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OCCASIONAL PAPER**

The jobs content of UK  
trade 1995-2004

REBECCA RILEY, NATIONAL INSTITUTE  
OF ECONOMIC AND SOCIAL RESEARCH

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## About this publication

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# Foreword

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This report was carried out as part of the Department for Business, Enterprise and Regulatory Reform's employment research programme. It is one of two research reports prepared for a labour market conference on 'Globalisation and Labour Markets', held in London on 13 December 2007. Papers and presentations from this conference can be found here: <http://www.berr.gov.uk/employment/research-evaluation/emar-events/labour-market-conference/index.html>

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**Grant Fitzner**

Director, Employment Market Analysis and Research

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# Executive summary

*This paper considers the jobs associated with UK imports and exports. Based on analysis of the UK Input-Output tables it provides up-to-date estimates of the numbers of jobs involved in producing UK exports and the number of jobs that might be required if UK imports were produced domestically. Because UK imports tend to be more labour intensive than UK exports, 0.4 million more jobs were required to produce imports than exports in 2004. The wider gains from trade associated with this figure mean that UK consumers are able to benefit from higher spending.*

## Aims and methodology

The main aim of this paper is to develop estimates of the jobs associated with UK international trade. More precisely, within this broad aim, the objectives of this paper are twofold. First, to construct up-to-date estimates of the job content of UK exports and imports using a factor content methodology similar to that described in a recent study for the United States (Groshen, Hobijn and McConnell, 2005). Second, based on these estimates, to identify potential changes in the jobs associated with UK exports and imports.

The research reported here is based on secondary analysis of the Input-Output tables for the United Kingdom, published by the Office for National Statistics (ONS), and the UK Labour Force Survey microdata made available by the ONS through the UK Data Archive. Neither the ONS nor the UK Data Archive bear any responsibility for the analysis or interpretation of the data reported here.

This research combines the information on the structure of UK production and UK imports and exports in the Input-Output tables with information on the structure of UK employment from the Labour Force Survey. This enables the mapping of the links between UK trade and employment over the period 1995-2004.

## Background

Input-Output tables provide details of the production linkages in the economy. Analysing these it is possible to discern the nature of production involved in meeting net export demand. Together with information on the employment structure of industry production these data provide a means of detailing the relationships between imports, exports and the domestic labour market. This type of analysis is widely used to study the associations between international trade and the structure of labour demand. The findings here are not to be confused with the impacts of international trade on the labour market against a counterfactual situation in which international trade did not take place. Such an analysis would need to take into account the wider benefits of trade, in particular the general equilibrium effects that arise

through changes in prices and the productivity and economic growth benefits to the UK from focusing production on goods and services for which it has a comparative advantage.

## Main findings

The main findings of this study are as follows:

- In 2004, more than 8 million jobs would have been required to produce UK imports domestically. This number is to a large extent offset by the numbers of jobs involved in producing UK exports.
- The difference between the number of jobs needed to produce imports domestically relative to the number of jobs associated with exports has risen significantly since the middle of the 1990s. The majority of this increase reflects the deterioration in the trade balance, particularly in goods trade and in trade with EU countries, rather than a change in labour demand arising with increased openness to trade.
- If the trade account was in balance, then 0.4 million more workers would be needed to produce UK imports than exports. This situation arises because UK imports are relatively labour intensive in comparison to UK exports.
- However, employment in the UK would not necessarily increase by 0.4 million if the UK were to give up the wider benefits of trade, since the cost of these imports would generally be higher if produced in the UK. As a consequence demand for products would fall, moderating any increase in employment.
- The types of jobs associated with imports and exports have also been changing between 1995 and 2004. In particular, international trade has contributed to a shift in the industrial structure of employment away from manufacturing jobs towards financial & business services jobs.
- The analysis also reinforces the importance of building the skills of UK workers. International trade appears to be associated with a shift in the skill structure of employment away from routine unskilled jobs and towards more skilled managerial & professional occupations. The majority of this shift had taken place before the mid 1990s.

## About this project

This research was prepared for a Department for Business, Enterprise and Regulatory Reform (BERR) research conference on 'Globalisation and the Labour Market', held in London in December 2007. It was carried out as part of the BERR employment relations research programme.

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## CHAPTER ONE

# Introduction

The increasingly global nature of trade and the consequent offshoring of production, which with recent developments in technology affect a growing number of sectors, is without doubt one of the key features of economic growth today. On one conventional measure of trade openness (the volume of imports plus exports relative to GDP) the openness of the UK economy has risen from 41 per cent to 55 per cent in the 10 years to 2004 alone.<sup>1</sup>

Globalisation or international trade is often thought to have significant influences on job markets and the skill structure of labour demand (see Molnar *et al.*, 2007, for a recent review). Without attempting to cover this very broad topic, this paper provides an up-to-date analysis of the linkages between the structure of UK employment and the structure of international trade based on estimates of the factor content of UK imports and exports, calculated using the UK input-output framework. The analysis covers the period 1995-2004 and examines the factor content of goods and services trade and of trade with EU countries and with countries outside the EU. Moreover, the analysis explores the potential magnitude and distribution across skill groups of changes in UK labour demand associated with international trade.

The factor content methods used here involve estimating how much labour, including different types of labour, is used to produce UK exports and how much labour would be needed to produce UK imports domestically.<sup>2</sup> In previous studies the precise assumptions made in undertaking such calculations depends on both the available data and the specific nature of the research question. Here the methods described in Groshen *et al.* (2005), to derive the job content of US exports and imports, are adapted to the UK data. These methods are then extended to allow for a decomposition of the job content of net imports into two distinct terms:

- The first of these depends on the degree of openness to trade and captures changes in labour demand that arise with the specialisation in production made possible with international trade.
- The second term measures the job content of net imports associated with unbalanced trade. This term captures the jobs embodied in trade flows that are more likely to be associated with other macroeconomic phenomena rather than attributable to international trade *per se*.

There are a number of assumptions involved in deriving the type of estimates reported here and in interpreting them it is important to be clear about these restrictions. These estimates do take into account both the direct effect of trade flows on jobs and the indirect effects of trade flows on jobs that arise when the

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<sup>1</sup> More recent trade statistics are strongly influenced by VAT missing trader intra-community fraud (First Release: UK Trade, National Statistics, 2007).

<sup>2</sup> A useful overview of factor content methodology, its merits and limitations is provided in Wood (1994), chapter 3.

demand for one product also affects the demand for other products that are used as intermediate goods in production. Nevertheless, these calculations cannot be described as full general equilibrium estimates of the impacts of trade on UK employment. Most importantly in the current context, these estimates do not take into account the effects of trade on factor prices and prices in general or potential substitution between different factors of production (factor input shares are assumed to be constant). Hence, the estimates of jobs embodied in trade flows in this paper do not take into account the potential effects of international trade in lowering UK prices and factor prices and the knock-on effects this might have on demand for products and employment. Therefore, they do not capture the full effect of international trade on the UK labour market.

