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# Location and Productivity of Knowledge- and Information-intensive Business Services

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# Location and Productivity of Knowledge- and Information-intensive Business Services*

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Abstract

Knowledge-intensive business services (KIBS), which produce skill-intensive services used as intermediate inputs, are becoming important for the economic growth and international competitiveness of advanced countries. This study, using establishment- and company-level micro data, analyzes the productivity of knowledge- and information-intensive services in Japan, including information services, publishers, and design services. We focus on the effect of urban density on the productivity of these services. Our estimations reveal that doubling the employment density of municipalities is associated with around 5% higher labor productivity of service providers, which is larger than that found in the manufacturing industry. However, quantitatively, the economies of density vary for individual services, suggesting that the services to be promoted by small and medium cities differ from those for which large metropolitan cities such as Tokyo and Osaka have strong comparative advantages.

*Keywords*: Knowledge-intensive business services, Productivity, Employment density, Economy of scale

*JEL Classifications*: D24, L84, L86, R32



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Location and Productivity of Knowledge- and Information-Intensive Business Services

## 1. Introduction

Enhancing the productivity of the service sector is a key policy issue for lifting the economy's potential growth rate, because the service sector accounts for more than 70% of GDP in advanced economies, including Japan. The government's 2015 revision of the Japan Revitalization Strategy states that "stimulating the service industry and raising its productivity" is a major mid-term economic policy. This study analyzes the productivity of knowledge- and information-intensive business services using establishment- and company-level micro data. The analysis focuses on the effect on productivity of employment density in the municipalities in which the service establishments or companies are located. The analysis specifically examines 14 business service industries using micro data from the Survey of Selected Service Industries (Ministry of Economy, Trade and Industry).

In some countries, attention is focused on one particular part of the service industry: knowledge-intensive business services (KIBS). This industry is characterized by its high intensity of knowledge and high skill levels. It mainly produces services that are used as intermediate inputs by businesses. The KIBS lacks a conclusive definition, but, in general, it includes computer-related services (e.g., software and information processing), research and development services, and business services (e.g., legal, accounting, and advertising).[1] Overall, these services are found in advanced countries and hire workers with high education levels. The industries themselves not only have high growth potential, but also affect the performance of other industries such as manufacturing that use their services as intermediate inputs. Barone and Cingano (2011) and Bourles *et al*. (2013) are examples of empirical analysis focused on OECD member countries. Their results suggest that imposing strong regulations on service businesses whose specialized services are intensively used as intermediate inputs by downstream manufacturers negatively affects the productivity and growth of such manufacturers. Boix-Domenech and Soler-Marco (2015) indicate that in the EU, creative service industries—such as publishing, audiovisual, radio and TV, architecture and engineering,

[1] Muller and Zenker (2001) and Muller and Doloreux (2009) present surveys on KIBS.

research and development, advertising, design, photography, and the arts and entertainment—have a strong positive impact on regional labor productivity through their spillover effect on other industries.

Recent research on value-added trade indicates that intermediate input services play a very important role in terms of international competitiveness. Ali-Yrkkö (2011) analyzes the geographical distribution of the added value of smartphones, most of which are assembled in, and exported from, China. This study shows that services and other intangible assets accounted for a very large part of the added value in the supply chain as a whole, and that industrialized countries are capturing a large part of the overall value-added of the global supply chain. Comprehensive analyses using world input–output tables show that industrial products account for a very high share of gross trade amounts, but in terms of value-added, the share of the added value of services is much higher than the figures shown for the gross exports (Daudin *et al*., 2011; Timmer *et al*., 2014; Johnson, 2014; Amador *et al*., 2015). According to Johnson (2014), services account for just 20% of gross exports worldwide, but the share more than doubles to 41% when we consider value-added exports. If we trace the source of added value back to factors of production, there is a strengthening trend in which industrialized nations specialize in activities performed by highly educated workers. In other words, numerous services are embedded in traded manufactured products, and typically, industrialized countries have a comparative advantage in these intermediate input services, especially knowledge- and skill-intensive business services.

In Japan, we can observe the percentage of employees who have at least graduated from a four-year university degree, from the Employment Status Survey (Ministry of Internal Affairs and Communications, 2012). The percentages are 60.8% in the information services industry, 57.3% in video, sound, and text information production and distribution industries (such as newspaper publishers, publishers other than newspapers, and video picture information production and distribution businesses), and 58.0% in advertising agencies. These figures are more than twice as high as the ratios for the manufacturing industry (25.5%) and the all-industry average (27.7%). In Japan, we can see that services such as these related to knowledge and information have a very high level of skill intensity.

However, according to the Japan Industrial Productivity (JIP) Database (Research Institute of Economy, Trade and Industry: RIETI), long-term (1970–2011) growth in aggregate total factor productivity (TFP) (converted to a yearly basis) has been negative or flat: -0.1% for advertising

agencies; -0.7% for information services; -0.9% for newspapers and publishers; and -0.0% for the video, sound, and text information production industry. As Corrado and Slifman (1999) point out, on identifying industries with long-term negative productivity growth, we cannot eliminate the possibility of measurement errors owing to limitations in the basic statistical data. However, it is a serious problem if productivity is worsening in those service industries under the trend toward a more knowledge-intensive society.

Regarding the productivity of service industries, past research indicated that in service industries characterized by "simultaneous production and consumption," the demand density of the area in which the establishment is located has a major impact on measured productivity (e.g., Morikawa, 2011). This result suggests that as the total population declines, we should "select and concentrate" the geographical distribution of the population in order to raise the productivity of the service industry, and that therefore, it would be efficient to build compact, population-dense cities. However, that analysis was limited to personal services (such as movie theaters, bowling alleys, golf driving ranges, and fitness clubs) and excluded business services. Compared to entertainment- and sports-related services studied by Morikawa (2011), the knowledge- and information-related business services analyzed in the present study are more likely to benefit from locating in large cities, which have numerous skilled workers who are sources of knowledge creation and simultaneously have a positive spillover effect on other workers.[2]

A relatively small number of past studies estimate the effect of agglomeration economies for business services. Graham (2007) uses data from British companies to show that urbanization economies tend to be larger for business services than for the manufacturing industry.[3] Melo *et al*. (2009) performed a meta-regression analysis of past research and conclude that the economic effect of urbanization is greater for the service industry than for the manufacturing industry. However, there have been a growing number of empirical studies on the service industry since then, and recent findings were not covered in that study. Combes *et al*. (2012), for example, analyze agglomeration economies using data from French establishments, including several business services. The results indicate that consulting, advertising, and business services, along

[2] Fujita and Tabuchi (1997) indicate that advances in communications and transportation technologies promote the centralization of knowledge-intensive activities in core areas.

[3] Graham's (2009) estimates are for more finely subdivided service industries and reveal that urbanization economies are found in the financial/insurance industries, management consulting, and video picture and sound services, but not in information services and advertising agencies, among others.

with printers and publishers other than newspapers (which are classified as manufacturing industries) have markedly higher productivity in areas with high employment density.[4] Several other studies have also subsequently confirmed agglomeration economies in business services. For example, Maré and Graham (2013) do so with New Zealand company-level data and Meliciani and Savona (2015), with EU regional data.

Glaeser and Gottlieb (2009), a representative survey on agglomeration economies, state that modern cities specialize in service industries where face-to-face contact is important, and that analysis of agglomeration economies in service industries is therefore a high priority issue to address for understanding the role of cities in modern economies. Further, Jacobs *et al*. (2014) focus on KIBS. Analyzing company-level data on the Netherlands, they show that KIBS and multinational corporations tend to co-agglomerate.[5] This result suggests a positive relationship between globalization and the trend in knowledge-intensive service agglomeration in large cities.

Empirical studies focusing on workers' occupations and skills suggest there is a large urban wage premium for cognitive skills and nonroutine tasks (e.g., Bacolod *et al*., 2009; Andersson *et al*., 2014). Using U.S. data, Bacolod *et al*. (2009) show that workers with strong cognitive skills and interpersonal skills obtain a large urban wage premium. Furthermore, using panel data matching Swedish companies and workers, Andersson *et al.* (2014) indicate that the urban wage premium is large for workers skilled in performing nonroutine tasks. Thus, the literature suggests advantages in knowledge-intensive services in densely populated urban areas.

Against this background, this study empirically analyzes productivity with a focus on economies of urban density in knowledge- and information-intensive business services, which were not addressed in Morikawa (2011). According to the results of this study using establishment- and company-level micro data, doubling the employment density of the municipality where service establishments or companies are located is associated with several percentage points higher labor productivity: greater economies of urban density are observed than for the manufacturing industry. However, the effect size differs considerably by the individual service industries. In service sectors that produce knowledge and information (video

[4] According to Combes *et al*. (2012), the TFP gap between areas with high and low employment density (categorized according to median value) is 18.5% for printers and publishers other than newspapers and 20.9% for business services, as compared to just 9.5% for the all-industry average.

[5] In an analysis by Jacobs *et al*. (2014), KIBS are defined as research and development services, economic services, technical and IT services, and marketing /advertising services.

picture information production and distribution, publishers other than newspapers, design businesses, and advertising agencies), remarkable economies of urban density are observed. On the other hand, software services, data processing and information services, mechanical designing businesses, machine repair services, and others show relatively low productivity gaps among different density areas.

The remainder of this paper is structured as follows. Section 2 explains the data used in the analysis, along with the analysis method. Section 3 reports results of cross-sectional estimation of value-added labor productivity for 14 sectors followed by estimation results using physical productivity for publishers, a sector for which physical output data is available, and compares the two sets of results. Section 4 summarizes the conclusions and discusses policy implications.

## 2. Data and Methodology

The analysis in this study uses 2010 and 2013 micro data from the Survey of Selected Service Industries (Ministry of Economy, Trade and Industry), a "Fundamental Statistics" survey performed under the Statistics Act, since 1973. The survey aims to understand the state of the service industry and to collect basic information for relevant planning policies. The surveys after 2009 have covered 28 service industries, including business services (e.g., information services industry, leasing industry, design businesses, and advertising agencies) and personal services (e.g., ceremony businesses, movie theaters, sports facilities, and private tutoring schools). The survey in 2013 was sent to about 45,000 businesses and had a response rate of about 85%. The survey unit is mainly the establishment, but in six sectors, it is "company." Through 1973 to 2008, these were census-style surveys, but at present, sampling-style surveys are performed, for all industries excluding seven industries,[6] using the Economic Census for Business Activity (Ministry of Internal Affairs and Communications) as a population of the establishments and companies. Some survey items are included in all sectors, such as the amount of capital, annual sales, annual operating expenses, and number of workers. Other items are specific to the individual industries, reflecting their characteristics. In the case of publishers other than newspapers, for example, the survey asked how many individual copies of books and

[6] Among the sectors analyzed in this study, only two (video picture information production and distribution and surveyor certification businesses) were part of a census-style survey.

magazines the company published in a year.

Unfortunately, however, the survey did not ask about measures of capital stock or its proxy for the business service industries. For this reason, the productivity measure in this study is not total factor productivity (TFP) but labor productivity (LP). However, the bias from differences in the capital–labor ratio at each establishment or company is expected to be relatively small, because the analysis is performed on individual narrowly defined service industries.

On the other hand, the survey has relatively rich information on worker characteristics. It breaks staff numbers down by regular, part-time, and temporary employees, as well as by gender. In addition, in the case of part-timers, it surveys the number of full-time equivalent figures at the establishments and companies, using the standard working hours as denominator.

The study analyzes 14 business service industries: software services; data processing and information services; Internet-based services; video picture information production and distribution; sound information production; newspaper publishers; publishers other than newspapers; services incidental to video picture, sound information, and text information production and distribution; design businesses; mechanical designing businesses; advertising agencies; surveyor certification businesses; machine repair services; and electrical machinery repair services. According to the 2012 Economic Census for Business Activity, these service industries account for more than 1.5 million workers and about 36 trillion yen in sales (see Table 1). Software services are a relatively large component, accounting for about half of the workers and sales of these 14 service industries.

