SCHWARTZ CENTER FOR
ECONOMIC POLICY ANALYSIS
THE NEW SCHOOL

SCEPA Working Paper 2009-12

Errors from the "Proportionality Assumption" in the Measurement of Offshoring: Application to German Labor Demand

Deborah Winkler
William Milberg

Schwartz Center for Economic Policy Analysis
and
Department of Economics
New School for Social Research, 6 East 16th Street, New York, NY 10003

WORKING PAPER SERIES

October 5, 2009

Errors from the "Proportionality Assumption" in the Measurement of Offshoring: Application to German Labor Demand

Deborah Winkler*

William Milberg**

October 5, 2009

* Research Fellow, Schwartz Center for Economic Policy Analysis, The New School for Social Research, and Consultant, The World Bank. Email: dwinkler2@worldbank.org.
The author is grateful to the Schwartz Center for Economic Policy Analysis for financial support.
The views expressed in the paper are those of the authors and should not be attributed to the World Bank, its Executive Directors or the countries they represent.

** Professor, Department of Economics, New School for Social Research and Faculty Research Fellow, Schwartz Center for Economic Policy Analysis. Email: milbergw@newschool.edu.

Errors from the "Proportionality Assumption" in the Measurement of Offshoring: Application to German Labor Demand

Deborah Winkler and William Milberg

Abstract

Offshoring – the importing of intermediate materials and services – has expanded rapidly in most industrialized countries and its impact on the labor markets in these countries has been the source of enormous debate in both scholarly and popular circles. Since data on imported inputs at the sectoral level are not available for the US and the UK, empirical research has relied entirely on a proxy-based measure offshoring, using what the OECD refers to as the "proportionality assumption". That is, every sector is assumed to import inputs of each material and service in the same proportion as its economy-wide use of that input.

German input-output data differentiate between domestically purchased inputs and imported inputs, which permits us to calculate a direct measure of sectoral imported input use. In this paper, we compare this measure to the proxy-based measure based on the standard proportionality assumption. We find that the direct measure differs significantly from the proxy-based measure for both services and materials offshoring. To assess the significance of using different measures, we substitute them for each other in standard labor demand equations focusing on German manufacturing between 1995 and 2004. We find that using the direct measure of offshoring gives very different results for labor demand – sometimes of opposite sign – compared to estimates using the proxy-based measure.

We perform a simple decomposition of the proxy-based measure and find that it fails to accurately capture the cross-sectoral variation in offshoring intensity because – as a result of the proportionality assumption – it is heavily influenced by the cross-sectoral variation in domestic input demand. The implications of our findings go beyond the case of Germany. They indicate that researchers must be cautious about drawing policy conclusions from estimates using the proxy-based measure of offshoring.

JEL No. F1, F2

Key Words: Services Offshoring, Offshoring Intensity, Labor Demand

1. Introduction

Offshoring – the importing of intermediate materials and services – has expanded rapidly in most industrialized countries and its impact on the labor markets in these countries has been the source of enormous debate in both scholarly and popular circles.[1] Since data on imported inputs at the sectoral level are not available for the US and the UK, empirical research has relied entirely on a proxy-based measure offshoring, using what the OECD refers to as the "proportionality assumption" (Grossman and Rossi-Hansberg, 2006). The US Bureau of Economic Analysis, for example, collects data on input use, but does not break out imported from domestically-produced inputs. Lacking information on a sector's imports of each input, researchers have instead applied the economy-wide import penetration ratio for a material or service input to approximate the imported input share of that material or service by all sectors. That is, every sector is assumed to import inputs of each material and service in the same proportion as its economy-wide use of that input. Without the information on imported input use, the proportionality assumption has been accepted in most major studies of the level and impact of offshoring.[2]

To date, there has been no way to assess the extent of error in measurement introduced by the use of the proportionality assumption, but recent data for Germany provide a test. German input-output data differentiate between domestically purchased inputs and imported inputs, which permits us to calculate a direct measure of sectoral imported input use. In this paper, we compare this measure to the proxy-based measure based on the standard proportionality assumption. We find that the direct measure differs significantly from the proxy-based measure for both services and materials offshoring. To assess the significance of using different measures, we substitute them for each other in standard labor demand equations. We find that using the direct measure of offshoring gives very different results for labor demand – sometimes of opposite sign – compared to estimates using the proxy-based measure. For example, using the proxy-based measure, services offshoring is found to have a positive and statistically significant effect on German employment. Using the direct measure, the estimated employment effect is significantly negative. This result is robust to a number of specifications and estimation techniques.

[1] For a concise survey of the scholarly literature on employment and wage effects of offshoring, see Milberg and Schöller (2008). For a discussion of the parallels between the scholarly and popular debates, see Milberg (2008).

[2] The assumption was first used by Feenstra and Hanson (1996, 1999) and has been adopted in all major studies, for example, Hummels et al. (2001), Amiti and Wei (2005, 2006) and Grossman and Rossi-Hansberg (2006). Further discussion of the proportionality assumption can be found in National Research Council (2006).

We perform a simple decomposition of the proxy-based measure and find that it fails to accurately capture the cross-sectoral variation in offshoring intensity because – as a result of the proportionality assumption – it is heavily influenced by the cross-sectoral variation in domestic input demand. The implications of our findings go beyond the case of Germany. They indicate that researchers must be cautious about drawing policy conclusions from estimates using the proxy-based measure of offshoring when we know, at least in the case of Germany for 1995-2004, that the direct measure gives a very different result.

This paper has five sections. In section 2 we discuss the alternative measures of offshoring – the direct measure and the proxy-based measure – differentiating between services and materials offshoring intensities, and present our calucations on these two measures for Germany in 1995 and 2004. In section 3 we look at the source of the apparent error in the proxy-based measure. Section 4 presents the econometric analysis of offshoring and labor demand using the two measures and confirms the error of the proxy measure. In Section 5 we conclude with a discussion of the implications for future research and data collection.

2. Offshoring Intensity

In this section, we calculate the direct and proxy measures of services and materials offshoring intensity for Germany from 1995 to 2004. The analysis uses annual input-output data from the German Federal Statistical Office (FSO). Input-output tables focus "on the interrelationships between industries in an economy with respect to the production and uses of their products and the products imported from abroad. In a table form […] the economy is viewed with each industry listed across the top as a consuming sector and down the side as a supplying sector" (UN, 1999, p. 3). We extract a symmetric 43-sector matrix from the original input-output tables containing 71 sectors, including all 36 manufacturing sectors in the original tables and seven of the 27 services sectors. We drop the primary sector (sectors 1-3) and the sectors 'mining' and 'quarrying' of the secondary sector (sectors 4-8) as they generally have little or no offshoring activity. 'Total non-energy inputs' in equations (1) and (5) contain all 36 material inputs plus the seven service inputs selected above. For a list of the 43 sectors covered, see Appendix 1.

In the following, we use the term "inputs" when we refer to the supplying sectors. The selection of the seven service inputs out of 27 follows the aggregation of Kalmbach et al. (2005) and includes *tradable business activities*. Business activities comprise 'other business activities' (sector 62), as well as the following six sectors: post and telecommunications; financial mediation (except insurance and pension funding); activities related to financial mediation; rental of machinery and equipment; computer and related activities; research and development (sectors 54, 55, 57, 59-61). We exclude 'wholesale, trade and commission excl. motor vehicles' services from the original definition, since in our view they do not represent typical offshoring services. Abramovsky et al. (2004), for instance, classify them as non-business services. Consumer-related[3] and social services[4] are also not considered, since the former in general do not represent typical offshoring services and the latter are not tradable.

2.1 Direct and Proxy Offshoring Intensity Measures

In this section we present the two measures of offshoring intensity: a direct offshoring intensity measure that uses direct information on imported input use and a proxy offshoring intensity measure that adopts the proportionality assumption that all sectors import an input at the economy wide rate. We explain the two different concepts by using the example of services offshoring intensity. These definitions can be applied analogously to materials offshoring intensity.

The *direct services offshoring intensity* (DOS) measures the share of imported service inputs s in total non-energy inputs used by sector i at time t and is calculated as follows:

$$DOS_{ist} = \frac{(imported\ input\ purchases\ of\ service\ s\ by\ sector\ i)_t}{(total\ non\text{-}energy\ inputs\ used\ by\ sector\ i)_t} \tag{1}$$

The direct services offshoring intensity across all service inputs s for sector i at time t is calculated by taking the sum over all DOS_{ist}:

$$DOS_{it} = \sum_{s} DOS_{ist} \tag{2}$$

The sectoral services offshoring intensity DOS_{it} should not be confused with DOS_{st}, which represents the average offshoring intensity of a certain service input s across all sectors i. This is

[3] Sectors within the classification of the FSO: 45, 47-53, 56, 58, 69-71.
[4] Sectors within the classification of the FSO: 63-68.

calculated by aggregating the respective DOS_{ist}, weighted by total sectoral non-energy inputs INP, which is[5]:

$$DOS_{st} = \sum_i DOS_{ist} * (INP_{it} / INP_t) \text{, where } INP_t = \sum_i INP_{it} \; . \qquad (3)$$

Summing DOS_{st} over all service inputs s yields the average services offshoring intensity DOS_t across all sectors i and all inputs s at time t:

$$DOS_t = \sum_s DOS_{st} \; . \qquad (4)$$

The second measure is the *proxy services offshoring intensity* (POS) which uses a proxy for the proportion of the imported service input s used in home production, defined as follows (see e.g. Feenstra and Hanson, 1996):

$$POS_{ist} = \left[\frac{(input\ purchases\ of\ service\ s\ by\ sector\ i)_t}{(total\ non\text{-}energy\ inputs\ used\ by\ sector\ i)_t} \right] \left[\frac{(imports\ of\ service\ s)_t}{production_{st} + imports_{st} - exports_{st}} \right] \qquad (5)$$

The first bracket gives the share of the purchased service input s in total non-energy inputs for sector i at time t, which we call the *sectoral input share*. However, the first ratio does not distinguish between domestically and foreign purchased inputs. Offshoring focuses solely on inputs purchased from abroad. Therefore, the second bracket gives an adjustment based on the share of total imported inputs s (the numerator) in the entire domestic disposability of this input s (the denominator), where the latter is composed of home production plus imports minus exports at time t. We call the second bracket of equation (3) the *overall import share*.

The proxy services offshoring intensity POS_{ist} of service input s in sector i is equal to the product of the two ratios. The proxy measure is based on the assumption of the same import share of service input s for all sectors, irrespective of actual sectoral differences. In Germany, for instance, the overall import share of other business activities was 4.5% in 2004. Hence, an import share of 4.5% is assumed for each sector i in the calculation of the sectoral import intensities for 2004. POS_{it}, POS_{st} and POS_t are defined analogously to equations (2), (3), and (4). We calculate direct and proxy materials offshoring intensities (DOM and POM) analogously to the services offshoring intensities.

5 Other authors, e.g. Amiti and Wei (2005, 2006), use sectoral outputs as weights. Using total non-energy inputs instead of output results in a more accurate overall offshoring intensity, as it directly refers to the denominator of the offshoring measure.

The definition of offshoring intensity suffers from three related shortcomings. The first two concern both offshoring intensity measures, whereas the last one only holds for the proxy offshoring measure. First, the numerator underestimates the actual offshoring values, since import prices – used here for the calculation of the offshoring measure – are generally lower than the actual purchase prices of these inputs. Second, total non-energy inputs only include purchased inputs, but not self-produced inputs used by sector *i*, which underestimates the denominator. Third, the application of the same import share of across all sectors in the proxy offshoring intensity is not accurate, since not every sector uses imports to the same extent. Thus, the offshoring intensity cannot be exactly measured (Amiti and Wei, 2005).

The first two shortcomings are mutually offsetting and the direct offshoring intensities presents a good measure for the proportion of imported inputs being used by sector *i* at time *t*. However, the third shortcoming – the proportionality assumption that applies the same import share to all sectors *i* in the proxy offshoring intensity measures – could constitute a major problem, since much of the import-induced cross-sectoral variation gets lost. Because of lack of data on the direct import of intermediates, the proxy measured is used in all major studies of offshoring.[6]

2.2 German Offshoring Intensity Using Direct and Proxy Measures

Table 1 presents the direct and proxy measures of average services offshoring intensity (weighted by total non-energy inputs) for each of the seven selected service inputs *s* over all 43 sectors *i* in 1995 and 2004 as defined in equation (3). For each service input we also show the (unweighted) mean and the standard deviation across the 43 sectors. The average services offshoring intensity measured directly, DOS_{st}, more than doubled from 1.37% in 1995 to 2.90% in 2004. At the service level, 'computer and related activities' grew on average from the third smallest share of 0.08% in 1995 to the fourth largest share of 0.39% in 2004. Average offshoring intensities of 'research and development' services increased from 0.13% in 1995 to 0.35% in 2004. Other business activities almost doubled their intensities from 0.53% in 1995 to 0.95% in 2004. These three service inputs are those that are typically associated with services offshoring and account for 58% of the total DOS_t in 2004.

