796	0.927
Num. obs.	3377	2721	1902	1087

Notes: $^{***}p < 0.01$; $^{**}p < 0.05$; $^{*}p < 0.1$. Standard errors between parentheses. This table summarizes the coefficients from the estimated linear regressions of adjustments of the sectoral employment share in Industry (B-E) to a 1% change in the sectoral penetration of robots, communication technology, information technology, and software & database, in Agriculture (A), Industry (B-E), Construction (F), Market Services (G-J), Financial & Business Services (K-N), and Non-Market Services (O-U). Controls variables include imports from China (in log-difference), real consumption index (in log-difference), and region and time fixed effects. Time horizons h range from 1 to 15 years and correspond to the window of the log-difference of variables in the regression.

Table OA.9: Employment share adjustment in Construction (F) to sectoral technology penetration

	Linear regression - Dep. var.: Employment share (in log)			
	$(h = 1)$	$(h = 5)$	$(h = 10)$	$(h = 15)$
Intercept	−0.010	0.001	−0.393***	−0.433***
	(0.016)	(0.039)	(0.058)	(0.086)
Robot penetration				
ROB in (B-E)	0.056***	0.133***	0.139***	0.124***
	(0.014)	(0.011)	(0.015)	(0.021)
ROB in (F)	−0.002	−0.007**	−0.002	0.001
	(0.002)	(0.003)	(0.004)	(0.003)
ROB in (O-U)	−0.008**	−0.020***	−0.049***	−0.009
	(0.003)	(0.005)	(0.006)	(0.006)
Communication Technology penetration				
CT in (A)	−0.019*	−0.022***	−0.033***	−0.023
	(0.011)	(0.008)	(0.010)	(0.018)
CT in (B-E)	0.052***	0.113***	0.212***	0.011
	(0.019)	(0.018)	(0.024)	(0.040)
CT in (F)	−0.009	−0.014	−0.048***	−0.096***
	(0.012)	(0.012)	(0.017)	(0.026)
CT in (G-J)	−0.036	−0.105***	−0.176***	0.095**
	(0.026)	(0.027)	(0.039)	(0.046)
CT in (K-N)	−0.077***	−0.104***	−0.097***	−0.050
	(0.020)	(0.016)	(0.021)	(0.038)
CT in (O-U)	0.049**	0.104***	0.055**	0.054
	(0.022)	(0.022)	(0.025)	(0.042)
Information Technology penetration				
IT in (A)	0.029***	0.046***	0.067***	0.055***
	(0.011)	(0.008)	(0.010)	(0.019)
IT in (B-E)	−0.121***	−0.263***	−0.322***	−0.145***
	(0.023)	(0.019)	(0.022)	(0.044)
IT in (F)	0.034***	0.114***	0.143***	0.178***
	(0.010)	(0.009)	(0.012)	(0.022)
IT in (G-J)	0.056**	0.178***	0.219***	0.075**
	(0.023)	(0.023)	(0.028)	(0.037)
IT in (K-N)	0.097***	0.137***	0.033	−0.028
	(0.020)	(0.017)	(0.029)	(0.033)
IT in (O-U)	−0.051**	−0.147***	−0.134***	−0.029
	(0.025)	(0.024)	(0.030)	(0.043)
Software-Database penetration				
SDB in (A)	−0.010	−0.000	0.014	−0.023*
	(0.007)	(0.006)	(0.008)	(0.013)
SDB in (B-E)	0.017	0.054***	0.015	0.059*
	(0.016)	(0.012)	(0.019)	(0.034)
SDB in (F)	−0.014	−0.078***	−0.079***	−0.043***
	(0.009)	(0.008)	(0.010)	(0.016)
SDB in (G-J)	−0.012	−0.036*	−0.010	−0.168***
	(0.017)	(0.019)	(0.027)	(0.032)
SDB in (K-N)	−0.007	0.033*	0.130***	0.134***
	(0.019)	(0.018)	(0.029)	(0.041)
SDB in (O-U)	0.018	0.049**	0.101***	0.018
	(0.018)	(0.020)	(0.027)	(0.036)
Imports	0.067***	0.069***	0.049**	0.116***
	(0.012)	(0.013)	(0.020)	(0.021)
Cons. Exp.	0.351***	0.648***	0.643***	0.440***
	(0.035)	(0.037)	(0.056)	(0.076)
R^2	0.217	0.688	0.866	0.939
Adj. R^2	0.166	0.663	0.851	0.926
Num. obs.	3377	2721	1902	1087

Notes: $^{***}p < 0.01$; $^{**}p < 0.05$; $^{*}p < 0.1$. Standard errors between parentheses. This table summarizes the coefficients from the estimated linear regressions of adjustments of the sectoral employment share in Construction (F) to a 1% change in the sectoral penetration of robots, communication technology, information technology, and software & database, in Agriculture (A), Industry (B-E), Construction (F), Market Services (G-J), Financial & Business Services (K-N), and Non-Market Services (O-U). Controls variables include imports from China (in log-difference), real consumption index (in log-difference), and region and time fixed effects. Time horizons h range from 1 to 15 years and correspond to the window of the log-difference of variables in the regression.

Table OA.10: Employment share adjustment in Market Services (G-J) to sectoral technology penetration

	Linear regression - Dep. var.: Employment share (in log)			
	$(h = 1)$	$(h = 5)$	$(h = 10)$	$(h = 15)$
Intercept	−0.001	0.017	0.051***	0.030
	(0.006)	(0.013)	(0.019)	(0.034)
Robot penetration				
ROB in (B-E)	−0.022***	−0.032***	−0.045***	−0.002
	(0.005)	(0.004)	(0.005)	(0.008)
ROB in (F)	0.003***	0.000	0.004***	0.004***
	(0.001)	(0.001)	(0.001)	(0.001)
ROB in (O-U)	−0.000	−0.004**	−0.005**	−0.003
	(0.001)	(0.002)	(0.002)	(0.002)
Communication Technology penetration				
CT in (A)	0.011***	−0.004	−0.004	0.007
	(0.004)	(0.003)	(0.003)	(0.007)
CT in (B-E)	0.011	0.028***	0.048***	−0.014
	(0.007)	(0.006)	(0.008)	(0.016)
CT in (F)	−0.004	0.018***	0.012**	0.009
	(0.004)	(0.004)	(0.006)	(0.010)
CT in (G-J)	−0.022**	−0.041***	−0.051***	0.022
	(0.009)	(0.009)	(0.013)	(0.018)
CT in (K-N)	0.030***	0.010*	0.007	0.031**
	(0.007)	(0.005)	(0.007)	(0.015)
CT in (O-U)	0.000	0.009	0.018**	0.054***
	(0.008)	(0.007)	(0.008)	(0.016)
Information Technology penetration				
IT in (A)	−0.006	−0.009***	−0.013***	−0.006
	(0.004)	(0.003)	(0.003)	(0.007)
IT in (B-E)	0.012	0.016**	0.021***	0.044**
	(0.008)	(0.006)	(0.007)	(0.017)
IT in (F)	−0.001	−0.024***	−0.022***	−0.017*
	(0.003)	(0.003)	(0.004)	(0.009)
IT in (G-J)	0.002	−0.007	−0.008	−0.047***
	(0.008)	(0.008)	(0.009)	(0.015)
IT in (K-N)	−0.015**	0.020***	0.004	−0.031**
	(0.007)	(0.006)	(0.009)	(0.013)
IT in (O-U)	−0.003	−0.036***	−0.042***	−0.041**
	(0.009)	(0.008)	(0.010)	(0.017)
Software-Database penetration				
SDB in (A)	−0.011***	0.004*	0.003	−0.003
	(0.002)	(0.002)	(0.003)	(0.005)
SDB in (B-E)	−0.001	−0.006	−0.023***	−0.034**
	(0.006)	(0.004)	(0.006)	(0.013)
SDB in (F)	0.000	0.002	0.002	0.000
	(0.003)	(0.003)	(0.003)	(0.006)
SDB in (G-J)	0.022***	0.045***	0.061***	0.034***
	(0.006)	(0.006)	(0.009)	(0.013)
SDB in (K-N)	−0.012*	−0.027***	−0.000	0.001
	(0.007)	(0.006)	(0.010)	(0.016)
SDB in (O-U)	0.005	0.029***	0.031***	−0.005
	(0.006)	(0.007)	(0.009)	(0.014)
Imports	0.015***	0.014***	0.006	0.064***
	(0.004)	(0.004)	(0.006)	(0.008)
Cons. Exp.	0.002	−0.055***	−0.077***	−0.097***
	(0.012)	(0.012)	(0.018)	(0.030)
R^2	0.150	0.479	0.778	0.903
Adj. R^2	0.095	0.437	0.753	0.883
Num. obs.	3377	2721	1902	1087

Notes: $^{***}p < 0.01$; $^{**}p < 0.05$; $^{*}p < 0.1$. Standard errors between parentheses. This table summarizes the coefficients from the estimated linear regressions of adjustments of the sectoral employment share in Market Services (G-J) to a 1% change in the sectoral penetration of robots, communication technology, information technology, and software & database, in Agriculture (A), Industry (B-E), Construction (F), Market Services (G-J), Financial & Business Services (K-N), and Non-Market Services (O-U). Controls variables include imports from China (in log-difference), real consumption index (in log-difference), and region and time fixed effects. Time horizons h range from 1 to 15 years and correspond to the window of the log-difference of variables in the regression.

Table OA.11: Employment share adjustment in Fin. & Bus. Services (K-N) to sectoral technology penetration

	Linear regression - Dep. var.: Employment share (in log)			
	$(h = 1)$	$(h = 5)$	$(h = 10)$	$(h = 15)$
Intercept	0.007	0.093***	0.145***	0.154**
	(0.011)	(0.025)	(0.038)	(0.068)
Robot penetration				
ROB in (B-E)	−0.009	−0.030***	−0.033***	0.021
	(0.010)	(0.007)	(0.010)	(0.017)
ROB in (F)	0.003**	0.007***	0.001	0.004
	(0.001)	(0.002)	(0.002)	(0.003)
ROB in (O-U)	0.009***	0.021***	0.021***	−0.002
	(0.002)	(0.003)	(0.004)	(0.005)
Communication Technology penetration				
CT in (A)	0.000	0.007	0.008	0.081***
	(0.007)	(0.005)	(0.006)	(0.014)
CT in (B-E)	−0.014	0.003	0.019	−0.011
	(0.013)	(0.011)	(0.015)	(0.032)
CT in (F)	0.006	0.012	0.030***	0.030
	(0.008)	(0.008)	(0.011)	(0.020)
CT in (G-J)	0.034*	−0.003	−0.088***	−0.214***
	(0.018)	(0.017)	(0.026)	(0.036)
CT in (K-N)	0.014	0.024**	0.026*	0.059*
	(0.013)	(0.010)	(0.014)	(0.030)
CT in (O-U)	0.008	0.010	0.029*	0.084**
	(0.015)	(0.014)	(0.016)	(0.033)
Information Technology penetration				
IT in (A)	0.016**	0.002	−0.019***	−0.057***
	(0.007)	(0.005)	(0.007)	(0.015)
IT in (B-E)	0.026	0.016	0.028**	−0.017
	(0.016)	(0.012)	(0.014)	(0.035)
IT in (F)	0.001	0.011**	−0.005	−0.012
	(0.007)	(0.006)	(0.008)	(0.017)
IT in (G-J)	−0.047***	0.002	0.089***	0.121***
	(0.015)	(0.015)	(0.018)	(0.029)
IT in (K-N)	−0.018	−0.055***	−0.042**	−0.092***
	(0.013)	(0.011)	(0.019)	(0.026)
IT in (O-U)	−0.073***	−0.084***	−0.140***	−0.043
	(0.017)	(0.015)	(0.019)	(0.034)
Software-Database penetration				
SDB in (A)	−0.017***	−0.007*	0.010*	−0.020**
	(0.004)	(0.004)	(0.006)	(0.010)
SDB in (B-E)	−0.006	−0.003	−0.028**	−0.011
	(0.011)	(0.007)	(0.012)	(0.026)
SDB in (F)	−0.013**	−0.031***	−0.028***	−0.053***
	(0.006)	(0.005)	(0.006)	(0.013)
SDB in (G-J)	0.016	−0.005	−0.027	0.078***
	(0.011)	(0.012)	(0.017)	(0.025)
SDB in (K-N)	0.018	0.037***	0.030	0.047
	(0.013)	(0.011)	(0.019)	(0.032)
SDB in (O-U)	0.059***	0.072***	0.097***	−0.054*
	(0.012)	(0.013)	(0.018)	(0.028)
Imports	0.001	0.001	0.019	0.040**
	(0.008)	(0.008)	(0.013)	(0.017)
Cons. Exp.	−0.064***	0.012	−0.085**	0.120**
	(0.023)	(0.023)	(0.036)	(0.060)
R^2	0.127	0.477	0.750	0.889
Adj. R^2	0.070	0.435	0.721	0.865
Num. obs.	3377	2721	1902	1087

Notes: $^{***}p < 0.01$; $^{**}p < 0.05$; $^{*}p < 0.1$. Standard errors between parentheses. This table summarizes the coefficients from the estimated linear regressions of adjustments of the sectoral employment share in Financial & Business Services (K-N) to a 1% change in the sectoral penetration of robots, communication technology, information technology, and software & database, in Agriculture (A), Industry (B-E), Construction (F), Market Services (G-J), Financial & Business Services (K-N), and Non-Market Services (O-U). Controls variables include imports from China (in log-difference), real consumption index (in log-difference), and region and time fixed effects. Time horizons h range from 1 to 15 years and correspond to the window of the log-difference of variables in the regression.

