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Industrial Production in Space: A Comparison of East Asia and Europe

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1. Introduction

It is well known that there is a clear contrast between the East Asian and European regions, in terms of intra-regional disparities in location advantages such as factor prices among countries. Such a contrast can be utilized to clarify the different ways in which changes in some economic variables affect other economic variables in connection with differences in location advantages within a region. In other words, the East Asian and European regions work as natural models with large and small intra-regional disparities in location advantages, respectively. A comparative analysis the two regions highlights the evidence that the consequences of changes in economic variables in a region with smaller disparities (i.e., Europe) are not necessarily the same as those in a region with larger disparities (i.e., East Asia), which provides clues to avoiding unexpected policy effects.

The contrasting intra-regional disparities in location advantages among countries between East Asian and Europe appear to lead to different tendencies in the international geographical distribution of the electric machinery industry within each region.[1] In East Asia, international production and distribution networks have developed dramatically particularly in the electric machinery industry since the 1990s (Kimura, 2006). As more East Asian countries have participated in the networks by attracting different pieces of production blocks according to different location

[1] Another consequence of the contrasting intra-regional disparities in location advantages shows up in differences in the mechanics of intra-regional trade in intermediate goods between East Asia and Europe (Kimura, Takahashi, and Hayakawa 2007). East Asian countries are engaged in vertical intra-industry trade with each other, which is motivated by differences in location advantages. In Europe, on the other hand, horizontal intra-industry trade is prevalent. As demonstrated theoretically in Helpman and Krugman (1985, p.173), a set of countries with smaller differences in location advantages is more likely to engage in this kind of intra-industry trade.

advantages, the electric machinery industry has evolved to a certain size in each of the countries. In Europe, on the other hand, industrial locations have come to be concentrated in certain countries as European integration proceeds (Overman, Redding and Venables, 2003). In particular, Midelfart-Knarvik et al. (2004) show that electrical apparatus is one of the industries that became geographically concentrated during the period 1970-1997. The international locations of the electric machinery industry is geographically dispersed across East Asia, but concentrated in a limited number of countries in Europe.

As well as the different tendencies in geographical distribution of the electric machinery industry, there would also be differences in spatial interdependence in the electric machinery production among countries within a region. If geographical remoteness is a major source of trade costs, the manner in which the production size of the industry in a country is related to that of neighboring countries might be different between East Asia and Europe. As suggested by the fragmentation theory, of which a pioneer work is Jones and Kierzkowski (1990), large disparities in location advantages encourage the geographical separation of production processes among countries with low trade costs, i.e., countries at a sufficiently short distance. The industry's production of each country is therefore positively associated with that of neighboring countries because the production expansion in one production process located in one country leads to increased production in the other relevant production processes located in the neighboring countries. East Asia as a region with large disparities in location advantages would attains a positive spatial interdependence in the industry's production among countries.

On the other hand, the new economic geography (NEG)[2] model suggests that, without differences in location advantages, a single agglomeration of an industry emerges among countries with low trade costs. The agglomeration of the industry is stretched over a limited number of cities in a country while the industry ceases to exist in the other countries in the neighborhood. Thus, Europe as a region with small disparities in location advantages is not expected to have the above-mentioned positive spatial interdependence in the industry's production among countries.

The purpose of this paper is to detect the expected difference in spatial interdependence in the electric machinery production between East Asia and Europe. We focus on the electric machinery industry, because the general tariff rates in this industry are generally low[3] compared with those in other industries, and therefore, by focusing on this industry, we are able to consider geographical distance as a major source of trade costs. Spatial interdependence has an important implication for regional economic development. In a region with positive spatial interdependence, countries can achieve simultaneous production expansion by the compartmentalization of production processes of an industry, i.e. division of labor between upstream and downstream production processes. In a region with negative spatial interdependence, on the other hand, there seems to be almost no leeway for a particular industry to experience simultaneous production expansion except by compartmentalization of different *industries*. Consequently, policy treatment for simultaneous economic development may differ according to the form of the spatial interdependence existing at the regional level.

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[2] See, for example, Fujita, Krugman, and Venables (1999), Fujita and Thisse (2002) and Baldwin et al. (2003).

[3] For example, the Information Technology Agreement, which was concluded in 1996, provides for participants to completely eliminate duties on IT products covered by the Agreement.

In order to explore the spatial interdependence in the electric machinery production among the countries in each of East Asia and Europe, we employ a spatial econometric technique, of which a pioneer work is Anselin (1988). Specifically, applying a spatial lag model separately for each region, we compare the estimated coefficients for the spatial weighting matrix, of which elements are the inverse of the distance between locations of interest (i.e., countries). The coefficient for the spatial weighting matrix captures how the economic variable of a country is associated with the variables of neighboring countries. In our study, it is expected that the size of the electric machinery industry, measured by its value-added and employment, in a country is positively associated with that in neighboring countries for the East Asian sample, but not for the European sample. Our empirical evidence for the difference in the intra-regional spatial interdependence will provide a new additional fact on the contrast between the two regions.

It is worth noting that our paper is related to studies that analyze international trade and foreign direct investment (FDI) by using spatial econometrics. A number of recent studies apply the method of spatial econometrics to the estimation of a gravity equation, which is well known as one of the most successful tools for the quantitative analysis of bilateral trade patterns (Behrens, Ertur, and Koch 2007; Porojan 2001; Sevela 2002). For example, Porojan (2001) estimates the gravity equation by using spatial econometrics techniques and finds substantial differences in both the magnitude and statistical significance of the estimates for the usual gravity variables. Among the studies on FDI (Coughlin and Segev 2000; Baltagi, Egger, and Pfaffermayr 2007; Blonigen et al. 2007), Blonigen et al. (2007) estimate a spatial lag model and attempt an empirical differentiation of the types of US outbound FDI (pure horizontal FDI,

export-platform, pure vertical FDI, and complex vertical FDI). Unlike these papers, we examine spatial interdependence in industrial production by employing a spatial lag model.

