# DOES AND HOW DOES GLOBALIZATION MATTER?

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First version: January 1996
This version: January 1999

**Abstract:**

In this paper we develop a new concept of globalization defined as the exposure of a productivity follower industry in one country to the productivity leader in another country. Globalization is measured by the intensity of contacts through trade and foreign direct investment. In a simple model and empirically we show that the exposure of a productivity follower to competition with the leader is highly correlated with the productivity gap of this industry. Competition restricted to one region such as Europe, or North America, or the Far East, is not sufficient to achieve highest productivity levels. Moreover, it turns out that FDI has a weight in the globalization index at least equal to trade. FDI can contribute directly to higher levels of domestic productivity by transferring the best production practices, and put pressure on other domestic producers to improve. The impact of trade on globalization can be weakened by tariffs and non-tariffs.

This paper is based on productivity studies at the McKinsey Global Institute and on research at the universities of Basel and Heidelberg. I would like to thank Martin N.Baily, Francis Bator, Bill Lewis and Robert Solow for advise. I benefited from comments and suggestions by Bart van Ark, Peter Bernholz, Martin Hellwig, Kathy Huang, Christoph Klingen, Ed Leamer, Bill Lewis, Christoph Schmidt, Armin Schmutzler and George Sheldon.

## 1. Introduction

In this paper we develop a new concept of globalization defined as the exposure of a productivity follower industry in one country to the productivity leader industry in another country. Globalization is measured by the intensity of contacts through trade and foreign direct investment. The nature of globalization will be used to understand productivity differences across countries, which can help to shed light on the following three related policy areas.

First, many policy debates pose the question where and how firms should compete. In recent years there has been a shift towards regional trade groupings, based on arguments that such regional trade groupings act as a substitute for the expansion of global trade. Furthermore, the strategic trade literature has revived interest in the justification for protection. Trade policies could help domestic firms to snatch excess returns away from their foreign rivals in markets with imperfect competition and/or increasing returns to scale [see e.g. BRANDER and SPENCER 1985, HELPMAN and KRUGMAN 1989, COOPER and RIEZMAN 1989, HWANG and SCHULMAN 1993].

Second, there is a considerable discussion about the impact of direct foreign investment and foreign ownership on the welfare of nations. Some authors argue that the economic fate of nations is still tied closely to the success of their domestically-based corporations [e.g. TYSON 1991, 1992, PORTER 1990, BREZIS, KRUGMAN, and TSIDDON 1993]. Others argue that the competitiveness of a country's corporations is no longer the same as the competitiveness of a country and there is no significant national specificity of learning due to the internationalization of production, distribution, and marketing. Popular literature in the U.S. often argues that direct foreign investments (FDI) will adversely affect U.S. employment and trade or lead to a shift of "good" jobs and "advanced" technology away from the United States [see e.g. GRAHAM and KRUGMAN 1989 and section 6.3. for a discussion of related literature].

Third, economists face the major task of explaining the wide disparity in per capita income across countries [e.g. MADDISON 1987]. Recent studies emphasize barriers to technology adoption [PARENTE and PRESCOTT 1994] and general nation-specific factors as explanations [COSTELLO 1994, LUCAS 1988].

## 2. Overview of Methodology and Results

We first use a new data set to compare differences of industry productivity levels in 1990 on the four-digit level across Germany (West Germany), Japan and the U.S. In the second step, we measure globalization, defined as the exposure of a productivity follower industry in one country to the leader. We measure globalization for productivity followers by the intensity of contacts through trade and foreign direct investments with other countries that have higher productivity. The index of globalization incorporates three basic routes of exposure of domestic operations[1] to operations in other countries that have higher productivity.

- Common ownership of domestic operations with operations in countries that have higher productivity (i.e. foreign direct investments or transplants).
- Exposure of incumbent domestic operations to foreign direct investments from countries with higher productivity.
- Exposure to trade. Trade can exert pressure on an industry through imports, through competition with productivity leaders in third countries or in the country hosting the productivity leader.

The globalization index establishes the following relationship: the higher the globalization (index), the higher is the exposure or the intensity of contacts of the domestic operations to operations with superior productivity.

In the third step, we examine a simple model which provides a theoretical foundation of the globalization index and the relationship between globalization and productivity gaps.

Finally, productivity differences are compared with the degree of globalization and its components for our sample of industries. We address the empirical question whether and how globalization matters. Our main results are as follows:

First, the exposure of a productivity follower to competition with the productivity leader is highly correlated with the productivity level of this industry relative to the leader. The high correlation could suggest that competition restricted to one region such as Europe, or North America, or the Far East, is not sufficient to stimulate operations in order to achieve highest productivity levels, and there are substantial dynamic gains from globalization.[2]

Second, the fact that some German industries have faced limited direct competition with productivity leaders could provide an explanation why the so-called German miracle faded.[3] Similarly, the low exposure of parts of Japanese manufacturing operations is consistent with their low productivity levels.

Third, it turns out that FDI has a weight in the globalization index at least equal to trade in Germany and the U.S. FDI can contribute directly to higher levels of domestic productivity by

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[1] We use the neutral term operations rather than firms. Domestic operations include all activities in a specific industry in one country. Transplants represent the part with foreign majority ownership. Domestic incumbent operations denote domestic operations excluding transplants from productivity leaders or from other countries.

[2] In trade theory, empirical studies have found consistently that static gains from trade globalization are small. If one includes the long-term reaction of capital formation in a dynamic setting, however, the measurable gains are larger. [e.g. BALDWIN 1992].

[3] The question whether there is an end of the German miracle is discussed in BERNHOLZ [1982] or DORNBUSCH [1993].

transferring the best production practices to the host country, and put pressure on other domestic producers to improve. The impact of trade on globalization, although also important,[4] can be weakened by tariffs and non-tariffs. Since production from foreign direct investments has achieved similar or even greater size than trade in manufacturing,[5] we illustrate that the transplants exposure channels could exceed the impact of trade in the process of globalization.

The paper is organized as follows: We first discuss productivity differences in industries across Germany, Japan, and the U.S. Next, we introduce the globalization index with some examples. We examine a simple model which provides a theoretical foundation of the globalization index and the relationship between globalization and productivity gaps. Then we define and calculate the globalization index and derive its properties. Thereafter, we test the hypotheses mentioned above and relate our results to other findings.

## 3. Productivity Comparison

We look at productivity differences of industries in Germany, Japan and U.S. Cross-country, cross-industry studies were traditionally based on growth rates [e.g. COSTELLO 1994, GRILLICHES and MAIRESSE 1991]. Hence, actual productivity level differences at a particular point in time were unknown. To calculate productivity levels, one needs a consistent set of output and input data across countries and an industry-specific currency conversion. Whereas some studies have calculated productivity levels for manufacturing sectors, using sector-specific currency conversions [VAN ARK and PILAT 1993], we calculate productivity levels at the industry level across countries.

First, we use newly calculated industry purchasing power parities. An industry purchasing power parity (henceforth industry $PPP$) compares the unit prices at the factory gate of similar goods produced in both countries. This requires price and product description on a very fine level since most industries produce a large variety of differentiated products [see VAN ARK and GERSBACH 1994].[6] In some industries we can use the fact that firms produce and sell in both countries, but even then country specific product adjustments can occur. The unit prices are aggregated using their quantity weights. The industry $PPP$ is defined as a bilateral Fisher index. The availability of industry $PPPs$ is the essential ingredient in measuring productivity levels at a disaggregated level. Industry $PPPs$ for our industries are shown in Table 1.

