International Convergence and Divergence of Material Input Structures: An Industry-Level Perspective

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Abstract. This paper analyzes whether international material input structures have converged or diverged over time. Pooled variances for 25 industries were obtained from OECD input-output tables in constant prices for nine countries over the period 1971-1990. It is found that high-tech industries were mainly characterized by divergence of material input structures, whereas convergence was found for many low-tech, more mature industries. In line with studies on (labor) productivity growth rates, convergence of material input structures was prevalent in the 1970s, while divergence dominated in the 1980s.

Keywords: convergence, technology, specialization, input-output tables

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1. Introduction

Over the past couple of decades, globalization has become a keyword to describe the increased interrelatedness of nations with respect to trade and knowledge diffusion. The question we address in this note is how production processes of industrialized countries have changed as a consequence of international technological linkages. Using information from input-output tables, we analyze for each industry whether the structures of material inputs have converged, or not. In our definition, convergence takes place if the diversity (or, variability) of production technologies used across countries decreases.[1] In this respect, our convergence concept resembles the σ-convergence concept that is well known in studies of labor productivity and total factor productivity convergence (see, e.g. Bernard and Jones, 1996a).

In this paper, we will view changes in material input structures in the light of so-called "technology gap" models of growth (see, e.g., Fagerberg, 1987). In these models, two sources of change are highlighted: innovation and technological catch-up. Suppose a situation in which countries use identical material input structures in an industry. Any innovation will then induce a tendency to divergence, since one or a few national industries start adopting a different production technology that is perceived as an improvement over current practice. Later on, technology flows from technological leaders to followers (see, for instance, Coe & Helpman, 1995, and Verspagen, 1997) may induce technological catch-up, since latecomer countries might learn how to produce according to the technologies operated by the original

[1] To be more exact, we propose the reduction in the pooled variance of the material input coefficients of an industry as an indicator of convergence.

innovator(s). Ceteris paribus, material input structures will become more alike, or, in other words, convergence will prevail.[2]

In the "real world", many of such processes are simultaneously at work. Convergence (divergence) occurs in a given time period if the effects of innovations by the leader are smaller (larger) than the effects of catch-up through assimilation of diffused technology by follower countries. Empirical analyses should provide answers to the question whether convergence or divergence prevails.[3] In this note, we use data from the OECD input-output tables in constant prices for nine countries over the period 1971-1990, to compute our convergence indicator for 25 industries.

The rest of the paper is organized as follows. The next section gives a more detailed presentation of the basic technology gap model. The interactions between innovation and technological catch-up are formalized and hypotheses about the typical industries for which convergence resp. divergence of material input structures should prevail are formed. Section 3 presents the convergence indicator we propose. Section 4 discusses the data we use and Section 5 deals with the results. Section 6 concludes.

2. Technology gap models and convergence

In traditional neoclassical economics (Solow, 1956), international differences in levels of labor productivity were seen as transitory phenomena. Due to more attractive rates of return to capital in low-productivity countries, investment rates were thought to be higher than in

[2] The issue of convergence of technologies has been studied quite extensively, but almost exclusively on the basis of trends in (labor or multifactor) productivity. Baumol (1986) is a classic contribution in this respect.

[3] Hoen (2002, Chapter 7) contains a first study, approaching the question from the perspective of trade theory, however.

high-productivity countries. Ultimately, all countries will tend towards the same productivity level. If (exogenous) technological progress is taken into account (countries increase their productivity at a constant pace), convergence towards a steady-state gap of productivity levels will result, and growth rates will tend to equalize. Characteristic of these models is that technology is considered to be common to all countries. Differences in savings rates are considered the main cause of productivity growth differentials.

In the technology gap literature (Fagerberg, 1987, and Verspagen, 1991, are seminal studies, see e.g. Lim and McAleer, 2004, for a recent contribution), a different approach is proposed. High-productivity countries attain productivity growth by means of innovation. Since the knowledge pertaining to these innovations is assumed to disseminate slowly (or, at least, not instantaneously), low-productivity countries will initially lose ground, both in terms of productivity levels and growth rates. As soon as low-productivity countries start to "benefit" from their technological backwardness (for instance, by imitating high-productivity processes and products) catch-up can occur. Thus, the dynamics of the productivity gap between high-productivity countries and low-productivity countries is basically viewed as the outcome of two opposing forces: innovation by the leaders and assimilation by followers.