The remainder of this paper is organized as follows: Section 2 provides a brief overview of international variations in location advantages and the size of electric machinery production in East Asia and Europe. Section 3 summarizes the spatial relationships among countries within a region from the perspective of the extent of intra-regional disparities in location advantages. In Section 4, we explain the empirical method employed to investigate spatial interdependence and present the results, followed by conclusions in the final section.

2. International Disparities in Location Advantages and Geographical Distribution of the Electric Machinery Industry

In this section, we first take a look at international disparities in location advantages in East Asia and Europe, and then at changes in the value-added of the electric machinery industry for countries in the two regions. The East Asian countries of interest in this paper are the nine economies of China, Hong Kong, Indonesia, Japan, the Republic of Korea, Malaysia, the Philippines, Singapore, and Thailand. The European countries of interest are the nine economies known as the "Core EU countries," namely, Austria, Denmark, France, Germany, Italy, Norway, Portugal, Spain, and the United Kingdom.

It is well known that international disparities in location advantages are relatively larger in East Asia than in Europe. Although the location advantages are determined by

a combination of various factors including factor prices (wages), infrastructure services, policy environment, and agglomeration effects, country's development stage as represented by GDP per capita could be taken as an approximate indicator. Figure 1 lists 117 countries in the world from left to right in descending order of GDP per capita in 2000.[4] We can immediately notice that most of the European countries have relatively high incomes, while the income levels vary widely among East Asian countries. As indicated by the difference in international variations in GDP per capita, location advantages are also expected to be diversified among East Asian countries but not so different among European countries.

== Figure 1 ==

Next, we investigate changes in the value-added of the electric machinery industry in East Asian and European countries, comparing the international geographical distribution patterns of the industry in the two regions. The value-added data for the electric machinery industry, which includes ISIC 383, Rev.2 or ISIC 3110-3230, Rev.3, are obtained from UNIDO's *The International Yearbook of Industrial Statistics*. The data are deflated by the GDP deflator obtained from the World Bank's World Development Indicators Online for the respective countries.

Figure 2 shows the changes in (the log of) real value-added ofthe electric machinery industry for East Asian countries from 1980 to 2000. As is clear from the figure, we can observe a steady increase in the value-added of the electric machinery

[4] The data for GDP per capita are obtained from the World Bank's World Development Indicators Online.

industry across East Asia. As of 1980, the value-added of the electric machinery industry in Japan was much higher than in the other eight countries, indicating Japan's dominant presence in the region at the time. Following that, except for the period of the Asian financial and currency crisis of 1997-98, the value-added of the electric machinery industry increased continually in most of the eight countries. In particular, the value-added of the electric machinery industry in China and the Rep. of Korea increased rapidly and approached the level of Japan. Such simultaneous production expansion may be attributed to the formation of international production networks stretched across the region.

== Figure 2 ==

Figure 3 shows the changes in (the log of) real value-added in the electric machinery industry for European countries, whose patterns look quite different from those of the East Asian countries. Although we can observe a rapid production expansion in the electric machinery industry for the East Asian region as a whole, value-added in most of the European countries remained relatively stable over the two decades in question. In particular, Germany has continued to enjoy the highest level of value-added in the electric machinery industry, in contrast to Denmark, Norway, and Portugal. The intra-regional geographical distribution of the electric machinery industry seems to have been almost unchanged in Europe during our sample period.

== Figure 3 ==

Last, we examine the σ-convergence of value-added in East Asia and Europe, namely the standard deviation of the log of value-added for the nine East Asian countries and the nine European countries (see, for example, Barro and Sala-i-Martin, 2003, Chapter 11). This index can be used for exploring the trend in geographical dispersion of industry across countries. In East Asia, the standard deviation rose in the former half of the 1980s, but it has decreased since the latter half of the 1980s (See Figure 4). On the other hand, it has been relatively constant in Europe.[5] Thus, we can conclude that the international locations of the electric machinery industry has been relatively unchanged in Europe but has become more geographically dispersed in East Asia at least since the latter half of the 1980s.

== Figure 4 ==

3. Agglomeration versus Fragmentation

This section briefly summarizes how the way in which industry sizes are interrelated among countries within a region depends on the extent of intra-regional disparities in location advantages. First, we consider the case in which a region with large disparities in location advantages faces no trade costs of any kind. In general, it is obvious that large intra-regional differences in location advantages play a critical role for the geographically dispersed distribution of industry. If production processes of an industry can be geographically fragmented, each production process will be located in a country which has location advantages for carrying out that process. This phenomenon

[5] Notice that the level of σ-convergence is not comparable between East Asia and Europe.

is called “fragmentation” (Jones and Kierzkowski, 1990). Since each production process is linked with the others through an input-output relation, a production expansion in one process leads to increased production in the relevant processes elsewhere. In this sense, under fragmentation, the industry’s production of each of the countries is positively related with that of the others.

Let us now suppose a case where trade costs, more specifically, costs for linking remotely located production processes, are incurred by firms. In this case, production processes are not necessarily fragmented or distributed in a dispersed manner according to location advantages. Some parts of the production processes are possibly concentrated in certain countries in order to save thecosts of shipping intermediate goods and semi-finished products. If international fragmentation of production processes is to be more profitable than concentration, given the differences in location advantages among countries within the region, trade costs must be sufficiently low. Therefore, if geographical remoteness is amajor source of trade costs, the closer countries are to each other geographically, the more likely fragmentation is to occur, and thus the more likely their production processes will be positively related with one another. In sum, international fragmentation of production leads to a positive spatial correlationamong countries in a region with large differences in location advantages.

