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Regional healthcare infrastructure disparities and foreign direct investment into Europe

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Abstract

This study examines the impact of sub-national healthcare infrastructure heterogeneity on the location choice of inward foreign direct investment (FDI). We do so by employing an augmented gravity model on Japanese firm-level FDI into European NUTS-2 regions during 2000-2019. Differences in each region's per capita number of hospital beds and practicing physicians highlight healthcare infrastructure heterogeneity across Europe. Negative binomial estimation results indicate that both hospital beds and practicing physicians significantly positively attract inward FDI, with physician density having the more significant impact. The findings are consistent with the hypothesis that local institutional quality is a determinant of FDI attraction.

Keywords: healthcare infrastructure, Europe, foreign direct investment, Japan
JEL Classification Codes: I10, F23

1. Introduction

This paper examines how a region's healthcare infrastructure attracts inward foreign direct investment (FDI). How population health and healthcare infrastructure affect economic outcomes is of significant concern to public policy officials. We examine sub-national FDI location choice, as healthcare infrastructure often differs as significantly within countries as it does across borders. For example, Schley (2018) notes the "design of European healthcare systems is heterogeneous," and regional deprivation of healthcare provision exists in many EU (NUTS-2) regions. As Potrafke and Roesel (2020) find, this heterogeneity may arise from government ideological differences across sub-national regions that can lead to urban-rural gaps in public infrastructure provision such as healthcare. Winkelmann, Muench, and Maier (2020), analyzing NUTS-2 per capita physician distribution, find a 2.4-fold difference between the highest and lowest density countries. This rises to 5.5-fold if examined at the sub-national level, with these differences not lessening over time.[1] We follow Schley (2018) and Winkelmann et. al. (2020) and examine NUTS-2 level European location choice of Japanese foreign affiliates

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[1] In contrast to our work, much research on regional healthcare differences focuses on healthcare outcomes. For Europe, see Asandului, Roman, and Fatulescu (2014); Herwartz and Schley (2018); and Felder and Tauchmann (2013). For the US, see Rettenmaier and Wang (2012); for India, see Kathuria and Sankar (2005).

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between 2000-2017.[2] Examining location choice at a granular level allows us to highlight intra- and inter-national healthcare infrastructure differences and detail the geographical dispersion of Japanese FDI throughout Europe.

Why study healthcare infrastructure? FDI hosts compete for inward investment and the FDI literature has increasingly focused on the role human capital plays in a location's comparative advantage.[3] While human capital is often measured by education or skill-level, health should be considered part of a location's human capital infrastructure.[4] Healthy workers are more productive workers, leading to decreased production costs and increased firm profitability. However, Nagel, et.al. (2015) indicate health and firm-profitability may not be linearly related; increased public health may be more expensive to firms depending upon how health care is financed at local- and national-levels.

Healthcare infrastructure is typically viewed as a beneficiary, and not a determinant, of increased inward FDI. The few papers that examine healthcare's effect on inward FDI typically focus on lesser-developed countries.[5] However, Giammanco and Gitto (2019) recently find European national healthcare expenditures, national insurance systems, and healthy populations significantly influence a nation's aggregate inward-FDI stock.

FDI decisions are made at the firm-level. Therefore, in contrast to Giammanco and Gitto (2019), we focus on firm-level FDI decisions regarding sub-national location choice, recognizing the significant within-country healthcare infrastructure heterogeneity. Our firm-level Japanese FDI data avoids intra-EU investment and allows us to identify individual investor decisions in response to Europe's changing healthcare infrastructure landscape.[6] Finally, combining national healthcare governance systems with regional healthcare infrastructure measures (hospital bed and practicing physician densities, life expectancy) and other regional characteristics provides a robust picture of the region's healthcare infrastructure to which Japanese firms may be attracted.

Our results find, while controlling for other regional characteristics, national-level health insurance schemes, and time dummies, European hospital bed and practicing physician densities positively impact NUTS-2 level inward-FDI. This heterogeneous healthcare infrastructure provision can lead to increased socioeconomic disparities across regions, potentially widening urban-rural and other regional economic inequalities.

2. Theoretical framework

Suhrcke, Sauto Arce, McKee and Rocco (2008) state "there is substantial and growing evidence that ill health reduces individuals' labor productivity and labor supply." Weil (2007) and others note that research on the health-economic output nexus falls at the individual or national level, focusing on either health inputs or health outcomes. We desire a mix of both, as we focus on how local population health affect human capital, which in turn affects labor productivity and thus firm profitability in an investment location. Several proxies help overcome our barrier of observing population health directly. Healthcare outcomes are jointly determined by a worker's

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[2] European Union, https://ec.europa.eu/eurostat/web/nuts/background. Most recently accessed: 5 February, 2021.
[3] This dates to Blomström and Kokko (2003) among others.
[4] E.g., see Globerman and Shapiro (2002) as well as Alsan, Bloom, and Canning (2006).
[5] See, for example, Globerman and Shapiro (2002); Alsan, Bloom, and Canning (2006); Azemar and Desbordes (2009), and Talukdar and Parvez (2017).
[6] Giammanco and Gitto (2019) examine changes to a nation's aggregate FDI stock, and thus cannot determine the FDI source. EU firms' domestic investments do not appear in FDI data, and thus their complete European investment pattern cannot be ascertained. With a non-EU investment source such as Japan, the entirety of their EU-located investment is viewed in the data. Japan serves as one of the largest non-European investors countries, with nearly $80bn in investment in 2019 alone (https://www.eu-japan.eu/news/japans-new-investment-boom-nordic-tech, accessed October 15, 2022). In addition, unlike most countries, detailed affiliate-specific investment data is publicly available.

genetic endowment and their consumption of healthcare inputs. The availability of these healthcare inputs - practicing physicians as a measure of day-to-day outpatient care, and hospital beds representing more serious inpatient care - are important inputs into the human capital formation.