Let us for simplicity assume that there is just one productivity leader, country 0. The productivity followers are denoted by i (i=1, ..., n). Then, the basic technology gap model is given by

$$\dot{y}_i - \dot{y}_0 = (\alpha_i - \alpha_0) + \beta_i \ln\left(\frac{y_i^{INI}}{y_0^{INI}}\right) \qquad (1)$$

where dots denote growth rates and the superscript INI indicates a value in the initial period. y stands for productivity. The constants α_i (i=0,...,n) and β_i (i=1,...,n) denote country-specific abilities to innovate ($\alpha_i \geq 0$), and abilities to assimilate technology that originated with the leader ($\beta_i \leq 0$), respectively.[4] Countries that are unable to assimilate any technology will be characterized by $\beta_i=0$. The better country *i* is at assimilating (for instance due to a relatively well-educated workforce), the more negative β_i will be.

For reasons of exposition, we assume that the leader's ability to innovate leads to a stable, continuous flow of innovations that yields productivity growth at rate α_0. Furthermore, let us assume that follower countries cannot innovate at all by themselves ($\alpha_i=0$, $i=1,\ldots,n$). The equilibrium gaps for the productivity levels can now easily be found by setting the left hand side of (1) equal to zero, that is -in equilibrium- the leader and the followers experience identical productivity growth rates. Solving for the right hand side yields:

$$\frac{y_i^*}{y_0^*} = e^{(\alpha_0 / \beta_i)} \tag{2}$$

Thus, the equilibrium gaps for productivity levels are larger the faster innovations arrive in the leader country and the smaller the rates of assimilation in follower countries are.

In many cases, productivity growth rates due to innovation as captured by α_0 are not stable over time (see, e.g. Freeman & Soete, 1997). As a consequence, the equilibrium gap in (2) and, therefore, actual productivity gaps will change over time. In the early stages of product life cycles, productivity growth is often slow (α_0 small), due to the initially limited scale at which innovative processes are used or innovated products are sold. Later on, productivity growth picks up ($\alpha_0\uparrow$), since the innovation has gained more popularity. Finally, at the time processes and products reach the stage of maturity, the rate of innovation usually goes down ($\alpha_0\downarrow$), because opportunities for further improvement get fished out. If it is

[4] Note that the ratio y_i^{INI} / y_0^{INI} in (1) is smaller than one.

assumed that the abilities to assimilate remain constant over time, the product life cycle can be held responsible for changes in the distribution of gaps, as reflected in its variance.

In the traditional technology gap literature described so far, technologies are indicated by productivity levels. In this study, we adopt a different perspective and use material input structures as indicators of technology. If assimilation of leading technologies is predominant, the industry-specific input structures will become more similar across countries. If innovation is a more important factor, however, the contrary is true. The innovating industry will adopt processes characterized by an input structure that deviates from what its foreign counterparts do. As a consequence, input structures will become more heterogeneous.

In the literature on productivity convergence, scholars often investigate trends in measures of dispersion, like the distribution's variance. If the dispersion in productivity or income levels is decreasing, Bernard and Jones (1996a), Sala-i-Martin (1996) and Proietti (2005), among others, denote this as σ-convergence. Several measures of dispersion have been used in the literature, ranging from variances, standard deviations, and standard deviations of transformed variables to weighted or unweighted coefficients of variation. In this paper, we will focus on intertemporal comparisons of variances, because statistical theory provides some natural yardsticks for assessing σ-convergence and σ-divergence for material input structures.