Table OA.12: Employment share adjustment in Non-Market Services (O-U) to sectoral technology penetration

	Linear regression - Dep. var.: Employment share (in log)			
	$(h = 1)$	$(h = 5)$	$(h = 10)$	$(h = 15)$
Intercept	0.010*	0.082***	0.258***	0.176***
	(0.006)	(0.014)	(0.021)	(0.036)
Robot penetration				
ROB in (B-E)	−0.023***	−0.049***	−0.063***	−0.059***
	(0.005)	(0.004)	(0.005)	(0.009)
ROB in (F)	0.000	0.000	−0.000	0.003*
	(0.001)	(0.001)	(0.001)	(0.001)
ROB in (O-U)	0.003**	0.004**	0.006***	0.006**
	(0.001)	(0.002)	(0.002)	(0.003)
Communication Technology penetration				
CT in (A)	−0.000	0.003	−0.006*	−0.017**
	(0.004)	(0.003)	(0.003)	(0.008)
CT in (B-E)	−0.013*	−0.035***	−0.036***	−0.029*
	(0.007)	(0.006)	(0.008)	(0.017)
CT in (F)	−0.008*	−0.008*	−0.002	−0.042***
	(0.005)	(0.004)	(0.006)	(0.011)
CT in (G-J)	0.039***	0.067***	0.075***	0.088***
	(0.010)	(0.010)	(0.014)	(0.019)
CT in (K-N)	0.015*	0.036***	0.025***	0.023
	(0.008)	(0.006)	(0.007)	(0.016)
CT in (O-U)	−0.015*	−0.061***	−0.055***	−0.033*
	(0.008)	(0.008)	(0.009)	(0.017)
Information Technology penetration				
IT in (A)	0.009**	−0.001	0.008**	0.022***
	(0.004)	(0.003)	(0.004)	(0.008)
IT in (B-E)	0.038***	0.059***	0.056***	0.165***
	(0.009)	(0.007)	(0.008)	(0.018)
IT in (F)	−0.004	−0.019***	−0.021***	0.009
	(0.004)	(0.003)	(0.004)	(0.009)
IT in (G-J)	−0.055***	−0.085***	−0.094***	−0.169***
	(0.009)	(0.008)	(0.010)	(0.016)
IT in (K-N)	−0.004	−0.006	0.029***	−0.011
	(0.008)	(0.006)	(0.010)	(0.014)
IT in (O-U)	−0.003	0.084***	0.075***	0.036**
	(0.009)	(0.009)	(0.011)	(0.018)
Software-Database penetration				
SDB in (A)	−0.013***	−0.009***	−0.015***	−0.009*
	(0.002)	(0.002)	(0.003)	(0.005)
SDB in (B-E)	−0.003	0.010**	0.013*	−0.086***
	(0.006)	(0.004)	(0.007)	(0.014)
SDB in (F)	0.012***	0.030***	0.023***	0.026***
	(0.003)	(0.003)	(0.003)	(0.007)
SDB in (G-J)	0.013*	0.006	0.005	0.069***
	(0.006)	(0.007)	(0.009)	(0.014)
SDB in (K-N)	−0.008	−0.035***	−0.062***	−0.007
	(0.007)	(0.006)	(0.010)	(0.017)
SDB in (O-U)	0.016**	−0.017**	−0.008	0.015
	(0.007)	(0.007)	(0.010)	(0.015)
Imports	−0.013***	−0.014***	−0.045***	0.007
	(0.005)	(0.005)	(0.007)	(0.009)
Cons. Exp.	−0.097***	−0.050***	−0.004	0.039
	(0.013)	(0.013)	(0.020)	(0.032)
R^2	0.234	0.566	0.788	0.901
Adj. R^2	0.184	0.531	0.763	0.880
Num. obs.	3377	2721	1902	1087

Notes: $^{***}p < 0.01$; $^{**}p < 0.05$; $^{*}p < 0.1$. Standard errors between parentheses. This table summarizes the coefficients from the estimated linear regressions of adjustments of the sectoral employment share in Non-Market Services (O-U) to a 1% change in the sectoral penetration of robots, communication technology, information technology, and software & database, in Agriculture (A), Industry (B-E), Construction (F), Market Services (G-J), Financial & Business Services (K-N), and Non-Market Services (O-U). Controls variables include imports from China (in log-difference), real consumption index (in log-difference), and region and time fixed effects. Time horizons h range from 1 to 15 years and correspond to the window of the log-difference of variables in the regression.

Table OA.13: Sectoral average wage adjustment in Agriculture (A) to sectoral technology penetration

	Linear regression - Dep. var.: Average wage (in log)			
	$(h = 1)$	$(h = 5)$	$(h = 10)$	$(h = 15)$
Intercept	0.141***	0.924***	1.348***	1.007***
	(0.031)	(0.066)	(0.099)	(0.173)
Robot penetration				
ROB in (B-E)	−0.095***	−0.092***	−0.051**	−0.041
	(0.027)	(0.019)	(0.025)	(0.042)
ROB in (F)	0.004	−0.028***	−0.003	0.011
	(0.004)	(0.005)	(0.006)	(0.007)
ROB in (O-U)	−0.024***	−0.014*	−0.053***	−0.065***
	(0.006)	(0.008)	(0.010)	(0.012)
Communication Technology penetration				
CT in (A)	0.003	−0.056***	−0.047***	−0.053
	(0.021)	(0.014)	(0.017)	(0.037)
CT in (B-E)	0.113***	0.080***	0.124***	−0.042
	(0.036)	(0.031)	(0.040)	(0.081)
CT in (F)	0.001	0.011	−0.086***	0.059
	(0.023)	(0.021)	(0.028)	(0.052)
CT in (G-J)	0.019	0.174***	0.165**	0.121
	(0.051)	(0.046)	(0.067)	(0.092)
CT in (K-N)	−0.027	−0.015	0.056	−0.081
	(0.039)	(0.027)	(0.035)	(0.077)
CT in (O-U)	−0.073*	−0.320***	−0.243***	−0.085
	(0.042)	(0.037)	(0.042)	(0.084)
Information Technology penetration				
IT in (A)	0.059***	0.066***	0.065***	0.096**
	(0.020)	(0.014)	(0.017)	(0.037)
IT in (B-E)	−0.229***	−0.262***	−0.338***	0.093
	(0.045)	(0.032)	(0.037)	(0.089)
IT in (F)	0.014	−0.016	0.031	0.070
	(0.019)	(0.015)	(0.021)	(0.044)
IT in (G-J)	0.000	−0.075*	−0.060	−0.300***
	(0.044)	(0.039)	(0.047)	(0.075)
IT in (K-N)	0.025	0.054*	0.025	−0.136**
	(0.039)	(0.029)	(0.049)	(0.067)
IT in (O-U)	−0.086*	0.301***	0.007	0.196**
	(0.048)	(0.041)	(0.050)	(0.086)
Software-Database penetration				
SDB in (A)	−0.049***	0.011	−0.033**	−0.029
	(0.013)	(0.011)	(0.014)	(0.025)
SDB in (B-E)	0.213***	0.299***	0.295***	−0.033
	(0.032)	(0.020)	(0.032)	(0.067)
SDB in (F)	−0.031*	0.028**	0.024	−0.126***
	(0.018)	(0.014)	(0.017)	(0.032)
SDB in (G-J)	0.014	−0.084***	−0.106**	0.225***
	(0.033)	(0.032)	(0.045)	(0.065)
SDB in (K-N)	0.020	−0.072**	−0.068	0.321***
	(0.037)	(0.030)	(0.050)	(0.082)
SDB in (O-U)	0.164***	0.010	0.180***	−0.086
	(0.035)	(0.034)	(0.046)	(0.072)
Imports	0.006	0.076***	0.086***	0.229***
	(0.024)	(0.023)	(0.033)	(0.042)
Cons. Exp.	−0.005	0.335***	0.231**	1.098***
	(0.067)	(0.062)	(0.094)	(0.153)
R^2	0.270	0.496	0.710	0.848
Adj. R^2	0.222	0.455	0.677	0.815
Num. obs.	3368	2712	1893	1082

Notes: $^{***}p < 0.01$; $^{**}p < 0.05$; $^{*}p < 0.1$. Standard errors between parentheses. This table summarizes the coefficients from the estimated linear regressions of adjustments of the sectoral average wage per worker in Agriculture (A) to a 1% change in the sectoral penetration of robots, communication technology, information technology, and software & database, in Agriculture (A), Industry (B-E), Construction (F), Market Services (G-J), Financial & Business Services (K-N), and Non-Market Services (O-U). Controls variables include imports from China (in log-difference), real consumption index (in log-difference), and region and time fixed effects. Time horizons h range from 1 to 15 years and correspond to the window of the log-difference of variables in the regression.

Table OA.14: Sectoral average wage adjustment in Industry (B-E) to sectoral technology penetration

	Linear regression - Dep. var.: Average wage (in log)			
	$(h = 1)$	$(h = 5)$	$(h = 10)$	$(h = 15)$
Intercept	0.034^{***}	0.258^{***}	0.214^{***}	0.618^{***}
	(0.011)	(0.024)	(0.033)	(0.064)
Robot penetration				
ROB in (B-E)	-0.026^{***}	-0.035^{***}	-0.062^{***}	-0.059^{***}
	(0.010)	(0.007)	(0.008)	(0.016)
ROB in (F)	-0.002	-0.008^{***}	0.003	-0.009^{***}
	(0.001)	(0.002)	(0.002)	(0.003)
ROB in (O-U)	0.003	0.002	0.013^{***}	-0.001
	(0.002)	(0.003)	(0.003)	(0.004)
Communication Technology penetration				
CT in (A)	-0.012^{*}	-0.039^{***}	-0.034^{***}	-0.002
	(0.007)	(0.005)	(0.006)	(0.013)
CT in (B-E)	-0.004	0.001	-0.093^{***}	0.033
	(0.013)	(0.011)	(0.013)	(0.030)
CT in (F)	0.026^{***}	0.096^{***}	0.090^{***}	0.085^{***}
	(0.008)	(0.008)	(0.009)	(0.019)
CT in (G-J)	0.035^{*}	-0.024	0.020	0.046
	(0.018)	(0.017)	(0.022)	(0.034)
CT in (K-N)	0.049^{***}	0.034^{***}	0.001	-0.006
	(0.014)	(0.010)	(0.012)	(0.028)
CT in (O-U)	-0.017	0.065^{***}	0.142^{***}	-0.111^{***}
	(0.015)	(0.014)	(0.014)	(0.031)
Information Technology penetration				
IT in (A)	-0.002	-0.005	-0.002	-0.059^{***}
	(0.007)	(0.005)	(0.006)	(0.014)
IT in (B-E)	0.019	0.010	0.022^{*}	-0.041
	(0.016)	(0.012)	(0.012)	(0.033)
IT in (F)	-0.008	-0.052^{***}	-0.053^{***}	-0.030^{*}
	(0.007)	(0.005)	(0.007)	(0.016)
IT in (G-J)	-0.049^{***}	0.012	-0.034^{**}	0.060^{**}
	(0.016)	(0.014)	(0.015)	(0.028)
IT in (K-N)	-0.012	-0.060^{***}	0.108^{***}	0.009
	(0.014)	(0.010)	(0.016)	(0.025)
IT in (O-U)	0.037^{**}	0.014	-0.074^{***}	0.015
	(0.017)	(0.015)	(0.017)	(0.032)
Software-Database penetration				
SDB in (A)	0.017^{***}	0.042^{***}	0.020^{***}	0.063^{***}
	(0.005)	(0.004)	(0.005)	(0.009)
SDB in (B-E)	0.023^{**}	0.032^{***}	0.148^{***}	0.107^{***}
	(0.011)	(0.007)	(0.011)	(0.025)
SDB in (F)	-0.009	-0.025^{***}	-0.035^{***}	-0.039^{***}
	(0.006)	(0.005)	(0.005)	(0.012)
SDB in (G-J)	0.013	0.013	0.013	-0.120^{***}
	(0.012)	(0.011)	(0.015)	(0.024)
SDB in (K-N)	-0.026^{*}	0.050^{***}	-0.086^{***}	0.015
	(0.013)	(0.011)	(0.016)	(0.030)
SDB in (O-U)	-0.022^{*}	-0.051^{***}	-0.070^{***}	0.062^{**}
	(0.013)	(0.012)	(0.015)	(0.026)
Imports	-0.018^{**}	-0.027^{***}	0.010	-0.071^{***}
	(0.009)	(0.008)	(0.011)	(0.016)
Cons. Exp.	0.255^{***}	0.291^{***}	0.207^{***}	0.140^{**}
	(0.024)	(0.023)	(0.031)	(0.056)
R^2	0.269	0.614	0.866	0.928
Adj. R^2	0.221	0.582	0.850	0.913
Num. obs.	3377	2721	1902	1087

Notes: $^{***}p < 0.01$; $^{**}p < 0.05$; $^{*}p < 0.1$. Standard errors between parentheses. This table summarizes the coefficients from the estimated linear regressions of adjustments of the sectoral average wage per worker in Industry (B-E) to a 1% change in the sectoral penetration of robots, communication technology, information technology, and software & database, in Agriculture (A), Industry (B-E), Construction (F), Market Services (G-J), Financial & Business Services (K-N), and Non-Market Services (O-U). Controls variables include imports from China (in log-difference), real consumption index (in log-difference), and region and time fixed effects. Time horizons h range from 1 to 15 years and correspond to the window of the log-difference of variables in the regression.