The structure of the paper is as follows. The next chapter discusses measurement and data issues, details of which are included in Annexes A and B. The main findings of the analysis are reported and discussed in chapter 3. Chapter 4 reports further findings on the industry and skill structure of jobs embodied in UK imports and exports.

## CHAPTER TWO

# Data and measurement

### 2.1 Measuring jobs embodied in trade

It is helpful to illustrate the basic concepts underlying the job content of net imports estimates of Groshen *et al.* (2005), and similar factor content studies, starting from a simple one industry-one commodity economy example.

Assuming that production in this economy requires the use of intermediate inputs equivalent to a share  $b$  of total output  $Y$  (intermediate inputs and value added), the amount of total output required to meet final demand  $F$  is simply  $Y=F+bY$ , which can be rearranged as  $Y=(1-b)^{-1}F$ . Assuming that net imports flow to final users, the amount of output required to produce net imports  $NM=M-X$ , where  $M$  denotes the value of gross imports and  $X$  denotes the value of gross exports, is  $(1-b)^{-1}NM$ .

To calculate what this means in terms of jobs, the amount of output required to replace net imports is multiplied by the number of jobs required to produce one unit of output,  $EMP/Y$ , where  $EMP$  is the number of people employed or jobs in the whole economy. Thus, the number of jobs embodied in net imports or the jobs content of trade,  $J$ , is measured as:

$$J = \frac{EMP}{Y}(1-b)^{-1}NM \quad (1)$$

This measure can also be written as the difference between the numbers of jobs which would be required to produce gross imports domestically less the numbers of jobs embodied in gross exports. Taking the UK in 2004 as an example, the value of imports exceeded the value of exports by £35 billion, and it required 30.7 million jobs to produce total output (intermediate and value added) of £2,152 billion, approximately half of which was used in intermediate production. The calculation in equation 1 would imply that there were 1 million jobs embodied in UK net trade in 2004, or 3¼ per cent of jobs.

Note that in this example the number of jobs embodied in net imports is essentially the deficit on the trade balance measured as a share of GDP. This is because in the above example the production of imports and exports is equally labour intensive, which follows from the assumption that there is only one industry and one commodity. Using input-output tables, which detail the production linkages in the economy, it is possible to take into account differences in the structure of production between imports and exports. For example, all else being equal, exports of 'high productivity' goods will be associated with fewer jobs than exports of 'low productivity' goods. There may also be a difference in the skill type of jobs embodied in trade, depending on the types of products that are exported versus those that are imported.

These points can be made more clearly if the expression in equation (1) is adapted to the multi-product/industry setting. In equation (2),  $j$  is a vector detailing the number of jobs embodied in UK net imports in different industries. The sum of these elements equals the total number of jobs embodied in total net

imports. The term  $\hat{y}^{-1}e$ , in equation (2), is an industry-by-industry matrix where diagonal elements give the ratio of jobs to gross output and off-diagonal elements are equal to zero. This is similar to  $EMP/Y$  in equation (1). The term  $L$ , in equation (2), is an industry-by-product matrix which details the way that final demand for products is turned into industry total output, taking into account the direct and indirect effects on output of demand for products, and is similar to  $(1-b)^{-1}$  in equation (1). The elements of vector  $m$  give the value of gross imports for each product in the economy, the sum of which equals the value of total gross imports,  $M$  above. Similarly, the elements of vector  $x$  give the value of gross exports of each product in the economy, the sum of which equals the value of total gross exports,  $X$  above. Details of the derivation of equation (2) using the UK Input-Output tables are shown in Annex B.

$$j = \hat{y}^{-1}eL(m - x) \quad (2)$$

The expression for jobs embodied in net imports in each industry in equation (2) can be decomposed into two components as in equation (3) below. There, the first term in brackets gives the labour content of net trade that arises from the difference in the distribution across products of 1 £ of imports (summarised in  $m/M$ ) and 1 £ of exports (summarised in  $x/X$ ) and depends on the scale of trade,  $\frac{(M+X)}{2}$ , or the degree of openness. In the one-industry/one-product example above this term was missing (equal to zero), because the distribution of trade across products was by definition the same for exports and imports. The second term in brackets in equation (3) gives the labour content of net trade that arises when trade is unbalanced, i.e. when the trade balance,  $(M - X)$ , is different from zero. This is independent of differences in the distribution across products of imports versus exports.

$$j = \left\{ \hat{y}^{-1}eL \frac{(M+X)}{2} \left( \frac{m}{M} - \frac{x}{X} \right) \right\} + \left\{ \hat{y}^{-1}eL(M - X) \frac{\left( \frac{m}{M} - \frac{x}{X} \right)}{2} \right\} \quad (3)$$

It is useful to make the distinction between these two separate parts of the factor content of net imports, as measured in Groshen *et al.* (2005), as these are often interpreted differently (Wood, 1994; Cortes *et al.*, 1999):

- On its own, the first term in brackets in equation (3) measures the jobs embodied in international trade when trade is balanced, capturing the effects on factor demand associated with the specialisation in production facilitated by international trade. This term is commonly interpreted as a proxy for the changes in labour demand that arise with international trade (subject to the caveats that accompany factor content studies).
- By contrast, the second term in brackets in equation (3) is thought of as capturing the jobs embodied in trade flows associated with other macroeconomic phenomena rather than a labour market effect of international trade.

## 2.2 Data

The input-output tables for the UK are available to download from the ONS for the period 1992-2004, detailing production linkages between 123 industry and product groups defined by SIC2003. This provides information on imports and exports for each of these products and the decomposition of these into goods

and services and EU and non-EU trade. Estimates of gross industry output are also available.

There are a number of issues in deriving the data needed to construct estimates of the way in which demand is linked to total supply (in equation 2 above this refers to  $L$ ). First, and probably most importantly, the supply matrix is not published in its entirety because of disclosure concerns. Diagonal elements of the matrix (and these are most important), column totals and row totals are published for every year. The ONS have published a detailed inverse Leontief matrix for 1995, providing some additional information. However, this is relatively out of date and is not useful for linking the production data to industry employment (since it measures product groups rather than industry groups). The full supply matrix is published for a disaggregation of the economy into 30 industry groups for the years 1998-2004. In this paper these 'aggregate' supply matrices are used to construct detailed supply matrices for 1997 and 2004. Details of industry/product groups are given in Annex A and details of the assumptions involved in constructing these detailed supply matrices are given in Annex B. The construction of the detailed matrices allows the calculations to take into account more accurately differences in trade intensities between industry/products and differences in labour requirements across industry/products.

Another issue is the availability of the intermediate use matrix in purchasers' prices only. It is necessary to convert these to basic prices for comparison to the supply matrix. Again, details of the assumptions involved are given in Annex B.