In the technology gap model represented by (1), the variance of equilibrium gaps is likely to increase (σ-divergence) during the transition from the early stage to the stage of growth. High-productivity innovators will leap forward, while more backward countries will stay further behind, which implies increased dispersion of productivity levels. During the subsequent transition from the stage of growth to the maturity stage, however, the variance of equilibrium gaps could well decrease (σ-convergence). Since adaptation to the equilibrium distribution of gaps is generally considered as a slow process due to relatively modest abilities to assimilate, actual convergence and divergence processes are long-run phenomena.

In the next section, we will outline how we adapt a measure of σ-convergence in the literature on productivity convergence to study convergence of material input structures at the industry level.

3. Methodology

We base our analysis on input-output tables in constant prices. From these, we obtain the elements z_{ij} with the (domestic plus imported) intermediate deliveries from industry i to industry j (i, j = 1,…,n) and domestic gross outputs x_j in industry j. The elements $a_{ij} = z_{ij} / x_j$ denote the input coefficients of material input i per unit of output in industry j. Convergence (respectively divergence) of material input structures in industry j would imply that the jth columns of the matrices **A** of input coefficients for the various countries become more (respectively less) similar. In line with the concept of σ-convergence for productivity levels outlined in the previous section, we analyze the changes in the similarity of the columns over time.[5]

Let the countries be denoted by the index $r = 1,\ldots,m_t$ and note that the number of countries included in the sample differs over time. Then for each industry j (= 1,…,n) at time t, we have

$$v_{ij}(t) = \frac{1}{m_t - 1}\sum_{r=1}^{m_t}[a_{ij}^r(t) - \bar{a}_{ij}(t)]^2 \text{, with } \bar{a}_{ij}(t) = \frac{1}{m_t}\sum_{r=1}^{m_t} a_{ij}^r(t) \qquad (3)$$

This expression reflects the extent to which the input coefficient a_{ij} differs from the average value computed for the full set of countries. If the material input structures for industry j would be exactly identical across countries, $v_{ij}(t)$ would be zero. The use of any input I as a proportion of gross output is the same for each country.

If some elements a_{ij} vary across countries for industry j, a summary measure is needed to indicate the dissimilarity of international production technologies. The pooled variance, obtained by taking the average of the variances $v_{ij}(t)$, is the most straightforward candidate summary measure, i.e.

$$v_j(t) = \frac{1}{n}\sum_{i=1}^{n} v_{ij}(t) \qquad (4)$$

If $v_j(t+1)$ is "substantially" smaller than $v_j(t)$, we will speak of convergence between period t and t+1. This resembles the conventional notion of σ-convergence, introduced in the previous section: from period t to period t+1, technologies have become more alike, most probably as a consequence of technology assimilation. Analogously, we will take a $v_j(t+1)$ that is "substantially" larger than $v_j(t)$ as an indication of divergence between t and t+1. As a yardstick, we use the corresponding F-statistic. For example (also other percentiles will be used),

- convergence took place if $v_j(t+1)/v_j(t) < F_{n(m_t-1)}^{n(m_{t+1}-1)}(0.05)$
- divergence took place if $v_j(t+1)/v_j(t) > F_{n(m_t-1)}^{n(m_{t+1}-1)}(0.95)$

[5] Appendix B contains a simplified illustration of the calculations involved.

It should be stressed that we use the critical values of *F*-distributions only as a yardstick to distinguish between "large" and "small" differences. The application of an *F*-test to decide whether the differences are significantly different (in a statistical sense), would require unrealistically strong assumptions. That is, we would have to assume that the observations $a_{ij}^{r}(t)$ are normally distributed with mean $\mu_i(t)$ and a common variance $\sigma^2(t)$. Moreover, the observations would need to be independent across countries *r* and supplier industries *i*. In particular the assumption regarding independency seems to be violated in reality, because country-specific substitution effects, for example, may play a role. Nevertheless, comparisons to critical values of *F*-distributions give sensible indicators of the strength of convergence or divergence processes.