[6] For example, Feenstra and Hanson (1996, 1999), Amiti and Wei (2005, 2006), Grossman and Rossi-Hansberg (2006), and OECD (2007).

The proxy measures of services offshoring intensity, POS_{st}, are shown at the bottom of Table 1. They are smaller than the direct measures. Applying the overall import share of a services category *s* to all sectors *i* thus seems to underestimate the real amount of imported service inputs. Average POS_t more than doubled from 0.88% in 1995 to 1.80% in 2004. Table 1 also shows that cross-sectoral standard deviations are generally much lower using the proxy measures compared to the direct measures. The corresponding measures of materials offshoring intensity by type of materials input can be found in Appendix 2. Note that analogously to subscript *s* in equations (1) to (5), subscript *m* stands for material inputs. In the case of materials offshoring, we find the reverse: the proxy measures tend to be higher than the direct measures. Cross-sectoral standard variations, on the other hand, are higher for the proxy measure than for the direct measure which we will explain in section.

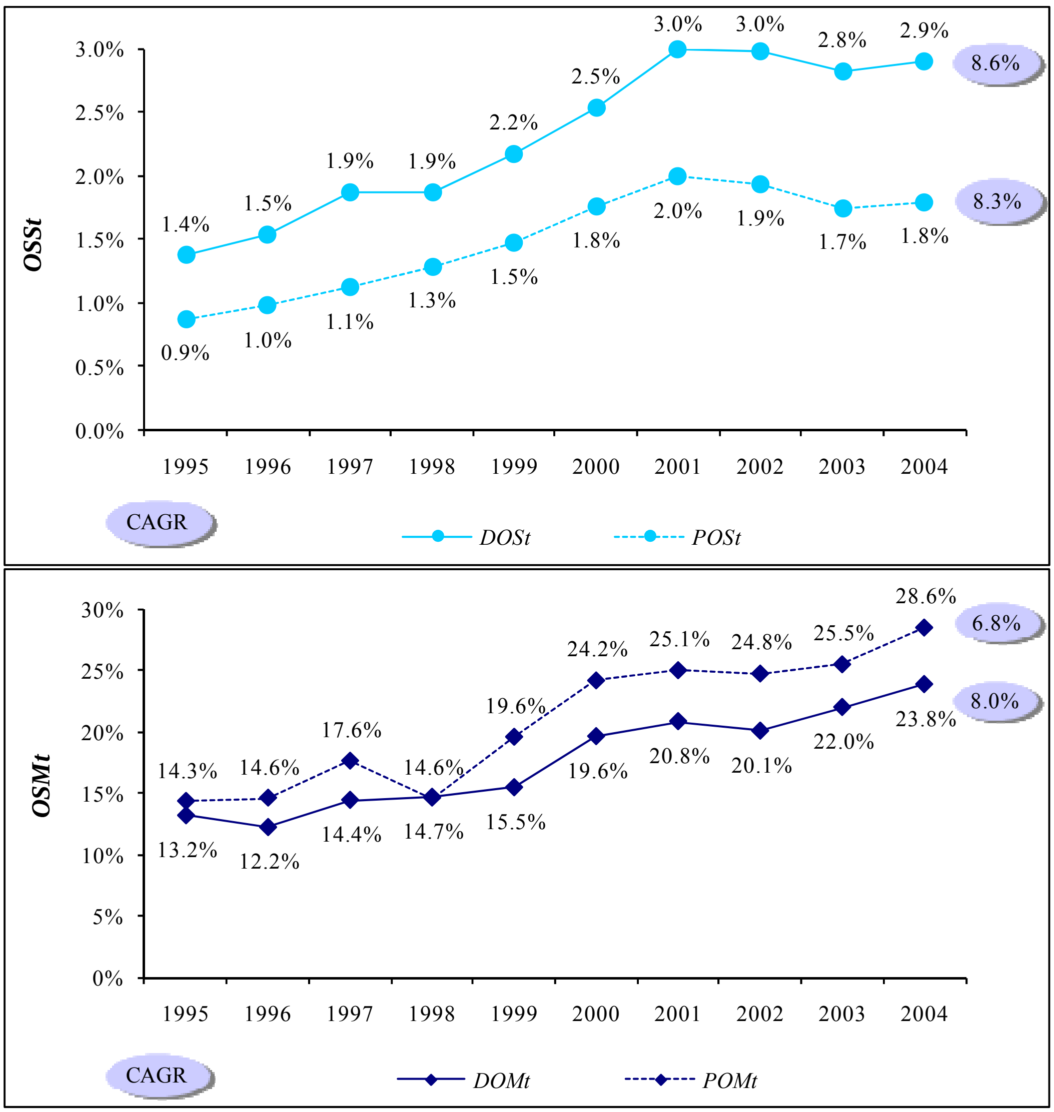
Table 1: Direct and Proxy Measures of Services Offshoring Intensity by Type of Service Input in Germany, 1995 and 2004

Service input *s*	**Rank**	***DOS*** **s 1995** (weighted average)	**Mean**	**Std Dev**	**Rank**	***DOS*** **s 2004** (weighted average)	**Mean**	**Std Dev**
Post and telecommunications	3	0.25%	0.25%	1.49%	2	0.52%	0.49%	3.04%
Financial intermediation	6	0.08%	0.06%	0.08%	6	0.19%	0.18%	0.10%
Activities related to financial intermediation	2	0.31%	0.19%	1.24%	3	0.51%	0.80%	4.71%
Renting of machinery and equipment	7	0.00%	0.00%	0.00%	7	0.00%	0.00%	0.00%
Computer and related activities	5	0.08%	0.13%	0.62%	4	0.39%	0.64%	2.07%
Research and development	4	0.13%	0.24%	1.00%	5	0.35%	0.64%	2.91%
Other business activities	1	0.53%	0.35%	1.03%	1	0.95%	0.73%	2.06%
Total *DOS t*		**1.37%**	**1.23%**	**2.53%**		**2.90%**	**3.48%**	**6.98%**
Service input *s*	**Rank**	***POS*** **s 1995** (weighted average)	**Mean**	**Std Dev**	**Rank**	***POS*** **s 2004** (weighted average)	**Mean**	**Std Dev**
Post and telecommunications	3	0.09%	0.10%	0.11%	4	0.22%	0.21%	0.64%
Financial intermediation	5	0.05%	0.05%	0.10%	6	0.09%	0.09%	0.16%
Activities related to financial intermediation	2	0.22%	0.26%	1.19%	2	0.31%	0.38%	1.78%
Renting of machinery and equipment	7	0.00%	0.00%	0.00%	7	0.00%	0.00%	0.00%
Computer and related activities	6	0.04%	0.06%	0.20%	3	0.27%	0.40%	1.42%
Research and development	4	0.05%	0.10%	0.44%	5	0.16%	0.27%	1.06%
Other business activities	1	0.42%	0.45%	0.41%	1	0.75%	0.74%	0.63%
Total *POSt*		**0.88%**	**1.03%**	**1.44%**		**1.80%**	**2.09%**	**2.78%**

Source: Own calculations, Data: FSO, revised input-output tables (1995 and 2004).

Figure 1 presents a plot of the development of the average services and materials offshoring intensities over all sectors in Germany as defined in equation (4). The continuous lines represent the direct measures. Average direct services offshoring intensities DOS_t have grown considerably by on average 8.6% per year from 1.4% in 1995 to 2.9% in 2004 possibly due to the increased use of ICT. Direct materials offshoring intensities have risen by 8.0% per year from 13.2% in 1995 to 23.8% in 2004. The relatively strong annual growth rate of materials offshoring compared to services offshoring is somewhat surprising, as the process of materials offshoring started earlier and perhaps should have reached its limit. One explanation would be the collapse of communism in Eastern Europe, which was followed by significant German foreign direct investment in Central and Eastern Europe, and subsequent wave of re-imports back to Germany. Another explanation is the growing reliance on East Asian contract manufacturers.

Figure 1: Offshoring Intensities of Intermediate Inputs in Germany (1995-2004)



Source: Own calculations. FSO, revised input-output tables (1995-2004). Weighted average across all sectors *i* by total non-energy inputs at time *t*.

The dashed lines in Figure 1 represent the average proxy measures POS_t and POM_t. Average services offshoring intensities POS_t are lower than the corresponding DOS_t measures. Nevertheless, the average annual growth rate is still 8.3% over the 1995-2004 period. On the other hand, the proxy measures of materials offshoring intensity POM_t are mostly higher than the corresponding direct measure DOM_t. The POM_t variable tracks the constant growth trend of the DOM_t measures with a lower CAGR of 6.8%. In sum, there is a clear difference in the average level and variation between the direct and proxy measures.

3. Error in Capturing Cross-Sectoral Variation Using the Proxy Measure

3.1 Loss of Cross-Sectoral Variation

In the following, we are interested how the proxy measure influences the *cross-sectoral variation* of offshoring, i.e. the variation across all sectors considered. In equation (5), we distinguished between the “sectoral input share” (first bracket) and the “overall import share” (second bracket). Accordingly, we can attribute the cross-sectoral variation of the proxy measure in equation (5) to the “input-induced variation”, i.e. the variation in the first bracket across all sectors, and the “import-induced variation”, i.e. the variation in the second bracket across all sectors.

Let us study the *import-induced variation* of the proxy measure compared to the direct measure in a first step. Applying the same overall import share for a service input s over all sectors i constitutes a major loss of cross-sectoral variation, which we will show in the following. Let us assume that a sector i only purchases two service inputs, s_1 and s_2. Then, the calculation of POS_{it} for a sector i at time t is given by:

$$POS_{it} = \sum_{s=1}^{2} POS_{ist} = \left[\frac{(input\ purchases\ of\ service\ s_1)_{it}}{(total\ non\text{-}energy\ inputs)_{it}}\right]\left[\frac{(imports\ of\ service\ s_1)_t}{production_{s_1t} + imports_{s_1t} - exports_{s_1t}}\right] + \left[\frac{(input\ purchases\ of\ service\ s_2)_{it}}{(total\ non\text{-}energy\ inputs)_{it}}\right]\left[\frac{(imports\ of\ service\ s_2)_t}{production_{s_2t} + imports_{s_2t} - exports_{s_2t}}\right] \qquad (6)$$

Now imagine the calculation of POS_{it} for a sector j (with $j \neq i$) which uses the same kinds of inputs as sector i at time t. We can see from equation (6) that only the first bracket of each summand – i.e. the input-induced variation – differs from sector i, while the second bracket of each summand remains as in sector i, – i.e. there is no import-induced variation across sectors.

As a consequence, the cross-sectoral variation in offshoring intensities is solely determined by the input-induced variation. The application of the proportionality assumption thus lowers the import-induced cross-sectoral variation.

3.2 Influence of Domestically-Purchased Inputs

We now analyze the *input-induced variation* of the proxy measure. As we have shown in the previous section, the cross-sectoral variation of POS_{it} is only determined by the input-induced variation, because of the proportionality assumption. Note that the term input-induced variation in opposition to import-induced variation could be misleading, as it includes both the variation of domestically purchased inputs and the variation of imported inputs of *s*. In the following section we show that this can lead to a biased sectoral input share (first bracket in equation 5), because the cross-sectoral variation is mainly determined by domestically purchased inputs.

The sectoral services offshoring intensities for the 36 manufacturing sectors using direct and proxy measures are plotted in Appendix 3. One can see that the two measures differ for each sector. The cross-sectoral standard deviations per year (on bottom) are stronger for the DOS_{it} measures. Consequently, the standard deviation of the DOS_{st} measures is also higher compared to that for POS_{st}, as already shown in Table 1. The category 'other business services', for instance, shows a standard deviation of 1.03% in 1995 using the DOS_t measures, while the standard deviation is only 0.41% for the POS_t measures.

Similar differences between the direct and the proxy measure can be detected for materials offshoring intensity. Appendix 4 shows the sectoral materials offshoring intensities in manufacturing using both measures. Despite the loss in import-induced variation explained in section 3.1, the cross-sectoral standard deviations of POM_{it} are higher than those for DOM_{it}. Likewise, the cross-sectoral standard deviations for the POM_{mt} measures are also higher compared to the DOM_{mt} measures (see Appendix 2).