Let us next examine the case where countries are located in a region with small disparities in location advantages. In particular, we consider the extreme case where countries are completely symmetrical in terms of location advantages. Furthermore, we restrict the size of the region to a sufficiently small area. The NEG model then suggests that a single agglomeration exists within the region for an industry if trade costs among countries are sufficiently low. Meanwhile, production in that industry ceases to exist in

all of the other countries. As a result, in a region limited to a sufficiently small area, no positive spatial relationships emerge among countries unless there are intra-regional disparities in location advantages. However, as noted in the hierarchical urban system, some agglomerations may co-exist in distant countries in the case of a region covering a sufficiently large area. Thus, if our sample European countries cover a large area, the co-existence of multiple agglomerations might lead to a negative spatial correlation among countries within the region.

In the previous section, we noted the dispersed distribution of the electric machinery industry in East Asia, which appears to stem from the development of international fragmentation of production. Such a development of fragmentation, driven by the large intra-regional disparities in location advantages, will yield a positive spatial correlation among countries in East Asia. On the other hand, the observed concentrated distribution of the electric machinery industry in Europe can be attributed to the relatively small differences in location advantages among countries in Europe. Since the core EU countries are limited to a small area and trade costs among those countries are sufficiently low, the small disparities in location advantages will not lead to any positive spatial relationships among the countries. Such differing patterns in spatial interdependence between East Asia and Europe are formally examined in the next section.

4. Empirical Analysis

This section describes the spatial econometric technique employed to incorporate the spatial relationships among countries within a region for the electric machinery

industry and presents estimation results.

4.1. Empirical Method

In this subsection, we explain our empirical method for investigating the spatial interdependence in the electric machinery industry in East Asia and Europe. We estimate the spatial lag model for the two regions, which enables us to carry out an empirical examination of the spatial relationships without losing a degree of freedom.

Our spatial lag model is as follows. Let Y^i_t denote the log of the value-added/employment of the electric machinery industry in country i in year t. Countries of interest in our analysis are the nine East Asian economies and the nine European economies, and the sample period ranges from 1980 to 2000, as in Section 2. Our spatial lag equation is given by:

$$\mathbf{Y} = \rho\mathbf{WY} + \mathbf{X\beta} + \boldsymbol{\varepsilon}, \tag{1}$$

where $\mathbf{Y}$ is an N×1 vector of observations on the dependent variable. $\mathbf{X}$ is an N×K matrix of observations on the exogenous variables that may affect the scale of the electric machinery industry's activities in a country of interest. Logs of GDP per capita and electricity production per capita are introduced as proxies for primary factors of production, i.e., wages and electricity supply. The market potential variable is expected to embody a country's potential market size. Specifically, we use a log of the Harris market potential index, which is defined as the sum of the inverse-distance-weighted, i.e., proximity-weighted, GDPs of all the countries in the world.[6] The development of infrastructure is partly captured by introducing telephone lines per 100 people. We also

[6] Intra-national distance is set to 0.66*(Surface area/π)$^{1/2}$ as found in the literature of home bias measurement (see for example Head and Mayer, 2000). This market potential index is known for working well from an empirical point of view (Head and Mayer, 2004).

introduce year dummy variables in order to control to some extent for changes in intra-regional trade costs other than time-invariant distance-related costs (i.e. **W**). **ε** is a vector of disturbances.

The spatial lag weighting matrix **W** is an N×N block-diagonal matrix, which is constructed as follows:

$$\mathbf{W}_t = \begin{bmatrix} 0 & d_t^{1,2} & \cdots & d_t^{1,I} \\ d_t^{2,1} & 0 & \ddots & \vdots \\ \vdots & \ddots & 0 & d_t^{I-1,I} \\ d_t^{I,1} & \cdots & d_t^{I,I-1} & 0 \end{bmatrix}, \quad \mathbf{W} = \begin{bmatrix} W_{1980} & 0 & 0 \\ 0 & \ddots & 0 \\ 0 & 0 & W_{2000} \end{bmatrix},$$

where d^{ij}_t is the inverse of the distance between countries i and j in year t. As distances are time-invariant, it will generally be the case that $W_{1980} = W_{1981} = \ldots = W_{2000}$. As is common, **W** is row-standardized. The i-th entry of the spatially lagged dependent variable **WY** can then be interpreted as a proximity-weighted average of value-added/employment of the machinery industry in other $j \neq i$ countries in a region.

As is well known, ordinary least squares (OLS) estimates are biased as well as inconsistent for the parameters of the spatial model. Rewriting the above equation as:

$$\mathbf{Y} = \mathbf{Z}\rho + \mathbf{X}\boldsymbol{\beta} + \boldsymbol{\varepsilon}, \tag{2}$$

where $\mathbf{Z} = \mathbf{WY}$, we can express our OLS estimate γ_{OLS} for ρ as:

$$\gamma_{OLS} = \rho + [\mathbf{Z}'\mathbf{MZ}]^{-1}\, \mathbf{Z}'\mathbf{M}\boldsymbol{\varepsilon}, \tag{3}$$

where $\mathbf{M} = \mathbf{I} - \mathbf{X}(\mathbf{X}'\mathbf{X})^{-1}\mathbf{X}'$. As the expected value of the second term is not equal to zero, the OLS estimate is biased. Furthermore, while the probability limit of $N^{-1}(\mathbf{Z}'\mathbf{MZ})$ can be a finite and nonsingular matrix, that of $N^{-1}(\mathbf{Z}'\mathbf{M}\boldsymbol{\varepsilon})$ is not equal to zero, except in the trivial case where ρ = 0. Thus, the OLS estimate is not only biased but also inconsistent. To obtain consistent estimators, we estimate the spatial lag equation by the maximum likelihood (ML) method, following the traditional literature in spatial

econometrics.[7] Given the estimates by the ML method, three familiar asymptotic tests are conducted in order to examine the existence of spatial dependence: the Wald test, the likelihood ratio test (LR test), and the Lagrange multiplier test (LM test).

