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Productivity Gains from Offshoring

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Productivity gains from offshoring: an empirical analysis for the Netherlands

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Abstract

A major question in the globalization debate is whether outsourcing and offshoring activities are beneficial to the home country. This paper investigates the effects on productivity and trade from the perspective of transaction costs, using a recent theory on trade in tasks. A production function is estimated for the Netherlands for the period 1972-2001. It suggests that the effect of offshoring manufacturing and services on total factor productivity (TFP) is positive and larger than the effect of R&D on productivity.

Keywords: globalization, offshoring, foreign direct investments, transaction costs, total factor productivity

JEL-codes: F10, F43, O47

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Productivity gains from offshoring: an empirical analysis for the Netherlands

Frank A.G. den Butter and Christiaan Pattipeilohy

1. Introduction

Globalization and the ICT-revolution made physical distance and international borders less important in trade transactions. However, the volume of trade is still relatively small as compared to what the standard Heckscher-Ohlin theorem on international trade would predict. Trefler (1995) shows that the neoclassical paradigm on international trade performs poorly in explaining actual observed levels of international trade. Several studies point to the relevance of transaction costs with respect to this 'missing trade' (see for example Eaton and Kortum, 2002). Transaction costs are all costs incurred when making a transaction and go far beyond costs associated with the transaction which are directly measurable such as transportation costs, taxes and duties.. These costs include finding a suitable transaction partner, specifying the transaction, the costs of actually conducting the transaction and the costs of sustaining a transaction. They are influenced by search costs, cultural and linguistic aspects, the institutional environment, opportunistic behaviour, among many other things. All these factors make transactions costly, thereby reducing the profitability of transactions. Reducing transaction costs increases the scope for profitable and value-creating trade. In fact, transaction costs represent the fictions in trade transactions and set a limit to (international) specialisation Lowering transaction costs thus enhances the scope for specialization, which, as already stressed by Adam Smith in his famous example of the pin factory, creates value for society as a whole.

Part of the globalization debate focuses on moving abroad production facilities to countries which are relatively abundantly endowed with cheap labour, e.g. the BRIC countries (Brazil, Russia, India and China). Recently however, there is some evidence that not only low-skilled labour is being moved from advanced to developing countries, but also high-skilled (white-collar) labour. This has renewed the interest of OECD-countries to specify the sectors in which they have a comparative advantage, and in what kind of economic activities they will have to specialize. An example is the Lisbon Strategy in which members of the European Union have explicitly set the target to become 'the most competitive knowledge-based economy in the year 2010.'

Following David Ricardo's notion of comparative advantages, economists stress the unambiguous gains from international trade. Public opinion however, does not seem to support that economist's view. An example is Gregory Mankiw, who, as chairman of the council of economic advisors, had pointed out that moving production overseas was just another way for the American economy to benefit from international trade. Mankiw's argument was economically sound, but politically unheard-of so that he really had a hard time defending that opinion during the 2004 American presidential elections (Mankiw and Swagel, 2005; Blinder, 2006).

This paper provides a follow up to a (small) part of that debate. Reduction of transaction costs through ICT and better transportation technology increased the scope for specialization. Moving fragments in the value chain abroad has become a more and more suitable strategy to exploit factor cost differentials and to increase competitiveness. The paper tries to assess the gains from this development by estimating the effects of offshoring on total factor productivity in the Netherlands. Our empirical model is based on concepts from modern theory of international trade and from transaction costs economics, and is especially inspired by the modelling of trade in tasks by Grossman and Rossi-Hansberg (2006a, 2006b). The contents of the paper is as follows. Section 2 gives a brief overview of relevant theoretical concepts, including the trade in tasks, for our empirical analysis. Section 3 reviews the literature on international specialization and fragmentation of the value chain, and the empirical evidence of the effect of these aspects of globalization on productivity. In section 4 we specify our empirical model and discuss its estimation results. Ample attention is paid to the construction of an indicator for vertical specialization at the macro level. Finally section 5 concludes.

2. Offshoring, transaction costs and trade in tasks

2.1 Transaction cost economics

As mentioned above, transaction costs play a major role in the decision to split up the production chain and to outsource parts of that chain. Ronald Coase (1937) introduced the transaction costs as 'the costs of using the price mechanism in the market' This concept was elaborated by Oliver Williamson, who defined transaction costs as the costs of running the economic system (see e.g. Williamson 1975; following Arrow, 1969). Nowadays the term transaction costs is used to describe all the costs incurred in setting up, making, and maintaining a transaction. Cheung (1987) describes transaction costs as all costs that are not conceivable in the so called 'Robinson-Crusoe economy'. North and Wallis (1994) distinguish between transformation costs and transaction costs. Transformation costs are incurred when the physical attributes of a good or service are changed. Transaction costs, on the other hand, are incurred when the property rights on a good or service change. Therefore transaction costs defy the existence of a frictionless economy: the neoclassical paradigm is only valid when there are zero transaction costs (North, 1991). Positive transaction costs influence allocation decisions by reducing the profitability of transactions. Some transaction which would otherwise be utility increasing may not occur when transaction costs exist.

What are the sources of these transaction costs? Williamson (1985) argues that transaction costs exist because of three phenomena: bounded rationality, opportunistic behaviour and asset specificity. *Bounded rationality* is based on two principles: informational complexities and informational uncertainty (Dietrich, 1994). Informational complexity refers to the fact that individuals have limited abilities to process all information that is available. Hence an individual is unable to process all relevant aspects of a transaction. Informational uncertainty on the other hand refers to the fact that it is impossible to perfectly foresee all future states of the world. Individuals engaged in a transaction can not perfectly foresee all contingencies involved in a transaction and therefore suffer from incomplete information (Tirole, 1988). When individuals are not globally rational, but behave according to bounded rationality, it is impossible to specify complete contracts without costs. Hence bounded rationality may lead to transaction costs. However, it is not a sufficient condition for such costs to occur.

