Offshoring and productivity (growth) in Dutch manufacturing and service industries: An empirical assessment

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Explanation of symbols

.	= data not available
*	= provisional figure
x	= publication prohibited (confidential figure)
–	= nil or less than half of unit concerned
–	= (between two figures) inclusive
0 (0,0)	= less than half of unit concerned
blank	= not applicable
2007–2008	= 2007 to 2008 inclusive
2007/2008	= average of 2007 up to and including 2008
2007/'08	= crop year, financial year, school year etc. beginning in 2007 and ending in 2008
2005/'06–2007/'08	= crop year, financial year, etc. 2005/'06 to 2007/'08 inclusive

Due to rounding, some totals may not correspond with the sum of the separate figures.

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Offshoring and productivity (growth) in Dutch manufacturing and service industries: An empirical assessment[1]

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Abstract

Although, many studies have looked at a direct relationship between offshoring and productivity (growth), the effect of competition on the output market as an additional mechanism has been rarely addressed in empirical studies. Companies operate in an environment with different degrees of competition, which might be related to the amount of offshoring they carry out as well as their productivity performance. Two main results emerge. First, on the basis of a decomposition analysis, we find that for manufacturing sectors gains in output productivity growth were caused by faster growth in intermediate imports offsetting negative contribution of growth rates of labor. Secondly, our analysis suggests that offshoring of services have a positive impact on industrial TFP growth. These results are also confirmed for offshoring, under form of vertical specialization, of services and manufacturing on the TFP growth of service sectors. We considered various specifications of the empirical model. Finally, we find evidence that offshoring compresses competition. This can be explained by the fact that, given output prices, lower production costs lead to higher price cost margins.

1. Introduction

Offshoring is typically assumed to improve productivity by increasing the efficiency with which inputs are used (Olsen, 2006). Economies are increasingly exposed to foreign influences. Relocating part of a production process abroad can boost productivity growth at home, since this allows producers to specialize in activities in which they are relatively efficient or for which the factors of production are abundantly present. For instance, manufacturers might offshore activities to foreign contractors with greater expertise in these areas (Houseman, 2007). A recent survey on international

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sourcing in Denmark, Sweden, Finland, Norway and the Netherlands suggest that saving costs as an efficiency seeking factor is the key driver for sourcing production or support functions abroad. Over half of the enterprises in these countries saw this as an important motivation (Statistics Denmark et al., 2008). The data also reveal that reducing labor costs is the main motivation. When manufacturers engage in offshoring activities, it is expected that they merely substitute imported materials or service inputs for their own labor and other inputs. While reinforcing the concerns about labor displacement implications, a better matching of the labor supply may also increase the efficiency of domestic inputs used.

While the above cited studies give us more insights into the overall economic rationale for engaging in offshoring, the aim of this chapter is to investigate the relationship between offshoring and total factor productivity (TFP) growth. How do imports of intermediate goods and services influence productivity growth? For a small open economy such as the Netherlands, do price-cost margins exert an important role in this influence? Which other patterns can be identified? These are the main questions that are addressed in the paper, however, there are some potential issues, related to measurement and methodological issues, that need further investigation. Our objectives are to explore these issues. We proceed in four steps.

The *first* problem is a fundamental methodological issue concerning the measurement of productivity growth. Studies that look at the empirical evidence on "offshoring" determinants of productivity growth usually assume a neoclassical framework whereby a number of important aspects that might contribute to productivity growth might be overlooked. To be in conformity with ongoing research, we find that the assumption of perfect competition is violated for many Dutch industries. We therefore propose a new index approach that measures productivity growth allowing for (time-varying) and sector-specific markups. Hence the productivity approach that we adopt in this paper eliminates any possible bias in the relationship between intermediate imports, offshoring and productivity.

Secondly, output growth, as a source of productivity growth, is usually determined, or at least can be attributed, to various factors of production that are used as inputs in the production process. In a growth accounting framework, the most common drivers to output growth are capital, labour, intermediate inputs, technology and total factor productivity (TFP) growth. TFP growth, referred to as the Solow residual, measures the change of output that can be explained by all other factors that are not explicitly subsumed in the production process. In a study based on annual EUKLEMS data of three small European countries: Austria, Belgium and the Netherlands, Kegels et al. (2008) show that the average annual output growth rate (measured in value-added GDP) has increased over the period 1970-2005. However, the growth performance was noticeably lower from 1995-2005 than from 1970-1995. Looking at sources of productivity growth, this slowdown in productivity growth has been primarily caused by more labour (hours worked) intensive growth caused by lower levels of unemployment and higher participation rates.

At the meso-level (industries), the amount of intermediate inputs imported is an indication of the extent to which production processes are internationally fragmented (see the work of Grossman and Rossi-Hansberg (2006), OECD (2008) and Houseman (2007) for recent applications). The recognition that the amount of intermediate inputs imported from abroad as an indication of international linkages of the production process, enables us to identify how much the growth of imported intermediate inputs contributes to productivity growth. In the *second* part of the paper, we therefore perform a decomposition analysis. Through this exercise, we can derive how much the growth rate of intermediate imports improves productivity and how it increases the efficiency with which the other inputs are used. For instance, available evidence for the USA suggest that faster growth rates of imported intermediates do indeed offset the negative contributions of capital and labor volume growth (Houseman, 2007). Yet, some other implications of offshoring can be analyzed at the meso-level. Since we focus on the impact of offshoring on TFP growth, it is also interesting to look into movements of imports of intermediate goods and TFP and their contribution to output growth whereby, for instance, TFP growth speed ups exhibit parallel increases with the growth of intermediate goods and services.

The *third* issue is conceptually and relates to a broad definition of offshoring. The OECD defines offshoring as activities where the production of goods or services is partially or totally transferred abroad to affiliated (within the same enterprise group) or non-affiliated enterprises (OECD, 2007). Substituting part of domestic production for intermediate inputs from abroad (either from a foreign affiliate or not) can be thought of as an offshoring activity. Empirical literature broadly identifies two types of offshoring indicators: (i) those constructed from the intermediate imports and (ii) those based on vertical specialization. We will introduce two offshoring indicators for each type. The first set of indicators is calculated on the basis of intermediate imports over total intermediate costs. The second set of indicators can be measured as the share of intermediate imports used in the production of exports. The difference between the two sets of indicators is that the former merely looks at the imports side while the latter also takes into account the export side. These indicators were constructed using data from symmetric input-output tables for the period 1989-2005, as released by Statistics Netherlands (see data appendix). Input-output tables distinguish the imported and domestic content of inter-industry transactions of goods and services, which allows us to quantify the extent of intermediate and service offshoring on the part of manufacturing and service industries.

As a *last* issue we ask whether offshoring increases productivity indirectly through markups? This hypothesis is actually also found in Kim (2000). Kim empirically suggests that TFP growth is *primarily* caused by lower markups.

Increased competition in the import market has some impact, but overall Kim argues that it was not the major force. We adopt a similar empirical approach where the interaction between markups and offshoring indicators is allowed in the model. Although, one shortcoming in that paper, which we address and relax, is that the assumption of a time-constant and industry-homogenous markups.

While the competition-productivity relationship is well established in the empirical literature (e.g., Nickell. 1996), the markups-offshoring relationship fits the relatively small strand of empirical literature that investigates the "imports-to-market-discipline" (IMD) hypothesis. Supported by the empirical literature (e.g., Levinsohn, 1993), the IMD hypothesis confirms that increased import competition (mainly due to increased trade liberalization) results into more competitive pressure. One source of ambiguity in this hypothesis is the broad concept of imports whereby no distinction is made between intermediate and final goods. This ambiguity is further explored by Egger and Egger (2004), Amiti and Konings (2005) and Abraham et al. (2006) and also addressed in this paper. These three studies provide robust evidence that intermediate imports have a *positive* influence on markups because "imported intermediates lower total costs and thus increase the markup, *all else equal*" (Amiti and Konings, 2005).

A second source of ambiguity is that while the effects of offshoring on productivity growth are quite intuitive according to these latter studies, it can also be argued that the impact of offshoring on productivity is given *indirectly* via a *reduction* in price cost margins (lower markups). Fixler and Siegler (1999) lay out the situation that the propensity to engage in offshoring is mainly generated through cost advantages. In particular, the authors show in a simple model that a firm will outsource to take advantage of cost differentials measured by marginal costs. In Bernard et al.'s (2003) model the impact of trade reforms on productivity is given via a reduction in the price of intermediate inputs (e.g. cheaper and higher quality imported inputs replace domestic one). In this case, the beneficial effect from intermediate input price reductions to lower markups lead to market reallocations from less productive to more productive firms, and the exit of the least productive ones.

2. TFP growth and markups

In the *first* section, we begin by deriving the markup measure in a framework that accommodates a broad range of underlying production structures. The markup is measured as the scale elasticity times the ratio of output over (multiple) inputs. We allow the markup to vary over time. The methodology for deriving the markup measures, in a general setting (employing any specification on the production function), is adopted from Amoroso et al. (2009). However, here we assume that the structure of the production function can be approximated by a translog (flexible) functional form. We also set up a simple methodology for calculating the markups. In section 2.2., we present the *index number approach* to the measurement of productivity growth taking time-varying market power and economies of scale into account. It involves dividing a (real) *output quantity index*, or the ratio between two outputs at two different time periods in case of one single output, by an *input quantity index* to obtain a measure of TFP growth[2]. We note that in this approach, the underlying production technology must have a flexible (e.g. translog) functional form.

