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Abstract

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

JEL-Codes: J210, O330, R230.

Keywords: automation technology, labor market, employment reallocation, sectoral composition.

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1 Introduction

Technologies displace workers by automating parts of their tasks, but they also raise productivity and stimulate economic activity. Determining which of these effects predominates has become a focus of social sciences research as we enter a new era of automation with robots and Artificial Intelligence (AI). However, the literature provides mixed evidence and lacks consensus.[1] Policymakers are also concerned about how automation will change the labor markets in their areas.

Local labor markets can vary greatly and may respond differently to automation technologies. For example, more than half of workers in Stuttgart are employed in the industrial sector, while in Andalusia, this figure is less than a third. It may not be reasonable to expect the same labor market adjustments in these two regions when adopting industrial robots. Additionally, labor markets in European regions may differ not only in their sectoral compositions but also in their technological capabilities. For example, both Brussels and Athens are service-intensive capital cities, but they may have different levels of automation adoption.

This paper examines how automation technologies are associated with changes in employment and wages in 227 regions across 22 European countries from 1995 to 2017. We combine data from several sources to construct a measure of technology penetration at the regional and sectoral (within-region) levels. We document how regional labor markets adjust to the penetration of robots, Communication Technology (CT), Information Technology (IT), and software/database technologies. At the sectoral level, we decompose sectoral adjustments to the penetration of automation technologies for each sector. These adjustments are derived from the sum of two mechanisms: the regional productivity effect and the sectoral reallocation effect. The former captures the change in regional economic activity which follows technology penetration, and the latter accounts for the resulting worker reallocations across sectors. We group regions into clusters based on their sectoral composition and productivity levels prior to the period of analysis. We describe the differences between clusters in terms of regional labor market adjustments and worker reallocation across sectors. Our analysis consists of four steps.

First, we combine data from several sources to construct our measure of technology penetration. Our sample includes 227 NUTS-2 regions located in 22 European countries, during the period 1995–2017. The ARDECO database provides information on employment-to-population ratios and average wages at the regional and (within-region) sectoral levels. We

[1] See Acemoglu and Restrepo (2018) for a canonical task-based framework that includes directed technological change and Aghion et al. (2022) for a comprehensive review of the literature presenting opposing views on the impact of automation technologies on job creation or destruction.

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, CT, IT, and software/database.[2] We use the International Federation of Robotics (IFR) for data on robots and the EU-KLEMS database (Release 2019) for information on the other three technologies.[3]

To estimate regional penetration, we construct our measure of technology penetration at the (within-region) sectoral level. Data on technology stocks are available at the country-sector level. We normalize technology stock at 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 using the regional share of gross fixed capital formation in the focal country and the focal sector. We estimate regional technology penetration as average penetration across sectors weighted by average sectoral composition of employment in the region between 1990 and 1994.

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

Third, we conduct our analysis at the sectoral level to enable a better understanding of the underlying changes within regions. We estimate the changes in employment (and the average wage) in one regional sector based on the changes in technology penetration in all the region's sectors. Thus, we allow for two types of effect on employment in each sector: direct, as the technology penetrates the same sector, that is the *within-sector* adjustment, and indirect, as the technology penetrates a different sector which may be associated to adjustments in the sector of interest, that is the *between-sector* adjustment.

We decompose the sectoral adjustments for each sector. These adjustments are due to combination of two mechanisms. First, the regional productivity effect captures the change

[2]Software acts as a proxy for AI penetration which is in line with Baruffaldi et al. (2020) who measure its incidence based on use of AI in open-source software. They show that AI software-related use has risen dramatically 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 data provide net capital stock (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. For data availability reasons, software and database are combined and considered as a unique technology.

in regional economic activity following the technology penetration, and second, the sectoral reallocation effect accounts for the reallocation of workers across sectors. We consider the change in the sectoral average wage relative to the regional average wage to determine whether reallocated workers are on average low-paid or high-paid workers.

Fourth, we cluster regions based on their characteristics to examine the heterogeneity in adjustments and worker reallocations. The structure of regional labor markets differs across European countries which would imply that their capacity to absorb external shocks also varies across regions with different industry compositions (Tóth et al. 2022). To account for these differences, we cluster the 227 regions using the K-means algorithm based on labor market characteristics before the period of analysis. We categorize regions based on two dimensions: sectoral composition of regional employment and regional level productivity. The first accounts for regional labor force specialization (agriculture, industry, services), and the second accounts for the differences in technology capabilities among European regions.

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

The analysis provides five main results. First, labor market adjustments to automation differ depending on the technology. Regional penetration of robots and IT is associated with increased employment, but a small decrease in wages. CT penetration is associated with a wage decline and software and database penetration is associated with higher wages.

Second, the type of technology also affects the timing of labor market adjustments. Adjustments to the penetration of IT and CT intensify gradually over time, that is, varying from small adjustments in the short run (5 years) to extensive long run (15 years) adjustments, whereas robots and software/database result in short-run sharp and large adjustments.

Third, labor market adjustments differ depending on the sector through which the automation technology penetrates. Adoption of robots in the industry sector seems to complement labor, and thus, is a driver of employment in the industry and other sectors. However, the overall positive relation between IT penetration and regional-level employment is driven

by market services, not by industry—where IT substitutes for workers. The large and positive association between software and database penetration and wages is driven by the industry sector while the non-significant relation with employment at the regional level is due to increased employment in industry and reduced employment in services that cancel out.

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

Fifth, between-region heterogeneity in labor market adjustments to penetration of automation technologies reflects sectoral specialization and technological capability differences among European regions. Robot penetration is associated with mostly positive employment changes in regional labor markets with the exception of service-intensive, low-productivity capital cities. In the case of the other three technologies, there is a clear divide between Southern and Eastern (low-productive) European regions and Northern and Western (high-productive) European regions. Although wages decrease, employment in Southern and Eastern regions benefits from regional penetration of IT and CT whereas in Northern and Western regions employment and wages benefit from penetration of software/database.

Our work is related to several literature strands. Prior work on the regional impact of automation technologies disagrees about 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). The findings from empirical studies differ in terms of which effect dominates. We use data on the penetration of four different automation technologies in a large number of regions, located in several European countries and provide new evidence on the reasons underlying heterogeneity in European labor market adjustments. We find that the differences in adjustments reflect the regional specialization and technological capabilities,[4] which highlights the divide in labor market adjustments to automation technologies between Southern and Eastern and Northern and Western European regions. Our findings show, also, that different automation technologies result in different adjustments and highlights that robots, which have attracted much research attention, are a subset of

[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 regional specificity that is related to technological capabilities.

automation technologies and do not represent the relationship with labor market dynamics for other technologies.

This paper contributes also to the methodological literature and work 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 exposure (i.e. penetration) using a shift-share design based on the structure of sectoral employment in the region prior to the period of analysis. This approach assumes that, in all regions, all firms in a given industry have the same propensity to adopt automation technologies. We contribute to this stream of work by constructing a measure that allows industries to differ in their technology adoption across regions and enables examination of the dynamics of employment and wages at the sectoral level within a region. However, our proposed measure has some limitations. Since we study employment adjustments in different sectors, we cannot employ the usual shift-share design which leverages the employment structure across sectors.

We contribute to the literature on ICT adoption and 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), much of which links adoption of ICT to employment polarization resulting from the complementarity between technology and skills. Studies in this stream of work suggest that ICT adoption shifts the demand for labor toward higher skilled workers and results in workers in intermediate-skilled jobs being displaced by these technologies. We add to this literature by disentangling the roles of IT and CT and showing that the sector through which these technologies penetrate matters. For instance, we find that penetration of CT in market services is associated with the displacement of less-skilled workers from that sector. However, the pattern in the industry sector is different.[5] The pattern of polarization observed in the industrial sector is related to penetration of IT which substitutes workers in that sector.

Finally, we contribute to the body of work 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). The disparities in both GDP and employment among European regions have increased since mid-2000 (Ehrlich and Overman 2020). Several studies link the growing inequalities across regions to different capacities to innovate and attract skilled labor (Lee and Rodriguez-Pose 2012,Iammarino et al. 2019, Boschma 2022). Differences in institutional quality also contribute to explaining

[5]Our findings for CT penetration are consistent with Akerman et al. (2015) who show that broadband internet worsens the labor market outcomes of unskilled workers due to their substitution for the performance of routine tasks.

the recent slowdown in labor productivity through the long-term returns to human capital and innovation (Rodriguez-Pose and Cataldo 2014, Rodríguez-Pose and Ganau 2021). We extend this literature by showing that divergences in adoption of automation technologies are related either to differences in sectoral composition when regional penetration occurs through services (i.e. agriculture-, industry-, or service-intensive regions) or to 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. Section 4 describes the sectoral adjustments and proposes a decomposition that accounts for worker reallocation among sectors. Section 5 describes our regional clusters based on sectoral composition and level of productivity and discusses the heterogeneity in adjustments and reallocation among clusters. Section 6 focuses on the regularities among across different technologies, industries, and regions. Section 7 concludes.

2 Data

2.1 Sample

Our sample includes 227 NUTS-2 regions from 22 European countries between 1995 and 2017.[6] We define sectors (of economic activity) based on the NACE Rev.2 classification sectors. In 2008, the NACE classification changed from Rev. 1.1 to Rev. 2, therefore, we aggregate the sections in order to to have consistent sectors; see appendix Table A.1 and A.2 for more details.

The aggregation results in the following six sectors: Agriculture (A) corresponding to activities related to agriculture, forestry, and fishing, Industry (B-E) corresponding to manufacturing, mining and quarrying, and utilities except Construction (F) which is a separate sector, Market Services (G-J) which includes service activities such as wholesale and retail trade, accommodation and food services, transportation and storage, and information and communication, Financial & Business Services (K-N) which corresponds to financial and insurance, real estate, and professional, scientific, technical, administration and support service activities, and Non-Market Services (O-U) which includes all other services such

[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.

as public administration and defense, education, human health and social work and 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 ARDECO data and are available at the NUTS-2 level.

The employment-to-population ratio, which corresponds to the total number of employed persons aged 15-64 (L) divided by the region's total population (N), is derived at both the regional and (within-region) sectoral levels, that is, 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, that is, respectively $W_r = C_r/L_r$ and $W_{ri} = C_{ri}/L_{ri}$.

Automation technology. We consider four different, but 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).

For data availability reasons, we consider Software (4a) and Database (4b) as a single technology.

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 of the six sectors: Industry (B-E), Construction (F) and Non-Market Services (O-U). About 30% of

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

We obtained the data to measure the stock of ICT from the EU-KLEMS database (Release 2019) which provides information on communication equipment (i.e. CT), computing equipment (i.e. IT), 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 based on net capital stock (at constant €2015 prices) which is derived from national accounts.[8]

Other variables. Gross Fixed Capital Formation (GFCF) data are from the ARDECO database which provides this information at the country-sector and region-sector levels. GFCF is defined as acquisitions of produced tangible and intangible assets 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 provided by the Inter-Country Input-Output database.[9] Technologies can generate economies of scale which translate into reduced prices which in turn stimulate product demand. Consequently, the increase in aggregate demand stimulates demand for labor (Bessen 2019).

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

In Section 5 we cluster regions, based on labor productivity levels. Therefore, we con-

[7]We follow the literature to allocate unclassified robots across the 3 sectors (see Acemoglu and Restrepo 2020). Although in some studies unclassified robots are not allocated (see Graetz and Michaels 2018, Dauth et al. 2021), we decided to include them to obtain a consistent measure after aggregating our measure of technology penetration across sectors. According to Jurkat et al. (2022), the share of unclassified robots has decreased sharply over time. Also, in some countries, data availability on robots by sector starts later. In these cases, we impute robot stocks backward by applying the average share of sectoral robots for the years where data on total stock are available (à la Graetz and Michaels 2018). Our results are robust to more complex imputation methods which account for the relative trend in robot stocks in each sector.

[8]For some countries, technology stocks are available at the regional but not the sectoral (within region) level. We calculated them by allocating regional-level technology stock to the sectors within that region using the sector share in regional gross fixed capital formation. This applies to five countries: Bulgaria, Hungary, Ireland, Poland, and Portugal. However, for six countries (i.e. Bulgaria, Estonia, Poland, Portugal, Slovakia, and Slovenia) technology stocks are available only since 2000.

[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.

struct a measure of labor productivity as the ratio of gross value added to total number of employed persons aged 15-64 in a given region.

2.3 Technology penetration

Prior work that computes technology penetration focuses on robots per worker. Although we extend the set of technologies to CT, IT and software/database, we compare our measure with this literature. The standard approach predicts the robot penetration in local labor markets, employing a shift-share design (see Acemoglu and Restrepo 2019, Aghion et al. 2019, Dauth et al. 2021). This approach allocates the change in robots based on regional industrial employment before the period of analysis. The underlying assumption is that regions more specialized in industries with higher levels of robot adoption at the national level will correspond to regions with the highest robot adoption rates.

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

Second, to study sectoral adjustments, we need to allocate automation technologies at the (within-region) sectoral level. At this level of analysis, the shift-share framework is not appropriate since it exploits the local sectoral structure to predict penetration at the regional level.

To overcome these limitations, we assume that firms in industry i are more likely to adopt automation technologies in regions with higher capital investment. We construct the share of GFCF share at the regional level as the ratio of regional sectoral GFCF to national sectoral GFCF.

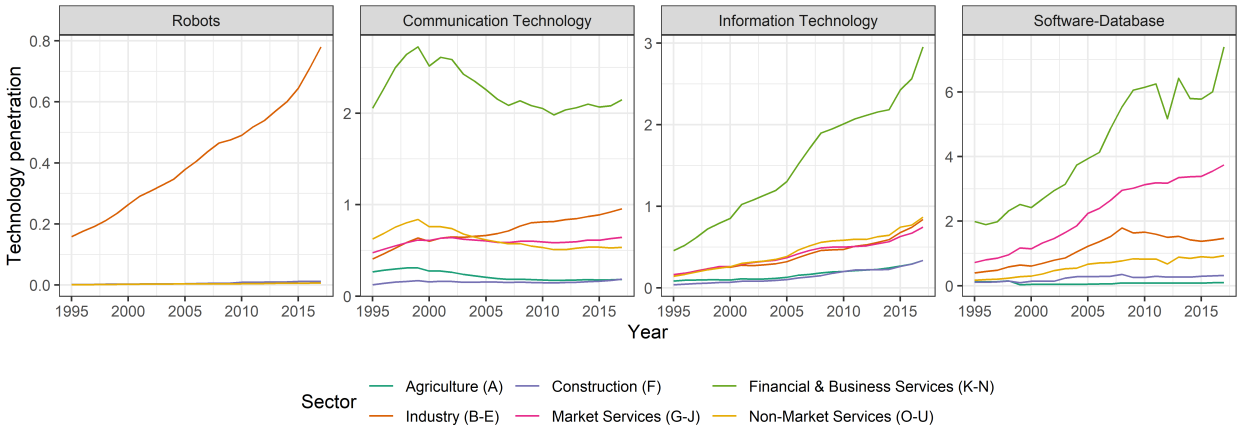
We define the penetration of technology K in sector i in region r in country c in year t as:

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

where $Tech_{cit}$ is the technology stock in sector i in the country c in the current year (as per Section 2.2), $\bar{L}_{ci}$ is the average level of employment in the sector in the country between 1990 and 1994,[11] and $GFCF_{rit}/GFCF_{cit}$ is the regional share of national GFCF in sector

[11] For 3 countries, employment data are not available for every year between 1990 and 1994: Czech Republic (from 1993), Germany (from 1991) and Poland (from 1992). For these countries, we use the average of the available years. For 4 countries, employment data are available only from 1995: Bulgaria, Hungary, Slovakia and Slovenia. For these countries, we use the level of employment in 1995.