Opportunistic behaviour refers to the 'self-interest seeking behaviour' of individuals (Williamson, 1985). Without opportunistic behaviour it would not be necessary to fully specify complete contracts. Therefore, the transaction costs which would arise through bounded rationality do not exist per se, in case individuals do not want to gain advantage over the loss of another individual. However, when individuals exhibit opportunistic behaviour the opposite is true. Individuals may use the incompleteness in contracts, which exist through bounded rationality, to their own gain. This opens up opportunities for strategic behaviour, and executive hazards. This in its turn causes the necessity for trading partners to monitor each other, and to enforce contracts legally.

Asset specificity is defined as the extent to which an investment supporting a transaction has more value in that specific transaction, than in any other purpose (McGuinness, 1994). Asset specificity determines the scope of the continuing interest of both contracting parties in each other (Williamson, 1985). When there is no asset specificity, markets are perfectly contestable, and individuals will not want to invest in continuing economic relationships (Dietrich, 1994).

Obviously, given the great variety and tine dimensional aspects of transaction costs, it is difficult to give an operational definition of this concept and quantify the transactions costs associated with trade. Of course, it is possible to calculate monetary values for transportation costs, contracting costs, legal fees etcetera. The measurement problem occurs with the more informal types of transaction costs, which relate for instance to trust, and institutional and cultural differences. In spite of these problems of definition and measurement some attempts have been made to estimate the size of transaction costs at the macro-level. Following the methodology of North and Wallis (1986), De Vor (1994) asserted that in 1990 total transaction costs in the Netherlands economy amounted to almost 53% of GNP. It implies that more than half of value added in production in the Netherlands relates to conducting transactions. In the period 1960-1990 total transaction costs increased with about 9 %-points. This can be ascribed completely to an increase in the private sector. According to De Vor's measurement transaction costs in the private sector are (in 1990) over 5 times higher than in the public sector. Van Dalen and Van Vuuren (2005) measure by means of occupational data that in the Netherlands approximately 25% of workers is employed in transaction jobs, and 29% if one includes transport tasks. However, these occupational data do not take into account time spent on coordination by production workers. Klamer and McCloskey (1995) note that one quarter of the GDP is related to persuasion, i.e. talks to make "real production" possible.

In their survey on "trade costs", Anderson and Van Wincoop (2004) illustrate the size of these trade costs by means of the tax equivalent of these costs: what would be the tax tariff on direct production costs if all trade costs where regarded as taxes – from a theoretical point of view trade costs have the same distortional effects on production as taxes. Anderson and Van Wincoop have a rather broad definition of trade costs so that it comprises most of the transaction costs discussed earlier in this section. Their main finding is that trade costs are large and variable. The example of the Barby doll, as discussed in Feenstra (1998), illustrates these large costs. The direct production costs of the doll are $1, but they are sold in the US for about 10$. So the costs of transportation, marketing, wholesaling and retailing have an *ad valorem* tax equivalent of 900%. In their own (rough) calculations Anderson and Van Wincoop arrive at an estimate of the tax equivalent of "representative" trade costs for industrialized countries of 170%. The number breaks down as follows: 21% transportation costs, 44% border related trade barriers and 55% retail and wholesale distribution costs (2.7 = 1.21*1.44*1.55). Anderson and Van Wincoop argue that further evidence on the importance of trade costs should be obtained by using microeconomic founded gravity equations. These models, inspired by Newton's equation of gravity in physics, relate the size of trade flows to GDP (analogue to mass in physics) and distance (De Groot et al, 2004). Including other variables in this model, which proxy (part of) transaction costs can give results on to what extent transaction costs influence international trade. Nowadays there is a rich literature on the effects of informal trade barriers on the level of trade, which stress the importance of transaction costs in international trade (see e.g. McCallum, 1995 or Helliwell, 1998)). For example, Den Butter and Mosch (2003) estimate a gravity equation to assess the effects of trust on trade flows and distinguish between formal and informal trust. It appears that an increase in both formal as informal trust reduces transaction costs and thus trade barriers and hence increases trade. Another example is De Groot et al (2004) who found that similar institutions in countries, and better institutions, enhance trade by reducing transaction costs.

2.2 Relevant concepts in globalization

Transaction costs reduction through ICT and economic reforms in some developing countries have opened up profitable business opportunities abroad. Firms can benefit from this trend of globalization in two ways, namely (i) exploitation of factor costs differentials and (ii) enlargement of sales areas (Gorter et al, 2005). In the former case firms try to lower their costs by reducing factor costs, hence increasing profits and/or competitiveness. In the latter case firms make the trade-off between economies of scale, which occur when all production facilities are located domestically, and gains from proximity to their sales area. Moving activities abroad reduces economies of scale, but also reduces costs of transportation, when firms will locate near sales areas. Advancements in ICT have reduced coordination costs significantly and hence reduced the importance of scale economies through physical proximity. Therefore, the reduction of transaction costs may either lead to a vertical or a horizontal split-up of the production chain.