Industry employment data are derived from the Quarterly Labour Force Survey (LFS) microdata records.<sup>3</sup> Industries in the LFS are coded to SIC(92) over the period 1994-2006. These are matched to the industry categories in the detailed UK Input-Output tables, which are classified on the basis of SIC(2003). In most instances differences between SIC(92) and SIC(2003), which largely occur between industry classes and sub-classes (4/5 digit level) within industry groups (3 digit level), do not cause difficulty in mapping the LFS data to the industry categories in the detailed UK Input-Output tables. The latter typically do not disaggregate beyond the 3 digit level.<sup>4</sup>

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<sup>3</sup> The levels and rates used in this analysis are derived from LFS microdata and will not aggregate to the levels published in the ONS Labour Market Statistics First Release and LFS Quarterly Supplement tables, as they are not based on the most up-to-date population estimates.

<sup>4</sup> Mismatch between the employment data derived from the LFS and the Input-Output data will arise from the inclusion of 'Head offices' within class 74.15 in SIC(2003), coded to the main activity of the businesses they serve in SIC(92), and the move of 'Operation of coin-operated photographic machines' from group 74.8 'Miscellaneous business activities not elsewhere classified' in SIC(92) to group 93.0 'Other service activities' in SIC(2003). Details of differences between SIC(92) and SIC(2003) and the likely implications for economic statistics are described in Jones (2003).

## CHAPTER THREE

# UK jobs embodied in trade

### 3.1 Results

Table 1 reports calculations of the employment content of international trade using the methodology and data described in the previous chapter and annexes to this report. Figures are shown for the employment content of gross imports, gross exports, and net imports (the difference between gross imports and gross exports). A positive number for the jobs content of net imports implies that the UK would need to employ additional labour if it were to produce net imports domestically. Conversely, if the number of jobs embodied in net imports is negative, this implies that more jobs are required to produce UK exports than to produce imports domestically. It is worth reiterating that the estimated jobs content of trade should not be interpreted as the impact of trade on employment, for the reasons discussed in chapters 1 and 2.

**Table 1. UK jobs embodied in international trade (millions)**

Year	1997 technology*			2004 technology*		
	Gross imports	Gross exports	Net imports	Gross imports	Gross exports	Net imports
1995	7.6	7.4	0.2	8.0	7.8	0.2
1996	7.8	7.6	0.2	8.2	7.9	0.2
1997	7.5	7.4	0.1	7.8	7.7	0.1
1998	7.7	7.3	0.4	8.0	7.5	0.4
1999	7.9	7.2	0.7	8.2	7.4	0.8
2000	8.6	7.7	0.9	9.0	8.0	1.0
2001	8.6	7.5	1.1	8.9	7.8	1.2
2002	8.6	7.3	1.2	8.8	7.5	1.3
2003	8.2	7.1	1.2	8.5	7.3	1.2
2004	8.0	6.8	1.2	8.2	7.0	1.3

Source: Author's calculations based on UK Input-Output tables & Labour Force Survey.

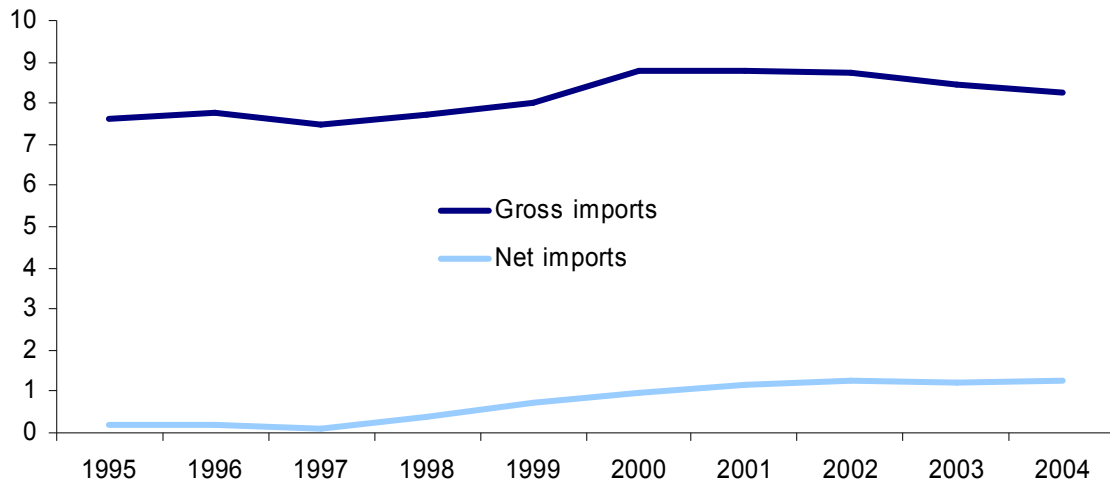
Note: \* Technology year refers to the date of the Input-Output data used to calculate the requirement matrix.

In Table 1 estimates are shown based on two separate assumptions about the UK production technology, one derived from the 1997 input-output tables, and the other derived in a similar manner from the 2004 input-output tables. This highlights changes in the job content of international trade that have occurred over time due to changes in the UK production structure independently of the distribution of trade across different products. In the case of net imports these changes are relatively minor. Generally in what follows, comparison over time are made using the 1997 production technology to estimate the employment content of trade in the years 1995-1997 (and sometimes 1998) and the 2004 production technology to estimate the employment content of trade in 2004.<sup>5</sup> For the years 1998-2003, estimates represent a weighted average of the results obtained using

<sup>5</sup> Export and import values (and hence the calculations of the job content of these) are inflated by VAT missing trader intra-community fraud (First Release: UK Trade, National Statistics, 2007). This mainly affects the data and calculations for 2001-3.

the two different technologies, with more weight attributed to the results obtained using the 2004 production technology for years closer to 2004.

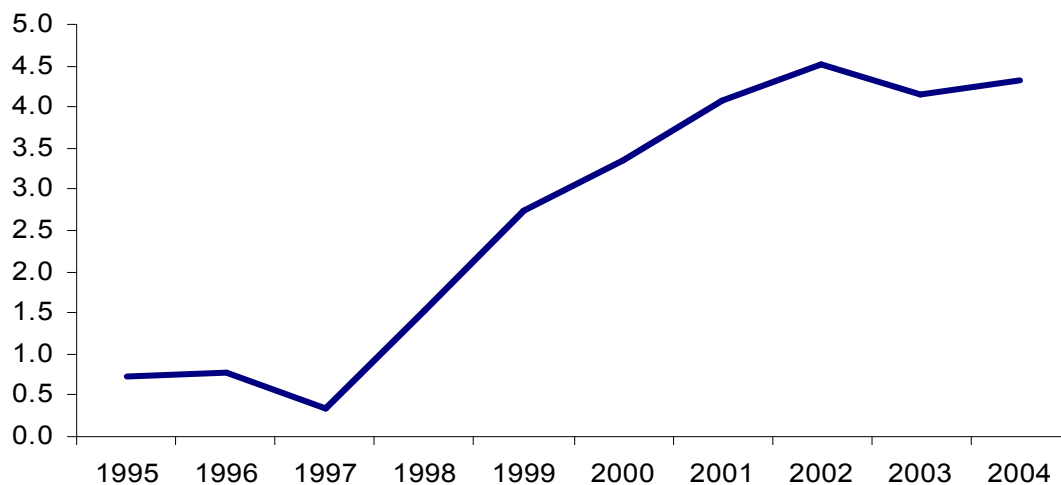
**Chart 1. UK jobs embodied in gross and net imports (millions)**



Source: Author's calculations based on UK Input-Output tables & Labour Force Survey.