Of these sectors, establishment-level data is available for nine industries: software services; data processing and information services; Internet-based services; design businesses; mechanical designing businesses; advertising agencies; surveyor certification businesses; machine repair services; and electrical machinery repair services. Company-level data is available for five industries: video picture information production and distribution; sound information production; newspaper publishers; publishers other than newspapers; and services incidental to video picture, sound information, and text information production and distribution. Since there are some cases where a company has multiple establishments located in different municipalities, results of the analysis using company-level data should be interpreted with some caution when regional characteristics are used as explanatory variables. However, in nearly all sectors, about 90% of businesses had just one establishment, as column (4) of Table 1 shows.

Using this data, I calculated the value-added labor productivity for each establishment or

company. The value-added (the numerator), is calculated as "annual sales – annual operating expenses + total wages + depreciation expense + leasing costs (land / building and machinery / equipment)."[7] The number of workers (the denominator) is constructed by adding up the number of sole proprietors, unpaid family member workers, paid executives, permanent employees (regular employees and part-timers), and temporary employees.[8] For part-timers, it is possible to use the number of full-time equivalent numbers, but when calculating labor productivity, I simply use the total number of workers. However, I use the number of full-time equivalent positions to correct the working hours when calculating the part-timer ratio, which is used as a control variable in the estimation, as discussed later.

Since this study is interested in economies of density in business services, the data from the Survey of Selected Service Industries are linked with data on the employment density of municipalities (number of workers/square kilometers of the municipality). I perform ordinary least square (OLS) regression to explain labor productivity (logarithm) where employment density (logarithm) of the municipality in which the establishment or company is located is the main explanatory variable, and measure the elasticity of labor productivity with respect to employment density for each industry.[9] In analyzing personal service industries, Morikawa (2011) use the population density of municipalities as an explanatory variable. However, in the business services that are the subject of this study, it is important to consider the density of potential user companies as well as workers who could be the source of knowledge and information spillover in the place where the company is located. In this regard, the employment density of a region is a more appropriate measure than the local population density to represent the density of economic activity.

Control variables include dummies for whether the establishment is a headquarters or a branch, worker characteristics, and company size. In the case of establishment-level surveys, businesses are asked whether they are a headquarters or branch establishment. Dummies for headquarters and branches are used as explanatory variables, where the reference category is an

[7] Ideally, the calculation of value-added would include interest payments, but the Survey of Selected Service Industries does not collect this information.

[8] "Temporary employees" are "nonpermanent employees, who are hired for a prescribed period of no more than one month or on a daily basis."

[9] The employment density of a municipality is calculated by dividing "employed persons based on place of working" in the 2010 Population Census by the square area of the municipality ($km^2$). Unfortunately, figures do not exist for "employed persons based on place of working" in 2013, so the same figures as in 2010 were used for the 2013 analysis.

establishment of a single-establishment company. This survey item does not appear in company-level surveys, but information on types of major businesses exists in most sectors, so dummies for type of business are used as explanatory variables. For example, in the case of services incidental to video picture, sound information, and text information production, the major businesses are categorized as follows: news providers, studio rental businesses, filming studios, post-production services, music studios, and other. In the case of newspaper publishers, there are five categories: general newspapers (national), general newspapers (regional), sports newspapers, professional and industry newspapers, and other.

Worker characteristics used as explanatory variables are (1) ratio of female employees, (2) ratio of part-timers, and (3) ratio of temporary employees to total employees. When analyzing the effect of municipalities' economic density on productivity, treatment of company size is an important issue. In this study, I perform separate estimations in which company size is included among the explanatory variables and in which it is excluded. In the estimation where company size is excluded, the estimated coefficient for employment density shows the economies of urban density including the effect such that the larger the city, the larger the size of its companies. On the other hand, when company size is included among the explanatory variables, the coefficient for employment density shows the productivity effect exclusive of the effect such that the larger the city, the larger the size of its companies. For company size, I use the amount of capital (tens of thousands of yen) converted to a logarithmic form. Since the dependent variable is labor productivity with the number of workers as denominator, I used the scale of capital instead of number of workers. As shown later, the results differ considerably depending on whether company size was controlled for.

To summarize, the baseline OLS estimation equation using the logarithm of labor productivity (*lnLP*) as a dependent variable can be expressed as follows:

$$\begin{aligned} lnLP = {} & \alpha + \beta_1 \ln(\text{employment density}) + \beta_2 \ln(\text{company size}) + \beta_3 \text{ ratio of female} \\ & + \beta_4 \text{ ratio of part-timers} + \beta_5 \text{ ratio of temporary employees} \\ & + \beta_6 \text{ headquarters / branch dummies} + \varepsilon \end{aligned} \quad (1)$$

For sectors where companies are the unit of the survey (e.g., video picture services, newspaper publishers, and publishers other than newspapers), dummies for the types of major business of companies are used instead of the headquarters / branch dummies.

The main interest of this study is the coefficient $\beta_1$, which is the elasticity of labor productivity with municipality employment density. When reporting regression results, all standard errors are adjusted for clustering at the municipality level, which accommodates the nonindependence of errors within municipalities. Estimation is also performed excluding company size from the baseline estimation to clarify how much of the observed elasticity of productivity to population density is due to the difference in company size.[10]

Of the sectors subject to the analysis, publishers other than newspapers are asked how many individual copies of books or magazines they publish in a year. It is natural to treat the total as publishers' physical output, so they are divided by the total number of workers to construct the measure of physical labor productivity (LPQ). The regression results using LPQ are compared with those obtained for the value-added-based labor productivity (LPR).[11] Since there may be large differences in the quality or unit price per book or magazine, there may be issues with using the number of copies published as a measure of output. However, in the case of publishers other than newspapers, there are eight types: general publishers, humanities and social science publishers, natural science publishers, arts and literature publishers, informational and educational publishers, how-to manual publishers, children's publishers, and other. By using these publisher types as dummy variables, it is possible to somewhat mitigate the bias arising from differences in output quality between, for example, general arts and literature publications and technical publications. Moreover, in light of the differences between books and magazines, I use the ratio of number of copies of books published to total copies published (books + magazines) as an additional explanatory variable to correct for the difference in quality between books and magazines. In addition to these control variables, the ratio of publishing business employees to all employees is used as an additional explanatory variable, because the number of copies of books and magazines published includes only the physical output from the publishing business of each company and not output from anything other than its core business.[12]

Summary statistics for labor productivity (logarithm) used as dependent variables are given in

[10] Since the analysis of this study is a simple cross-sectional regression, we cannot eliminate a possible reverse causality resulting from a sorting effect, namely, that highly skilled workers gather in large cities or highly productive establishments and companies locate in large cities.

[11] In Morikawa (2011), which deals with personal services, the variables of total number of users or total number of guests were used as physical output measures.

[12] In the case of value-added labor productivity, both the numerator and denominator are figures for entire establishments or companies. They include data such as sales, costs, and number of workers of businesses other than the core business.

Table 2 by industry. While there are differences between sectors, the simple average of the standard deviations in productivity is about 0.8, which indicates that even within narrowly-defined industries there is a great deal of productivity dispersion. Summary statistics for the other variables including the population density (logarithm) are reported in Appendix Table 1.

## 3. Estimation Results

### 3.1 Value-Added Productivity and Employment Density

The elasticity of labor productivity with respect to density—the estimated coefficient for the employment density of a municipality—is summarized in Table 3. Results are shown separately for the years 2010 and 2013. The levels of statistical significance are evaluated based on cluster-robust standard errors. The detailed estimation results including other explanatory variables are presented in Appendix Table 2.

Column (1) of Table 3 presents estimation results when company size (logarithm of capital amount) is excluded as an explanatory variable, and column (2) gives the estimation results for when it is included. As explained in the previous section, the estimation results reported in column (1) that do not control for company size, include the effect of company size, namely that the greater the employment density of a region, the greater the size of its companies. In all sectors, except for surveyor certification businesses in 2010, the coefficients for employment density are positive and statistically significant. The greater the employment density of the municipality in which establishments or companies are located, the higher their productivity is. The simple average of coefficients for the industries analyzed is about 0.08, meaning that doubling the employment density of a municipality in which a business is located is associated with an approximately 6% higher labor productivity.

However, there is considerable heterogeneity in the size of the elasticity by industries. The elasticities are quite large for video picture information production and distribution; sound information production; newspaper publishers; publishers other than newspapers; and services incidental to video picture, sound, and text information production and distribution. On the other hand, software services; data processing and information services; mechanical designing

businesses; machine repair services; and electrical machinery repair services show relatively small elasticities.

Software services and data processing and information services are not strongly characterized by “simultaneous production and consumption.” In the case of software, consumption is not necessarily simultaneous with production. Package software, in particular, is distributed in a manner very similar to manufactured products. Data processing and information services can overcome geographic simultaneity by using telecommunications networks. Thus, I interpret the results for these sectors to mean that locating in large dense cities does not necessarily give them a strong advantage. Mechanical designing businesses and machine repair services are service industries but closely related to activities of the manufacturing industry, so it is advantageous to them to locate close to establishments of the manufacturing industry rather than in large cities.

Column (2) of Table 3 shows the estimated density elasticity controlling for company size. In nearly all sectors with the exceptions of sound information production and surveyor certification businesses in 2010, the coefficients of employment density are positive and statistically significant. The simple average of the estimated elasticities is about 0.05, meaning that doubling the employment density of a municipality is associated with a 3%-4% increase in labor productivity. This is about 60% of the elasticity shown in column (1), where company size is not controlled for. For software services and data processing and information services, the elasticity is rather small, just 0.01-0.02. Since the larger the city the larger the size of service establishments and companies, the pure employment density effect excluding the size effect becomes somewhat smaller.

Several reasons might be offered to explain the higher productivity of KIBS in large cities with high employment density. First, there may be geographical sorting based on differences in worker quality (Yankow, 2006; Gould, 2007), which is not observed in the data used in this study. Second, there may be traditional mechanisms of agglomeration economies at work, such as knowledge spillover through channels such as face-to-face contact. Third, there may be a selection effect: the large number of companies and establishments and the high degree of competition in large cities may prevent less productive companies and establishments from surviving, which in turn raises average productivity (Syverson, 2004a, 2004b; Combes *et al*., 2012). It would be difficult to use the study data to assess the relative importance of these potential mechanisms, but we can observe the last mechanism to some extent. This is because if

we assume less productive companies and enterprises exit from the market, we would expect the left side of the productivity distribution (the low end) to be truncated.

Looking at software services, data processing and information services, design businesses, and advertising agencies (sectors for which there are relatively large samples), I compare the productivity distributions (kernel density distributions) of establishments located in municipalities with either high or low employment density. The municipalities are categorized based on the median employment density of the establishments sampled in each sector.

Results using 2013 data are shown in Figure 1. For software services and advertising agencies, the productivity distribution does appear to be truncated on the left side for those establishments located in regions of high employment density, suggesting that there is a selection mechanism at work through fierce competition. For data processing and information services and design businesses, on the other hand, the productivity distribution is towards the right for those establishments located in municipalities with high employment density. However, even in these sectors, the productivity distribution curves for establishments located in municipalities with low employment density have low peaks and long tails. While there are differences between sectors, the results suggest that the selection mechanism is at work to some extent, such that low-productivity establishments in large cities are forced out from the market.