Table OA.15: Sectoral average wage adjustment in Construction (F) to sectoral technology penetration

	Linear regression - Dep. var.: Average wage (in log)			
	$(h = 1)$	$(h = 5)$	$(h = 10)$	$(h = 15)$
Intercept	−0.020	−0.101**	−0.296***	−0.003
	(0.017)	(0.040)	(0.062)	(0.095)
Robot penetration				
ROB in (B-E)	0.004	−0.095***	−0.093***	−0.021
	(0.015)	(0.011)	(0.016)	(0.023)
ROB in (F)	0.005**	0.009***	0.020***	−0.011***
	(0.002)	(0.003)	(0.004)	(0.004)
ROB in (O-U)	0.008**	0.048***	0.060***	0.018***
	(0.004)	(0.005)	(0.006)	(0.007)
Communication Technology penetration				
CT in (A)	0.037***	0.009	0.032***	0.181***
	(0.011)	(0.009)	(0.011)	(0.020)
CT in (B-E)	−0.023	−0.002	−0.106***	−0.032
	(0.020)	(0.019)	(0.025)	(0.044)
CT in (F)	−0.006	−0.022*	0.013	0.127***
	(0.013)	(0.013)	(0.018)	(0.029)
CT in (G-J)	−0.043	−0.060**	−0.126***	−0.320***
	(0.028)	(0.028)	(0.042)	(0.051)
CT in (K-N)	0.043**	0.090***	0.081***	−0.039
	(0.021)	(0.016)	(0.022)	(0.042)
CT in (O-U)	0.015	0.168***	0.198***	−0.383***
	(0.023)	(0.023)	(0.026)	(0.046)
Information Technology penetration				
IT in (A)	−0.009	0.041***	0.036***	−0.120***
	(0.011)	(0.009)	(0.011)	(0.020)
IT in (B-E)	0.004	0.032	0.091***	−0.187***
	(0.025)	(0.020)	(0.023)	(0.049)
IT in (F)	−0.004	−0.033***	−0.082***	−0.155***
	(0.010)	(0.009)	(0.013)	(0.024)
IT in (G-J)	0.007	0.004	0.010	0.206***
	(0.024)	(0.024)	(0.029)	(0.041)
IT in (K-N)	−0.003	−0.024	0.081***	0.238***
	(0.021)	(0.017)	(0.031)	(0.037)
IT in (O-U)	−0.036	−0.123***	−0.209***	0.241***
	(0.026)	(0.025)	(0.032)	(0.047)
Software-Database penetration				
SDB in (A)	−0.030***	−0.048***	−0.062***	−0.053***
	(0.007)	(0.006)	(0.009)	(0.014)
SDB in (B-E)	0.025	0.055***	0.115***	0.225***
	(0.017)	(0.012)	(0.020)	(0.037)
SDB in (F)	0.010	0.096***	0.108***	0.050***
	(0.010)	(0.008)	(0.010)	(0.018)
SDB in (G-J)	0.033*	0.055***	0.120***	0.125***
	(0.018)	(0.019)	(0.029)	(0.036)
SDB in (K-N)	−0.030	−0.080***	−0.195***	−0.235***
	(0.021)	(0.018)	(0.031)	(0.045)
SDB in (O-U)	0.028	−0.006	−0.005	0.121***
	(0.019)	(0.021)	(0.029)	(0.040)
Imports	−0.057***	−0.071***	−0.027	−0.154***
	(0.013)	(0.014)	(0.021)	(0.023)
Cons. Exp.	0.001	0.013	−0.066	−0.143*
	(0.037)	(0.038)	(0.060)	(0.084)
R^2	0.096	0.383	0.615	0.796
Adj. R^2	0.037	0.333	0.571	0.753
Num. obs.	3377	2721	1902	1087

Notes: $^{***}p < 0.01$; $^{**}p < 0.05$; $^{*}p < 0.1$. Standard errors between parentheses. This table summarizes the coefficients from the estimated linear regressions of adjustments of the sectoral average wage per worker in Construction (F) to a 1% change in the sectoral penetration of robots, communication technology, information technology, and software & database, in Agriculture (A), Industry (B-E), Construction (F), Market Services (G-J), Financial & Business Services (K-N), and Non-Market Services (O-U). Controls variables include imports from China (in log-difference), real consumption index (in log-difference), and region and time fixed effects. Time horizons h range from 1 to 15 years and correspond to the window of the log-difference of variables in the regression.

Table OA.16: Sectoral average wage adjustment in Market Services (G-J) to sectoral technology penetration

	Linear regression - Dep. var.: Average wage (in log)			
	$(h = 1)$	$(h = 5)$	$(h = 10)$	$(h = 15)$
Intercept	0.012	0.183***	0.040	0.122**
	(0.009)	(0.022)	(0.032)	(0.056)
Robot penetration				
ROB in (B-E)	0.024***	0.011*	0.008	0.049***
	(0.008)	(0.006)	(0.008)	(0.014)
ROB in (F)	−0.006***	−0.005***	−0.000	−0.015***
	(0.001)	(0.002)	(0.002)	(0.002)
ROB in (O-U)	−0.001	0.005**	0.016***	−0.006
	(0.002)	(0.003)	(0.003)	(0.004)
Communication Technology penetration				
CT in (A)	−0.005	−0.026***	−0.028***	0.033***
	(0.006)	(0.005)	(0.005)	(0.012)
CT in (B-E)	0.005	−0.012	−0.037***	0.021
	(0.011)	(0.010)	(0.013)	(0.026)
CT in (F)	−0.016**	−0.030***	−0.032***	0.041**
	(0.007)	(0.007)	(0.009)	(0.017)
CT in (G-J)	−0.041***	0.021	0.029	−0.083***
	(0.016)	(0.015)	(0.021)	(0.030)
CT in (K-N)	0.016	0.020**	−0.008	−0.044*
	(0.012)	(0.009)	(0.011)	(0.025)
CT in (O-U)	−0.013	0.011	0.012	−0.259***
	(0.013)	(0.012)	(0.013)	(0.027)
Information Technology penetration				
IT in (A)	0.009	0.033***	0.027***	−0.040***
	(0.006)	(0.005)	(0.005)	(0.012)
IT in (B-E)	−0.047***	−0.051***	−0.060***	−0.191***
	(0.014)	(0.011)	(0.012)	(0.029)
IT in (F)	0.005	0.016***	0.012*	−0.050***
	(0.006)	(0.005)	(0.007)	(0.014)
IT in (G-J)	0.045***	0.028**	0.003	0.097***
	(0.013)	(0.013)	(0.015)	(0.025)
IT in (K-N)	−0.007	−0.052***	0.001	0.101***
	(0.012)	(0.010)	(0.016)	(0.022)
IT in (O-U)	0.032**	0.034**	0.006	0.170***
	(0.015)	(0.014)	(0.016)	(0.028)
Software-Database penetration				
SDB in (A)	−0.003	−0.023***	−0.020***	0.001
	(0.004)	(0.004)	(0.005)	(0.008)
SDB in (B-E)	0.017*	0.046***	0.099***	0.132***
	(0.010)	(0.007)	(0.010)	(0.022)
SDB in (F)	0.020***	0.018***	0.020***	0.026**
	(0.005)	(0.005)	(0.005)	(0.010)
SDB in (G-J)	0.007	−0.034***	−0.002	0.006
	(0.010)	(0.011)	(0.015)	(0.021)
SDB in (K-N)	−0.001	0.040***	0.017	−0.033
	(0.011)	(0.010)	(0.016)	(0.027)
SDB in (O-U)	−0.020*	−0.040***	−0.052***	0.075***
	(0.011)	(0.011)	(0.015)	(0.023)
Imports	−0.016**	−0.056***	−0.007	−0.107***
	(0.007)	(0.007)	(0.011)	(0.014)
Cons. Exp.	0.106***	0.225***	0.045	0.300***
	(0.021)	(0.021)	(0.030)	(0.050)
R^2	0.139	0.401	0.701	0.869
Adj. R^2	0.083	0.353	0.667	0.841
Num. obs.	3377	2721	1902	1087

Notes: $^{***}p < 0.01$; $^{**}p < 0.05$; $^{*}p < 0.1$. Standard errors between parentheses. This table summarizes the coefficients from the estimated linear regressions of adjustments of the sectoral average wage per worker in Market Services (G-J) to a 1% change in the sectoral penetration of robots, communication technology, information technology, and software & database, in Agriculture (A), Industry (B-E), Construction (F), Market Services (G-J), Financial & Business Services (K-N), and Non-Market Services (O-U). Controls variables include imports from China (in log-difference), real consumption index (in log-difference), and region and time fixed effects. Time horizons h range from 1 to 15 years and correspond to the window of the log-difference of variables in the regression.

Table OA.17: Sectoral average wage adjustment in Fin. & Bus. Services (K-N) to sectoral technology penetration

	Linear regression - Dep. var.: Average wage (in log)			
	$(h = 1)$	$(h = 5)$	$(h = 10)$	$(h = 15)$
Intercept	0.008	−0.006	−0.075	0.254***
	(0.014)	(0.033)	(0.049)	(0.086)
Robot penetration				
ROB in (B-E)	0.028**	−0.008	0.005	−0.024
	(0.012)	(0.009)	(0.012)	(0.021)
ROB in (F)	−0.001	−0.008***	0.006*	−0.008**
	(0.002)	(0.003)	(0.003)	(0.003)
ROB in (O-U)	−0.006**	0.004	0.002	0.010*
	(0.003)	(0.004)	(0.005)	(0.006)
Communication Technology penetration				
CT in (A)	0.005	−0.018***	−0.012	−0.043**
	(0.009)	(0.007)	(0.008)	(0.018)
CT in (B-E)	−0.015	−0.053***	−0.069***	−0.056
	(0.016)	(0.015)	(0.020)	(0.040)
CT in (F)	−0.019*	−0.021**	−0.082***	0.025
	(0.010)	(0.010)	(0.014)	(0.026)
CT in (G-J)	−0.048**	−0.078***	0.013	0.170***
	(0.023)	(0.023)	(0.033)	(0.046)
CT in (K-N)	0.009	0.017	0.004	−0.092**
	(0.017)	(0.013)	(0.018)	(0.038)
CT in (O-U)	−0.013	0.024	−0.022	−0.232***
	(0.019)	(0.018)	(0.021)	(0.042)
Information Technology penetration				
IT in (A)	−0.016*	0.012*	0.027***	0.016
	(0.009)	(0.007)	(0.008)	(0.018)
IT in (B-E)	−0.012	0.013	−0.013	0.089**
	(0.020)	(0.016)	(0.018)	(0.044)
IT in (F)	−0.008	−0.032***	0.001	−0.050**
	(0.008)	(0.007)	(0.010)	(0.022)
IT in (G-J)	0.049**	0.018	−0.135***	−0.137***
	(0.020)	(0.019)	(0.023)	(0.037)
IT in (K-N)	0.025	0.097***	0.055**	0.206***
	(0.017)	(0.014)	(0.024)	(0.033)
IT in (O-U)	0.048**	0.031	0.146***	0.067
	(0.021)	(0.020)	(0.025)	(0.043)
Software-Database penetration				
SDB in (A)	0.005	0.003	−0.019***	0.028**
	(0.006)	(0.005)	(0.007)	(0.013)
SDB in (B-E)	0.005	0.042***	0.075***	0.022
	(0.014)	(0.010)	(0.016)	(0.034)
SDB in (F)	0.030***	0.067***	0.090***	0.054***
	(0.008)	(0.007)	(0.008)	(0.016)
SDB in (G-J)	0.005	0.061***	0.146***	−0.009
	(0.015)	(0.016)	(0.023)	(0.032)
SDB in (K-N)	−0.032*	−0.111***	−0.046*	−0.116***
	(0.017)	(0.015)	(0.025)	(0.041)
SDB in (O-U)	−0.033**	−0.053***	−0.122***	0.132***
	(0.016)	(0.017)	(0.023)	(0.036)
Imports	−0.018*	−0.068***	−0.027*	−0.093***
	(0.011)	(0.011)	(0.017)	(0.021)
Cons. Exp.	0.139***	0.057*	−0.075	−0.258***
	(0.030)	(0.031)	(0.047)	(0.076)
R^2	0.111	0.394	0.651	0.850
Adj. R^2	0.053	0.346	0.610	0.818
Num. obs.	3377	2721	1902	1087

Notes: $^{***}p < 0.01$; $^{**}p < 0.05$; $^{*}p < 0.1$. Standard errors between parentheses. This table summarizes the coefficients from the estimated linear regressions of adjustments of the sectoral average wage per worker in Financial & Business Services (K-N) to a 1% change in the sectoral penetration of robots, communication technology, information technology, and software & database, in Agriculture (A), Industry (B-E), Construction (F), Market Services (G-J), Financial & Business Services (K-N), and Non-Market Services (O-U). Controls variables include imports from China (in log-difference), real consumption index (in log-difference), and region and time fixed effects. Time horizons h range from 1 to 15 years and correspond to the window of the log-difference of variables in the regression.