2.1 Derivation of time-varying markups

This section extends Amoroso et al. (2009)[3]. In particular, we let each firm (industry) $i \in \{1,....N\}$ face the following production function for period t :

(1) $$y_{it} = a_{it} f_i(\mathbf{x_{it}}) \qquad i = 1,2,....N \; ; \; t = 0,....,T$$

where y_{it} measures firm i's gross output, $\mathbf{x_{it}} \equiv (x_{i1t}, x_{i2t},...., x_{iJ_it})'$ denotes the vector of J_i non-negative factor inputs, $f_i(\cdot)$ is the core of the (differentiable) production function and a_{it} is TFP measured as Hicks-neutral disembodied technical change.

We can write firm i's profit optimization problem as follows:

(2) $$\max_{\mathbf{x_{it}}} \; p_{it}(y_{it})y_{it} - \mathbf{w'_{it}}\mathbf{x_{it}} \; : \; y_{it} = a_{it} f_i(\mathbf{x_{it}})$$

and $\mathbf{w_{it}} \equiv (w_{i1t}, w_{i2t},....., w_{iJ_it})'$ is the sector's vector of J_i input prices, and $p_{it}(y_{it})$ is the inverse demand function which represents the market price as a function of the industry output. The first order conditions implied by (2) yield the following equations:

(3) $$p_{it}(y_{it}) + \frac{\partial p_{it}(y_{it})}{\partial y_{it}} y_{it} = c_{it} \text{ and}$$

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2 Under perfect competition on the input markets, the input quantity index is a function of the input prices and quantities for the two periods under consideration (Laspeyres, Paasche, Fisher's ideal quantity index being the square root of the product of the Laspeyres and Paasche quantity indexes, and Törnqvist's (1936) quantity index).

3 In this paper, we assume market imperfection in the output market. In Amoroso et al. (2009), we extend this approach by assuming: market friction in the labour market and (ii) Cournot competition by imposing that the inverse demand function is $p_{it}(y_t)$; that is, the market price as a function of the aggregate industry output.

$$\left[p_{it}(y_{it})+y_{it}\frac{\partial p_{it}(y_{it})}{\partial y_{it}}\right]\frac{\partial y_{it}}{\partial \mathbf{x}_{\mathbf{it}}}=\mathbf{w}_{\mathbf{it}}$$

where c_{it} are the marginal costs. Note that in case of perfect competition $\partial p_{it}/\partial y_{it}$ goes to zero, implying that prices are set at marginal costs and inputs are paid their marginal products. For firm *i* the first order condition with respect to output (3) can be rewritten as:

$$(4) \qquad \frac{p_{it}(y_{it})-c_{it}}{p_{it}(y_{it})}=-\frac{\partial p_{it}(y_{it})}{\partial y_{it}}\frac{y_{it}}{p_{it}},$$

or the Lerner index as a measure of a monopolist's market power is inversely related to the price elasticity of market demand,

$$(5) \qquad L_{it}=\frac{1}{\varepsilon_{it}},$$

where $\varepsilon_{it}\equiv-\frac{\partial y_{it}}{\partial p_{it}(y_{it})}\frac{p_{it}(y_{it})}{y_{it}}$ is firm *i* 's elasticity of demand with respect to price and $L_{it}\equiv\frac{p_{it}(y_{it})-c_{it}}{p_{it}(y_{it})}$ is firm *i* 's Lerner index or Price Cost Margin (PCM). The Lerner index is defined in the range of $0\leq L_{it}=\frac{1}{\varepsilon_{it}}\leq 1$. Note that the markup ratio (μ_{it}), which we define as the ratio of product price over production cost can easily be related to the Lerner index.

$$(6) \qquad \mu_{it}\equiv p_{it}/c_{it}=1/(1-L_{it})\geq 1$$

From (4) and (5) we obtain that the last equality in (3) can be rewritten as:

$$\mathbf{w}_{\mathbf{it}}=\frac{\partial y_{it}}{\partial \mathbf{x}_{\mathbf{it}}}p_{it}(y_{it})[1-L_{it}],$$

or for any individual input factor $k\in J_i$:

$$(7) \qquad \frac{\partial \ln y_{it}}{\partial \ln x_{ikt}}\frac{y_{it}}{x_{ikt}}p_{it}(y_{it})[1-L_{it}]=w_{ikt}:k=1,2,....,J_i\ ;\ t=0,....,T$$

$$\frac{\partial \ln y_{it}}{\partial \ln x_{ikt}}=\frac{1}{[1-L_{it}]}\frac{w_{ikt}x_{ikt}}{y_{it}p_{it}(y_{it})}=\mu_{it}s_{ikt},$$

where s_{ikt} denotes the share of input *k* in the total production value of firm *i*, or $s_{ikt}\equiv w_{ikt}x_{ikt}/[y_{it}p_{it}(y_{it})]$ so that firm *i*'s factor input share can be written as

(8) $$s_{kt} = \sum_{k=1}^{J_i} s_{ikt} = \mathbf{w}'_{\mathbf{it}}\mathbf{x}_{\mathbf{it}} / [y_{it} p_{it}(y_{it})]$$

In the last equality of equation (a6a), the output elasticity of any individual input *k* can be expressed as a partial scale elasticity under the standard homogeneity assumption (see e.g., Chambers, 1988). Summing over all partial elasticities of scale, θ_{ikt},:

(9) $$\theta_{it} \equiv \sum_{k=1}^{J_i} \frac{\partial y_{it}}{\partial x_{ikt}} \frac{x_{ikt}}{y_{it}} = \sum_{k=1}^{J_i} \theta_{ikt},$$

where θ_{it} is the returns to scale parameter. Using the last equality of equation (7) and taking into account of (8), the time-varying markup in (6) can be rewritten as the ratio between the time-varying, input-dependent elasticity of scale and the total (observable with data) input share:

(10) $$\mu_{it} = \frac{y_{it} p_{it}(y_{it})}{\mathbf{w}'_{\mathbf{it}}\mathbf{x}_{\mathbf{it}}} \theta_{it}$$

There are three important features of the markup involved in (10): (i) it allows for variable, time-varying returns to scale, (ii) the markup measure is allowed to vary over time[4], (iii) the output-input share can be reliable observed with data.

In order to determine equation (10), there is a range of methodologies from which we can select. First, on the assumption that once an estimate for the returns to scale parameter θ_{it} is obtained, an estimate for the period *t* markup, μ_{it} can be obtained using equation (10). In this framework, there are two methods for estimating the scale parameters. The first (standard) method is simply to estimate a (flexible) translog production function. Alternatively, the translog assumption of the production form fits the index number approach developed in Nakajima et al. (1998) for estimating the returns to scale parameter[5]. This method overcomes potential multicollinearity problems that may be inherent with estimating a translog production function. On the other hand, we can select various approaches that measure (econometrically) the markups μ_{it} directly from which the scale elasticities can be unique determined according to equation (10). For example, the so called primal (see Hall, 1990) and dual approach (see Roegers, 1995), allows us to obtain an estimate of the markups (or Lerner indices) directly. While the above mentioned methods rely on various assumptions on the relationship between outputs and inputs, the theoretical validation of these methods are quite robust in the literature. Nevertheless in various experiments, we encounter some problems that are

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[4]See Amoroso *et al*. (2009) for an overview of literature that criticizes the assumption of constant markups.

[5]Consistent with the index number approach for estimating the returns to scale parameter, the authors derive the following panel equation, $\Delta \ln y_{it} = a_{it} + \theta_{it} \Delta \ln \mathbf{x}_{it} + \varepsilon_{it}$, where each of the variables are consistent with those used in the text.

inherent to the cyclicality of the markup and the scale elasticities when using *industry* data in a relative short time span with many industry sectors[6].

Instead, we are going to apply equation (10) directly on yearly industry data based on a unique data set of time series of Dutch input-output tables for the sample period 1987-2005 (see appendix for a description of the data). Note that in equation (10), the markup μ_{it} of each industry can be derived from the Lerner index l_{it} and the corresponding profit-output ratio[7]:

$$(11) \qquad l_{it} = \frac{y_{it}}{y_{it}} \frac{p_{it} - c_{it}}{p_{it}} = \frac{p_{it} y_{it} - \mathbf{w}_{\mathbf{it}}^{'} \mathbf{x}_{\mathbf{it}} \frac{1}{\theta_{it}}}{p_{it} y_{it}}$$

$$= \frac{\pi_{it}}{p_{it} y_{it}}$$

This empirical implementation is motivated by the Statistics Netherlands' National Accounting system of supply and use tables where the cost of capital input is computed using an exogenous interest rate (see Balk and van den Bergen, 2007). The theoretical underpinnings of using an exogenous interest rate ensures that the restriction of constant returns to scale, perfect competition and hence that profits equals zero, is not satisfied (Balk, 2008). In essence, it turns out that the profits π_{it} in equation (11) can be simply computed by subtracting the user cost of capital from the gross operating surplus and wages of self-employed (Statistics Netherlands, 2007)[8].

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6 In particular, with the translog production function (time-series, panel), we were unable to obtain reliable estimates for returns to scale due to the multicollinarity problem. Alternatively, using the index number approach requires some assumptions on the time-varying scale coefficient, θ_{it}, when using industry-specific data. The estimated value of the time-varying scale parameter θ_{it} can be computed by assuming general second-order polynomials in time as, $\theta_{it} = \gamma_{i0} + \gamma_{i1} t + \gamma_{i2} t^2 + \gamma_{i3} t^3$. Applying GMM panel data estimation we obtained scale coefficients between .5 and .8 which would be too unrealistic with comparable findings. In addition, the Hall and Roeger's econometric equations are orginally derived from a Cobb-Douglas representation assuming constant markups.

7 Under the assumption that $c_{it} y_{it} = \frac{\mathbf{w}_{it} \mathbf{x}_{it}}{\theta_{it}}$

8 The effect of assumptions of competition based on endogenous or exogenous rates of return has already been empirically addressed in Schreyer (2003), Balk (2008) and van den Bergen et al. (2007). In general, these studies show that assumptions about perfect foresight (endogenous interest rates), and hence perfect competition yield a substantial variability over industries and time of the *TFP* growth measure.