Figure 1: Technology penetration by sectors



Notes: This figure presents the dynamics of 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), aggregated across regions. The x-axis is the year and the y-axis is the technology penetration. Column panels refer to technologies.

i.[12]

Figure 1 depicts average technology penetration by sector from 1995 to 2017 aggregated across regions. Industry (B-E) is the most robot-intensive sector, although there is some presence of robots in Construction (F) and Non-Market Services (G-J). The penetration of robots in Industry (B-E) increased almost fourfold between 1995 and 2017 and showed no signs of slow down after the financial crisis. CT varies across sectors. On average, penetration increased in Industry (B-E) across regions but decreased in Financial & Business Services (K-N) from year 2000 and remained relatively stable across the whole period in the other sectors. IT shows a different pattern from robots and CT. Penetration increased in all sectors, especially Financial & Business Services (K-N), showing some slow down for only a few years after the 2008 financial crisis. The pattern of penetration of software/database is similar to IT with a large increase in Financial and Business Services (K-N) and Market Services (G-J) and a slow down in Industry (B-E) after the 2008 financial crisis.

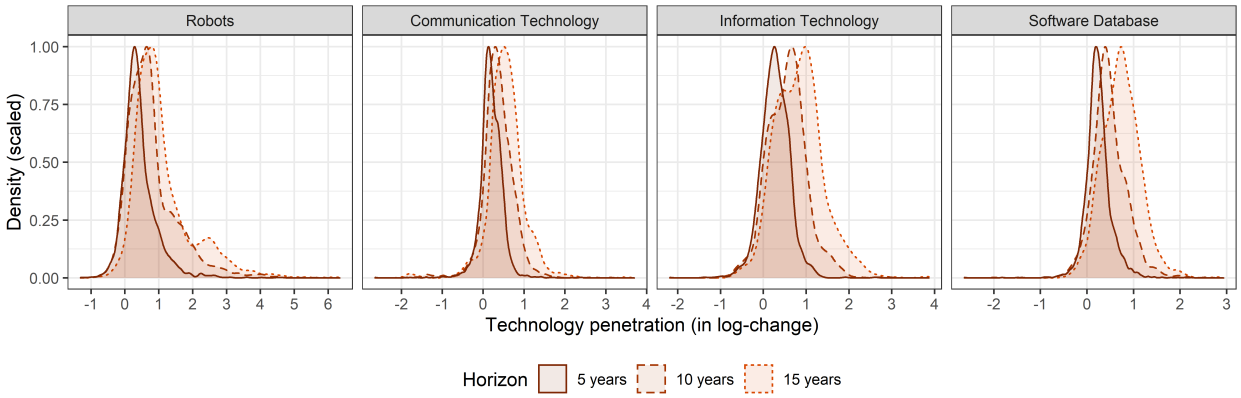
We follow the literature and define the regional penetration of technology K according to the differences across sectors. It is computed as the average penetration across sectors—from Equation (1)—weighted by the sectoral share of employment in the region before the period of analysis. Thus,

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

where $\bar{L}_{ri}$ is the average level of employment in sector i in region r between 1990 and 1994,

[12]We consider investment in digital automation technologies to be capital investment.

Figure 2: Distributions of changes in technology penetration



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

$\bar{L}_r$ 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). Appendix Table B.6 presents the summary statistics for regional-level technology penetration.

2.4 Technology penetration over time horizons

We measure the change in technology penetration between the years t and $t+h$ as:

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

where h is the horizon to the window of the change. Figure 2 depicts the change in technology penetration distributions at the regional level for 5, 10, and 15-year time horizons.

For all automation technologies, the change in technology penetration distribution 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. The robot distribution is more skewed which suggests low levels of penetration in almost all regions.

Table 1 presents the change in technology penetration at the regional level. The average region is predicted to experience a 294% growth in robot penetration over a 10-year horizon with a median growth rate of about 99%. This median growth rate indicates that penetration of robots doubled in more than half of the regions over a 10-year period. The median growth rates for CT, IT and software/database are respectively 47%, 81% and 61%. For all four technologies, we observe a widening of regional differences as the width of the distribution

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 summary statistics for rate of growth of penetration of robots, communication technology, information technology, and software/database, at the regional level for the 227 NUTS-2 regions and the 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.

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 regional labor market adjustments based on employment-to-population ratio and average wage associated to changes in the regional penetration of technologies over different time horizons:

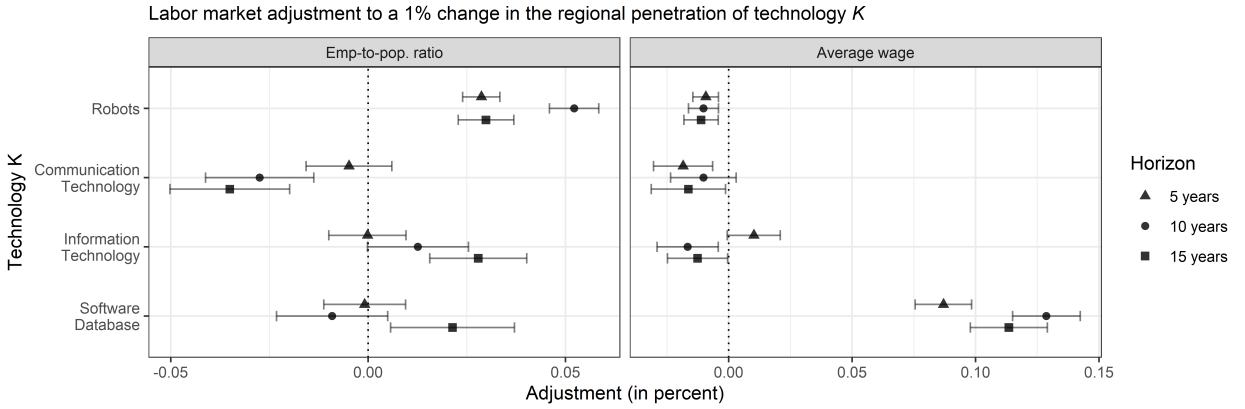
$$\Delta Y_{r,t+h} = \alpha_h + \sum_K \beta_h^K \Delta K_{r,t+h} + X\psi + u_{r,t+h}, \tag{3}$$

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—that is, the percentage change in the outcome variable Y associated to a 1% change in the penetration of technology K.

Figure 3 depicts the relationship between labor market outcomes and technology penetration at the regional level, based on the estimated β_h^K coefficients from Equation (3) at 95% confidence intervals. Although we estimate the relationship over all 1 to 15-year time horizons, we only report the results for the 5-year, 10-year and 15-year horizons which we consider respectively as the short run, medium run and long run.

Robot penetration at the regional level tends to be correlated with good employment prospects but a small although statistically significant and persistent decline in the average wage. For instance, over a 10-year horizon, which foresees the highest levels of employment,

Figure 3: Regional labor market adjustments to technology penetration



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

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 rate of growth of robot penetration in our sample is around 99% for the 10-year horizon. This indicates that robot penetration has (at least) doubled in 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.

Penetration of CT seems to have saved labor with employment levels declining with technology penetration in the medium to long run. Over the 10-year horizon, the employment-to-population ratio elasticity is about 0.027. For a region with the median CT penetration (47%), this corresponds to a decline of 1.3% in the regional employment-to-population ratio. However, in the case of this technology, wages move in the same direction as employment. Although we observe no significant change in the average wage over the 10-year horizon, the short and long-run horizons provide significantly negative although small estimates.

The adjustments to IT penetration are in a similar direction to those observed for robots, that is, an increase in employment and a decline in the average wage. However, IT shows some differences in the timing of adjustments and the magnitude of the coefficients. The effect on employment is greater for the 15-year horizon, while the effect on wages peaks at the 10-year horizon. In the medium run, the respective values for the employment-to-population ratio and average-wage elasticities are 0.013 and -0.017. For a region with 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%.

Penetration of software/database is associated with large changes in wages, but no major implications for employment in the short and medium run. In the medium run, average wage elasticity is about 0.087, 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 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 along two dimensions. First, the *direction of the adjustment* depends on the technology. On average, regional labor markets tend to benefit from software/database investments through an associated increase in wages. Robot and IT investments complement regional employment but bring about a small decrease in wages. CT has the most detrimental implications for employment with a moderate decline in wages. However, the different role of CT may depend on its overall decline associated with an increase in employment and wages.

Second, the *timing of the adjustment* depends, also, on the technology. Labor markets show gradual employment adjustments to the penetration of IT and CT over the short to long runs. Conversely, sharp and large adjustments (in terms of employment for robots and wages for software/database) emerge immediately for robots and software/database in the short run. These differences in the timing of adjustments may be due to different levels of technology maturity, potential application and labor force adaptation.

These above patterns provide an overview of the relationship between labor markets and technology penetration at the regional level. However, penetration of the technologies differs substantially across sectors (see Figure 1) and across regions with similar sectoral composition (see Section 5). For instance, robots tend to be used mostly in industry while IT, CT and software/database tend to be used mostly in the services sectors. However, these results are aggregated at the regional level and may conceal sector-specific patterns and inter-dependencies among sectors.

4 Sectoral adjustments and workers' reallocation between sectors

In this section, we analysis is at the (within-region) sectoral level to provide a better understanding of the different adjustments of employment and wages to different technologies. We proceed in two steps. First, we distinguish adjustments due to the penetration of automation technologies within the focal sector from adjustments due to penetration in other sectors in

the region. Second, we decompose these employment and wage adjustments into two effects: the *sectoral reallocation effect*, and the *regional adjustment effect*. In the rest of the paper, we focus on the 10-year horizon; the results for the other time horizons are provided 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 sector and the three service sectors—the results for Agriculture (A) and Construction (F) are provided in the online appendix.

4.1 Empirical specification

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

We estimate sectoral adjustments separately for the six sectors j:

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

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.

The 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—that is, the adjustment in sector j to a 1% increase in the penetration of technology K in that sector; while γ_{ji}^K corresponds to the *between*-sector adjustment—that is, the adjustment in sector j to a 1% 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*. In the case of the employment-to-population ratio, the *sectoral reallocation effect* captures the reallocation of employment from other sectors to sector i following the penetration of an automation technology K in sector j. In the case of the average wage, the *sectoral reallo-*

cation effect captures the relative change in wage i relative to the regional average. The *regional adjustment effect* corresponds to the regional adjustment to employment and wages that follows penetration of an automation technology K in sector j. This effect captures the adjustment 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 in Equation (4).

The decomposition for the average wage is similar. We consider the identity $W_{ri} \equiv w_{ri} \times W_r$, where W_{ri} is the average wage in sector i and $w_{ri} \equiv W_{ri}/W_r$ is the average wage in sector i relative to the average wage in the region. In what follows, we refer to this latter ratio as the relative wage in 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 in Equation (4).

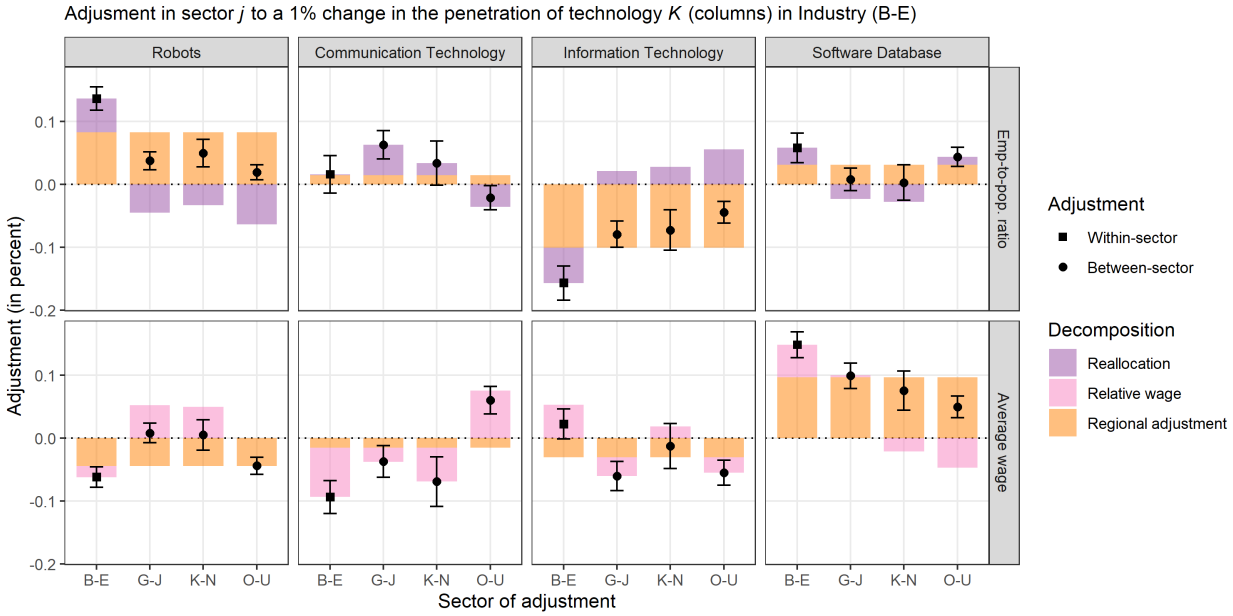
Since the average wage is defined as total compensation divided by employment, the change in the relative wage in sector i can be written as the difference between the change in the relative compensation in sector i and the change in the employment share, namely, $\Delta w_{ri} \equiv \Delta c_{ri} -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

4.3 Results

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

The decomposition distinguishes two effects. The regional adjustment effect captures the

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 10-year horizon corresponds to the window of the log-change of the variables in the regression. The x-axis represents the sector of adjustment and the y-axis represents the adjustment (as a percentage). 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 derived from 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. Appendix Tables D.2, D.4, and D.5 present the respective regressions for the regional employment-to-population ratio, the sectoral employment-to-population ratio and the sectoral employment share, from which the coefficients are derived. Appendix Tables D.3, D.6, and D.7 present the regressions for the regional average wage, the sectoral average wage, and the sectoral relative wage, from which the coefficients are derived.

overall effect of the technology penetration in the industry on regional employment or the regional average wage. The sectoral reallocation effect indicates how sectoral employment (or the average wage) changes relative to regional employment (or average wage). We present the results by technology.

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

In terms of employment in the industry sector, 61% of the increase is due to an increase in overall economic activity at the regional level, with the remaining 39% due to the reallocation of workers from the service sectors to industry. The increase in overall economic activity linked to industry investment in robots is associated with an increase in employment in all

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.

Industry sector wages follow the negative trend observed at the regional level (Figure 3) with 71% of the decline due to the absolute downward adjustment to wages in the region despite an overall increase in employment. There are two not mutually exclusive potential explanations for this 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 the vacancies they generate. The decline in the relative wage in industry seems to indicate that service workers who move to the industry sector are those at the bottom of the wage distribution. This would seem to be suggested by the increases in the relative wages in Market Services (G-J) and Financial & Business Services (K-N)—which do not experience an overall reduction in wages. However, this relative difference represents only 29% of the reduction in wages in the industry sector and, thus, explains only a small part of the decrease in regional wages.

The results for CT 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 observe a significant wage decline with an elasticity of -0.093. For a region with median change in CT penetration in industry (49%), this corresponds to a decline of 4.6% in the average industry wage.

Regional employment adjustments to CT are very small which suggests that CT penetration in industry does not complement robot penetration. The only discernible pattern is that related to the reallocation of workers from Non-Market Services (O-U) to Market Services (G-J) which follows penetration of CT in the industrial sector. This might be related to outsourcing of communication activities from industry to specialized service providers in industry J (information and communication).