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4 The idea that trade could increase international competition is an old one. However, it has been very difficult to assess the strength of the disciplinary power [e.g. CLARK, KASERMAN, MAYO 1990]. The phenomena is frequently claimed to be especially relevant in developing countries where the protected domestic market often will only support a few firms [see e.g. LEVINSOHN 1993].

5 There are several studies documenting flows of FDI [e.g. OECD 1992].

6 For industries which produce only one similar good, the industry PPP is simply the relationship of the unit prices at the factory gate. Suppose the factory gate price of a unit in the U.S. was $1, while the price of the same unit in Germany was 2 DM. Then the industry PPP would be 2DM/$. Since the standard ICP purchasing power parities are defined at the final expenditure level and not available at a very disaggregated level, the industry PPPs for this study were derived during the work at the MCKINSEY GLOBAL INSTITUTE. For details on the methodology and calculations, see VAN ARK and GERSBACH [1994].

**Table 1:**

**Industry PPPs in 1990**
**(relative to U.S. $)**

| | Industry PPPs | |
|---|---|---|
| **Case Studies** | **GE/US (DM/$)** | **JP/US (Yen/$)** |
| Auto cars | 2.24 | 114 |
| Auto parts | 2.24 | 120 |
| Metalworking | 2.18 | 138 |
| Steel | 1.9 | 170 |
| Computer | 2.06 | 154 |
| Consumer electr. | 2.97 | 115 |
| Detergents | 2.02 | 188 |
| Beer | 2.23 | 210 |
| Food | 2.06 | 241 |

Table 1 reveals that there are wide variations among the industry *PPPs*. Compared to the average nominal exchange rate in this year (GE/US: 1.62 DM/$, JP/US: 145 Yen/$), the industry *PPPs* for Germany are generally above the exchange rate which reflects the common view that the German currency was overvalued against the Dollar at this time. The Japanese industry *PPPs* are distributed around the exchange rate with beer and food processing showing very high price levels.

Second, value added per hours worked were calculated for each industry, adjusted for capacity utilization differences and translated into $ using the industry *PPPs*.[7] Table 2 shows the results for

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[7] A complete overview of the various data sources and the consistency requirements can be found in VAN ARK and GERSBACH [1994].

nine case studies for which industry *PPPs* were available. The sample of industries covers roughly 20% of value added in the whole manufacturing sector in each country.

**Table 2:**

**Labor Productivity of Industry in 1990**
**Value added at industry PPP per hour worked (U.S. = 100)**

| | Relative Productivity | | |
|---|---|---|---|
| **Industries** | **GE** | **JP** | **U.S.** |
| Auto cars | 66 | 116 | 100 |
| Auto parts | 76 | 124 | 100 |
| Metalworking | 101 | 119 | 100 |
| Steel | 100 | 145 | 100 |
| Computer | 89 | 95 | 100 |
| Consumer electr. | 62 | 115 | 100 |
| Detergents | 88 | 94 | 100 |
| Beer | 44 | 69 | 100 |
| Food | 76 | 33 | 100 |

Looking first at the German-U.S. comparisons, for metalworking and steel labor productivity in 1990 was virtually identical. Table 2 reveals that productivity in Germany is lower than productivity in operations in the U.S. in seven of the industries. And since Table 2 also shows that productivity in operations located in Japan is ahead of those in the U.S. in five of these industries, it is clear that productivity in some operations in Germany is far lower than those of the Japanese operations which are the international productivity leader.

Two additional observations are necessary to put the results for Germany (West Germany) in perspective. First, we are only covering roughly 20% percent of the manufacturing sector. Second, a weighted average of our sample of industries would reveal almost the same productivity levels for Japan and Germany (83 percent of the U.S. level for Japan and 79 percent of the U.S. level for

Germany), since the food industry in Japan roughly employs the same number of workers as the industries auto cars, auto parts, metalworking and steel together. Moreover, examinations of the service industries [e.g. BAILY 1993] show that productivity in the service sector in Germany is higher on average than in Japan. Hence, the industry results are consistent with the fact that per capita income in Germany is slightly higher than in Japan using aggregate PPP comparisons.

Turning to the U.S.-Japan comparison, the wide variations in productivity relative to the U.S. are striking. In food processing, for example, operations in Japan have only a third of the U.S. level of productivity, whereas in the steel industry, operations in Japan are 45 percent above the U.S. level.

We use labor productivity levels as indicator of performance differences. It can be argued that labor productivity is not fully sufficient as a performance criterion and one should use total factor productivity. The reasons for singling out labor productivity are as follows. First, labor productivity is the most important part of total factor productivity. Second, as discussed in GERSBACH [1994], total factor productivity and labor productivity are highly correlated in five of these industries. Third, reliable international differences of total factor productivity levels for the whole sample were impossible to obtain.

# 4. The Globalization Index

## 4.1. Basic Concepts

We turn now to the construction and measurement of the globalization index of the productivity followers in Table 1. The term globalization is used in the literature in many different ways, requiring a precise definition in every application. Globalization in this paper is defined as the exposure of a productivity follower to the productivity leader, measured by the intensity of contacts through trade and foreign direct investment.[8] The definition of globalization applies mainly to an industry that is lagging in productivity. Globalization for productivity leaders could, of course, be included as a normalization since they are trivially fully exposed to themselves.

A globalization index for an industry should take at least the following channels of exposure or contacts into account:

- The domestic production which takes place in transplants (FDI) operated by firms headquartered in productivity leader countries; the exposure of transplants to the productivity leader occurs through common ownership.

[8] Terminology in this area is very vague. The term globalization often refers to the set of processes that bring people and places together in either more frequent contact or contact in a wider variety of activities than was the case in the past [e.g. HARRIS 1993]. Sometimes globalization refers to the outcome of the process.

- The exposure of domestic incumbent operations to transplants from the productivity leader or from other countries.

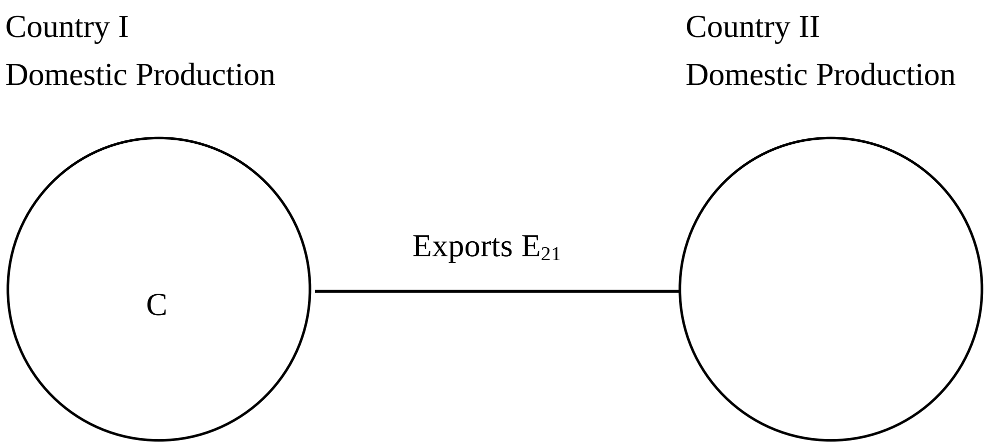
- The exposure of domestic incumbent operations to competition with the productivity leader country through trade: imports from the leading country, exports to the leading country, and exports to third countries where competition with exports from the productivity leader exists.