Table OA.18: Sectoral average wage adjustment in Non-Market Services (O-U) to sectoral technology penetration

	Linear regression - Dep. var.: Average wage (in log)			
	$(h = 1)$	$(h = 5)$	$(h = 10)$	$(h = 15)$
Intercept	0.004	0.072***	−0.165***	−0.160***
	(0.008)	(0.018)	(0.027)	(0.047)
Robot penetration				
ROB in (B-E)	−0.041***	−0.027***	−0.044***	0.002
	(0.007)	(0.005)	(0.007)	(0.011)
ROB in (F)	0.002*	−0.004***	0.008***	0.003
	(0.001)	(0.001)	(0.002)	(0.002)
ROB in (O-U)	0.000	−0.009***	−0.007***	0.002
	(0.002)	(0.002)	(0.003)	(0.003)
Communication Technology penetration				
CT in (A)	0.014**	0.006	−0.005	0.031***
	(0.005)	(0.004)	(0.005)	(0.010)
CT in (B-E)	0.020**	0.036***	0.060***	0.078***
	(0.010)	(0.008)	(0.011)	(0.022)
CT in (F)	0.015**	0.010*	−0.027***	−0.065***
	(0.006)	(0.006)	(0.008)	(0.014)
CT in (G-J)	−0.055***	−0.125***	−0.123***	−0.073***
	(0.013)	(0.013)	(0.019)	(0.025)
CT in (K-N)	0.026***	0.026***	0.001	0.030
	(0.010)	(0.007)	(0.010)	(0.021)
CT in (O-U)	−0.008	0.060***	0.097***	0.070***
	(0.011)	(0.010)	(0.012)	(0.023)
Information Technology penetration				
IT in (A)	−0.011**	0.008**	0.007	−0.025**
	(0.005)	(0.004)	(0.005)	(0.010)
IT in (B-E)	−0.009	−0.062***	−0.055***	−0.153***
	(0.012)	(0.009)	(0.010)	(0.024)
IT in (F)	−0.011**	−0.011***	0.012**	0.021*
	(0.005)	(0.004)	(0.006)	(0.012)
IT in (G-J)	0.048***	0.088***	0.080***	0.057***
	(0.012)	(0.011)	(0.013)	(0.020)
IT in (K-N)	−0.003	0.022***	−0.017	0.005
	(0.010)	(0.008)	(0.014)	(0.018)
IT in (O-U)	−0.016	−0.063***	−0.071***	−0.082***
	(0.013)	(0.011)	(0.014)	(0.023)
Software-Database penetration				
SDB in (A)	−0.006*	−0.035***	−0.019***	−0.008
	(0.003)	(0.003)	(0.004)	(0.007)
SDB in (B-E)	0.032***	0.048***	0.049***	0.079***
	(0.008)	(0.005)	(0.009)	(0.018)
SDB in (F)	−0.008*	0.001	0.004	0.041***
	(0.005)	(0.004)	(0.005)	(0.009)
SDB in (G-J)	0.012	0.034***	0.053***	0.027
	(0.009)	(0.009)	(0.013)	(0.018)
SDB in (K-N)	−0.020**	−0.036***	0.050***	−0.020
	(0.010)	(0.008)	(0.014)	(0.022)
SDB in (O-U)	0.025***	0.037***	0.002	0.020
	(0.009)	(0.009)	(0.013)	(0.019)
Imports	−0.007	−0.050***	0.008	−0.018
	(0.006)	(0.006)	(0.009)	(0.011)
Cons. Exp.	0.238***	0.302***	0.128***	0.238***
	(0.018)	(0.017)	(0.026)	(0.041)
R^2	0.200	0.577	0.790	0.912
Adj. R^2	0.147	0.543	0.766	0.893
Num. obs.	3377	2721	1902	1087

Notes: $^{***}p < 0.01$; $^{**}p < 0.05$; $^{*}p < 0.1$. Standard errors between parentheses. This table summarizes the coefficients from the estimated linear regressions of adjustments of the sectoral average wage per worker in Non-Market Services (O-U) to a 1% change in the sectoral penetration of robots, communication technology, information technology, and software & database, in Agriculture (A), Industry (B-E), Construction (F), Market Services (G-J), Financial & Business Services (K-N), and Non-Market Services (O-U). Controls variables include imports from China (in log-difference), real consumption index (in log-difference), and region and time fixed effects. Time horizons h range from 1 to 15 years and correspond to the window of the log-difference of variables in the regression.

Table OA.19: Relative sectoral average wage adjustment in Agriculture (A) to sectoral technology penetration

	Linear regression - Dep. var.: Wage share (in log)			
	$(h = 1)$	$(h = 5)$	$(h = 10)$	$(h = 15)$
Intercept	0.128***	0.790***	1.347***	0.870***
	(0.030)	(0.064)	(0.095)	(0.168)
Robot penetration				
ROB in (B-E)	−0.073***	−0.058***	−0.007	−0.017
	(0.027)	(0.018)	(0.024)	(0.041)
ROB in (F)	0.005	−0.023***	−0.008	0.017**
	(0.004)	(0.005)	(0.006)	(0.007)
ROB in (O-U)	−0.025***	−0.015**	−0.059***	−0.067***
	(0.006)	(0.007)	(0.010)	(0.012)
Communication Technology penetration				
CT in (A)	−0.003	−0.042***	−0.032**	−0.081**
	(0.020)	(0.014)	(0.016)	(0.035)
CT in (B-E)	0.107***	0.073**	0.139***	−0.066
	(0.036)	(0.030)	(0.039)	(0.078)
CT in (F)	0.002	−0.002	−0.079***	0.045
	(0.023)	(0.020)	(0.027)	(0.051)
CT in (G-J)	0.045	0.230***	0.208***	0.141
	(0.050)	(0.044)	(0.064)	(0.089)
CT in (K-N)	−0.056	−0.044*	0.050	−0.064
	(0.038)	(0.026)	(0.034)	(0.075)
CT in (O-U)	−0.066	−0.356***	−0.311***	0.021
	(0.041)	(0.036)	(0.040)	(0.081)
Information Technology penetration				
IT in (A)	0.059***	0.052***	0.049***	0.128***
	(0.020)	(0.014)	(0.016)	(0.036)
IT in (B-E)	−0.218***	−0.232***	−0.308***	0.169**
	(0.044)	(0.031)	(0.035)	(0.086)
IT in (F)	0.015	0.000	0.039*	0.085**
	(0.019)	(0.014)	(0.020)	(0.043)
IT in (G-J)	−0.011	−0.111***	−0.065	−0.330***
	(0.043)	(0.038)	(0.045)	(0.073)
IT in (K-N)	0.026	0.061**	−0.005	−0.190***
	(0.038)	(0.028)	(0.047)	(0.065)
IT in (O-U)	−0.087*	0.302***	0.038	0.157*
	(0.047)	(0.039)	(0.048)	(0.083)
Software-Database penetration				
SDB in (A)	−0.038***	0.026**	−0.009	−0.033
	(0.012)	(0.010)	(0.014)	(0.025)
SDB in (B-E)	0.179***	0.243***	0.198***	−0.120*
	(0.031)	(0.019)	(0.031)	(0.066)
SDB in (F)	−0.035**	0.014	0.006	−0.138***
	(0.017)	(0.013)	(0.016)	(0.031)
SDB in (G-J)	−0.008	−0.109***	−0.159***	0.219***
	(0.032)	(0.030)	(0.044)	(0.063)
SDB in (K-N)	0.035	−0.072**	−0.064	0.333***
	(0.037)	(0.029)	(0.048)	(0.080)
SDB in (O-U)	0.159***	0.024	0.215***	−0.143**
	(0.034)	(0.033)	(0.044)	(0.070)
Imports	0.014	0.110***	0.083***	0.266***
	(0.023)	(0.022)	(0.032)	(0.041)
Cons. Exp.	−0.179***	0.103*	0.110	0.943***
	(0.066)	(0.060)	(0.091)	(0.149)
R^2	0.295	0.487	0.709	0.853
Adj. R^2	0.248	0.445	0.675	0.821
Num. obs.	3368	2712	1893	1082

Notes: $^{***}p < 0.01$; $^{**}p < 0.05$; $^{*}p < 0.1$. Standard errors between parentheses. This table summarizes the coefficients from the estimated linear regressions of adjustments of the relative sectoral average wage per worker in Agriculture (A) to a 1% change in the sectoral penetration of robots, communication technology, information technology, and software & database, in Agriculture (A), Industry (B-E), Construction (F), Market Services (G-J), Financial & Business Services (K-N), and Non-Market Services (O-U). Controls variables include imports from China (in log-difference), real consumption index (in log-difference), and region and time fixed effects. Time horizons h range from 1 to 15 years and correspond to the window of the log-difference of variables in the regression.

Table OA.20: Relative sectoral average wage adjustment in Industry (B-E) to sectoral technology penetration

	Linear regression - Dep. var.: Wage share (in log)			
	$(h = 1)$	$(h = 5)$	$(h = 10)$	$(h = 15)$
Intercept	0.022**	0.124***	0.213***	0.482***
	(0.010)	(0.020)	(0.028)	(0.056)
Robot penetration				
ROB in (B-E)	−0.004	−0.000	−0.018**	−0.035**
	(0.009)	(0.006)	(0.007)	(0.014)
ROB in (F)	−0.002	−0.004**	−0.002	−0.004*
	(0.001)	(0.002)	(0.002)	(0.002)
ROB in (O-U)	0.003	0.001	0.006**	−0.003
	(0.002)	(0.002)	(0.003)	(0.004)
Communication Technology penetration				
CT in (A)	−0.019***	−0.024***	−0.020***	−0.029**
	(0.007)	(0.004)	(0.005)	(0.012)
CT in (B-E)	−0.009	−0.006	−0.078***	0.009
	(0.011)	(0.009)	(0.011)	(0.026)
CT in (F)	0.027***	0.082***	0.098***	0.072***
	(0.007)	(0.006)	(0.008)	(0.017)
CT in (G-J)	0.061***	0.032**	0.062***	0.065**
	(0.016)	(0.014)	(0.019)	(0.029)
CT in (K-N)	0.020*	0.005	−0.005	0.011
	(0.012)	(0.008)	(0.010)	(0.025)
CT in (O-U)	−0.010	0.029**	0.075***	−0.005
	(0.013)	(0.011)	(0.012)	(0.027)
Information Technology penetration				
IT in (A)	−0.003	−0.018***	−0.018***	−0.027**
	(0.006)	(0.004)	(0.005)	(0.012)
IT in (B-E)	0.029**	0.040***	0.053***	0.035
	(0.014)	(0.010)	(0.010)	(0.028)
IT in (F)	−0.007	−0.037***	−0.045***	−0.015
	(0.006)	(0.005)	(0.006)	(0.014)
IT in (G-J)	−0.060***	−0.025**	−0.039***	0.031
	(0.014)	(0.012)	(0.013)	(0.024)
IT in (K-N)	−0.010	−0.053***	0.078***	−0.044**
	(0.012)	(0.009)	(0.014)	(0.021)
IT in (O-U)	0.035**	0.015	−0.044***	−0.024
	(0.015)	(0.013)	(0.014)	(0.028)
Software-Database penetration				
SDB in (A)	0.027***	0.058***	0.044***	0.059***
	(0.004)	(0.003)	(0.004)	(0.008)
SDB in (B-E)	−0.011	−0.024***	0.052***	0.019
	(0.010)	(0.006)	(0.009)	(0.022)
SDB in (F)	−0.013**	−0.038***	−0.055***	−0.051***
	(0.006)	(0.004)	(0.005)	(0.010)
SDB in (G-J)	−0.009	−0.012	−0.039***	−0.125***
	(0.010)	(0.010)	(0.013)	(0.021)
SDB in (K-N)	−0.011	0.049***	−0.083***	0.027
	(0.012)	(0.009)	(0.014)	(0.026)
SDB in (O-U)	−0.027**	−0.038***	−0.035***	0.005
	(0.011)	(0.011)	(0.013)	(0.023)
Imports	−0.010	0.006	0.007	−0.034**
	(0.008)	(0.007)	(0.009)	(0.014)
Cons. Exp.	0.081***	0.059***	0.088***	−0.016
	(0.021)	(0.019)	(0.027)	(0.049)
R^2	0.188	0.492	0.756	0.857
Adj. R^2	0.135	0.451	0.728	0.826
Num. obs.	3373	2717	1898	1083

Notes: $^{***}p < 0.01$; $^{**}p < 0.05$; $^{*}p < 0.1$. Standard errors between parentheses. This table summarizes the coefficients from the estimated linear regressions of adjustments of the relative sectoral average wage per worker in Industry (B-E) to a 1% change in the sectoral penetration of robots, communication technology, information technology, and software & database, in Agriculture (A), Industry (B-E), Construction (F), Market Services (G-J), Financial & Business Services (K-N), and Non-Market Services (O-U). Controls variables include imports from China (in log-difference), real consumption index (in log-difference), and region and time fixed effects. Time horizons h range from 1 to 15 years and correspond to the window of the log-difference of variables in the regression.