In the industrial sector, 83% of the decline in wages is due to the fall in the sectoral wage relative to the regional wage. Since there is no reallocation from or to industry, the decline in wages supports the hypothesis that a part of the communication activities is outsourced. Outsourcing does not change employment locally but it puts downward pressure on wages in the sector. The decline in the relative wage in Market Services (G-J) and the rise in the relative wage in Non-Market Services (O-U) suggests that the downward pressure is the result of low-paid workers in the public sector being reallocated to the private sector.

The results for IT are reported in the third-column panels. On average, in the industry sector, IT increases at similar rates to robots and is associated to symmetrical sectoral adjustments. Employment elasticity of IT is -0.157 while average wage elasticity is 0.022,

but not significant. For a region with median change in IT penetration in industry (80%), this corresponds to a decline in industry employment of 12.6% and a non-significant increase in wages.

The 63% decline in IT employment in the industrial sector is due to the decrease in overall regional economic activity, with the remaining 37% due to the reallocation of workers toward the service sectors. In the service sectors, this reallocation from industry does not compensate for the negative regional adjustment due to penetration of IT in the industry sector. Similar to the case of robots, Non-Market Services (O-U) are the least affected by IT as they are the largest recipient of the worker reallocation. However, in Non-Market Services (O-U), this is not sufficient to counteract the overall fall in employment associated with IT investment in industry.

In the industry sector, the decline in regional wages associated with IT penetration is offset by an increase in the relative within sector wage. In two out of three service sectors, we observe the opposite change in relative sectoral wages, which suggests that workers who reallocate from industry to Market (G-J) and Non-Market (O-U) service sectors are at the bottom of the wage distribution.

The results for software/database are reported in the fourth column panels. Penetration of software/database technology in industry increased steadily up to the 2008 crisis and then declined (see Figure 1). Although this pattern is not associated with significant changes in regional employment (Figure 3), we observe an increase in industry employment, also, with an increase in the average wage in the industrial sector. The employment-to-population ratio and average wage elasticities are, respectively, 0.058 and 0.148. For a region with median change in software/database penetration in industry (58%), this corresponds to a 3.4% increase in employment and a rise of 8.6% in the average wage.

In the industrial sector, about half of the increase in employment is due to the overall increase in regional employment, with the rest due to the reallocation of workers from the service sectors. This is similar to the pattern observed for robot penetration in the industry sector. However, in the case of Market Services (G-J) and Financial & Business Services (K-N), the reallocation effect dampens the positive regional adjustment effect leading to no change in employment.

The rise in industry sector wages is due 64% to an increase in the regional wage and 36% to an increase in industry wages relative to the regional wage. Both service sectors affected by the reallocation of employment to the industry sector show little change in their relative wages, which suggests that penetration of software/database in industry attracts high-skilled workers from other sectors and/or from outside the region.

Figure 5 depicts the sectoral adjustments to penetration of CT, IT, and software/database

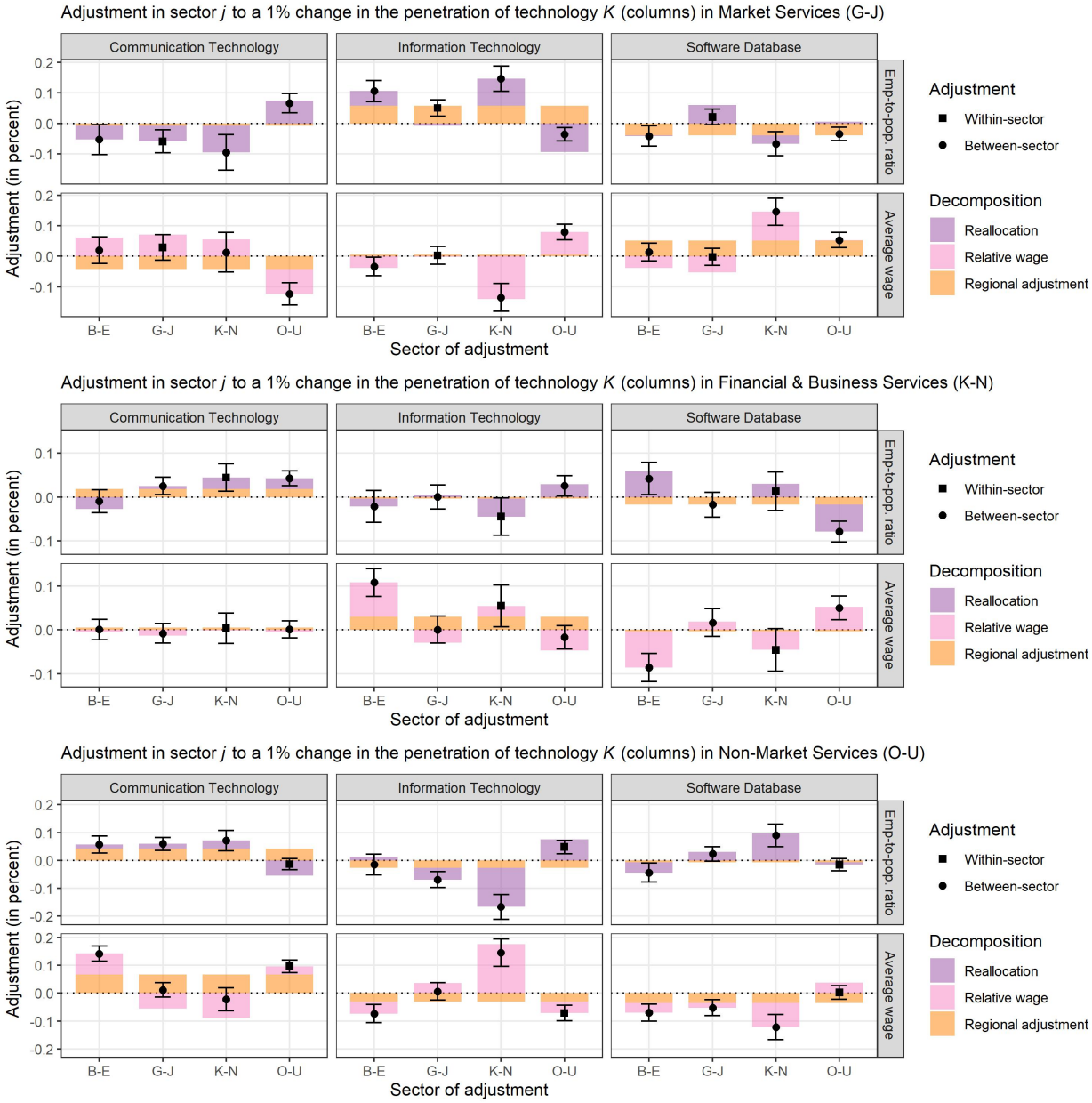
in the service sectors. We do not include robots since this technology is not pervasive in the service sectors (see Figure 1). Each of the panels in the figure refers to technology penetration in one of the three service sectors. The figure's structure and decomposition are similar to those described for the penetration of automation technologies in the industry sector (Figure 4). We present the results by technology.

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

The results for IT are reported in the second column panels. In contrast to the case of industry, IT penetration in Market Services (G-J) is associated with a boost in regional economic activity in all sectors. However, penetration of IT in market services is associated with a reallocation from public services toward either industry or financial and business services. On average, these reallocated workers tend to be 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) and Non-Market Services (O-U) is followed by a reallocation of low-paid workers from the former to the latter. In the first case, IT seems to displace workers who find employment 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).

The results for software/database are reported in the third column panels. In contrast to what we observe for industry, investment in software/database in all service sectors is associated with a regional decrease in employment, which 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 this decrease by attracting low-paid workers from Financial & Business services. In the case of Non-Market Services (O-U), the reallocation involves only the other sectors: employment reallocates from the industrial sector to the other two service sectors. In the case of Financial & Business Services (K-N) sectors, we

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



Notes: This figure presents the decomposition of sectoral adjustments to the employment-to-population ratio and the 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 10-year time horizon corresponds to the window of the log-change of the variables in the regression. The x-axis represents the sector of penetration and the y-axis represents the adjustment (as a percentage). 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 derived from 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. Appendix Tables D.2, D.4, and D.5, respectively, present the regional employment-to-population ratio, sectoral employment-to-population ratio and sectoral employment share regressions, from which the coefficients are derived. Appendix Tables D.3, D.6, and D.7, respectively, present the regressions for the regional average wage, the sectoral average wage, and the sectoral relative wage, from which the coefficients are derived.

observe a reallocation of workers from the public service sector to the sector of penetration and industry. These 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 supports the idea that different automation technologies have diverse implications for regional labor markets. Regional labor adjustments to different technologies, whether positive or negative, are likely to be driven by specific sectors; non-significant values are likely to be hiding the reverse dynamics in other sectors.

Most labor adjustments in European regions are the result of investments in automation technologies in the industry sector despite a material decrease in the relative share of employment in that sector. Adjustment patterns in the industry sector are likely to be more easily distinguishable. Different automation technologies are associated with different labor adjustments within sectors.

For instance, introduction of robots in the industry sector seems to complement workers, and enhances employment in other sectors. However, regional level changes (see Fig. 3) are driven mainly by within the industry changes. Other sectors benefit from the overall increase in economic activity, but worker specialization in industry increases as workers reallocate from services.

In contrast, the overall positive relation between IT penetration and employment at the regional level (Fig. 3) is driven by market services, not by industry where the technology substitutes workers. The substitution effect of IT in the industry sector is associated to reduced employment in services, with only a small share of industry employees finding employment in any of the service sectors. Overall, we find little structural change from industry to services associated with IT investment in any sector and, in the private sector, the effect of IT is mainly to reallocate workers to the service sectors. Apart from market services, where some new jobs are created, investment in the financial sectors causes redundant workers who move to the public sector, while the public sector becomes more attractive for low-paid workers.

Industry is responsible also for the large and positive association between increased penetration of software/database and wages at the regional level (Fig. 3). The non-significant relation with employment at the regional level is due to an increase in industry sector wages and a corresponding (cancelling out) decrease in services wages.

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

Worker reallocation among sectors explains a large part of regional labor dynamics following increased penetration of automation technologies. Robot penetration in the industry sector is associated with a reallocation of low-paid workers from the service sectors to the in-

dustries in the region. CT penetration in services is associated with reallocation of low-paid workers across service sectors. IT penetration in the industry is associated with reallocation of low-paid workers from industry to service sectors. Software/database penetration in the industry sector is associated with reallocation of high-paid workers from the service sectors and/or from outside the region.

5 Heterogeneity of technology penetration across European regions

In this section, we account for the heterogeneity among European regions including differences among regions within countries. In previous studies, regions are grouped with no consideration of sectoral specialization, technological capability, or skills differences.[13] On the one hand, workers in regions less endowed with technological capabilities and skills can find it more difficult to adjust to technology penetration.[14] On the other hand, since we know that automation technology penetration varies across sectors, and also that within the same sector and other sectors in the same region employment and wages adjust differently to technology penetration (Section 4), labor markets are likely to adjust differently to different technologies. This adjustment will depend on whether the region is specialized in industry, services, or agriculture. Our analysis proceeds in three steps. First, we group European regions into clusters based on sectoral specialization and labor productivity. Second, for each cluster, we reassess labor market adjustment to automation technology penetration. Third, we replicate the sectoral adjustments analysis.

5.1 European region clusters

We cluster the 227 regions based on their economic structure in the four years before the period of analysis, that is, between 1990 and 1994. We consider the region's sectoral specialization and technological capabilities. The former aspect refers to the region's sectoral composition, that is, 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 to regions of automation

[13] At the macro level, technological capabilities stem from the combination of physical investment, human capital (i.e. skills and training required to achieve technological change) and technology initiative (i.e. availability of basic scientific knowledge, R&D spending, patenting, etc.) (Lall 1992). Wirkierman et al. (2021) show that differences in capability stock, combined with trade interdependence among regions can explain divergences in (high-tech) employment and wages between different European regions.

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

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 columns PC1 to PC4. Cluster variables include productivity and employment shares in agriculture (A), industry (B-E and F), and service (K-N, G-J, and O-U).

technologies available at the country-sector level, based on sector specialization, using the methodology described in Section 2.3. We measure technology capabilities as the level of labor productivity, estimated as gross value added per worker. This allows us to distinguish between two regions, such as capital cities, which might both be service-intensive, but which might show different productivity levels (e.g. Paris, Île-de-France versus Sofia, Sofia City).

Clustering the variables involves a trade-off in that the inclusion of more variables may provide a better depiction of the regional economic structure, but including additional variables reduces the number of countries in the sample due to missing values for some small countries. Although the two dimensions we consider do not reflect the fine detail of the regions' economic structure, we believe that, in terms of our objectives, they convey significant information.[15]

We standardize our four cluster variables. First, we standardize sectoral employment share at the country level. Second, we standardize our labor productivity measure over the entire sample.

We start by employing a principal component analysis to identify those dimensions along which regions differ the most. Table 2 presents the eigenvectors of the principal component analysis. Principal component 1 (PC1) primarily reflects the differences among regions with high shares of employment in agriculture and/or industry versus services. The negative sign on the productivity-related element means that it captures the fact that service-intensive regions tend also to be the most productive regions. Principal component 2 (PC2) distinguishes between industry-intensive and agriculture-intensive regions and, also, shows that productivity (which is correlated with services) is associated with industry-intensive regions.

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

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 within 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; productivity refers to the gross value added per worker which is standardized over the entire sample.

Principal component 3 (PC3) completes the circle by differentiating agriculture-intensive regions. The greater productivity element of this vector for industry and agriculture reflects the bigger gap between low- and high-productivity regions in agriculture and industry, compared to services, which is because service-intensive regions tend to be capital cities. These three principal components explain 98% of the variance. Principal component 4 (PC4) acts as a residual.

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

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

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

Our preferred classification includes seven clusters.[16] Table 3 describes the clusters and their centers, that is, the within-cluster averages. The sample falls into two groups of clusters (high productivity clusters 1 to 4 and low productivity clusters 5 to 7), based on differences

[16]Our preferred classification is based on three metrics: Within-cluster Sum of Squares (WSS), Akaike Information Criterion (AIC) and Bayesian Information Criterion (BIC). Appendix Figure C.1 presents the goodness-of-fit based on these metrics, for sets ranging in size from 1 to 15. Both the WSS and AIC are strictly decreasing. Therefore, we consider sets in the neighborhood of the minimum BIC. This suggests sets in the range 7 to 9, with 8 being the minimum BIC. Although a clustering that includes 8 clusters is the minimum for the BIC, we prefer a classification with only 7 clusters since both cluster specifications mostly differentiate based on the service-intensive clusters. The 8-cluster specification generates an in-between additional k-mean to produce three clusters from clusters 1 and 2. To ease interpretation of the results and without any loss of meaning, we prefer to consider a lower number (7) of clusters.

in productivity.

Among the high-productivity clusters (High): clusters 1 and 2 correspond to service-intensive regions. Cluster 1 includes 23 regions that specialize in higher value-added service activities (e.g. KIBS) while the 32 regions in cluster 2 are more rural and a significant share of their economic activities is in agriculture and service activities (e.g. hospitality) and likely to be lower value added. Cluster 3 is the largest cluster and includes 61 industry-intensive regions. Cluster 4 includes 42 primarily agricultural regions, but includes some with significant industrial economic activity.

The low-productivity cluster classification directly reflects the regional sectoral composition. Cluster 5 regroups 19 service-intensive regions, cluster 6 includes 31 industry-intensive regions and cluster 7 gathers the 19 remaining agriculture-intensive regions.

Figure 6 maps the geographical distribution of the clusters. This map provides three main results which confirm the consistency of the clustering.

First, the productivity dimension reflects the Northern-Western versus Southern-Eastern economic divide in Europe. For instance, all fo the French and Netherlands regions are included in the high-productive clusters whereas Bulgarian and Czech regions are in the low-productivity clusters along with some Southern European regions such as Galicia, Calabria, most Greek regions and Portugal.