In the following we introduce the globalization index for the trade channel and the two foreign direct investment channels by examples and provide the economic rationale for our measure of globalization.

### 4.2. The Trade Channel Example

Consider the following trade situation, represented in Figure 1.

Figure 1




Assume that productivity in country I is lagging relative to the productivity leader in country II. The only channel of exposure are exports from II to I, denoted by $E_{21}$. Hence, exports from I to II are assumed to be zero. Moreover, in this example, we neglect any barriers to trade and foreign direct investments. We denote by C the domestic production volume which is sold entirely in country I.

Then, we define the globalization of the domestic industry in I, denoted by $G_I$, as:

$$(1) \quad G_{\mathrm{I}} = \min\left\{1, \frac{2E_{21}}{E_{21} + C}\right\}$$

We immediately obtain:

$$(2) \quad G_{\mathrm{I}} = \begin{cases} 1 & \text{if } E_{21} = C \\ 0 & \text{if } E_{21} = 0 \end{cases}$$

The following reasoning underlines this definition: if $E_{21} = C$, i.e. the exports from II reach the same level as domestic production in I, the industry in I competes with the industry in II like head-to-head competition of two companies of equal size [see e.g. TIROLE 1988]. Hence, we interpret $E_{21} = C$ as full exposure of the domestic industry I to the productivity leader in II.[9] Full exposure is indexed as 1 ($G_I$ = 1). In the next subsection, we provide a theoretical foundation of the positive relationship between our measure of globalization and incentives to improve productivity in a simple Cournot model in which firms can invest in productivity improvements.

If $E_{21}$ is zero, no exposure is present and $G_I$ becomes zero. Equation (1) implies that $G_I$ is always between zero and one. For given C, the globalization index is monotonically increasing in $E_{21}$ and represents the increasing intensity of contacts of the industry in country I to the productivity leader. Hence, the higher is the intensity of competition or contacts with the productivity leader industry in country II, the higher the globalization index of the operations in country I.

One could also choose different normalization procedures, e.g. by setting the globalization index equal to one if C is sufficiently small compared to $E_{21}$. As discussed in section 5, our results are robust against changes in the normalization procedure. Note that we use realized production volumes and market shares as a measure of the exposure of one industry to another. As demonstrated in the next subsection, realized market shares are a proxy for the exposure of industries. Similarly, as illustrated in the industrial organization literature, capacity constraints, time needed to install capacity extensions and other operation facilities, to change brand names or to gain reputation, etc., relate ex post market shares to the intensity of ex ante competition in industries [see e.g. TIROLE 1988, SUTTON 1991].[10]

To account for all possible trade contacts, we also need to take into account that country I exports to country II or that country I and II compete in a third country. Moreover, trade restrictions can diminish the exposure of a domestic industry to productivity leaders and hence must be accounted for as well. This will be done in the general definition of the globalization index.

### 4.3. A Simple Model of Exposure and Productivity Improvements

In this section we provide a simple two-period model that relates the exposure of an industry to the productivity leader with the incentives to improve productivity. For simplicity, we consider a domestic industry, represented by firm 1, that sells entirely in the domestic market. A second firm

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9 This is the reason why we have $2E_{21}$ in the numerator in (1).

10 See also BRESNAHAN [1989] who suggests that more concentrated industries are more likely to show greater heterogeneity of costs.

headquartered in the productivity leader country exports to the domestic market. The inverse market demand function in each period is given by:

(3) $p = a - bD$

$p$ is the price, $D$ denotes the industry demand and $a, b$ are two parameters. Initially, in the first period marginal costs of the domestic industry are assumed to be constant and given by $c \geq 0$. The productivity leader firm enjoys a productivity or cost advantage of $\Delta > 0$ and, hence, its marginal costs amount to $c - \Delta$.

We assume that firm 2 faces additional costs of $t > 0$ when selling to the domestic market. These costs can represent transportation costs or may be caused by tariffs or non-tariff barriers. Obviously, $t$ is a measure of how strongly the domestic industry is exposed to exports from firm 2. As we will see later, our measure of exposure is closely related to $t$.

Firm 1 has the possibility to lower costs in the second period by investing a part of the profits. In particular, we assume that firm 1 has marginal costs $c - \gamma\Delta$ if it invests an amount of $g(g)$ in cost reduction. We assume decreasing marginal returns to cost reductions or increasing marginal investment costs and hence:

(4) $g'(g) > 0,\ g''(g) > 0,\ g(0) = 0, g \in [0,1]$

Lowering marginal costs increases the profit prospects of firm 1, but requires investment. Hence, the problem of firm 1 is given by:

(5) $\max_{g} \{p_1(g) - g(g)\}$

To solve the optimization problem of firm 1 we derive quantities, denoted by $q_1$ and $q_2$, and profits, denoted by $p_1$ and $p_2$, for given costs $c - \Delta$ of firm 2 and costs $c - \gamma\Delta$ of firm 1. Standard formulas [see e.g. Tirole 1988] imply:

$$(6)\quad p_1 = \frac{(a - c + 2g\Delta - \Delta + t)^2}{9b},\quad q_1 = \frac{(a - c + 2g\Delta - \Delta + t)}{3b}$$

$$p_2 = \frac{(a - c + 2\Delta - g\Delta - 2t)^2}{9b},\quad q_2 = \frac{(a - c + 2\Delta - g\Delta - 2t)}{3b}$$

The first-order condition for the investment problem of firm 1 yields:

$$(7)\quad \frac{1}{9b} \cdot 2\{(a - c + 2\gamma\Delta - \Delta + t)\} \cdot 2\Delta = g'(\gamma)$$

Let us consider $\gamma(t)$ as an implicit function of *t*.

We obtain:

(8) $$\frac{8\Delta^2}{9b} g'(t) + \frac{4\Delta}{9b} = g''(g)g'(t)$$

and therefore

(9) $$g'(t) = \frac{4\Delta}{9bg''(g) - 8\Delta^2}$$

Hence, as long as $g''(g) < \frac{8\Delta^2}{9b}$, the amount of cost reduction firm 1 undertakes is decreasing with $t$. Therefore, the higher the exposure of the domestic industry, the higher the incentives are to improve productivity. For given $g''(g)$, the condition is more likely to be fulfilled if the cost difference between home and foreign firms is more significant.

Finally, we show that our measure of exposure is closely related to the underlying reason for exposure differences, captured by $t$. In the first period, when cost reduction has not been already undertaken, the realized quantities, denoted by $q_1{}^\circ, q_2{}^\circ$, amount to:

(10) $$q_1{}^\circ = \frac{(a - c - \Delta + t)}{3b}$$

$$q_2{}^\circ = \frac{(a - c + 2\Delta - 2t)}{3b}$$

Connecting the variables in the model with the variables in the trade example, our definition of exposure before firm 1 embarks on investments in order to reduce costs is thus given:

(11) $$G_{\mathrm{I}} = \min\left\{1, \frac{2E_{21}}{E_{21} + C}\right\} = \min\left\{1, \frac{2\, q_1{}^\circ}{q_1{}^\circ + q_2{}^\circ}\right\} = \min\left\{1, \frac{2(a - c - \Delta + t)}{2(a - c) + \Delta - t}\right\}$$

$G_{\mathrm{I}}$ is monotonically increasing in $t$. The higher $t$, the higher is the measured exposure of the domestic industry to exports. Also ex post, i.e. after firm 2 has reduced costs, the resulting exposure is in the same way monotonically increasing in $t$. Thus, our measure of exposure captures the underlying reason for exposure, represented by $t$. Summarizing our results we obtain:

**Proposition**

*(i)* $G_{\mathrm{I}}$ *is monotonically increasing in* $t$.