Table OA.21: Relative sectoral average wage adjustment in Construction (F) to sectoral technology penetration

	Linear regression - Dep. var.: Wage share (in log)			
	$(h = 1)$	$(h = 5)$	$(h = 10)$	$(h = 15)$
Intercept	-0.032^{**}	-0.235^{***}	-0.299^{***}	-0.141
	(0.016)	(0.035)	(0.058)	(0.091)
Robot penetration				
ROB in (B-E)	0.026^{*}	-0.061^{***}	-0.049^{***}	0.002
	(0.014)	(0.010)	(0.015)	(0.022)
ROB in (F)	0.005^{**}	0.013^{***}	0.015^{***}	-0.005
	(0.002)	(0.003)	(0.004)	(0.004)
ROB in (O-U)	0.007^{**}	0.047^{***}	0.054^{***}	0.017^{***}
	(0.003)	(0.004)	(0.006)	(0.006)
Communication Technology penetration				
CT in (A)	0.031^{***}	0.023^{***}	0.046^{***}	0.152^{***}
	(0.011)	(0.008)	(0.010)	(0.019)
CT in (B-E)	-0.028	-0.010	-0.091^{***}	-0.056
	(0.019)	(0.016)	(0.023)	(0.042)
CT in (F)	-0.004	-0.036^{***}	0.021	0.113^{***}
	(0.012)	(0.011)	(0.017)	(0.027)
CT in (G-J)	-0.017	-0.004	-0.084^{**}	-0.300^{***}
	(0.027)	(0.025)	(0.039)	(0.048)
CT in (K-N)	0.014	0.062^{***}	0.076^{***}	-0.022
	(0.020)	(0.014)	(0.021)	(0.040)
CT in (O-U)	0.023	0.133^{***}	0.132^{***}	-0.276^{***}
	(0.022)	(0.020)	(0.024)	(0.044)
Information Technology penetration				
IT in (A)	-0.009	0.027^{***}	0.020^{**}	-0.088^{***}
	(0.011)	(0.008)	(0.010)	(0.019)
IT in (B-E)	0.015	0.062^{***}	0.121^{***}	-0.112^{**}
	(0.024)	(0.017)	(0.021)	(0.046)
IT in (F)	-0.003	-0.017^{**}	-0.073^{***}	-0.139^{***}
	(0.010)	(0.008)	(0.012)	(0.023)
IT in (G-J)	-0.005	-0.033	0.005	0.177^{***}
	(0.023)	(0.021)	(0.027)	(0.039)
IT in (K-N)	-0.002	-0.017	0.050^{*}	0.184^{***}
	(0.020)	(0.015)	(0.028)	(0.035)
IT in (O-U)	-0.038	-0.122^{***}	-0.179^{***}	0.203^{***}
	(0.025)	(0.022)	(0.029)	(0.045)
Software-Database penetration				
SDB in (A)	-0.019^{***}	-0.033^{***}	-0.039^{***}	-0.057^{***}
	(0.007)	(0.006)	(0.008)	(0.013)
SDB in (B-E)	-0.009	0.000	0.021	0.139^{***}
	(0.017)	(0.011)	(0.019)	(0.035)
SDB in (F)	0.006	0.082^{***}	0.089^{***}	0.038^{**}
	(0.009)	(0.007)	(0.010)	(0.017)
SDB in (G-J)	0.012	0.031^{*}	0.069^{***}	0.119^{***}
	(0.017)	(0.017)	(0.026)	(0.034)
SDB in (K-N)	-0.015	-0.080^{***}	-0.193^{***}	-0.222^{***}
	(0.020)	(0.016)	(0.029)	(0.043)
SDB in (O-U)	0.022	0.007	0.029	0.063^{*}
	(0.018)	(0.018)	(0.027)	(0.038)
Imports	-0.049^{***}	-0.038^{***}	-0.030	-0.117^{***}
	(0.013)	(0.012)	(0.019)	(0.022)
Cons. Exp.	-0.172^{***}	-0.218^{***}	-0.184^{***}	-0.293^{***}
	(0.035)	(0.034)	(0.055)	(0.080)
R^2	0.128	0.445	0.647	0.833
Adj. R^2	0.070	0.400	0.607	0.797
Num. obs.	3373	2717	1898	1083

Notes: $^{***}p < 0.01$; $^{**}p < 0.05$; $^{*}p < 0.1$. Standard errors between parentheses. This table summarizes the coefficients from the estimated linear regressions of adjustments of the relative sectoral average wage per worker in Construction (F) to a 1% change in the sectoral penetration of robots, communication technology, information technology, and software & database, in Agriculture (A), Industry (B-E), Construction (F), Market Services (G-J), Financial & Business Services (K-N), and Non-Market Services (O-U). Controls variables include imports from China (in log-difference), real consumption index (in log-difference), and region and time fixed effects. Time horizons h range from 1 to 15 years and correspond to the window of the log-difference of variables in the regression.

Table OA.22: Relative sectoral average wage adjustment in Market Services (G-J) to sectoral technology penetration

	Linear regression - Dep. var.: Wage share (in log)			
	$(h = 1)$	$(h = 5)$	$(h = 10)$	$(h = 15)$
Intercept	−0.000	0.049***	0.038*	−0.014
	(0.007)	(0.016)	(0.023)	(0.044)
Robot penetration				
ROB in (B-E)	0.046***	0.045***	0.052***	0.073***
	(0.006)	(0.004)	(0.006)	(0.011)
ROB in (F)	−0.006***	−0.001	−0.006***	−0.009***
	(0.001)	(0.001)	(0.001)	(0.002)
ROB in (O-U)	−0.002	0.004**	0.010***	−0.008**
	(0.001)	(0.002)	(0.002)	(0.003)
Communication Technology penetration				
CT in (A)	−0.011**	−0.011***	−0.013***	0.005
	(0.005)	(0.003)	(0.004)	(0.009)
CT in (B-E)	−0.001	−0.019***	−0.022**	−0.003
	(0.008)	(0.007)	(0.009)	(0.020)
CT in (F)	−0.015***	−0.043***	−0.024***	0.027**
	(0.005)	(0.005)	(0.007)	(0.013)
CT in (G-J)	−0.016	0.077***	0.071***	−0.063***
	(0.012)	(0.011)	(0.015)	(0.023)
CT in (K-N)	−0.013	−0.008	−0.013*	−0.027
	(0.009)	(0.006)	(0.008)	(0.019)
CT in (O-U)	−0.006	−0.025***	−0.055***	−0.152***
	(0.010)	(0.009)	(0.010)	(0.021)
Information Technology penetration				
IT in (A)	0.008*	0.019***	0.011***	−0.007
	(0.005)	(0.003)	(0.004)	(0.009)
IT in (B-E)	−0.037***	−0.021***	−0.029***	−0.115***
	(0.011)	(0.008)	(0.008)	(0.022)
IT in (F)	0.006	0.032***	0.021***	−0.034***
	(0.004)	(0.004)	(0.005)	(0.011)
IT in (G-J)	0.034***	−0.009	−0.002	0.068***
	(0.010)	(0.009)	(0.011)	(0.019)
IT in (K-N)	−0.005	−0.045***	−0.029***	0.047***
	(0.009)	(0.007)	(0.011)	(0.017)
IT in (O-U)	0.031***	0.034***	0.037***	0.131***
	(0.011)	(0.010)	(0.012)	(0.022)
Software-Database penetration				
SDB in (A)	0.007**	−0.008***	0.003	−0.003
	(0.003)	(0.002)	(0.003)	(0.006)
SDB in (B-E)	−0.017**	−0.009*	0.003	0.044***
	(0.007)	(0.005)	(0.007)	(0.017)
SDB in (F)	0.015***	0.005	0.001	0.013
	(0.004)	(0.003)	(0.004)	(0.008)
SDB in (G-J)	−0.015*	−0.058***	−0.053***	−0.000
	(0.008)	(0.007)	(0.010)	(0.016)
SDB in (K-N)	0.014	0.040***	0.019*	−0.021
	(0.009)	(0.007)	(0.011)	(0.021)
SDB in (O-U)	−0.025***	−0.027***	−0.017	0.017
	(0.008)	(0.008)	(0.011)	(0.018)
Imports	−0.008	−0.022***	−0.010	−0.070***
	(0.006)	(0.005)	(0.008)	(0.011)
Cons. Exp.	−0.068***	−0.007	−0.074***	0.147***
	(0.016)	(0.015)	(0.022)	(0.039)
R^2	0.155	0.494	0.757	0.838
Adj. R^2	0.099	0.453	0.728	0.803
Num. obs.	3373	2717	1898	1083

Notes: $^{***}p < 0.01$; $^{**}p < 0.05$; $^{*}p < 0.1$. Standard errors between parentheses. This table summarizes the coefficients from the estimated linear regressions of adjustments of the relative sectoral average wage per worker in Market Services (G-J) to a 1% change in the sectoral penetration of robots, communication technology, information technology, and software & database, in Agriculture (A), Industry (B-E), Construction (F), Market Services (G-J), Financial & Business Services (K-N), and Non-Market Services (O-U). Controls variables include imports from China (in log-difference), real consumption index (in log-difference), and region and time fixed effects. Time horizons h range from 1 to 15 years and correspond to the window of the log-difference of variables in the regression.

Table OA.23: Relative sectoral average wage adjustment in Fin. & Bus. Services (K-N) to sectoral technology penetration

	Linear regression - Dep. var.: Wage share (in log)			
	$(h = 1)$	$(h = 5)$	$(h = 10)$	$(h = 15)$
Intercept	−0.005	−0.140***	−0.075*	0.114
	(0.012)	(0.028)	(0.041)	(0.076)
Robot penetration				
ROB in (B-E)	0.050***	0.026***	0.049***	−0.001
	(0.011)	(0.008)	(0.010)	(0.019)
ROB in (F)	−0.001	−0.004*	0.001	−0.002
	(0.002)	(0.002)	(0.003)	(0.003)
ROB in (O-U)	−0.007***	0.003	−0.005	0.008
	(0.003)	(0.003)	(0.004)	(0.005)
Communication Technology penetration				
CT in (A)	−0.001	−0.004	0.003	−0.071***
	(0.008)	(0.006)	(0.007)	(0.016)
CT in (B-E)	−0.020	−0.060***	−0.054***	−0.080**
	(0.014)	(0.013)	(0.017)	(0.035)
CT in (F)	−0.018*	−0.035***	−0.074***	0.011
	(0.009)	(0.009)	(0.012)	(0.023)
CT in (G-J)	−0.022	−0.022	0.055**	0.189***
	(0.020)	(0.019)	(0.028)	(0.040)
CT in (K-N)	−0.020	−0.012	−0.002	−0.075**
	(0.015)	(0.011)	(0.015)	(0.034)
CT in (O-U)	−0.006	−0.012	−0.089***	−0.126***
	(0.017)	(0.016)	(0.017)	(0.036)
Information Technology penetration				
IT in (A)	−0.017**	−0.001	0.011	0.049***
	(0.008)	(0.006)	(0.007)	(0.016)
IT in (B-E)	−0.001	0.042***	0.018	0.164***
	(0.018)	(0.014)	(0.015)	(0.039)
IT in (F)	−0.007	−0.016**	0.009	−0.035*
	(0.008)	(0.006)	(0.009)	(0.019)
IT in (G-J)	0.037**	−0.018	−0.140***	−0.167***
	(0.018)	(0.017)	(0.019)	(0.033)
IT in (K-N)	0.027*	0.104***	0.025	0.152***
	(0.015)	(0.012)	(0.020)	(0.029)
IT in (O-U)	0.046**	0.031*	0.176***	0.030
	(0.019)	(0.017)	(0.021)	(0.037)
Software-Database penetration				
SDB in (A)	0.015***	0.018***	0.004	0.024**
	(0.005)	(0.004)	(0.006)	(0.011)
SDB in (B-E)	−0.028**	−0.013	−0.021	−0.064**
	(0.013)	(0.008)	(0.013)	(0.029)
SDB in (F)	0.026***	0.053***	0.071***	0.041***
	(0.007)	(0.006)	(0.007)	(0.014)
SDB in (G-J)	−0.017	0.037***	0.094***	−0.014
	(0.013)	(0.013)	(0.019)	(0.028)
SDB in (K-N)	−0.016	−0.111***	−0.043**	−0.104***
	(0.015)	(0.013)	(0.021)	(0.036)
SDB in (O-U)	−0.038***	−0.040***	−0.087***	0.073**
	(0.014)	(0.014)	(0.019)	(0.031)
Imports	−0.009	−0.034***	−0.031**	−0.056***
	(0.010)	(0.009)	(0.014)	(0.018)
Cons. Exp.	−0.034	−0.174***	−0.194***	−0.408***
	(0.027)	(0.026)	(0.039)	(0.067)
R^2	0.120	0.503	0.750	0.877
Adj. R^2	0.062	0.463	0.721	0.850
Num. obs.	3373	2717	1898	1083