Suppose a representative multinational firm k considers all feasible locations for its new foreign affiliate. The firm chooses the location that maximizes its profits π, with region i profits

$$\pi_{ki} = p_i Y_k - r_i K_k - w_i L_k \qquad (1)$$

where p represents output price, Y represents firm $k's$ output in location I, K and L represent capital and labor, with r and w are the returns to capital and labor in location i.[7]

The firm chooses the amount of capital and labor that maximizes its profits, subject to its production function. We adapt Weil's (2007) more macro-oriented framework on health and economic growth to our more micro-oriented model and suppose the firm has the following Cobb-Douglas production function:

$$Y_k = A_k K_k^{\alpha} (H_k)^{1-\alpha} \qquad (2)$$

where Y_k represents firm $k's$ output, A_k is a firm-specific productivity term, K_k its physical capital, and H_k represents a composite labor term. This term can be written as

$$\mathrm{H_k = L_k h_i \upsilon_i} \qquad (3)$$

where L_k represents the amount of labor the firm hires, h_i represents the average per-worker health in region i, and υ_i represents a composite of the remaining average per-worker human capital attributes common to region i.

Ceteris paribus, a worker with a higher health level can work longer hours or be faster at their assigned task(s) and are thus equivalent production-wise to multiple unhealthy workers. Increases in region-specific health inputs h_i should lead to greater overall firm productivity and profitability than regions with lower h_i levels. In addition, in comparing our two measures of health inputs and their effect on h_i, access to physicians and physician services are more likely to contribute to increased labor productivity and firm profitability than hospital beds. Such access is likely to have greater positive impact on decreasing worker absenteeism, presenteeism, worker mental health issues, and the other direct and indirect costs of worker illness. While greater access to hospitals and hospital beds is important to those acutely sick, better access to physicians acts to decrease worker need for such acute treatment.[8] Finally, while individual firms do spend their own funds to improve employee health outcomes and improve worker productivity, it is clearly cheaper to the firm for the regional healthcare funds to create a healthier labor force and increase average worker health h_i than for the firm to pay for this increase themselves.

3. The data

3.1. Health data

We use 244 NUTS-2 regions from Eurostat's 2016 European Nomenclature of Territorial Units for Statistics (NUTS) classification system.[9] Our focus on the pre-COVID 2000-2019 period

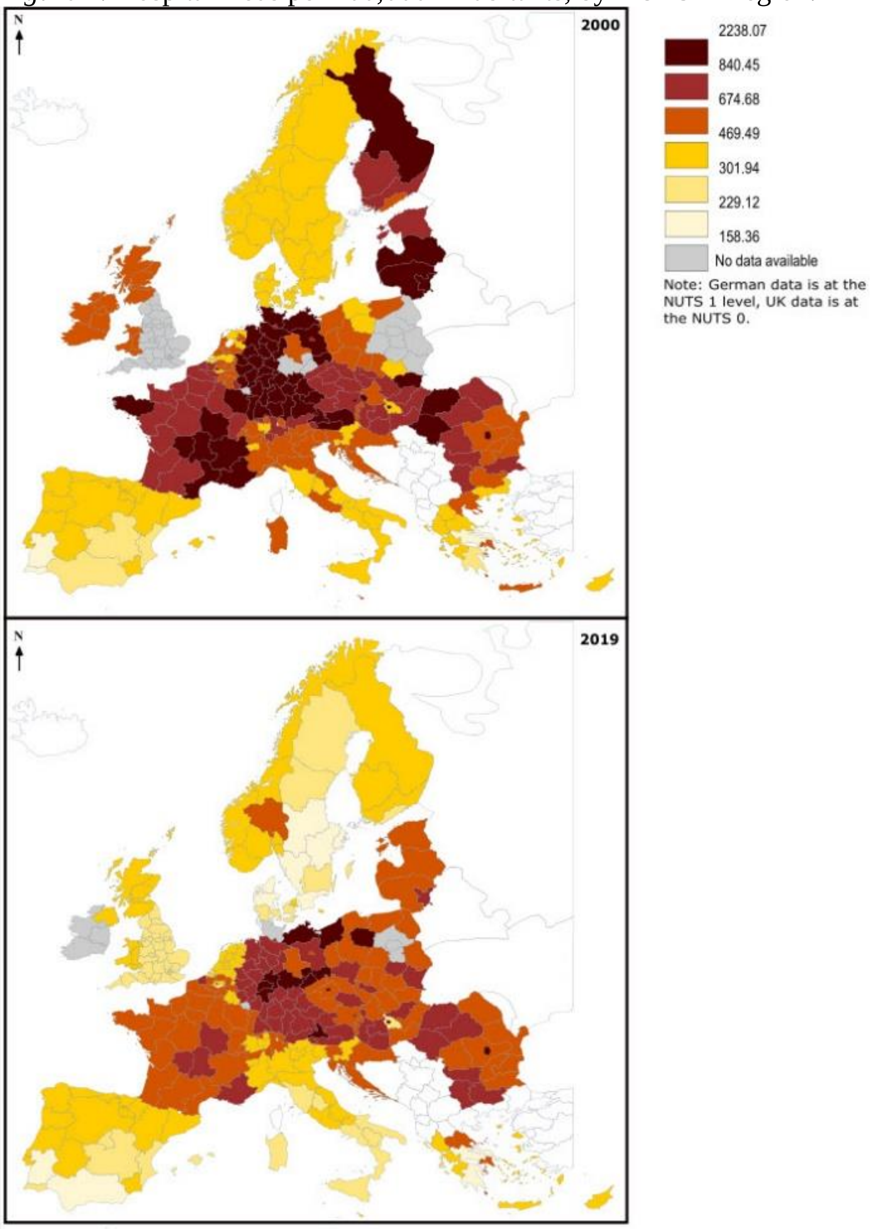
[7] Note that the firm is not limited to only selling its goods in region i, but can rather sell throughout Europe, so p may be equivalent across all regions. As a result, the firm's profitability focus and investment location choice will lie on the cost side of this equation, not on its revenues.