Why are there such differences in the standard deviation across sectors between the direct and proxy measures? In the following, we show the extent to which domestically purchased inputs as opposed to imported inputs influence the input-induced variation. To do this, we introduce two *domestic outsourcing variables* to reflect the amount of home-purchased service inputs and home-purchased material inputs. The domestic services outsourcing intensity *HPS* is calculated as follows:

$$HPS_{ist} = \frac{(domestic\ input\ purchases\ of\ service\ s\ by\ sector\ i)_t}{(total\ non\text{-}energy\ inputs\ used\ by\ sector\ i)_t} \quad (7)$$

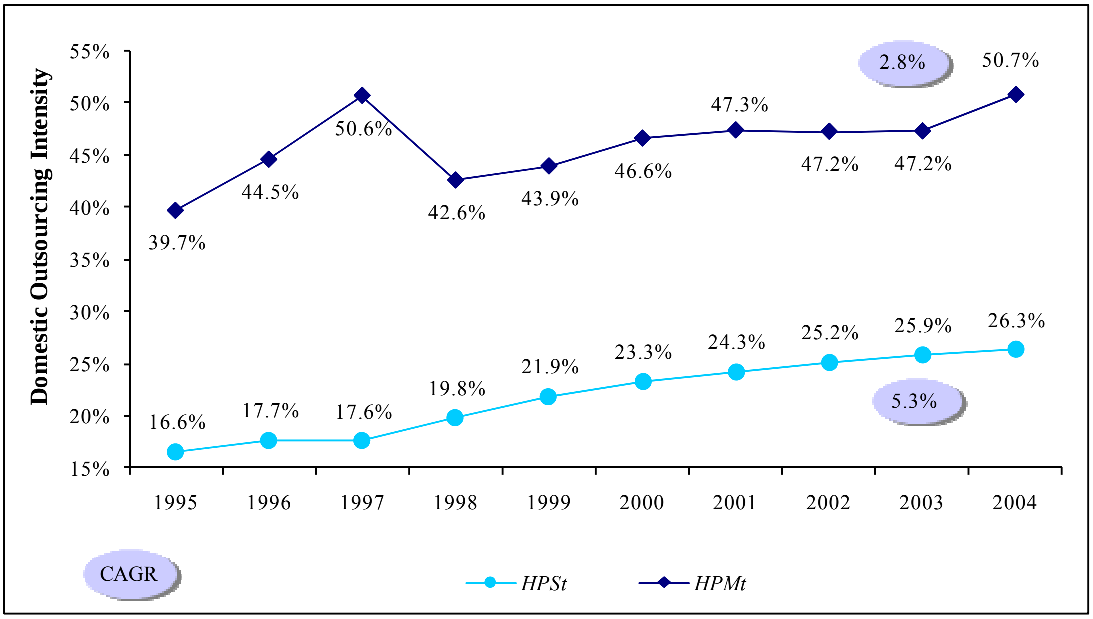
The domestic services outsourcing intensity HPS_{it} for sector *i* at time *t* is calculated by taking the sum over all HPS_{ist}: $HPS_{it} = \sum_s HPS_{ist}$. The domestic materials outsourcing intensity *HPM* is calculated analogously.

According to this definition, summing up equations (7) and (1) yields the left bracket of equation (5), i.e. the sectoral input share. Such domestic outsourcing is fully captured in the proxy measures, and is plotted in Figure 2 for the period 1995-2004. The average domestic outsourcing intensities are much higher than the offshoring intensities shown in Figure 2.[7] We thus expect domestic outsourcing to exert a stronger influence on the cross-sectoral input-induced variation. Between 1995 and 2004, domestic services outsourcing grew at an average rate 5.3% per annum, (from 16.6% to 26.3%), while the overall domestic materials outsourcing intensity grew from 39.7% in 1995 to 50.7% in 2004, a compound annual growth rate of 2.8%.

The cross-sectoral correlations presented in Appendix 5 show that the sectoral POS_{it} measures have a very high correlation with the corresponding domestic services outsourcing intensities HPS_{it}, which is reflected in an average correlation of 0.9. This means that most of the cross-sectoral variation in POS_{it} is in fact determined by the domestic services outsourcing intensity and not by imported service inputs. Despite the fact that the POM_{it} measure shows an overall correlation with the *domestic materials outsourcing intensity* HPM_{it} of almost zero, the sectoral data reveal that 22 sectors have a pairwise correlation of more than 50%. This is due to the fact that some sector pairs show positive and others have a negative correlation. We explain these differences by the fact that the ratio of domestic to imported inputs is much higher in services than in materials (see Figures 1 and 2). The influence of domestic outsourcing, and thus the error, would seem to be less severe for materials compared to services.

[7] Note that the offshoring and domestic outsourcing measures for materials or services do not sum to 100%. The denominator in both measures is 'total non-energy inputs', which includes both material and service inputs, while the numerator includes only services or materials, depending on the measure.

Figure 2: Domestic Outsourcing Intensity of Intermediate Inputs in Germany



Source: Own calculations. Data: FSO, revised input-output tables (1995-2004). Weighted average across all sectors *i* by total non-energy inputs at time *t*.

We conclude that the input-induced variation is mostly determined by domestically purchased inputs, which is stronger in the case of service inputs. A high standard deviation of the domestic outsourcing variables thus influences the variation in the proxy measure. To support our hypothesis, we present the sectoral domestic outsourcing intensities and their standard deviations in Appendix 5. The standard deviations of $HPS_{it.}$ and HPM_{it} are much higher than the respective standard deviations of DOS_{it} and DOM_{it}, which implies a strong influence of domestically purchased inputs on the variation of POS_{it} and POM_{it}. Moreover, the standard deviations of HPM_{it} (with 36 material inputs) across all sectors are higher than the standard deviations of $HPS_{it.}$ (with seven service inputs).

To sum up: the use of proxy measures significantly influences the degree of cross-sectoral variation. First of all, the cross-sectoral variation of the proxy measure is only determined by the input-induced variation due to the proportionality assumption, since there is by assumption no cross-sectoral variation in the overall import shares. In general this implies less cross-sectoral variation in the proxy measure of offshoring. Second, the input-induced variation is to a large extent determined by domestically purchased inputs, which can have an upward or downward effect on the cross-sectoral variation, depending on the cross-sectoral variation in domestic input demand compared to that for imported inputs. In our specific case, we detected a lower cross-sectoral variation in the proxy measure for services, but a higher cross-sectoral variation for materials. This indicates a strong upward effect of the input-induced variation for materials on the cross-sectoral variation.

These two effects lead in general to erroneous measurement, and this error may be particularly important when the proxy measure is used in cross-sectoral analysis of offshoring. We test this hypothesis in the next section, where we measure the impact of services offshoring on labor demand in German manufacturing using both the direct and the proxy offshoring measures.

4. Offshoring and Labor Demand in Germany

4.1 Empirical Model

We use a standard model of labor demand, following the labor demand specification of Hamermesh (1993). A firm's linearly homogenous production function *F* with constant returns to scale is described as follows:

$$Y = F(L, K, S, M, T) \qquad \frac{\partial F}{\partial x_1} > 0,\ \frac{\partial^2 F}{\partial x_1^2} < 0,\ \frac{\partial^2 F}{\partial x_1 \partial x_2} > 0 \qquad \text{with } x_1, x_2 = L, K, S, M, T \tag{8}$$

where labor *L*, capital *K*, intermediate services *S*, intermediate materials *M*, and technology *T* are the input factors. The technology shifter, *T*=*T*(*OS, OM*), is a function of services and materials offshoring *OS* and *OM*.[8] *T* represents a change of the production function due to offshoring.

The corresponding linearly homogeneous cost function, conditional on the level of output *Y*, is the following:

$$C = C(Y, w, r, p^S, p^M, p^T) \qquad \frac{\partial C}{\partial c_1} > 0,\ \frac{\partial C}{\partial c_1 \partial c_2} > 0 \qquad \text{with } c_1, cx_2 = w, r, p^S, p^M, p^T \tag{9}$$

where *w* designates wages, *r* the rental rate on capital, p^S, p^M, and p^T the prices for service, material, and technology inputs, and *Y* the constant output.

[8] We use *OS* and *OM* in the following, when the variables can represent the direct or the proxy measure.

Using Shephard's Lemma[9], the conditional labor demand function L^d is derived as follows:

$$L^* = L^d(Y, w, r, p^S, p^M, p^T) \quad (10)$$

In log-linear form, we can write:

$$\ln L_{it} = \alpha_0 + \eta_Y \ln Y_{it} + \eta_L \ln w_{it} + \eta_K \ln r_{it} + \eta_S \ln p_{it}^S + \eta_G \ln p_{it}^M + \eta_T \ln p_{it}^T \quad (11)$$

In this form, the equation results in the employment-output elasticity η_Y, the price elasticity of demand for labor η_L, the cross-elasticity of demand for labor due to a change in the rental rate on capital η_K, the cross-elasticities of demand for labor due to a change in input prices for services, goods, and technology η_S, η_M, and η_T.

Wages are observed directly, but some choices must be make on the specification of the input prices. The rental rate on capital, r, is assumed to be the same for all companies and to be a function of time *r=f(t)*. *r* is not directly included in the estimation model, but will be captured by adding fixed-year dummies. The input prices for service and material inputs p^S and p^M can be subdivided into foreign input prices and domestic input prices (see Winkler, 2009). Following Amiti and Wei (2005), we use offshoring intensities as an inverse proxy for import prices of services as well as of materials. The lower are the prices of imported services or material inputs, the higher the offshoring intensities should be. Therefore, we use the offshoring variables as inverse proxies for imported input prices.

Winkler (2009) uses the previously calculated domestic outsourcing intensities *HPS* and *HPM* as an inverse proxy for the prices of home-purchased service and material inputs. However, these variables can only be calculated using the domestic input matrices of the input-output tables. Unlike the offshoring intensity measures, we do not know an alternative proxy measure for domestic outsourcing intensities. Therefore, we do not include *HPS* and *HPM* in the regressions. This also makes our study more comparable with other studies that do not include domestic outsourcing intensities (e.g. Amiti and Wei, 2005, 2006). Finally, the input prices p^T of the technology shifter *T* need to be determined. Since adequate measures for p^T are not available and *T=T*(*OS, OM*), we use *OS* and *OM* as inverse proxies for the prices of technology p^T,

[9] According to Shephard's Lemma (1953) factor demand is determined by the first partial derivative of the cost function with respect to the corresponding factor price, regardless of the kind of production function.

because falling prices of technology inputs p^T are expected to be reflected in higher offshoring intensities.

Equation (11) thus reduces to:

$$\ln L_{it} = \alpha_0 + \eta_Y \ln Y_{it} + \eta_L \ln w_{it} + \eta_{OS} \ln OS_{it} + \eta_{OM} \ln OM_{it} + \delta_t D_t + \varepsilon_{it} \qquad (12)$$

Note that *OS* and *OM* have *two functions* in equation (12). First, they are used as (inverse) proxies for other foreign input prices, and second, they are used as (inverse) proxies for the prices of the technology shifter *T.* Higher output is expected to be associated positively with labor demand, that is $\eta_Y > 0$. Increasing wages are expected to be associated negatively, that is $\eta_L < 0$. Concerning *OS* and *OM*, their net effects are not unambiguous as noted by Amiti and Wei (2006). Offshoring can influence employment in at least three ways. First, if input prices p^S and p^M fall, i.e. if *OS* and *OM* increase, labor is likely to be substituted for imported inputs. We call this the input substitution effect. Analogously, if input prices p^T decrease, i.e. if *OS* and *OM* rise, labor is likely to be substituted for technology in what we call the technology substitution effect. Second, offshoring could augment productivity via *T*, so that less labor is needed for the same amount of output (*productivity effect*). The substitution effect influences labor demand in a direct manner, whereas the productivity effect is indirect.

Besides these two negative effects, *scale effects* could influence labor demand positively. If productivity effects lead to lower prices, this would be expected to be associated with a greater quantity demanded, in turn increasing the demand for labor. Thus, the net effect of offshoring is not clear. If the negative substitution or productivity effects are larger than the positive scale effects, then $\eta_{OS} < 0$ and $\eta_{OM} < 0$. If the scale effects dominate the other effects for all variables, we would expect $\eta_{OS} > 0$ and $\eta_{OM} > 0$

4.2 Estimation Results

We estimate the effect of offshoring on labor demand using the consistent fixed effects estimator which allows unobserved time-constant sector-specific effects c_i to be correlated with some explanatory variables x_{it}. All estimations produce standard errors robust to both heteroscedasticity (Huber-White sandwich estimators) and any form of intra-cluster correlation. Table 2 shows the results using the fixed effects estimator including all sectors, Table 3 shows the results excluding outliers 'pharmaceuticals' and 'recycling', and Table 4 applies the instrumental variables two-stage least squares (IV 2SLS) estimator to control for potential endogeneity of the offshoring variables. The correlation matrix, summary statistics and data description can be found in Appendices 7 to 9.