These strategic decisions to move part of the production abroad can also be described as the “make or buy” and the location decision. These decisions bring about four possibilities indicated in table 1. Following Gorter et al (2005),te table provides a taxonomy which distinguishes between offshoring and outsourcing. Both terms are somewhat confusingly used to describe the general phenomenon of moving (parts of the) production abroad in this era of globalization. In the definition of table 1 offshoring relates to direct foreign investments (DFI). As mentioned above, these can be of a vertical and of a horizontal nature.

Table 1: Terminology in Production Fragmentation

	Domestic	**Abroad**
Within firm	Own production	Offshoring
Outside firm	Outsourcing	Offshore outsourcing

Closely connected to the “make or buy” and the location decision is the question about what tasks the firms will actually move abroad. Markusen and Strand (2007) argue that this is not only a question of skill-intensity, i.e. low skill tasks will be moved offshore to low wage countries, but also of many other characteristics like routinization, codifiability and the need for face-to-face contact. In this vein, Levy and Murnane (2004) argue that more routine parts of the production process can be moved offshore more easily, because there may arise fewer misunderstandings about relevant information. Leamer and Storper (2001) introduce codifiability of information as an important determinant for offshoring or outsourcing tasks. They distinguish between codifiable information and tacit knowledge. Codifiable information is information which can be computerized and fully documented, and hence can easily be exchanged over a large distance. For the exchange of tacit knowledge on the other hand, individuals would have to know each other (Grossman and Rossi-Hansberg, 2006a). Tasks using relatively more codifiable information are therefore more suited to move offshore than tasks using relatively more tacit knowledge. Blinder (2006) includes the need for geographical proximity as a determinant for the appropriateness of a task being offshored. For example, a task which needs regular direct face-to-face contact is relatively difficult to offshore.

2.3 Transaction costs and offshoring

Obviously transaction costs are a major determinant of the extent to which moving production abroad can be profitable. A reduction of transaction costs will most probably lead to an increase in the scale and scope of offshoring.and outsourcing. Empirical research confirms this hypothesis. Hummels et al (1999) find that from 1972 until 1990 there has been a significant increase in the international vertical specialization of the production process, i.e. a rise in offshoring, for almost al OECD countries (excluding Japan). These authors argue that only a minor reduction in formal and informal trade barriers increases the profitability of utilizing international factor cost differentials considerably. Chen and Chang (2006) repeat this exercise for Taiwan and Korea and find a similar conclusion for these two countries. Feenstra (1998) remarks that reductions in transportation and communication costs in recent years have led to a faster integration of the global economy, while on the other hand fostering a disintegration of the production process.

These characteristics of today's globalization also raises the need for a paradigm shift in the theory of international trade. (see for example Grossman and Rossi-Hansberg; 2006a 2006b and Baldwin and Robert-Nicoud, 2006). The argument is that many tasks, which were non-tradable yesterday, have become tradable today. In the days of Adam Smith and David Ricardo, communication between Britain and Portugal was as fast as the trading of goods itself. Production could very well be specialized within a production facility but it still required physical proximity. This has become less and less true in international trade.

2.4 Trade in tasks

From that perspective Grossmann and Rossi-Hansberg (2006a, 2006b) present a model for the determinants of international trade, which makes an explicit distinction between trade in goods (which is the standard approach to modelling international trade) and trade in tasks. Here production involves conducting a continuum of 'tasks'. Different economies are now not trading in finished goods, but it are these tasks, or sub-sets of the production process, which are tradable. Some tasks may require high-skilled labour input, while other tasks require low-skilled labour or even another factor inputs like capital or different categories of labour.

Tasks can be performed abroad when it is less costly for a firm to perform a task offshore than domestically. Off shoring tasks incurs transaction costs. The crucial assumption is that some tasks are moved abroad more easily than others. It implies that moving some tasks abroad may incur more transaction costs than other tasks. So when will firms choose to move tasks abroad? This will only be the case when the joint costs of foreign factor input and transaction costs are less than the domestic costs of factor input. Hence in this framework, some tasks will still be performed at home, while others can be performed abroad.

What are implications of this distinction in trade in goods and trade in tasks, which are relevant to our empirical analysis? Let us, for the sake of expositional purposes, assume that only low-skilled tasks can be moved abroad. By lowering transaction costs it becomes profitable to move more low-skill tasks abroad. Grossmann and Rossi-Hansberg distinguish three effects of the reduction in transaction costs; (i) a productivity effect; (ii) a relative-price effect and (iii) a labour-supply effect. The productivity effect occurs through a decline in the costs of tasks being moved abroad. Firms incur lower costs, since more tasks can be performed offshore less costly, which drives up the demand for domestic factor inputs, hence increasing the return to domestic factors. The relative-price effect occurs through a change in the terms of trade of a country. This effect is likely to influence the return on low-skilled labour adversely. An improvement in the terms of trade, defined by the price of exports in terms of imports, will put downward pressure on low-skill wage since the exporting, high-skill industry becomes more profitable and will draw resources from the import-competing sector. Finally the labour-supply effect occurs through the release of domestic labour, which is freed by moving labour abroad. This effect is also likely to depress low-skill wages.