[8] While not the focus on this paper, business ``cost of illness" studies typically focus on firm direct costs (such as medical care) and opportunity costs (such as lost labor productivity and the cost of hiring replacement workers). See, for example, ``Poor Worker Health Costs U.S. Employers Half a Trillion Dollars A Year" (Forbes.com, November 15, 2018. https://www.forbes.com/sites/brucejapsen/2018/11/15/poor-worker-health-costs-u-s-employers-half-trillion-dollars-a-year/?sh=2bf058716d3b.)

[9] 281 NUTS-2 regions exist in NUTS 2016 classification system, including those in non-EU member countries. Given our data restrictions, we investigate FDI into 244 NUTS-2 regions.

is the result of NUTS-2 data availability[10]; national-level healthcare data pre-dates our sample, but consistent pre-2000 sub-national healthcare infrastructure data does not. The Eurostat regional healthcare data includes hospital bed and practicing physician totals per 100k inhabitants. Unfortunately, UK data is generally not available below the NUTS-0 (country) level; German hospital and physician data are available in Eurostat and national statistical agencies only at the NUTS-1 level. However, 9 of the 16 German NUTS-1 regions are also NUTS-2 regions.[11] Previous European sub-national healthcare heterogeneity research (Schley, 2018; Winkelmann, et. al., 2020) suffer from the same data limitations and limit their analysis similarly.[12]

Figure 1. Hospital Beds per 100,000 inhabitants, by NUTS-2 Region.



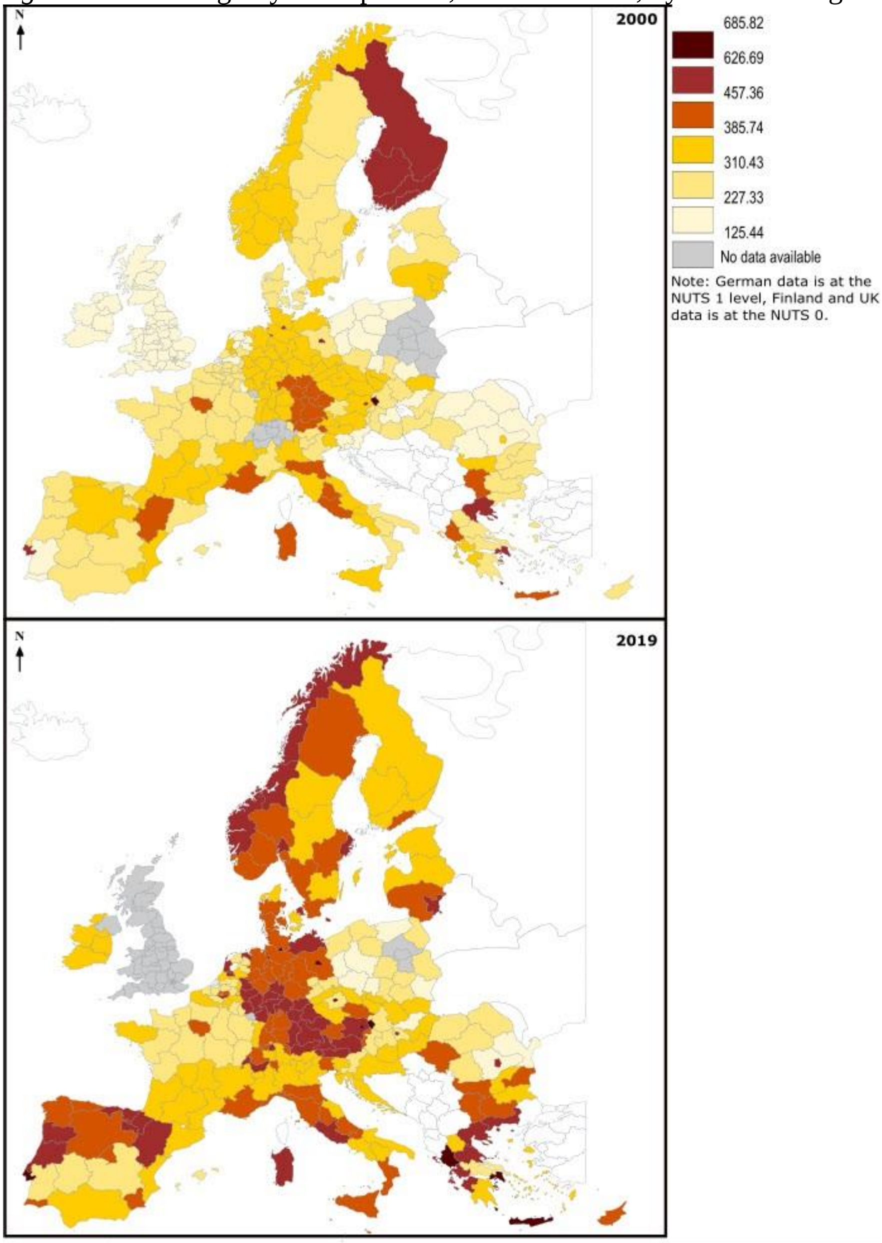
[10] We restrict our sample to pre-COVID years, as total global FDI fell by 34% in 2020, with Europe realizing an 80% year-over-year reduction in inward FDI. Source: Japan External Trade Organization (https://www.jetro.go.jp/en/invest/investment_environment/ijre/report2021/ch1/sec2-1-1.html) Last Accessed: 21 October, 2022.