2.2 Productivity growth

A reasonable and general assumption is to impose that $f_i(\cdot)$ can be approximated by a translog (flexible) functional form, which implies a second-order approximation to any arbitrary twice-differentiable production function.

With the translog (flexible) functional form assumption we can apply Diewert's (1976, p.118) quadratic approximation identity lemma to expression (1), relating differences in the firm's production between period *t* and some base period 0 as:

$$(12) \qquad \Delta \ln y_{it} \equiv \ln f_i(\mathbf{x_{it}}) - \ln f_i(\mathbf{x_{i0}}) + \Delta \ln a_{it}$$

$$= \frac{1}{2}\sum_{k=1}^{J_i}\left[\frac{\partial \ln f_i(\mathbf{x_{it}})}{\partial \ln x_{ikt}} + \frac{\partial \ln f_i(\mathbf{x_{i0}})}{\partial \ln x_{ik}}\right]\left[\ln x_{ikt} - \ln x_{ik0}\right] + \Delta \ln a_{it}$$

Substituting the last equality of equation (7) into equation (12) yields:

$$(13) \qquad \Delta \ln y_{it} = \frac{1}{2}\sum_{k=1}^{J_i}\left[\mu_{it} s_{ikt} + \mu_{i0} s_{ik0}\right]\Delta \ln x_{ikt} + \Delta \ln a_{it}$$

where the markup ratio, μ_{it} may vary over time and $\Delta \ln a_{it}$ is the TFP expressed as an index of technical change which is measured by the difference between the relative change in real outputs and the relative changes in inputs. The technical change index is *exact* if the right-hand side of the second line in equation (13) can be represented by observable data. An important issue is that in this latter case, equation (13) represents a more appropriate measurement of TFPG. We use gross output as a measure of output and relate it to three inputs: capital (*k*), labor (*l*), domestic consumption of imported goods (*m*) and services and imported consumption of intermediate goods and services (*m**).

Considering two consecutive periods, equation (13) can then be rewritten as,

$$(14) \qquad \Delta \ln y_{it} = \frac{1}{2}\left(\mu_{it} s_{ilt} + \mu_{i,t-1} s_{il,t-1}\right)\Delta \ln l_{it}$$

$$+ \frac{1}{2}\left(\mu_{it} s_{idmt} + \mu_{i,t-1} s_{idm,t-1}\right)\Delta \ln m_{it}$$

$$+ \frac{1}{2}\left(\mu_{it} s_{ifmt} + \mu_{i,t-1} s^{*}_{ifm,t-1}\right)\Delta \ln m^{*}_{it}$$

$$+ \frac{1}{2}\left(\mu_{it} s_{ikt} + \mu_{i,t-1} s_{ik,t-1}\right)\Delta \ln k_{it}$$

$$+ \Delta \ln a_{it}$$

where s_l, s_k, s_{dm} and s_{fm} are the labor, capital and domestic and imported intermediate input shares in total output respectively. Equation (14), representing the TFP index, depends on market power. Note that if market power exists (i.e. μ_{it} > 1), this changes the effects of factor inputs. Hence, the assumption of perfect markets that is usually maintained in such measures could lead to potential biases. The way that TFP growth is affected by relaxing the assumption of perfect competition ($\mu_{it} \neq 1$) depends on the variability of industries' inputs and the correlation with their market power. Under the assumption that all inputs have positive growth rates, Harrison (1994), Hall (1990) and Kee (2004) have shown that market power and economies of scale may cause an underestimation of the Solow measure of productivity.

3 Analysis of the data

In this section, we validate our model assumptions on the data outlined in the previous section. In section 3.1, we analyze the data on the basis of a productivity decomposition method. We decompose intermediate goods and services inputs into a part that is domestically sourced and the share that is imported from abroad. This allows us to identify *possible* patterns on how "offshoring" affects productivity growth. In section 3.2., we discuss the markups for each of the 36 sectors over the period 1989-2005.

3.1 Decomposition method of productivity growth

Using equation (14), the empirical decomposition of real output growth or productivity growth for all sectors is shown in table 1a. Average growth rates for each of the output and input components are reported for the total sample period 1989-2005 (column average) and the following four sub-periods: 1989-1992, 1993-1996, 1997-2000, and 2001-2005. To understand how offshoring might affect output growth, we decompose output growth into the contribution of labor growth (measured as total hours worked), capital, purchases of intermediate goods and services (see data appendix for a description of each of the variables) and TFP growth. The intermediates' source of growth component is further broken down by intermediates purchased on the domestic market and those imported from foreign countries[9]. As noted above, TFP growth generated by equation (14) has the clean theoretical interpretation that the simplifying assumption of perfect competition in the output market is relaxed.

We see that the importance of output growth and the contributions each factor input to this growth varies notably by sector. With regard to gains in real output, our results show that output growth over the period 1989-2005 was higher in service sectors than in manufacturing. The fastest growth rates in real output

[9] In case, the foreign content of intermediate inputs are not separately recorded, the OECD (crudely) measures the imported share as the weighted sum of all intermediate inputs used in domestic production, using the import share in total production plus imports for each sector as the weights.

(ranging from 4.8% to 9.9%) are found in service sectors such as, wholesaling (NACE 51), air transport (NACE 62), post and telecommunications (NACE 64), financial intermediation (NACE 65), renting of machinery and equipment (NACE 71), computer and related activities (NACE 72) and other business activities (NACE 74). The fastest growth rate of output in manufacturing is around 3-4% in chemicals (NACE 24) and machinery and equipment (NACE 29). Output growth rates occurred during the period 1997-2001, but fell sharply in the period 2001-2005.

With regard to the factor of production inputs, respectively labor, capital, domestic and imported intermediate inputs, in general, table 1a shows that the growth in intermediate inputs and, to a lesser extent, capital was an important source to output growth. However during the decades, negative labor growth was more pronounced for the period 2001-2005 compared to the other sub-periods. For instance, for total manufacturing during 1989-2005, the growth of output of 2.641% can be decomposed (explained) by the growth in domestic intermediate inputs with .68% domestically, .82% by foreign inputs, and capital grew by .36% while the volume of labor fell with .20%.

When we focused on the differences between manufacturing and services a notable result was that in most manufacturing sectors output gains occurred when labor growth rates fell while a considerable shift to growth in intermediate imports occurred. This may underline the empirical evidence that output productivity gains in manufacturing are accompanied by increased offshoring. The contribution of growth rates in intermediate imports on output growth is concentrated in sectors such as, food, beverages and tobacco (NACE 15, 16), paper and paper products (NACE 21), chemicals (NACE 24), metals (NACE 27-28) and machinery and equipment (NACE 29). On the other hand, our results show that service industries are characterized by different sources of productivity growth. In terms of average growth rates that were calculated on the basis of the total sample period, 1989-2005, a first notable result was that for most of the sectors, output productivity was caused by increases in labor, capital, and domestic intermediate inputs and to a lesser extent by intermediate imports with exceptions in: water transport and air transport (NACE 61 and 62), financial intermediation (NACE 65) and R&D (NACE 73). Secondly, we noted that for most of the sectors, the growth rates of intermediate imports increased until 1997-2001 and decreased in the subsequent periods.

With TFP growth, we see some distinct patterns between manufacturing and service sectors. For most of the manufacturing sectors, increasing TFP seems to be an important source of output growth. Notable increases in the rates of change in TFP occurred in chemicals (NACE 24), motor vehicles (NACE 34, 35) and other industrial activities (NACE 20, 26, 36). TFP growth contributed negatively in the beginning period 1989-1992 but accelerated in subsequent sub-periods. In contrast to the contribution of the other production factors, there were positive growth rates for most of manufacturing in the two latter periods. The contribution of TFPG in the service sectors is widespread. There are very strong gains in wholesale trade (NACE 51), air transport (NACE 62), post and telecommunications (NACE 64) and computer and related activities (NACE 72).

3.2 Imperfect competition: The presence of markups

Central to our analysis, it is important to know to what extent the level of competition, measured by markups (μ), exist in Dutch industries: competition is important for the TFP growth measurement and its relationship to offshoring.

Table 2a in the annex reports the markups (μ_{it}) per industry and per year, using input-output tables. Industries with relatively high average markups in the period 1989-2005 are for instance mining and quarrying (NACE 10, 11, 14), wholesale trade (NACE 51) and insurance and pension funding (NACE 66) as of 1993. In addition, for these sectors, the price-cost margins have increased over time, as well as for cokes, refined petroleum products, nuclear fuel (NACE 23) in the period 2001-2005. This implies that competition has decreased in these sectors despite regulatory reforms and competitive pressure from imports. Sectors with declining markups (more competition) in the previous two decades are retail trade (NACE 52), financial intermediation (NACE 65) as of 1993 and rubber and plastics products (NACE 25). Markups declined during 1989-1992 but increased significantly afterwards.

For the economy as a whole, markups have increased in the Netherlands in the period 1989-2005 and more notably so for services sectors than for manufacturing sectors. This implies that the overall level of competition in the Dutch economy has declined compared to the late 1980s. This finding is corroborated by the findings of Creusen et al. (2006) who use the price-cost-margin and relative profits measure (e.g., Boone et al., 2007), using firm level data to investigate competition in the Dutch market sector. Creusen et al. conclude that the overall level of competition has likely decreased in the period 1993-2001, but that the evolution of markups at firm-level is complex. Regulatory reforms have stimulated competitive behavior but this was offset by a strong increase in market demand.