Table 2: Fixed Effects Estimations (1995-2004)

Dependent variable: $\ln L_t$								
	Fixed effects using *DOS* and *DOM* measures				Fixed effects using *POS* and *POM* measures			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$\ln Y_t$	0.3418***	0.1216**	0.2271**	0.1401**	0.3398***	0.1291**	0.1771**	0.0973
	(0.002)	(0.020)	(0.050)	(0.032)	(0.005)	(0.028)	(0.036)	(0.203)
$\ln Y_{t-1}$		0.2484***		0.0613		0.2277**		0.0503
		(0.010)		(0.470)		(0.014)		(0.402)
$\ln w_t$	-0.5369***	-0.4414***	-0.4701***	-0.3499***	-0.5357***	-0.4395***	-0.4623***	-0.3621***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
$\ln w_{t-1}$		-0.1250**		-0.1560***		-0.1300*		-0.1490***
		(0.037)		(0.005)		(0.053)		(0.008)
$\ln OS_t$	-0.0403*	-0.0092	-0.0133	0.0121	0.0910*	0.0569	0.0860**	0.0577
	(0.059)	(0.653)	(0.313)	(0.549)	(0.064)	(0.133)	(0.030)	(0.132)
$\ln OS_{t-1}$		-0.0406**		-0.0243**		-0.0068		0.0075
		(0.013)		(0.020)		(0.825)		(0.770)
$\ln OM_t$	0.0095	-0.0051	0.0258	0.0116	-0.0128	-0.0026	0.0524	0.0444
	(0.672)	(0.769)	(0.367)	(0.596)	(0.844)	(0.955)	(0.253)	(0.327)
$\ln OM_{t-1}$		0.0109		0.0376		0.0160		0.0616
		(0.665)		(0.137)		(0.737)		(0.108)
$\ln(IM/Y)_t$			0.0209	0.0429			0.0195	0.0357
			(0.602)	(0.127)			(0.449)	(0.194)
$\ln(IM/Y)_{t-1}$				-0.0396				-0.0368
				(0.295)				(0.235)
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Joint significance tests:								
$\ln Y_t + \ln Y_{t-1} = 0$		p>F=0.0062		p>F=0.0970		p>F=0.0181		p>F=0.1650
$\ln w_t + \ln w_{t-1} = 0$		p>F=0.0000		p>F=0.0000		p>F=0.0000		p>F=0.0000
$\ln OS_t + \ln OS_{t-1} = 0$		p>F=0.0415		p>F=0.0641		p>F=0.2827		p>F=0.2751
$\ln OG_t + \ln OG_{t-1} = 0$		p>F=0.8727		p>F=0.3239		p>F=0.9273		p>F=0.1763
$\ln(IM/Y)_t + \ln(IM/Y)_{t-1} = 0$				p>F=0.1973				p>F=0.3325
AIC	-855.8	-821.6	-849.8	-809.7	-834.9	-813.5	-879.3	-836.6
Observations	347	312	319	287	360	324	330	297
R-squared	0.64	0.65	0.66	0.66	0.62	0.63	0.68	0.68

Source: Own calculations. p*<0.1, p**<0.05, p***<0.001 (p-values in parentheses).

In each case we consider instantaneous effects and additional one-period lags of the independent variables. Employment is associated with income and wages in the predicted fashion under all estimation techniques, whether the estimation includes proxy or direct measures of offshoring. In all cases the income variable (contemporaneous and one-year lag) is positive in most cases statistically significant. Similarly, the wage variable (contemporaneous and one-year lag) is always negative and in most cases significant. When lagged values of these variables were included, they were in all cases jointly significant with the contemporaneous value (see joint significance tests at the bottom of each table).

There are different results, however, for the offshoring variables depending on if they are measured in a direct or proxy fashion. In the fixed effects models (both with and without outliers), materials offshoring varies from positive to negative, but is statistically insignificant in all models. In the IV 2SLS estimated with year fixed effects without outliers (Table 4), the direct measure of materials offshoring is negative and significant in columns (1) and (3) and insignificant in (2) and (4). The proxy measure of offshoring has a negative sign in all cases, and the effect is larger and statistically significant at a higher level in columns (5) and (7).

Table 3: Fixed Effects Estimations without Outliers (1995-2004)

Dependent variable: $\ln L_t$								
	Fixed effects w/o outliers[1)] using *DOS* and *DOM* measures				Fixed effects w/o outliers[2)] using *POS* and *POM* measures			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$\ln Y_t$	0.3547***	0.1297**	0.2578**	0.1508**	0.2717***	0.1210**	0.1716**	0.0983
	(0.001)	(0.018)	(0.037)	(0.039)	(0.008)	(0.046)	(0.041)	(0.213)
$\ln Y_{t-1}$		0.2530***		0.0873		0.1628**		0.0406
		(0.009)		(0.334)		(0.029)		(0.503)
$\ln w_t$	-0.5627***	-0.4770***	-0.5007***	-0.3831***	-0.4770***	-0.4238***	-0.4959***	-0.3992***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
$\ln w_{t-1}$		-0.1090*		-0.1477***		-0.0704		-0.1399**
		(0.067)		(0.008)		(0.266)		(0.017)
$\ln OS_t$	-0.0397*	-0.0097	-0.0139	0.0112	0.0591	0.0381	0.1102**	0.0744*
	(0.056)	(0.641)	(0.292)	(0.589)	(0.114)	(0.206)	(0.020)	(0.056)
$\ln OS_{t-1}$		-0.0398**		-0.0245**		-0.0106		0.0247
		(0.013)		(0.023)		(0.728)		(0.297)
$\ln OM_t$	0.0065	-0.0040	0.0160	0.0071	-0.0036	0.0060	0.0726	0.0708
	(0.788)	(0.825)	(0.629)	(0.780)	(0.957)	(0.902)	(0.109)	(0.112)
$\ln OM_{t-1}$		0.0039		0.0263		0.0133		0.0558
		(0.882)		(0.343)		(0.775)		(0.128)
$\ln(IM/Y)_t$			0.0388	0.0488			0.0368	0.0470*
			(0.398)	(0.136)			(0.112)	(0.054)
$\ln(IM/Y)_{t-1}$				-0.0231				-0.0281
				(0.560)				(0.385)
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Joint significance tests:								
$\ln Y_t + \ln Y_{t-1} = 0$		p>F=0.0047		p>F=0.1121		p>F=0.0316		p>F=0.1960
$\ln w_t + \ln w_{t-1} = 0$		p>F=0.0000		p>F=0.0000		p>F=0.0000		p>F=0.0000
$\ln OS_t + \ln OS_{t-1} = 0$		p>F=0.0398		p>F=0.0708		p>F=0.3666		p>F=0.1098
$\ln OM_t + \ln OM_{t-1} = 0$		p>F=0.9643		p>F=0.6074		p>F=0.9588		p>F=0.0902
$\ln(IM/Y)_t + \ln(IM/Y)_{t-1} = 0$				p>F=0.2608				p>F=0.1069
AIC	-836.8	-803.3	-828.5	-786.3	-897.0	-845.5	-868.7	-828.5
Observations	337	303	309	278	340	306	320	288
R-squared	0.65	0.66	0.67	0.66	0.68	0.67	0.70	0.70

Source: Own calculations. p*<0.1, p**<0.05, p***<0.001 (p-values in parentheses).
1) Columns 1 to 4 exclude the outlier ‘pharmaceuticals’.
2) Columns 5 to 8 exclude the outliers ‘pharmaceuticals’ and ‘recycling’.

Table 4: IV 2SLS Fixed Effects Estimations without Outliers (1995-2004)

Dependent variable: $\ln L_t$								
	Instrumental Variables 2SLS: Fixed effects w/o outlier[1)] using *DOS* and *DOM* measures				Instrumental Variables 2SLS: Fixed effects w/o outliers[2)] using *POS* and *POM* measures			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$\ln Y_t$	0.3537***	0.2368**	0.2549***	0.1439*	0.2825***	0.1893*	0.2545***	0.1083
	(0.001)	(0.048)	(0.002)	(0.059)	(0.003)	(0.082)	(0.001)	(0.161)
$\ln Y_{t-1}$			0.2424***	0.2361***			0.0676	0.1395**
			(0.001)	(0.006)			(0.276)	(0.023)
$\ln w_t$	-0.5509***	-0.5124***	-0.4750***	-0.4573***	-0.5419***	-0.4597***	-0.4760***	-0.4261***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
$\ln w_{t-1}$			-0.1405**	-0.1078*			-0.1336*	-0.0722
			(0.029)	(0.073)			(0.070)	(0.267)
$\ln OS_t$	-0.0511**	-0.0298	-0.0625***	-0.0402	0.0911	0.1872	0.0439	0.1176
	(0.021)	(0.365)	(0.008)	(0.161)	(0.106)	(0.186)	(0.494)	(0.468)
$\ln OM_t$	-0.0815*	0.0376	-0.1181**	-0.0238	-0.2426***	-0.0216	-0.2201***	-0.0185
	(0.063)	(0.430)	(0.019)	(0.627)	(0.001)	(0.884)	(0.005)	(0.901)
Year fixed effects	No	Yes	No	Yes	No	Yes	No	Yes
Joint significance tests:								
$\ln Y_t + \ln Y_{t-1} = 0$			p>F=0.0002	p>F=0.0128			p>F=0.0040	p>F=0.0483
$\ln w_t + \ln w_{t-1} = 0$			p>F=0.0000	p>F=0.0000			p>F=0.0000	p>F=0.0000
First stage results:								
Shea Partial R-squared:								
$\ln OS_t$	0.5297	0.5092	0.5274	0.5066	0.3297	0.1923	0.3111	0.1802
$\ln OM_t$	0.4320	0.3142	0.4144	0.3173	0.4501	0.3247	0.4405	0.3274
Hanson J statistic[3)] P-val.	$X^2(4)=0.05$	$X^2(4)=0.49$	$X^2(4)=0.05$	$X^2(4)=0.42$	$X^2(4)=0.04$	$X^2(4)=0.09$	$X^2(4)=0.03$	$X^2(4)=0.13$
AIC	-603.5	-649.6	-610.7	-666.8	-648.1	-692.8	-653.2	-711.2
Observations	235	235	235	235	238	238	238	238
R-squared	0.48	0.59	0.50	0.63	0.51	0.61	0.53	0.65

Source: Own calculations. p*<0.1, p**<0.05, p***<0.001 (p-values in parentheses).
1) Columns 1 to 4 exclude the outlier 'pharmaceuticals'.
2) Columns 5 to 8 exclude the outliers 'pharmaceuticals' and 'recycling'.
3) Over-identification test of all instruments.

The dramatic differences in the results between proxy and direct measures occurs with services offshoring. In the fixed effect estimations (Table 2), the proxy variable has a positive and statistically significant coefficient in columns (5) and (7). The direct services offshoring measure has a negative sign in all cases and is significant in contemporaneous form in model (1) and in lagged form in models (2) and (4). A very similar result occurs when outliers are removed (Table 3). In the IV 2SLS fixed effects estimations (Table 4), the direct services offshoring variable is negative and significant when year fixed effects are not included (columns 1 and 3). By comparison, the coefficient on the proxy measure of services offshoring (models 5-8) is always positive and statistically insignificant.

5. Concluding Remarks

The proportionality assumption in the measurement of offshoring has been adopted in all the major empirical, input-output based studies of offshoring. In this paper we provide a first assessment of the merits of that assumption. Since Germany collects imported inputs directly, we were able to construct a direct measure of offshoring to compare to the proxy measure, where the proxy measure was constructed with the proportionality assumption. We estimated the effect of offshoring on German labor demand for a sample of 36 sectors over the period 1995-2004 and found that the direct and proxy measures of offshoring give very different results, especially in the case of services offshoring. In many cases where the proxy measure gives a positive and insignificant coefficient, the direct measure has a negative and significant coefficient. This finding is robust to different estimation techniques.

We also performed a simple decomposition of the proxy-based measure. We find that the proxy measure fails to accurately capture the cross-sectoral variation in offshoring intensity because – as a result of the proportionality assumption – it is heavily influenced by the cross-sectoral variation in domestic input demand. More precisely, the cross-sectoral variation of the proxy measure is only determined by the input-induced variation, and the input-induced variation is to a large extent determined by domestically-purchased inputs.

The implications of our findings go beyond the case of Germany. Researchers must be cautious about drawing policy conclusions from estimates using the proxy-based measure of offshoring when we know, at least in the case of Germany for 1995-2004, that using a direct measure sometimes gives the opposite result. Whereas the proxy measure would support the view that workers should have no "fear of offshoring", the direct measure indicates that offshoring has a negative effect on labor demand. The two results would support very different policy prescriptions. Researchers relying (because of a lack of data) on the proxy measure should be very cautious interpreting the results of their analysis.

Given our results, we would urge that industrialized countries seek to improve data on imported intermediates along the lines suggested by Sturgeon (2006). This would be especially important for the US, the UK, and Japan, where offshoring levels and their labor market effects are known to be significant and the subject of considerable policy debate.

References

Abramovsky, L., Griffith, R., and M. Sako, 2004. Offshoring of Business Services and its Impact on the UK Economy. Advanced Institute of Management Research, London Business School, November 2004.

Amiti, M. and S.-J. Wei, 2005. Fear of service outsourcing: Is it justified?. Economic Policy 20(42), 308-347.

Amiti, M. and S.-J. Wei, 2006. Service Offshoring, Productivity and Employment: Evidence from the US. CEPR Discussion Paper, No. 5475, February 2006.

Feenstra, R. C. and G. H. Hanson, 1996. Globalization, Outsourcing and Wage Inequality. American Economic Review 86(2), 240-245.

Feenstra, R. C. and G. H. Hanson, 1999. The Impact of Outsourcing and High-Technology Capital on Wages: Estimates for the United States, 1979-1990. The Quarterly Journal of Economics 114(3), 907-940.

Grossman, G. M. and E. Rossi-Hansberg, 2006. The Rise of Offshoring: It's Not Wine for Cloth Anymore. Paper presented at The New Economic Geography: Effects and Policy Implications, Jackson Hole: Federal Reserve Bank of Kansas City, pp. 59-102.