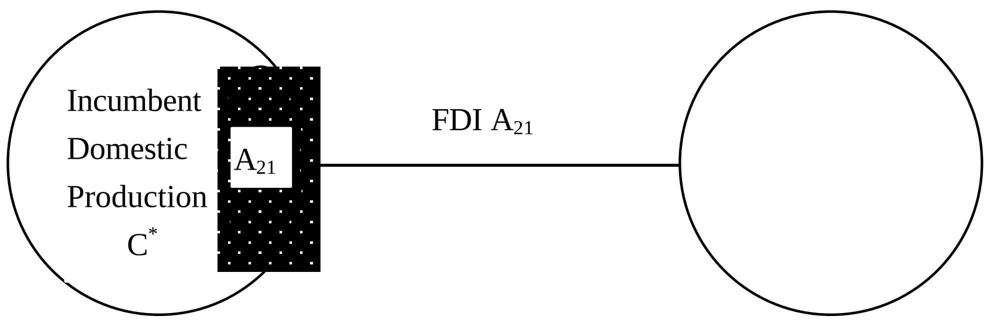
*(ii) If* $g''(g) < \frac{8\Delta^2}{9b}$, *the amount of cost reduction* $g\Delta$ *is monotonically decreasing in* $t$.

Hence, as long as $g''(g) < \frac{8\Delta^2}{9b}$, we obtain that the higher the exposure of the domestic industry the larger the incentives are to improve productivity and hence the incentives to narrow the gap to the productivity leader. Thus, our simple model predicts that exposure or globalization and productivity gaps are positively correlated.

### 4.4. The Foreign Direct Investment Example

In order to develop a globalization index which takes into account trade and FDI, we consider first an example where only FDI is present. The example is represented in Figure 2:

Figure 2




Assume again that productivity in country I is lagging relative to country II. Now we assume that trade is absent, but we have foreign direct investments from country II, represented by the production volume $A_{21}$. C* denotes the production volume of the incumbent domestic operations. Hence, overall production volume in country I, denoted by P, amounts to:

(12) $P = A_{21} + C^*$

Note that we need to define the globalization index for the overall production volume P since productivity is also measured for the entire production volume P in country I. Thus, we have to distinguish two channels of exposure of P. First, transplants $A_{21}$ are exposed to operations in country II through common ownership. Second, incumbent domestic operations C* are exposed to $A_{21}$.

In order to avoid confusion, we use the following language. Exposure index refers to the exposure of a particular part of P. The overall exposure of P is called globalization index. Hence, we need to define two separate exposure indices for $A_{21}$ and C* which in turn need to be aggregated into the globalization index for P. The exposure index of $A_{21}$ is denoted by $G_I^{\,1}$ and the exposure index of C* is denoted by $G_I^{\,2}$. The exposure intensities of $A_{21}$ and C* and the globalization index $G_I$ for the total production volume P are defined as follows:

(13) $G_I^1 = 1$ Exposure index of $A_{21}$

(14) $G_I^2 = \min\left\{1, \frac{2A_{21}}{A_{21} + C*}\right\}$ Exposure index of C*

(15) $G_I = G_I^{\,1}\frac{A_{21}}{A_{21} + C*} + G_I^{\,2}\frac{C*}{A_{21} + C*} = \frac{A_{21} + G_I^{\,2} C*}{A_{21} + C*}$ Globalization index of P = $A_{21}$+C*

The exposure indexes of $A_{21}$ and C* follow the same considerations as in the trade example. The globalization index is a weighted average of the different exposure intensities. We discuss the economic rational for each definition.

The exposure index $G_I^{\,1}$ of $A_{21}$ is defined as 1 and hence transplants are assumed to be fully exposed to their home operations through common ownership. This definition is justified by the ability of firms to replicate technologies of their plants in other plants, i.e. transplants exhibit very similar productivity as their home operations [see e.g. GERSBACH 1994, BLOMSTROEM and KOKKO 1994 and the discussion in section 5].

The exposure index $G_I^{\,2}$ of C* is defined in the same way as in the trade example. The incumbent domestic operations compete in their market with transplants. Because transplants are fully exposed to their home operations, they have an impact on the incumbent domestic operations just like exports form the productivity leader. Hence, compared to equation (1), we have now $A_{21}$ instead of $E_{21}$, but the rationale is the same. Obviously, $G_I^{\,2}$ is again between 0 and 1.

Finally, we need to aggregate the separate exposure indexes into the globalization index. Since both indexes $G_I^{\,1}$ and $G_I^{\,2}$ measure the exposure of a particular part of the production volume in I, the globalization index for the total production volume P is defined as an average of the different exposure intensities, weighted by the corresponding production volumes. Clearly, since $G_I^{\,2}$ is between zero and 1, $G_I$ is also between zero and 1.

To obtain a complete representation of foreign direct investment exposure, the transplants from third countries and transplants from country I in II must be taken into account. Moreover, the interaction with trade exposure needs to be accounted for. Again, this will be done in the general definition of the globalization index. We first introduce the necessary notation.

## 4.5. Notation

A home country is denoted by I, the country where the productivity leader is headquartered by II and any third non-leader country by III. This notation can also apply to a given industry in I, II and III. Note that the domestic industry in I includes all operations in this industry located in country I, independent of ownership considerations. The remaining variables are summarized in Table 3.

**Table 3:**

| Variable | Explanation |
|---|---|
| $P_I$ | Total domestic production volume |
| $A_{21}$ | Production vol. of transplants from II |
| $A_{31}$ | Production vol. of transplants from III |
| C | Domestic incumbent production volume |
| C* | Domestic incumbent production sold in I |
| $E_{21}$ | Exports of II to I |
| $E_{12}$ | Exports of I to II |
| $E_{13}$ | Exports of I to III |
| $E_{23}$ | Exports of II to III |
| $P_{III}$ | Production volume in III |
| e | Nominal exchange rate II to I |
| PPP | Industry purchasing power parity II to I |
| $PF_I$ | Protection index of I against imports |
| $G_I$ | Globalization index of industry in I |
| $G_{III}$ | Globalization index of industry in III |

Note that:

(16) $P_I = A_{31} + A_{21} + C^* + E_{12} + E_{13}$

Except for $PF_I$, and the globalization index itself, all variables are self-explanatory. $PF_I$ is an index which measures the extent of barriers in country I to imports from the productivity leader and other countries. $PF_I$ summarizes all tariff and non-tariff barriers as well as other reasons why competition from abroad does not have the same impact as domestic competition. For manufactured goods, the deviation of the industry $PPP$ from the exchange rate serves as a proxy for the extent of barriers to foreign competition or international goods arbitrage. Thus, we define $PF_I$ as:

(17) $PF_{\mathrm{I}} = \max\left[0,\ \min\left\{1, (PPP - e)/e\right\}\right]$

This definition relies on the idea that, for tradable goods where transportation costs are relatively small, the higher the barriers, the lower the degree of international goods arbitrage and the higher the deviation of domestic prices from world market prices which are captured by the exchange rate.[11] $PF_I$ is zero when the industry purchasing power parity coincides with the exchange rate or lies below it. $PF_I$ reaches 1 when the industry $PPP$ is twice the exchange rate which is interpreted as full protection since it replicates the situation of the Japanese food industry, which is the most protected industry in our sample and which was viewed by trade barrier criteria in 1990 as fully protected.