On the other hand, Konings et al. (2001) find that markups were high in the Netherlands in the period before competition legislation was amended (1994-1996) and that Dutch firms behave less competitively than Belgian firms (the Netherlands is referred to as a `cartel paradise'). Markups were consistently higher in the Netherlands than in Belgium, where the existing regulatory system was more effective than in the Netherlands at that time (1994-1996). In addition, the impact of import competition on competitive behavior was much stronger in Belgium than in the Netherlands. We also find that sectors which increase their import of intermediate inputs do not necessarily face lower or decreasing markups.

Christopulo and Vermeulen (2008) estimate industrial markup ratios for 8 Euro area countries including the Netherlands using an estimation method that follows closely Roeger (1995). In only four out of the fifty sectors, perfect competition cannot be rejected: the markup ratios vary between one (for leather, NACE 19; office equipment, NACE 30; other transport equipment, NACE 35; R&D, NACE 73) to 2.95 (for real estate activities, NACE 70). Overall, the estimated markup are statistically not different during the sub-periods 1981-1992 with those from 1993-2004. In their study, markups have risen in wood (NACE 20), activities related to financial intermediation (NACE 67) and declined in financial intermediation (NACE 65) and sanitation (NACE 90).

4 Measuring offshoring

In order to measure the effects of offshoring on TFP growth, and if so, through the mechanism of imperfect competition, we consider 4 indicators using symmetric input-output tables for the period 1988-2005 released by Statistics Netherlands. The tables distinguish the imported and domestic content of inter-industry transactions of goods and services, which allow us to quantify the extent of intermediate and service offshoring on the part of manufacturing and service industries[10].

According to the OECD definition (OECD, 2007), "offshoring" relates to activities where the production of goods or services are partially or totally transferred abroad to affiliated (within the same enterprise group) or non-affiliated enterprises. While there is a range of indicators that can be used to measure "offshoring", each of them with a specific economic meaning to "offshoring", the empirical literature identifies two types of indicators: those constructed from the intermediate imports and those based on vertical specialization. We discuss each of them below.

4.1 Intermediate imports approach

The first type of indicators - provided by Feenstra and Hanson (1999) - comprises indicators that are calculated on the basis of intermediate inputs over total costs, which for each industry *i* at time *t* can be written as:

$$(15) \qquad OFF_{it}^{1} = m_{it}^{f} / \left(m_{it}^{f} + M_{it}^{d} \right)$$

where m_{it}^{f} are the *total* imports of intermediate inputs of by industry *i* and m_{it}^{d}

[10]It is evident that "offshoring" can be measured on the basis of different kind of data (e.g., survey data, firm level data, sectoral data). Here we refer to Olsen (2006) and OECD (2007) for discussions on direct and indirect measures of offshoring that are constructed from various data aggregations.

m_{it}^{d} is the amount of the *total* domestic intermediate inputs used by industry *i.* This index measures the *broad index* (from Feenstra and Hanson, 1999) since it includes the share of intermediate inputs from *all* industries (including the industry itself) over the total intermediate inputs. In the same line, Feenstra and Hanson (1999) also propose a *narrow index* (which we denote as $OFFSH_{it}^{2}$ OFF_{it}^{2}) of offshoring which is defined as the ratio of the imported intermediate inputs from the same industry abroad and the total $m_{it}^{f} + m_{it}^{d}$ inputs from that industry. There are two reasons why this latter measure is regarded as a more appropriate measure of offshoring: first, it seems more realistic that intermediate imports of the same industry was, or could have been, a production activity in the domestic country (Feenstra and Hanson, 1999); and second, the narrow measure is the only one in line with the WTO mode 1 definition of offshoring (Olsen, 2006). Both the narrow and broad index of offshoring have also been used by Daveri and Jona-Lasinio (2008) in their analysis for Italian manufacturing sectors.

Table 3a in the appendix report shows the two indicators of offshoring for each of the sectors. Overall, both the narrow and broad measure indicate a high degree of heterogeneity across industries[11]. According to the broad measure, sectors with the highest shares are mainly found in manufacturing, ranging from 30% in food, beverage and tobacco (NACE 15, 16) to 80% in coke and refined petroleum products (NACE 23). Generally, the narrow measure suggests similar offshoring intensities within manufacturing with the exception of publishing and printing (NACE 22) and coke and refined petroleum products (NACE 23). Differences between the two indictors suggest that these sectors are characterized by high intensity of imported inputs from outside the sectors. In servicing, both indicators confirm that the offshoring intensity is especially high in the R&D sector (NACE 72) and financial intermediation (NACE 65) and water transport (NACE 61). Over time, both indicators confirm that in most of the sectors, offshoring activities have not significantly changed. This latter result is consistent with other countries where a similar trend is shown for the broad measure of offshoring (OECD, 2007). An apparent exception is found in fabricated metal products (NACE 28), where according to the narrow measure, offshoring rose from 4% in 1989 to 14% in 2005.

4.2 Vertical specialization and the import content of trade

A second type of studies focuses on the concept of vertical specialization - measured by the import content of exports. Hummels et al. (2001) argue that

[11]In section 5, we elaborate on differences between each of the 4 indicators in a panel dimension (across industries and time).

offshoring indicators measured by solely the imports of intermediates face two problems. First of all, imports of intermediate inputs give only a partial picture of offshoring because it only takes into account the dependence of domestic producers on foreign production. Secondly, differences between intermediate and final goods and especially services are not always clear. For that reason, we also employ this type of indicators.

Vertical specialization refers to the splitting of production processes into separate parts, which are subsequently relocated in different locations. In theory, each segment of the production chain is relocated to that area or country that is abundant in the production factors needed in that stage of production (e.g. low wages or a high-skilled labour force). Subsequently, fragmentation of production causes increased levels of international trade, especially in terms of intermediate inputs or semi-manufactures.

The concept of vertical specialization is characterized by three aspects (Hummels et al., 2001): (i) goods and services are produced in multiple stages; (ii) two or more countries specialize in some - but not all - stages of production; en (iii) at least one country uses the imported intermediate input in the production process and the produced output is exported. The first and second characteristics are consistent with the concept of offshoring while the third characteristic distinguishes vertical specialization from the imports of intermediate inputs. The index proposed by Hummels et al. (2001) includes not only the value of inputs which are directly used in exports but also the value of inputs which are indirectly used in the production of exports. We refer to a recent study of Breda et al. (2008) that have used the direct and indirect approach of vertical specialization for a range of European countries.

Vertical specialization can be measured as the share of intermediate imports used in the production of exports (Breda et al., 2008). These intermediate commodities and services can enter an industry directly via imports from abroad or via intermediate deliveries between domestic sectors.

Using matrix notation, equation (16) relates the direct imports of intermediate inputs of each industry to its industry exports. Equation (17) takes into account all the imports that are needed to produce one unit of exports, entering the production process either via direct imports from abroad or through intermediate deliveries between industries (OECD, 2005).

(16) $$VS_{it}^{1} = \text{direct import content of exports} = \mu M \bullet \frac{e}{E}$$

(17) $$VS_{it}^{2} = \text{total import content of exports} = \mu M \bullet (1-D)^{-1} \bullet \frac{e}{E}$$

where μ is an $1*n$ unit vector of dimension n and M is an $n*n$ matrix, consisting of the intermediate imports going into each sector, divided by sector output. Column j in matrix M shows the amount of imports needed from each (foreign) sector i that is needed to produce one unit of sector j's output. Matrix

D is also an $n*n$ matrix, showing the input coefficients for domestic inputs; i.e. the ratios of domestic inputs in total sector output, for each sector. Subtracting matrix D from an identity matrix I and calculating the inverse of the resulting matrix yields the so-called Leontieff inverse matrix. This matrix shows the direct and indirect effects of a one-unit increase in sector j 's output on the output of industry i . The Leontieff matrix makes it possible to determine the total amount of sector output needed to satisfy final demand and demand for intermediate supplies, given a certain amount of final demand (R.E. Miller and P.D. Blair, 1985). Vector e is the amount of export produced per sector, where E is the total export produced in the Netherlands, $E = \sum e_i$.

In contrast to other related studies (e.g., Breda et al., 2008), we exclude not only transit trade but also re-exports from the analysis since these trade flows refer to commodities which enter and subsequently leave Dutch territory without any significant industrial processing. Since we are merely interested in the exports that originate from domestic production, the inclusion of re-exports would yield towards a downward bias of the indicators (see Jaarsma, 2005, for a more detailed analysis on Dutch re-exports).

Industries, for which the share of direct imports in exports is high, also relative to the total amount of imports in exports, are likely to be part of a vertical production chain. The intermediate imports enter their production process directly and to a lesser degree via domestic suppliers, which indicates that these imports are a vital input in production. Examples of such sectors are the coke, refined petroleum products and nuclear fuel industry, the research and development sector and the mining and quarrying industry.

Figure 1: Total and direct import of manufacturing intermediates in exported manufactures (services)

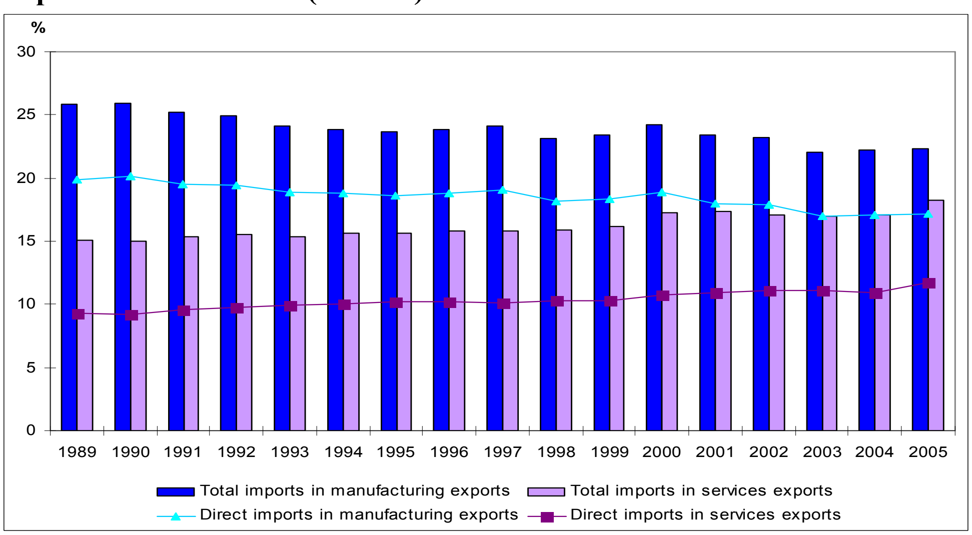

Figure 1 shows that on average the share of total imports in Dutch exports (excluding re-exports) has not increased significantly in the period 1989-2005. However, for services sectors in general, the import content of export has increased since 1989, to almost one fifth per unit export. Manufacturing sectors have experienced a declining import content of export, from approximately 26 percent per unit export, to a little over one fifth.