[11] This includes the city-states of Berlin, Bremen, and Hamburg as well as the states of Brandenburg, Schleswig-Holstein, and Thuringia.

[12] We address this issue in section 4.2.

Figure 1 indicates a downward trend with respect to European hospital bed density. Germany (the country with the highest hospital bed concentration), France, and Finland realized the greatest decreases. Northern Italy lost many hospital beds while no significant change is noted in Spain. Physician density (Figure 2) increased in most regions between 2000-2017. Norway, Sweden, and Germany gained the highest number of physicians followed by Spain. France saw little change while Eastern European countries like Lithuania realized large physician density increases. Spain and Italy find a higher doctor concentration of doctors in the North; France finds its greatest density in the South.

Figure 2. Practicing Physician per 100,000 inhabitants, by NUTS-2 Region.



Although universal healthcare is widespread across the continent, heterogeneity exists with respect to healthcare systems regarding funding and benefits. The World Health Organization identifies four major national healthcare systems: Social Health Insurance (SHI), National Health Insurance (NHI), Compulsory Health Insurance (CHI), and National Health System

(NHS). [13] The characterization of health systems may be challenging as each system can present varying features across different countries (Joumard, André and Nicq, 2010). While we know that most national systems now exhibit some mixture of models, and these health systems are ever evolving by means of reforms, we follow Giammanco and Gitto (2019) as well as the World Health Organization in our characterization of each nation's system.

Table 1. European National Health Finance Schemes.

SHI	**CHI**	**NHI**	**NHS**
Austria	Belgium	Bulgaria	Denmark
France	Czech Republic	Croatia	Finland
Greece	Netherlands	Cyprus	Ireland
	Germany	Estonia	Italy
	Slovakia	Hungary	Latvia
		Lithuania	Malta
		Luxembourg	Norway
		Poland	Portugal
		Romania	Spain
		Slovenia	Sweden
			United Kingdom

Note: SHI - Social Health Insurance; CHI - Compulsory Health Insurance; NHI - National Health Insurance; NHS - National Health System. Source: World Health Organization.

3.2. FDI and regional data

Toyo Keizai Inc.'s *Japanese Overseas Investment: A complete listing by firms and countries (JOI)* provides the Japanese outward FDI data, which includes each affiliate's establishment date, street address, and postal code. Web searches and host-country business directories are used for investments without a listed location. Figure 3 indicates 169 NUTS-2 regions received the 1462 affiliates established during our sample. Affiliates are established by Japanese parents in every 2-digit manufacturing and service sector. Very few investments are in healthcare manufacturing or health services fields, but rather are in a wide varied of manufacturing and service-related industries, industries that are both labor- and capital-intensive in nature. JOI data allows us to create *Agglomeration*, the number of previously established Japanese affiliates in a region prior to a particular affiliate's establishment. Regional Japanese agglomeration effects should positively influence FDI.

We augment our gravity-type model with variables controlling for additional region-specific characteristics. *Regional GDP* measures the region's economic activity, hypothesized to positively affect inward FDI. *Distance* is the great-circle distance from the region's largest city to Tokyo. Greater distance typically decreases FDI, although this may not occur here; within-Europe distances to Tokyo do not vary as significantly as when FDI hosts are more globally dispersed. *Regional Size* to account for the region's density; NUTS-2 regions are approximately equal in population but not in area.[14] We hypothesize smaller areas will receive increased inward FDI, as these are more likely to be regions proximate to large cities and major transportation infrastructure. *Unemployment* is based on the EU Labor Force Survey data; increased unemployment, a sign of reduced economic activity, should decrease inward FDI. *Tertiary Education* measures the percentage of the region's workforce with at least that

[13] There is limited space in this paper to adequately differentiate the various national level health insurance schemes. For more detail, see World Health Organization, Global Health Expenditure Database (https://apps.who.int/nha/database/Select/Indicators/en). Last accessed: 28 October, 2022.
[14] Data descriptive statistics are provided in Table 2, with cross correlations displayed in Table 3.

education level; increased education levels should positively increase inward FDI. Finally, we control for the region's *Mean Age* and *Population Over 65*, which may be correlated with the number of hospital beds and physicians in a location, as older-aged residents make greater use of healthcare infrastructure.

Figure 3. Location of Japanese Foreign Direct Investment by NUTS-2 Region.