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

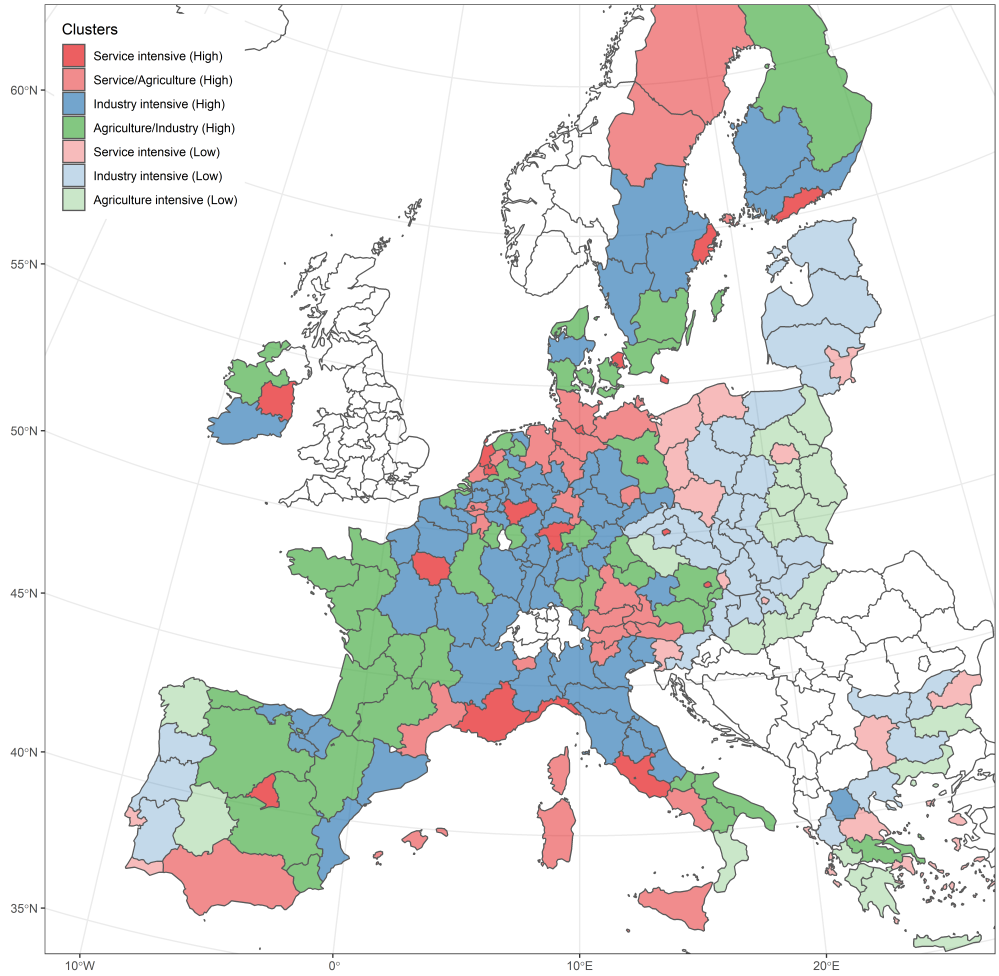
Third, regions within countries tend to be similar to their neighbors, that is, they show a spatial coherence which is demonstrated by their clustering. For instance, regions in Northern Italy tend to be industry-intensive whereas those in the South are concentrated mostly on agriculture. Also, economic activity in the West of France includes both agriculture or industry, whereas regions in the North and East of France tend to be industry-intensive.

5.2 Labor market adjustments

We investigate differences in the labor market and technology penetration relationship, at the regional level by interacting cluster fixed effects with technology penetration in the baseline specification. We estimate the following regression:

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

Figure 6: Regional clusters



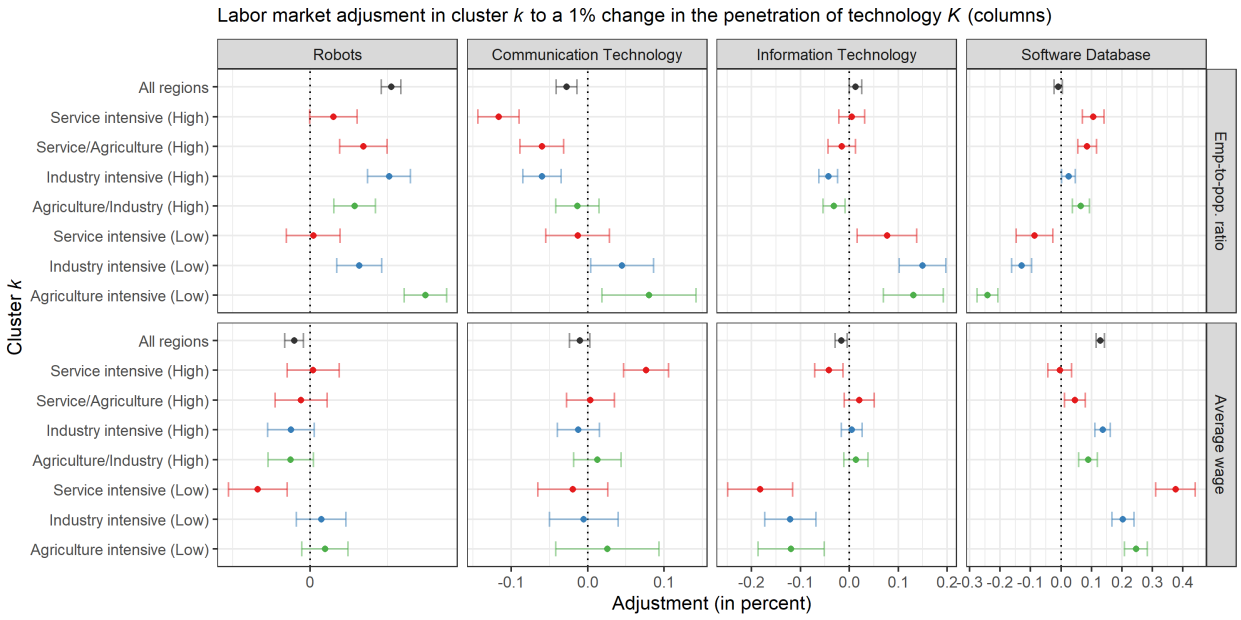
Notes: This figure presents the geographical distribution of the clusters. These clusters are obtained using the K-means algorithm. The set of clustering variables includes the shares of employment in agriculture, industry and services, standardized at the country level, and regional productivity, expressed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

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 is included in 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 for trade exposure, final demand, and 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 might be cluster-specific.

Figure 7 summarizes the relationship between regional-level labor market outcomes and technology penetration 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 (see Figure 3) is confirmed for almost all regions, except those,

Figure 7: Heterogeneity in regional adjustments to technology penetration



Notes: This figure presents the regional-level adjustments to 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, by cluster and regional membership. The 10-year time horizon corresponds to the window of the log-change of the variables in the regression. Clusters are (from top to bottom): high-productivity Service intensive regions, Service/Agriculture intensive regions, Industry intensive regions and Agriculture/Industry intensive regions; and low-productivity Service intensive regions, Industry intensive regions and Agriculture intensive regions. Clusters are obtained using K-means. Clustering variables refer to employment shares in agriculture, industry and services, standardized at the country level, and productivity, expressed as gross value added per worker, standardized over the entire sample. The x-axis represents the adjustment (as a percentage) and the y-axis represents the cluster. Row panels refer to the adjusted variables and the 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. Appendix Table D.8 reports the regression coefficients.

such as capital cities, that are specialized mainly in services. Among the group of high-productivity regions, industry-intensive regions experience the highest increase in employment from the penetration of robots (with an elasticity of 0.051), although differences across clusters are not statistically significant. A region with median change in robot penetration, included in industry-intensive cluster (60%), this corresponds to an increase in employment of 3.1%. Among the low-productivity regions, agriculture-intensive regions benefit the most (with an elasticity of 0.074). In this agriculture-intensive cluster, the median change in robot penetration is about 438% which suggests an increase of 32.4% in employment.

The negative association between robot penetration and wages at the regional level (see Figure 3) is confirmed only for low-productivity regions, specialized in services, such as Eastern European capital cities. In other words, in regions that experience an increase in employment, there is no significant variation in wages associated with penetration of robots; however, in regions specialized in services that do not experience an increase in employment, after 10 years, higher penetration of robots is associated with lower wages.

Penetration of CT shows a clear divide in the employment-to-population ratio, between high- and low-productivity regions. The negative association with employment, observed for all regions combined, is driven by the high-productivity regions. Although high-productivity service-intensive regions experience the largest decline in employment as the result of 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 is associated with a productivity-based divide between European regions. The more productive Northern and Western European regions tend to experience no orr only a few negative changes to employment and wages from IT penetration, whereas the less productive Southern and Eastern European regions experience positive (negative) changes in employment (wages). For a median change in IT penetration in industry-intensive regions with low productivity (90%), this corresponds to a rise in the employment-to-population ratio of 13.5% and a -10.9% decline in the regional average wage.

On average, and considering all European regions together, penetration of software/database at the regional level is associated with no change to employment, but large positive changes to wages. Looking at the heterogeneity indicates two composition effects. First, high-productivity regions experience positive changes to employment while low-productivity regions experience negative changes to employment. Second, low-productivity regions drive the positive regional wage change with large elasticities—especially in service-intensive regions. The positive association of wages 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 adjustments to both employment and wages to automation technologies. Implementation of robots at the regional level is almost always associated with positive changes to employment, with exception of capital city regions. Penetration of the other three automation technologies shows a pattern of regularity, suggesting a clear divide between Southern and Eastern (low productive) and Northern and Western (high productive) European regions. Software/database penetration at the regional level is associated with positive changes to both employment and wages in Northern and Western regions, but with large negative adjustments to employment and large positive adjustments to wages in Southern and Eastern regions. Both older technologies—IT and CT—have no or a negative association with employment in Northern and Western European regions, but a significant and positive association with employment in Southern and Eastern regions. However, these latter two regions experience a reduction in wages not enjoyed by regions in the North and West.

This pattern would seem to highlight that those regions (Northern and Western) where

ICTs are well established, do not show increased employment from further IT and CT penetration, whereas, in the Southern and Eastern regions which catching up in ICT stock, penetration of these technologies is faster and generates net employment. In the meantime, the high-productivity regions, which are operating at the technological frontier, are more concerned about the potential implications for employment of advanced robotics and artificial intelligence.

5.3 Sectoral adjustments

We examine the heterogeneity of sectoral adjustments to technology penetration based on the region's *initial sectoral composition* and *initial level of productivity*. We regrouped our relatively small-sized clusters according to these dimensions using the classification provided in Table 3. For the region's *initial sectoral composition*, we define three groups: Service-intensive (clusters 1 + 2 + 5), Industry-intensive (clusters 3 + 6) and Agriculture-intensive (clusters 4 + 7). For *initial level of productivity*, we define two groups: High-productivity (clusters 1 to 4) and low-productivity (clusters 5 to 7).

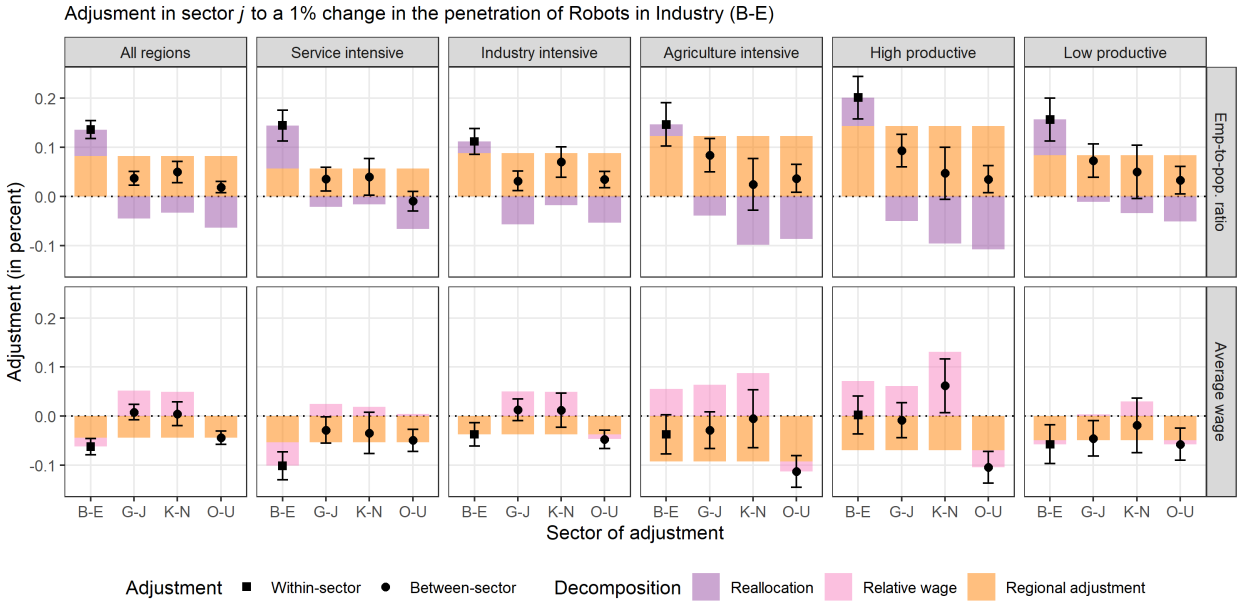
We carry out separate estimations of the adjustment, based on these two clustering dimensions, for the six sectors j:

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

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 is included in 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 for trade exposure, final demand and region and 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, for each automation technology, we focus on the adjustments in one sector. The online appendix provides details of the decomposition of the sectoral adjustments in the other sectors. In the next section, we summarize across-cluster regularities with respect to technologies and sectors.

We start by looking at the penetration of industrial robots. Figure 8 depicts the sectoral adjustments to the penetration of robots in Industry (B-E), by cluster. We focus on the industry sector since this includes most investment in robots. The positive regional adjustment of employment and the negative regional adjustment of wages are consistent across all clusters, although with important differences. The regional increase in employment is observed

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

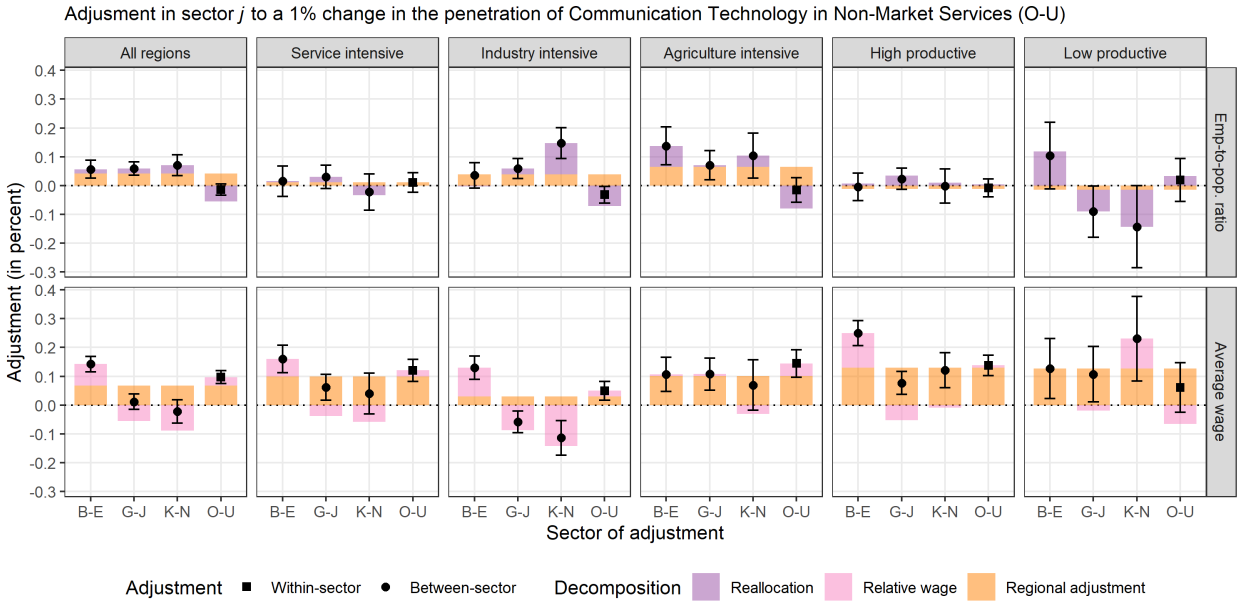


Notes: This figure presents the decomposition of the sectoral adjustments to the employment-to-population ratio and average wage in Industry (B-E), Market Services (G-J), Financial & Business Services (K-N), and Non-Market Services (O-U), to a 1% change in the penetration of robots in Industry (B-E), according to the region's initial sectoral composition and level of productivity. The 10 year time horizon corresponds to the window of the log-change of the variables in the regression. The x-axis represents the sector of penetration and the y-axis represents the adjustment (as a percentage). Column panels refer to the cluster type and the row panels refer to the adjusted variable. Coefficients are reported with a 95% confidence interval and can be interpreted as elasticities since they are derived from 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.