The coefficients for company size are summarized in Table 4. The coefficients are positive and statistically significant at the 1% level for all sectors, meaning economies of scale clearly can be observed.[13] Since labor productivity and capital are both expressed as logarithms, the size of the coefficient can be interpreted as the scale elasticity of the value-added. While the figures differ by sector, in most cases there is relatively high scale elasticity, at about 0.1–0.2. Even in regressions using data at the establishment level, the size variable is the capital of the "company," so it refers to economies of company size, not economies of establishment size. The result suggests that companies with a strong headquarters function that operate multiple establishments are highly productive.[14]

Of the control variables, coefficients for the ratios of female workers, part-timers, and temporary employees are negative in many sectors, and the estimated coefficients are statistically significant in most cases (see Appendix Table 2). Moreover, in the case of

[13] Because the dependent variable is not TFP but labor productivity, we cannot rule out the possibility that the greater the size of a company, the higher the capital-labor ratio is.
[14] Headquarters function is a very important function in modern companies (Morikawa, 2015).

estimations using establishment-level data, the coefficients for branch establishment dummy are often positive and significant, taking one company-one establishment as the reference category. This is possibly because branch establishments have little inputs on headquarters functions.[15]

Overall, the service industries that create knowledge and information content (information production, publishers, design businesses, and advertising agencies) benefit greatly from economies of urban density. On the other hand, cities with relatively low density do not present much of a disadvantage to industries where distance does not create great barriers (software services and data processing and information services) or sectors closely related to the manufacturing activity (mechanical designing businesses and machine repair services).

### 3.2 Physical Productivity of Publishers

Of the sectors analyzed in this study, publishers other than newspapers have physical output data: the number of copies of books and magazines published. In this subsection, I measure the physical labor productivity (LPQ), which uses that physical output as a numerator, and I take the LPQ as dependent variable to analyze economies of density. Although the number of copies of books and magazines published has a limitation as an output measure as explained in section 2, it is a natural measure of physical output for publishers. Moreover, adding dummies for the types of major business in each of eight categories and using the ratio of copies of books to total copies of books and magazines as explanatory variables makes it possible to control for differences in output quality to some extent.

The relationship between value-added productivity (LPR) and physical productivity (LPQ) is plotted in Figure 2. Here, employee characteristics (ratios of female, part-time, and temporary workers), ratio of books, and ratio of employees working in the publishing business (in the case of physical productivity) are controlled for (and employment density and company size are not), and the residuals of the estimations are plotted. The horizontal axis represents value-added productivity and the vertical axis physical productivity (both expressed as logarithms). The figure shows that companies with high value-added productivity also tend to have high physical

[15] On the other hand, there are some cases where the coefficient for headquarters dummy is positive and significant, but in most sectors, the coefficients are not statistically significant.

productivity.[16] Alternatively, businesses that publish many copies of books or magazines per employee also have high value-added per employee.

Key points of the estimation results are presented in Table 5. The baseline estimation here uses ratio of books and ratio of employees working in the publishing business as additional explanatory variables (see Appendix Table 3 for details of estimation results). In the case where company size is not controlled for, the estimated coefficients for employment density are very large (0.15 for 2010 and 0.27 for 2013), though there is considerable difference between these two years (column (1) of Table 5). In contrast, the coefficients are 0.11 for 2010 and 0.14 for 2013 when value-added productivity is used as a dependent variable as already shown in Table 3. In the case of LPQ, or productivity measured in physical terms, doubling the employment density of a municipality in which a business is located is associated with 10%–20% higher labor productivity, and the productivity gap between regions is greater than that measured by LPR. In other words, companies located in large cities have high value-added productivity not because the price of the books and magazines they sell is relatively expensive. If anything, it is just the opposite.

Although not shown in the tables, in LPQ estimates, the coefficient of the ratio of books is significantly negative. This result is expected, as it reflects the fact that more copies of magazines than books are published per unit of input. The result additionally reflects the fact that publishers of specialty publications have lower physical productivity than general publishers, in that general publishers publish more copies of books and magazines. The coefficient for the ratio of employees in the core business of publishing is a significant positive figure as expected. In other words, companies with a high ratio of employees engaged in the business of publishing have high physical productivity in their core business. Interestingly, in the publishing industry, the coefficient for the ratio of female workers is not statistically significant, whether measured by LPR or LPQ. In this industry, there is no evidence that the higher the ratio of female employees, the lower the productivity.

Books and magazines, the products of publishers, are not characterized by “simultaneous production and consumption,” which is a typical characteristic of services. This is evidenced by the fact that until “information and communications industry” was established as one of the divisions of industries in the Japan Standard Industrial Classification in 2002, publishing had

[16] However, the correlation coefficient was about 0.35 in both 2010 and 2013, which is not so high.

been classified within the manufacturing industry. Publishing is an industry with a large volume of production and distribution inventory. Therefore, the urban agglomeration economies observed in publishers other than newspapers would seem not to be related to the demand side (customers living close to the place of production), but rather, to the supply side. It is conceivable that knowledge spillovers in large cities with a high level of agglomeration and significantly dense human networks are related to the above finding.

## 4. Conclusions

This study uses establishment- and company-level micro data from the Survey of Selected Service Industries to measure labor productivity and analyze the economies of urban density for knowledge- and information-related business services in Japan, such as information services, publishers, and design businesses.

The analysis results can be summarized as follows. First, the higher the employment density of the municipalities in which these services are located, the higher the productivity of establishments and companies. There are greater economies of density in knowledge- and information-related business services than in the manufacturing industry. On average, doubling the employment density of a municipality is associated with about 5% higher labor productivity for service establishments and companies located there. Second, however, this relationship differs considerably depending on the industries. In the knowledge and information industries (video picture information production and distribution, publishers, design businesses, and advertising agencies), there are great economies of urban density. Third, there are significant economies of scale of companies in these services. Fourth, as regards publishers, greater economies of urban density are observed when using a measure of physical productivity (LPQ) than when using a measure of value-added productivity (LPR).

These results show that urban density plays a key role for the knowledge- and information-intensive business services that are likely to support future economic growth. This suggests that selection and concentration (maintaining concentrations of population in large cities) is desirable in the scenario of declining population in Japan. At the same time, however, the fact that there are considerable differences in the coefficients of employment density depending on the sector tells us that there are service industries to be promoted in large cities

like Tokyo and Osaka and others that can be promoted in small and medium-sized cities with relatively low employment densities. For example, it would be difficult for publishers, design businesses, and advertising agencies to raise their productivity in small and medium-sized cities, while sectors where information and communication technologies overcome the barrier of distance (software services, data processing and information services) and sectors where accessibility to manufacturing establishments is important (mechanical designing businesses and machine repair services) do not necessarily gain a great advantage by locating in large cities. To put it another way, small- and medium-sized cities, if they have appropriate economic environments, have the ability for some types of services to achieve a reasonable level of productivity. Moreover, the fact that there are economies of company size suggests that it would be effective for large companies to develop networks of establishments in many regions for the sake of enhancing productivity in Japan as a whole.

It should be noted that there are some limitations to the present analysis. First, this study considered labor productivity, and not TFP, because capital stock data is unavailable for service industries. However, the impact of differences in capital–labor ratios is thought to be an insignificant problem, because the analysis is performed on narrowly defined individual service industries. Second, employee data in the Survey of Selected Service Industries do not cover detailed worker characteristics, such as educational background, age, and years of experience. The high productivity in service establishments and companies located in large and dense cities may be because of the availability of many high-quality workers. Third, this study's findings are limited to cross-sectional facts for the years 2010 and 2013. Therefore, the results cannot necessarily be interpreted as a causality running from urban density to productivity. We cannot eliminate a possible reverse causality resulting from a sorting mechanism, namely, that highly productive establishments and companies tend to relocate to large cities. Further research is needed to overcome these limitations.

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Table 1 Economic Size of the Selected Service Industries

| | (1) Establishments | (2) Employees | (3) Sales (100 million yen) | (4) Ratio of single establishment firms |
|---|---|---|---|---|
| Software | 23,144 | 759,922 | 159,352 | 81.0% |
| Data processing and information services | 7,225 | 150,330 | 20,848 | 93.1% |
| Internet-based services | 2,302 | 36,455 | 12,399 | 92.1% |
| Video picture information production and distribution | 3,385 | 45,751 | 12,368 | 90.4% |
| Sound information production | 462 | 4,290 | 2,096 | 89.4% |
| Newspaper publishers | 2,654 | 48,025 | 15,540 | 66.9% |
| Publishers other than newspapers | 4,349 | 68,953 | 20,818 | 87.6% |
| Design businesses | 7,048 | 32,729 | 3,866 | 95.5% |
| Mechanical designing businesses | 6,273 | 74,548 | 9,765 | 92.8% |
| Advertising agencies | 7,887 | 105,660 | 68,465 | 86.0% |
| Surveyor Certification businesses | 1,269 | 23,082 | 2,568 | 81.5% |
| Machine repair services | 10,765 | 108,426 | 19,224 | 91.1% |
| Electrical machinery repair services | 5,055 | 53,024 | 10,353 | 92.5% |
| Total | 81,818 | 1,511,195 | 357,662 | 88.2% |

Notes: Author's calculation from the Economic Census for Business Activity (2012). Among the 14 service industries studied, services incidental to video picture, sound information, and text information production and distribution are not reported in the Economic Census at the 3-digit industry classification.

Table 2 Summary Statistics of Labor Productivity by Industry

| | (1) 2010 | | | | | (2) 2013 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | mean | sd | min | max | N | mean | sd | min | max | N |
| Software | 6.450 | 0.657 | 1.099 | 9.542 | 3,763 | 6.504 | 0.622 | 1.466 | 9.043 | 2,822 |
| Data processing and information services | 6.425 | 0.745 | -0.111 | 9.542 | 3,705 | 6.505 | 0.719 | 2.001 | 9.354 | 2,351 |
| Internet-based services | 6.558 | 0.777 | -0.111 | 9.023 | 1,133 | 6.562 | 0.759 | 4.437 | 9.229 | 1,096 |
| Video picture information production and distribution | 6.227 | 0.946 | 1.609 | 9.980 | 650 | 6.375 | 0.753 | 3.274 | 9.931 | 563 |
| Sound information production | 6.417 | 1.465 | 0.000 | 9.183 | 58 | 6.002 | 1.152 | 1.846 | 8.989 | 205 |
| Newspaper publishers | 6.194 | 0.773 | 3.373 | 8.958 | 297 | 6.259 | 0.722 | 3.526 | 7.991 | 285 |
| Publishers other than newspapers (LPR) | 6.553 | 0.768 | 3.203 | 8.894 | 696 | 6.533 | 0.738 | 3.638 | 9.538 | 536 |
| Publishers other than newspapers (LPQ) | 1.942 | 1.674 | -2.862 | 7.023 | 856 | 2.069 | 1.666 | -3.555 | 6.839 | 665 |
| Services incidental to video picture, sound information, character information production and distribution | 6.300 | 0.664 | 3.823 | 8.040 | 143 | 6.365 | 0.601 | 3.823 | 8.445 | 282 |
| Design businesses | 6.218 | 0.494 | 3.350 | 8.909 | 1,574 | 6.217 | 0.521 | 3.730 | 7.735 | 1,248 |
| Mechanical designing businesses | 6.381 | 0.705 | 1.232 | 9.202 | 1,777 | 6.472 | 0.686 | 2.755 | 9.892 | 1,285 |
| Advertising agencies | 6.155 | 0.420 | 4.605 | 7.564 | 996 | 6.230 | 0.415 | 3.683 | 7.475 | 1,064 |
| Surveyor certification businesses | 6.301 | 0.781 | 1.705 | 9.408 | 449 | 6.259 | 0.828 | 2.886 | 9.381 | 689 |
| Machine repair services | 6.572 | 0.794 | -0.223 | 10.060 | 1,182 | 6.507 | 0.638 | 3.384 | 8.687 | 1,657 |
| Electrical machinery repair services | 6.774 | 0.822 | 2.565 | 9.271 | 1,078 | 6.701 | 0.700 | 2.939 | 9.882 | 1,614 |

Notes: The figures are the value-added labor productivities expressed in logarithm. Number of copies of books and magazines published is used as numerator of the physical labor productivity of publishers.