Our particular interest is in the estimates for ρ, the East Asian and European values of which are to be compared. ρ will indicate the strength and sign of the spatial relationships among countries within a region for the electric machinery industry. A significantly positive/negative sign for ρ implies that the electric machinery industry's activities in a country are positively/negatively correlated with those in neighboring countries. For the East Asian region, in which international production networks have developed in the electric machinery industry, production processes located in each country will be interrelated with those in neighboring countries. In Europe, on the other hand, production locations in the electric machinery industry have been locked into a limited number of countries. In particular, if our nine sample countries cover only a sufficiently small area, once agglomeration is formed within a certain country, the industry's activities would not be yielded to neighboring countries. Therefore, we expect the sign of ρ to be positive and significant for East Asia, but insignificant for Europe.

Our data sources are as follows. Data for value-added and employment in the electric machinery industry are obtained from UNIDO's *The International Yearbook of Industrial Statistics*.[8] Data for distances are drawn from the CEPII's website.[9] Data for

[7] For details on ML estimation of the spatial lag model, see Anselin (1988, Ch.6).

[8] Note that data covering several years are not available for several countries. If data on either item, i.e. value-added or employment are available, the data for the missing item is estimated by using the available item's growth rate. Or, if the data for the previous year and the following year are available, we replace a missing datum with the average value of both periods.

[9] http://www.cepii.fr/anglaisgraph/bdd/distances.htm.

all explanatory variables are obtained from the World Bank's World Development Indicators Online. All variables are deflated by the GDP deflator, as necessary. The basic statistics for variables used in the spatial lag regression are reported in Table 1. Naturally, the mean values of all explanatory variables are larger in Europe than in East Asia.

== Table 1 ==

4.2. Empirical Results

The spatial lag equation is estimated separately for the East Asian region and the European region. We also estimate the equations without **WY** or **X**. Table 2 reports the estimates for East Asia.

== Table 2 ==

First, as expected, the coefficients for **WY** are significantly positive for the East Asian sample. Except for the LM test in column (V), the three kinds of tests, i.e., the Wald, LR, and LM tests, reject the null hypothesis of no spatial dependence. A positive sign for the coefficient ρ indicates that the production in the electric machinery industry in a country is positively correlated with that of its neighboring countries in East Asia. Such a positive spatial interdependence would be a consequence of large disparities in location advantages among countries in the region. That is, given the large disparities, international fragmentation of production in the electric machinery industry expands among neighboring countries. Such fragmentation across neighboring countries yields

positive spatial interdependence in electric machinery production within East Asia.

Second, the estimates for the other regressors are as follows. The coefficients for GDP per capita, which is employed as a proxy for wage, are significantly negative, though they are insignificant in the value-added equations. The coefficients for electricity production per capita are positively significant in both equations. Contrary to our expectation, however, the estimated coefficients for market potential and telephone lines are significantly negative. The negative signs for telephone lines seem to be due to a multicolinearity issue. Indeed, there is high correlation (86%!) between telephone lines and GDP per capita in the East Asian sample. The negative signs for market potential are somehow puzzling, but might be due to its correlation with any location advantages on the supply side which are not fully captured in our estimation. In this regard, while location advantages, such as factor prices, on the supply side are considered to be crucial elements in the development of international fragmentation, no studies stress the importance of those, such as market potential, on the demand side.

The results for the European sample are reported in Table 3. As is consistent with our expectation, in Europe, the coefficients for **WY** are insignificantly estimated, and all the three kinds of tests result in the null hypothesis of no spatial dependence not being rejected.[10] Such an insignificant result implies that our sample countries cover only a small area. The relatively large scale of production in Germany may function as a huge single agglomeration among the core EU countries. The coefficients for the other

[10] For the European sample, the insignificant estimates for **WY** are quite robust. For example, changing the range of the sample in terms of years or countries (adding some other EU countries such as Greece or Finland) does not affect the result. Enlarging the geographical scope (e.g., adding Eastern European countries) might, however, change the result because the spatial interrelationships within a region with a *large* area are expected to be different from those within a region limited to a small area such as the European sample in this paper.

regressors are estimated to be significant with reasonable signs, except for electricity production per capita: Those for GDP per capita are estimated to be negative, while those for market potential and telephone lines are estimated to be positive. Of particular note is that the scale of production and employment in the electric machinery industry in a country is positively affected by its market potential in Europe, in stark contrast to the results for the East Asian sample. The previous studies in the NEG show that the better market access a county/country has, the larger benefits it can enjoy from agglomeration (see, for example, Hanson 2005; Redding and Venables 2004). Within a region such as Europe, in which industrial concentration prevails, a certain country with great market potential attracts a large number of firms, resulting in increased production and demand for labor.