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

As already noted, most of the decline in wages is observed in service-intensive regions and, particularly, lower productivity regions. We find, also, that in those regions, two sectors drive this wage reduction: Industry (B-E) and Non-Market Services (O-U). In low-productive regions (with any type of specialization) this reduction is due entirely to a reduction in wages across all sectors in the region. In service-intensive (both high and low-productivity) regions, the decline in industry wages is caused by a combination of the regional effect and the reallocation of low-paid workers from the private services sectors to industry. The increase in the relative wage in Industry (B-E) which increases wages in agriculture-intensive regions, suggests that reallocated workers receive higher than the initial wages in that sector. This

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



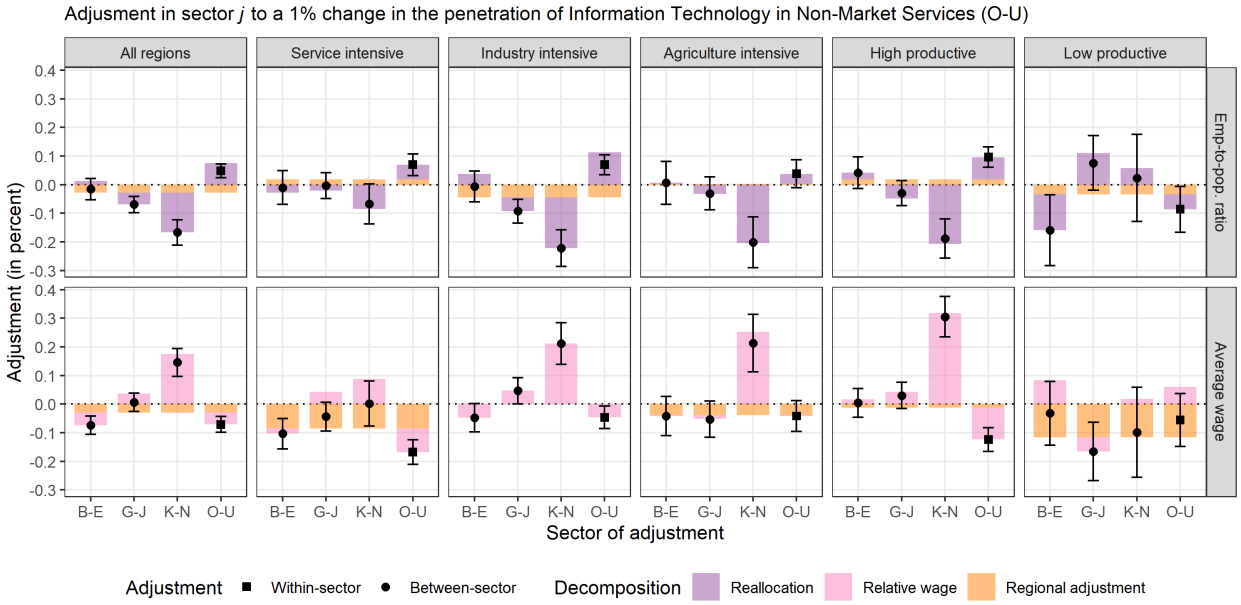
Notes: This figure presents the decomposition of the sectoral adjustments to employment-to-population ratio and the average wage, in Industry (B-E), Market Services (G-J), Financial & Business Services (K-N), and Non-Market Services (O-U), to a 1% change in the penetration of communication technology in Non-Market Services (O-U), according to the region's initial sectoral composition and level of productivity. The 10 year time horizon corresponds to the window of the log-change of the variables in the regression. The x-axis represents the sector of penetration and the y-axis represents the adjustment (as a percentage). Column panels refer to the type of cluster and the row panels refer 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.

suggests the effect of a reallocation of high-skilled workers to industry.

We examine the effects of the penetration of CT in the public service sector, where we see most reallocation of workers. Figure 9 shows the sectoral adjustments to penetration in Non-Market Services (O-U). Regional adjustments indicate that the positive association of the average wage (at the regional level) to CT penetration, in 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 other three productive sectors. These reallocation patterns show some differences, related to clusters. In the industry-intensive regions, workers are mostly reallocated to Financial & Business Services (K-N), whereas they are reallocated to Industry (B-E). In low-productivity regions, CT penetration in Non-Market Services (O-U) generates a reallocation across productive sectors, mostly from services to industry.

Figure 10 shows the sectoral adjustments to the penetration of IT 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 to the public service sector. This pattern

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

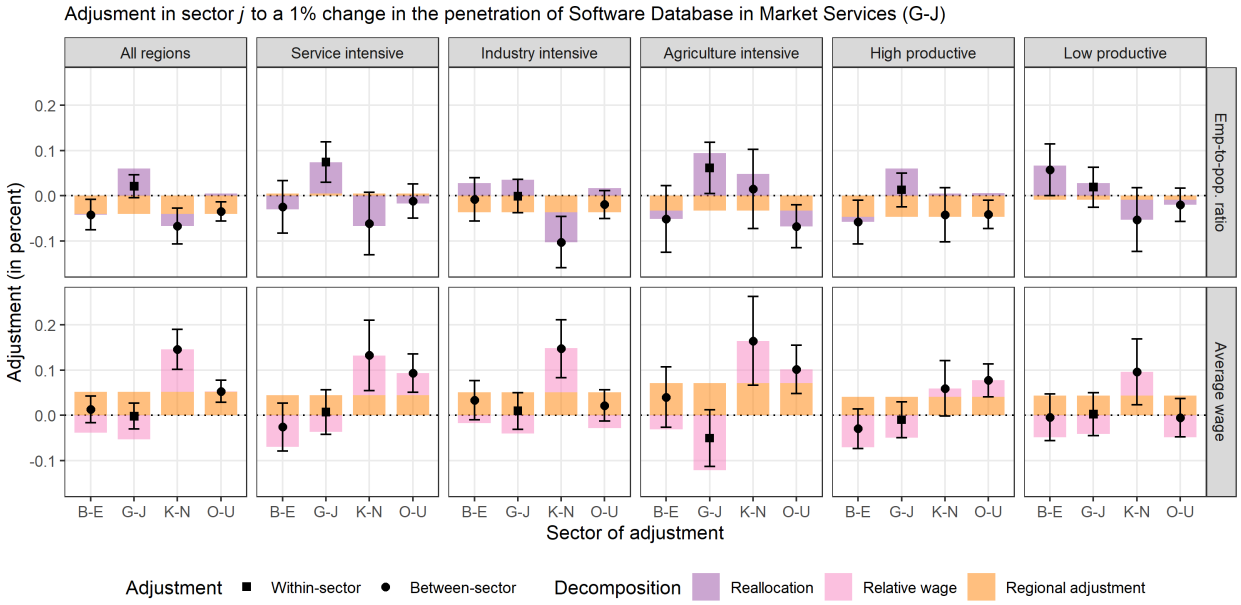


Notes: This figure presents the decomposition of the sectoral adjustments to the employment-to-population ratio and the average wage, in Industry (B-E), Market Services (G-J), Financial & Business Services (K-N), and Non-Market Services (O-U), to a 1% change in the penetration of information technology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

is more pronounced for industry-, and agriculture-intensive, and high-productivity regions. However, service-intensive and low-productivity regions experience a negative regional adjustment to wages.

Finally, we examine penetration of software/database in Market Services (G-J), which is the sector that experiences the largest change. Figure 11 depicts the sectoral adjustments to penetration of software/database in Market Services (G-J),by cluster. 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 prompts a reallocation across productive service sectors, that is, from Financial & Business Services (K-N) to Market Services (G-J). However, this reallocation pattern differs across clusters. In service-intensive regions, in addition to the low-paid workers from Financial & Business Services (K-N), high-paid workers from Industry (B-E) also reallocate to Market Services (G-J). In industry-intensive regions, only financial and business sector workers reallocate. In agriculture-intensive regions, workers attracted to Market Services (G-J) are either high-paid workers from industry or low-paid workers from the public sector.

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 region's initial sectoral composition and level of productivity. The 10-year time horizon corresponds to the window of the log-change of the variables in the regression. The x-axis represents the sector of penetration and the y-axis represents the adjustment (as a percentage). Column panels refer to the type of cluster and row panels refer to the adjusted variable. Coefficients are reported with a 95% confidence interval and can be interpreted as elasticities since they are derived from 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, sectors and regions

The decomposition of different technologies in different sectors and regions shows considerable heterogeneity in labor adjustments, some of which require further investigation. The more detailed results for specific technologies/sectors/regions highlight several regularities, which are summarized below.

First, across different regions, technologies and industries, we find that in European regional labor markets the adjustment to increased penetration of automation technologies is greater for employment compared to wages. In other words, we observe significant changes to wages among only a few combinations of regions-technologies-industries whereas we observe significant variations in employment across regions-technologies-industries. Some of variations are discussed in detail above.

Second, across technologies and industries, most labor market adjustments (both employment and wages) occur in high-productivity regions (Northern and Western Europe). In

low-productivity regions, we observe significant changes to employment and wages only in a small combination of technologies and sectors, possibly due to lower investment in automation technologies in these regions. The high/low productivity divide tends to explain most of the variation in the industry sector across different regions, with past specialization being less relevant for explaining these heterogeneous outcomes. However, in the case of the three service sectors, the initial specialization is more relevant since most of the heterogeneity in labor market adjustments across regions is explained by past specialization in services.

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

Fourth, we observed three main regularities in relation to the technologies studied. i) Robots, which are used mainly in industry, are associated with a positive increase in employment, both within the industry and in other sectors. In almost all regions there is an increase in employment, with the exception of low-productive and service-intensive regions where the employment-to-population ratio falls. These latter regions are also the only regions that experience a reduction in the average regional wage associated with investment in robots. ii) IT and CT are associated with different labor market adjustments. IT is linked to a decrease in employment in most sectors following IT investment in the industry sector. CT is associated with changes to employment and wages only in the services sectors (but not in industry) and tends to be associated with indirect positive spillovers on employment in other sectors. iii) Increased penetration of software/database is followed by an increase in wages in the industry sector, but not in the service sector. Most other sectors experience an adjustment to their wages after penetration in industry.

Fifth, three regularities emerge in relation to different sectors. i) Employment in industry increases following increased investment in robots and software/database, but decreases following increased investment in IT and CT. ii) In the case of market services, the pattern of employment adjustments is reversed—both in the sector of investment and in other sectors. For example, increased penetration of software/database 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). In the case of wages, we find no significant changes to the wages of workers in market services, following increased penetration of any automation technology in market services, although in most

other sectors, the changes linked to all the technologies are significant. iii) In the case of financial and business services and non-market services there is no common pattern along either dimension: adjustments tend to differ across technologies and regions.

7 Conclusion

This paper examines labor market adjustments to automation technologies in 227 regions located across 22 European countries. We use several sources of data to measure penetration of robots, CT, IT, and software/database. We analyze how employment and wages change with the penetration of these technologies, at the regional and (within-region) sectoral levels. We decompose the sectoral adjustments to account for worker reallocation among sectors. By clustering regions based on their specialization and technology capabilities, we provide evidence of the causes 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 in labor market adjustments to automation technologies, among European regions.

First, we show that labor market adjustments to automation differ with the technology. This suggests that, although robot technology has received the most attention in work on automation technology, it is only a subset of automation technologies and is not necessarily representative of all other technologies. We show, also, that the timing of the adjustments to automation technologies also differs. The most recent technologies (i.e. robots and software/database) seem to have much more contemporaneous effects than ICTs.

Second, our results suggest that regional changes to employment and wages are driven by sectoral penetration of technologies. In particular, implementation of robot technology in industry is associated with positive employment changes. In the case of IT, CT and software/database, the implications differ depending on their penetration through the industry or services sectors. Our results suggest, following penetration of automation technologies, there is substantial employment reallocation among sectors, mostly concerning low-paid workers. However, this does not take account of inflows and outflows from other regions, a limitation that we plan to address in future work.

Third, we find that the specialization and technology capabilities of European regions are key drivers of labor market adjustments and sectoral reallocation of workers. Our analysis highlights the huge divide between Southern and Eastern, and Northern and Western European regions, and between service-intensive and industry/agriculture-intensive regions.

Our work has some implications for policymakers. Local public policies aimed at in-

troduction of automation technologies to benefit all workers should consider labor market specificities such as regional workforce specialization and technology capabilities. The public sector is affected by changes in technology penetration in the public and other sectors, and is often the recipient for displaced workers. The role of the public service sector in employment should be carefully considered when assessing the consequences of automation on employment. Reallocated workers tend to be those at the bottom of the wage distribution suggesting also that they are the least skilled. Skill training should be provided to ensure these reallocated workers continue to be employable.