Table 3 Elasticity of Labor Productivity with Respect to Employment Density

A. 2010

| | (1) Without size | | (2) With size | | N |
|---|---|---|---|---|---|
| Software | 0.037 | *** | 0.012 | ** | 3,763 |
| Data processing and information services | 0.033 | *** | 0.018 | ** | 3,705 |
| Internet-based services | 0.068 | *** | 0.041 | *** | 1,133 |
| Video picture information production and distribution# | 0.123 | *** | 0.080 | *** | 650 |
| Sound information production# | 0.233 | * | 0.098 | | 58 |
| Newspaper publishers# | 0.109 | *** | 0.046 | ** | 297 |
| Publishers other than newspapers# | 0.110 | *** | 0.066 | *** | 696 |
| Services incidental to video picture, sound information, character information production and distribution# | 0.103 | *** | 0.056 | *** | 143 |
| Design businesses | 0.058 | *** | 0.054 | *** | 1,574 |
| Mechanical designing businesses | 0.070 | *** | 0.052 | *** | 1,777 |
| Advertising agencies | 0.032 | *** | 0.025 | *** | 996 |
| Surveyor Certification businesses | 0.002 | | -0.004 | | 449 |
| Machine repair services | 0.062 | *** | 0.040 | *** | 1,182 |
| Electrical machinery repair services | 0.059 | *** | 0.045 | *** | 1,078 |
| (Mean) | 0.078 | | 0.045 | | |

B. 2013

| | (1) Without size | | (2) With size | | N |
|---|---|---|---|---|---|
| Software | 0.048 | *** | 0.015 | *** | 2,797 |
| Data processing and information services | 0.045 | *** | 0.017 | ** | 2,332 |
| Internet-based services | 0.082 | *** | 0.036 | *** | 1,088 |
| Video picture information production and distribution# | 0.121 | *** | 0.082 | *** | 557 |
| Sound information production# | 0.212 | *** | 0.152 | *** | 204 |
| Newspaper publishers# | 0.103 | *** | 0.050 | *** | 282 |
| Publishers other than newspapers# | 0.143 | *** | 0.103 | *** | 533 |
| Services incidental to video picture, sound information, character information production and distribution# | 0.112 | *** | 0.091 | *** | 280 |
| Design businesses | 0.067 | *** | 0.060 | *** | 1,243 |
| Mechanical designing businesses | 0.076 | *** | 0.053 | *** | 1,272 |
| Advertising agencies | 0.027 | *** | 0.017 | ** | 1,061 |
| Surveyor Certification businesses | 0.040 | ** | 0.036 | * | 684 |
| Machine repair services | 0.042 | *** | 0.022 | ** | 1,645 |
| Electrical machinery repair services | 0.047 | *** | 0.044 | *** | 1,602 |
| (Mean) | 0.083 | | 0.056 | | |

Notes: #: company-level data. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively, based on the cluster robust standard errors. Figures in column (1) do not include company size as an explanatory variable.

Table 4 Estimated Coefficients for Company Size

| | (1) 2010 | | (2) 2013 | |
|---|---|---|---|---|
| Software | 0.124 | *** | 0.126 | *** |
| Data processing and information services | 0.129 | *** | 0.128 | *** |
| Internet-based services | 0.143 | *** | 0.149 | *** |
| Video picture information production and distribution# | 0.194 | *** | 0.163 | *** |
| Sound information production# | 0.357 | *** | 0.238 | *** |
| Newspaper publishers# | 0.185 | *** | 0.166 | *** |
| Publishers other than newspapers# | 0.216 | *** | 0.151 | *** |
| Services incidental to video picture, sound information, character information production and distribution# | 0.215 | *** | 0.096 | *** |
| Design businesses | 0.055 | *** | 0.054 | *** |
| Mechanical designing businesses | 0.097 | *** | 0.106 | *** |
| Advertising agencies | 0.080 | *** | 0.097 | *** |
| Surveyor Certification businesses | 0.153 | *** | 0.148 | *** |
| Machine repair services | 0.077 | *** | 0.073 | *** |
| Electrical machinery repair services | 0.075 | *** | 0.089 | *** |
| (Mean) | 0.150 | | 0.127 | |

Notes: The amount of capital is used as measure of company size. #: company-level data. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

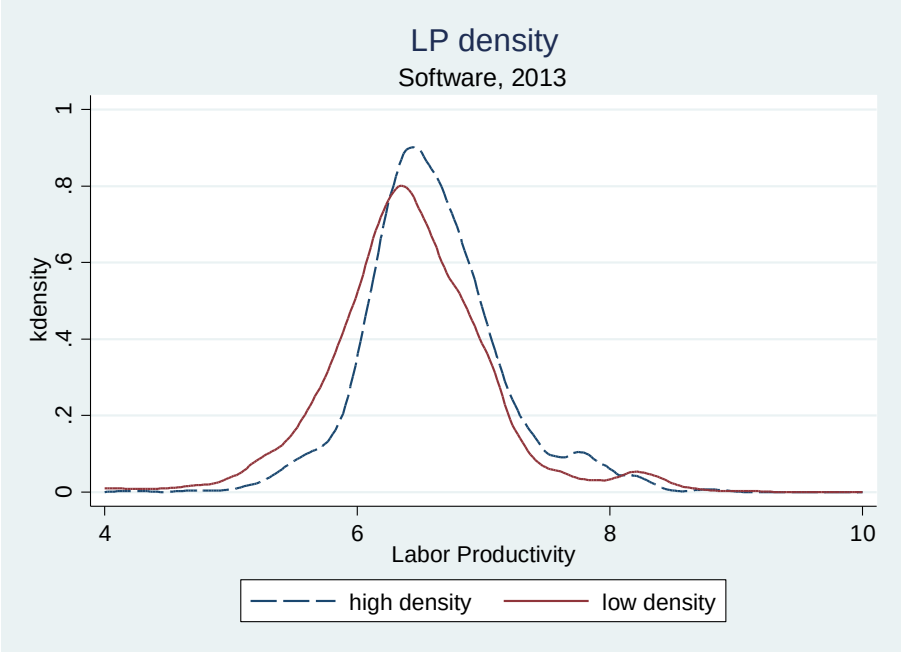
Table 5 Publishers' Elasticity of Physical Labor Productivity with Respect to Employment Density

| | (1) Without firm size | | (2) With firm size | | N |
|---|---|---|---|---|---|
| 2010 | 0.150 | *** | 0.117 | *** | 856 |
| 2013 | 0.267 | *** | 0.217 | *** | 660 |

Notes: *** indicates statistical significance at the 1% level based on the cluster robust standard errors. Figures in column (1) do not include company size as an explanatory variable.

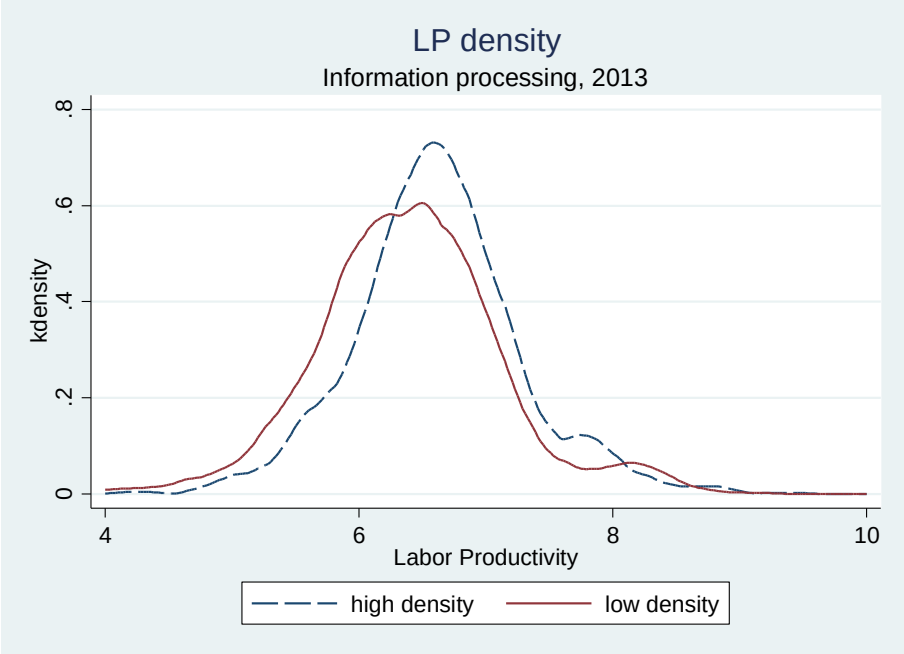
Figure 1 Kernel Density Distribution of Labor Productivity by Location

(1) Software

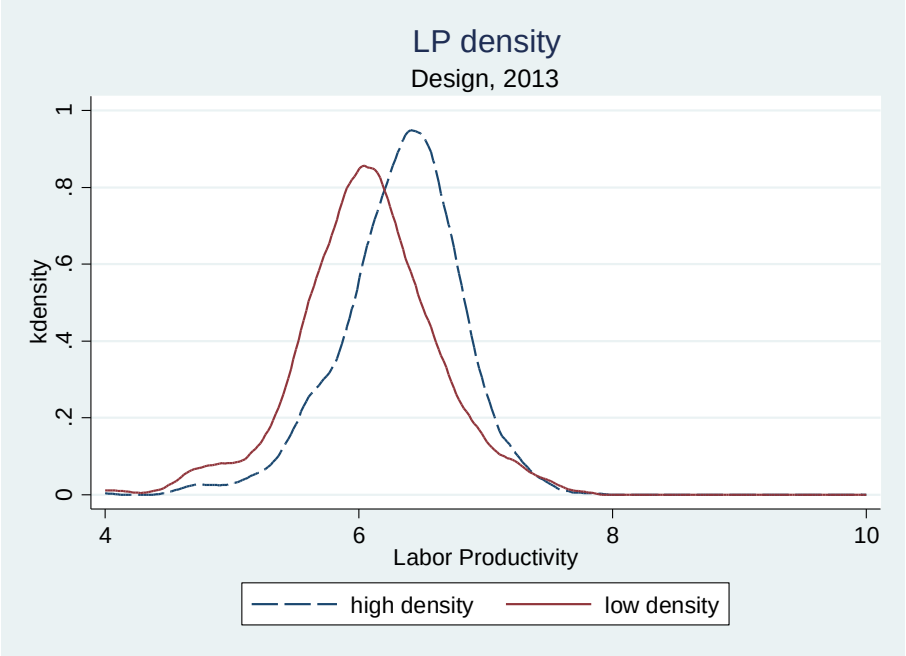



Note: The high- and low-density locations are divided by the median of the sample.