Meanwhile the decrease in the costs of offshoring affects high-skilled labour and other factor inputs as well. Offshoring of low-skill tasks has no productivity effect for other factor inputs, since it has no direct effect on the wage bill of these other factors. However, the relative-price effect and the labour-supply effect do have such a direct effect. The relative-price effect, causing an increase in the terms of trade, boosts the high-skill intensive exporting industry and hence the return on high-skilled labour. The labour-supply effect drives down relative prices of low-skilled labour, which is equivalent to an increase in the relative price of high-skilled labour. All in all, the conclusion from this model is that a decrease in the costs of offshoring can affect the returns on low- and high-skilled labour in different ways. When, for low-skilled labour, the positive productivity effect outweighs the negative relative-price and labour-supply effects, low-skilled labour will benefit. Otherwise the return on low-skilled labour decreases. The return on high-skilled labour will increase in all cases, since both the relative-price effect and the labour-supply effect are positive. So form the perspective of distribution the important issue is whether positive effects for low-skilled labour outweigh the adverse effects. This appears to be different for a small Heckscher-Ohlin economy and for a large Heckscher-Ohlin economy. In the first case domestic low-skilled labour benefits from the increased offshoring and domestic high-skilled labour and other factors are unaffected. In the case of a large economy like for instance the United States, which can influence on world prices, the situation is different.. The question is whether the productivity effect outweighs the relative-price effect. This depends, for example, on the elasticity of demand of traded goods, which determines the relative strength of price-movements. The conclusion is that it equally possible for low-skilled labour to benefit than it is to loose out from the reduction in the costs of offshoring. As before, the return on high-skilled labour is only affected by the relative-price effect and hence benefits from reducing the costs of offshoring. These effects do not differ very much when the model allows for other tasks next to low-skill tasks to become tradable as well.

However, the effect that domestic factors can gain from offshoring tasks could also be predicted by Ricardian determinants like comparative advantages. So the question is whether the trade in tasks model really makes a difference in explaining trade flows. Baldwin and Robert-Nicaud (2006) argue that it does. The special feature of the trade in tasks model is that when certain tasks are moved abroad, this is done in all industries. For example, when low-skill tasks are moved abroad, this is done both in the industry which is intensive in low-skilled labour and in the industry which is intensive in high-skilled labour. Therefore trade in tasks will even occur when there are no differences in relative endowments. This kind of trade is not explained by the traditional Heckscher-Ohlin framework. The trade in tasks model thus successfully links trade and transaction costs to Trefler's (1995) 'missing trade puzzle' (Baldwin and Robert-Nicaud, 2006). That is why this model provides a theoretical argument of our empirical analysis in section 4. of the relationship between productivity and various types of off shoring for a trading country, such as the Netherlands. First the next section discusses some empirical studies of others with respect to offshoring and productivity gains.

3. Review of the empirical literature

3.1 Gains from offshoring?

We first discuss studies that focus on the gains from offshoring. The McKinsey Global Institute (MGI; 2003, 2005) estimates that for every dollar spent on offshoring, the American economy would gain an additional $1.12 till $1.14. These gains are propagate as lower consumer prices and higher producer profits. The MGI study shows that the gains of offshoring for France and Germany are considerably lower, i.e. an additional $0.74 and $0.86 respectively. MGI finds that the benefits of offshoring are largely dependent on labour market flexibility, i.e. the strength of the labour market to adjust, and on cultural and linguistic factors. For example, English as their first language makes easier for American firms to move abroad than for French and German firms. These cultural and linguistic factors are of course again linked to the concept of transaction costs. In their study for the United States Amiti and Wei (2004) estimate the effects on labour productivity of manufacturing and services separately. They find no significant effect of offshoring of manufacturing. They do however find a positive significant effect of moving services abroad. An increase in service-offshoring by 1 percentage point increases labour productivity by 0.43 to 0.57 percentage points. In a follow-up Amiti and Wei (2006) address possible endogeneity issues of the explanatory variables. In this more sophisticated analysis they now find a significant positive effect of offshoring of manufacturing on labour productivity as well.

From an extensive literature review of the effects of outsourcing and offshoring on productivity levels,. Bjerren Olsen (2006) concludes that no plain general result emerges from the literature. There are however some indicative conclusions. First it seems that the benefits of offshoring are subject to diminishing returns. Some studies point out that the productivity gains from offshoring manufacturing are actually quite small while the gains from offshoring services are large. This might be the case because the offshoring of services is a relatively new phenomenon compared to the offshoring of manufacturing. Offshoring of manufacturing may have reached its point of diminishing returns where additional investments are no longer profitable, while the benefits from service-offshoring are just being reaped. Bjerren Olsen also finds that the gains from service-offshoring are larger when a company is already active internationally.

3.2 Losses from offshoring?

The anti-globalization sentiment is that through the reduction in transaction costs and the opening up of labour-abundant BRIC economies (Brazil, Russia, India and China) not only low-skill jobs will move abroad, but in the long run also more high-skill jobs. Indeed, recently specific services, such as call centres, accounting services, but also high-tech production facilities such as computer software facilities have moved abroad, e.g. to India. It is feared that Western countries loose their comparative advantages to these high-pace developing countries. A study by Naghavi and Ottaviano (2004) challenges the notion of the previous sections that offshoring is an all-win game. They formulate a model in which offshoring might damage domestic economic growth, because offshoring can reduce innovation and hence technological progress. For example when firms decide to move part of their production process to low-wage countries, they usually only move production facilities which can benefit from the lower wages, but not research and development (R&D) facilities, which need the technologically advanced labour in the domestic country. This gives rise to reduced feed-back from production facilities to R&D facilities due to geographical distance. Also it is often assumed that increased competition stimulates innovation by firms. When firms move abroad to compete in costs, incentives to innovate may deteriorate, reducing overall economic growth domestically (Naghavi and Ottaviano, 2004).