The results in Table 1 suggest that the labour content of imports and exports are of a similar magnitude, between 7 and 9 million jobs per annum. However, there is a small difference, which has been gradually rising over the period shown, as illustrated in Chart 1 by the jobs embodied in net imports. In 2004 the job content of net imports was 1.3 million. In other words, if UK net imports were to be produced domestically in 2004, this would require 1.3 million jobs. For the years shown, the job content of net imports was at its lowest in 1997 at 0.1 million. Chart 2 illustrates the jobs content of net imports measured relative to total employment, which has risen between 1997 and 2004 from 0.3 to 4.6 per cent.

**Chart 2. UK jobs embodied in net imports as a share of total employment (per cent)**



Source: Author's calculations based on UK Input-Output tables & Labour Force Survey.

The rise in this measure of jobs embodied in net trade is mostly associated with the deterioration in the trade balance. Table 2 shows the overall measure of jobs embodied in net trade, measured as a share of total employment, decomposed into the two terms shown in equation (3). That is, a balanced trade term proxying changes in labour demand associated with international trade, and an unbalanced trade term measuring jobs embodied in trade that are explained by the factors underlying the trade deficit.

**Table 2. UK jobs embodied in net imports (share of total employment)**

	Total	Balanced trade	Unbalanced trade
1995	0.7	0.3	0.4
1996	0.8	0.5	0.3
1997	0.3	0.6	-0.2
1998	1.5	0.7	0.9
1999	2.8	1.0	1.8
2000	3.4	1.3	2.1
2001	4.2	1.4	2.8
2002	4.7	1.6	3.1
2003	4.3	1.6	2.8
2004	4.6	1.5	3.1

Source: Author's calculations based on UK Input-Output tables & Labour Force Survey.

The change in the balanced trade effect suggests that international trade was associated with a small increase in jobs embodied in UK net imports of less than 1 per cent of total employment between 1997 and 2004. This arises mainly because the production of UK imports has become increasingly labour intensive (measured using UK production methods) relative to the production of UK exports.

Most of the rise between 1997 and 2004 in jobs embodied in UK trade is explained by the unbalanced trade term. This suggests that the deterioration in the trade balance over this period, likely to be explained in large part by the weakness of savings and strong population growth, was associated with an increase in jobs embodied in net imports of  $3\frac{1}{3}$  per cent of employment (3.1 per cent in 2004 less -0.2 per cent in 1997).<sup>6</sup>

The detailed UK input-output data distinguish between trade in goods and services and trade from EU and non-EU countries. Table 3 shows the breakdown of jobs embodied in gross imports, gross exports and net imports between goods and services trade.

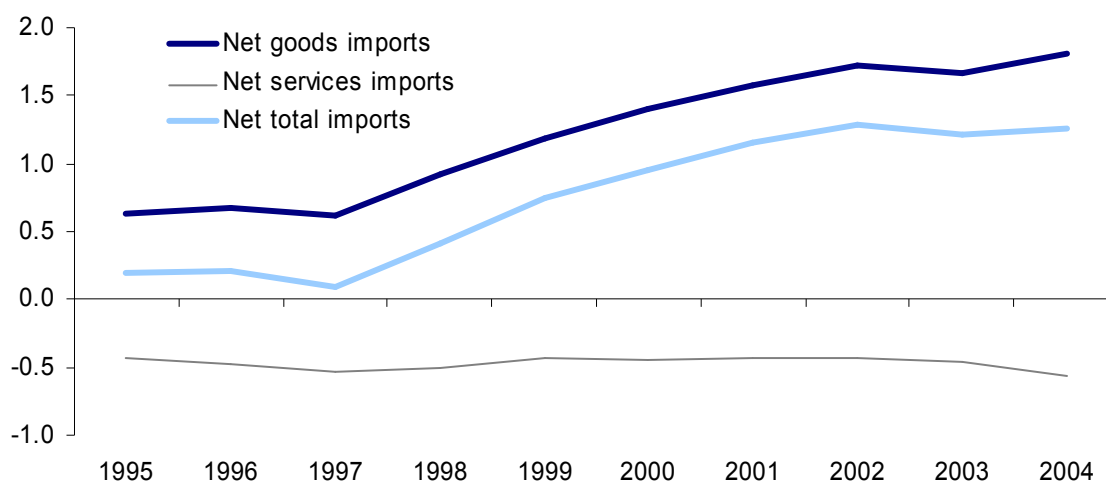
<sup>6</sup> Changes over time in the jobs content of imports might appear slightly larger if these were calculated using real rather than nominal trade and output values (as in e.g. Sachs & Shatz, 1994). This is because the external trade prices are falling relative to the GDP deflator over this period.

**Table 3. UK jobs embodied in goods and services trade (millions)**

	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Goods imports	6.1	6.2	5.9	6.1	6.2	6.9	6.9	6.9	6.6	6.4
Goods exports	5.4	5.5	5.3	5.2	5.1	5.5	5.4	5.2	4.9	4.6
Net goods imports	0.6	0.7	0.6	0.9	1.2	1.4	1.6	1.7	1.7	1.8
Services imports	1.6	1.6	1.5	1.6	1.8	1.9	1.9	1.9	1.9	1.8
Services exports	2.0	2.1	2.1	2.1	2.2	2.3	2.3	2.3	2.3	2.4
Net services imports	-0.4	-0.5	-0.5	-0.5	-0.4	-0.4	-0.4	-0.4	-0.5	-0.6
All imports	7.6	7.8	7.5	7.7	8.0	8.8	8.8	8.8	8.4	8.2
All exports	7.4	7.6	7.4	7.3	7.3	7.8	7.6	7.5	7.2	7.0
Net imports	0.2	0.2	0.1	0.4	0.8	1.0	1.2	1.3	1.2	1.3

Source: Author's calculations based on UK Input-Output tables & Labour Force Survey.