The present work suggests new research directions. First, labor market adjustments would seem to depend on regional characteristics such as sectoral specialization and productivity. Over the long run, institutions are potential drivers of both aspects and, thus, are key to labor market adjustments. Second, since we focus in this paper on sectoral employment, the inclusion of more and better data on occupations and skills would provide a better understanding of worker reallocation. Third, although we account in part for migration through population changes, by considering the employment-to-population ratio, we do not consider worker 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

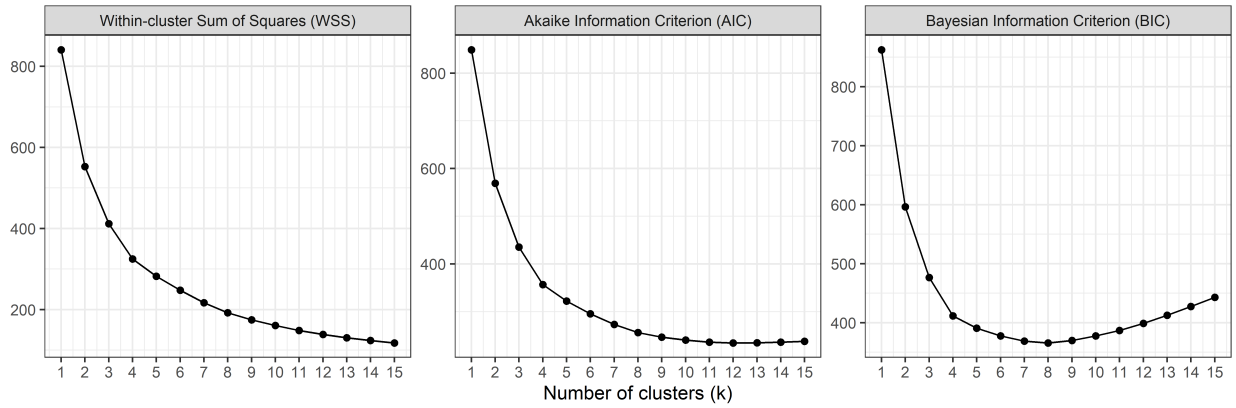
		Robots			Comm. Tech.			Info. Tech.			Soft. Data.			
h	Sector	Q2	Mean	SD	Q2	Mean	SD	Q2	Mean	SD	Q2	Mean	SD	N
5	A				0.19	0.32	0.89	0.25	0.53	1.64	0.18	0.44	1.19	2727
	B-E	0.42	0.73	0.99	0.21	0.34	0.70	0.23	0.36	0.70	0.25	0.37	0.71	2727
	F	0.84	14.95	86.65	0.17	0.41	0.97	0.33	0.63	1.35	0.17	0.39	1.06	2727
	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

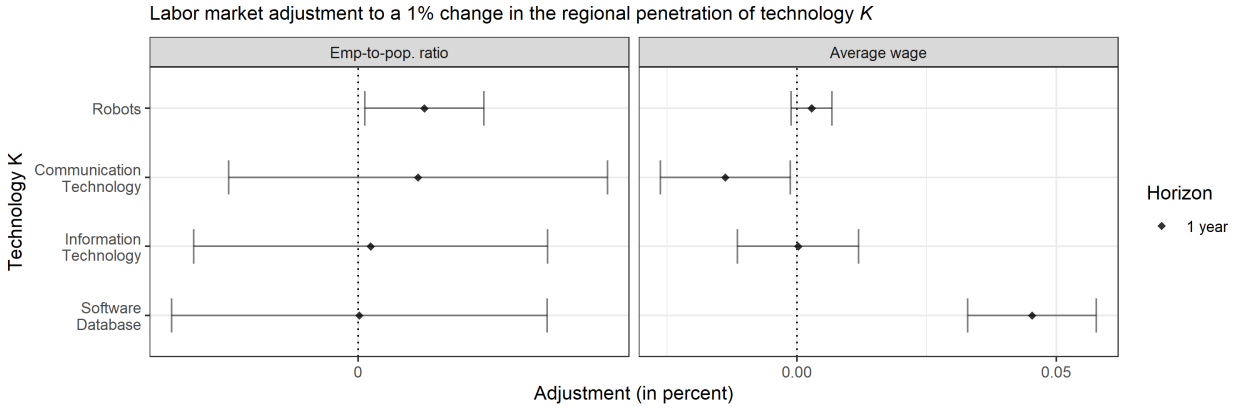
	Linear regression - Dep. var.: in logarithm							
	$h = 1$		$h = 5$		$h = 10$		$h = 15$	
	(Emp.)	(Wage)	(Emp.)	(Wage)	(Emp.)	(Wage)	(Emp.)	(Wage)
Intercept	0.007	0.013**	0.105***	0.113***	−0.025	−0.035*	0.068***	0.042**
	(0.005)	(0.006)	(0.014)	(0.015)	(0.019)	(0.019)	(0.020)	(0.020)
Robots	0.004**	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

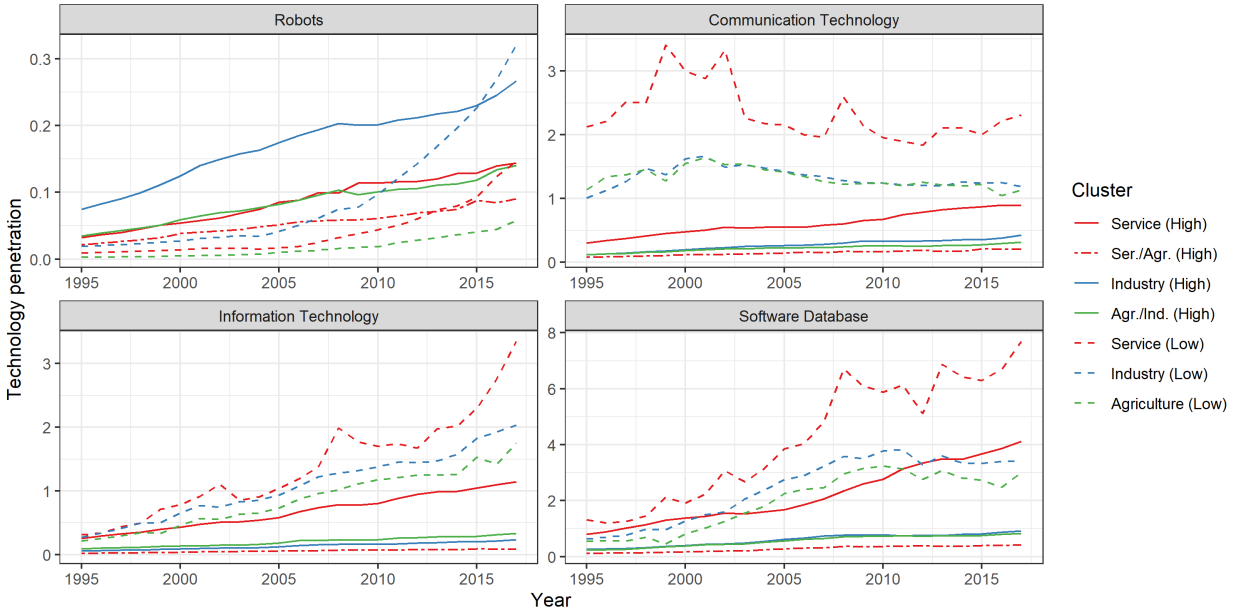
Heterogeneous adjustments of labor markets to automation technologies

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

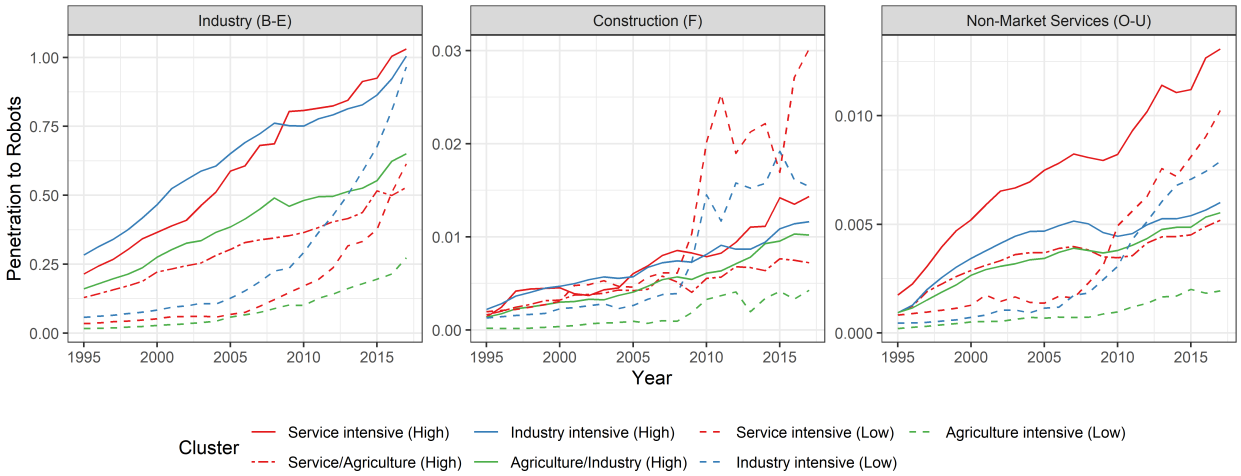


Notes: This figure presents the dynamics of the average regional penetration of robots, communication technology, information technology, and software database, which is aggregated across regions in the same cluster. The x-axis corresponds to the year and the y-axis corresponds to the technology penetration.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



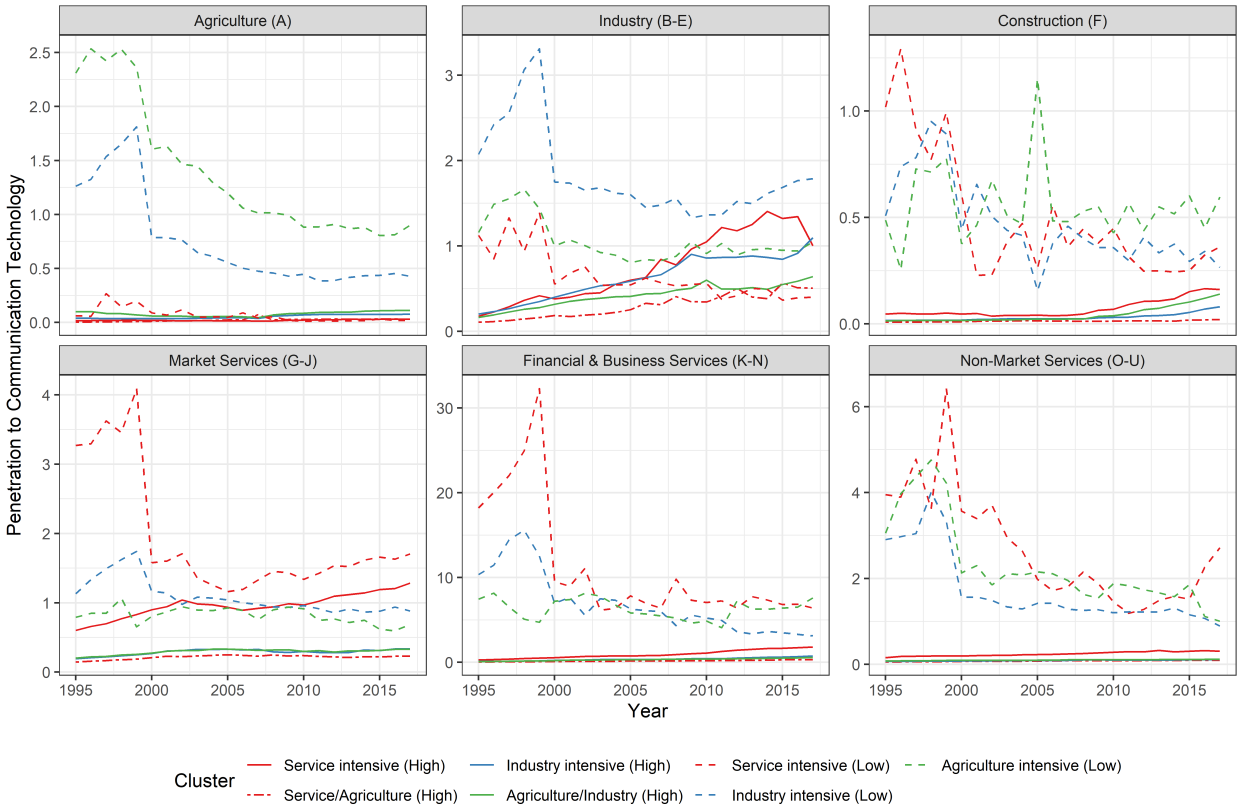
Notes: This figure presents the dynamics of the average penetration of robots in Agriculture (A), Industry (B-E), Construction (F), Market Services (G-J), Financial & Business Services (K-N) and Non-Market Services (O-U), which is aggregated across regions in the same cluster. The x-axis corresponds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

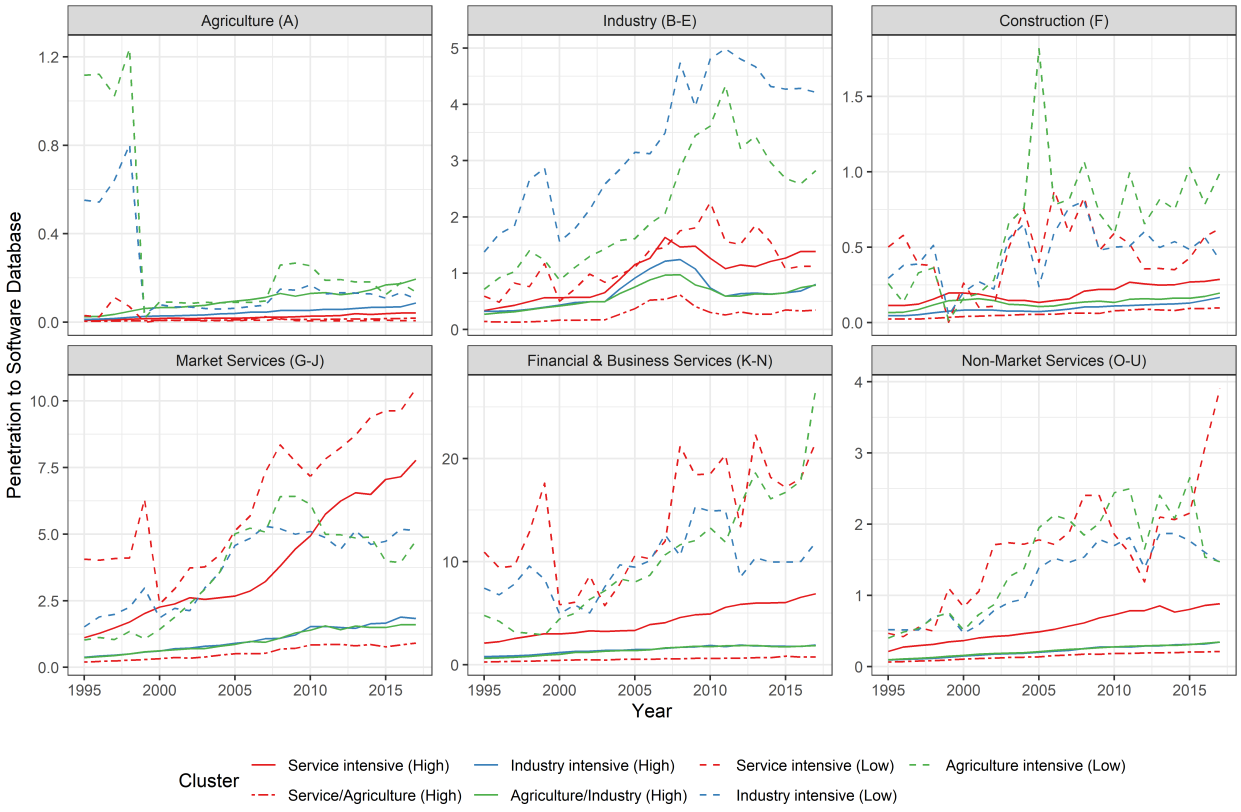


Notes: This figure presents the dynamics of the average penetration of communication technology in Agriculture (A), Industry (B-E), Construction (F), Market Services (G-J), Financial & Business Services (K-N) and Non-Market Services (O-U), which is aggregated across regions in the same cluster. The x-axis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