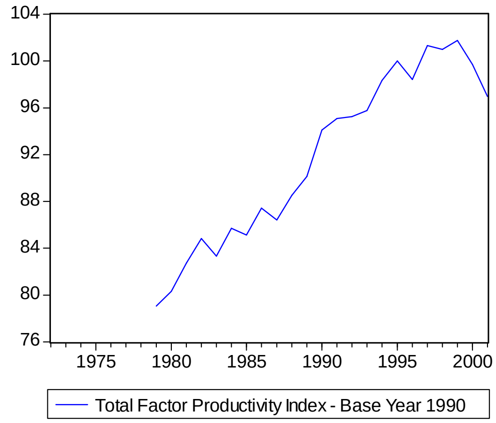
Apart from this possible negative effect of offshoring on R&D, the theoretical model of the previous section suggests that two other negative effects may occur, namely the relative-price effect and the labour-supply effect. When these effects are large they may outweigh the positive productivity effect. Bhagwahti et al (2004) put the relative-price effect in a historical perspective. They argue that a similar anti-globalization sentiment as today's existed in Europe in the 1950s when the American economy was rapidly expanding and in the United States in the 1970s when the Japanese economy was growing at a fast pace. Bhagwati et al conclude, however, that the relative-price effect has been relatively small in these situations and is unlikely to outweigh other beneficial effects. The public discussion on offshoring mostly focuses on the labour-supply effect. The argument is that when labour is moved abroad, unemployment will rise, since there are fewer jobs to be filled domestically. Some authors (see e.g. Biermans and Van Leeuwen, 2006) argue that this contention is an example of the so-called 'lump of labour fallacy', i.e. the presumption that in an economy only a limited and fixed amount of work needs to be done. This presumption is considered a fallacy by most economists, who argue that the amount of work is not static but adapts to demand. In the case of offshoring, when production jobs are moved abroad, there may be an increase in the number of jobs of those who coordinate production abroad.. Moreover, whereas domestic firms are moving jobs abroad, foreign firms will move jobs to the home-country. In this perspective Biermans and van Leeuwen (2006) find that jobs being moved to the Netherlands are mostly jobs in manufacturing.

In his study of the effects of offshoring on the Dutch labour market for the period 1996-2003. Vroom (2007) shows that the number of low-skill jobs was not affected adversely by offshoring during the whole sample period. However, the demand for high-skilled labour was affected adversely by offshoring during recession (2000-2003). During the economic boom in the sample period (1996-2000) and on average over the whole sample period the demand for high-skilled labour was also unaffected by offshoring. Domestic factor mobility determines the size of the labour-supply effect. With high labour mobility the negative labour-supply effect will be small. Labour market rigidities also bring about that short run effects of offshoring on the domestic economy are less favourable than long run effects (Bjerring Olsen, 2006).Egger and Egger (2001) find that offshoring leads to a decrease in labour productivity among low-skilled workers of 0.18% in the short run, but in the long run offshoring yielded a 0.53% increase in low-skill labour productivity. All in all some evidence suggests that the losses from offshoring may outweigh the benefits, at least in the short run. Whether this occurs is eventually an empirical question. The next section provides an answer to this question for the Netherlands.

4. Empirical analysis for the Netherlands

The model for trade in tasks in section 3 shows how reductions in the costs of offshoring can lead to productivity gains. This section tests this hypothesis by estimating the effects of offshoring on 'total factor productivity' (TFP) in the Netherlands. In our empirical framework TFP is that part of production growth, which can not be explained by the changes in capital or labour inputs. Productivity gains through offshoring is regarded as a possible determinant of that residual.[†] Figure.1 pictures the development of total factor productivity from 1979 until 2001. The overall trend appears to be upward, although the trend seems to reverse in the last two years of the reference period. Verbruggen (2001) argues that this downturn in TFP-growth is for the most part due to 'labour hoarding' in the economic recession of those years, i.e. employers did not lay off labour capacity because it was too expensive to make workers redundant and hire them again in the upsurge after the recession..

Figure 1: Total Factor Productivity in the Netherlands, 1979-2001



Source: EU KLEMS Database, March 2007

4.1 The model

In order to assess the effects of offshoring on TFP we estimate a production function for the Netherlands using yearly data from the observation period1972 - 2001. This production function is assumed to be of the Cobb-Douglas functional form and given by

$$Y_t = A_t F(K_t, L_t) \quad \textbf{(1)}$$

$$Y_t = A_t K_t^{\beta_1} L_t^{\beta_2} \quad \textbf{(2)}$$

where *Y* is output, *K* is capital input, *L* is labour input and finally *A* is the technology component or TFP. The subscript *t* refers to time and all variables, including *A* are allowed to vary through time in our model specification. For practical convenience we will drop the time subscript for the time being, and reintroduce it later, when we are going to estimate the model. The coefficients β_1 and β_2 represent production technology and jointly determine the returns to scale of both factors. function has the nice feature When β_1 and β_2 add up to one, the Cobb-Douglas production function exhibits constant returns, which is an assumption of the theoretical model in section 3. When the coefficients add up to more than one, the production function exhibits increasing returns to scale. When on the other hand they add up to less than one, we have decreasing returns to scale. Using this feature we can thus also easily check our assumption on returns to scale in the economy.

Taking the natural log of both sides of the production function yields the following expression.