== Table 3==

5. Concluding Remarks

There is a clear contrast in intra-regional disparities in location advantages such as factor prices between East Asia and Europe. Such a contrast yields various kinds of differences between the regions with regard to industrial activities. This paper has conducted an empirical investigation of the differences in spatial relationships among countries in East Asia and Europe by applying the spatial lag model to each of the two regions. As a result of the empirical analysis, we found that, while the scale of the electric machinery industry in a country is positively correlated with that of neighboring countries in East Asia, there is no spatial correlation detected in Europe. In future work,

it would be invaluable to study whether the spatial relationship turns out to be negative in the case of Europe covering a larger area including Eastern European countries.

Our findings provide us with the following implication for regional economic development. First, in the case of the East Asian region, the findings indicate that, as long as keeping significant differences in location advantages among countries, they could continue simultaneous production expansion by the compartmentalization of production processes of an industry. To achieve some extent of economic development in *all* countries of this region, it is important for each country to keep or create strong location advantages in its strong area of production processes rather than aiming to undertake a broader range of processes at the expense of the other countries. Second, the positive spatial interdependence implies that (either external or internal) negative economic shocks would easily spread all over the region. In order to reduce the vulnerability of regional economy to external shocks, for example, it would be important to enhance intra-regional final demand for goods produced within the region by shedding the overdependence on the external demand. Third, as is the case of the electric machinery industry, simultaneous production expansion across the region can be realized in other industries as well, if the broadly-defined trade costs, including the technical costs for the separation of production processes, are reduced.

For the European region, on the other hand, several countries are unlikely to experience simultaneous production expansion of a particular industry, but an individual country could achieve economic development by waiting for a rise in congestion costs in a leading country for a particular industry (e.g. in the case of the electric machinery industry in Germany) or by compartmentalization of differing industries. In either case, however, the core EU countries would not necessarily be able to retain the whole

production process within single countries. Some parts of the process might be relocated to Eastern European or others countries to take advantage of cheaper labor. Thus, Europe is headed for some difficult maneuvering in facilitating even economic development over the whole region.

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Table 1. Basic Statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
East Asia					
Y (Value-added)	189	22.38	1.50	20.01	25.79
Y (Employment)	189	12.23	1.43	9.99	15.26
GDP per capita	189	8.48	1.19	6.31	10.61
Market potential	189	33.30	8.03	22.00	43.05
Electric production per capita	189	7.20	1.25	4.00	9.02
Telphone lines per 100 *persons*	189	1.94	1.75	-1.52	4.08
Europe					
Y (Value-added)	231	22.32	1.44	19.79	25.20
Y (Employment)	231	11.39	1.41	8.92	13.85
GDP per capita	231	10.00	0.38	9.00	11.44
Market potential	231	33.87	8.06	22.97	43.74
Electric production per capita	231	8.69	0.64	7.25	10.34
Telphone lines per 100 *persons*	231	3.69	0.34	2.32	4.27

Table 2. Estimation Results: East Asia

	Value Added			Employment		
	(I)	(II)	(III)	(IV)	(V)	(VI)
WY		0.451***	0.498***		0.236*	0.337***
		[0.104]	[0.096]		[0.125]	[0.112]
GDP per capita	0.168		0.224	-0.590***		-0.597***
	[0.200]		[0.161]	[0.204]		[0.155]
Market potential	-0.475		-0.529**	-0.566*		-0.616***
	[0.324]		[0.240]	[0.289]		[0.232]
Electric production per capita	1.525***		1.472***	1.734***		1.726***
	[0.276]		[0.238]	[0.260]		[0.230]
Telphone lines per 100 *persons*	-0.798***		-0.798***	-0.719***		-0.728***
	[0.250]		[0.204]	[0.236]		[0.197]
Year dummy	Yes	Yes	Yes	Yes	Yes	Yes
Wald test		18.68***	26.71***		3.57*	9.10***
LR test		13.58***	18.29***		3.22*	7.64***
LM test		9.73***	13.41***		2.35	5.83**
Observations	189	189	189	189	189	189
R-sq	0.3174			0.3617		
Log likelihood		-330	-299		-330	-289