In table 3a, we report the total import content of exports. We see that the sharpest declines were found in the sectors which produce office, accounting, computing and electrical machinery, radio and television equipment, medical precision and optical instruments and in the textiles, apparel and leather industry.

Obviously the import content in export is high in sectors which are intensive in the use of raw materials and natural resources which are not found in the Netherlands. As such, the export products of the coke, refined petroleum products and nuclear fuel industry (NACE 23) consist of a large share of imported inputs, approximately 60 percent in 2005.

The lowest shares of embodied imports are found in most services sectors, such as health and social work (NACE 85) and activities auxiliary to financial intermediation (NACE 67). Services are more difficult to trade and to split in production stages, and are often produced close to the market, which makes it obvious that the level of imports in exports is lower for services sectors. Exceptions are the sectors air transport, water transport and research and development, which have high and increasing shares of import in their export products. The air and water transport sectors (NACE 61, 62) import many supporting and auxiliary transport activities (NACE 63) from abroad, while the imports of the R&D sector (NACE 73) mainly consist of intra-industry trade, i.e. R&D services from abroad (intra-industry trade).

5 Impact of offshoring and competition on TFP growth

In this section we analyze the relationship between offshoring and TFP growth, taking into account the degree of competition that is present in that industry. In particular, we ask whether offshoring increases TFP productivity indirectly through the mechanism of markups. The *direct* empirical link between offshoring and TFP (or productivity growth) has already been well established in the literature. Olsen (2006) reviews the existing literature offshoring activities and productivity. With specific reference to offshoring-productivity effects at the *industry* level, empirical evidence suggests that the productivity effects of offshoring in services must be distinguished from the effects of offshoring in manufacturing. This comes from the rapid increase in service growth which has been attributable to the outsourcing of services. Crino (2008) and Amiti and Wei (2004) find strong productivity impacts of service offshoring while, according to the two latter studies, offshoring of materials have no significant effects. On the other hand, Amiti and Wei (2006) find in a more sophisticated analysis a significant positive effect of offshoring manufacturing on productivity. In a more recent study, Daveri and Jona-Lasinio (2008) confirm Amiti and Wei (2004) result with evidence that only the offshoring of materials impact productivity growth. With specific reference to Dutch (aggregated) industry, Den Butter and Pattipeilohy (2007) estimate the effects of offshoring on productivity growth for the 1972-2001. The authors find that offshoring in manufacturing and services only affects output of the total service sector while the offshoring of the manufacturing sector has a positive impact on manufacturing and the total industry.

While the effects of offshoring on productivity growth are quite intuitively, it can also be argued that the impact of offshoring on productivity is given *indirectly* via a reduction in price cost margins (lower markups). Fixler and Siegler ((1999) lay out the situation that the propensity to engage in offshoring is mainly generated through cost advantages. In particular, the authors show in a simple model that a firm will outsource to take advantage of cost differentials measured by marginal costs. In Bernard et al. (2003) model the impact of trade reforms on productivity is given via a reduction in the price of intermediate inputs (e.g. cheaper and higher quality imported inputs replace domestic one). In this case, the beneficial effect from intermediate input price reductions to lower markups lead to market reallocations from less productive to more productive firms, and the exit of the least productive ones. The testable hypothesis that competition is the causal link to TFP growth is also found in Kim (2000) where it is empirically suggested that TFP growth is *primarily* caused by lower markups. Increased competition in the import market has some impact, but overall Kim argues that it was not the major force.

While the competition-productivity relationship is well established in the empirical trade literature (e.g., see Winters, 2004, for an extensive overview), the markups-offshoring relationship fits the relative small strand of empirical literature that investigates the "imports-to-market-discipline" (IMD) hypothesis (e.g., Levinsohn, 1993). The IMD hypothesis confirms that increased import competition (mainly due to increased trade liberalization) results into a more competitive pressure. However, one major source of ambiguity in this hypothesis is the broad concept of imports whereby no distinction is made between intermediate and final goods. This ambiguity is further explored by Egger and Egger (2004), Amiti and Konings (2005) and Abraham et al. (2006). These three studies provide robust evidence that intermediate imports have a positive influence on markups because "imported intermediates lower total costs and thus increase the markup, all else equal" (Amiti and Konings, 2005).

Turning to our empirical model, we allow for the interaction between markups and offshoring. From a measurement point of view, we improve two shortcomings that are generally addressed: (i) the assumption of a time-constant markups, (ii) the application of different offshoring measures and (iii) the causal link between offshoring and productivity.

5.1 Model

The *general* form of our estimating equation is:

$$(18) \qquad TFP_{it} = \alpha_i S_i + \alpha_t T_t + \beta_1 OFF + \beta_2 \mu_{it} + \beta_5 OFF_{it} * \mu_{it} + \varepsilon_{it}$$

where S_i and T_t are respectively the *i* sector and *t* time dummies, OFF is the offshoring variable, and μ_{it} is markups. The offshoring variable (OFF) is measured by equation (15). We apply the broad and narrow OFF measure and vertical specialization (VS_{it}). The broad measure is further divided into services (OFF^S) and manufacturing (OFF^M). The dependent variable TFP_{it} is derived from equation (14) ($\Delta \ln a_{it}$) and ε_{it} is the error term. The presence of fixed industry effects (S_i) capture unobservable influences that remain constant over time (macroeconomic and institutional effects) while the time effects (T_t) can be considered as productivity shocks specific to the year but constant over all industries. The interaction effects $OFF_{it} * \mu_{it}$ is also added to capture the possible impact of offshoring on the markup. The coefficients β_1 and β_2 are direct effects on TFP while the coefficient β_5 on the interactive term would be negative if more offshoring leads to a compression of the markups (more competition).

5.2 Results

Equation (18) is the standard model. However, the problem of endogeneity between markups and offshoring need to be solved econometrically, namely, markups and the imports of intermediates consumption also appear indirectly in the dependent variable TFP. A possible solution is to apply an OLS instrumented variable approach however the problem with this approach is the lack of good instruments. Staiger and Stock (1994) discusses the bias that exists when inadequate instruments are used. Instead we follow the conventional approach (e.g., Dobbelare, 2004) and estimate the model using the Generalized Method of Moments (GMM) technique for panel data as advocated by Arellano and Bond (1991). Under the assumption that current random shocks are uncorrelated with past values from firm-level regressors, we use past values of μ and OFF from *t-1* and *t-2* . Estimation is carried out by the Dynamic Panel Data program developed by Arellano and Bond, which is also available with STATA. We also note that in order to stress differences between services and manufacturing, we omit the agricultural and mining sectors (NACE 10-14) in this analysis.

In table 1, we represent the results of our GMM estimation of equation (18) using various specifications. We note that period and industry-specific effects were tested with each of these regressions.

Table 1: Offshoring, markups and TFP growth (GMM)

	I	II	III	IV
OFF_{it}^{M}	.148 (.091)		.101 (.082)	-.193 (.062)**
OFF_{it}^{S}	.252 (.131)**		.232 (.024)**	-.754 (.234)**
μ_{it}		-.261 (.092)**	-.244 (.052)**	-.163 (.040)**
$OFF_{it}^{M} * \mu_{it}$				.186 (.067)**
$OFF_{it}^{S} * \mu_{it}$				.741 (.241)**
Time dummies	y	y	y	y
No. obs.	510	510	510	510
Sargan IV test	23.021	27.289	24.255	19.572

Notes: ** indicates 5% significance; * indicates 10% significance; Time effects are included as regressors and instruments in all eqtns. Sargan IV tests the correlation among instruments and residuals (asympt.)

Two variables appear to be significant throughout all specifications. First, the coefficient on the markup indicates that more competition leads to more TFP growth. Second, the offshoring of services variable is always significant at the 5% level. On the other hand, the contribution of manufacturing offshoring does not have any effect on productivity regardless the inclusion of the markups. Although, the signs are positive, their significance level is rejected at the 10% level. The specification of our estimating equation accordingly to column IV results reports variables to be all significant at the 5% level. The positive sign of the interaction effects indicate that more offshoring leads to less competition. These results imply that the IMD hypothesis is not supported for intermediate goods and services. These results are in line with previous research by Egger and Egger (2004), Amiti and Konings (2005) and Abraham et al. (2006). The evidence that intermediate imports have a positive influence on markups is explained by a wider price cost margin. In addition, a notable result is that under the assumption of perfect competition, net effects of the offshoring variables on productivity are marginal negative, although, statistical significant. It must be noted that the effect of industry-specific variables were for a majority of sectors non-significant and were excluded from the analysis. When we accounted for these fixed effects, the direct and net effects of the offshoring and competition variables were not significant at the 5% level.

We have carried out some further robust analysis. *First*, the effect of the narrow concept of offshoring according to each of the specifications outline above appears not to have any effect on TFP growth. This fact also holds for the markup variable.