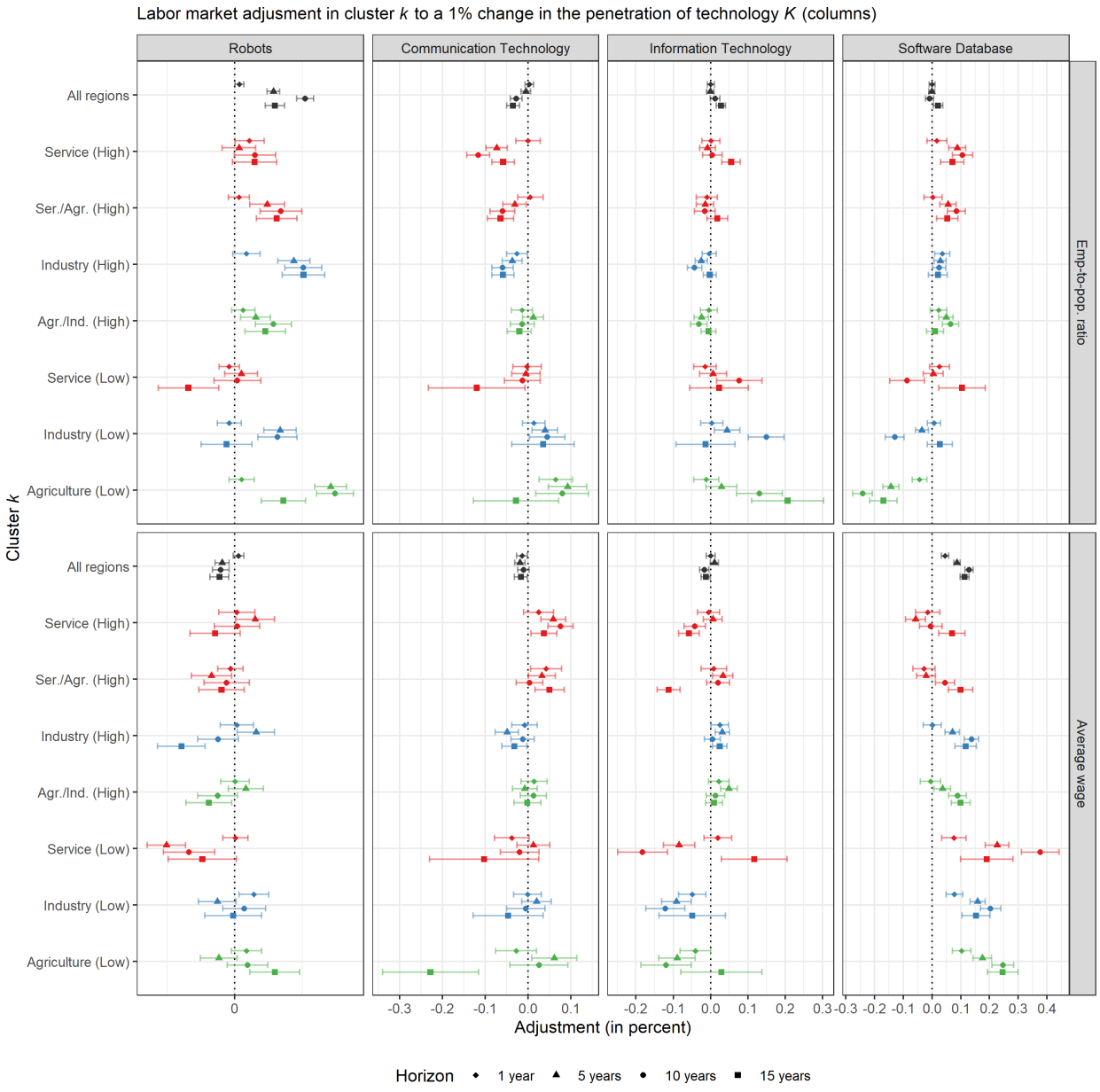
Notes: $^{***}p < 0.01$; $^{**}p < 0.05$; $^{*}p < 0.1$. Standard errors between parentheses. This table summarizes the coefficients from the estimated linear regressions of adjustments of the relative sectoral average wageper worker in Financial & Business Services (K-N) to a 1% change in the sectoral penetration of robots, communication technology, information technology, and software & database, in Agriculture (A), Industry (B-E), Construction (F), Market Services (G-J), Financial & Business Services (K-N), and Non-Market Services (O-U). Controls variables include imports from China (in log-difference), real consumption index (in log-difference), and region and time fixed effects. Time horizons h range from 1 to 15 years and correspond to the window of the log-difference of variables in the regression.

Table OA.24: Relative sectoral average wage adjustment in Non-Market Services (O-U) to sectoral technology penetration

	Linear regression - Dep. var.: Wage share (in log)			
	$(h = 1)$	$(h = 5)$	$(h = 10)$	$(h = 15)$
Intercept	−0.008	−0.063***	−0.166***	−0.299***
	(0.007)	(0.016)	(0.024)	(0.041)
Robot penetration				
ROB in (B-E)	−0.019***	0.008*	0.000	0.026**
	(0.006)	(0.004)	(0.006)	(0.010)
ROB in (F)	0.003***	0.000	0.002	0.009***
	(0.001)	(0.001)	(0.002)	(0.002)
ROB in (O-U)	−0.001	−0.010***	−0.014***	0.000
	(0.001)	(0.002)	(0.002)	(0.003)
Communication Technology penetration				
CT in (A)	0.008	0.020***	0.010**	0.003
	(0.005)	(0.003)	(0.004)	(0.009)
CT in (B-E)	0.014*	0.028***	0.075***	0.054***
	(0.008)	(0.007)	(0.010)	(0.019)
CT in (F)	0.017***	−0.004	−0.019***	−0.078***
	(0.005)	(0.005)	(0.007)	(0.012)
CT in (G-J)	−0.029**	−0.069***	−0.081***	−0.054**
	(0.012)	(0.011)	(0.016)	(0.022)
CT in (K-N)	−0.003	−0.003	−0.005	0.047**
	(0.009)	(0.006)	(0.009)	(0.018)
CT in (O-U)	−0.000	0.024***	0.030***	0.176***
	(0.009)	(0.009)	(0.010)	(0.020)
Information Technology penetration				
IT in (A)	−0.012**	−0.005	−0.009**	0.007
	(0.005)	(0.003)	(0.004)	(0.009)
IT in (B-E)	0.002	−0.032***	−0.025***	−0.078***
	(0.010)	(0.008)	(0.009)	(0.021)
IT in (F)	−0.010**	0.005	0.020***	0.036***
	(0.004)	(0.004)	(0.005)	(0.010)
IT in (G-J)	0.037***	0.051***	0.075***	0.028
	(0.010)	(0.009)	(0.011)	(0.018)
IT in (K-N)	−0.002	0.029***	−0.047***	−0.049***
	(0.009)	(0.007)	(0.012)	(0.016)
IT in (O-U)	−0.017	−0.063***	−0.041***	−0.120***
	(0.011)	(0.010)	(0.012)	(0.020)
Software-Database penetration				
SDB in (A)	0.004	−0.020***	0.005	−0.012**
	(0.003)	(0.003)	(0.003)	(0.006)
SDB in (B-E)	−0.002	−0.008	−0.047***	−0.008
	(0.007)	(0.005)	(0.008)	(0.016)
SDB in (F)	−0.012***	−0.012***	−0.015***	0.029***
	(0.004)	(0.003)	(0.004)	(0.008)
SDB in (G-J)	−0.009	0.010	0.001	0.022
	(0.007)	(0.008)	(0.011)	(0.015)
SDB in (K-N)	−0.004	−0.037***	0.053***	−0.008
	(0.009)	(0.007)	(0.012)	(0.020)
SDB in (O-U)	0.020**	0.050***	0.038***	−0.037**
	(0.008)	(0.008)	(0.011)	(0.017)
Imports	0.001	−0.017***	0.005	0.019*
	(0.005)	(0.005)	(0.008)	(0.010)
Cons. Exp.	0.064***	0.071***	0.008	0.085**
	(0.015)	(0.015)	(0.023)	(0.036)
R^2	0.153	0.389	0.653	0.834
Adj. R^2	0.098	0.340	0.612	0.798
Num. obs.	3373	2717	1898	1083

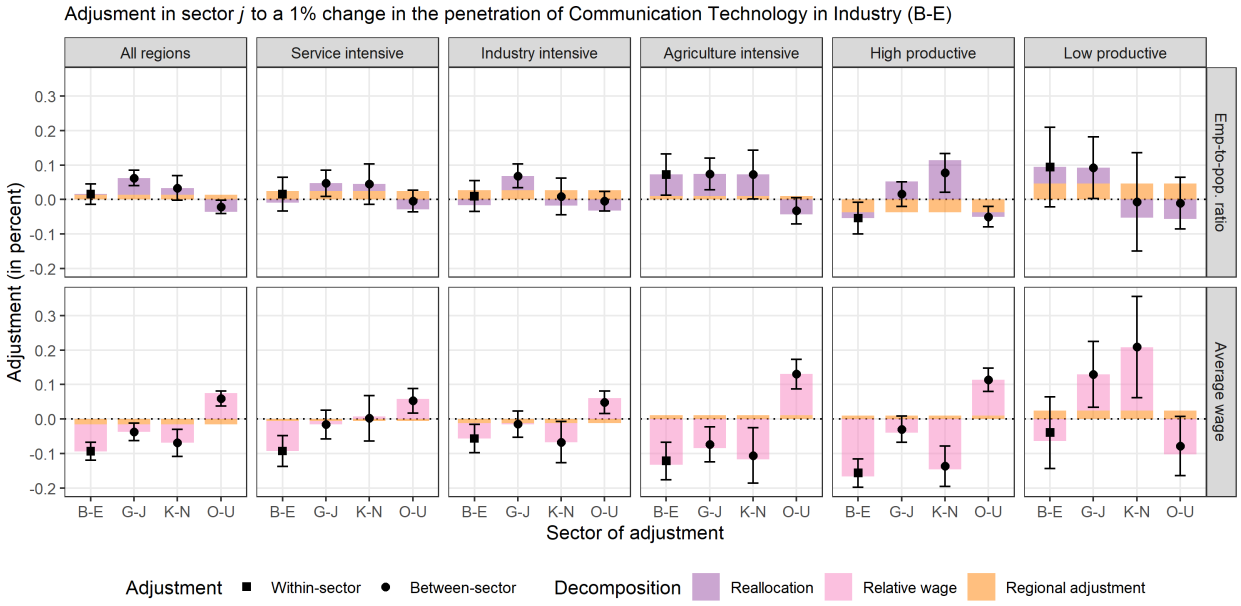
Notes: $^{***}p < 0.01$; $^{**}p < 0.05$; $^{*}p < 0.1$. Standard errors between parentheses. This table summarizes the coefficients from the estimated linear regressions of adjustments of the relative sectoral average wage per worker in Non-Market Services (O-U) to a 1% change in the sectoral penetration of robots, communication technology, information technology, and software & database, in Agriculture (A), Industry (B-E), Construction (F), Market Services (G-J), Financial & Business Services (K-N), and Non-Market Services (O-U). Controls variables include imports from China (in log-difference), real consumption index (in log-difference), and region and time fixed effects. Time horizons h range from 1 to 15 years and correspond to the window of the log-difference of variables in the regression.

Figure OA.7: Heterogeneity in regional adjustments to technology penetration



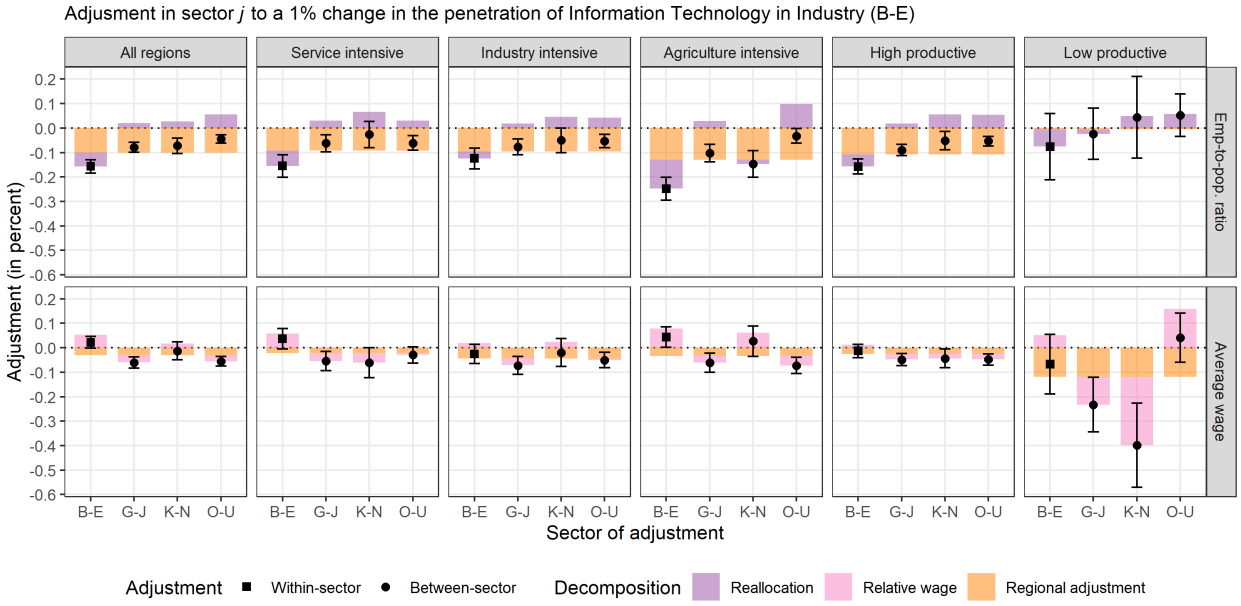
Notes: This figure presents the adjustments at the regional level of employment and the average wage to a 1% change in the regional penetration of robots, communication technology, information technology, and software & database, according to the cluster in which the region belongs. Clusters are (from top to bottom): Service intensive regions (with High productivity), Service/Agriculture intensive regions (with High productivity), Industry intensive regions (with High productivity), Agriculture/Industry intensive regions (with High productivity), Service intensive regions (with Low productivity), Industry intensive regions (with Low productivity), and Agriculture intensive regions (with Low productivity). Clusters are obtained with K-means. The set of clustering variables contains the employment shares in agriculture, industry, and service standardized at the country level and the labor productivity, expressed in gross value added per worker, standardized over the entire sample. The x-axis corresponds to the adjustment (in percent) and the y-axis corresponds to the cluster. Column panels refer to technologies. The coefficients are reported with a 95% confidence interval. The coefficients can be interpreted as elasticities and are obtained using linear regressions with variables in log difference along with region and time fixed effects. Time horizons range from 1 to 15 years and correspond to the window of the log-change of variables in the regression.