Chart 3 illustrates graphically the breakdown of jobs embodied in net imports between goods and services trade. This suggests that the number of jobs embodied in net services imports is negative, i.e. services trade runs a jobs surplus. In both 1997 and 2004 the UK exported services output equivalent to approximately ½ million jobs per annum. In contrast, less people are employed in producing goods exports than would be needed to produce goods imports domestically. This gap has increased from 0.6 million jobs in 1997 to 1.8 million jobs in 2004. Thus, the rise in the job content of goods trade entirely explains the rise in the job content of total trade between 1997 and 2004. The increase is due to a rise in the number of jobs embodied in imports as well as a fall in the number of jobs involved in meeting export demand.

**Chart 3. UK jobs embodied in net imports of goods and services (millions)**

Source: Author's calculations based on UK Input-Output tables & Labour Force Survey.

In Table 4 UK jobs embodied in net imports of goods and services are decomposed into balanced and unbalanced trade terms, similar to the breakdown in Table 2 for overall trade. In Table 4 UK jobs embodied in net imports are shown in millions rather than as a share of total employment as in Table 2. The bottom rows of Table 4 are commensurate to the numbers in Table 2.

Most of the 1.8 million jobs embodied in net goods imports in 2004, is explained by the deficit on the trade account for goods (as represented by the “Goods unbalanced” term in Table 4). Similarly, the 1.2 million increase in the number of jobs embodied in net goods imports between 1997 and 2004 is explained by the rise in the deficit over this period. In 2004 only 0.3 million jobs embodied in net goods imports were associated with the effects of international trade on labour demand (as represented by the “Goods balanced” term in Table 4).

The 0.6 million jobs that are required to produce net services exports (shown in Table 4 as -0.6 million jobs embodied in net imports) reflect the trade surplus in services trade rather than an increase in labour demand associated with international trade.

**Table 4. UK jobs embodied in net imports of goods and services (millions)**

	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Goods balanced	0.2	0.2	0.2	0.2	0.3	0.4	0.4	0.4	0.4	0.3
Goods unbalanced	0.4	0.5	0.4	0.7	0.9	1.0	1.2	1.4	1.3	1.5
Net goods imports	0.6	0.7	0.6	0.9	1.2	1.4	1.6	1.7	1.7	1.8
Services balanced	-0.1	-0.1	-0.1	-0.1	0.0	-0.1	0.0	0.0	0.0	0.0
Services unbalanced	-0.3	-0.4	-0.5	-0.5	-0.4	-0.4	-0.4	-0.4	-0.5	-0.6
Net services imports	-0.4	-0.5	-0.5	-0.5	-0.4	-0.4	-0.4	-0.4	-0.5	-0.6
All balanced	0.1	0.1	0.1	0.2	0.3	0.4	0.4	0.4	0.4	0.4
All unbalanced	0.1	0.1	-0.1	0.2	0.5	0.6	0.8	0.9	0.8	0.8
Net imports	0.2	0.2	0.1	0.4	0.8	1.0	1.2	1.3	1.2	1.3

Source: Author's calculations based on UK Input-Output tables & Labour Force Survey.

Table 5 shows the job content of trade with EU and non-EU countries. These are shown for 1998 and 2004 rather than 1997 and 2004, because of a break in the country coverage of these data between 1997 and 1998. From 1998 onwards the trade data for the EU include trade with 25 member states.

**Table 5. UK jobs embodied in trade with EU and non-EU countries (millions)**

	EU countries*		Non-EU countries	
	1998	2004	1998	2004
Goods imports	3.4	3.7	2.7	2.7
Goods exports	3.1	2.6	2.0	1.9
Net goods imports	0.3	1.0	0.6	0.8
Services imports	0.8	1.0	0.8	0.9
Services exports	0.8	1.0	1.3	1.4
Net services imports	0.0	0.0	-0.5	-0.6
All imports	4.2	4.6	3.5	3.6
All exports	4.0	3.6	3.3	3.4
Net imports	0.3	1.0	0.1	0.2

Source: Author's calculations based on UK Input-Output tables & Labour Force Survey.

Note: \* European Union data cover 25 member states

Overall it would appear that the number of jobs embodied in net imports, and increases in this number between 1998 and 2004, arise largely from trade with EU countries. The relatively small job content of net imports from countries outside the EU comes about via the jobs surplus in services trade (shown as a negative value in Table 5), which offsets the jobs deficit against non-EU countries in goods trade. The UK does not hold a jobs surplus in services trade with EU countries and the rising number of jobs embodied in net goods imports from the EU implies that in 2004 the job content of net imports from the EU accounts for more than 80 per cent of the job content of all net imports.

In Table 6 UK jobs embodied in net imports of goods and services from EU and non-EU countries are decomposed into balanced and unbalanced trade terms, similar to the breakdowns in Tables 2 and 4.

The estimates in Table 6 suggest that balanced trade with countries outside the EU is associated with a small number of jobs embodied in net imports of 0.1 million. This is associated entirely with goods trade. In 1998 balanced trade with the EU was associated with a similar number of 0.1 million jobs embodied in net imports. In 2004 the jobs embodied in net imports associated with balanced trade with the EU remains small, but has increased to 0.3 million jobs. Again, this is associated entirely with developments in goods trade. It appears that between 1998 and 2004 the labour intensity of UK goods imports from the EU (measured using UK production technologies) has increased relative to the labour intensity of UK goods exports to the EU.

**Table 6. UK jobs embodied in net imports from EU and non-EU countries (millions)**

	EU countries*		Non-EU countries	
	1998	2004	1998	2004
Goods balanced	0.1	0.3	0.1	0.1
Goods unbalanced	0.2	0.8	0.5	0.7
Net goods imports	0.3	1.0	0.6	0.8
Services balanced	0.0	0.0	0.0	0.0
Services unbalanced	0.0	0.0	-0.5	-0.6
Net services imports	0.0	0.0	-0.5	-0.6
All balanced	0.1	0.3	0.1	0.1
All unbalanced	0.2	0.7	0.0	0.1
Net imports	0.3	1.0	0.1	0.2

Source: Author's calculations based on UK Input-Output tables & Labour Force Survey.

Note: \* European Union data cover 25 member states

## 3.2 Discussion

This analysis suggests that the number of UK jobs required to produce net imports domestically has increased quite significantly between 1997 and 2004 and this is largely down to a rise in the number of jobs embodied in net imports of goods from the EU. In interpreting these developments it is helpful to consider how these changes come about. As discussed in chapter 2 it is possible to think of the number of jobs embodied in net imports as determined by two factors: the labour intensity of imports versus exports and the magnitude of imports versus exports. The analysis here suggests that it is the latter of these that explains the

majority of the current level and increase since 1997 in the job content of net imports. In other words, the estimated jobs deficit is mostly explained by the deficit on the trade balance rather than by a reduction in labour demand brought about through international trade.