### 4.6. The General Definition of the Globalization Index

To construct the general globalization index, we extend the construction principles in the trade and foreign direct investment example to the general case. We employ a three step procedure. First, we split the production volume in country I in transplants, incumbent domestic production and exports. Second, we define the exposure index of each part, building on the examples introduced above. Third, we aggregate the individual exposure indexes.

*The exposure of* $A_{21}+A_{31}$*:*

Using the construction example for foreign direct investment, transplants from the productivity leaders are fully exposed to their home operations through common ownership. Transplants from third countries carry the exposure of their home operations, given by $G_{III}$, to country I. Hence, using the same aggregation rule as in equation (15), the overall exposure of $A_{21}+A_{31}$, denoted by $G_I^1$ is defined as follows:

$$(18)\quad G_I^1=\frac{A_{21}G_{II}+A_{31}G_{III}}{A_{21}+A_{31}}=\frac{A_{21}+A_{31}G_{III}}{A_{21}+A_{31}}$$

Note that $G_I^1$ is the exposure index for the production volume $A_{21}+A_{31}$. $G_I^1$ is composed of the transplants $A_{21}$ of the productivity leader and the transplants $A_{31}$ from third countries weighted by their globalization index $G_{III}$.

*The exposure of C*:*

The incumbent's domestic production $C^*$ sold at home is exposed to both the transplants in its country and to the imports from the productivity leader. The exposure of C* is denoted as $G_I^2$ and defined as follows:

[11] Alternatively, the protection factor could be normalized by calculating the difference between the industry PPP and the PPP for total manufacturing, in order to avoid the influence of the volatility of the exchange rate. The results with this method would be similar. Traditionally, since no industry PPPs were available, the extent of protection is often calculated using tariff and non-tariff indexes [see e.g. DICK 1993].

(19) $G_I^{\,2} = \min \left\{ 1, \frac{2\left(A_{21} + G_{III} A_{31} + E_{21}\left(1 - PF_I\right)\right)}{A_{21} + A_{31} + E_{21} + C*} \right\}$

The exposure of C* is composed of the exposure to transplants captured by $A_{21} + G_{III} A_{31}$ and to trade captured by $E_{21}\left(1 - PF_I\right)$. $G_I^{\,2}$ follows the same rationale as before. In addition, however, we have to take into account that $A_{31}$ and $E_{21}$ do not have the same impact as transplants from the productivity leader or exports without trade barriers. Therefore, we scale down $A_{31}$ by $G_{III}$ since these transplants carry the exposure of their home operations and hence C* is only exposed to $A_{31}$ through $G_{III}$. Clearly, $A_{31}$ is relevant in the denominator, since $A_{31}$ enters the production volume and therefore influences how much C* is exposed to transplants and trades. Similarly, the intensity of contacts through trade is scaled down by the impact of possible barriers to trade competition, captured by $PF_I$. Thus, if there is incomplete international goods arbitrage, the competitive pressure from domestic sales of transplants is higher than that of a similar volume sold through international trade.[12]

Since we will estimate the differential impact of trade and transplants, we split the exposure index of C* in a transplant and trade part, according to their shares. Hence:

(20) $G_I^{\,2}(Transpex) = G_I^{\,2} \cdot \left\{ \frac{A_{21} + G_{III} A_{31}}{A_{21} + G_{III} A_{31} + E_{21}\left(1 - PF_I\right)} \right\}$

(21) $G_I^{\,2}(Trade) = G_I^{\,2} \cdot \left\{ \frac{E_{21}\left(1 - PF_I\right)}{A_{21} + G_{III} A_{31} + E_{21}\left(1 - PF_I\right)} \right\}$

Obviously, we obtain:

(22) $G_I^{\,2} = G_I^{\,2}(Transpex) + G_I^{\,2}(Trade)$

Hence, the exposure intensity of C* is composed of a transplant and trade exposure intensity according to the shares of transplants and trades in the overall volume $A_{21} + G_{III} A_{31} + E_{21}\left(1 - PF_I\right)$, which in turn determines the exposure of C*.

*The exposure of $E_{12}$ and $E_{13}$:*

Two additional channels for international competition can be important. The exposure of the production volume $E_{12}$, denoted by $G_I^{\,3}$, is defined as:

(23) $G_I^{\,3} = 1$

[12] Without using any barrier index for trade, the exposure through trade would increase by roughly one third.

Theoretically, the exposure of $E_{12}$ could be less than 1 if $E_{12}$ were to make up more than half of the market size in II. In all real examples, this is unrealistic. Thus, we assume $G_I^{\,3}$ as 1.

Finally, we denote the exposure of $E_{13}$ as $G_I^{\,4}$, which is defined as:

$$(24)\quad G_I^{\,4} = \min\left\{1,\ \frac{2E_{23}}{P_{III} + E_{23} + E_{13}}\right\}$$

$G_I^{\,4}$ measures the intensity of competition faced by incumbent domestic operations exporting to third countries when competing with the productivity leader. Note that the basic construction principles for the exposure indexes are applied in a similar way for this case. The exposure of $E_{13}$ to $E_{23}$ is dwarfed by $P_{III}$. If $P_{III} + E_{13} \le E_{23}$, the exposure would be 1. If $E_{13}$ and $E_{23}$ are small, compared to the market size in III, then direct competition between $E_{13}$ and $E_{23}$ is small and therefore the exposure index will be small.

## 4.7. The Globalization Index

We now derive the overall globalization index. Note that we have not considered every possible route through which exposure could occur. E.g., the influence of transplants from the productivity leader on transplants from other countries in one country, exports from third countries to the domestic country, transplants from productivity follower operations in the country which hosts the productivity leader etc. These factors are neglected because they are quantitatively insignificant for our industries. However, they could be included and, by using the same principle, one can derive a more general version of the globalization index which, however, in our case does not lead to changes of the globalization index.

Since each factor measures how a particular part of the production volume in I competes with the leader or other foreign operations with higher productivity, the overall globalization index is defined as an average of the individual exposure indexes, weighted by the production volume shares. Hence:

$$(25)\quad G_I = \left\{G_I^{\,1}\left(A_{21} + A_{31}\right) + G_I^{\,2}C^* + G_I^{\,3}E_{12} + G_I^{\,4}E_{13}\right\} / P_I$$

Note that $G_I$ depends on $G_{III}$. In the next section, we discuss some simple properties of the globalization index.