Hamermesh, D., 1993. Labor Demand. Princeton University Press, Princeton.

Hummels, D., Ishii, J., and K.-M. Yi, 2001. The Nature and Growth of Vertical Specialization in World Trade. Journal of International Economics 54(1), 75-96.

Kalmbach, P., Franke, R., Knottenbauer, K., and H. Krämer, 2005. Die Interdependenz von Industrie und Dienstleistungen, Zur Dynamik eines komplexen Beziehungsgeflechts. Edition Sigma, Berlin.

Milberg, W., 2008. Outsourcing Economics, in Ruccio, D. (ed.), Economic Representations: Academic and Everyday, Routledge, London, pp. 56-72.

Milberg, W. and D. Schöller, 2008. Globalization, Offshoring and Economic Insecurity in Industrialized Countries. World Economic and Social Survey 2008 Background Paper, Department of Economic and Social Affairs, United Nations.

National Research Council, 2006. Analyzing the U.S. Content of Imports and the Foreign Content of Exports. The National Academy Press, Washington, D.C.

OECD, 2007. Offshoring and Employment: Trends and Impact. July 2007, OECD, Paris.

Shephard, R. W., 1953. Cost and Production Functions. Princeton University Press, Princeton.

Sturgeon, T., 2006. Services Offshoring Working Group Final Report. MIT Industrial Performance Center, September 2006.

UN, 1999. Handbook of Input-Output Table, Compilation and Analysis. Studies in Methods, Handbook of National Accounting, Series F, No. 74, October 1999, United Nations, New York.

Winkler, D., 2009. Services Offshoring and its Impact on the Labor Market – Theoretical Insights, Empirical Evidence, and Economic Policy Recommendations for Germany. Contributions to Economics, Springer, Heidelberg.

Appendices

Appendix 1: Sectoral Classification

	Manufacturing Sectors (36 Sectors)
1	Food products
2	Beverages
3	Tobacco products
4	Textiles
5	Wearing apparel, dressing and dying of fur
6	Leather, leather products and footwear
7	Wood and products of wood and cork
8	Pulp and paper
9	Paper products
10	Publishing
11	Printing
12	Coke, refined petroleum products and nuclear fuel
13	Pharmaceuticals
14	Chemicals exluding pharmaceuticals
15	Rubber products
16	Plastic products
17	Glass and glass products
18	Ceramic goods and other non-metallic mineral products
19	Iron and steel
20	Non-ferrous metals
21	Metal castings
22	Fabricated metal products, except machinery and equipment
23	Machinery and equipment, n.e.c.
24	Office, accounting and computing machinery
25	Electrical machinery and apparatus, n.e.c.
26	Radio, television and communication equipment
27	Medical, precision and optical instruments
28	Motor vehicles, trailers and semi-trailers
29	Other transport equipment
30	Manufacturing n.e.c.
31	Recycling
32	Electricity, steam and hot water supply
33	Gas and gas supply
34	Collection, purification and distribution of water
35	Construction site and civil engineering
36	Construction installation and other construction
	Service Sectors (7 Sectors)
37	Post and telecommunications
38	Financial intermediation except insurance and pension funding
39	Activities related to financial intermediation
40	Renting of machinery and equipment
41	Computer and related activities
42	Research and development
43	Other business activities

Appendix 2: Materials Offshoring Intensities per Input Category in Germany

Material input *m*	***DOMm* 1995** (weighted average)	**Mean**	**Std Dev**	***DOMm* 2004** (weighted average)	**Mean**	**Std Dev**	***POMm* 1995** (weighted average)	**Mean**	**Std Dev**	***POMm* 2004** (weighted average)	**Mean**	**Std Dev**
Food products	0.51%	0.35%	1.75%	0.68%	0.60%	2.73%	0.42%	0.30%	1.52%	0.63%	0.43%	2.17%
Beverages	0.02%	0.04%	0.24%	0.03%	0.04%	0.22%	0.02%	0.06%	0.36%	0.04%	0.09%	0.57%
Tobacco products	0.01%	0.14%	0.93%	0.00%	0.05%	0.32%	0.00%	0.06%	0.36%	0.00%	0.05%	0.34%
Textiles	0.46%	1.14%	4.18%	0.44%	1.11%	3.69%	0.68%	1.92%	7.36%	0.70%	2.05%	7.44%
Wearing apparel, dressing, and dying of fur	0.17%	0.58%	3.78%	0.17%	0.58%	3.76%	0.14%	0.54%	3.53%	0.16%	0.68%	4.43%
Leather, leather products, and footwear	0.10%	0.86%	5.46%	0.10%	0.73%	4.52%	0.12%	0.91%	5.61%	0.15%	1.12%	6.80%
Wood and products of wood and cork	0.37%	0.46%	1.60%	0.38%	0.48%	1.55%	0.38%	0.52%	2.03%	0.37%	0.53%	1.96%
Pulp and paper	0.67%	1.41%	4.94%	0.83%	1.90%	6.83%	0.76%	1.67%	5.72%	0.91%	1.99%	6.72%
Paper products	0.08%	0.14%	0.29%	0.16%	0.26%	0.43%	0.12%	0.25%	0.66%	0.30%	0.54%	1.35%
Publishing	0.03%	0.06%	0.28%	0.11%	0.16%	0.75%	0.02%	0.02%	0.05%	0.11%	0.11%	0.34%
Printing	0.04%	0.04%	0.10%	0.06%	0.06%	0.12%	0.08%	0.13%	0.38%	0.07%	0.12%	0.34%
Coke, refined petroleum products, and nuclear fuel	0.38%	0.60%	2.19%	0.78%	1.17%	3.94%	0.31%	0.60%	2.47%	0.75%	1.41%	6.26%
Pharmaceuticals	0.11%	0.21%	1.29%	0.18%	0.35%	2.25%	0.11%	0.13%	0.77%	0.52%	0.88%	5.75%
Chemicals exluding pharmaceuticals	1.93%	1.76%	3.60%	3.39%	3.58%	6.63%	2.22%	2.03%	3.18%	3.88%	3.27%	5.46%
Rubber products	0.21%	0.15%	0.48%	0.40%	0.32%	1.16%	0.21%	0.17%	0.49%	0.50%	0.39%	1.31%
Plastic products	0.44%	0.36%	0.46%	0.77%	0.67%	0.91%	0.56%	0.45%	0.80%	0.94%	0.74%	1.31%
Glass and glass products	0.15%	0.36%	1.75%	0.23%	0.50%	2.55%	0.16%	0.33%	1.31%	0.25%	0.50%	2.04%
Ceramic goods & other non-metallic mineral products	0.35%	0.27%	0.75%	0.34%	0.31%	0.73%	0.47%	0.41%	1.52%	0.38%	0.36%	1.27%
Iron and steel	1.02%	0.57%	1.48%	1.68%	1.27%	4.32%	1.17%	0.73%	3.03%	1.83%	1.12%	4.52%
Non-ferrous metals	1.10%	1.19%	4.98%	1.69%	2.63%	9.80%	1.11%	1.37%	5.02%	1.78%	2.64%	9.88%
Metal castings	0.07%	0.03%	0.12%	0.26%	0.23%	1.25%	0.10%	0.05%	0.11%	0.29%	0.13%	0.34%
Fabricated metal products, excl. machinery & equip.	0.52%	0.38%	0.51%	1.00%	0.71%	0.99%	0.67%	0.44%	0.76%	1.24%	0.78%	1.41%
Machinery and equipment, n.e.c.	0.78%	0.46%	1.08%	1.84%	1.05%	2.47%	0.96%	0.62%	1.15%	1.93%	1.20%	2.39%
Office, accounting, and computing machinery	0.30%	0.52%	2.56%	0.59%	1.05%	4.16%	0.39%	0.71%	2.85%	1.06%	1.94%	7.60%
Electrical machinery and apparaturs, n.e.c.	0.70%	0.37%	1.04%	1.52%	0.80%	2.48%	1.02%	0.57%	1.63%	2.14%	1.20%	3.65%
Radio, television, and communication equipment	0.61%	0.59%	2.46%	1.67%	1.53%	5.98%	0.60%	0.61%	2.14%	2.20%	2.36%	8.93%
Medical, precision, and optical instruments	0.14%	0.20%	0.65%	0.33%	0.48%	1.59%	0.16%	0.27%	0.75%	0.37%	0.64%	2.12%
Motor vehicles, trailers, and semi-trailers	1.52%	0.26%	1.57%	2.83%	0.56%	2.98%	1.12%	0.19%	1.08%	3.86%	0.64%	3.45%
Other transport equipment	0.11%	0.15%	1.01%	0.41%	0.55%	3.60%	0.11%	0.14%	0.90%	0.70%	0.95%	6.21%
Manufacturing n.e.c.	0.09%	0.12%	0.63%	0.30%	0.40%	2.52%	0.07%	0.09%	0.49%	0.24%	0.26%	1.49%
Recycling	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Electricity, steam, and hot water supply	0.03%	0.06%	0.15%	0.48%	0.91%	5.31%	0.03%	0.06%	0.08%	0.24%	0.42%	0.83%
Gas and gas supply	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Collection, purification, and distribution of water	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Construction site and civil engineering	0.01%	0.01%	0.01%	0.00%	0.01%	0.02%	0.01%	0.01%	0.03%	0.00%	0.00%	0.01%
Construction installation & other construction	0.14%	0.08%	0.32%	0.21%	0.12%	0.55%	0.01%	0.01%	0.02%	0.02%	0.02%	0.04%
Total Materials Offshoring Intensity in *t*	**13.17%**	**13.91%**	**10.86%**	**23.84%**	**25.19%**	**16.90%**	**14.31%**	**16.36%**	**12.69%**	**28.57%**	**29.57%**	**19.68%**

Source: Source: Own illustration. Data: FSO, revised input-output tables (1995 and 2004).