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

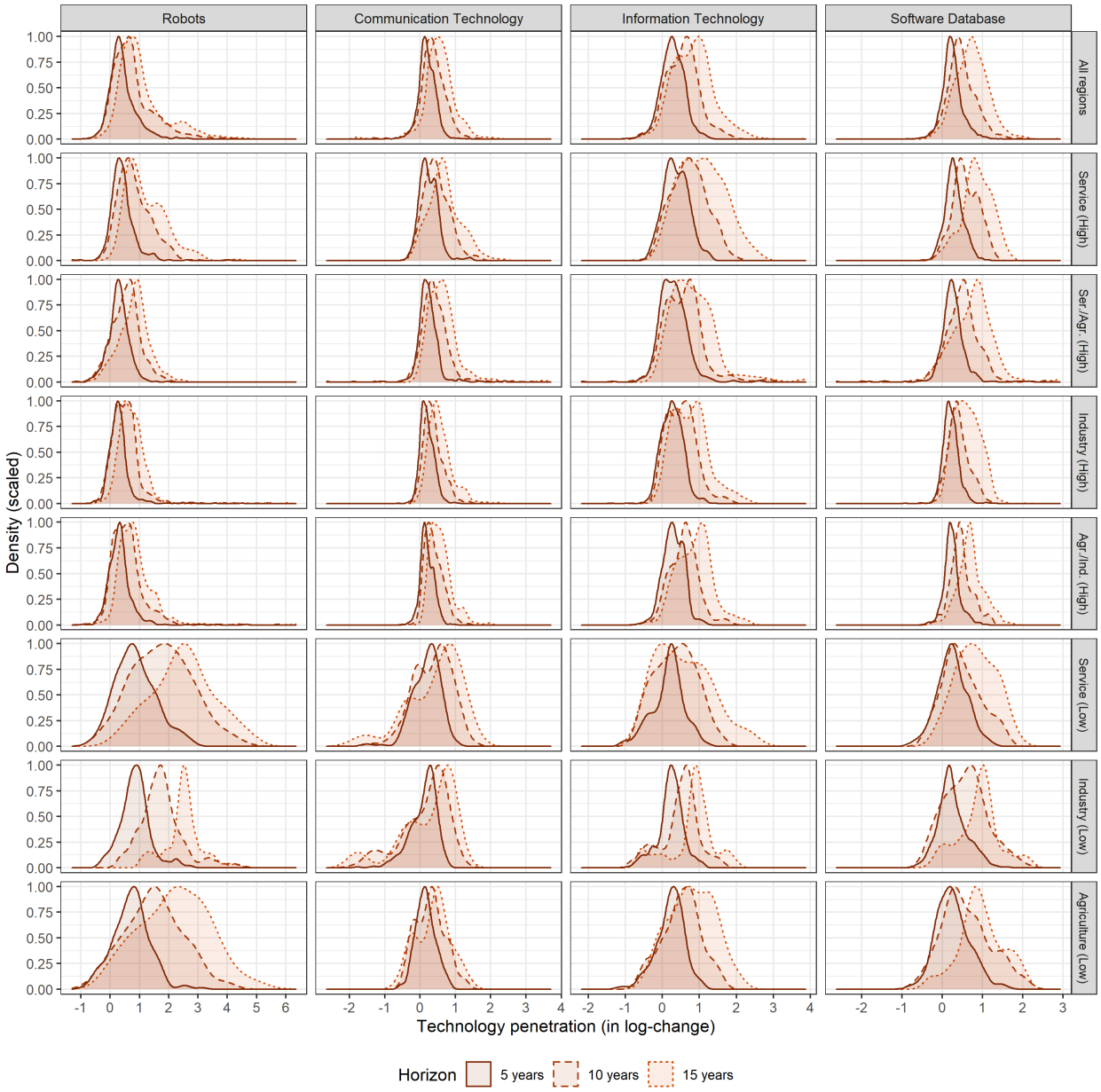
Notes: This figure presents the dynamics of the average penetration of information technology in Agriculture (A), Industry (B-E), Construction (F), Market Services (G-J), Financial & Business Services (K-N) and Non-Market Services (O-U), which is aggregated across regions in the same cluster. The x-axis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

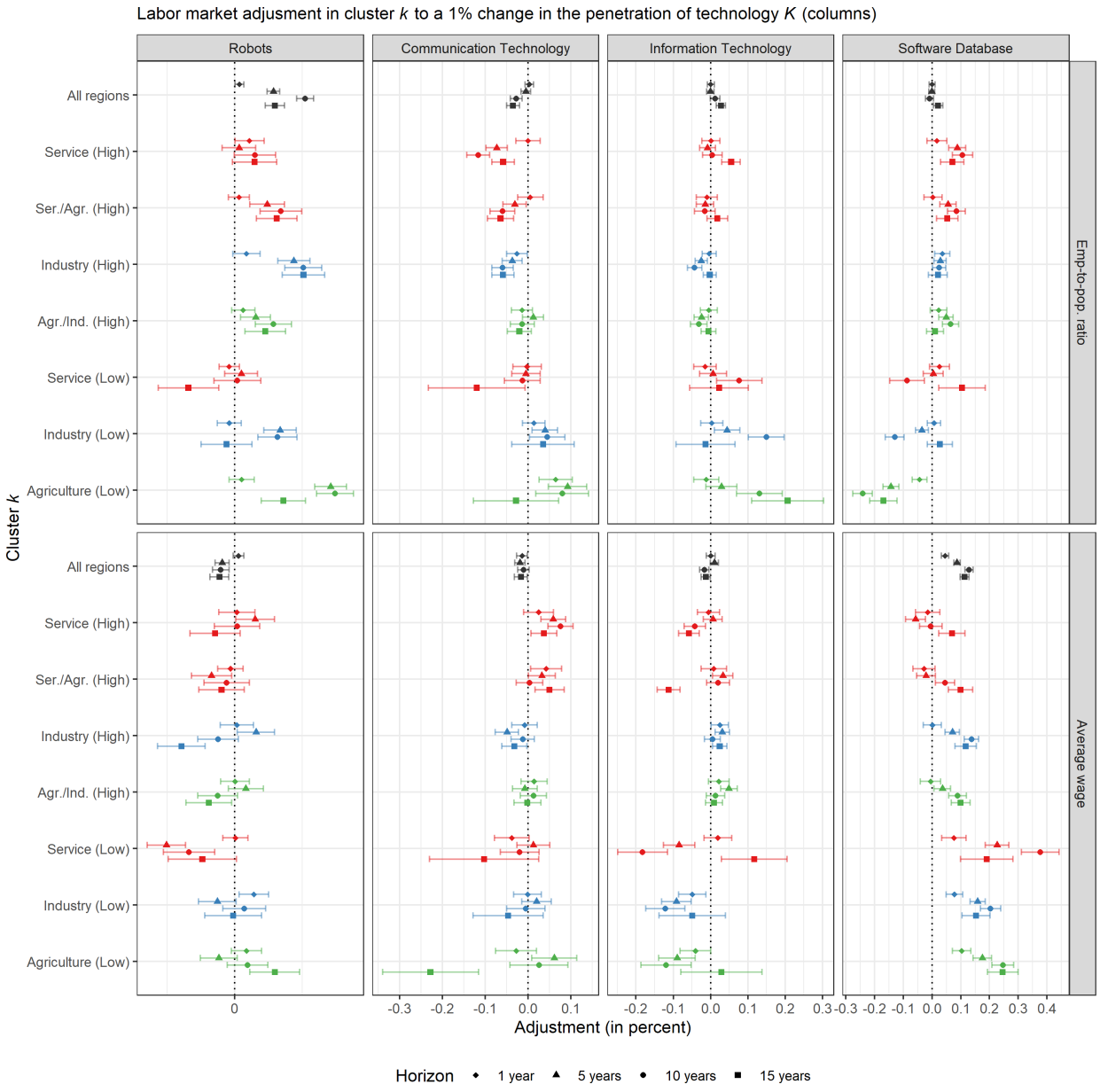
Notes: $^{***}p < 0.01$; $^{**}p < 0.05$; $^{*}p < 0.1$. Standard errors between parentheses. This table summarizes the coefficients from the estimated linear regressions of adjustments of the relative sectoral average wageper worker in Financial & Business Services (K-N) to a 1% change in the sectoral 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

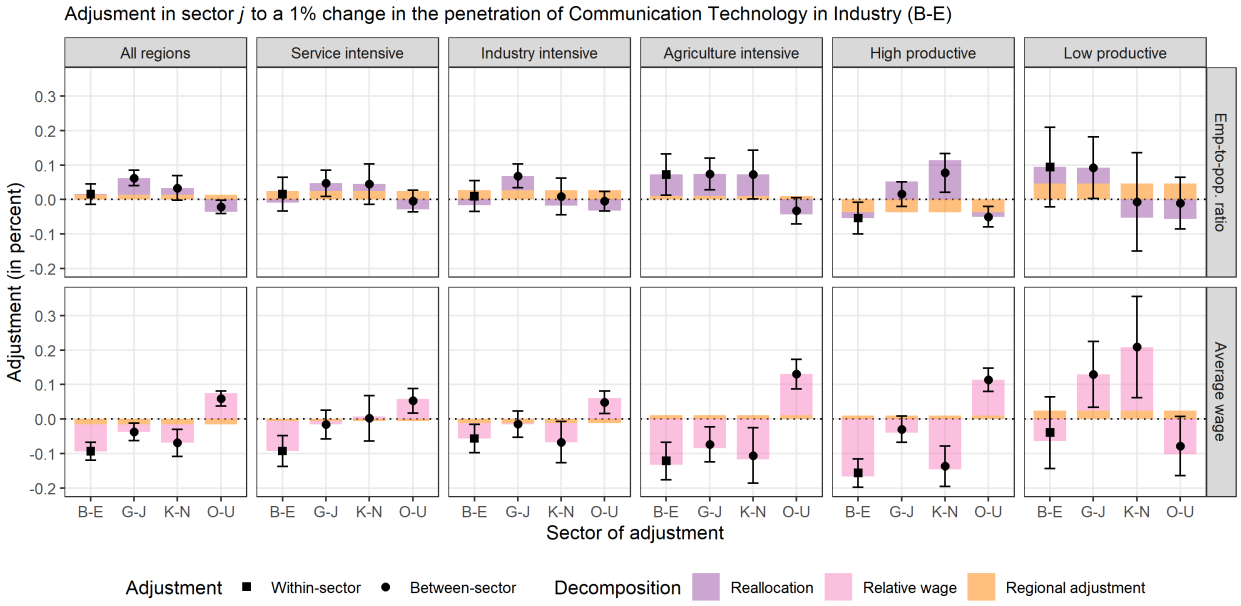
Notes: $^{***}p < 0.01$; $^{**}p < 0.05$; $^{*}p < 0.1$. Standard errors between parentheses. This table summarizes the coefficients from the estimated linear regressions of adjustments of the relative sectoral average wage per worker in Non-Market Services (O-U) to a 1% change in the sectoral penetration 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



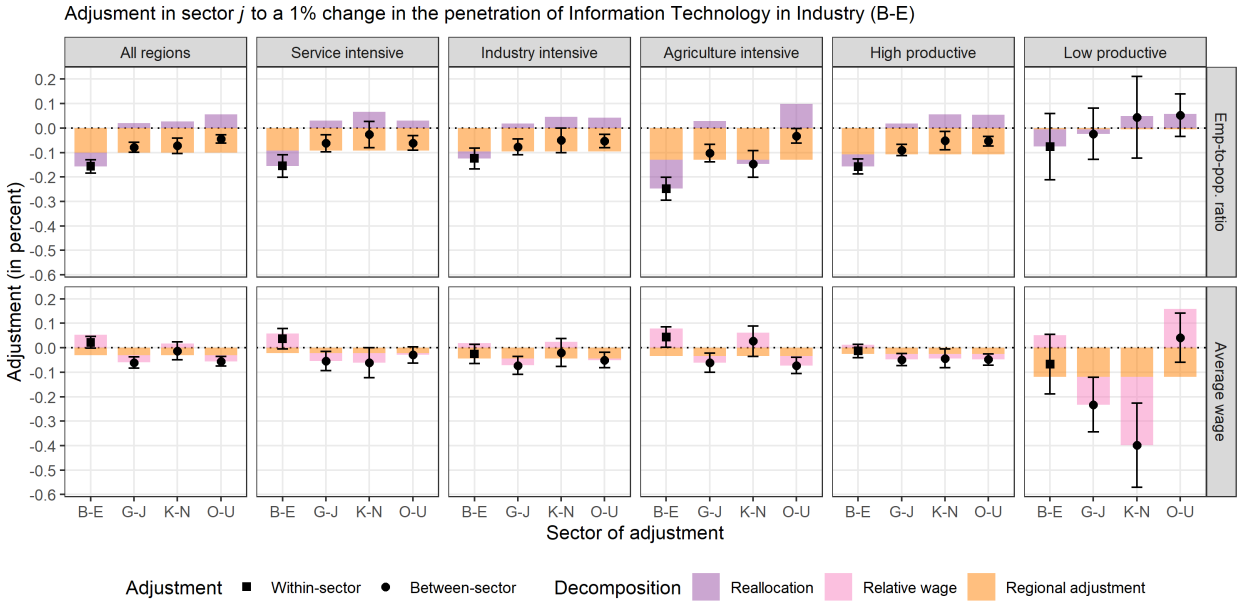
Notes: This figure presents the adjustments at the regional level of employment and the average wage to a 1% change in the regional penetration of robots, communication technology, information technology, and software & database, according to the cluster in which the region belongs. Clusters are (from 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



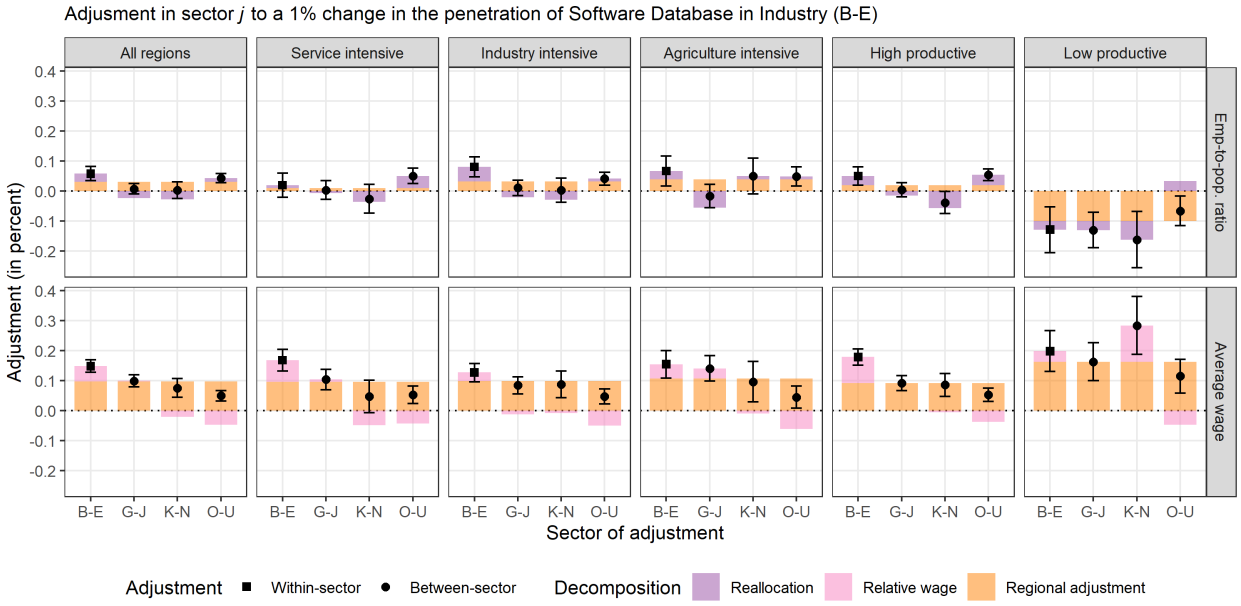
Notes: This figure presents the decomposition of sectoral adjustments of the employment-to-population ratio and average wage in Industry (B-E), Market Services (G-J), Financial & Business Services (K-N), and Non-Market Services (O-U), to a 1% change in the penetration of communication technology in Industry (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