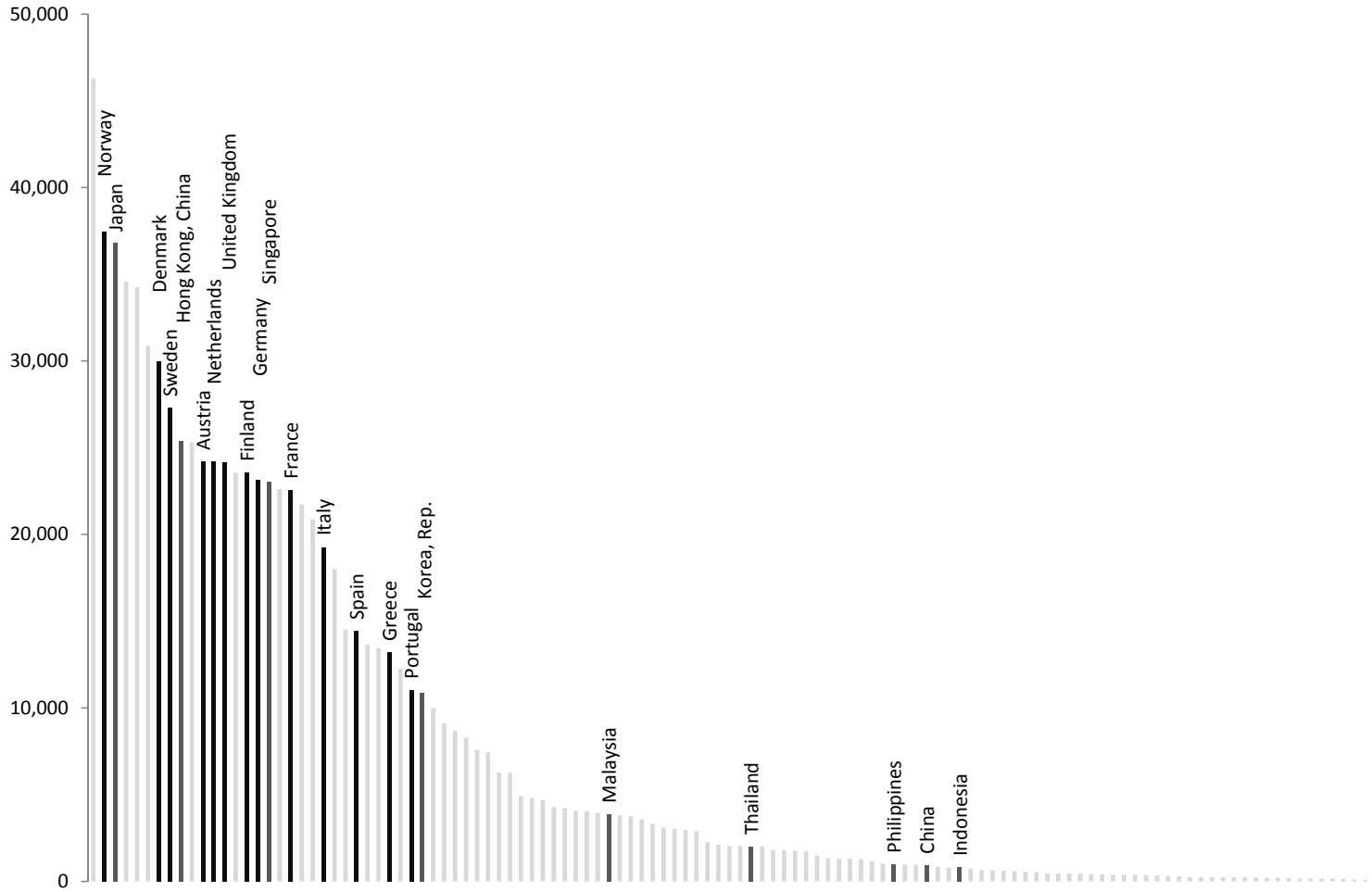
Notes: Standard errors are in parentheses. ***, **, and * show 1%, 5%, and 10% significance, respectively. **Y** is an N×1 vector of observations on the dependent variable (a log of value-added/employment). The spatial lag weighting matrix **W** is an N×N block-diagonal matrix. The *i*-th entry of the spatially lagged independent variable **WY** can be interpreted as a proximity-weighted average of value-added/employment of the machinery industry in other $j \neq i$ countries in a region. **W** is row-standardized. Sample countries are China, Hong Kong, Indonesia, Japan, Republic of Korea, Malaysia, the Philippines, Singapore, and Thailand.

Table 3. Estimation Results: Europe

	Value Added			Employment		
	(I)	(II)	(III)	(IV)	(V)	(VI)
WY		0.138	-0.005		0.234	0.125
		[0.156]	[0.166]		[0.145]	[0.156]
GDP per capita	-1.175***		-1.176***	-2.030***		-2.014***
	[0.246]		[0.302]	[0.221]		[0.283]
Market potential	3.119***		3.120***	3.124***		3.102***
	[0.256]		[0.354]	[0.232]		[0.331]
Electric production per capita	0.331*		0.331*	0.405**		0.415**
	[0.188]		[0.197]	[0.176]		[0.184]
Telphone lines per 100 *persons*	0.844*		0.845**	1.182***		1.164***
	[0.434]		[0.420]	[0.401]		[0.392]
Year dummy	Yes	Yes	Yes	Yes	Yes	Yes
Wald test		0.78	0.00		2.61	0.64
LR test		0.73	0.00		2.28	0.60
LM test		0.45	0.00		1.43	0.36
Observations	231	231	231	231	231	231
R-sq	0.2814			0.3451		
Log likelihood		-410	-374		-406	-358