[†] Usually economists assume that the main driver behind growth in TFP is technological growth, see e.g. Romer (2005).

$$y = a + \beta_1 k + \beta_2 l \qquad \textbf{(3)}$$

In equation (3)lowercase letters denote the natural log of there capital counterparts, so e.g. $y = \log Y$. In our specification we will let offshoring influence production through the technology factor, or:

$$a = \hat{a} + \beta_3 x^m + \beta_4 x^s + \delta \ \mathrm{z} \qquad \textbf{(4)}$$

In this expression x^m and x^s are a measure of international vertical integration of the production process in manufacturing and services respectively. Finally we include *z* as a list of control variables, with δ as the vector containing their respective coefficients. We estimate a number of alternative model specifications including additional control variables in order to improve the model and counter omitted variable bias. Substituting the expression for TFP in our production function yields the following log-linear regression equation to be estimated.

$$y = \hat{a} + \beta_1 k + \beta_2 l + \beta_3 x^m + \beta_4 x^s + \delta \mathrm{z} + \varepsilon \qquad \textbf{(5)}$$

In expression (5) ε is included to denote the error term. The coefficients of this expression are estimated using Ordinary Least Squares (OLS). It assumes that none of the independent variables is correlated with the error term. If this assumption does not hold, we need to find appropriate instruments and use Instrumental Variable (IV) estimation. The estimated coefficients β_3 and β_4 influence *a*, representing TFP. A positive value on the offshoring coefficients implies, that offshoring leads to an increase in TFP.

4.2 The data

In order to estimate expression (5) we use data from the EU KLEMS Database, March 2007. These include data on gross domestic product (*Y*), capital input (*K*) and labour input (*L*) over the observation period 1972-2001.[‡] We have adjusted this data for inflation by using the GDP price deflator (base year 1990) also included in the EU KLEMS Database.

In order to include the effects of offshoring in our model we need an appropriate measure for this phenomenon. For that reason we adapt the measure of vertical specialization of a country's production process in the international economy, used by Hummels et al (1999). This measure, which they label *VS*, measures the value of imported inputs embodied in goods that are exported, i.e. the foreign value added embodied in exports. This measure for each industry *i* reads as:

$$VS_i = \left(\frac{\text{imported inputs}_\text{i}}{\text{gross output}_\text{i}} \right) \cdot \text{exports}_\text{i} \qquad \textbf{(6)}$$

To obtain a *VS* measure for the country as a whole, Hummels et al sum over all industries and normalize by total exports. The latter is done in order to study the composition of trade. Aggregate *VS* increases when imported inputs increase or when exports increase in the sectors which utilize imported inputs relatively intensively. Our measure of vertical specialization used in the regression analysis, and which we will calculate for both manufacturing (*m*) and services (*s*), now becomes:

[‡] The data can be downloaded free from http://www.euklems.net.

$$VS^h = \frac{\sum_j VS_{hj}}{\sum_j X_{hj}}, \text{ with } j = \text{ all industries belonging to sector h}$$

$$\text{and } h = m, s \qquad \textbf{(7)}$$

For the computation of these measure of vertical specialization we use input-output tables from Eurostat and the OECD over the years 1972-2001.[§]. In matrix notation, the following expression is calculated.

$$VS^h = \mathbf{uA^M X} / X_h \qquad \textbf{(8)}$$

In expression (8) the vector ***u*** refers to a *1xn* vector of 1's. X is an *nx1* vector of exports and X_h is total number of exports. The matrix $\boldsymbol{A^M}$ is an *nxn* matrix in which element a_{ij} refers to the number of imported inputs M from industry i to produce one unit of output in industry j, i.e. $a_{ij} = M_i / Y_j$.

Table 2 shows the calculated indicators for vertical specialization for a number of years. In order to compare the results for the Netherlands with those of a number of large OECD economies we have also computed the indicators for Germany, the United States and Japan.

Table 2: Vertical Specialization in four OECD Countries

Vertical Specialization Index: Eurostat and OECD Database, Results								
	Netherlands		**Germany**		**United States**		**Japan**	
Year	Manufacturing	Services	Manufacturing	Services	Manufacturing	Services	Manufacturing	S
1970s*	0.2996	0.0000	**	**	0.0337	0.0000	0.1301	0.
1980s*	0.3991	0.0000	0.1315	0.0043	0.0510	0.0000	0.1503	0.
1990	0.3515	0.0093	0.1823	0.0052	0.0738	0.0000	0.1186	0.
2000	0.4397	0.0162	0.2688	0.0080	0.1205	0.0008	**	*

* *The indices for the Netherlands, United States and Japan do not cover the whole decades as some data were not available.*
*** No data available to calculate these values.*
Source: Own calculations based on OECD and Eurostat Input-Output Database following Hummels et al (1999)

The results from table 2 illustrate that the Netherlands is, of all countries considered, by far most vertically integrated with the rest of the world. This confirms the fact that the Netherlands, as a medium sized economy, is characterized by its large degree of openness to trade with the rest of the world. The table also shows that for all countries but Japan, the degree of vertical specialization is increasing and even accelerating, both in manufacturing and in services. Japan is characterized by a relative stable degree of vertical specialization. Vertical specialization in services has historically been very low. It seems that there has been almost no scope for offshoring in services until the 1990s. A scope for future research is to see whether the ICT-revolution in the beginning of the 21st century has enhanced the degree

[§] The data can be accessed for free at the website of the OECD, http://www.oecd.org, and the website of Eurostat, http://epp.eurostat.ec.europa.eu.

of vertical specialization in services, since the increased utilization of Internet and other more advanced communication techniques seems likely to have reduced transaction costs so that the offshoring of services has become more and more profitable. Figure 2 illustrates s the overall development of vertical specialization and offshoring in the Netherlands. We note that in constructing the yearly data we have used weighted averages to fill in missing data. That is because the database from the OECD does not contain input-output tables for all the relevant years..