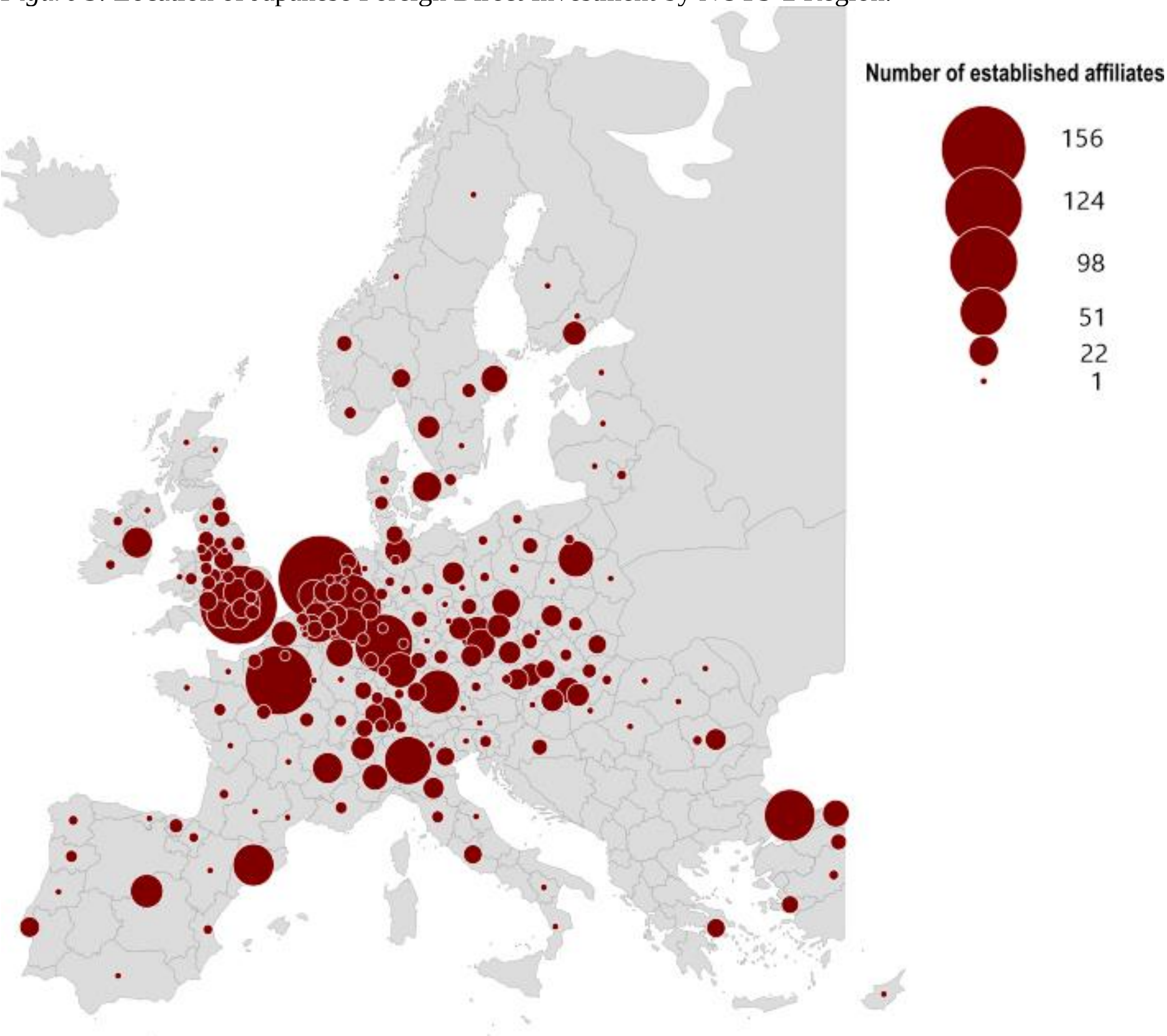


Table 2. Data Descriptive Statistics.

Statistic	Mean	Std. Dev.	Min	Max
Life Expectancy	79.57	2.89	70.20	85.50
Regional GDP (billions of euros)	44.56	50.82	0.92	733.87
Distance (miles)	5,783.15	436.80	4860	6,926
Regional Size (100s of km^2)	15.45	23.57	0.14	227.12
Unemployment (%)	8.38	5.28	1.20	37
Tertiary Education (%)	25.12	9.30	11.60	58.4
Median Age	41.21	3.56	31.6	51.7
Population Over 65 (%)	17.97	31.8	9.8	27.4
FDI Agglomeration	12.72	36.73	0	389

Table 3. Cross-correlation table.

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
(1) Hospital Beds	1.000										
(2) Physicians	0.053	1.000									
(3) Life Expect	-0.321	0.343	1.000								
(4) Regional GDP	-0.010	0.222	0.315	1.000							
(5) Distance	-0.239	0.048	0.191	0.052	1.000						
(6) Regional Size	-0.104	-0.157	-0.054	-0.041	-0.119	1.000					
(7) Unemployment	-0.243	0.010	-0.065	-0.079	0.118	0.109	1.000				
(8) Tertiary Education	-0.111	-0.201	0.301	0.204	0.009	0.094	-0.348	1.000			
(9) Median Age	0.279	0.131	0.206	0.167	0.201	0.132	0.084	0.339	1.000		
(10) Population Over 65	0.241	0.118	0.094	0.314	0.283	0.188	0.032	0.411	0.501	1.000	
(11) FDI Agglomeration	0.058	0.125	0.201	0.631	0.041	-0.136	-0.121	0.036	0.289	0.210	1.000