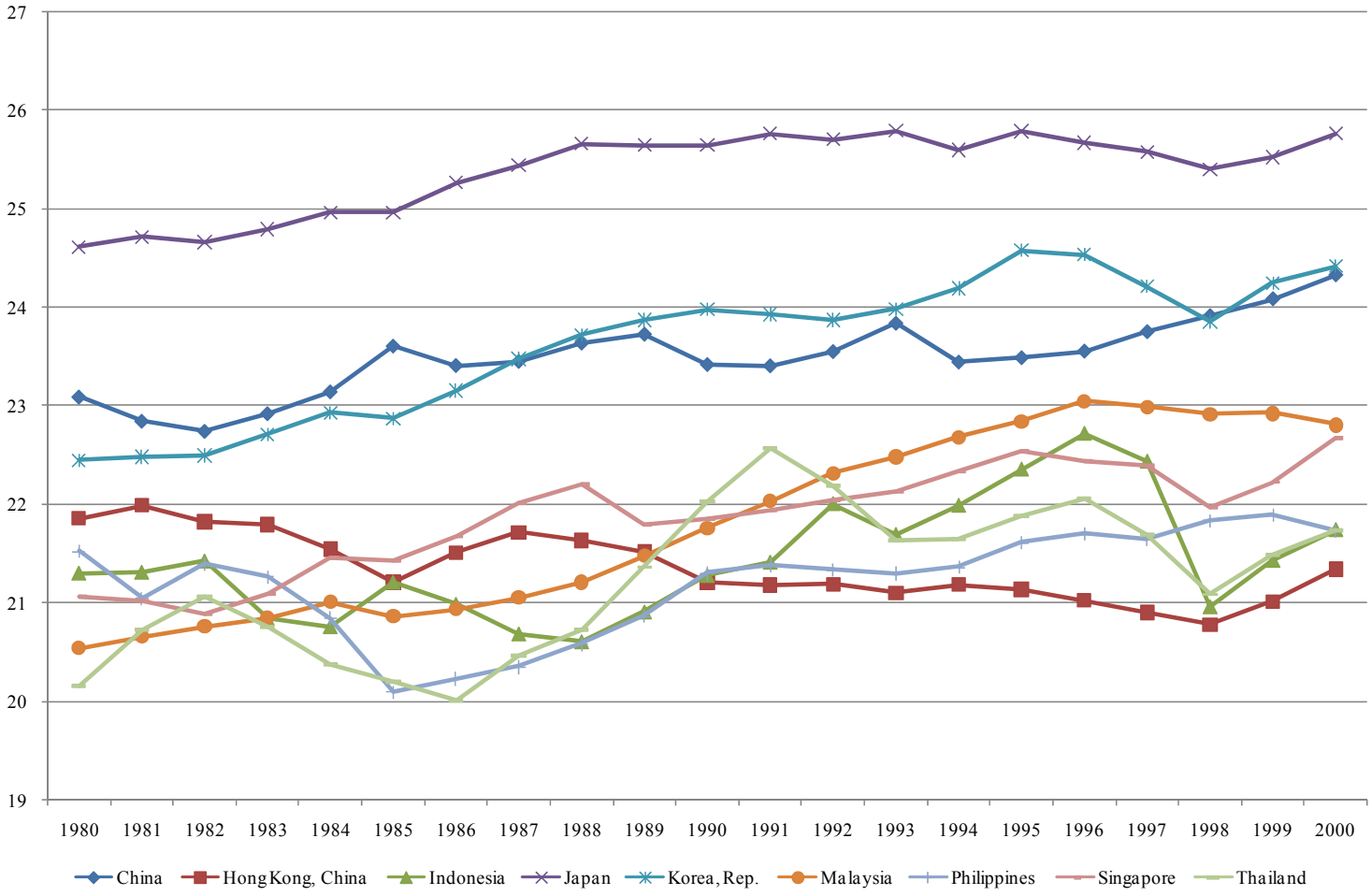
Notes: Standard errors are in parentheses. ***, **, and * show 1%, 5%, and 10% significant, respectively. **Y** is an N×1 vector of observations on the dependent variable (a log of value-added/employment). The spatial lag weighting matrix **W** is an N×N block-diagonal matrix. The *i*-th entry of the spatially lagged independent variable **WY** can be interpreted as a proximity-weighted average of value-added/employment of machinery industry in other $j \neq i$ countries in a region. **W** is row-standardized. Sample countries are Austria, Denmark, France, Germany, Italy, Norway, Portugal, Spain, and United Kingdom.

Figure 1. Ranking of GDP per capita for 117 Countries in 2000 (US Dollar)



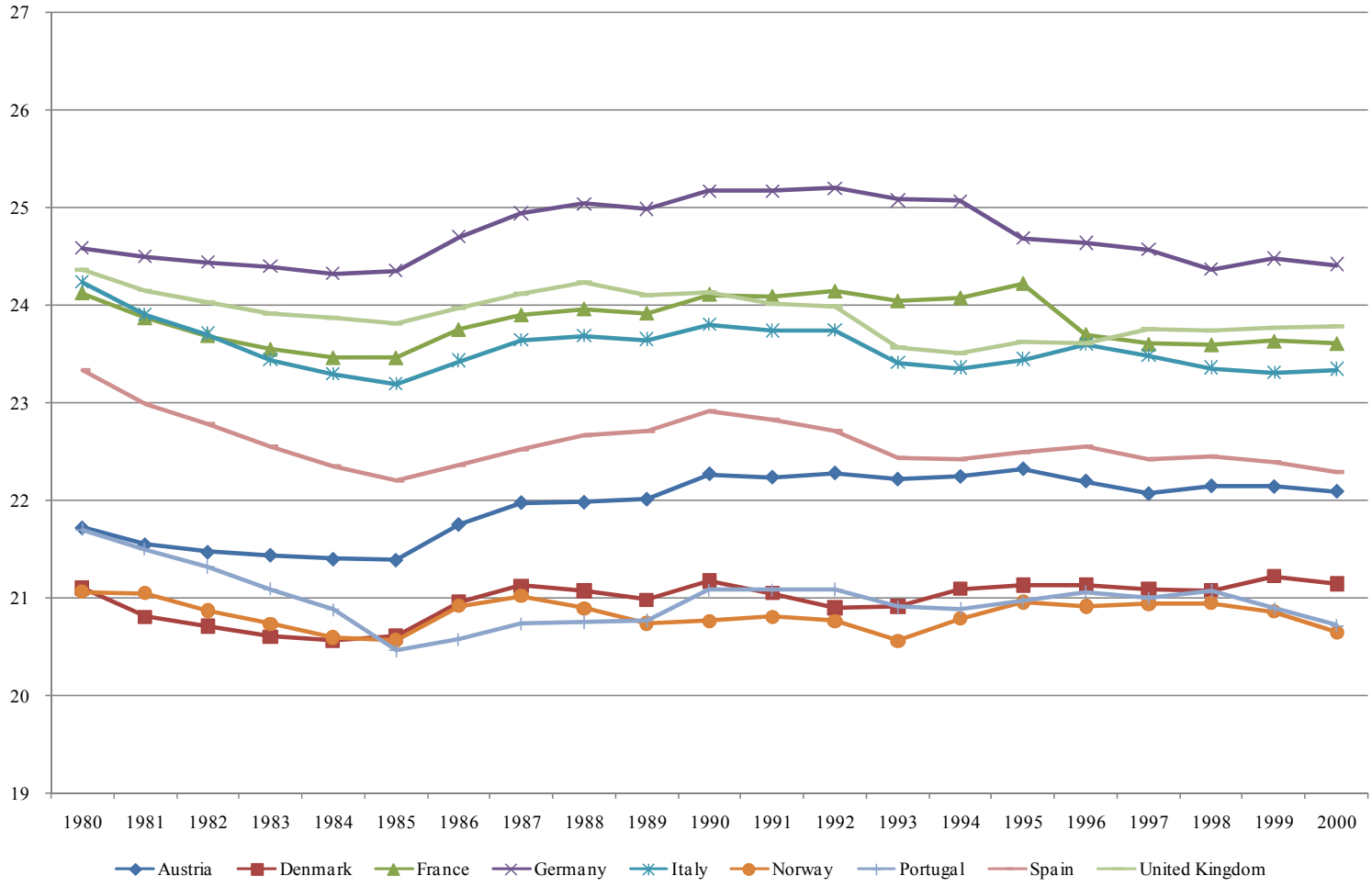
Source: *World Development Indicator* (World Bank).