The deterioration in the trade balance since 1997 and the associated rise in the job content of net imports, are likely to reflect the weakness of savings (and the strength of consumer spending) observed over this period as well as strong growth in labour supply necessitating capital inflows and imports for use in intermediate production. In a “no trade” counterfactual economy, these developments would most likely have manifested themselves in rising prices and weaker demand, rather than in an increase in jobs relative to the actual situation. Therefore, it makes sense to separate out this component of the jobs content of net imports.

Comparing the timing of changes in unemployment with the estimated increase in the job content of net imports further highlights that most of the increase in the jobs embodied in net imports does not reflect a worsening of the employment situation arising from international trade. In particular:

- Between 1997 and 2004 the number of jobs embodied in total net imports rose by 14,000 jobs per month on average. Most of this increase occurred between 1997 and 2001, when the increase in the employment content of net trade rose on average by 22,700 heads per month, as the trade balance fell from 0.2 to -2.7 per cent of money GDP. At the same time the unemployment rate fell from 7 per cent to less than 5 per cent.
- Between 2001 and 2004 the employment content of net trade rose on average by a much smaller 2,300 heads per month. During this time the trade balance deteriorated only a little further from its position in 2001 and further falls in unemployment were relatively minor.

Thus, purely on the basis of timing, it would seem difficult to argue that the measured rise in jobs embodied in trade has impacted adversely on employment opportunities in the UK.

Therefore, the analysis suggests that the majority of jobs embodied in net imports, and the change since the middle of the 1990s, is explained by factors other than international trade. In particular, the factor content of balanced trade estimates, which adjust for the trade deficit, suggest that only around 0.4 million more workers would be needed to produce UK imports than exports in 2004. This effect arises because it took 5.7 per cent more labour to produce a given amount of imports than it did to produce the same amount of exports (in nominal terms) in 2004. Thus, in comparison to UK exports, UK imports were labour intensive. As such, a shift in production away from imported goods towards exported goods is associated with a small reduction in labour demand. In comparison, in 1997 it took only 1.9 per cent more labour to produce a given amount of imports than it did to produce the same amount of exports (in nominal terms), equivalent to 0.1 million jobs at that time. The increase in the relative labour intensity of imported versus exported products between 1997 and 2004 is attributable to increases in the labour intensity of imports from the EU relative to exports to the EU.

Speculatively, the emergence of trade with lower labour cost EU countries may have contributed to the estimated increase in the labour content of imports from

the EU (measured per unit) relative to exports from the EU. However, it is difficult to draw strong conclusions about the nature of trade specialisation and its causes without taking into account the nature of production amongst the UK's trading partners or without looking at the factor intensity of domestic consumption (Kwok, 2006; Leamer, 1980; Wood, 1995). The estimates here measure the labour intensity of imports if these were produced in the UK, rather than if these were produced in the country of origin.

These figures for the UK can be compared to the patterns seen in the US data. There are several parallels. Groshen *et al.* (2005) find a relatively sharp increase in the jobs content of US net imports between 1997 and 2003 of 2.9 million jobs. As in the UK, the majority of this increase takes place before 2001 and coincides with a sharp deterioration in the trade balance. Another similarity between the UK and US figures is the finding of a jobs deficit in goods trade and a jobs surplus in services trade.

There are also key differences between these estimates of the UK job content of net imports and the estimates in Groshen *et al.* (2005) for the US. Groshen *et al.* (2005) suggest that the job content of US net imports in 2003 amounted to 2.6 million, equivalent to 2.4 per cent of total payroll employment. The estimates in this paper suggest that the job content of UK net imports in 2003 amounted to 4.4 per cent of total employment. This difference in magnitude is all the more notable given the size of the US trade deficit, which is larger than the UK equivalent. Of course, direct comparison of these figures is likely to be complicated by differences in details of the methodology. For example, the US figures are derived from a significantly more disaggregated grouping of industry/product categories (192 groupings, see Chentrens and Andreassen, 2003), which may account for some discrepancy between the figures.<sup>7</sup> Productivity differentials will also help to explain some of the difference in estimates of the jobs content of trade. A US worker generates on average 23 per cent more output per annum than a UK worker<sup>8</sup>, which, all else being equal, implies that fewer workers are required to produce a given amount of output, and hence a given amount of net imports. But, these differences are unlikely to account for much more than a quarter of the discrepancy between the US and UK figures.

Most of the difference between the figures for the US and the UK is explained by differences in the estimated labour intensity of imports versus exports. The estimates in Groshen *et al.* (2005) imply that US imports are significantly less labour intensive than US exports. This seems counter-intuitive, as one might expect US imports to be relatively labour intensive given the skill and capital intensity of US production. This finding, first observed in Leontief (1953), has become known as the Leontief paradox. The apparent paradox is partly explained by the failure to take into account in these estimates the nature of production in US import source countries (Kwok, 2006), where production of

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<sup>7</sup> It is also unclear how imports are treated in the requirement matrix in the Groshen *et al.* (2005) study. In this paper, for the purposes of calculating the jobs that would be required if all imports are produced domestically, import market share is assumed to be zero. If instead one allows imports to be used as intermediate inputs to produce final demand ("other imports" in this context), then the job content of UK net imports equals 0.1 per cent of total employment in 2004 rather than the 4.6 per cent of total employment illustrated in chart 1.

<sup>8</sup> Source: Office for National Statistics.

comparable goods may be considerably more labour intensive, and the failure to take into account the labour content of non-comparable imports (Leamer, 1980). The question that arises is why a similar paradoxical result is not found in factor content estimates for the UK. One explanation is that differences in production methods between the UK and its trading partners are likely to be smaller than differences in production methods between the US and its trading partners. This is because globally the US is the technology leader and because production methods are likely to be more integrated amongst comparatively small and proximate EU countries (the UK's main trading partners), than between the US and its trading partners.

### 3.3 Summary

To summarise, in 2004, the most recent year for which data is available, the job content of UK net imports is estimated at 1¼ million jobs. Underlying this figure is a larger labour deficit of 1.8 million jobs associated with trade in goods and a labour surplus of 0.6 million jobs associated with services trade. In 2004 1 million jobs would be required to replace net imports from the EU countries, and a ¼ million jobs would be required to replace net imports from the non-EU countries.

The jobs content of trade has risen significantly since the middle of the 1990s. This is mainly due to a rise in the job content of net goods imports from the EU countries, as exports have fallen and imports have increased. If the trade account was in balance, international trade would be associated with a relatively small jobs deficit of 0.4 million. The fact that there is any job deficit in this situation arises because UK imports are relatively labour intensive in comparison to UK exports. The majority of the rise in the labour content of net imports between the mid 1990s and 2004 reflects the deterioration in the trade balance rather than a shift in labour demand arising with international trade.