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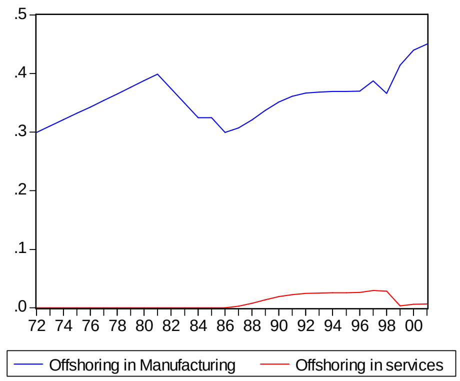
Figure 2: Vertical Specialization in the Netherlands – Offshoring Manufacturing and Services



These data are used to estimate a number of alternatives for specification (5). This specification also includes some control variables *z*. First of all we will include the usual determinant of growth in TFP, i.e. expenditure on research and development (R&D). R&D expenditure is often used as a proxy for innovation, and therefore as a determinant which endogenizes technological progress. For that reason, the Lisbon strategy of 2000 which purports to make the EU "the most competitive and the most dynamic knowledge-based economy in the world" by 2010" focuses on knowledge and research and development. One of the criteria of the Lisbon Strategy is that 3% of the GDP is invested in R&D. For our estimates we use data on R&D from the OECD R&D Expenditure Database, Volume 2006. Since R&D can have a long lasting effect on income it should be included as a stock variable. We specify the stock of R&D by aggregating R&D expenditure which depreciates 20 percent each year.

In one of our alternative specifications we let the parameter $\hat{a}$ be time-dependent, in order to allow for changes in the exogenous (and unexplained) part of technological progress through time. For that reason we split up our observation period of 30 years into three subperiods of 10 years by including two dummy variables for the years 1982-1991 and 1992-2001, which make the period 1972-1981 our base years.

4.3 Estimation results

Table 3 gives the estimation results of four variants of specification (5) where total output acts as dependent variable. Alternative 1 is a simple Cobb Douglas production function without any explanatory variables for TFP. In this alternative both the coefficients of labour and capital are positive and (highly) significant. In alternative 2 both indicators of vertical specialization are added to alternative 1. Here the indicator for offshoring of manufacturing obtains a highly significant coefficient with the expected positive sign. It implies that in the observation period vertical outsourcing of manufacturing contributed considerably to production and has therefore enhanced productivity. However, offshoring of services does not contribute much to productivity: the sign of its coefficient is positive indeed, but the effects not at all significant. It is interesting to note that in alternative 1 returns to scale (the sum of the coefficients of capital and labour input) is somewhat larger than one, suggesting some increasing returns to scale. In alternative 2 (and all other alternatives of the table) the returns to scale are closer to 1, suggesting constant returns to scale, which is more in line with our theoretical assumptions of section 3. This outcome can also be seen as a hint that by omitting determinants which endogenise part of the technological progress, returns to scale are overestimated. In alternative 3 we have included the stock of R&D as additional explanatory variable. This control variable does not bring about an improvement of our model; on the contrary: the coefficients of both offshoring manufacturing and of R&D are positive as expected, but standard errors are high so that the effects are not significant. Moreover, the coefficient value of labour is rather high and of capital rather low in this regression. The low coefficient value of the stock of R&D in alternative 3 suggests that R&D has contributed less to productivity growth in the Netherlands than offshoring. This is in conformity with the hypothesis that the Netherlands, as an open economy and an trading nation, has benefited much from the possibilities of globalization to reduce transaction costs and to offshore parts of the production chain. These innovations in trade may have been at least as important for productivity growth than innovations stemming from investments in R&D. A caveat here is that innovations through R&D and the possibilities to offshore manufacturing may be much related, which would explain that the coefficient become insignificant when both determinants are included as explanatory variables.

Finally, the results for alternative 4 show that de dummy variables for the subperiods do not obtain significant coefficient values, so that there seem to be no systematic changes in the exogenous part of TFP during the observation period.

Table 3: Estimation Results for four alternatives of Specification (5) – Ordinary Least Squares

Production Function Estimation, Results				
Dependent Variable: Output	$y = \hat{a} + \beta_1 k + \beta_2 l + \beta_4 x^m + \beta_5 x^s + \delta z + \varepsilon$			
Explanatory Variables	*Alternative 1*	*Alternative 2*	*Alternative 3*	*Alternative 4*
Residual TFP ($\hat{a}$ ")	0.8307*** (0.0779)	1.2129*** (0.0860)	0.6817** (0.2606)	1.2390*** (0.0895)
Capital (β_1) Natural log	0.2046*** (0.0288)	0.3539*** (0.0322)	0.1800*** (0.0461)	0.3571*** (0.0386)
Labour (β_2) Natural log	0.8329*** (0.0332)	0.6475*** (0.0391)	0.8377*** (0.0654)	0.6430*** *(0.0434)*
Offshoring Manufacturing (β_3)		0.4165*** (0.0720)	0.1424 (0.0904)	0.3913*** (0.0818)
Offshoring Services (β_4)		0.1003 (0.1467)	-0.1259 (0.1527)	-0.0324 (0.1854)
Control Variables				
Research and Development (δ_1) Natural log			0.0214 (0.0478)	
Dummy Variable 1982-1991 (δ_2)				0.0000 (0.0094)
Dummy Variable 1992-2001 (δ_3)				0.0063 (0.0102)
Returns to scale ($\beta_1 + \beta_2$)	1.0353	1.0014	1.0177	1.0001

Standard errors in parentheses: Significant at the 10 percent level;** Significant at the 5 percent level;*** Significant at the 1 percent level*

The previous analysis looks at the influence of offshoring manufacturing and services on *total* output. However, it is conceivable that offshoring manufacturing mainly affects output of the manufacturing sector, and offshoring services mainly the output of the service sector. Therefore we have also estimated a model specification using sectoral data inputs. The estimated regression equation for this specification is:

$$y_h = \hat{a}_h + \beta_{1h} k_h + \beta_{2h} l_h + \beta_{4h} x^h + \varepsilon \quad \text{with} \quad h = m, s \qquad \textbf{(9)}$$

The estimation results for both manufacturing and services are shown in table 4,.