Second, we also tested the inclusion of some other additional variables. We included R&D as a ratio in total output and the export concentration ratio of the top 10% exporters in total exporters and the price index of the intermediate imports. The effect of each of these variables (separate and combined) on productivity was not significant even at the 10% significance while the above conclusions remain robust. We therefore used them as additional instruments in the GMM estimation.

Table 2: Direct import content, markups and TFP growth (GMM)

	Industry			Services	
VS_{it}^{1}	.219 (.102)**	.225 (.102)**	.225 (.101)**	.328 (.107)*	.346 (.172)**
μ_{it}		.092 (.241)			.215 (.298)
R&D expenditure per output			.048 (.031)*		
Time dummies	y	y	y	y	y
No. obs.	510	510	510	300	300
Sargan IV test	15.124	11.012	14.210	18.215	15.659

Notes: ** indicates 5% significance; * indicates 10% significance; Time effects are included as regressors and instruments in all eqtns; Sargan IV tests the correlation among instruments and residuals (asympt., Chi)

Finally, we also employed vertical specialization VS_{it}^{2} measured by equation (16) and (17). By doing so, we were not able to further distinguish between services and manufacturing. The problem is that using a breakdown between imports and exports between services and manufacturing resulted into zero values for many of the sectors. We therefore kept these variables at its aggregate and estimated three sector groups: total industry, services and manufacturing. The results are summarized in table 2 and 3.

Table 3: Direct import content, markups and TFP growth (GMM)

	Industry		Manufacturing		Services	
VS_{it}^2	.200 (.075)**	.278 (.007)**	.000 (.000)	.368 (.137)**	.528 (.133)**	-.091 (.065)
μ_{it}		-.075 (.017)**	.076 (.043)*		.090 (.218)	.036 (.052)
$VS_{it}^2 * \mu_{it}$						.103 (.038)**
Time dummies	y	y	y	y	y	y
No. obs.	510	510	210	300	300	300
Sargan IV test	15.124	17.772	11.112	18.215	15.659	14.114

Notes: ** indicates 5% significance; * indicates 10% significance; Time effects are included as regressors and instruments in all eqtns; Sargan IV tests the correlation among instruments and residuals (asympt., Chi).

We only report those results with significance of any of the variables. With regards to the manufacturing group, we did not succeed in reporting any significant results. In other words, we did not find any significant, direct and indirect impacts of vertical specialization on TFP growth. For the servicing sector and total industry, vertical specialization (direct and indirect import content) did have a significant impact on TFP growth and remains robust after including markups. When we included an indirect mechanism via the interaction term the indirect and direct effects of the direct import content of exports were not significant. However, in the last column of table 3 we see that the impact of vertical specialization impacts TFP growth positively through higher markups. Finally, we also note a positive effect of the R&D per unit expenditure variable on TFP for servicing sectors.

6 Conclusion

This paper shows that competition plays a major role in establishing the relationship between offshoring and productivity (growth). The effect of competition on the output market as an additional mechanism is an important determinant for many of the Dutch sectors.

The recognition that the amount of intermediate inputs imported from abroad as an indication of international linkages of the production process, enables us to identify to what extent the growth of imported intermediate inputs is an important contributor of productivity growth. In the first part of the paper, we therefore performed a decomposition analysis. We found that gains in output productivity growth in manufacturing were caused by faster growth in intermediate imports offsetting the falling growth rates of labor. A major implication of this result is that intermediate imports may be seen as an important source of productivity growth by increasing the efficiency of other inputs in the production process.

In the second part of the paper, put forward the importance of measurement which may generate important policy implications. We put forward a consistent measure of TFP growth. Our TFP measure indicates to what extent industries can produce more efficiently by taken into account the contribution of competition. TFP growth is an important measure for welfare at all levels of the economy. Second, our analysis give also an interesting route for policy measures aimed at improving productivity growth. While offshoring can be measured by various indicators, its direct relationship with TFP growth depends at various levels of competition. In this sense, policy instruments aimed at stimulating the intensity of competition domestically may also influence the decision to relocate parts of the production and hence TFP growth.

Finally, our analysis suggests that offshoring of services have a positive impact on TFP. These results are also confirmed for offshoring, under form of vertical specialization, of services and manufacturing on the TFP growth of service sectors. We considered various specifications of the empirical model. Finally, we find evidence that offshoring compresses competition. This can be explained by the fact that, given output prices, lower production costs lead to higher price cost margins. Furthermore, we find evidence that offshoring compresses competition. This can be explained by the fact that, given output prices, lower production costs lead to higher price cost margins.

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Appendix

A Input Output Data

We make use of the input output tables provided by Statistics Netherlands for the sample period 1987-2006. The classification of sectors in manufacturing and service industries that are listed in the input-output tables corresponds exactly to the NACE rev. 1 classification.

Productivity growth is calculated by using the changes in the volume of the output value and production factor costs. The values for inputs and outputs from the input-output tables are available in current prices as well as prices from the previous year. This enables us to eliminate the influence of price changes in order to compute changes in volumes.

Output: Gross output and intermediate inputs were extracted from the input-output tables. Total consumption of intermediate goods (domestic + imported) for all sectors are available in a separate data file from the national accounts.

Capital input: The data on capital stock (*k*) and the corresponding consumption of capital (*wk*) are provided by the national accounts. The consumption of capital are computed using an exogenous interest rate allowing for deviations between output and input costs (see Balk and van den Bergen, 2007; Balk, 2008) for a more detailed data analysis).

Labor input: data on labor input includes wages and salaries (including social contributions), and the number of hours worked. For labor input, we use total man-hours worked, which is preferred to the number of workers (Morrison (1999)). Generally, it is preferred to allow for different types of workers (e.g., production/non-production workers, temporary, part-time,etc.). Statistics Netherlands does distinguish workers according to gender and type of contract: full-time, part-time, flexible. However, we prefer to take labor as homogeneous since the sectoral labor data for the period 1988-2006 underwent many undesired changes in sectoral classifications.

R&D expenditure: refers to the total cost of research and development carried out by an enterprise's own employees. Total R&D expediture comprises the actual R&D investment, such as setting up laboratories, research-sites, machinery and equipment, as well as the exploitation-cost of R&D which are the salaries and social security payments of R&D personnel and other exploitation costs such as administrative expenditure, travel cost, electricity etc. In this analysis, we have included R&D expenditure as a share in total production for each sector, in order to properly deflate for pricechanges. Sectors with a high share of R&D expenditure in production are for instance the sector that produces Office, accounting, computing and electrical machinery, radio and television equipment, medical, precision and optical instruments or the sector that sells, maintains and repairs motor vehicles and motorcycles.

The variable top-10 exporters: measures which share of a sector's export is carried out by its ten largest enterprises. This shows to what extent a sector is inhabited by a few large firms, or whether a sector sustains many small enterprises. If increased offshoring influences the productivity of enterprises, the magnitude and direction of this effect might be influenced by the degree of competition in a sector.