Figure OA.8: Decomposition of the sectoral adjustments to the penetration of communication technology in Industry (B-E) by clusters



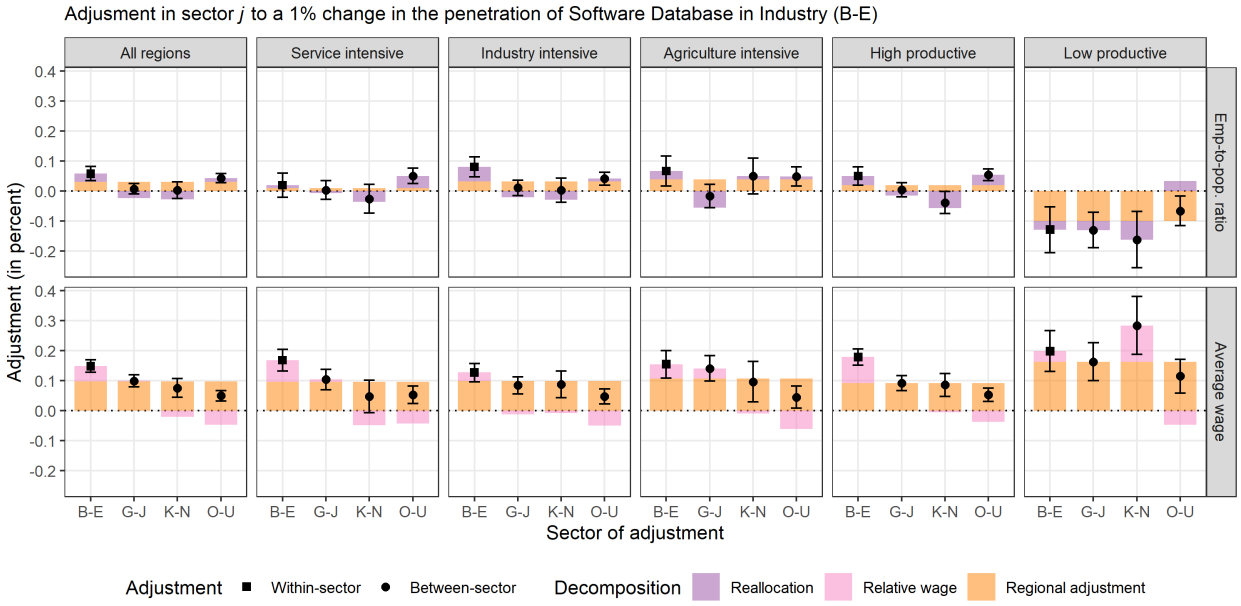
Notes: This figure presents the decomposition of sectoral adjustments of the employment-to-population ratio and average wage in Industry (B-E), Market Services (G-J), Financial & Business Services (K-N), and Non-Market Services (O-U), to a 1% change in the penetration of communication technology in Industry (B-E) according to the initial sectoral composition and the initial level of productivity of the region. The time horizon is 10 year and corresponds to the window of the log-change of variables in the regression. The x-axis corresponds to the sector of penetration and the y-axis corresponds to the adjustment (in percent). Column panels refer to the technology and row panels to the adjusted variable. Coefficients are reported with a 95% confidence interval and can be interpreted as elasticities since they are obtained using linear regressions with variables in log difference. Controls variables include imports from China (in log-change), real consumption expenditure (in log-change), and region and cluster-specific time fixed effects.

Figure OA.9: Decomposition of the sectoral adjustments to the penetration of information technology in Industry (B-E) by clusters



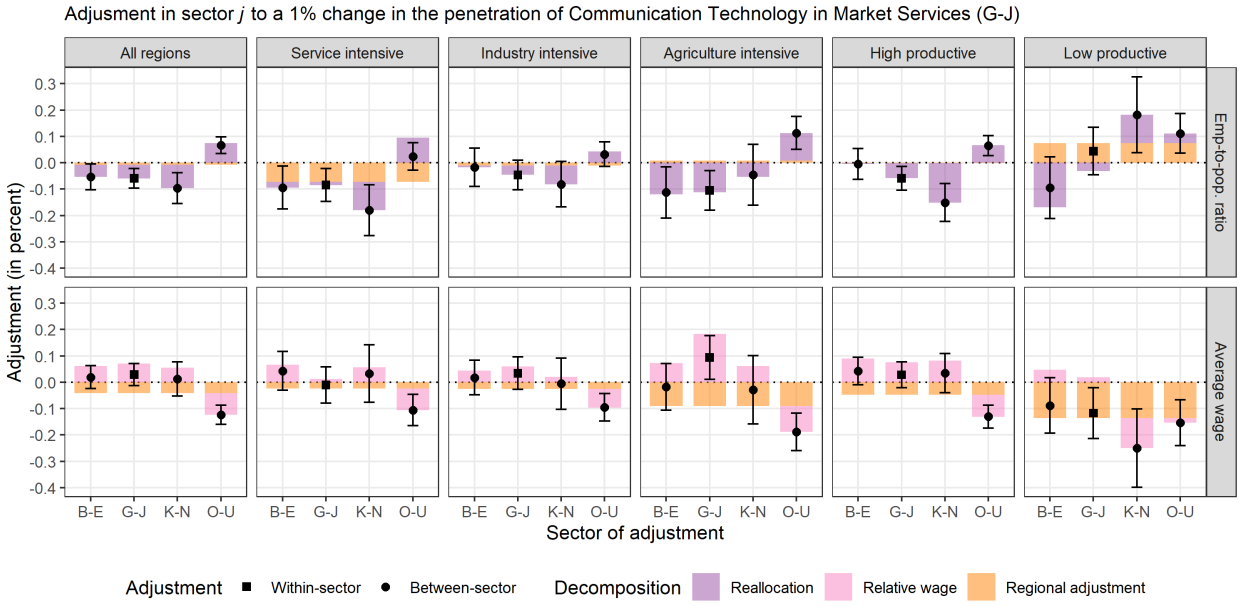
Notes: This figure presents the decomposition of sectoral adjustments of the employment-to-population ratio and average wage in Industry (B-E), Market Services (G-J), Financial & Business Services (K-N), and Non-Market Services (O-U), to a 1% change in the penetration of information technology in Industry (B-E) according to the initial sectoral composition and the initial level of productivity of the region. The time horizon is 10 year and corresponds to the window of the log-change of variables in the regression. The x-axis corresponds to the sector of penetration and the y-axis corresponds to the adjustment (in percent). Column panels refer to the technology and row panels to the adjusted variable. Coefficients are reported with a 95% confidence interval and can be interpreted as elasticities since they are obtained using linear regressions with variables in log difference. Controls variables include imports from China (in log-change), real consumption expenditure (in log-change), and region and cluster-specific time fixed effects.

Figure OA.10: Decomposition of the sectoral adjustments to the penetration of software & database in Industry (B-E) by clusters



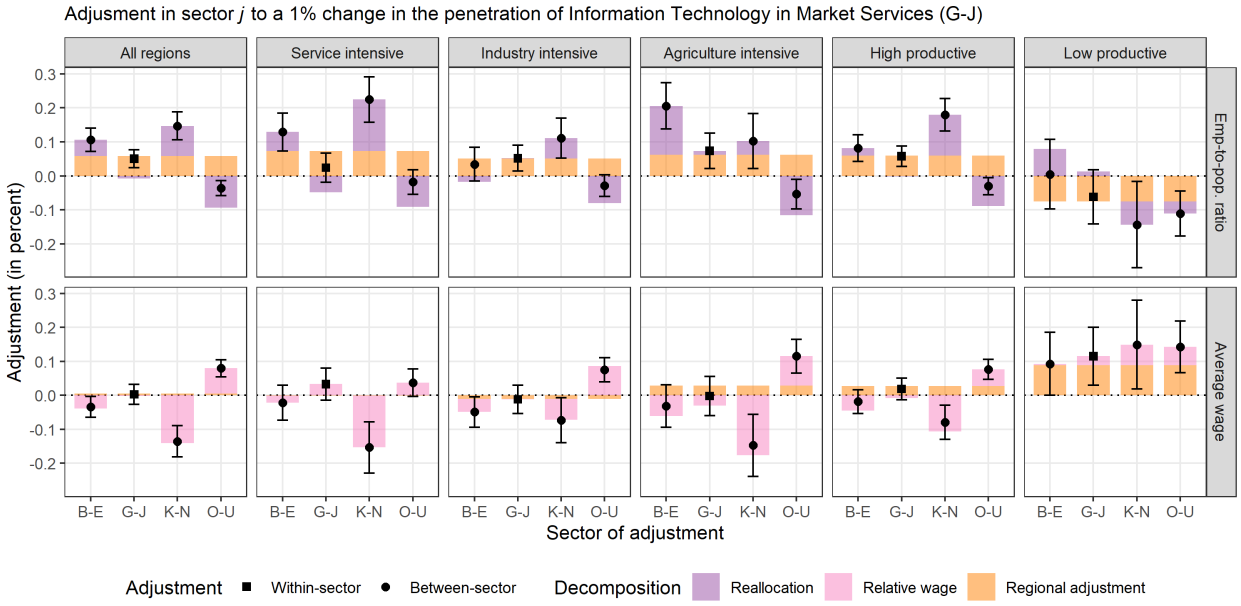
Notes: This figure presents the decomposition of sectoral adjustments of the employment-to-population ratio and average wage in Industry (B-E), Market Services (G-J), Financial & Business Services (K-N), and Non-Market Services (O-U), to a 1% change in the penetration of software & database in Industry (B-E) according to the initial sectoral composition and the initial level of productivity of the region. The time horizon is 10 year and corresponds to the window of the log-change of variables in the regression. The x-axis corresponds to the sector of penetration and the y-axis corresponds to the adjustment (in percent). Column panels refer to the technology and row panels to the adjusted variable. Coefficients are reported with a 95% confidence interval and can be interpreted as elasticities since they are obtained using linear regressions with variables in log difference. Controls variables include imports from China (in log-change), real consumption expenditure (in log-change), and region and cluster-specific time fixed effects.

Figure OA.11: Decomposition of the sectoral adjustments to the penetration of communication technology in Market Services (G-J) by clusters



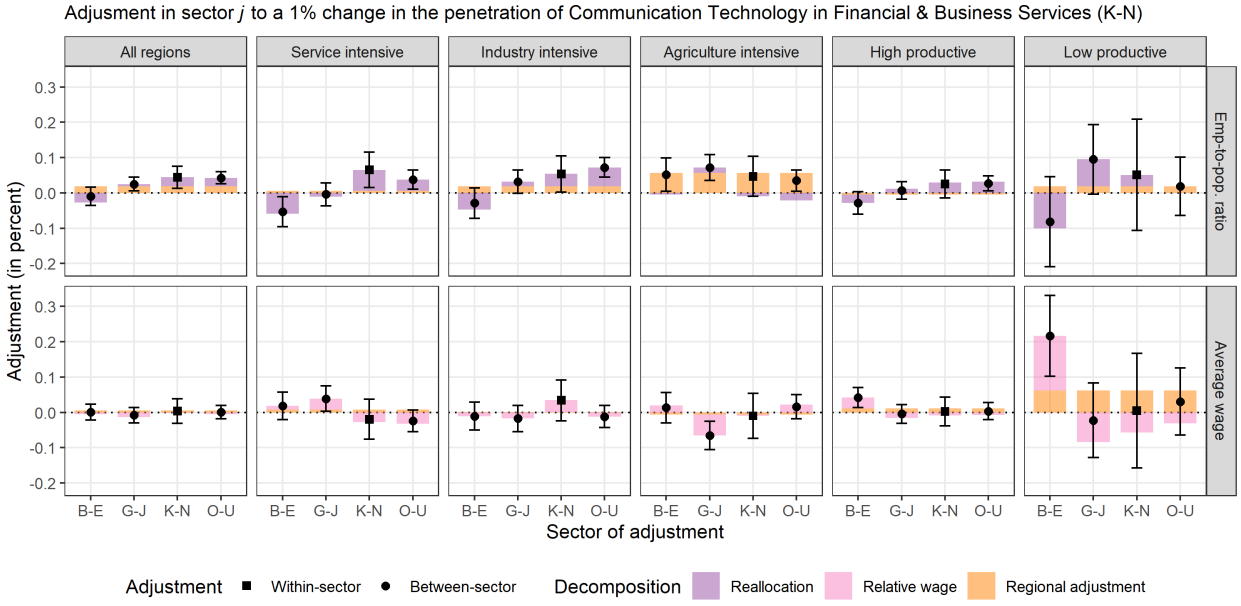
Notes: This figure presents the decomposition of sectoral adjustments of the employment-to-population ratio and average wage in Industry (B-E), Market Services (G-J), Financial & Business Services (K-N), and Non-Market Services (O-U), to a 1% change in the penetration of communication technology in Market Services (G-J) according to the initial sectoral composition and the initial level of productivity of the region. The time horizon is 10 year and corresponds to the window of the log-change of variables in the regression. The x-axis corresponds to the sector of penetration and the y-axis corresponds to the adjustment (in percent). Column panels refer to the technology and row panels to the adjusted variable. Coefficients are reported with a 95% confidence interval and can be interpreted as elasticities since they are obtained using linear regressions with variables in log difference. Controls variables include imports from China (in log-change), real consumption expenditure (in log-change), and region and cluster-specific time fixed effects.