4. Data

We study the changes in material input structures in the way outlined in the previous section on the basis of a set of national input-output tables compiled by the OECD (OECD, 1995). It contains input-output tables for ten developed countries, using a 35-industry classification.[6] For each country, three to five tables are available, roughly for the period 1968-1990. Unfortunately, the years for which tables are compiled do not exactly coincide. We decided to

[6] These countries are Australia (AU), Canada (CA), Denmark (DK), France (FR), Germany (GE), Japan (JP), The Netherlands (NL), the United Kingdom (UK) and the United States of America (US). The OECD database also contains a single table for Italy. Since changes in tables are considered, we could not include Italy in our analysis.

follow the suggestion made in OECD (1995) to assign each table to a subperiod. Table 1 presents this grouping of tables.[7]

INSERT TABLE 1

Our analyses are based on the tables that contain all intermediate inputs, both domestically produced and imported (in the OECD database these tables are encoded as "TIOK"). This choice is in accordance with the idea that material input structures should resemble technologies of industries. Mere changes in the mix of domestically produced and imported inputs should not affect these representations, unless domestically produced inputs from supplying industry *i* would be different from imported inputs from industry *i*. Since the OECD constructed the tables according to an internationally harmonized industry classification, risks that substantial systematic differences affect the results are strongly reduced.

The interindustry transactions recorded in the tables for any country are denominated in the national currency. Further, the tables are expressed in constant prices. As a consequence, information on (physical) quantities of inputs (which represent the material input structures we are interested in) is thus approximated as well as possible, because inflation and changes in exchange rates do not contaminate the coefficients.[8]

Since national statistical agencies did not construct their national input-output tables in exactly the same way, the OECD tables are not fully comparable. Some industries are not contained as separate entities in tables for some countries, whereas they do for others (see

7 We decided to adopt the grouping suggested by OECD (1995, p. 7), except for one table. That is, we included UK(1979) in the third subperiod, whereas OECD (1995) assigned it to the second subperiod. Our grouping yields less variance within groups with respect to timing.

OECD, 1995, p. 12). To make the tables as comparable as possible we had to aggregate a limited number of industries. The aggregation scheme is included in Appendix A. We finally computed the pooled variances for 25 industries, each of them based on material input coefficients vectors that consist of 25 elements.

5. Results

Applying equations (3) and (4) to the OECD (1995) tables and using the specified criteria for convergence and divergence, yields the results documented in Table 2. The rightmost columns refer to trends over the entire period of analysis, i.e. 1971-1990. An overwhelming majority of industries (i.e., 19 out of 25) has experienced either convergence or divergence of material input structures, as measured by the yardstick of the 10^{th}, respectively the 90^{th}, percentiles of the appropriate *F*-distributions.

INSERT TABLE 2

In particular, many manufacturing industries that are widely considered as "low-tech" – such as textiles (4), wood products (5), paper (6), petroleum (8), and basic metals (11) – appear to have converged. Convergence is also found for primary industries – agriculture (1) and mining (2) – and for a limited number of services industries. This is in line with the prediction from the technology gap literature briefly discussed in Section 2, based on the argument that innovation by technological leaders has slowed down in these "mature" industries. The technology gap will thus be narrowed if the ability of follower countries to assimilate diffused

[8] It should be mentioned that the base years used for deflation are not identical for all countries, which may

technology has not decreased. This would yield clearcut tendencies towards convergence of the material input structures.

The results for most high-tech and medium-tech manufacturing industries support this explanation. Most industries that belong to this group – such as chemicals (7), plastics (9), machinery (13), ships (14), and transport equipment, (15) – show either divergence or no discernible tendency. An increase of the leaders' innovation rates will widen the technology gap inducing divergence, if abilities to assimilate knowledge remain unaltered. A similar argument seems to hold for business services (24), an industry characterized by a high degree of organizational innovation.

It should be noted, however, that we are not able to explain the findings for every industry. For example, the low-tech industries glass and stone (10) and metal products (12) show divergence, whereas the high-tech industry instruments (16) is found to have experienced convergent tendencies. Specialization might play a role in this (for example, metal products is characterized by a high degree of product differentiation which may be taken as an indication of specialization).