## CHAPTER FOUR

# The structure of UK jobs embodied in trade

### 4.1 Occupation structure

If one is willing to assume that the jobs embodied in net trade in a particular industry/product category are distributed proportionally across skill groups, leaving the skill distribution within the industry/product group unchanged, then it is relatively straightforward to disaggregate the measure of jobs embodied in trade into jobs by skill type (the necessary assumptions are probably more easily accepted the greater the industry detail).

Information on the skill distribution within the relevant industry groupings at particular points in time can be obtained from the Labour Force Survey. For the purposes here individuals are grouped into routine, intermediate level, and managerial and professional occupations according to their occupation in their main job. Each occupation group accounts for roughly a third of total employment. Cell size limitations in the Labour Force Survey necessitate aggregation of the data into broader industry/product groups.<sup>9</sup> This leaves 66 industry/product groups rather than the 117 used to calculate the numbers in chapter 3 and in table 9 below.<sup>10</sup> Interestingly, this aggregation does not change substantially the estimates of the number of jobs embodied in trade.

Table 7 reports estimates of the job content of gross imports, gross exports, and the difference between these, i.e. the job content of net imports. Results are shown for trade with particular country groups or particular product groups, much as in previous sections, but these are then disaggregated into routine, intermediate, and managerial & professional jobs. For example, looking at the first row final column, the job content of net imports in 2004 is estimated at 1.2 million. Moving down the column, these 1.2 million jobs included 0.7 million routine unskilled jobs, 0.3 million intermediate level jobs, and 0.2 million managerial & professional jobs. Figures are shown for 1998 and 2004 rather than 1997 and 2004 because of the change in country coverage of the EU data between 1997 and 1998.

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<sup>9</sup> The Labour Force Survey is based on a sample of UK households. Individual responses are weighted to obtain estimates representative of the UK population. The ONS advise against the use of estimates that are based on the responses of less than 30 individuals (equivalent to a population weighted estimate of approximately 10,000), due to the large sampling error associated with such estimates.

<sup>10</sup> Individual industry/product groups in Annex A are aggregated to sub-section level for sub-sections CA, DA, DB, DC, DG, DI, DK, DL, DN, E. "Agriculture" and "Fishing" are aggregated together (A, B) and "Domestic services" (P) are included with industry group "Other service activities" (O 93).

**Table 7. UK jobs embodied in trade by occupation (millions)**

Occupation group	1998			2004		
	Imports	Exports	Net imports	Imports	Exports	Net imports
All trade	7.65	7.27	0.37	8.14	6.95	1.19
Routine	3.07	2.67	0.40	2.95	2.25	0.70
Intermediate	2.30	2.23	0.06	2.37	2.05	0.32
Managerial & professional	2.28	2.37	-0.09	2.83	2.65	0.18
Goods	6.00	5.12	0.88	6.30	4.56	1.74
Routine	2.41	1.97	0.44	2.28	1.57	0.71
Intermediate	1.82	1.55	0.27	1.85	1.34	0.51
Managerial & professional	1.76	1.59	0.17	2.18	1.65	0.53
Services	1.65	2.15	-0.50	1.84	2.39	-0.55
Routine	0.66	0.69	-0.03	0.67	0.68	-0.01
Intermediate	0.47	0.68	-0.21	0.52	0.71	-0.19
Managerial & professional	0.51	0.78	-0.26	0.65	1.00	-0.35
EU countries	4.23	3.93	0.30	4.61	3.60	1.01
Routine	1.72	1.47	0.25	1.69	1.18	0.51
Intermediate	1.26	1.20	0.06	1.33	1.06	0.28
Managerial & professional	1.25	1.26	-0.01	1.58	1.36	0.23
Non-EU countries	3.42	3.35	0.07	3.53	3.35	0.18
Routine	1.35	1.20	0.15	1.26	1.07	0.19
Intermediate	1.04	1.04	0.00	1.03	0.99	0.04
Managerial & professional	1.03	1.11	-0.08	1.24	1.29	-0.05

Source: Author's calculations based on UK Input-Output tables & Labour Force Survey.

Note: European Union data cover 25 member states; Figures for 1998 are calculated using the structure of UK production in 1997; Estimates calculated using 66 industry/product groups.

There are several observations one might make on the basis of these numbers. The job content of UK net imports is always (for the disaggregations shown) highest for routine unskilled jobs. This suggests that international trade both with EU countries and with countries outside the EU, and in both goods and services, is associated with a reduction in relative labour demand for unskilled workers. However, the shift in the relative demand for skilled labour that is associated with international trade has not necessarily changed over this period. While exports are more skill intensive in 2004 than in 1998, the labour mix needed to produce imports domestically has also become more skill intensive.

The figures seem to suggest that the UK specialises in the production of skill intensive products, which, according to the Heckscher-Ohlin theorem, would suggest that in the UK skilled labour is relatively abundant. However, as mentioned in chapter 3, it is not necessarily possible to infer the nature of trade specialisation from the estimates here. Nevertheless, these results would be in accordance with the analysis provided in Webster (1993), which suggested that the UK was a net exporter of skill intensive products and relatively well endowed with skilled labour in 1984. The analysis in Gregory *et al.* (2001) suggested that the impact of trade on changes in the relative demand for skilled labour between 1979 and 1990 were small. The analysis here suggests that the impact of trade on changes in the relative demand for skilled labour between 1998 and 2004 are also small.

The skill intensity of UK exports relative to UK imports is evident both in goods and services trade, although it is most stark in services trade, particularly in 2004. The relative skill content of jobs embodied in net imports is similar across EU and non-EU countries.

Table 8 decomposes the jobs content of net imports into a balanced and unbalanced trade effect. In addition to the conclusions reached on the basis of the estimates reported in Table 7, these estimates suggest that international trade is associated with a small reduction in the absolute demand for unskilled labour and a small increase in the absolute demand for skilled labour (managerial & professional occupations). The increase in the demand for skilled labour is associated in particular with services trade and is similar for trade with EU and non-EU countries.

**Table 8. UK jobs embodied in net imports by occupation (millions)**

Occupation group	1998			2004		
	Balanced	Un-balanced	Net imports	Balanced	Un-balanced	Net imports
All trade	0.15	0.23	0.37	0.36	0.83	1.19
Routine	0.32	0.09	0.40	0.41	0.29	0.70
Intermediate	-0.01	0.07	0.06	0.07	0.24	0.32
Managerial & professional	-0.16	0.07	-0.09	-0.13	0.30	0.18
Goods	0.18	0.69	0.88	0.25	1.49	1.74
Routine	0.16	0.27	0.44	0.18	0.53	0.71
Intermediate	0.06	0.21	0.27	0.07	0.44	0.51
Managerial & professional	-0.04	0.21	0.17	0.00	0.53	0.53
Services	-0.04	-0.46	-0.50	0.03	-0.58	-0.55
Routine	0.13	-0.17	-0.03	0.18	-0.19	-0.01
Intermediate	-0.07	-0.14	-0.21	-0.02	-0.17	-0.19
Managerial & professional	-0.11	-0.15	-0.26	-0.13	-0.22	-0.35
EU countries	0.11	0.19	0.30	0.28	0.73	1.01
Routine	0.18	0.07	0.25	0.25	0.26	0.51
Intermediate	0.00	0.06	0.06	0.06	0.21	0.28
Managerial & professional	-0.07	0.06	-0.01	-0.04	0.26	0.23
Non-EU countries	0.04	0.03	0.07	0.08	0.11	0.18
Routine	0.14	0.01	0.15	0.15	0.04	0.19
Intermediate	-0.01	0.01	0.00	0.01	0.03	0.04
Managerial & professional	-0.09	0.01	-0.08	-0.09	0.04	-0.05

Source: Author's calculations based on UK Input-Output tables & Labour Force Survey.