(2) Data processing and information services



(3) Design businesses




(4) Advertising agencies

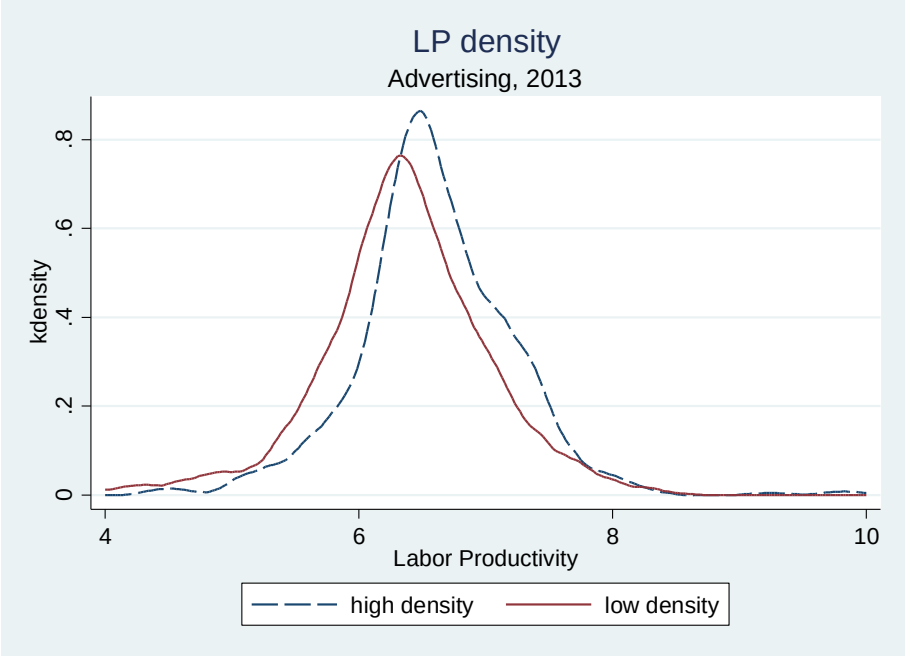
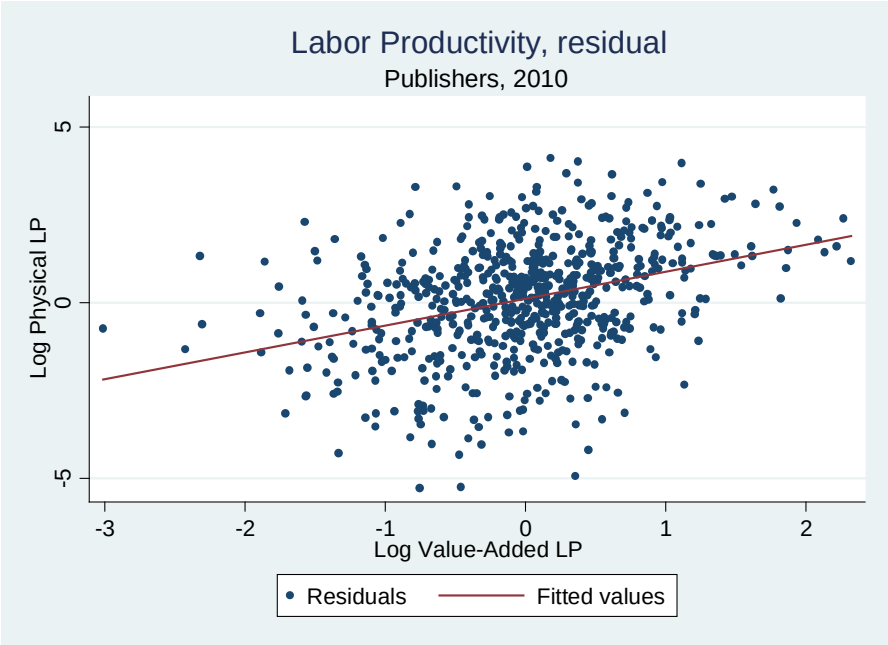
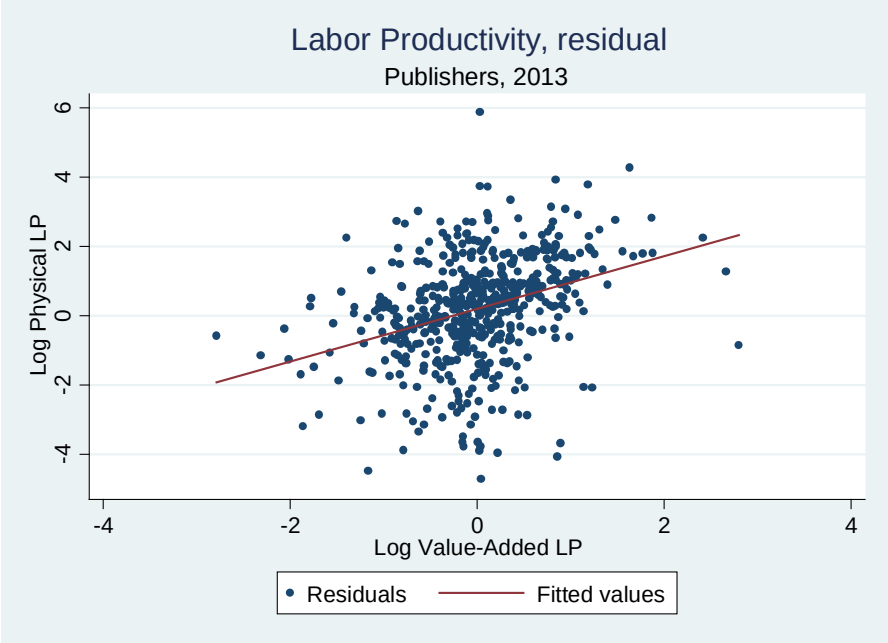


Figure 2 Physical and Revenue Productivities (Publishers)

A. 2010




B. 2013




Note: Labor productivities are the residuals after controlling for the characteristics of employees (the ratios of female, part-time, and temporary employees), ratio of books, and ratio of employees working in the publishing business.

Appendix Table 1 Summary Statistics of the Major Variables by Industry

| | | (1) 2010 | | | | | (2) 2013 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | mean | sd | min | max | N | mean | sd | min | max | N |
| Software | *lnlp* | 6.450 | 0.657 | 1.099 | 9.542 | 3,763 | 6.504 | 0.622 | 1.466 | 9.043 | 2,822 |
| | *lncap* | 8.724 | 2.195 | 0.000 | 17.526 | 3,946 | 8.817 | 2.338 | 0.000 | 17.642 | 3,081 |
| | *fratio* | 0.220 | 0.165 | 0.000 | 1.000 | 3,997 | 0.227 | 0.172 | 0.000 | 1.000 | 3,130 |
| | *pratio* | 0.037 | 0.101 | 0.000 | 1.000 | 3,997 | 0.039 | 0.097 | 0.000 | 1.000 | 3,130 |
| | *tratio* | 0.014 | 0.071 | 0.000 | 0.909 | 3,997 | 0.009 | 0.059 | 0.000 | 1.000 | 3,130 |
| | *lnempdens* | 8.220 | 1.923 | 2.397 | 11.040 | 3,999 | 7.906 | 2.067 | 1.937 | 11.040 | 3,098 |
| Data processing and information services | *lnlp* | 6.425 | 0.745 | -0.111 | 9.542 | 3,705 | 6.505 | 0.719 | 2.001 | 9.354 | 2,351 |
| | *lncap* | 8.515 | 2.123 | 0.000 | 17.599 | 3,780 | 8.642 | 2.361 | 0.000 | 17.642 | 2,568 |
| | *fratio* | 0.338 | 0.256 | 0.000 | 1.000 | 3,907 | 0.315 | 0.246 | 0.000 | 1.000 | 2,655 |
| | *pratio* | 0.090 | 0.166 | 0.000 | 1.000 | 3,907 | 0.075 | 0.147 | 0.000 | 0.939 | 2,655 |
| | *tratio* | 0.023 | 0.102 | 0.000 | 0.984 | 3,907 | 0.016 | 0.083 | 0.000 | 1.000 | 2,655 |
| | *lnempdens* | 8.304 | 2.030 | 2.510 | 11.040 | 3,909 | 7.876 | 2.127 | 1.937 | 11.040 | 2,634 |
| Internet-based services | *lnlp* | 6.558 | 0.777 | -0.111 | 9.023 | 1,133 | 6.562 | 0.759 | 4.437 | 9.229 | 1,096 |
| | *lncap* | 8.662 | 2.288 | 0.000 | 17.599 | 1,217 | 8.272 | 2.653 | 0.000 | 17.296 | 1,287 |
| | *fratio* | 0.300 | 0.198 | 0.000 | 1.000 | 1,252 | 0.294 | 0.219 | 0.000 | 1.000 | 1,339 |
| | *pratio* | 0.078 | 0.144 | 0.000 | 1.000 | 1,252 | 0.055 | 0.114 | 0.000 | 0.833 | 1,339 |
| | *tratio* | 0.019 | 0.091 | 0.000 | 0.909 | 1,252 | 0.017 | 0.085 | 0.000 | 1.000 | 1,339 |
| | *lnempdens* | 8.213 | 2.068 | 2.745 | 11.040 | 1,255 | 7.811 | 2.239 | 1.937 | 11.040 | 1,327 |
| Video picture information production and distribution | *lnlp* | 6.227 | 0.946 | 1.609 | 9.980 | 650 | 6.375 | 0.753 | 3.274 | 9.931 | 563 |
| | *lncap* | 7.044 | 1.374 | 0.693 | 14.850 | 889 | 6.850 | 1.358 | 0.000 | 13.973 | 940 |
| | *fratio* | 0.266 | 0.205 | 0.000 | 1.000 | 978 | 0.288 | 0.204 | 0.000 | 1.000 | 988 |
| | *pratio* | 0.052 | 0.138 | 0.000 | 0.968 | 978 | 0.084 | 0.160 | 0.000 | 1.000 | 988 |
| | *tratio* | 0.049 | 0.160 | 0.000 | 0.968 | 978 | 0.051 | 0.158 | 0.000 | 1.000 | 988 |
| | *lnempdens* | 8.601 | 2.096 | 2.625 | 11.040 | 978 | 8.192 | 2.062 | 2.189 | 11.040 | 980 |
| Sound information production | *lnlp* | 6.417 | 1.465 | 0.000 | 9.183 | 58 | 6.002 | 1.152 | 1.846 | 8.989 | 205 |
| | *lncap* | 7.490 | 1.830 | 5.704 | 14.898 | 59 | 6.443 | 1.605 | 0.000 | 14.897 | 246 |
| | *fratio* | 0.302 | 0.204 | 0.000 | 0.750 | 59 | 0.309 | 0.252 | 0.000 | 1.000 | 241 |
| | *pratio* | 0.057 | 0.125 | 0.000 | 0.778 | 59 | 0.081 | 0.172 | 0.000 | 1.000 | 241 |
| | *tratio* | 0.035 | 0.130 | 0.000 | 0.750 | 59 | 0.033 | 0.124 | 0.000 | 0.800 | 241 |
| | *lnempdens* | 9.427 | 1.598 | 4.875 | 11.040 | 59 | 8.855 | 1.843 | 3.065 | 11.040 | 828 |
| Newspaper publishers | *lnlp* | 6.194 | 0.773 | 3.373 | 8.958 | 297 | 6.259 | 0.722 | 3.526 | 7.991 | 285 |
| | *lncap* | 7.616 | 1.481 | 2.303 | 12.936 | 324 | 7.573 | 1.513 | 2.303 | 12.936 | 347 |
| | *fratio* | 0.318 | 0.200 | 0.000 | 1.000 | 381 | 0.339 | 0.196 | 0.000 | 1.000 | 374 |
| | *pratio* | 0.082 | 0.122 | 0.000 | 0.714 | 381 | 0.125 | 0.146 | 0.000 | 0.750 | 374 |
| | *tratio* | 0.021 | 0.081 | 0.000 | 0.667 | 381 | 0.024 | 0.093 | 0.000 | 0.750 | 374 |
| | *lnempdens* | 6.484 | 2.222 | 1.916 | 11.040 | 381 | 6.549 | 2.253 | 1.916 | 11.040 | 371 |
| Publishers other than newspapers | *lnlp* | 6.553 | 0.768 | 3.203 | 8.894 | 696 | 6.533 | 0.738 | 3.638 | 9.538 | 536 |
| | *lncap* | 7.366 | 1.136 | 2.303 | 13.394 | 819 | 7.367 | 1.298 | 1.792 | 13.806 | 640 |
| | *fratio* | 0.408 | 0.222 | 0.000 | 1.000 | 895 | 0.418 | 0.214 | 0.000 | 1.000 | 685 |
| | *pratio* | 0.067 | 0.120 | 0.000 | 1.000 | 895 | 0.115 | 0.153 | 0.000 | 1.000 | 685 |
| | *tratio* | 0.022 | 0.088 | 0.000 | 0.846 | 895 | 0.018 | 0.077 | 0.000 | 1.000 | 685 |
| | *lnempdens* | 9.106 | 1.964 | 2.836 | 11.040 | 895 | 8.596 | 2.109 | 2.843 | 11.040 | 680 |
| | *lnlp_phy* | 1.942 | 1.674 | -2.862 | 7.023 | 856 | 2.069 | 1.666 | -3.555 | 6.839 | 665 |
| | *book_ratio* | 0.535 | 0.451 | 0.000 | 1.000 | 856 | 0.516 | 0.446 | 0.000 | 1.000 | 665 |
| Services incidental to video picture, sound information, character information production and distribution | *lnlp* | 6.300 | 0.664 | 3.823 | 8.040 | 143 | 6.365 | 0.601 | 3.823 | 8.445 | 282 |
| | *lncap* | 6.942 | 1.319 | 4.605 | 13.850 | 214 | 6.517 | 1.063 | 0.000 | 10.810 | 573 |
| | *fratio* | 0.345 | 0.271 | 0.000 | 1.000 | 254 | 0.379 | 0.284 | 0.000 | 1.000 | 594 |
| | *pratio* | 0.085 | 0.184 | 0.000 | 0.901 | 254 | 0.102 | 0.187 | 0.000 | 1.000 | 594 |
| | *tratio* | 0.029 | 0.116 | 0.000 | 0.900 | 254 | 0.032 | 0.121 | 0.000 | 0.825 | 594 |
| | *lnempdens* | 9.148 | 1.787 | 3.693 | 11.040 | 254 | 8.840 | 1.874 | 3.328 | 11.040 | 590 |
| Design businesses | *lnlp* | 6.218 | 0.494 | 3.350 | 8.909 | 1,574 | 6.217 | 0.521 | 3.730 | 7.735 | 1,248 |
| | *lncap* | 6.456 | 0.884 | 0.000 | 11.513 | 1,986 | 6.486 | 0.968 | 0.693 | 13.514 | 1,646 |
| | *fratio* | 0.397 | 0.282 | 0.000 | 1.000 | 2,592 | 0.416 | 0.293 | 0.000 | 1.000 | 2,068 |
| | *pratio* | 0.026 | 0.094 | 0.000 | 1.000 | 2,592 | 0.043 | 0.119 | 0.000 | 1.000 | 2,068 |
| | *tratio* | 0.016 | 0.083 | 0.000 | 1.000 | 2,592 | 0.013 | 0.074 | 0.000 | 1.000 | 2,068 |
| | *lnempdens* | 8.785 | 1.994 | 0.582 | 11.040 | 2,592 | 8.365 | 2.114 | 2.518 | 11.040 | 2,054 |
| Advertising agencies | *lnlp* | 6.381 | 0.705 | 1.232 | 9.202 | 1,777 | 6.472 | 0.686 | 2.755 | 9.892 | 1,285 |
| | *lncap* | 7.621 | 1.569 | 0.000 | 15.590 | 2,081 | 7.715 | 1.580 | 0.000 | 15.590 | 1,482 |
| | *fratio* | 0.330 | 0.206 | 0.000 | 1.000 | 2,155 | 0.328 | 0.203 | 0.000 | 1.000 | 1,510 |
| | *pratio* | 0.060 | 0.130 | 0.000 | 1.000 | 2,155 | 0.056 | 0.110 | 0.000 | 0.750 | 1,510 |
| | *tratio* | 0.017 | 0.089 | 0.000 | 1.000 | 2,155 | 0.017 | 0.083 | 0.000 | 0.870 | 1,510 |
| | *lnempdens* | 7.824 | 2.120 | 3.145 | 11.040 | 2,156 | 7.729 | 2.092 | 3.145 | 11.040 | 1,496 |