Several generations of trade theories predict that countries will specialize in different production processes (Jones, 1956, Krugman, 1981, Grossman, 1992). The OECD input-output tables, however, are rather aggregated, whereas specialization typically takes place at the more detailed level of "subindustries". Each of these can be characterized by its own material input structure. Once such subindustries are aggregated into an industry, the subindustries in which a country is specialized will most strongly influence the structure of the (aggregate) industry. Changes in the input structure of an industry may therefore also be partly due to changes in the mix of its subindustries, as caused by changes in specialization patterns. The problem, however, is that an increase in specialization may lead to convergence

affect our results.

in one case and to divergence in an other. Therefore, although specialization may play some role, it cannot be used as a factor to explain the observed patterns of convergence/divergence, because the direction of its effect cannot be ascertained.

Looking at the results for shorter subperiods, it is not surprising that a far more heterogeneous pattern is found than for the results over the entire period. The bottom row shows that an initial tendency towards convergence was gradually overturned. In the late 1980s, divergence rather than convergence of material input structures was found most often. This result is in line with studies that focus on convergence and divergence of labor productivity levels (see, e.g., Bernard & Jones, 1996a, 1996b, and Los & Timmer, 2005). From the perspective of single industries, only few show a more or less persistent development, such as agriculture (1), ships (14), other manufacturing (17), utilities (18) and government services (25). For the other industries, it is remarkable that subperiods with convergence are often followed by subperiods of divergence (and vice versa). These counteracting short-run effects certainly call for further analysis at a more detailed industry level. At the present level, they seem to have blurred the long-run tendencies indicated by the results for the entire period.

6. Conclusions

This note explored opportunities to incorporate changing patterns of material input structures into analyses of international convergence and divergence. For the period 1971-1990, the analysis based on pooled variances of input coefficients revealed that high-tech industries were mainly characterized by divergence of material input structures, whereas convergence was found for many low-tech, more mature industries. These results confirm hypotheses derived from the literature on technology gap models. As is in line with studies that focus on convergence and divergence of (labor) productivity growth rates, convergence of material input structures was prevalent in the 1970s, while divergence dominated in the 1980s.

References

Baumol, William J. (1986), "Productivity Growth, Convergence, and Welfare: What the Long-Run Data Show", *American Economic Review*, vol. 76, pp. 1072-1085.

Bernard, Andrew B. and Charles I. Jones (1996a), "Technology and Convergence", *Economic Journal*, vol. 106, pp. 1037-1044.

Bernard, Andrew B. and Charles I. Jones (1996b), "Comparing Apples to Oranges: Productivity Convergence and Measurement Across Industries and Countries", *American Economic Review*, vol. 86, pp. 1216-1238.

Coe, David T. and Elhanan Helpman (1995), "International R&D Spillovers", *European Economic Review*, vol. 39, pp. 859-887.

Fagerberg, Jan (1987), "A Technology Gap Approach to Why Growth Rates Differ", *Research Policy*, vol. 16, pp. 87-99.

Freeman, Chris and Luc Soete (1997), *The Economics of Industrial Innovation*, Third edition (Cambridge, Mass.: MIT Press).

Grossman, Gene M. (1992), *Imperfect Competition and International Trade* (Cambridge, Mass.: MIT Press).

Hoen, Alex R. (2002), *An Input-Output Analysis of European Integration* (Amsterdam: North-Holland/Elsevier).

Jones, Ronald W. (1956), “Factor Proportions and the Heckscher-Ohlin Theorem”, *Review of Economic Studies*, vol. 24, pp. 1-10.

Krugman, Paul R. (1981), “Intraindustry Specialization and the Gains from Trade”, *Journal of Political Economy*, vol. 89, pp. 959-973.

Lim, Lee Kian and Michael McAleer (2004), “Convergence and Catching Up in ASEAN: A Comparative Analysis”, *Applied Economics*, vol. 36, pp. 137-153.

Los, Bart and Marcel P. Timmer (2005), “The ‘Appropriate Technology’ Explanation of Productivity Growth Differentials: An Empirical Approach”, *Journal of Development Economics*, vol. 77, pp. 517-531.