4. Results

We investigate the count of new Japanese affiliates established in each NUTS-2 region during our sample period. Our dependent variable is a non-negative integer, and Figure 3 indicates the distribution of investment locations is not equally distributed across host regions. Therefore, we reject OLS for a count models specification; with overdispersion in our data, we favor a Negative Binomial model.[15] The negative binomial model provides the additional advantage of being preferred to the typically-employed multinomial logit model when the number of choice alternatives is large.[16]

4.1 Baseline model

We begin our analysis by investigating FDI location choice across all 244 NUTS-2 regions. To avoid selection bias, we include regions for which no Japanese investment is recorded in the *JOI.* Following the sub-national location choice literature in assuming a non-nested decision structure, we envision firms choosing among each of the regions for their preferred investment location. Our estimating equation for the count of new affiliates established in an individual NUTS-2 region *i* and year *t* is

$$FDI_{it} = HospitalBeds_{i,t-1} + Physicians_{i,t-1} + NationalInsuranceStructure_{i,t-1} + NUTSRegionalCharacteristics_{i,t-1} + \varepsilon_i$$

National Insurance Structure is a set of dummies represent each region's the national-level health insurance structure. *Life Expectancy*, *Distance*, *Regional GDP*, *Regional Size*, *Unemployment*, *Tertiary Education*, *Mean Age*, *Population Over 65*, and *Agglomeration* are included in the vector of *NUTSRegionalCharacteristics*. Independent variables are lagged one year to eliminate endogeneity concerns and more accurately represent the time lag between investment decision and affiliate initial operation.[17]

Table 4 provides our initial empirical estimation results. As the negative binomial estimation models the log of the expected count of the region's established affiliates, regression coefficients represent the change in the estimated log count of affiliates for a one unit change in the independent variable. Positive coefficients signal a positive effect on the region's inward FDI, while negative coefficients indicate increases in the variable serve to deter inward FDI.

Table 4. Japanese FDI Location: NUTS-2 Location Choice.

[15] The dispersion test results indicate the presence of overdispersion with a parameter of 1.49, with a p-value of the test equals 2.63e-07. This allows us to reject the null hypothesis of equidispersion. The test was performed using a reduced model of our regression: $FDI = HospitalBeds + Physicians + RegionalGDP + RegionalSize$.

[16] E.g., see Guimarães, Figueiredo, and Woodward (2003) and Schmidheiny and Brülhart (2011).

[17] A two-year lag was also considered; estimation results prove qualitatively similar.

	At NUTS-2 Level						Including Germany
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
$HospitalBeds_{t-1}$	**0.070*** **	**0.157*** **	**0.073***	**0.077***	**0.079***	**0.061***	**0.021***
	(0.0234)	**(0.035)**	**(0.042)**	**(0.048)**	**(0.050)**	**(0.034)**	**(0.010)**
$Physicians_{t-1}$	**0.204*** **	**0.109** **	**0.166** **	**0.200*** **	**0.211*** **	**0.179** **	**0.237*** **
	(0.0414)	**(0.0471)**	**(0.069)**	**(0.068)**	**(0.070)**	**(0.101)**	**(0.071)**
$CompulsoryIns._{t-1}$		**0.344***	0.318	**0.556*** **	**0.550*** **	**0.539*** **	**0.442** **
		(0.197)	(0.212)	**(0.209)**	**(0.204)**	**(0.214)**	**(0.223)**
$SocialIns._{t-1}$		**-0.361***	**-1.319*** **	**-1.334*** **	**-1.337*** **	**-1.201*** **	**-1.194*** **
		(0.213)	**(0.347)**	**(0.371)**	**(0.378)**	**(0.314)**	**(0.425)**
$NationalIns._{t-1}$		**-0.811*** **	-0.110	0.428	0.431	0.401	**0.817*** **
		(0.208)	(0.299)	(0.331)	(0.340)	(0.339)	**(0.311)**
$LifeExpectancy_{t-1}$			-0.018	0.051	0.049	0.057	**0.077***
			(0.036)	(0.042)	(0.041)	(0.038)	**(0.041)**
$RegionalGDP_{t-1}$			**0.007** **	**0.007*** **	**0.006*** **	**0.010*** **	**0.014*** **
			(0.004)	**(0.002)**	**(0.002)**	**(0.004)**	**(0.001)**
$Distance$			**-0.127***	**-0.133** **	**-0.130** **	**-0.129** **	-0.078
			(0.066)	**(0.062)**	**(0.062)**	**(0.067)**	(0.069)
$RegionalSize$			**-0.015*** **	**-0.012** **	**-0.010** **	**-0.015** **	**-0.011*** **
			(0.005)	**(0.005)**	**(0.005)**	**(0.007)**	**(0.005)**
$Unemployment_{t-1}$			**-0.036*** **	-0.025	-0.029	-0.033	**-0.027** **
			(0.014)	(0.015)	(0.017)	(0.021)	**(0.013)**
$Agglomeration_{t-1}$			**0.017*** **	**0.014*** **	**0.010*** **	**0.017*** **	**0.008*** **
			(0.005)	**(0.004)**	**(0.004)**	**(0.006)**	**(0.001)**
Tertiary Education$_{t-1}$				**0.201** **	**0.200** **	**0.201** **	**0.214** **
				(0.099)	**(0.097)**	**(0.099)**	**(0.121)**
Mean Age$_{t-1}$				-0.399			
				(0.244)			
PopOver65$_{t-1}$					-0.259	-0.209	-0.197
					(0.199)	(0.154)	(0.143)
Constant	**-2.346*** **	**-2.513*** **	-1.023	**-1.444** **	**-3.716** **	**-2.974** **	**-7.894** **
	(0.204)	**(0.198)**	(2.901)	**(0.681)**	**(1.849)**	**(1.551)**	**(3.855)**
No. of Observations	3102	3102	2425	2443	2443	2443	2878
/lnAlpha	1.473***	1.441***	-0.173***	-1.321***	-0.413**	-1.402***	-0.718*
Year Dummies	NO	NO	NO	NO	NO	YES	YES
Adj R^2	0.0103	0.0171	0.201	0.214	0.207	0.239	0.244

Note: Robust standard errors in parentheses. * p<0.10, ** p<0.05, *** p<0.01.