| | | (1) 2010 | | | | | (2) 2013 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | mean | sd | min | max | N | mean | sd | min | max | N |
| Mechanical designing businesses | *lnlp* | 6.155 | 0.420 | 4.605 | 7.564 | 996 | 6.230 | 0.415 | 3.683 | 7.475 | 1,064 |
| | *lncap* | 6.890 | 1.227 | 2.303 | 14.286 | 1,155 | 6.916 | 1.250 | 2.303 | 12.899 | 1,273 |
| | *fratio* | 0.222 | 0.195 | 0.000 | 1.000 | 1,383 | 0.216 | 0.197 | 0.000 | 1.000 | 1,499 |
| | *pratio* | 0.027 | 0.089 | 0.000 | 0.850 | 1,383 | 0.038 | 0.104 | 0.000 | 1.000 | 1,499 |
| | *tratio* | 0.015 | 0.072 | 0.000 | 0.800 | 1,383 | 0.014 | 0.075 | 0.000 | 0.923 | 1,499 |
| | *lnempdens* | 6.950 | 1.682 | 2.754 | 11.040 | 1,383 | 6.824 | 1.662 | 1.033 | 11.040 | 1,493 |
| Surveyor Certification businesses | *lnlp* | 6.301 | 0.781 | 1.705 | 9.408 | 449 | 6.259 | 0.828 | 2.886 | 9.381 | 689 |
| | *lncap* | 7.765 | 1.271 | 3.912 | 12.668 | 412 | 7.677 | 1.421 | 2.303 | 14.296 | 622 |
| | *fratio* | 0.311 | 0.196 | 0.000 | 1.000 | 460 | 0.315 | 0.215 | 0.000 | 1.000 | 711 |
| | *pratio* | 0.111 | 0.158 | 0.000 | 1.000 | 460 | 0.136 | 0.182 | 0.000 | 1.000 | 711 |
| | *tratio* | 0.020 | 0.079 | 0.000 | 0.714 | 460 | 0.027 | 0.114 | 0.000 | 1.000 | 711 |
| | *lnempdens* | 6.670 | 1.548 | 2.759 | 11.040 | 460 | 6.741 | 1.618 | 2.542 | 11.040 | 708 |
| Machine repair services | *lnlp* | 6.572 | 0.794 | -0.223 | 10.060 | 1,182 | 6.507 | 0.638 | 3.384 | 8.687 | 1,657 |
| | *lncap* | 8.219 | 2.533 | 0.000 | 16.676 | 1,283 | 7.824 | 2.303 | 2.303 | 15.956 | 1,804 |
| | *fratio* | 0.172 | 0.164 | 0.000 | 1.000 | 1,487 | 0.178 | 0.174 | 0.000 | 1.000 | 2,119 |
| | *pratio* | 0.047 | 0.112 | 0.000 | 0.757 | 1,487 | 0.049 | 0.123 | 0.000 | 1.000 | 2,119 |
| | *tratio* | 0.024 | 0.096 | 0.000 | 0.886 | 1,487 | 0.024 | 0.100 | 0.000 | 0.903 | 2,119 |
| | *lnempdens* | 6.640 | 1.797 | 1.354 | 11.040 | 1,487 | 6.446 | 1.736 | 0.795 | 11.040 | 2,104 |
| Electrical machinery repair services | *lnlp* | 6.774 | 0.822 | 2.565 | 9.271 | 1,078 | 6.701 | 0.700 | 2.939 | 9.882 | 1,614 |
| | *lncap* | 9.240 | 2.511 | 0.000 | 15.808 | 1,192 | 9.231 | 2.675 | 0.000 | 17.642 | 1,791 |
| | *fratio* | 0.169 | 0.181 | 0.000 | 1.000 | 1,376 | 0.177 | 0.176 | 0.000 | 1.000 | 1,985 |
| | *pratio* | 0.067 | 0.140 | 0.000 | 1.000 | 1,376 | 0.072 | 0.144 | 0.000 | 1.000 | 1,985 |
| | *tratio* | 0.019 | 0.090 | 0.000 | 1.000 | 1,376 | 0.015 | 0.082 | 0.000 | 1.000 | 1,985 |
| | *lnempdens* | 6.681 | 1.779 | 2.079 | 11.040 | 1,376 | 6.786 | 1.753 | 1.677 | 11.040 | 1,970 |

Notes: The notations of the variables: value-added labor productivity (*lnlp*), Amount of capital (*lncap*), ratio of female employees (*fratio*), ratio of part-timers (*pratio*), ratio of temporary employees (*tratio*), employment density (*lnempdens*), physical labor productivity (*lnlp_phy*), ratio of books (*book_ratio*).

Appendix Table 2 Estimation Results by Industry

(1) Software

| | 2010 | | | | 2013 | | | |
|---|---|---|---|---|---|---|---|---|
| | (1) | | (2) | | (3) | | (4) | |
| ln Density | 0.0370 | *** | 0.0122 | ** | 0.0478 | *** | 0.0153 | *** |
| | (0.0072) | | (0.0062) | | (0.0064) | | (0.0053) | |
| ln Capital | | | 0.1235 | *** | | | 0.1261 | *** |
| | | | (0.0066) | | | | (0.0057) | |
| Female | -0.0888 | | -0.0200 | | -0.2107 | ** | -0.0812 | |
| | (0.0764) | | (0.0704) | | (0.0838) | | (0.0797) | |
| Part-timer | -0.6896 | *** | -0.6247 | *** | -0.8312 | *** | -0.8243 | *** |
| | (0.1495) | | (0.1429) | | (0.1350) | | (0.1355) | |
| Temporary | -1.4844 | *** | -1.3724 | *** | -1.0253 | *** | -0.8086 | *** |
| | (0.2242) | | (0.2195) | | (0.2243) | | (0.2198) | |
| Branch | 0.2048 | *** | 0.0395 | * | 0.1691 | *** | 0.0044 | |
| | (0.0213) | | (0.0221) | | (0.0214) | | (0.0208) | |
| Headquarters | 0.5191 | *** | 0.1595 | *** | 0.4966 | *** | 0.1132 | *** |
| | (0.0289) | | (0.0250) | | (0.0276) | | (0.0278) | |
| Cons. | 6.0041 | *** | 5.2493 | *** | 6.0096 | *** | 5.2665 | *** |
| | (0.0625) | | (0.0626) | | (0.0539) | | (0.0517) | |
| Nobs. | 3,763 | | 3,740 | | 2,797 | | 2,783 | |
| $R^2$ | 0.1547 | | 0.2694 | | 0.1724 | | 0.3071 | |

Notes: Cluster-robust standard errors are reported in parentheses. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

(2) Data processing and information services

| | 2010 | | | | 2013 | | | |
|---|---|---|---|---|---|---|---|---|
| | (1) | | (2) | | (3) | | (4) | |
| ln Density | 0.0332 | *** | 0.0182 | ** | 0.0449 | *** | 0.0167 | ** |
| | (0.0082) | | (0.0073) | | (0.0086) | | (0.0077) | |
| ln Capital | | | 0.1290 | *** | | | 0.1285 | *** |
| | | | (0.0076) | | | | (0.0070) | |
| Female | -0.4961 | *** | -0.3140 | *** | -0.6207 | *** | -0.3916 | *** |
| | (0.0634) | | (0.0601) | | (0.0817) | | (0.0722) | |
| Part-timer | -0.8904 | *** | -0.7785 | *** | -0.9229 | *** | -0.9200 | *** |
| | (0.0766) | | (0.0740) | | (0.1168) | | (0.1155) | |
| Temporary | -1.6722 | *** | -1.5899 | *** | -1.0714 | *** | -0.9227 | *** |
| | (0.1593) | | (0.1513) | | (0.2014) | | (0.1949) | |
| Branch | 0.1545 | *** | -0.0045 | | 0.1464 | *** | -0.0119 | |
| | (0.0244) | | (0.0256) | | (0.0264) | | (0.0267) | |
| Headquarters | 0.4812 | *** | 0.1397 | *** | 0.4865 | *** | 0.1201 | *** |
| | (0.0327) | | (0.0311) | | (0.0303) | | (0.0325) | |
| Cons. | 6.2541 | *** | 5.3332 | *** | 6.2441 | *** | 5.4076 | *** |
| | (0.0692) | | (0.0819) | | (0.0735) | | (0.0700) | |
| Nobs. | 3,705 | | 3,610 | | 2,332 | | 2,284 | |
| $R^2$ | 0.2458 | | 0.335 | | 0.2474 | | 0.3593 | |