Appendix 3: Sectoral *DOS* vs. *POS* Measures

	DOSit										Std. Dev.	***POSit***										Std. Dev.
	1995	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	over *t*	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	over *t*
Food products	0.0011	0.0008	0.0009	0.0009	0.0010	0.0020	0.0025	0.0029	0.0031	0.0032	0.0010	0.0059	0.0062	0.0070	0.0077	0.0085	0.0100	0.0118	0.0113	0.0101	0.0103	0.0021
Beverages	0.0023	0.0038	0.0041	0.0045	0.0042	0.0051	0.0070	0.0070	0.0052	0.0050	0.0014	0.0134	0.0146	0.0154	0.0164	0.0180	0.0206	0.0216	0.0202	0.0172	0.0165	0.0027
Tobacco products	0.0081	0.0134	0.0150	0.0172	0.0193	0.0226	0.0331	0.0351	0.0376	0.0391	0.0112	0.0170	0.0072	0.0197	0.0220	0.0126	0.0303	0.0323	0.0293	0.0246	0.0269	0.0081
Textiles	0.0002	0.0005	0.0003	0.0002	0.0002	0.0013	0.0016	0.0024	0.0014	0.0015	0.0008	0.0030	0.0030	0.0033	0.0037	0.0038	0.0043	0.0047	0.0050	0.0039	0.0041	0.0007
Wearing apparel, dressing, and dying of fur	0.0000	0.0003	0.0003	0.0008	0.0008	0.0011	0.0014	0.0015	0.0009	0.0009	0.0005	0.0027	0.0028	0.0031	0.0031	0.0033	0.0034	0.0039	0.0040	0.0029	0.0032	0.0004
Leather, leather products, and footwear	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0017	0.0017	0.0021	0.0020	0.0020	0.0023	0.0029	0.0027	0.0020	0.0021	0.0004
Wood and products of wood and cork	0.0006	0.0051	0.0051	0.0049	0.0054	0.0015	0.0020	0.0019	0.0013	0.0013	0.0019	0.0034	0.0034	0.0036	0.0040	0.0049	0.0053	0.0052	0.0047	0.0037	0.0039	0.0008
Pulp and paper	0.0020	0.0014	0.0011	0.0011	0.0011	0.0039	0.0045	0.0047	0.0043	0.0043	0.0016	0.0024	0.0023	0.0027	0.0031	0.0036	0.0048	0.0047	0.0047	0.0040	0.0042	0.0010
Paper products	0.0040	0.0013	0.0012	0.0012	0.0012	0.0066	0.0060	0.0061	0.0078	0.0077	0.0029	0.0025	0.0024	0.0028	0.0031	0.0034	0.0044	0.0046	0.0046	0.0040	0.0044	0.0009
Publishing	0.0064	0.0105	0.0124	0.0119	0.0118	0.0229	0.0283	0.0271	0.0287	0.0302	0.0092	0.0165	0.0187	0.0211	0.0250	0.0277	0.0302	0.0322	0.0312	0.0278	0.0294	0.0055
Printing	0.0025	0.0026	0.0027	0.0032	0.0033	0.0050	0.0058	0.0066	0.0053	0.0055	0.0015	0.0029	0.0031	0.0034	0.0042	0.0048	0.0053	0.0059	0.0062	0.0050	0.0054	0.0012
Coke, refined petroleum products, and nuclear fuel	0.0035	0.0024	0.0024	0.0020	0.0030	0.0037	0.0050	0.0062	0.0068	0.0068	0.0019	0.0147	0.0151	0.0159	0.0126	0.0148	0.0100	0.0097	0.0118	0.0136	0.0140	0.0021
Pharmaceuticals	0.0691	0.0714	0.0916	0.0704	0.0923	0.1477	0.1499	0.1666	0.2091	0.1965	0.0540	0.0146	0.0182	0.0232	0.0318	0.0357	0.0450	0.0526	0.0576	0.0613	0.0577	0.0175
Chemicals exluding pharmaceuticals	0.0037	0.0030	0.0038	0.0041	0.0046	0.0093	0.0120	0.0126	0.0158	0.0164	0.0053	0.0047	0.0051	0.0058	0.0065	0.0074	0.0093	0.0095	0.0095	0.0081	0.0088	0.0018
Rubber products	0.0027	0.0041	0.0043	0.0063	0.0065	0.0078	0.0089	0.0091	0.0068	0.0070	0.0021	0.0046	0.0049	0.0058	0.0072	0.0077	0.0097	0.0097	0.0085	0.0075	0.0080	0.0018
Plastic products	0.0095	0.0054	0.0060	0.0062	0.0066	0.0153	0.0167	0.0183	0.0122	0.0129	0.0048	0.0053	0.0059	0.0070	0.0079	0.0095	0.0116	0.0126	0.0129	0.0096	0.0105	0.0027
Glass and glass products	0.0016	0.0040	0.0049	0.0052	0.0059	0.0052	0.0056	0.0068	0.0053	0.0060	0.0014	0.0088	0.0088	0.0101	0.0108	0.0120	0.0143	0.0149	0.0142	0.0125	0.0131	0.0023
Ceramic goods & other non-metallic mineral products	0.0087	0.0063	0.0062	0.0062	0.0063	0.0102	0.0126	0.0128	0.0099	0.0096	0.0026	0.0102	0.0103	0.0111	0.0119	0.0138	0.0150	0.0148	0.0141	0.0119	0.0122	0.0018
Iron and steel	0.0012	0.0007	0.0007	0.0008	0.0007	0.0027	0.0032	0.0028	0.0063	0.0068	0.0023	0.0015	0.0016	0.0019	0.0022	0.0022	0.0028	0.0032	0.0028	0.0027	0.0031	0.0006
Non-ferrous metals	0.0014	0.0004	0.0007	0.0008	0.0008	0.0068	0.0080	0.0082	0.0070	0.0070	0.0035	0.0014	0.0015	0.0018	0.0022	0.0025	0.0036	0.0038	0.0036	0.0030	0.0033	0.0009
Metal castings	0.0002	0.0016	0.0015	0.0030	0.0028	0.0026	0.0034	0.0039	0.0057	0.0063	0.0019	0.0026	0.0026	0.0033	0.0042	0.0046	0.0055	0.0056	0.0060	0.0060	0.0070	0.0015
Fabricated metal products, excl. machinery & equip.	0.0014	0.0024	0.0027	0.0026	0.0028	0.0036	0.0048	0.0052	0.0043	0.0044	0.0012	0.0037	0.0041	0.0045	0.0054	0.0061	0.0069	0.0076	0.0073	0.0068	0.0071	0.0014
Machinery and equipment, n.e.c.	0.0032	0.0027	0.0031	0.0030	0.0031	0.0054	0.0062	0.0066	0.0057	0.0059	0.0016	0.0044	0.0051	0.0056	0.0066	0.0073	0.0087	0.0101	0.0099	0.0094	0.0098	0.0022
Office, accounting, and computing machinery	0.0044	0.0196	0.0289	0.0363	0.0303	0.0270	0.0367	0.0362	0.0263	0.0224	0.0098	0.0064	0.0072	0.0096	0.0117	0.0112	0.0174	0.0202	0.0183	0.0155	0.0136	0.0047
Electrical machinery and apparaturs, n.e.c.	0.0052	0.0049	0.0054	0.0059	0.0053	0.0085	0.0091	0.0112	0.0091	0.0098	0.0023	0.0050	0.0057	0.0064	0.0078	0.0084	0.0085	0.0116	0.0123	0.0110	0.0119	0.0027
Radio, television, and communication equipment	0.0060	0.0025	0.0027	0.0025	0.0037	0.0128	0.0162	0.0174	0.0120	0.0112	0.0059	0.0056	0.0063	0.0071	0.0072	0.0097	0.0136	0.0161	0.0159	0.0139	0.0133	0.0041
Medical, precision, and optical instruments	0.0043	0.0044	0.0050	0.0052	0.0050	0.0079	0.0090	0.0094	0.0079	0.0076	0.0020	0.0055	0.0061	0.0070	0.0087	0.0097	0.0121	0.0133	0.0133	0.0121	0.0117	0.0030
Motor vehicles, trailers, and semi-trailers	0.0027	0.0008	0.0009	0.0011	0.0013	0.0061	0.0067	0.0065	0.0061	0.0065	0.0027	0.0019	0.0025	0.0027	0.0037	0.0047	0.0062	0.0066	0.0061	0.0045	0.0049	0.0017
Other transport equipment	0.0013	0.0026	0.0032	0.0038	0.0036	0.0036	0.0040	0.0043	0.0039	0.0038	0.0009	0.0038	0.0055	0.0059	0.0069	0.0075	0.0098	0.0124	0.0123	0.0101	0.0098	0.0029
Manufacturing n.e.c.	0.0001	0.0003	0.0003	0.0003	0.0003	0.0017	0.0022	0.0025	0.0018	0.0018	0.0009	0.0047	0.0049	0.0055	0.0063	0.0069	0.0082	0.0087	0.0080	0.0068	0.0072	0.0014
Recycling	0.0000	0.0049	0.0061	0.0067	0.0049	0.0012	0.0014	0.0011	0.0013	0.0019	0.0024	0.0029	0.0033	0.0049	0.0054	0.0050	0.0092	0.0107	0.0098	0.0088	0.0110	0.0031
Electricity, steam, and hot water supply	0.0037	0.0059	0.0068	0.0075	0.0068	0.0069	0.0076	0.0064	0.0092	0.0100	0.0017	0.0080	0.0090	0.0101	0.0122	0.0134	0.0133	0.0154	0.0121	0.0099	0.0105	0.0023
Gas and gas supply	0.0015	0.0077	0.0092	0.0098	0.0127	0.0071	0.0090	0.0098	0.0093	0.0105	0.0029	0.0073	0.0071	0.0093	0.0110	0.0166	0.0222	0.0240	0.0221	0.0200	0.0224	0.0068
Collection, purification, and distribution of water	0.0000	0.0070	0.0081	0.0086	0.0092	0.0054	0.0061	0.0059	0.0043	0.0049	0.0026	0.0066	0.0074	0.0080	0.0102	0.0118	0.0116	0.0115	0.0111	0.0091	0.0104	0.0019
Construction site and civil engineering	0.0015	0.0031	0.0032	0.0027	0.0026	0.0017	0.0021	0.0024	0.0018	0.0018	0.0006	0.0052	0.0059	0.0065	0.0067	0.0075	0.0082	0.0077	0.0070	0.0064	0.0063	0.0009
Construction installation & other construction	0.0009	0.0011	0.0011	0.0010	0.0010	0.0014	0.0018	0.0022	0.0017	0.0017	0.0004	0.0033	0.0038	0.0039	0.0046	0.0047	0.0052	0.0055	0.0058	0.0046	0.0049	0.0008
Cross-sectoral Std. Dev.	0.0113	0.0119	0.0155	0.0127	0.0157	0.0243	0.0251	0.0277	0.0345	0.0324		0.0043	0.0044	0.0055	0.0065	0.0070	0.0089	0.0100	0.0103	0.0105	0.0101	

Source: Own illustration. Data: FSO, revised input-output tables (1995-2004).

Appendix 4: Sectoral *DOM* vs. *POM* Measures

	DOMit 1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	Std. Dev. over *t*
Food products	0.1416	0.1221	0.1442	0.1181	0.1169	0.1479	0.1711	0.1660	0.2191	0.2392	0.0418
Beverages	0.0931	0.1165	0.1184	0.1329	0.1308	0.1058	0.1114	0.1101	0.1115	0.1058	0.0118
Tobacco products	0.1208	0.0873	0.0843	0.0720	0.1112	0.0838	0.1087	0.1058	0.0807	0.0872	0.0161
Textiles	0.3591	0.2665	0.2810	0.3012	0.2924	0.3860	0.4141	0.3915	0.3689	0.3600	0.0521
Wearing apparel, dressing, and dying of fur	0.4549	0.4785	0.5779	0.6177	0.4514	0.4739	0.5755	0.5617	0.4205	0.4599	0.0686
Leather, leather products, and footwear	0.4309	0.4911	0.6266	0.4866	0.4541	0.4920	0.5604	0.5667	0.4780	0.4387	0.0628
Wood and products of wood and cork	0.1178	0.1350	0.1488	0.1612	0.1679	0.1334	0.1298	0.1253	0.1464	0.1614	0.0170
Pulp and paper	0.2994	0.2363	0.2289	0.3278	0.3155	0.4193	0.4165	0.4075	0.4286	0.4495	0.0819
Paper products	0.1813	0.1620	0.1713	0.1776	0.1891	0.2285	0.2324	0.2442	0.3228	0.2979	0.0552
Publishing	0.0365	0.0591	0.0528	0.0461	0.0375	0.0518	0.0562	0.0571	0.0619	0.0676	0.0101
Printing	0.1611	0.1586	0.1690	0.1880	0.2033	0.2177	0.2309	0.2131	0.1916	0.1955	0.0244
Coke, refined petroleum products, and nuclear fuel	0.1878	0.2481	0.3742	0.2558	0.1912	0.2551	0.2402	0.2239	0.2747	0.2786	0.0526
Pharmaceuticals	0.1353	0.1833	0.1971	0.1874	0.1864	0.1405	0.1476	0.1815	0.2454	0.2216	0.0349
Chemicals exluding pharmaceuticals	0.1446	0.0981	0.1313	0.1541	0.1799	0.2451	0.2572	0.2300	0.3556	0.3788	0.0943
Rubber products	0.1716	0.1831	0.2046	0.2291	0.2240	0.2531	0.2895	0.2944	0.4186	0.4409	0.0930
Plastic products	0.2024	0.2081	0.2247	0.2396	0.2458	0.2862	0.3306	0.2943	0.3015	0.3319	0.0485
Glass and glass products	0.1588	0.1201	0.1302	0.1291	0.1319	0.1815	0.2265	0.2134	0.2490	0.2839	0.0579
Ceramic goods & other non-metallic mineral products	0.0767	0.0879	0.0934	0.0932	0.0907	0.0821	0.0973	0.0932	0.0780	0.0859	0.0070
Iron and steel	0.0905	0.0789	0.0895	0.0947	0.0780	0.1095	0.1113	0.0956	0.2686	0.4123	0.1100
Non-ferrous metals	0.3340	0.2914	0.3691	0.3702	0.3207	0.4417	0.4485	0.4817	0.4359	0.5321	0.0773
Metal castings	0.1121	0.0707	0.1029	0.1297	0.1166	0.2646	0.2947	0.3069	0.5027	0.6695	0.1972
Fabricated metal products, excl. machinery & equip.	0.1594	0.1351	0.1477	0.1629	0.1478	0.1995	0.2136	0.2127	0.2087	0.2414	0.0364
Machinery and equipment, n.e.c.	0.1572	0.1532	0.2139	0.2053	0.2096	0.2580	0.2736	0.2763	0.2877	0.3127	0.0550
Office, accounting, and computing machinery	0.2247	0.1578	0.2749	0.1553	0.0799	0.4370	0.4849	0.5032	0.4655	0.4069	0.1582
Electrical machinery and apparaturs, n.e.c.	0.1242	0.1204	0.1500	0.1906	0.2065	0.2065	0.2187	0.2343	0.2511	0.2814	0.0532
Radio, television, and communication equipment	0.1897	0.2011	0.2403	0.0807	0.1240	0.4120	0.4917	0.5007	0.4276	0.4407	0.1595
Medical, precision, and optical instruments	0.1305	0.1382	0.1561	0.1936	0.1989	0.2672	0.3039	0.2955	0.2772	0.3101	0.0713
Motor vehicles, trailers, and semi-trailers	0.1553	0.1380	0.1512	0.1590	0.1919	0.2274	0.2322	0.2272	0.3083	0.3387	0.0681
Other transport equipment	0.1463	0.2040	0.1799	0.1648	0.3691	0.3902	0.3821	0.3576	0.3744	0.4032	0.1078
Manufacturing n.e.c.	0.1829	0.2027	0.2427	0.2956	0.2936	0.3116	0.3778	0.3846	0.3446	0.3636	0.0714
Recycling	0.0104	0.0146	0.0348	0.0445	0.0415	0.0329	0.0419	0.0442	0.0510	0.0713	0.0174
Electricity, steam, and hot water supply	0.0955	0.0674	0.0677	0.0734	0.0780	0.1004	0.1890	0.2420	0.4128	0.4571	0.1473
Gas and gas supply	0.0136	0.0216	0.0231	0.0314	0.0448	0.0433	0.0526	0.0498	0.0531	0.0564	0.0153
Collection, purification, and distribution of water	0.0540	0.0648	0.0685	0.0971	0.1025	0.0971	0.1139	0.1097	0.1028	0.1147	0.0219
Construction site and civil engineering	0.0881	0.0704	0.0745	0.0750	0.0890	0.1105	0.1149	0.1042	0.0969	0.0978	0.0155
Construction installation & other construction	0.1420	0.1501	0.1676	0.1898	0.1773	0.2026	0.2312	0.2211	0.2016	0.1991	0.0290
Cross-sectoral Std. Dev.	0.1019	0.1036	0.1316	0.1221	0.1055	0.1315	0.1448	0.1460	0.1358	0.1508	