Figure OA.12: Decomposition of the sectoral adjustments to the penetration of information technology in Market Services (G-J) by clusters



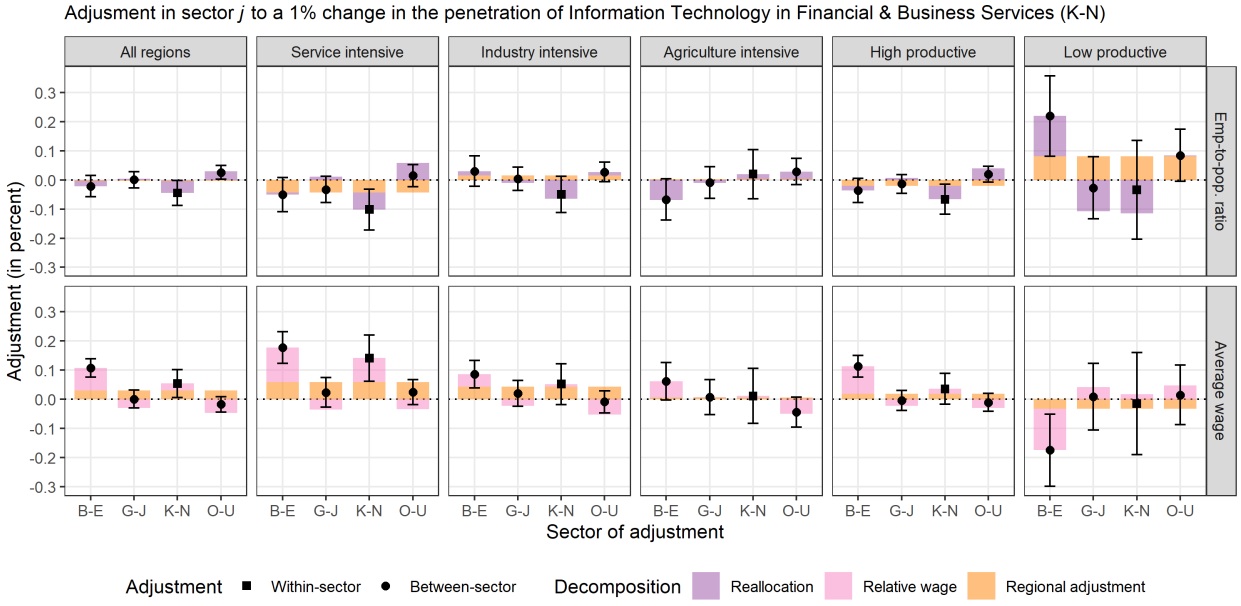
Notes: This figure presents the decomposition of sectoral adjustments of the employment-to-population ratio and average wage in Industry (B-E), Market Services (G-J), Financial & Business Services (K-N), and Non-Market Services (O-U), to a 1% change in the penetration of information technology in Market Services (G-J) according to the initial sectoral composition and the initial level of productivity of the region. The time horizon is 10 year and corresponds to the window of the log-change of variables in the regression. The x-axis corresponds to the sector of penetration and the y-axis corresponds to the adjustment (in percent). Column panels refer to the technology and row panels to the adjusted variable. Coefficients are reported with a 95% confidence interval and can be interpreted as elasticities since they are obtained using linear regressions with variables in log difference. Controls variables include imports from China (in log-change), real consumption expenditure (in log-change), and region and cluster-specific time fixed effects.

Figure OA.13: Decomposition of the sectoral adjustments to the penetration of communication technology in Financial & Business Services (K-N) by clusters



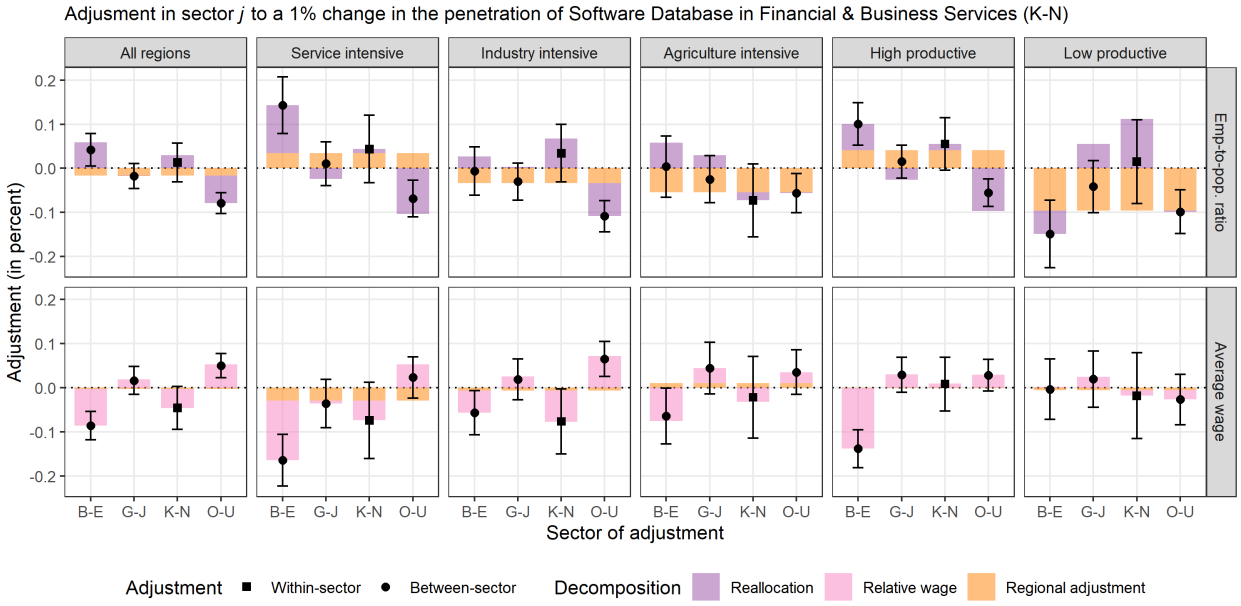
Notes: This figure presents the decomposition of sectoral adjustments of the employment-to-population ratio and average wage in Industry (B-E), Market Services (G-J), Financial & Business Services (K-N), and Non-Market Services (O-U), to a 1% change in the penetration of communication technology in Financial & Business Services (K-N) according to the initial sectoral composition and the initial level of productivity of the region. The time horizon is 10 year and corresponds to the window of the log-change of variables in the regression. The x-axis corresponds to the sector of penetration and the y-axis corresponds to the adjustment (in percent). Column panels refer to the technology and row panels to the adjusted variable. Coefficients are reported with a 95% confidence interval and can be interpreted as elasticities since they are obtained using linear regressions with variables in log difference. Controls variables include imports from China (in log-change), real consumption expenditure (in log-change), and region and cluster-specific time fixed effects.

Figure OA.14: Decomposition of the sectoral adjustments to the penetration of information technology in Financial & Business Services (K-N) by clusters



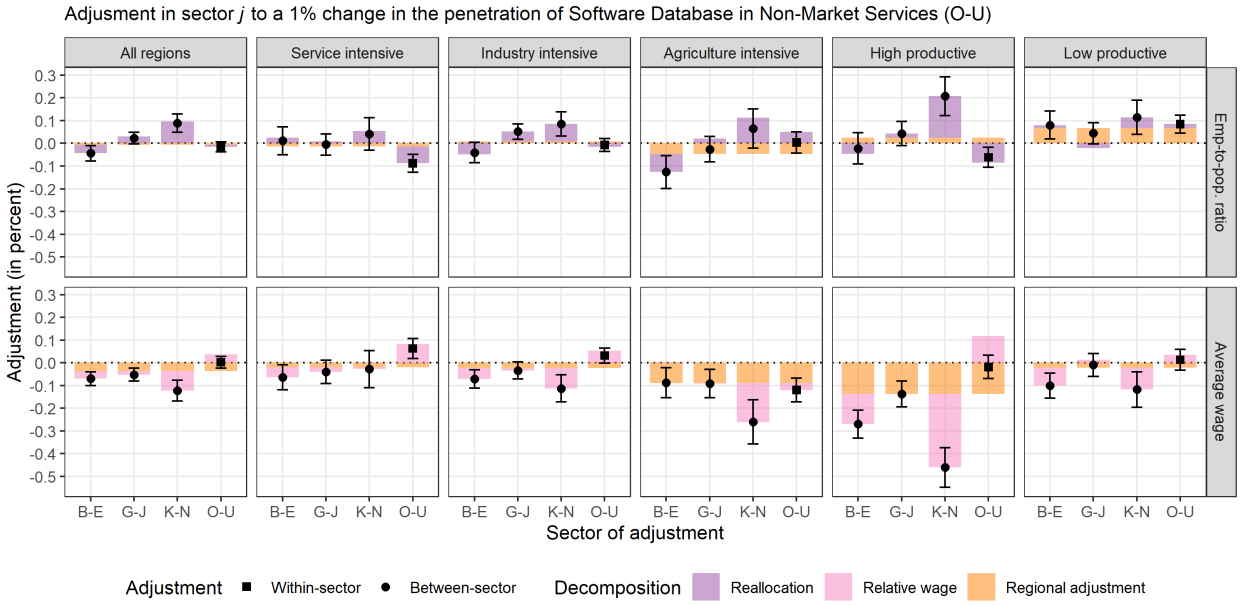
Notes: This figure presents the decomposition of sectoral adjustments of the employment-to-population ratio and average wage in Industry (B-E), Market Services (G-J), Financial & Business Services (K-N), and Non-Market Services (O-U), to a 1% change in the penetration of information technology in Financial & Business Services (K-N) according to the initial sectoral composition and the initial level of productivity of the region. The time horizon is 10 year and corresponds to the window of the log-change of variables in the regression. The x-axis corresponds to the sector of penetration and the y-axis corresponds to the adjustment (in percent). Column panels refer to the technology and row panels to the adjusted variable. Coefficients are reported with a 95% confidence interval and can be interpreted as elasticities since they are obtained using linear regressions with variables in log difference. Controls variables include imports from China (in log-change), real consumption expenditure (in log-change), and region and cluster-specific time fixed effects.

Figure OA.15: Decomposition of the sectoral adjustments to the penetration of software & database in Financial & Business Services (K-N) by clusters



Notes: This figure presents the decomposition of sectoral adjustments of the employment-to-population ratio and average wage in Industry (B-E), Market Services (G-J), Financial & Business Services (K-N), and Non-Market Services (O-U), to a 1% change in the penetration of software & database in Financial & Business Services (K-N) according to the initial sectoral composition and the initial level of productivity of the region. The time horizon is 10 year and corresponds to the window of the log-change of variables in the regression. The x-axis corresponds to the sector of penetration and the y-axis corresponds to the adjustment (in percent). Column panels refer to the technology and row panels to the adjusted variable. Coefficients are reported with a 95% confidence interval and can be interpreted as elasticities since they are obtained using linear regressions with variables in log difference. Controls variables include imports from China (in log-change), real consumption expenditure (in log-change), and region and cluster-specific time fixed effects.

Figure OA.16: Decomposition of the sectoral adjustments to the penetration of software & database in Non-Market Services (O-U) by clusters



Notes: This figure presents the decomposition of sectoral adjustments of the employment-to-population ratio and average wage in Industry (B-E), Market Services (G-J), Financial & Business Services (K-N), and Non-Market Services (O-U), to a 1% change in the penetration of software & database in Non-Market Services (O-U) according to the initial sectoral composition and the initial level of productivity of the region. The time horizon is 10 year and corresponds to the window of the log-change of variables in the regression. The x-axis corresponds to the sector of penetration and the y-axis corresponds to the adjustment (in percent). Column panels refer to the technology and row panels to the adjusted variable. Coefficients are reported with a 95% confidence interval and can be interpreted as elasticities since they are obtained using linear regressions with variables in log difference. Controls variables include imports from China (in log-change), real consumption expenditure (in log-change), and region and cluster-specific time fixed effects.