OECD (1995), *The OECD Input-Output Database* (Paris: OECD).

Proietti, Tommasso (2005), “Convergence in Italian Regional Per-Capita GDP”, *Applied Economics*, vol. 37, pp. 497-506.

Sala-i-Martin, Xavier (1996), “The Classical Approach to Convergence Analysis”, *Economic Journal*, vol. 106, pp. 1019-1036.

Solow, Robert M. (1956), “A Contribution to the Theory of Economic Growth”, *Quarterly Journal of Economics*, vol. 70, pp. 65-94.

Verspagen, Bart (1991), “A New Empirical Approach to Catching Up or Falling Behind”, *Structural Change and Economic Dynamics*, vol. 2, pp. 359-380.

Verspagen, Bart (1997), “Estimating International Technology Spillovers Using Technology Flow Matrices”, *Weltwirtschaftliches Archiv*, vol. 133, pp. 226-248.

Appendix A: Industry classification for analyses based on OECD (1995) data

No.	Description	OECD IO code	ISIC Rev. 2 code
1.	Agriculture, forestry and fishery	1	1
2.	Mining and quarrying	2	2
3.	Food, beverage and tobacco	3	31
4.	Textiles, apparel and leather	4	32
5.	Wood products and furniture	5	33
6.	Paper, paper products and printing	6	34
7.	Chemicals, including drugs and medicines	7+8	351+352
8.	Petroleum and coal products	9	353+354
9.	Rubber and plastic products	10	355+356
10.	Non-metallic mineral products	11	36
11.	Basic metals	12+13	37
12.	Metal products	14	381
13.	Machinery, including electronics	15+16+17+18	382+383
14.	Shipbuilding and repairing	19	3841
15.	Other transport equipment	20+21+22	384-3841
16.	Professional goods	23	385
17.	Other manufacturing	24	39
18.	Electricity, gas and water	25	4
19.	Construction	26	5
20.	Wholesale and retail trade	27	61+62
21.	Restaurants and hotels	28	63
22.	Transport and storage services	29	71
23.	Communication services	30	72
24.	Financial and business services	31+32	8
25.	Community, social and government services	33+34+35	9

Appendix B: Illustration of computations

Consider the following simplified tables with input coefficients, for the hypothetical countries A and B (m_t=2, see equation (3)), for t=0 and t=1.

Country A, t=0

	1	2	3
1	0.2	0.1	0.1
2	0.2	0.2	0.1
3	0.2	0.1	0.3

Country B, t=0

	1	2	3
1	0.3	0.2	0.1
2	0.2	0.1	0.1
3	0.1	0.1	0.2

Country A, t=1

	1	2	3
1	0.2	0.1	0.1
2	0.2	0.2	0.1
3	0.2	0.1	0.3

Country B, t=1

	1	2	3
1	0.2	0.3	0.1
2	0.2	0.1	0.1
3	0.1	0.1	0.2

Suppose one is interested in the convergence or divergence of material input coefficients of industry 1 (j=1), in this small set of countries. According to equation (3), we first compute $\bar{a}_{11}(0) = \frac{1}{2}(0.2 + 0.3) = 0.25$, and $\bar{a}_{11}(1) = \frac{1}{2}(0.2 + 0.2) = 0.2$. In a similar vein, we find $\bar{a}_{21}(0) = 0.2$, $\bar{a}_{21}(1) = 0.2$, $\bar{a}_{31}(0) = 0.15$, and $\bar{a}_{31}(1) = 0.15$. These average input coefficients for the first column and the input coefficients themselves yield $v_{11}(0) = (0.2\text{-}0.25)^2 + (0.3\text{-}0.25)^2 = 0.005$ and $v_{11}(1) = (0.2\text{-}0.2)^2 + (0.2\text{-}0.2)^2 = 0$. Similarly, we find $v_{21}(0) = 0$, $v_{21}(1) = 0$, $v_{31}(0) = 0.005$ and $v_{21}(1) = 0.005$.