	POMit 1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	Std. Dev. over *t*
Food products	0.1317	0.1425	0.1771	0.1428	0.1383	0.1615	0.1725	0.1728	0.1912	0.2016	0.0238
Beverages	0.1103	0.1087	0.1187	0.1099	0.1114	0.1334	0.1340	0.1326	0.1486	0.1461	0.0154
Tobacco products	0.0945	0.0755	0.0738	0.0686	0.1343	0.0903	0.1029	0.1042	0.0950	0.1085	0.0195
Textiles	0.4638	0.4446	0.4863	0.4673	0.4657	0.4923	0.4863	0.4859	0.4875	0.4798	0.0150
Wearing apparel, dressing, and dying of fur	0.6082	0.5570	0.6823	0.7069	0.5990	0.6789	0.6677	0.6891	0.6452	0.7027	0.0501
Leather, leather products, and footwear	0.4402	0.4560	0.5621	0.4956	0.5049	0.5624	0.6191	0.6319	0.5410	0.5640	0.0636
Wood and products of wood and cork	0.2016	0.1824	0.2165	0.2199	0.2340	0.2378	0.2288	0.2192	0.2207	0.2413	0.0177
Pulp and paper	0.3317	0.2832	0.3423	0.3239	0.3707	0.4537	0.4110	0.3900	0.4139	0.4215	0.0531
Paper products	0.2822	0.2456	0.2904	0.2659	0.2857	0.3697	0.3753	0.3871	0.3897	0.3848	0.0582
Publishing	0.0338	0.0347	0.0413	0.0383	0.0443	0.0555	0.0539	0.0580	0.0590	0.0552	0.0100
Printing	0.1934	0.1612	0.1622	0.1850	0.1971	0.2539	0.2639	0.2671	0.2459	0.2459	0.0419
Coke, refined petroleum products, and nuclear fuel	0.2159	0.2113	0.2617	0.1753	0.2211	0.3726	0.2986	0.2718	0.3786	0.4497	0.0887
Pharmaceuticals	0.1213	0.1343	0.1887	0.1485	0.1437	0.2216	0.3297	0.3145	0.2850	0.4839	0.1159
Chemicals exluding pharmaceuticals	0.1692	0.1953	0.2518	0.2356	0.2526	0.2948	0.3160	0.2914	0.3017	0.3314	0.0529
Rubber products	0.2013	0.1826	0.2123	0.2521	0.2560	0.3237	0.3280	0.3246	0.3742	0.4085	0.0766
Plastic products	0.1766	0.1466	0.1610	0.1982	0.2103	0.2591	0.2735	0.2583	0.2700	0.3103	0.0552
Glass and glass products	0.1441	0.1355	0.1631	0.1540	0.1574	0.2055	0.2161	0.2186	0.2083	0.2303	0.0356
Ceramic goods & other non-metallic mineral products	0.1272	0.1193	0.1272	0.1287	0.1356	0.1503	0.1464	0.1441	0.1351	0.1509	0.0110
Iron and steel	0.2293	0.2157	0.2650	0.2396	0.1937	0.2594	0.2506	0.2340	0.2467	0.3438	0.0397
Non-ferrous metals	0.3213	0.2950	0.3981	0.3732	0.3942	0.5408	0.5102	0.5160	0.5013	0.6145	0.1044
Metal castings	0.2099	0.2225	0.3216	0.2941	0.2921	0.4006	0.4019	0.3969	0.4253	0.5193	0.0971
Fabricated metal products, excl. machinery & equip.	0.1763	0.1534	0.1631	0.1965	0.1981	0.2415	0.2373	0.2381	0.2537	0.2977	0.0456
Machinery and equipment, n.e.c.	0.1644	0.1724	0.1914	0.2113	0.2208	0.2695	0.2812	0.2923	0.3037	0.3430	0.0611
Office, accounting, and computing machinery	0.2471	0.2131	0.3430	0.3913	0.3738	0.6818	0.6511	0.7143	0.6963	0.6791	0.2030
Electrical machinery and apparaturs, n.e.c.	0.1527	0.1515	0.1847	0.2183	0.2293	0.2696	0.3044	0.3167	0.3168	0.3706	0.0758
Radio, television, and communication equipment	0.1672	0.1610	0.2101	0.1834	0.3187	0.5032	0.5141	0.5591	0.5842	0.6480	0.1952
Medical, precision, and optical instruments	0.1628	0.1622	0.2112	0.2198	0.2591	0.3389	0.3644	0.3761	0.3895	0.4382	0.1010
Motor vehicles, trailers, and semi-trailers	0.1183	0.1407	0.1736	0.1921	0.2305	0.2776	0.2943	0.3030	0.3211	0.3546	0.0813
Other transport equipment	0.1420	0.1996	0.2379	0.2786	0.3765	0.4962	0.5784	0.5920	0.5635	0.5824	0.1783
Manufacturing n.e.c.	0.1916	0.1883	0.2237	0.2510	0.2663	0.3002	0.2893	0.3031	0.3012	0.3224	0.0484
Recycling	0.0275	0.0258	0.0400	0.0373	0.0374	0.0686	0.0772	0.0722	0.0721	0.0897	0.0234
Electricity, steam, and hot water supply	0.0715	0.0708	0.0832	0.0931	0.0953	0.1134	0.1283	0.1260	0.1421	0.1607	0.0306
Gas and gas supply	0.0266	0.0216	0.0303	0.0341	0.0496	0.0804	0.0915	0.0950	0.0997	0.1285	0.0377
Collection, purification, and distribution of water	0.0724	0.0742	0.0828	0.1081	0.1157	0.1261	0.1269	0.1314	0.1288	0.1532	0.0272
Construction site and civil engineering	0.1405	0.1357	0.1476	0.1345	0.1455	0.1441	0.1217	0.1205	0.1278	0.1258	0.0100
Construction installation & other construction	0.1877	0.1899	0.2070	0.2281	0.2260	0.2494	0.2404	0.2449	0.2503	0.2523	0.0247
Cross-sectoral Std. Dev.	0.1211	0.1131	0.1402	0.1366	0.1280	0.1669	0.1667	0.1754	0.1672	0.1791	

Source: Own illustration. Data: FSO, revised input-output tables (1995-2004).

Appendix 5: Correlation per Sector

Sector	ln*POS* with ln*HPS*	ln*POM* with ln*HPM*
1	0.9316	0.6367
2	0.7974	0.1888
3	0.9743	0.4938
4	0.8660	-0.6270
5	0.3774	-0.2668
6	0.7975	0.5548
7	0.8414	-0.3938
8	0.9555	-0.3943
9	0.9109	0.0625
10	0.8534	0.4093
11	0.9142	0.4707
12	0.9732	0.8299
13	0.8915	0.7139
14	0.8856	0.1969
15	0.8932	0.8416
16	0.9300	0.5367
17	0.8412	-0.2155
18	-0.0699	-0.6444
19	0.8826	0.4941
20	0.9802	0.7943
21	0.9711	-0.1708
22	0.9172	0.9690
23	0.9472	0.7441
24	0.9176	0.6081
25	0.9533	0.9161
26	0.9825	0.6371
27	0.9674	0.9607
28	0.9834	0.9814
29	0.9736	0.7621
30	0.9536	-0.4605
31	0.9789	0.9954
32	0.9203	0.7762
33	0.9869	0.9488
34	0.8916	-0.4489
35	0.5789	0.7683
36	0.8838	-0.9230
overall	0.8933	-0.0145