(3) Internet-based services

| | 2010 | | | | 2013 | | | |
|---|---|---|---|---|---|---|---|---|
| | (1) | | (2) | | (3) | | (4) | |
| ln Density | 0.0678 | *** | 0.0408 | *** | 0.0821 | *** | 0.0362 | *** |
| | (0.0119) | | (0.0099) | | (0.0094) | | (0.0082) | |
| ln Capital | | | 0.1432 | *** | | | 0.1492 | *** |
| | | | (0.0122) | | | | (0.0084) | |
| Female | -0.1339 | | 0.0073 | | -0.3397 | *** | -0.1201 | |
| | (0.1202) | | (0.1216) | | (0.0975) | | (0.0915) | |
| Part-timer | -0.8164 | *** | -0.6465 | *** | -0.9793 | *** | -0.8222 | *** |
| | (0.1255) | | (0.1149) | | (0.1855) | | (0.1921) | |
| Temporary | -1.3193 | *** | -1.1952 | *** | -0.9597 | *** | -0.7681 | *** |
| | (0.3922) | | (0.3912) | | (0.2105) | | (0.2115) | |
| Branch | 0.1179 | ** | -0.0617 | | 0.1454 | *** | -0.0295 | |
| | (0.0576) | | (0.0574) | | (0.0462) | | (0.0422) | |
| Headquarters | 0.6856 | *** | 0.2492 | *** | 0.6951 | *** | 0.1865 | *** |
| | (0.0587) | | (0.0558) | | (0.0637) | | (0.0461) | |
| Cons. | 5.9051 | *** | 4.9687 | *** | 5.8818 | *** | 5.0337 | *** |
| | (0.1162) | | (0.1282) | | (0.0779) | | (0.0877) | |
| Nobs. | 1,133 | | 1,120 | | 1,088 | | 1,071 | |
| $R^2$ | 0.1817 | | 0.298 | | 0.2574 | | 0.4118 | |

(4) Video picture information production and distribution

| | 2010 | | | | 2013 | | | |
|---|---|---|---|---|---|---|---|---|
| | (1) | | (2) | | (3) | | (4) | |
| ln Density | 0.1231 | *** | 0.0804 | *** | 0.1211 | *** | 0.0815 | *** |
| | (0.0234) | | (0.0210) | | (0.0168) | | (0.0148) | |
| ln Capital | | | 0.1937 | *** | | | 0.1626 | *** |
| | | | (0.0292) | | | | (0.0211) | |
| Female | -0.1244 | | -0.1558 | | -0.2251 | | -0.1816 | |
| | (0.1977) | | (0.1802) | | (0.1564) | | (0.1471) | |
| Part-timer | -1.0618 | *** | -1.0706 | *** | -0.7676 | *** | -0.7658 | *** |
| | (0.2591) | | (0.2388) | | (0.2059) | | (0.1953) | |
| Temporary | -1.5660 | *** | -1.6153 | *** | -1.4728 | *** | -1.4354 | *** |
| | (0.3865) | | (0.3651) | | (0.2508) | | (0.2322) | |
| Cons. | 5.2197 | *** | 4.2608 | *** | 5.3914 | *** | 4.6050 | *** |
| | (0.2224) | | (0.2496) | | (0.1461) | | (0.1840) | |
| Types of business | yes | | yes | | yes | | yes | |
| Nobs. | 650 | | 636 | | 557 | | 546 | |
| $R^2$ | 0.1868 | | 0.2599 | | 0.2037 | | 0.2746 | |

(5) Sound information production

| | 2010 | | | | 2013 | | | |
|---|---|---|---|---|---|---|---|---|
| | (1) | | (2) | | (3) | | (4) | |
| ln Density | 0.2333 | * | 0.0983 | | 0.2123 | *** | 0.1517 | *** |
| | (0.1189) | | (0.1226) | | (0.0455) | | (0.0375) | |
| ln Capital | | | 0.3571 | *** | | | 0.2379 | *** |
| | | | (0.0618) | | | | (0.0340) | |
| Female | -0.1832 | | -0.4047 | | 0.1883 | | 0.0044 | |
| | (1.2481) | | (1.0389) | | (0.3045) | | (0.3288) | |
| Part-timer | -1.3805 | | -1.9291 | | -0.7918 | ** | -0.7888 | ** |
| | (1.4720) | | (1.1650) | | (0.3294) | | (0.3362) | |
| Temporary | -0.8252 | | -0.6948 | | -1.7077 | *** | -1.6879 | *** |
| | (1.3175) | | (1.3693) | | (0.5535) | | (0.5398) | |
| Cons. | 4.6239 | *** | 2.9920 | ** | 4.3374 | *** | 3.2800 | *** |
| | (1.1928) | | (1.1596) | | (0.3849) | | (0.3871) | |
| Types of business | yes | | yes | | yes | | yes | |
| Nobs. | 58 | | 58 | | 204 | | 204 | |
| $R^2$ | 0.1186 | | 0.2598 | | 0.1560 | | 0.2510 | |

(6) Newspaper publishers

| | 2010 | | | | 2013 | | | |
|---|---|---|---|---|---|---|---|---|
| | (1) | | (2) | | (3) | | (4) | |
| ln Density | 0.1086 | *** | 0.0461 | ** | 0.1029 | *** | 0.0499 | *** |
| | (0.0208) | | (0.0197) | | (0.0223) | | (0.0189) | |
| ln Capital | | | 0.1845 | *** | | | 0.1657 | *** |
| | | | (0.0294) | | | | (0.0402) | |
| Female | -1.3403 | *** | -0.9584 | *** | -0.9753 | *** | -0.5559 | * |
| | (0.2541) | | (0.2678) | | (0.2478) | | (0.2842) | |
| Part-timer | -1.4184 | *** | -1.3130 | *** | -1.5234 | *** | -1.3747 | *** |
| | (0.3443) | | (0.3623) | | (0.3005) | | (0.3065) | |
| Temporary | -1.2326 | ** | -1.9084 | *** | -1.1129 | ** | -1.8348 | *** |
| | (0.6237) | | (0.6754) | | (0.5136) | | (0.3319) | |
| Cons. | 6.4906 | *** | 4.9524 | *** | 6.6788 | *** | 5.2148 | *** |
| | (0.2688) | | (0.4801) | | (0.2483) | | (0.4685) | |
| Types of business | yes | | yes | | yes | | yes | |
| Nobs. | 297 | | 279 | | 282 | | 273 | |
| $R^2$ | 0.3670 | | 0.4245 | | 0.3382 | | 0.4029 | |

(7) Publishers other than newspapers

| | 2010 | | | | 2013 | | | |
|---|---|---|---|---|---|---|---|---|
| | (1) | | (2) | | (3) | | (4) | |
| ln Density | 0.1095 | *** | 0.0661 | *** | 0.1427 | *** | 0.1026 | *** |
| | (0.0177) | | (0.0172) | | (0.0150) | | (0.0153) | |
| ln Capital | | | 0.2162 | *** | | | 0.1506 | *** |
| | | | (0.0185) | | | | (0.0335) | |
| Female | 0.0751 | | 0.1267 | | -0.1333 | | -0.0742 | |
| | (0.1832) | | (0.1693) | | (0.1790) | | (0.1839) | |
| Part-timer | -1.2015 | *** | -1.4074 | *** | -0.8876 | *** | -0.9018 | *** |
| | (0.2590) | | (0.2293) | | (0.3324) | | (0.3224) | |
| Temporary | -1.2255 | *** | -1.2793 | *** | -1.0281 | *** | -0.9803 | *** |
| | (0.2552) | | (0.2526) | | (0.3102) | | (0.3252) | |
| Book ratio | 0.0200 | | 0.0311 | | 0.0570 | | 0.0905 | |
| | (0.0635) | | (0.0596) | | (0.0574) | | (0.0573) | |
| Cons. | 5.5561 | *** | 4.2761 | *** | 5.4425 | *** | 4.6002 | *** |
| | (0.1871) | | (0.2034) | | (0.1630) | | (0.2489) | |
| Types of business | yes | | yes | | yes | | yes | |
| Nobs. | 681 | | 648 | | 528 | | 504 | |
| $R^2$ | 0.1433 | | 0.2185 | | 0.2561 | | 0.3066 | |

(8) Services incidental to video picture, sound information, character information production and distribution

| | 2010 | | | | 2013 | | | |
|---|---|---|---|---|---|---|---|---|
| | (1) | | (2) | | (3) | | (4) | |
| ln Density | 0.1032 | *** | 0.0564 | *** | 0.1116 | *** | 0.0913 | *** |
| | (0.0245) | | (0.0182) | | (0.0222) | | (0.0226) | |
| ln Capital | | | 0.2151 | *** | | | 0.0961 | *** |
| | | | (0.0336) | | | | (0.0313) | |
| Female | -0.3266 | | -0.0771 | | -0.1669 | | -0.0472 | |
| | (0.2722) | | (0.2168) | | (0.1296) | | (0.1124) | |
| Part-timer | -0.2053 | | -0.3481 | ** | -0.9227 | *** | -0.8639 | *** |
| | (0.2499) | | (0.1693) | | (0.1914) | | (0.1687) | |
| Temporary | -1.6941 | *** | -1.8897 | *** | -1.4437 | *** | -1.4812 | *** |
| | (0.2356) | | (0.1738) | | (0.2142) | | (0.2025) | |
| Cons. | 5.6482 | *** | 4.2326 | *** | 5.5165 | *** | 5.0049 | *** |
| | (0.3434) | | (0.3649) | | (0.2155) | | (0.2286) | |
| Nobs. | 143 | | 139 | | 280 | | 276 | |
| $R^2$ | 0.2623 | | 0.4174 | | 0.2837 | | 0.3100 | |

(9) Design businesses

| | 2010 | | | | 2013 | | | |
|---|---|---|---|---|---|---|---|---|
| | (1) | | (2) | | (3) | | (4) | |
| ln Density | 0.0585 | *** | 0.0544 | *** | 0.0673 | *** | 0.0596 | *** |
| | (0.0105) | | (0.0091) | | (0.0082) | | (0.0077) | |
| ln Capital | | | 0.0551 | *** | | | 0.0543 | *** |
| | | | (0.0144) | | | | (0.0153) | |
| Female | -0.1354 | ** | -0.1066 | ** | -0.1634 | *** | -0.1539 | *** |
| | (0.0530) | | (0.0470) | | (0.0551) | | (0.0543) | |
| Part-timer | -0.6460 | *** | -0.6796 | *** | -0.6765 | *** | -0.6445 | *** |
| | (0.1076) | | (0.1022) | | (0.1589) | | (0.1662) | |
| Temporary | -1.1090 | *** | -0.8586 | *** | -0.9386 | *** | -0.8092 | *** |
| | (0.1322) | | (0.1286) | | (0.1757) | | (0.2178) | |
| Branch | 0.1210 | *** | 0.0828 | ** | 0.1051 | *** | 0.0811 | ** |
| | (0.0397) | | (0.0402) | | (0.0393) | | (0.0362) | |
| Headquarters | 0.0923 | ** | 0.0431 | | 0.0702 | | 0.0120 | |
| | (0.0388) | | (0.0348) | | (0.0596) | | (0.0566) | |
| Cons. | 5.7685 | *** | 5.4565 | *** | 5.7293 | *** | 5.4564 | *** |
| | (0.0857) | | (0.1264) | | (0.0763) | | (0.1184) | |
| Nobs. | 1,574 | | 1,472 | | 1,243 | | 1,195 | |
| $R^2$ | 0.1237 | | 0.114 | | 0.1319 | | 0.1324 | |