Figure 2. Changes in Value-added in the Electric Machinery Industry: East Asia



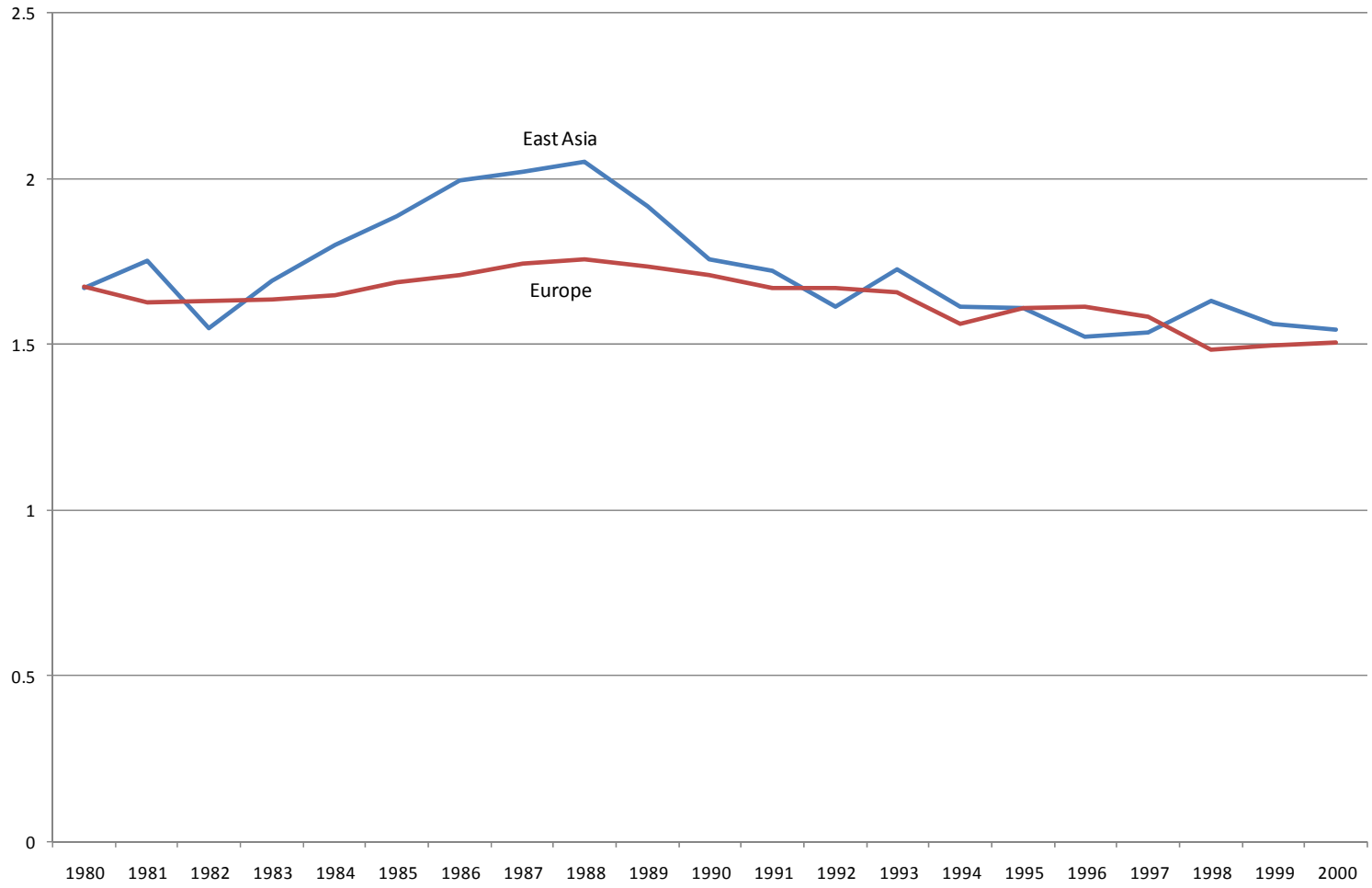
Source: *The International Yearbook of Industrial Statistics* (UNIDO).

Figure 3. Changes in Value-added of Electric Machinery Industry: Europe



Source: *The International Yearbook of Industrial Statistics* (UNIDO)

Figure 4. σ-convergence of Value-added in East Asia and Europe



Source: *The International Yearbook of Industrial Statistics* (UNIDO)