The above-mentioned cell-specific variances can now be used to compute the pooled variances expressed in equation (4): $v_1(0)$ = (0.005+0+0.005)/3 = 0.0033 and $v_1(1)$ = (0+0+0.005)/3 = 0.0017. In this specific case, the pooled variance for industry 1's material inputs has decreased. To get insight into the strength of this process, we compute the ration between $v_1(1)$ and $v_1(0)$, which is 0.50 and compare this value to $F_2^2(0.05)$ = 0.053. The observed ratio is much larger, so the tendency towards convergence would not be sufficient to warrant inclusion as C* in Table 2.

Table 1: Availability and grouping of OECD tables

"1971"	AU(68)	CA(71)	DK(72)	FR(72)		JP(70)	NL(72)	UK(68)	US(72)
"1976"	AU(74)	CA(76)	DK(77)	FR(77)	GE(78)	JP(75)	NL(77)		US(77)
"1980"		CA(81)	DK(80)	FR(80)		JP(80)	NL(81)	UK(79)	US(82)
"1985"	AU(86)	CA(86)	DK(85)	FR(85)	GE(86)	JP(85)	NL(86)	UK(84)	US(85)
"1990"	AU(89)	CA(90)	DK(90)	FR(90)	GE(90)	JP(90)		UK(90)	US(90)

Note: First column contains labels for subperiods. Values between parentheses refer to years.

Table 2. Convergence and divergence of sectoral input structures in the OECD, 1971-1990.

Industry	71-76	C/D	76-80	C/D	80-85	C/D	85-90	C/D	71-90	C/D
1	0.695	C***	1.072		0.714	C**	0.823	C*	0.438	C***
2	0.970		0.769	C**	0.746	C**	1.408	D***	0.783	C*
3	0.791	C*	1.219		0.730	C**	1.190		0.838	
4	1.072		0.774	C*	1.283	D*	0.709	C***	0.755	C**
5	0.587	C***	1.263	D**	0.686	C***	1.243	D*	0.632	C***
6	1.042		1.113		0.655	C***	1.084		0.824	C*
7	1.406	D**	0.910		0.696	C***	1.147		1.020	
8	0.918		0.219	C***	4.328	D***	0.422	C***	0.367	C***
9	0.747	C**	1.023		0.988		1.504	D***	1.136	
10	0.969		1.119		0.938		1.203		1.223	D*
11	0.969		0.362	C***	1.194		1.033		0.433	C***
12	1.074		0.918		1.257	D*	1.093		1.354	D**
13	1.033		0.940		0.759	C**	2.180	D***	1.606	D***
14	1.109		1.337	D**	1.265	D*	1.563	D***	2.934	D***
15	1.928	D***	0.778	C*	1.086		1.363	D**	2.220	D***
16	0.965		0.792	C*	0.946		0.984		0.711	C**
17	0.845	C*	0.771	C*	0.849		0.807	C*	0.446	C***
18	0.761	C**	0.770	C**	0.991		1.052		0.611	C***
19	0.882		1.862	D***	0.796	C*	1.104		1.444	D***
20	1.174		0.548	C***	1.187		1.094		0.836	
21	0.738	C**	0.574	C***	1.457	D***	0.979		0.604	C***
22	0.810	C*	0.826		1.157		1.152		0.892	
23	0.523	C***	0.985		1.094		1.483	D***	0.837	
24	0.559	C***	1.362	D**	0.616	C***	2.847	D***	1.336	D**
25	0.537	C***	0.469	C***	0.806	C*	1.181		0.240	C***
Total	C:	11		11		10		4		12
	D:	2		4		5		8		7

Notes: The numbers represent the ratios of pooled variances between the final year and the initial year of the periods indicated in the column headings, for the industries in the corresponding rows (see equation (4)).

The letter C indicates 'significant' convergence. In this case *, **, and *** show that the observed ratio is smaller than the 10th, 5th, or 1st percentile, respectively, of the corresponding *F*-distribution. The letter D indicates 'significant' divergence. In this case, *, **, and *** show that the observed ratio is larger than the 90th, 95th, or 99th percentile, respectively, of the corresponding *F*-distribution.