(10) Mechanical designing businesses

| | 2010 | | | | 2013 | | | |
|---|---|---|---|---|---|---|---|---|
| | (1) | | (2) | | (3) | | (4) | |
| ln Density | 0.0321 | *** | 0.0246 | *** | 0.0265 | *** | 0.0167 | ** |
| | (0.0083) | | (0.0086) | | (0.0067) | | (0.0068) | |
| ln Capital | | | 0.0800 | *** | | | 0.0969 | *** |
| | | | (0.0176) | | | | (0.0105) | |
| Female | -0.4854 | *** | -0.3562 | *** | -0.4929 | *** | -0.3815 | *** |
| | (0.0858) | | (0.0884) | | (0.0837) | | (0.0820) | |
| Part-timer | -0.4062 | *** | -0.4229 | *** | -0.3538 | ** | -0.3424 | ** |
| | (0.1259) | | (0.1235) | | (0.1454) | | (0.1385) | |
| Temporary | -0.7978 | *** | 0.0309 | | -1.0291 | *** | 0.0254 | |
| | (0.1693) | | (0.0356) | | (0.2126) | | (0.0349) | |
| Branch | 0.0911 | *** | 0.0549 | | 0.0652 | * | 0.0781 | ** |
| | (0.0343) | | (0.0379) | | (0.0365) | | (0.0309) | |
| Headquarters | 0.1690 | *** | -0.5811 | *** | 0.2211 | *** | -0.8813 | *** |
| | (0.0359) | | (0.1518) | | (0.0302) | | (0.1875) | |
| Cons. | 6.0195 | *** | 5.5104 | *** | 6.1287 | *** | 5.5200 | *** |
| | (0.0636) | | (0.1160) | | (0.0553) | | (0.0891) | |
| Nobs. | 996 | | 974 | | 1,061 | | 1,041 | |
| $R^2$ | 0.1296 | | 0.1637 | | 0.1693 | | 0.2188 | |

(11) Advertising agencies

| | 2010 | | | | 2013 | | | |
|---|---|---|---|---|---|---|---|---|
| | (1) | | (2) | | (3) | | (4) | |
| ln Density | 0.0698 | *** | 0.0518 | *** | 0.0763 | *** | 0.0534 | *** |
| | (0.0087) | | (0.0081) | | (0.0090) | | (0.0086) | |
| ln Capital | | | 0.0970 | *** | | | 0.1056 | *** |
| | | | (0.0108) | | | | (0.0172) | |
| Female | -0.5305 | *** | -0.4404 | *** | -0.5802 | *** | -0.4927 | *** |
| | (0.0949) | | (0.0910) | | (0.1166) | | (0.1156) | |
| Part-timer | -0.6516 | *** | -0.6491 | *** | -0.5184 | *** | -0.5441 | *** |
| | (0.1198) | | (0.1169) | | (0.1808) | | (0.1814) | |
| Temporary | -2.0409 | *** | -1.9289 | *** | -1.2746 | *** | -1.1211 | *** |
| | (0.2337) | | (0.2373) | | (0.2267) | | (0.2280) | |
| Branch | 0.2041 | *** | 0.1106 | *** | 0.2072 | *** | 0.0974 | ** |
| | (0.0328) | | (0.0362) | | (0.0384) | | (0.0412) | |
| Headquarters | 0.4460 | *** | 0.2568 | *** | 0.4548 | *** | 0.2623 | *** |
| | (0.0409) | | (0.0453) | | (0.0387) | | (0.0438) | |
| Cons. | 5.9039 | *** | 5.3438 | *** | 5.9323 | *** | 5.3418 | *** |
| | (0.0758) | | (0.0975) | | (0.0831) | | (0.1216) | |
| Nobs. | 1,777 | | 1,761 | | 1,272 | | 1,263 | |
| $R^2$ | 0.2444 | | 0.2629 | | 0.2089 | | 0.2434 | |

(12) Surveyor certification businesses

| | 2010 | | | | 2013 | | | |
|---|---|---|---|---|---|---|---|---|
| | (1) | | (2) | | (3) | | (4) | |
| ln Density | 0.0022 | | -0.0036 | | 0.0402 | ** | 0.0362 | * |
| | (0.0210) | | (0.0206) | | (0.0204) | | (0.0203) | |
| ln Capital | | | 0.1529 | *** | | | 0.1476 | *** |
| | | | (0.0398) | | | | (0.0244) | |
| Female | -0.9730 | *** | -0.6747 | ** | -0.3829 | ** | -0.2736 | |
| | (0.2514) | | (0.3078) | | (0.1822) | | (0.1859) | |
| Part-timer | 0.4804 | | -0.0050 | | -0.5283 | *** | -0.5069 | *** |
| | (0.3122) | | (0.3614) | | (0.1791) | | (0.1822) | |
| Temporary | -0.9089 | *** | -0.9969 | *** | -1.0554 | *** | -1.1207 | *** |
| | (0.3040) | | (0.3117) | | (0.2604) | | (0.2730) | |
| Branch | 0.2155 | *** | 0.0252 | | 0.2601 | *** | 0.0393 | |
| | (0.0683) | | (0.0746) | | (0.0687) | | (0.0704) | |
| Headquarters | 0.4809 | *** | 0.2054 | ** | 0.6826 | *** | 0.3839 | *** |
| | (0.0834) | | (0.0872) | | (0.0700) | | (0.0709) | |
| Cons. | 6.3504 | *** | 5.3406 | *** | 5.9140 | *** | 4.9593 | *** |
| | (0.1657) | | (0.3348) | | (0.1395) | | (0.2158) | |
| Nobs. | 449 | | 407 | | 684 | | 610 | |
| $R^2$ | 0.1643 | | 0.1720 | | 0.1925 | | 0.2344 | |

(13) Machine repair services

| | 2010 | | | | 2013 | | | |
|---|---|---|---|---|---|---|---|---|
| | (1) | | (2) | | (3) | | (4) | |
| ln Density | 0.0617 | *** | 0.0396 | *** | 0.0424 | *** | 0.0219 | ** |
| | (0.0140) | | (0.0143) | | (0.0094) | | (0.0092) | |
| ln Capital | | | 0.0773 | *** | | | 0.0730 | *** |
| | | | (0.0124) | | | | (0.0114) | |
| Female | 0.0473 | | 0.2706 | | -0.4874 | *** | -0.2844 | ** |
| | (0.1902) | | (0.1871) | | (0.1192) | | (0.1316) | |
| Part-timer | -0.7337 | *** | -0.7068 | *** | -0.4874 | *** | -0.5446 | *** |
| | (0.1859) | | (0.1854) | | (0.1236) | | (0.1185) | |
| Temporary | -1.7909 | *** | -1.6110 | *** | -1.0785 | *** | -0.9377 | *** |
| | (0.1966) | | (0.2102) | | (0.1300) | | (0.1423) | |
| Branch | 0.2079 | *** | 0.1290 | ** | 0.2150 | *** | 0.1396 | *** |
| | (0.0577) | | (0.0575) | | (0.0421) | | (0.0426) | |
| Headquarters | 0.5957 | *** | 0.3310 | *** | 0.3909 | *** | 0.1636 | *** |
| | (0.0492) | | (0.0583) | | (0.0367) | | (0.0380) | |
| Cons. | 5.9358 | *** | 5.5473 | *** | 6.1734 | *** | 5.8163 | *** |
| | (0.1046) | | (0.1238) | | (0.0680) | | (0.1069) | |
| Nobs. | 1,182 | | 1,135 | | 1,645 | | 1,579 | |
| $R^2$ | 0.2296 | | 0.2453 | | 0.1969 | | 0.2116 | |

(14) Electrical machinery repair services

| | 2010 | | | | 2013 | | | |
|---|---|---|---|---|---|---|---|---|
| | (1) | | (2) | | (3) | | (4) | |
| ln Density | 0.0587 | *** | 0.0445 | *** | 0.0467 | *** | 0.0445 | *** |
| | (0.0129) | | (0.0122) | | (0.0099) | | (0.0090) | |
| ln Capital | | | 0.0746 | *** | | | 0.0895 | *** |
| | | | (0.0135) | | | | (0.0083) | |
| Female | -0.0237 | | 0.1564 | | 0.1095 | | 0.2440 | ** |
| | (0.1752) | | (0.1869) | | (0.1105) | | (0.1068) | |
| Part-timer | -0.4766 | ** | -0.4630 | * | -0.5148 | *** | -0.5166 | *** |
| | (0.2276) | | (0.2361) | | (0.1141) | | (0.1084) | |
| Temporary | -1.2095 | *** | -1.1679 | *** | -1.4516 | *** | -1.1911 | *** |
| | (0.3100) | | (0.3269) | | (0.2290) | | (0.2975) | |
| Branch | 0.3082 | *** | 0.1944 | *** | 0.1948 | *** | 0.0930 | * |
| | (0.0620) | | (0.0648) | | (0.0513) | | (0.0493) | |
| Headquarters | 0.8423 | *** | 0.5298 | *** | 0.6006 | *** | 0.2410 | *** |
| | (0.0536) | | (0.0810) | | (0.0364) | | (0.0498) | |
| Cons. | 5.8592 | *** | 5.4538 | *** | 6.0125 | *** | 5.4082 | *** |
| | (0.1044) | | (0.1332) | | (0.0767) | | (0.0812) | |
| Nobs. | 1,078 | | 1,050 | | 1,602 | | 1,571 | |
| $R^2$ | 0.2586 | | 0.2630 | | 0.2207 | | 0.2614 | |

Appendix Table 3 Estimation Results of Publishers' Physical Productivity

| | 2010 | | | | 2013 | | | |
|---|---|---|---|---|---|---|---|---|
| | (1) | | (2) | | (3) | | (4) | |
| ln Density | 0.1501 | *** | 0.1175 | *** | 0.2670 | *** | 0.2174 | *** |
| | (0.0338) | | (0.0353) | | (0.0283) | | (0.0313) | |
| ln Capital | | | 0.2794 | *** | | | 0.2274 | *** |
| | | | (0.0603) | | | | (0.0421) | |
| Female | -0.0844 | | 0.1039 | | -0.1544 | | 0.0085 | |
| | (0.2916) | | (0.3057) | | (0.2923) | | (0.3275) | |
| Part-timer | -0.4256 | | -1.0106 | ** | -0.5390 | | -0.5384 | |
| | (0.4667) | | (0.4588) | | (0.4689) | | (0.4978) | |
| Tenporary | -1.1236 | | -0.6157 | | -1.0896 | | -0.3219 | |
| | (0.7347) | | (0.7917) | | (0.7681) | | (0.8146) | |
| Book ratio | -0.6426 | *** | -0.6349 | *** | -0.6874 | *** | -0.6516 | *** |
| | (0.1201) | | (0.1328) | | (0.1782) | | (0.1863) | |
| Main business ratio | 1.0142 | *** | 1.5577 | *** | 0.8995 | ** | 0.9604 | *** |
| | (0.2510) | | (0.2983) | | (0.3659) | | (0.3628) | |
| Cons. | 0.6417 | * | -1.7164 | *** | -0.0622 | | -1.4938 | *** |
| | (0.3627) | | (0.5837) | | (0.4941) | | (0.5470) | |
| Types of business | yes | | yes | | yes | | yes | |
| Nobs. | 856 | | 788 | | 660 | | 617 | |
| $R^2$ | 0.1171 | | 0.1512 | | 0.2018 | | 0.2250 | |

Notes: Cluster-robust standard errors are reported in parentheses. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.