## 4.8. Properties of the Globalization Index

We first establish that the globalization index satisfies the same boundary conditions as the exposure indexes:

**Property of Globalization Index:**

$0 \leq G_I \leq 1$

**Proof:**

Clearly, $G_I \geq 0$. Hence, it remains to show that $G_I \leq 1$. According to our definitions, we obtain:

$$(26)\quad G_I^{\,1} = \frac{A_{21} + A_{31} G_{III}}{A_{21} + A_{31}},\ G_I^{\,2} \leq 1,\ G_I^{\,3} \leq 1,\ G_I^{\,4} \leq 1$$

Since $P_I = A_{21} + A_{31} + C^* + E_{12} + E_{13}$, it remains to be shown that $A_{21} + A_{31} G_{III} \leq A_{21} + A_{31}$ or $G_{III} \leq 1$. Assume $G_{III} > 1$. As long as $C^*$ (or $A_{21}, E_{12}, E_{13}$) are greater than zero, $G_I$ would be smaller than $G_{III}$. Since $G_{III}$ is derived in a similar way as $G_I$, $G_{III} > 1$ requires that $G_I > 1$. However, as long as $C^*$ for country $III$ in $G_{III}$ (or $A_{21}, E_{12}, E_{13}$ for country $III$) is greater than zero, $G_I$ would be greater than $G_{III}$, which leads to a contradiction. (q.e.d.)

We have only considered a relatively simple globalization index. The analysis as well as the rather simple properties of the globalization index can be extended in two directions. First, one can formally include all exposure channels that were empirically unimportant for our nine case studies. Second, the globalization index can be formally extended to $n$ countries, each having the possibility to invest in the other countries.

Other features of our definition of globalization are noteworthy. First, globalization applies mainly to an industry which is lagging in productivity. Globalization for productivity leaders could, of course, be included as a normalization since they are trivially fully exposed to themselves. Second, our globalization definition can coincide with traditional approaches for characterizing globalization based only on geographical considerations or trade volumes [e.g. STORPER 1992], but it can also differ. For instance, in the eighties the German car industry was closely linked to the U.S. car industry through foreign direct investments from the U.S. The German industry, however, was less exposed to the productivity leader Japan than was the United States and hence, the German industry was less global according to our globalization concept. Third, our definition refers to the exposure of a collection of operations in one country to a collection of operations in another country. We therefore single out the international part of competition in order to test whether domestic competition is sufficient or not to achieve and maintain high relative productivity.

## 4.9. Globalization Index for Non-Transplant Operations

We also derive the globalization index for the domestic non-transplant operations which are defined as the industry in country I excluding the transplants from the productivity leader. We simply redefine $G_I^{\,1}$ as $A_{31}G_{III}$ and $P_I$ as $A_{31} + C^* + E_{12} + E_{13}$. Then the same procedure as before yields the globalization index for the domestic non-transplant operations, denoted by $G_I°$. Since $A_{21}$ is excluded in the numerator and denominator for $G_I°$ we immediately get:

(27) $G_I \geq G_I°$

# 5. Empirical Implementation

## 5.1. Hypotheses and Estimation

The globalization index yields three basic channels through which globalization can occur:

(28)
$$\begin{aligned} &TRANSP: && = \left\{G_I^{\,1}\left(A_{21} + A_{31}\right)\right\} / P_I, && \text{direct impact of transplants} \\ &TRANSPEXP: && = \left\{G_I^{\,2}(Transpex) \cdot C^*\right\} / P_I, && \text{exposure to transplants} \\ &TRADE: && = \left\{\mathrm{G}_\mathrm{I}^{\,2}(Trade) \cdot C^* + G_I^{\,3}E_{12} + G_I^{\,4}E_{13}\right\} / P_I && \text{trade} \end{aligned}$$

Note that $P_I$ is used to normalize the globalization parts. To set up the empirical implementation we consider the following regression equation:

(29) $$PRODLEVE = b_0 + b_1 TRANSP + b_2 TRANSPEXP + b_3 TRADE$$

where PRODLEVE is the level of labor productivity of a follower industry indexed by setting the productivity of the leader as 100. We distinguish two cases. PRODLEVE can apply either to all domestic operations or just to the non-transplant domestic operations.

We examine the following hypotheses: First, overall exposure of a productivity follower to competition with the productivity leader is highly correlated with the productivity level of this industry relative to the leader. Second, the same should hold for domestic non-transplant operations, i.e., if we exclude the transplants of the productivity leader from the productivity level calculation and from the globalization index. Moreover, we address the following questions. Which channels are dominant in the process of globalization and productivity convergence, and are there differences in the pattern of globalization across countries?

### 5.2. Data

We test the hypotheses using the sample introduced in section three which yields 18 productivity laggards. The globalization index is calculated as follows. The production volume of industries is derived from the Census of Manufacturers in the various countries [for details see VAN ARK and GERSBACH 1994]. Trade data are derived for the industries using the United Nations Trade Data Base. Transplant production volumes in various industries are derived from industry reports.

### 5.3. Econometric Issues

The estimation equation (29) is used to test our hypotheses. Ordinary least squares (OLS) are used as a starting point. Apart from the well-known issues in linear regression analysis, a variety of econometric problems have to be taken into account. First, the derivation of the globalization index was based on a specific normalization. Thus, it is important to see whether the empirical results depend on the normalization procedure. Since a different normalization procedure is mainly a scaling factor, although non-linear, the results turn out to be robust to changes of the normalization. Second, the estimation equation in (29) exhibits heteroskedasticity in the error term and we employ White's heteroskedasticity-consistent covariance matrix to estimate the standard errors.

Third, our regression equation could suffer from a significant simultaneity effect. One can argue that productivity laggards attract FDI and trade. Thus, all three aspects of the globalization index could depend on the relative productivity levels and thus globalization and productivity are jointly determined. To address the simultaneity issue we look at instrumental variables (IV). Searching for IV´s in our context suggests scale per industry as an appropriate variable. Scale per industry is defined by the average sales per company in the industry of the country where globalization is measured.[13] Scale is highly correlated with the globalization index. FDI and Trade is usually performed by multinational, and thus large sized companies, as e.g. in the automotive or the computer industry in Germany, Japan or US. Moreover, as shown in BAILY and GERSBACH [1995], with the exception of the beer industry, scale differences are not a significant explanatory factor for productivity differences across countries in the manufacturing industries of our sample. Thus, there is no reason why scale per industry should be correlated with the error term. To test whether globalization is an endogenous variable, we perform the IV procedure for the relationship between productivity levels and the overall globalization index. Industry scale is the instrumental variable. Subsequently, we perform the Hausman specification error test [HAUSMAN 1978] by examining the null hypothesis that the difference between the coefficient under OLS and the coefficient under IV is zero. The test statistics is not significant at the 5 percent level. Accordingly, we can treat the globalization index as exogenous and we estimate the regression equation by OLS.

[13] Alternatively, scale can be measured by the number of employees per company which, however, is more affected by differences in outsourcing across industries than sales per company. Since sales per company is higher correlated with globalization than the number of employees per company, we use sales per company for the IV procedure.

# 6. Results

## 6.1. Globalization

The resulting globalization index is reported in Table 4. As Table 4 illustrates, there are wide variations in the degree of globalization. Moreover, every country has industries with high and low relative globalization indexes.