Appendix 6: Sectoral *HPS* and *HPM* Measures

	HPSit 1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	Std. Dev. over *t*	*HPMit* 1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	Std. Dev. over *t*
Food products	0.1453	0.1506	0.1523	0.1608	0.1755	0.1800	0.2023	0.2124	0.2154	0.2165	0.0286	0.4683	0.5322	0.6354	0.4693	0.4377	0.4680	0.5012	0.4993	0.5431	0.5475	0.0570
Beverages	0.3512	0.3712	0.3478	0.3584	0.3900	0.3878	0.3844	0.3947	0.3791	0.3580	0.0173	0.4940	0.4578	0.4708	0.3669	0.3491	0.4217	0.4255	0.4160	0.4576	0.4359	0.0449
Tobacco products	0.4017	0.1554	0.3882	0.4228	0.2349	0.4992	0.4992	0.4984	0.4550	0.4926	0.1195	0.3789	0.3136	0.2710	0.2101	0.4424	0.2411	0.2628	0.2667	0.2249	0.2450	0.0732
Textiles	0.0728	0.0705	0.0702	0.0769	0.0779	0.0777	0.0810	0.0912	0.0819	0.0844	0.0065	0.6177	0.6605	0.6824	0.5484	0.5259	0.4503	0.4566	0.4591	0.4572	0.4424	0.0931
Wearing apparel, dressing, and dying of fur	0.0602	0.0616	0.0615	0.0568	0.0605	0.0546	0.0600	0.0665	0.0542	0.0595	0.0036	0.3897	0.2682	0.2782	0.2250	0.2698	0.3002	0.2890	0.2914	0.2648	0.2746	0.0421
Leather, leather products, and footwear	0.0398	0.0402	0.0461	0.0402	0.0402	0.0406	0.0477	0.0478	0.0401	0.0427	0.0033	0.2574	0.2141	0.1875	0.2198	0.2453	0.2672	0.3203	0.3175	0.2533	0.2900	0.0435
Wood and products of wood and cork	0.1051	0.0993	0.0979	0.1008	0.1175	0.1185	0.1127	0.1108	0.1072	0.1091	0.0072	0.7464	0.6791	0.7560	0.6328	0.6648	0.6588	0.6526	0.6595	0.6011	0.6434	0.0480
Pulp and paper	0.0640	0.0600	0.0647	0.0715	0.0803	0.0922	0.0863	0.0917	0.0918	0.0944	0.0135	0.5230	0.5820	0.7762	0.3977	0.4825	0.4558	0.4526	0.4464	0.4714	0.4816	0.1065
Paper products	0.0788	0.0771	0.0802	0.0826	0.0880	0.0930	0.0954	0.1014	0.1032	0.1083	0.0111	0.6216	0.6300	0.7964	0.5352	0.5625	0.6278	0.6423	0.6220	0.6007	0.6190	0.0686
Publishing	0.3922	0.4220	0.4042	0.4666	0.4900	0.4659	0.4635	0.4783	0.4920	0.5153	0.0402	0.3499	0.3516	0.4092	0.3673	0.4383	0.4579	0.4324	0.4181	0.3616	0.3460	0.0423
Printing	0.1271	0.1328	0.1272	0.1413	0.1521	0.1484	0.1566	0.1735	0.1649	0.1691	0.0170	0.5407	0.5009	0.5105	0.4573	0.4992	0.5304	0.5547	0.5520	0.4906	0.5010	0.0306
Coke, refined petroleum products, and nuclear fuel	0.3892	0.3877	0.3622	0.2839	0.3296	0.1969	0.1814	0.2345	0.3102	0.3128	0.0745	0.6908	0.5966	0.5236	0.2464	0.4505	0.7236	0.5670	0.5273	0.8808	1.1540	0.2485
Pharmaceuticals	0.1299	0.1378	0.1458	0.1993	0.2023	0.2021	0.1864	0.1950	0.2697	0.2597	0.0470	0.2981	0.3124	0.4616	0.2221	0.1995	0.3894	0.5055	0.4458	0.2944	0.4941	0.1119
Chemicals exluding pharmaceuticals	0.0993	0.1014	0.1017	0.1081	0.1216	0.1254	0.1212	0.1276	0.1321	0.1423	0.0147	0.4393	0.7112	0.9651	0.5409	0.5297	0.5610	0.5729	0.5928	0.6066	0.6332	0.1418
Rubber products	0.1131	0.1129	0.1209	0.1387	0.1462	0.1595	0.1518	0.1439	0.1605	0.1668	0.0198	0.4133	0.3802	0.4317	0.4080	0.3989	0.4965	0.4898	0.4905	0.4715	0.4783	0.0440
Plastic products	0.1169	0.1241	0.1325	0.1430	0.1612	0.1614	0.1600	0.1682	0.1631	0.1752	0.0200	0.4795	0.4425	0.4995	0.4337	0.4277	0.4937	0.4720	0.4955	0.4918	0.5478	0.0363
Glass and glass products	0.2049	0.1953	0.1974	0.2037	0.2227	0.2320	0.2295	0.2341	0.2416	0.2490	0.0193	0.4367	0.4471	0.5062	0.4184	0.4083	0.4582	0.4446	0.4487	0.3915	0.3982	0.0338
Ceramic goods & other non-metallic mineral products	0.2616	0.2581	0.2484	0.2515	0.2796	0.2588	0.2390	0.2454	0.2415	0.2430	0.0122	0.6800	0.6343	0.6075	0.5442	0.5586	0.5660	0.5266	0.5258	0.4892	0.5180	0.0589
Iron and steel	0.0377	0.0386	0.0404	0.0460	0.0435	0.0461	0.0484	0.0460	0.0517	0.0585	0.0063	0.8068	1.0116	1.3028	0.8240	0.6289	0.7738	0.7859	0.8045	0.7937	0.9882	0.1862
Non-ferrous metals	0.0399	0.0415	0.0449	0.0532	0.0576	0.0667	0.0660	0.0681	0.0658	0.0707	0.0118	0.2854	0.3552	0.4604	0.3181	0.3834	0.4616	0.4500	0.4131	0.4234	0.4778	0.0656
Metal castings	0.0688	0.0664	0.0748	0.0901	0.0941	0.0997	0.0962	0.1037	0.1138	0.1309	0.0202	0.4456	0.6811	1.0178	0.5712	0.5485	0.5419	0.5344	0.4961	0.4807	0.5158	0.1652
Fabricated metal products, excl. machinery & equip.	0.0923	0.0984	0.0931	0.1065	0.1156	0.1153	0.1188	0.1225	0.1301	0.1326	0.0145	0.5358	0.5285	0.5230	0.5531	0.5529	0.5771	0.5824	0.5802	0.6006	0.6474	0.0378
Machinery and equipment, n.e.c.	0.1036	0.1166	0.1130	0.1304	0.1403	0.1444	0.1576	0.1668	0.1804	0.1856	0.0285	0.4697	0.4922	0.4534	0.4712	0.4646	0.4789	0.5035	0.4927	0.5249	0.5589	0.0317
Office, accounting, and computing machinery	0.1398	0.1300	0.1366	0.1580	0.1417	0.2074	0.2075	0.1927	0.1832	0.1588	0.0298	0.0883	0.1125	0.1228	0.2828	0.3262	0.2798	0.2343	0.2323	0.1937	0.1726	0.0803
Electrical machinery and apparaturs, n.e.c.	0.1016	0.1116	0.1119	0.1316	0.1391	0.1254	0.1630	0.1800	0.1876	0.1973	0.0346	0.4264	0.4279	0.4695	0.4987	0.5117	0.5030	0.5677	0.5301	0.5005	0.5631	0.0485
Radio, television, and communication equipment	0.1201	0.1298	0.1330	0.1328	0.1770	0.2119	0.2318	0.2390	0.2456	0.2317	0.0521	0.1384	0.1141	0.1287	0.2295	0.3654	0.2809	0.2238	0.2059	0.2389	0.2550	0.0767
Medical, precision, and optical instruments	0.1296	0.1398	0.1447	0.1737	0.1893	0.2048	0.2125	0.2295	0.2416	0.2285	0.0407	0.3116	0.2954	0.3513	0.3110	0.3557	0.3999	0.4133	0.4036	0.4501	0.4484	0.0571
Motor vehicles, trailers, and semi-trailers	0.0447	0.0585	0.0566	0.0734	0.0915	0.1003	0.0989	0.0969	0.0857	0.0920	0.0202	0.2604	0.3612	0.4347	0.4511	0.5183	0.6017	0.6409	0.6484	0.6323	0.6898	0.1429
Other transport equipment	0.0869	0.1118	0.1054	0.1179	0.1231	0.1361	0.1557	0.1581	0.1574	0.1521	0.0252	0.2692	0.3414	0.3733	0.3919	0.2857	0.3711	0.4346	0.4544	0.4914	0.4626	0.0746
Manufacturing n.e.c.	0.1143	0.1177	0.1158	0.1276	0.1385	0.1410	0.1424	0.1411	0.1355	0.1406	0.0115	0.4112	0.3664	0.3858	0.3660	0.3914	0.3976	0.3779	0.3681	0.3214	0.3428	0.0264
Recycling	0.0901	0.0913	0.1205	0.1276	0.1118	0.1867	0.2048	0.2136	0.2131	0.2558	0.0597	0.2083	0.2048	0.3271	0.3049	0.2718	0.5963	0.6238	0.6322	0.5702	0.7330	0.2016
Electricity, steam, and hot water supply	0.2250	0.2436	0.2415	0.2837	0.3021	0.2676	0.2939	0.2630	0.2446	0.2522	0.0251	0.3275	0.3462	0.3580	0.4931	0.4994	0.4286	0.4448	0.4375	0.4628	0.5655	0.0751
Gas and gas supply	0.1866	0.1702	0.1973	0.2259	0.3303	0.3976	0.4083	0.4022	0.4153	0.4566	0.1118	0.3311	0.2990	0.3711	0.3186	0.3610	0.4411	0.4313	0.4388	0.4275	0.4793	0.0616
Collection, purification, and distribution of water	0.1923	0.2011	0.1911	0.2403	0.2679	0.2427	0.2286	0.2287	0.2197	0.2444	0.0250	0.7198	0.7532	0.7351	0.8189	0.8288	0.6846	0.6137	0.6166	0.6127	0.6889	0.0796
Construction site and civil engineering	0.2232	0.2369	0.2373	0.2362	0.2656	0.2643	0.2278	0.2222	0.2271	0.2152	0.0170	0.9358	0.9159	0.8871	0.7365	0.8037	0.6912	0.6036	0.6163	0.6167	0.5801	0.1383
Construction installation & other construction	0.0994	0.1119	0.1070	0.1216	0.1248	0.1254	0.1243	0.1327	0.1305	0.1338	0.0114	0.6372	0.6313	0.6252	0.6097	0.6009	0.5698	0.5539	0.5511	0.5493	0.5416	0.0377
Cross-sectoral Std. Dev.	0.1012	0.0943	0.0973	0.1017	0.1030	0.1112	0.1103	0.1101	0.1109	0.1156		0.1900	0.2073	0.2525	0.1615	0.1409	0.1318	0.1246	0.1276	0.1503	0.1908	

Source: Own illustration. Data: FSO, revised input-output tables (1995-2004).

Appendix 7: Correlation Matrix (without Outliers)

	$\ln Y_t$	$\ln Y_{t-1}$	$\ln w_t$	$\ln w_t$	$\ln DOS_t$	$\ln DOS_{t-1}$	$\ln POS_t$	$\ln POS_{t-1}$	$lnDOM_t$	$\ln DOM_{t-1}$	$\ln POM_t$	$\ln POM_{t-1}$	$\ln HPS_t$	$\ln HPS_{t-1}$	$\ln HPM_t$	$\ln HPM_{t-1}$
$\ln Y_t$	1.0000															
$\ln Y_{t-1}$	0.9954	1.0000														
$\ln w_t$	0.1384	0.1273	1.0000													
$\ln w_{t-1}$	0.1376	0.1266	0.9730	1.0000												
$\ln DOS_t$	-0.1061	-0.1076	0.3451	0.3467	1.0000											
$\ln DOS_{t-1}$	-0.0989	-0.0931	0.3468	0.3487	0.9022	1.0000										
$\ln POS_t$	-0.1290	-0.1248	0.1880	0.1873	0.7107	0.6914	1.0000									
$\ln POS_{t-1}$	-0.1218	-0.1091	0.1917	0.1885	0.7012	0.7008	0.9681	1.0000								
$\ln DOM_t$	0.1528	0.1444	0.1527	0.1477	-0.1105	-0.1195	-0.3175	-0.2813	1.0000							
$\ln DOM_{t-1}$	0.1321	0.1389	0.1391	0.1312	-0.1526	-0.1286	-0.3393	-0.2856	0.9356	1.0000						
$\ln POM_t$	0.0944	0.0805	0.1146	0.1046	-0.2068	-0.2092	-0.4373	-0.4053	0.8895	0.8670	1.0000					
$\ln POM_{t-1}$	0.0953	0.0929	0.0968	0.0788	-0.2270	-0.2196	-0.4556	-0.4062	0.8752	0.8935	0.9752	1.0000				
$\ln HPS_t$	-0.1277	-0.1171	0.0596	0.0624	0.5926	0.5976	0.9335	0.9107	-0.4540	-0.4623	-0.5918	-0.5959	1.0000			
$\ln HPS_{t-1}$	-0.1245	-0.1087	0.0618	0.0634	0.5851	0.5858	0.9061	0.9316	-0.4344	-0.4308	-0.5717	-0.5678	0.9742	1.0000		
$\ln HPM_t$	0.3065	0.3011	-0.1663	-0.1350	-0.2953	-0.2704	-0.3135	-0.2959	-0.1674	-0.1926	-0.0441	-0.0597	-0.1964	-0.1887	1.0000	
$\ln HPM_{t-1}$	0.2916	0.2988	-0.1913	-0.1773	-0.2854	-0.2607	-0.2806	-0.2542	-0.1237	-0.1705	-0.0561	-0.0083	-0.1599	-0.1499	0.8754	1.0000

Appendix 8: Summary Statistics

Variable	Obs	Mean	Std Dev	Min	Max
$\ln L_t$	360	4.95857	1.193256	2.079442	7.375882
$\ln Y_t$	360	10.09768	1.057592	7.352441	12.43005
$\ln Y_{t-1}$	324	10.08927	1.05493	7.352441	12.37422
$\ln w_t$	360	3.684319	0.3741977	2.885917	4.724108
$\ln w_{t-1}$	324	3.677526	0.3706786	2.919391	4.724108
$\ln DOS_t$	347	-5.451265	1.188521	-9.113486	-1.56484
$\ln DOS_{t-1}$	312	-5.495673	1.196417	-9.113486	-1.56484
$\ln DOM_t$	360	-1.739417	0.7123115	-4.569239	-0.401197
$\ln DOM_{t-1}$	324	-1.777272	0.708497	-4.569239	-0.4675112
$\ln POS_t$	360	-4.923661	0.7191872	-6.545177	-2.792723
$\ln POS_{t-1}$	324	-4.942728	0.7196687	-6.545177	-2.792723
$\ln POM_t$	360	-1.545565	0.6845935	-3.832979	-0.3364642
$\ln POM_{t-1}$	324	-1.580076	0.6828826	-3.832979	-.3364642
$\ln (IM/Y)_t$	330	-1.291672	1.220144	-4.816542	0.9946187
$\ln (IM/Y)_{t-1}$	297	-1.307515	1.223805	-4.814771	0.9946187

Appendix 9: Data

The empirical analysis covers ten observations over time for 36 manufacturing industries which leads to a total number of 360 observations per variable. Input-output data at current prices is used to calculate *offshoring intensities DOS, DOM, POS* and *POM* as well as domestic outsourcing intensities *HPS* and *HPM*. German input-output tables are disaggregated to 71 sectors following the three-digit and, for some sectors, the four-digit NACE Rev. 1.1 classification (German Federal Statistical Office: revised input-output tables 1995 to 2004 in current prices; Fachserie 18 Reihe 2). *Gross output data Y* is retrieved from the input-output tables. We calculated real output using sectoral producer price indices from the German Federal Statistical Office.[10] *Labor demand* is mapped using sectoral employment data from the input-output tables. The number of employees is preferred to the number of total employment. The latter considers all persons that are engaged in domestic production of a country, whereas the former excludes self-employed an unpaid family workers and better reflects the workforce of companies that is exposed to layoffs due to offshoring.

Sector-specific labor compensation of employees is used as a measure for disaggregated *wages w* and is retrieved from the OECD STAN Industrial Database based on Federal Statistical Office data. Labor compensation consists of annual wages and salaries of employees at a sectoral level paid by producers as well as supplements such as contributions to social security, private pensions, health insurance, life insurance and similar schemes. Labor compensation instead of gross wages and salaries is chosen, since labor demand is rather driven by a firm's entire labor costs. Some sectors only have wage data available at a more aggregated level. Therefore, disaggregation is acquired weighting the wage data by its sectoral output share.[11] The data is divided by the respective sectoral employment to calculate average annual labor compensation per employee. As labor demand depends on *real wages*, an appropriate price index is needed. Therefore, sectoral producer price indices from the Federal Statistical Office are used, since producer prices rather than consumer prices matter.

[10] Producer price indices are available at several aggregation levels (28, 107 and 225 sectors). Since some producer prices at the required input-output aggregation level were not available, we used producer prices of more disaggregated sectors (within the same industry) as a proxy, because similar price trends can be expected there. This procedure was also done in cases where years were missing.

[11] Wage data, e.g., are only available for the aggregated sector 'food products and beverages'. The wages of the aggregated sector are weighted with the respective output shares of the single sectors 'food products' and 'beverages' in order to achieve more disaggregated sectoral wages. This procedure was done eight times in the following sectors: 1-2; 8-9; 10-11; 15-16; 17-18; 19-21; 32-33 and 35-36.