Table 1a: ISIC	Sectors	Output					Labor					Capital				
		1989-1992	1993-1996	1997-2000	2001-2005	1989-2005	1989-1992	1993-1996	1997-2000	2001-2005	1989-2005	1989-1992	1993-1996	1997-2000	2001-2005	1989-2005
1,2,5	Agriculture, hunting, forestry, fishing	2,794	0,568	1,775	0,066	1,228	0,275	-0,081	0,235	-0,002	0,100	0,589	0,342	0,483	0,685	0,534
10, 11, 14	Mining and quarrying	4,076	2,807	-2,645	0,975	1,284	0,000	-0,053	-0,198	-0,092	-0,086	2,489	1,833	1,474	0,946	1,642
15, 16	Food, beverages, tobacco	2,925	2,454	1,353	0,290	1,669	0,024	-0,351	0,015	-0,350	-0,176	0,256	0,157	0,120	0,132	0,164
17, 18, 19	Textiles, apparel, leather	1,156	-1,190	1,921	-4,344	-0,833	-0,149	-1,652	-0,437	-1,648	-1,011	0,185	-0,040	-0,012	-0,096	0,003
21	Paper and paper products	1,929	2,046	3,472	0,527	1,907	0,344	-0,879	-0,176	-0,547	-0,328	0,596	0,185	0,247	0,167	0,291
22	Publishing, printing and reproduction	2,958	1,163	3,476	-2,079	1,176	0,506	-0,986	-0,032	-1,272	-0,494	0,498	0,378	0,293	-0,005	0,274
23	Coke, refined petroleum products, nuclear fuel	2,264	2,705	-0,178	0,057	1,144	-0,018	0,063	-0,145	0,020	-0,018	-0,045	-0,143	0,303	-0,030	0,018
24	Chemicals and chemical products	2,197	4,634	4,234	2,541	3,351	0,003	-0,724	-0,122	-0,160	-0,246	0,676	0,197	0,263	0,178	0,320
25	Rubber and plastics products	4,810	1,382	4,602	0,816	2,780	0,953	-0,348	0,700	-0,440	0,178	0,721	0,497	0,248	0,227	0,412
27	Basic metals	0,542	2,581	3,426	1,537	1,993	-0,304	-0,806	-0,146	-0,591	-0,469	0,260	-0,291	0,263	-0,036	0,044
28	Fabricated metal products	4,684	2,067	3,596	-0,731	2,219	0,563	-0,533	0,160	-0,540	-0,114	0,404	0,134	0,250	0,082	0,209
29	Machinery and equipment	3,664	4,768	6,224	0,950	3,728	0,648	-0,484	0,527	-0,305	0,073	0,285	0,134	0,213	0,105	0,180
30, 31, 32, 33	Office, accounting, computing and electrical machinery, radio and television equipment, medical, precision and optical instruments	4,902	4,132	6,679	-4,014	2,516	-0,753	-0,756	-0,113	-0,852	-0,632	0,261	0,072	0,218	0,015	0,134
34, 35	Motor vehicles and other transport equipment	4,779	0,443	6,360	-1,853	2,180	0,289	-0,706	0,260	-0,557	-0,201	0,189	0,221	0,091	0,008	0,120
20, 26, 36, 37	Other industrial activities	1,835	2,393	4,199	-1,311	1,597	0,683	0,037	0,468	-0,533	0,123	0,372	0,221	0,223	0,109	0,224
40, 41	Electricity, gas, water	4,116	3,071	0,907	0,842	2,152	-0,052	-0,288	-0,220	-0,207	-0,193	0,583	0,991	0,238	0,096	0,455
45	Construction	1,525	1,092	4,244	-1,268	1,242	0,102	-0,039	0,648	-0,510	0,017	0,139	0,113	0,198	0,060	0,123
50	Sale, maintenance and repair of motor vehicles and motorcycles	4,244	2,927	6,518	-0,869	2,965	0,701	0,335	0,783	-0,205	0,368	0,634	0,491	0,550	0,198	0,453
51	Wholesale trade	4,863	5,032	7,789	2,202	4,809	1,607	0,491	1,336	-0,429	0,682	0,576	0,139	0,349	0,178	0,303
52	Retail trade	3,399	1,207	4,082	0,491	2,188	1,637	0,122	1,384	-0,052	0,724	0,551	0,635	0,557	0,378	0,521
55	Hotels and restaurants	4,672	2,296	4,819	-2,012	2,182	1,429	0,868	0,818	-0,357	0,628	0,540	0,222	0,276	0,239	0,315
60	Land transport	3,753	2,083	4,202	0,087	2,388	1,200	-0,236	0,815	-0,259	0,342	1,168	0,661	0,464	0,364	0,646
61	Water transport	3,833	0,582	5,087	2,682	3,025	-0,190	-0,357	0,167	-0,196	-0,147	0,683	-0,037	0,546	0,090	0,307
62	Air transport	7,196	8,316	5,680	1,136	5,321	0,978	-0,291	0,652	-0,215	0,252	2,748	0,264	0,127	0,010	0,742
63	Supporting and auxiliary transport activities	2,860	5,293	6,088	1,625	3,829	0,271	0,023	1,015	0,394	0,424	1,462	1,316	1,098	1,130	1,245
64	Post en telecommunications	5,342	3,899	20,326	6,182	8,775	0,045	-0,337	1,585	-0,863	0,051	2,176	1,144	2,678	0,192	1,468
65	Financial intermediation	5,327	3,175	9,184	2,785	4,981	0,306	-0,476	1,606	-0,515	0,186	1,244	0,836	1,636	-0,174	0,823
66	Insurance and pension funding	4,820	3,270	3,216	0,649	2,851	0,510	0,160	0,673	-0,280	0,234	1,435	0,443	0,107	-0,208	0,406
67	Activities auxiliary to financial intermediation	1,956	7,050	7,188	-1,900	3,252	1,217	2,216	2,647	-0,109	1,398	0,796	0,234	0,634	0,185	0,446
70	Real estate activities	3,396	3,323	3,192	1,686	2,828	0,182	0,165	0,249	0,127	0,178	6,452	5,184	4,093	4,132	4,916
71	Renting of machinery and equipment	12,495	6,454	9,799	-0,774	6,536	0,658	0,434	0,634	0,025	0,414	5,804	3,040	6,358	3,188	4,515
72	Computer and related activities	10,253	12,553	18,635	0,592	9,925	4,069	5,277	6,559	-0,075	3,720	0,888	0,531	0,626	0,107	0,513
73	Research and development	5,011	0,928	1,970	1,985	2,445	0,742	2,040	2,075	-0,457	1,008	0,495	0,166	0,271	0,028	0,227
74	Other business activities	6,207	5,683	6,350	-0,468	4,154	2,180	2,850	2,119	-0,264	1,605	0,380	0,156	0,277	0,120	0,227
85	Health and social work	2,758	2,073	2,364	3,346	2,677	1,131	0,778	2,027	2,103	1,545	0,617	0,495	0,393	0,500	0,501
92	Recreational, cultural and sporting activities	2,706	2,645	4,228	1,770	2,774	0,731	1,286	0,970	0,022	0,709	0,500	0,493	0,435	0,275	0,417
	Total manufacturing	**3,026**	**2,728**	**3,665**	**-0,187**	**2,161**	**0,150**	**-0,510**	**0,085**	**-0,462**	**-0,201**	**0,364**	**0,158**	**0,204**	**0,096**	**0,199**
	Total services	**4,060**	**3,424**	**5,881**	**1,047**	**3,453**	**0,915**	**0,618**	**1,225**	**-0,013**	**0,645**	**1,272**	**1,005**	**0,917**	**0,828**	**0,995**

Table 1a: ISIC	Sectors	Intermediate inputs domestic origin					Intermediate inputs foreign origin					TFP growth				
		1989-1992	1993-1996	1997-2000	2001-2005	1989-2005	1989-1992	1993-1996	1997-2000	2001-2005	1989-2005	1989-1992	1993-1996	1997-2000	2001-2005	1989-2005
1,2,5	Agriculture, hunting, forestry, fishing	0,282	-0,087	0,371	-0,785	-0,098	0,148	0,227	0,312	-0,042	0,150	1,499	0,166	0,373	0,209	0,541
10, 11,14	Mining and quarrying	1,517	0,389	-0,941	-0,241	0,156	0,886	1,501	1,584	0,519	1,087	-0,817	-0,862	-4,565	-0,156	-1,515
15, 16	Food, beverages, tobacco	0,771	0,882	0,473	-0,367	0,392	1,023	0,746	0,659	0,403	0,690	0,852	1,019	0,086	0,471	0,599
17, 18, 19	Textiles, apparel, leather	1,213	0,126	1,993	-0,729	0,570	0,187	-0,284	-0,764	-1,472	-0,636	-0,280	0,659	1,142	-0,399	0,241
21	Paper and paper products	0,364	0,869	1,163	0,246	0,636	1,412	1,512	1,161	0,032	0,970	-0,787	0,358	1,078	0,629	0,338
22	Publishing, printing and reproduction	0,853	0,388	1,903	-1,007	0,444	0,998	0,266	0,303	-0,153	0,324	0,102	1,117	1,010	0,358	0,630
23	Coke, refined petroleum products, nuclear fuel	0,722	-0,483	0,168	-0,247	0,023	0,736	2,803	-0,030	-0,402	0,707	0,870	0,466	-0,474	0,715	0,413
24	Chemicals and chemical products	0,797	1,183	1,514	0,501	0,969	0,877	1,858	1,668	0,642	1,225	-0,156	2,120	0,911	1,380	1,083
25	Rubber and plastics products	0,247	0,363	2,923	1,255	1,200	2,504	1,025	0,196	-0,677	0,677	0,386	-0,155	0,535	0,451	0,313
27	Basic metals	0,759	1,154	0,944	0,038	0,683	0,332	0,722	1,664	0,744	0,858	-0,506	1,803	0,701	1,382	0,877
28	Fabricated metal products	1,783	0,458	0,964	-0,106	0,723	1,018	0,697	1,713	-0,180	0,754	0,916	1,311	0,509	0,013	0,648
29	Machinery and equipment	1,734	2,125	2,682	-0,670	1,342	1,350	1,056	1,597	1,376	1,347	-0,353	1,938	1,205	0,444	0,787
30, 31, 32, 33	Office, accounting, computing and electrical machinery, radio and television equipment, medical, precision and optical instruments	1,662	1,341	1,665	-1,310	0,713	1,867	1,949	2,656	-0,806	1,286	1,865	1,526	2,254	-1,061	1,016
34, 35	Motor vehicles and other transport equipment	2,138	0,026	1,620	-1,105	0,565	1,599	-0,352	2,502	-0,501	0,735	0,563	1,253	1,888	0,301	0,960
20, 26, 36, 37	Other industrial activities	0,966	1,406	1,658	-0,092	0,921	0,742	0,616	0,870	-0,505	0,376	-0,928	0,113	0,980	-0,290	-0,047
40, 41	Electricity, gas, water	3,047	2,337	0,481	-0,612	1,200	0,462	0,216	0,921	0,830	0,620	0,076	-0,184	-0,513	0,735	0,070
45	Construction	0,915	0,943	2,075	-0,607	0,747	0,432	0,262	0,680	-0,094	0,296	-0,062	-0,187	0,643	-0,118	0,058
50	Sale, maintenance and repair of motor vehicles and motorcycles	1,616	1,115	2,575	-0,285	1,165	0,664	0,937	1,078	-0,058	0,614	0,628	0,048	1,532	-0,520	0,367
51	Wholesale trade	1,721	1,455	2,241	0,174	1,326	0,646	0,475	1,061	0,372	0,623	0,313	2,471	2,803	1,907	1,875
52	Retail trade	1,540	1,061	1,733	-0,097	0,991	0,311	-0,037	0,070	0,214	0,144	-0,640	-0,575	0,337	0,048	-0,192
55	Hotels and restaurants	1,731	1,185	1,430	-0,488	0,879	0,805	0,652	0,585	0,255	0,556	0,167	-0,631	1,709	-1,661	-0,196
60	Land transport	0,669	0,390	1,697	-0,001	0,648	0,424	0,458	-0,041	0,137	0,238	0,291	0,810	1,268	-0,153	0,512
61	Water transport	0,581	-0,689	1,760	0,410	0,509	2,163	0,725	0,986	1,246	1,278	0,596	0,940	1,629	1,133	1,078
62	Air transport	0,933	1,766	1,637	-0,671	0,823	1,154	2,780	2,123	0,639	1,613	1,383	3,797	1,140	1,373	1,891
63	Supporting and auxiliary transport activities	1,169	2,467	2,766	0,479	1,647	0,771	0,714	0,889	0,168	0,608	-0,814	0,772	0,320	-0,545	-0,095
64	Post en telecommunications	1,660	1,822	8,041	1,598	3,181	0,829	1,258	4,098	1,067	1,769	0,631	0,013	3,924	4,188	2,306
65	Financial intermediation	0,948	1,441	3,119	0,335	1,394	2,988	0,480	3,565	-0,307	1,565	-0,158	0,894	-0,742	3,447	1,012
66	Insurance and pension funding	0,603	2,183	3,544	-0,366	1,382	0,190	0,054	0,428	0,072	0,179	2,083	0,430	-1,537	1,430	0,650
67	Activities auxiliary to financial intermediation	0,966	1,719	2,523	-0,217	1,162	0,129	0,236	0,369	-0,056	0,156	-1,152	2,645	1,015	-1,703	0,089
70	Real estate activities	0,839	0,515	1,334	1,117	0,961	0,150	0,104	0,043	-0,002	0,069	-4,228	-2,645	-2,526	-3,688	-3,296
71	Renting of machinery and equipment	3,170	1,804	3,423	-0,991	1,684	0,220	0,278	0,439	0,215	0,284	2,642	0,898	-1,055	-3,212	-0,360
72	Computer and related activities	2,709	4,082	8,155	-0,149	3,473	0,378	0,705	0,884	0,249	0,536	2,208	1,958	2,412	0,461	1,683
73	Research and development	1,391	0,038	0,894	0,323	0,642	2,700	0,655	1,343	0,639	1,293	-0,317	-1,970	-2,612	1,453	-0,726
74	Other business activities	2,580	1,972	3,070	-0,634	1,607	0,660	0,302	0,667	0,334	0,482	0,408	0,403	0,216	-0,025	0,234
85	Health and social work	0,896	0,544	0,614	0,637	0,671	0,276	0,333	0,515	0,393	0,380	-0,162	-0,077	-1,186	-0,287	-0,420
92	Recreational, cultural and sporting activities	2,022	1,027	2,216	0,705	1,446	0,520	0,586	0,432	0,177	0,414	-1,067	-0,746	0,176	0,591	-0,212
	Total manufacturing	**1,063**	**0,881**	**1,324**	**-0,299**	**0,681**	**1,104**	**1,054**	**1,234**	**0,080**	**0,822**	**0,345**	**1,145**	**0,819**	**0,398**	**0,660**
	Total services	**1,471**	**1,291**	**2,371**	**0,045**	**1,221**	**0,638**	**0,409**	**0,905**	**0,247**	**0,532**	**-0,236**	**0,101**	**0,464**	**-0,061**	**0,059**