**Table 4:**

**Globalization of Domestic Industries in 1990**

| | **Globalization Index (x 100)** | | | | **Country** |
|---|---|---|---|---|---|
| **Case Studies** | Total | Transplants | Transplant Exposure | Trade | |
| Auto cars | 49 | 16 | 15 | 18 | GE |
| Auto parts | 43 | 16 | 11 | 16 | GE |
| Metalworking | 18 | 2 | 4 | 12 | GE |
| Steel | 2 | 0 | 0 | 2 | GE |
| Computer | 94 | 65 | 14 | 15 | GE |
| Consumer electr. | 45 | 18 | 20 | 7 | GE |
| Detergents | 95 | 40 | 46 | 9 | GE |
| Beer | 3 | 0 | 0 | 3 | GE |
| Food | 43 | 13 | 22 | 8 | GE |
| Computer | 81 | 17 | 25 | 39 | JP |
| Detergents | 78 | 30 | 39 | 9 | JP |
| Beer | 3 | 0 | 0 | 3 | JP |
| Food | 8 | 1 | 2 | 5 | JP |
| Auto cars | 73 | 22 | 30 | 21 | US |
| Auto parts | 72 | 29 | 25 | 18 | US |
| Metalworking | 46 | 10 | 16 | 20 | US |
| Steel | 57 | 20 | 30 | 7 | US |
| Consumer electr. | 92 | 58 | 16 | 18 | US |

## 6.2. Globalization and Productivity

The central globalization relationship in equation (29) was estimated for all 18 productivity followers. To illustrate the overall relationship, in Figure 3 relative productivity levels of lagging industries are plotted against their overall globalization index.

Figure 3

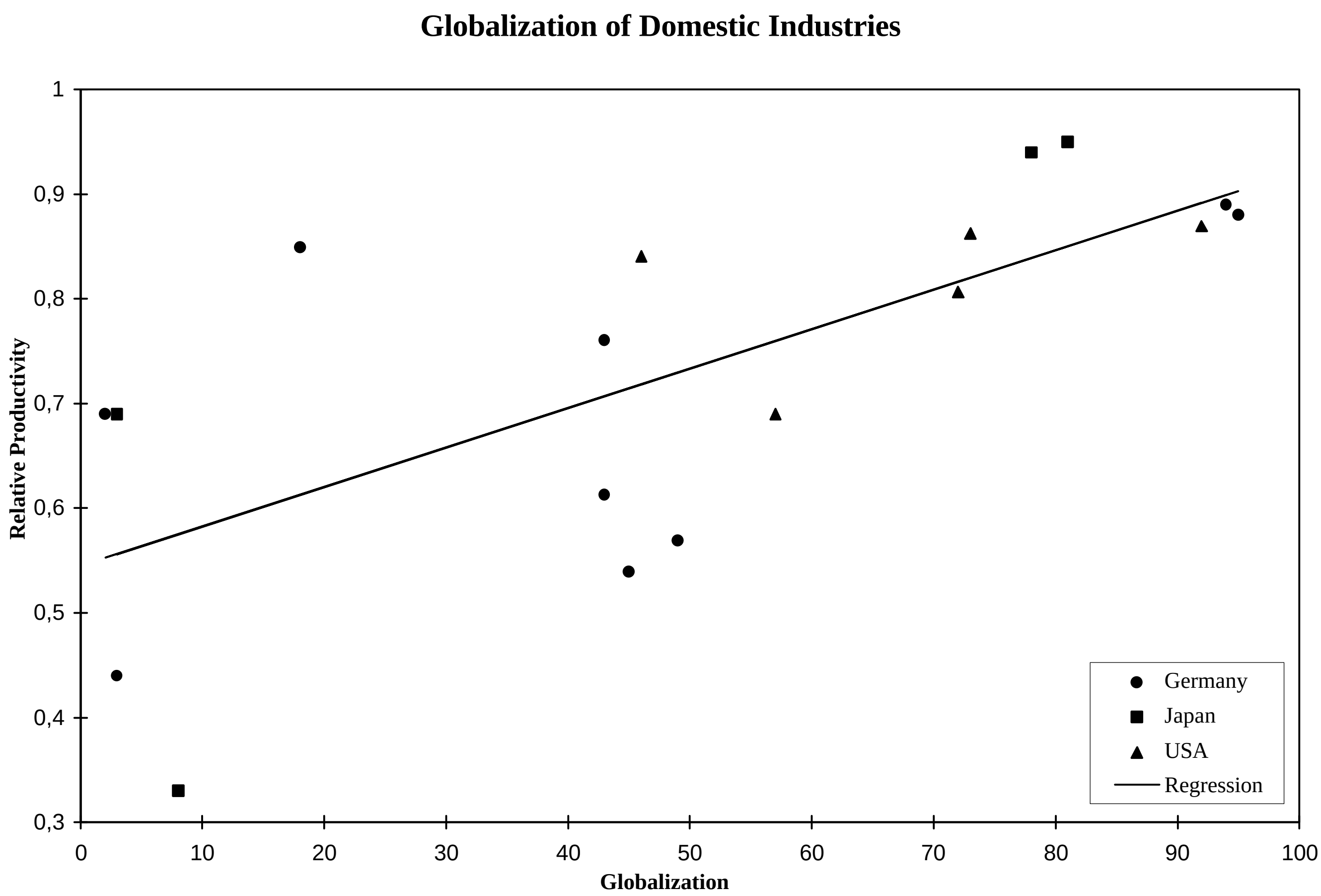


Table 5 and 6 report regression results for our sample, first for the relationship between productivity levels and the globalization index.

**Table 5:**

**Globalization and Productivity for Productivity Followers**

**Dependent Variable: Productivity Levels (Relative to Leader)**

| | |
|---|---|
| Independent variables: | |
| Constant: | 54.360** |
| (7.49) | |
| Globalization index: | 0.38** |
| (0.10) | |
| Number of observations: | 18 |
| $R^2$ adjusted | 46% |
| F (1,16) | 15.29** |

Notes: Standard errors are shown in parentheses. * denotes significance at the 5 percent level, ** denotes significance at the 1 percent level.

**Table 6:**

**Globalization and Productivity for Productivity Followers**

**Dependent Variable: Productivity Levels (Relative to Leader)**

| | |
|---|---|
| Independent variables: | |
| Constant: (8.24) | 52.20** |
| Transplants: (0.09) | 0.26** |
| Transplant Exposure (0.20) | 0.42* |
| Trade (0.25) | 0.68** |
| Number of observations: | 18 |
| $R^2$ adjusted: | 42% |
| F (3, 14) | 5.00* |

Notes: Standard errors are shown in parentheses. * denotes significance at the 5 percent level, ** denotes significance at the 1 percent level.

The regression in Table 5 shows that the relationship between globalization and relative productivity levels is highly significant. $R^2$ is high given the sample size and the fact that we use cross-section data. Thus, the regression in Table 5 indicates that globalization does matter and the theoretical predictions of the model are supported.

The regression as well as a glance at Tables 2 and 4 suggests that all of the industries for which the globalization index was above about 0.7 have productivities relatively close to the productivity leader, i.e. the gap is smaller than 20 percentage points. A globalization index of 0.7 indicates a substantial exposure of the domestic industry. It could be achieved e.g. with a market share of over 30% transplants from the productivity leader if there are no other channels for international competition. This is, for instance, the case in the German computer and in the German soap and detergent industries. The magnitude of productivity gaps and associated globalization indexes is economically significant because it may indicate how much exposure through transplants or trade can be required to cause the transfer of the best production techniques and how many productivity gains can be achieved by increased globalization. Moreover, it suggests that protectionism is costly because it limits technology transfer [see FEENSTRA 1992 for an assessment of protectionism].