Table 4: Estimation results for manufacturing and services sectors separately – Ordinary Least Squares

Production Function Estimation, Sectoral Level, Results		
Dependent variable: sectoral output $y_h = \hat{a}_h + \beta_{1h}k_h + \beta_{2h}l_h + \beta_{4h}x^h + \varepsilon$ with $h = m, s$		
Explanatory Variables	*Manufacturing*	*Services*
Residual TFP ($\hat{a}$ ")	0.8551***	0.5888***
	(0.0705)	(0.1405)
Capital (β_1) Natural log	0.2825***	0.2763***
	(0.0331)	(0.0442)
Labour (β_2) Natural log	0.7853***	0.7668***
	(0.0394)	(0.0520)
Offshoring Manufacturing (β_3)	0.3340***	
	(0.0929)	
Offshoring Services (β_4)		0.7208*
		(0.4157)
Returns to scale ($\beta_1 + \beta_2$)	1.0678	1.0431

*Standard errors in parentheses: * Significant at the 10 percent level;** Significant at the 5 percent level; *** Significant at the 1 percent level*

The results in table 4 on output of the manufacturing sector are quite similar to the results of alternative 2 in table 3 for total output. The coefficient of offshoring manufacturing obtains a positive sign and is again highly significant. The result of interest of table 4 is that for the output of the service sector. Here offshoring services obtains a positive sign and is rather high albeit only significant at the 10% level. As offshoring services is a rather recent phenomenon it seems plausible that its effect on productivity does not show up in the regression equation for total output. Now that a positive contribution shows up in explaining output of the service sector, it may indicate that offshoring services will, in the future, be an important source for productivity increases. A puzzling aspect of the regression outcomes of table 4 is that in both alternatives the returns to scale are rather high as compared with the outcomes of table 3.

4.4 Discussion

The regression results of tables 3 and 4 are bound to some caveats which open up a scope for future research We already mentioned the interaction between investments in R&D and offshoring. This is related to the possibility of endogeneity of our explanatory variables on offshoring. The use of OLS assumes that our regressors are exogenous, i.e. uncorrelated with the error term. However, offshoring may be endogenous in our model. In such cases instrumental variables should be used in order to avoid simultaneity bias. Endogeneity may be the result of unobserved effects, which are correlated with both productivity and offshoring (Bjerring Olsen, 2006). A reason may be that high-skilled labour intensive firms are more likely to move low-skilled labour offshore, and focus on their core competences, than firms with less labour skill diversity. A related problem is that of reverse causality. Offshoring may not be productivity increasing per se, but more productive firms may engage in offshoring more quickly. In this situation, productivity is in first instance increased by other determinants than offshoring. In order to deal with such simultaneity Amiti and Wei (2006) use a measure of the utilization of Internet and digital phones as an instrument for offshoring. A reason for selecting these instruments is the finding of Freund and Weinhold (2002) that internet penetration has a significant influence on the trade in services between countries.

Another suggestion for future research is to construct a panel dataset, by including more countries to our time-series. However, presently such dataset is difficult to construct as the OECD database does not contain input-output tables for consecutive years for many countries. These input-output tables are only available for different years for different countries so that it is difficult to construct consistent time series data for our measure of vertical specialization *VS*. When more consistent and recent data become available, it would be especially interesting to focus on the effects on productivity of offshoring services. Since there has been an ongoing improvement in the utilization of information- and communication technology, it seems likely that service-offshoring has increased in recent years.

All in all we acknowledge that our empirical analysis only provides a first indication of the importance of the effects of offshoring on productivity. Our conclusion so far is that offshoring has possibly enhanced productivity in 1972-2001, which raises hope for future offshoring opportunities and might temper anti-globalization sentiments.

5. Conclusions

This paper shows that transaction costs play a major role in the ongoing fragmentation of production and specialization which is a key feature of globalization. Such specialization brings about offshoring and outsourcing of tasks which are to be executed at those locations in the world where costs are lowest. If transaction costs are sufficiently low, offshoring will enhance productivity and therefore be welfare increasing. Our empirical time series analysis for the Netherlands, using indicators for vertical specialization, suggests that indeed such positive effects on productivity occur. These innovations in trade and in organizing production along with keeping transaction costs low, are at least as important for productivity growth in the Netherlands as innovations which stem from investments in R&D. Of course both types of innovations are much interconnected. A further investigation of the spill-overs between these different forms of innovations provides a scope for future research. Another subject for future research is to see whether the productivity increases through the reduction of transaction costs and the exploitation of possibilities for offshoring and specialization are of specific interest to a trading nation with an open economy such as the Netherlands. The suggestion is that such trading nations have comparative advantages in orchestrating production and in trade in tasks. It would imply extending our empirical analysis to other countries as well. The analysis could also be extended by estimating the effects of vertical specialization for more sectors of industry, or even by using micro data at the firm level

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