Column (1), our baseline result, finds *Hospital Beds* and *Physicians* positively and significantly increase a region's inward FDI, with *Physicians* having a greater positive impact on FDI than *Hospital Beds.* Column (2) adds the national level insurance scheme, finding that each plan significantly affects inward investment relative to those regions under a national health system scheme. Since these initial regressions exclude many traditional gravity-type FDI determinants, columns (3)-(5) add the remaining explanatory variables, while column (6) adds a set of year dummy variables to control for unobserved year characteristics. Our estimation results support our *a priori* expectations - hospital bed and physician density positively affect inward FDI in all six regression models, with the number of physicians more strongly impacting inward FDI than hospital beds. Our other gravity model variables display the predicted signs and significance levels, as do *Regional Size*, *Tertiary Education*, and *Agglomeration*. *Life Expectancy* has no significant impact on location choice, a perhaps unsurprising result since European regions display less life expectancy variation than often seen in studies involving lesser developed countries. A region's population age does not affect inward FDI, although its national insurance program does affect inward FDI, supporting the Giammanco and Gitto (2019) result.

Not all healthcare data is available at the NUTS-2 disaggregation. As such, column (8) displays our regression results including the German NUTS-1 data. Some results change with this inclusion. While *Hospital Beds* remains only slightly statistically significant, *Physicians* becomes more so, and now positively affects inward FDI at the 1%-level. *Life Expectancy* becomes weakly significant, while *Distance* no longer affects location choice. These findings are likely the result of a combination of the significant drop in hospital bed density in Germany (see Figure 1) while also decreasing the regional precision of our data. For example, NUTS-1 North Rhine-Westphalia (includes Düsseldorf and Cologne) and Hesse (includes Frankfurt am Main) receive a significant inward FDI totals but include more rural NUTS-2 regions that do not attract much inward FDI. Employing NUTS-1 data for both region types likely overestimates the healthcare infrastructure in the more rural, less attractive regions (see Potrafke and Roesel, 2020), lowering our estimation precision.

Overall, *Hospital Beds* and *Physicians* serve as positive inward-FDI influences at the NUTS-2 level, including when controlling for the full set of gravity model variables and time dummies. Importantly, following our a priori expectations, practicing physicians' density appears to impact inward-FDI more significantly than hospital beds.

Table 5. FDI Location Choice Using Clustered Standard Errors.

				Including Germany		
	NUTS-2	NUTS-1	NUTS-0	NUTS-2	NUTS-1	NUTS-0
$HospitalBeds_{t-1}$	**0.061***	**0.061***	**0.061***	**0.021***	**0.021***	**0.021***
	(0.034)	**(0.034)**	**(0.031)**	**(0.010)**	**(0.011)**	**(0.010)**
$Physicians_{t-1}$	**0.179****	**0.179****	**0.179****	**0.237*****	**0.237*****	**0.237*****
	(0.111)	**(0.111)**	**(0.109)**	**(0.070)**	**(0.074)**	**(0.076)**
$CompulsoryIns._{t-1}$	**0.539*****	**0.539*****	**0.539*****	**0.442****	**0.442****	**0.442****
	(0.228)	**(0.224)**	**(0.241)**	**(0.225)**	**(0.231)**	**(0.228)**
$SocialIns._{t-1}$	**-1.201*****	**-1.201*****	**-1.201*****	**-1.194*****	**-1.194*****	**-1.194*****
	(0.331)	**(0.308)**	**(0.356)**	**(0.408)**	**(0.431)**	**(0.451)**
$NationalIns._{t-1}$	0.401	0.401	0.401	**0.817*****	**0.817*****	**0.817*****
	(0.367)	(0.353)	(0.378)	**(0.309)**	**(0.313)**	**(0.321)**
$LifeExpectancy_{t-1}$	0.057	0.057	0.057	**0.077****	**0.077***	**0.077***
	(0.039)	(0.037)	(0.040)	**(0.039)**	**(0.043)**	**(0.045)**
$RegionalGDP_{t-1}$	**0.010****	**0.010****	**0.010****	**0.014*****	**0.014*****	**0.014*****
	(0.005)	**(0.005)**	**(0.005)**	**(0.001)**	**(0.001)**	**(0.002)**
$Distance$	**-0.129****	**-0.129****	**-0.129****	-0.078	-0.078	-0.078
	(0.067)	**(0.064)**	**(0.071)**	(0.055)	(0.063)	(0.071)
$RegionalSize$	**-0.015****	**-0.015****	**-0.015****	**-0.011*****	**-0.011****	**-0.011****
	(0.008)	**(0.006)**	**(0.007)**	**(0.004)**	**(0.005)**	**(0.005)**
$Unemployment_{t-1}$	-0.033	-0.033	-0.033	**-0.027****	**-0.027****	**-0.027****
	(0.024)	(0.025)	(0.029)	**(0.014)**	**(0.013)**	**(0.013)**
$Agglomeration_{t-1}$	**0.017*****	**0.017*****	**0.017*****	**0.008*****	**0.008*****	**0.008*****
	(0.008)	**(0.007)**	**(0.006)**	**(0.001)**	**(0.001)**	**(0.001)**
Tertiary Education$_{t-1}$	**0.201****	**0.201****	**0.201****	**0.214***	**0.214****	**0.214****
	(0.101)	**(0.099)**	**(0.102)**	**(0.118)**	**(0.109)**	**(0.107)**
PopOver65$_{t-1}$	-0.209	-0.209	-0.209	-0.197	-0.197	-0.197
	(0.167)	(0.161)	(0.167)	(0.138)	(0.151)	(0.155)
Constant	**-2.974****	**-2.974****	**-2.974****	**-7.894****	**-7.894****	**-7.894****
	(1.555)	**(1.540)**	**(1.540)**	**(3.864)**	**(3.870)**	**(3.881)**
No. of Observations	2443	2443	2443	2878	2878	2878
/lnAlpha	-1.402***	-1.402***	-1.402***	-0.718*	-0.718*	-0.718*
Adj. R^2	0.239	0.239	0.239	0.244	0.244	0.244