### 6.3. Channels for Globalization

It appears that the relationship between productivity and the degree of exposure with the productivity leaders is strong. Moreover, if we decompose the globalization index into its components, Table 6 indicates that all three - transplants, exposure to transplants and trade contribute significantly, at least at the 5% level. However, we cannot conclude that the coefficients for trade, transplants and transplant exposure are different. In fact, we test for the null hypothesis that the coefficients on the three components of the globalization index are jointly equal to one another, i.e. $b_1 = b_2$ and $b_1 = b_3$ using the corresponding F-statistic yields. The hypothesis that the coefficients are jointly equal cannot be rejected at the five percent significance level. Equally, one cannot reject the hypothesis that the coefficient of the joint effect of transplants and transplant exposure is equal to the trade coefficient.

To gain a better understanding of the relative weights of the components in the globalization index, we calculate the average globalization index for the productivity followers. Each industry's globalization index is weighted by its employment share. The average globalization index amounts to 12 for transplants, 15 for transplant exposure and 12 for trade. The overall average globalization index is 39.

The direct effects of transplants and trade have an equal weight in the globalization index. However, the joint effects of transplant and transplant exposure exceed the weight of trade. Thus, together with the regression coefficients, transplants from productivity leaders are at least an equal force to globalize industries as trade. Recent arguments from the business literature[14] support this conclusion. Transplants from countries with higher productivity can contribute directly to higher levels of domestic productivity, since they transfer knowledge and best production practices to other domestic producers, e.g. through the natural movement of personnel, and put additional competitive pressure on the incumbent domestic producers.

The above results suggest that there are beneficial interactions in terms of efficiency between foreign direct investments from countries with high productivity levels and incumbent domestic operations in industrialized countries. Related literature has shown that foreign direct investments also interact with operations in their home country, either financially, because investments in different

[14] see e.g. MCKINSEY GLOBAL INSTITUTE [1993].

locations compete for scarce funds, or production related, because FDI may either substitute or complement home exports [STEVENS and LIPSEY 1992]. BLOMSTROEM and KOKKO [1994] show that the relationship between Swedish investment abroad and home country exports seems to be complementary on a net base.

The role of foreign direct investment in developing countries has also received considerable attention. Although, empirical studies that use aggregate data find a positive correlation between sectoral productivity and the sectoral level of FDI [e.g. BLOMSTROEM 1986], studies that use plant level data find either a negative correlation or no relationship [AITKEN and HARRISON 1992 and HADDAD and HARRISON 1993]. A recent study by [AITKEN, HANSON, and HARRISON 1994] provides evidence that multinationals can enhance the export prospects of domestic firms by providing inputs and knowledge not available in the local market.

We can construct country-level globalization indexes for productivity followers, with each industry's globalization index weighted by its employment share. The average globalization indices per country are 39 for Germany, 17 for Japan and 66 for the U.S. The results suggest that productivity followers in the U.S. have the highest overall level of globalization, with follower industries in Germany next. Productivity followers in Japan are low in overall globalization, held down by the large food industry.

Some German industries have faced limited direct competition with productivity leaders. This could be interpreted as one factor why the so-called German miracle faded, creating attention among economists in the last decade [e.g. BERNHOLZ 1982, DORNBUSCH 1993]. Obviously, the picture for Japan is incomplete since we do not consider productivity leader industries. However, as aggregate productivity studies suggest, the share of employment in Japanese manufacturing industries which are leading in productivity is only between 10 and 20% [see e.g. VAN ARK and GERSBACH 1994].

### 6.4. Globalization of Non-Transplant Industries

To examine whether the relationship between exposure to productivity leaders and relative productivity holds without the direct influence of the transplant production volume, we test the relationship between the globalization index of the non-transplant domestic industries and their productivities.

In section 4.9., we already derived a globalization index for the non-transplant domestic industry by using a recalculation procedure employing the existing data from the overall globalization index.

The relative productivity levels of the non-transplant domestic industries must be newly calculated. They were recalculated for domestic operations excluding transplants from the productivity leader based on their share in total domestic industry. The resulting productivity for the domestic non-transplant industry is derived by setting the productivity of the productivity leader transplants equal to 100, i.e., equal to the operations in their home country. This is justified by company reports in six of the nine case studies[15], in which there is a substantial transplant share. The reports show that multinational companies have been able to replicate on average the same productivity level in similar plants across Germany, Japan, U.S. Usually, there is a range of 0-10% productivity difference between transplants and similar home operations.[16]

The result of the test is shown in Table 7. Although the relationship is not as strong as when the transplants were included, a significant correlation between globalization index and relative productivity remains. This finding contributes to the robustness of our analysis, because it shows that, given the independent evidence on high productivity of transplants, the extent of transplant and trade exposure are significantly positively associated with the relative productivity levels.

**Table 7:**

**Globalization Index and Productivity Levels for Domestic Non-Transplant Industries**

**Dependent Variable: Productivity Levels (relative to Leader)**

| | |
|---|---|
| Independent variables: | |
| Constant:<br>(7.35) | 55.7** |
| Globalization index:<br>(0.11) | 0.34** |
| Number of observations: | 18 |
| $R^2$ adjusted: | 39% |
| F(1,16) | 10.01** |

Notes: Standard errors are shown in parenthesis. * denotes significance at the 5 percent level, ** at the 1 percent level.

[15] For details see MCKINSEY GLOBAL INSTITUTE [1993] or GERSBACH [1994].

[16] The qualitative results are not affected if we assume e.g. that transplants are within an interval of [90%, 110%] relative to productivity compared to their home operations.

# 7. Conclusions

We have found empirical evidence that there is a strong relationship between globalization and productivity differences with the most efficient producers. We have already mentioned some of the caveats concerning the empirical examinations.

Obviously, there can be a time-lag between increased globalization and convergence of productivity, e.g., barriers to the adoption of technologies, as it is documented in the literature,[17] or it simply requires time to change organizations and production processes. Time-lags could be one of the major reasons why the correlation between productivity and globalization is not even higher than reported. On the other hand, time-lags enable us to discuss some of the potential developments which may occur in some industries. Let us mention two potential examples.

An interesting phenomenon could occur in the German automotive industry. Since the German automotive industry is substantially exposed to the U.S. industry through transplants[18] and the U.S. industry closely approached the productivity leader Japan, the exposure of the German industry to the productivity leaders is increasing. This could imply a future correction of the substantial productivity gaps observed in the past.

In Japan, there is an evolution towards liberalization of the food industry. Since food processing productivity is very low we would expect increasing transplants of multinationals in order to exploit their productivity advantages as well as rising trade volumes implying a consolidation and large productivity gains in the whole industry.

In summary, we think that the globalization index can be a useful tool for the analysis of productivity convergence and the indication of dynamic gains from globalization. It may, therefore, reveal insights which can be important for economic policy. Our main conclusion is that globalization matters. This shows that competition can be insufficient if restricted to only one region, e.g. only to Europe, to North America, or to the Far East.[19]

Obviously, our sample is rather small and does not enable us to derive conclusions outside the three countries studied. Moreover, the attempt in this paper to measure productivity and globalization as precisely as possible limits the sample size and does not allow us to relate changes in globalization to changes in relative productivity levels. However, if the results should be supported for larger samples, a stimulation of globalization may provide high payoffs in terms of economic welfare. Then, increasing convergence of productivity levels is the expected outcome.

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17 For instance, SPENCE and HAZARD [1990] discuss that domestic incumbents had often difficulties responding quickly to the entry of foreign competitors.

18 The share of U.S. transplants is between 20 and 25%.

19 Recent proposals for a European Constitution recognize the danger of regional competition which would only be limited to Europe [e.g. BERNHOLZ et al. 1994].

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