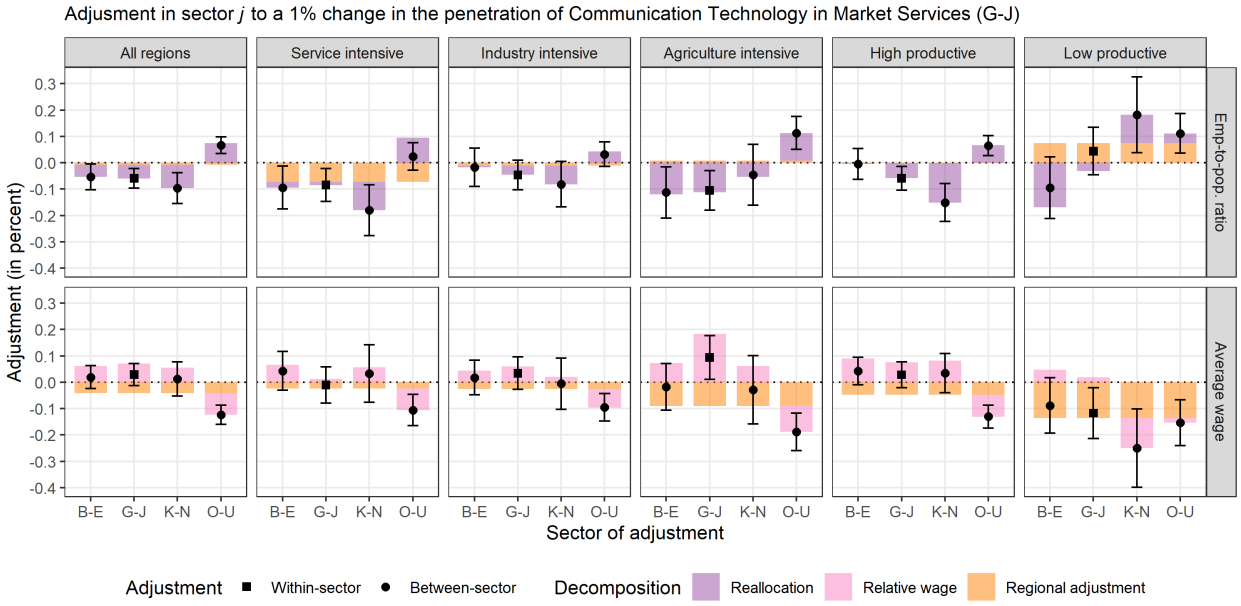
Notes: This figure presents the decomposition of sectoral adjustments of the employment-to-population ratio and average wage in Industry (B-E), Market Services (G-J), Financial & Business Services (K-N), and Non-Market Services (O-U), to a 1% change in the penetration of information technology in Industry (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



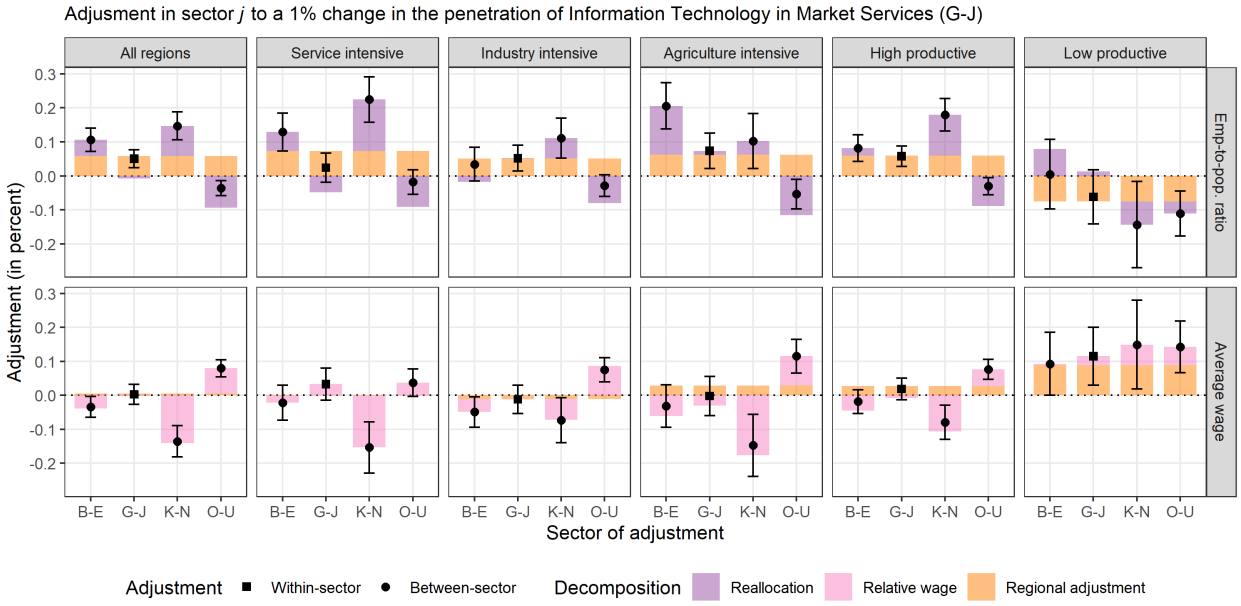
Notes: This figure presents the decomposition of sectoral adjustments of the employment-to-population ratio and average wage in Industry (B-E), Market Services (G-J), Financial & Business Services (K-N), and Non-Market Services (O-U), to a 1% change in the penetration of software & database in Industry (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



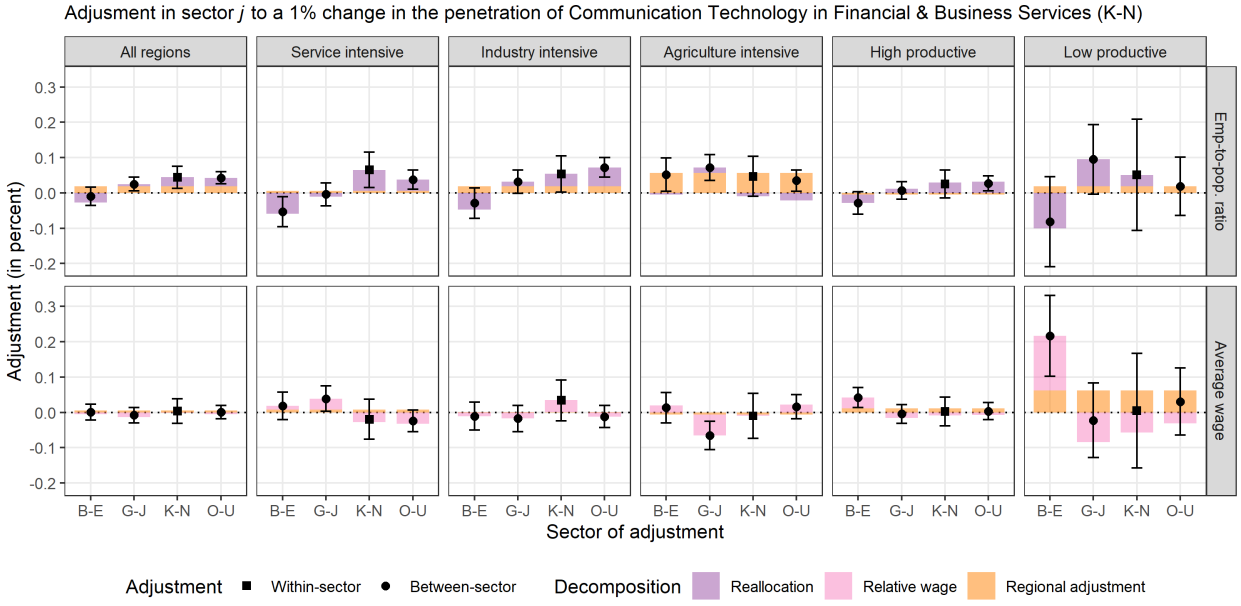
Notes: This figure presents the decomposition of sectoral adjustments of the employment-to-population ratio and average wage in Industry (B-E), Market Services (G-J), Financial & Business Services (K-N), and Non-Market Services (O-U), to a 1% change in the penetration of communication technology in Market 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



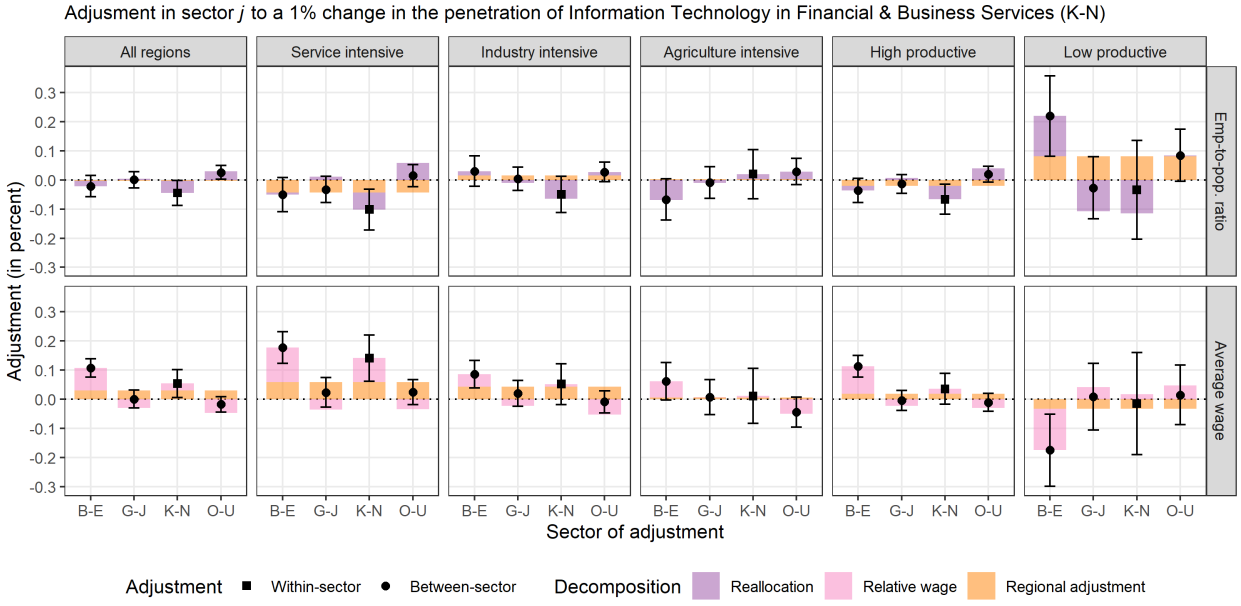
Notes: This figure presents the decomposition of sectoral adjustments of the employment-to-population ratio and average wage in Industry (B-E), Market Services (G-J), Financial & Business Services (K-N), and Non-Market Services (O-U), to a 1% change in the penetration of information technology in Market 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



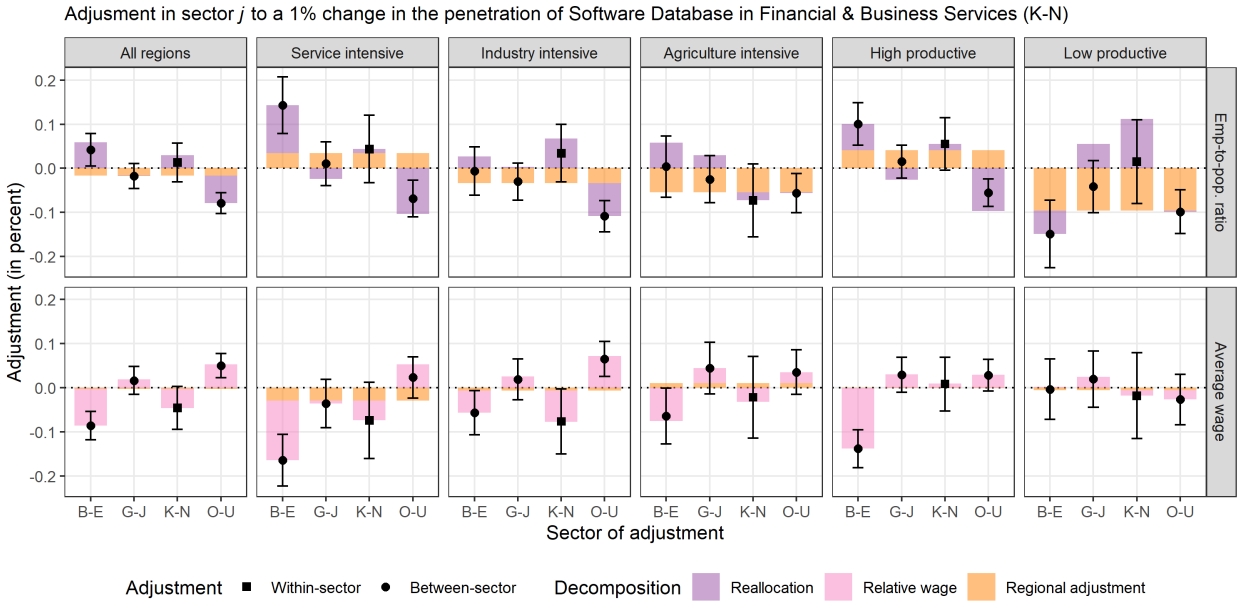
Notes: This figure presents the decomposition of sectoral adjustments of the employment-to-population ratio and average wage in Industry (B-E), Market Services (G-J), Financial & Business Services (K-N), and Non-Market Services (O-U), to a 1% change in the penetration of communication technology in Financial & 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



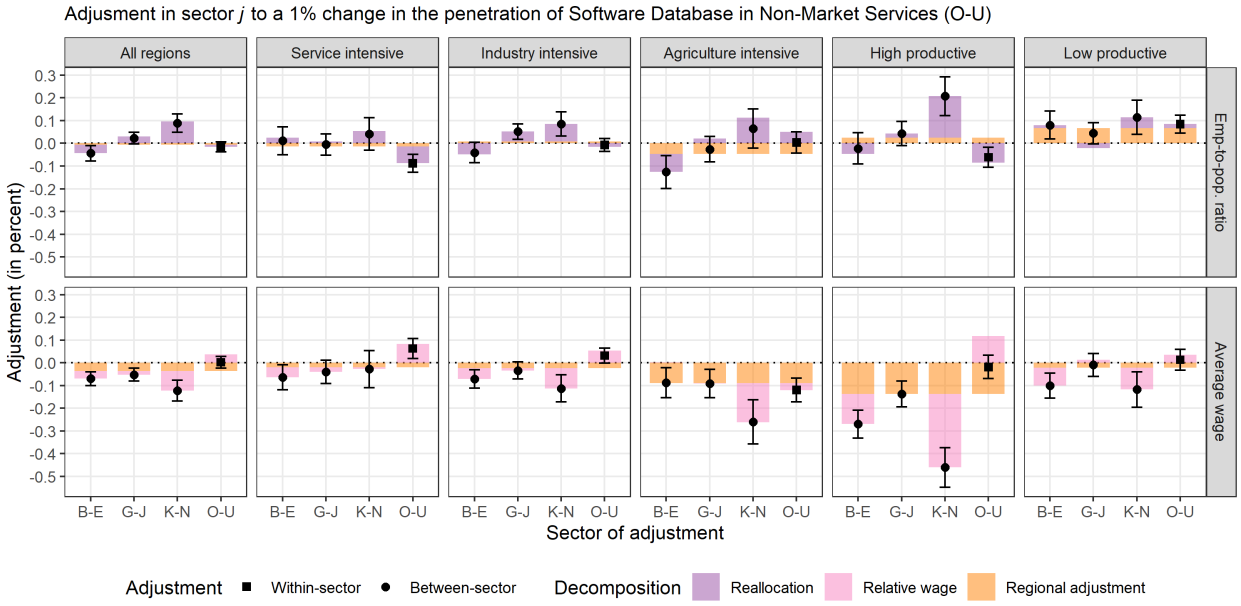
Notes: This figure presents the decomposition of sectoral adjustments of the employment-to-population ratio and average wage in Industry (B-E), Market Services (G-J), Financial & Business Services (K-N), and Non-Market Services (O-U), to a 1% change in the penetration of information technology in Financial & 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.