Note: Clustering at NUTS-level indicated at column top. * p<0.10, ** p<0.05, *** p<0.01. Year dummies included in all estimations.

Table 6. NUTS-2 Location Choice Using Logarithmic Regional Variables.

	(1)	(2)	(3)
$Ln\ HospitalBeds_{t-1}$	**1.054*** **	**1.714*** **	**1.573***
	(0.190)	**(0.408)**	**(0.855)**
$Ln\ Physicians_{t-1}$	**0.443*** **	**0.256*** **	**0.245***
	(0.191)	**(0.118)**	**(0.130)**
$Ln\ LifeExpectancy_{t-1}$		**1.779** **	1.309
		(1.004)	(0.897)
$Ln\ RegionalGDP_{t-1}$			**0.023** **
			(0.001)
$Ln\ Distance$			-0.507
			(0.692)
$Ln\ RegionalSize$			**-0.104***
			(0.058)
$Ln\ Unemployment_{t-1}$			**0.875*** **
			(0.0854)
$Ln\ Agglomeration_{t-1}$			**0.875*** **
			(0.0854)
Ln Tertiary Education$_{t-1}$			**0.091***
			(0.051)
Ln PopOver65$_{t-1}$		-1.309	-1.057
		(0.981)	(0.831)
Constant	**-6.418*** **	**-3.042*** **	**4.867** **
	(1.973)	**(1.396)**	**(2.442)**
No. of Observations	3102	2878	2878
/lnAlpha	-1.401***	-1.718***	-0.954***
Year Dummies	YES	YES	YES
Adj. R^2	0.022	0.112	0.264

Note: Clustered standard errors in parentheses. * p<0.10, ** p<0.05, *** p<0.01. Health insurance dummies also included.

4.2 Robustness checks

Since location choice is examined regionally, our estimation error terms may be clustered geographically. In Table 5 we examine various possible clustering scenarios (NUTS-2, NUTS-1, NUTS-0). Columns (1) - (3) provide estimation results based on Table 4's column (6), while columns (4)-(6) include the German data (Table 4, column (7)). Note our qualitative results change little from Table 4.

We also take the natural log of our explanatory variables to examine possible nonlinearities and diminishing returns within our data; Table 6 provides the results. These regressions employ the full set of estimators (Table 4, column 6) with errors clustered at the NUTS-2 level. Diminishing returns to additional *Physicians* does not appear to exist in any specifications. In contrast, *Hospital Beds* is only strongly significant in models with a less-than-complete set of regressors; including the full set of regressors (column 3), *Hospital Beds* is only slightly significant. This provides additional support that, while both *Physicians* and *Hospital Beds* appear to be significant FDI influences, it is the number of practicing physicians that is more important to productivity and thus firm location. Finally, *Agglomeration* is significant in each of the model specifications.

5. Conclusion

We study European NUTS-2 healthcare infrastructure heterogeneity on Japanese firm-level FDI location choice. Hospital bed density proxies a region's acute in-patient healthcare facilities, while practicing physician density measures outpatient medical support. Since physician services appear to be more directly related to day-to-day employee health, physician density should impact FDI location choice more than hospital beds. Significant healthcare infrastructure discrepancies exist across European nations, while even greater heterogeneity often exists within countries.

Our augmented gravity model estimation finds, holding constant a region's specific attributes and its national health insurance structure, hospital bed and practicing physician densities both positively attract inward FDI. However, the number of practicing physicians in a region more significantly impacts inward FDI than hospital beds. We believe that this is because, while hospitals are designed to treat those very sick, better access to physicians acts to decrease worker need for such acute treatment; physician services are more likely to keep workers healthy, reducing the costly effects of illness, absenteeism, presenteeism, and worker mental health issues. Areas with improving healthcare infrastructure will benefit from increased inward FDI, while those realizing declining healthcare infrastructure may miss out on the economic growth and important socioeconomic impacts (Potrafke and Roesel, 2020) brought about by inward FDI. The heterogeneous rates at which hospital beds per capita are dropping across Europe may only widen the disparity of inward FDI location choice and the positive economic attributes FDI brings to the region.

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