Table 2a: Markups per industry

ISIC	Sectors	Markups				
		1989-1992	1993-1996	1997-2000	2001-2005	Average
1,2,5	Agriculture, hunting, forestry, fishing	**1,010**	**1,000**	**1,000**	**1,000**	**1,002**
10, 11, 14	Mining and quarrying	2,060	1,906	1,883	2,199	2,023
15, 16	Food, beverages, t 1.008obacco	1,023	1,038	1,050	1,064	1,045
17, 18, 19	Textiles, apparel, leather	1,016	1,004	1,020	**1,002**	1,010
21	Paper and paper products	**1,019**	**1,000**	**1,000**	1,004	1,006
22	Publishing, printing and reproduction	1,050	1,084	1,102	1,089	1,082
23	Coke, refined petroleum products, nuclear fuel	**1,000**	**1,000**	**1,002**	1,058	1,018
24	Chemicals and chemical products	**1,021**	1,046	1,076	1,078	1,057
25	Rubber and plastics products	1,047	1,026	1,046	1,016	1,033
27	Basic metals	**1,029**	**1,012**	1,027	**1,046**	1,029
28	Fabricated metal products	1,028	1,027	1,040	1,014	1,027
29	Machinery and equipment	1,038	1,020	1,042	1,050	1,038
30, 31, 32, 33	Office, accounting, computing and electrical machinery, radio and television equipment, medical, precision and optical instruments	**1,000**	**1,000**	**1,003**	**1,000**	**1,001**
34, 35	Motor vehicles and other transport equipment	**1,000**	**1,000**	1,045	1,039	1,022
20, 26, 36, 37	Other industrial activities	**1,002**	**1,002**	1,020	1,023	1,012
40, 41	Electricity, gas, water	**1,000**	**1,000**	**1,001**	1,045	1,014
45	Construction	1,012	1,014	1,015	1,024	1,016
50	Sale, maintenance and repair of motor vehicles and motorcycles	1,020	**1,006**	1,050	1,069	1,038
51	Wholesale trade	1,097	1,077	1,176	1,211	1,144
52	Retail trade	1,054	1,056	1,087	1,038	1,058
55	Hotels and restaurants	1,063	1,061	1,103	1,112	1,086
60	Land transport	1,018	**1,008**	1,037	1,045	1,028
61	Water transport	**1,000**	**1,000**	**1,011**	1,003	**1,003**
62	Air transport	**1,000**	**1,000**	**1,001**	**1,000**	**1,000**
63	Supporting and auxiliary transport activities	**1,000**	**1,000**	1,009	**1,006**	1,004
64	Post en telecommunications	1,045	1,073	1,084	1,132	1,086
65	Financial intermediation	**1,047**	1,115	1,057	1,118	1,086
66	Insurance and pension funding	**1,009**	1,082	1,133	1,254	1,128
67	Activities auxiliary to financial intermediation	**1,000**	**1,023**	1,189	1,103	1,080
70	Real estate activities	**1,000**	**1,000**	**1,067**	**1,060**	1,033
71	Renting of machinery and equipment	**1,000**	**1,002**	**1,000**	**1,000**	**1,000**
72	Computer and related activities	**1,001**	**1,010**	1,089	1,059	1,041
73	Research and development	**1,000**	**1,000**	**1,000**	**1,001**	**1,000**
74	Other business activities	1,046	1,062	1,057	1,039	1,050
85	Health and social work	1,023	1,031	1,043	1,073	1,044
92	Recreational, cultural and sporting activities	**1,000**	**1,000**	**1,000**	1,008	1,002
15-37	Total manufacturing	1,019	1,026	1,042	1,048	1,035
40-92	Total services	1,029	1,036	1,061	1,073	1,051

Note: Markups in bold are not statistically different from 1 at the 5% level.

Table 3a: Offshoring indicators; 1989-2005

ISIC	Sectors	Average 1989-2005				
		Offshoring broad (eq. 2)	Offshoring_ manufacturing (eq. 3)	Offshoring_ services (eq. 4)	Offshoring _narrow	Import content of export
1,2,5	Agriculture, hunting, forestry, fishing	13,25	11,00	2,25	3,74	13,23
10, 11, 14	Mining and quarrying	36,49	25,10	11,40	18,21	9,65
15, 16	Food, beverages, tobacco	31,36	29,00	2,36	14,08	27,53
17, 18, 19	Textiles, apparel, leather	52,89	50,85	2,03	34,21	13,78
21	Paper and paper products	55,33	51,72	3,61	39,15	32,47
22	Publishing, printing and reproduction	32,15	25,64	6,51	0,33	19,44
23	Coke, refined petroleum products, nuclear fuel	78,48	77,56	0,92	3,25	62,05
24	Chemicals and chemical products	48,87	43,93	4,94	31,18	29,55
25	Rubber and plastics products	52,34	50,02	2,32	10,01	25,23
27	Basic metals	51,62	42,61	9,02	30,14	21,48
28	Fabricated metal products	37,84	36,13	1,71	9,76	23,81
29	Machinery and equipment	43,60	39,58	4,02	19,00	23,37
30, 31, 32, 33	Office, accounting, computing and electrical machinery, radio and television equipment, medical, precision and optical instruments	47,37	32,02	15,35	18,98	11,26
34, 35	Motor vehicles and other transport equipment	49,50	48,44	1,07	23,86	29,72
20, 26, 36, 37	Other industrial activities	40,61	37,81	2,79	16,46	15,25
40, 41	Electricity, gas, water	11,56	7,53	4,03	2,12	18,40
45	Construction	19,71	17,70	2,01	0,60	21,83
50	Sale, maintenance and repair of motor vehicles and motorcycles	33,23	28,55	4,68	0,01	20,60
51	Wholesale trade	25,93	7,47	18,46	8,81	12,63
52	Retail trade	10,73	3,99	6,74	0,00	8,21
55	Hotels and restaurants	20,69	17,88	2,81	0,00	16,29
60	Land transport	13,43	8,45	4,98	0,42	9,63
61	Water transport	53,58	4,85	48,72	13,61	42,02
62	Air transport	44,23	13,44	30,79	9,04	35,39
63	Supporting and auxiliary transport activities	14,05	2,01	12,04	4,29	15,09
64	Post en telecommunications	31,21	7,36	23,85	18,12	18,49
65	Financial intermediation	46,76	0,67	46,09	38,05	16,30
66	Insurance and pension funding	10,61	0,78	9,82	5,21	9,76
67	Activities auxiliary to financial intermediation	7,83	3,04	4,79	0,03	5,51
70	Real estate activities	4,04	1,97	2,07	0,00	6,40
71	Renting of machinery and equipment	8,65	5,81	2,84	0,62	9,60
72	Computer and related activities	9,13	3,67	5,47	1,27	7,77
73	Research and development	64,60	10,00	54,60	53,39	30,20
74	Other business activities	13,23	2,78	10,44	3,94	11,58
85	Health and social work	20,19	19,05	1,13	0,00	7,08
92	Recreational, cultural and sporting activities	15,13	3,28	11,85	3,18	17,28