Note: European Union data cover 25 member states; Figures for 1998 are calculated using the structure of UK production in 1997; Estimates calculated using 66 industry/product groups.

## 4.2 Industry structure

Rather than aggregate into a total figure the number of jobs embodied in trade within each industry/product group, Table 9 illustrates how the number of jobs embodied in trade is distributed across main industry sectors. The jobs content of gross imports is greatest in manufacturing industries, distribution, hotels & restaurants industries, and finance & business services industries. The same is the case for exports and in both 1997 and 2004. But, the jobs involved in

producing exports in finance & business services industries outweigh the job content of gross imports in these industries. In contrast, the jobs involved in producing exports in manufacturing industries do not outweigh the job content of gross imports in these industries. Given the findings in the previous chapter it is unsurprising that the majority of the job content of net imports, and the change in this figure over time, is explained by manufacturing industries. The jobs surplus in services trade discussed in chapter 3 is generated by trade in finance & business services.

**Table 9. UK jobs embodied in trade by industry (millions)**

	1997			2004		
	Imports	Exports	Net imports	Imports	Exports	Net imports
Agriculture & fishing (A,B)	0.26	0.12	0.13	0.22	0.08	0.14
Energy & water (C,E)	0.15	0.14	0.01	0.19	0.15	0.03
Manufacturing (D)	3.92	3.54	0.38	4.11	2.92	1.20
Construction (F)	0.09	0.10	-0.01	0.10	0.10	0.01
Distribution, hotels & rest. (G,H)	1.06	0.98	0.08	1.13	0.82	0.31
Transport & communications (I)	0.55	0.58	-0.03	0.66	0.62	0.04
Finance & business services (J,K)	1.09	1.54	-0.46	1.36	1.81	-0.45
Education, health, PAD & other services (L-P)	0.37	0.39	-0.02	0.46	0.47	-0.01
All (A-P)	7.48	7.39	0.09	8.23	6.97	1.26

Source: Author's calculations based on UK Input-Output tables & Labour Force Survey.

On the basis of these numbers one might reasonably conclude that international trade has contributed to a change in the industrial composition of UK employment away from manufacturing industries and towards finance & business services industries, in comparison to the closed economy counterfactual. These changes in the industry structure of employment associated with trade are more obvious in 2004 in comparison to 1997.

### 4.3 Summary

Analysis of the industrial structure of jobs embodied in UK net imports suggests that international trade has contributed to a shift in the industrial structure of employment away from manufacturing jobs towards financial & business services jobs. Analysis of the skill structure of the job content of UK net imports, as measured by occupations, suggests that international trade has been associated with a shift in the skill structure of employment away from routine unskilled jobs and towards managerial and professional occupations.

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# Annex A: Industry groups

**Table A1. Classification of Input-Output industry/product groups by Standard Industrial Classification (2003)**

	Sub-sections	Divisions, groups, classes	Industry/product groups
A	Agriculture	01	Agriculture
		02	Forestry
B	Fishing	05	Fishing
CA	Mining	10	Coal extraction
		11 to 12	Oil & gas extraction
CB	Other mining	13 to 14	Metal ores extraction; Other mining & quarrying
DA	Food	15.1	Meat processing
		15.2 to 15.3	Fish & fruit processing
		15.4 to 15.5	Oils & fats; Dairy products
		15.6	Grain milling & starch
		15.7	Animal feed
		15.81 to 15.82	Bread, biscuits etc.
		15.83 to 15.84	Sugar; Confectionery
		15.85 to 15.89	Other food products
		15.91 to 15.97	Alcoholic beverages
		15.98	Soft drinks & mineral waters
DB	Textiles	16	Tobacco products
		17.1	Textile fibres
		17.2	Textile weaving
		17.3	Textile finishing
		17.4	Made-up textiles
		17.51	Carpets & rugs
		17.52 to 17.54	Other textiles
		17.6 to 17.7	Knitted goods
		18	Wearing apparel & fur products
		DC	Leather
19.3	Footwear		
DD	Wood	20	Wood & wood products
DE	Paper	21.1	Pulp, paper & paperboard
		21.2	Paper & paperboard products
		22	Printing & publishing
DF	Coke	23	Coke ovens, refined petroleum & nuclear fuel
DG	Chemicals	24.11 to 24.12	Industrial gases & dyes
		24.13 to 24.14	Inorganic chemicals; Organic chemicals
		24.15, 24.2	Fertilisers; Pesticides
		24.16 to 24.17	Plastics & synthetic resins etc.
		24.3	Paints, varnishes, printing ink etc.
		24.4	Pharmaceuticals
		24.5	Soap & toilet preparations
		24.6 to 24.7	Other chemical products; Man-made fibres
DH	Rubber	25.1	Rubber products
		25.2	Plastic products
DI	Minerals	26.1	Glass & glass products

		26.2 to 26.3	Ceramic goods
		26.4	Structural clay products
		26.5	Cement, lime & plaster
		26.6 to 26.8	Articles of concrete, stone etc.
DJ	Metals	27.1 to 27.3	Iron & steel
		27.4	Non-ferrous metals
		27.5	Metal castings
		28.1	Structural metal products
		28.2 to 28.3	Metal boilers & radiators
		28.4 to 28.5	Metal forging, pressing etc.
		28.6	Cutlery, tools etc.
		28.7	Other metal products
DK	Machinery	29.1	Mechanical power equipment
		29.2	General purpose machinery
		29.3	Agricultural machinery
		29.4	Machine tools
		29.5	Special purpose machinery
		29.6	Weapons & ammunition
		29.7	Domestic appliances nec
DL	Electrical	30	Office machinery & computers
		31.1 to 31.2	Electric motors & generators etc.
		31.3	Insulated wire & cable
		31.4 to 31.6	Electrical equipment nec
		32.1	Electronic components
		32.2	Transmitters for TV, radio & phone
		32.3	Receivers for TV & radio
		33	Medical & precision instruments
DM	Vehicles	34	Motor vehicles
		35.1	Shipbuilding & repair
		35.2, 35.4 to 35.5	Other transport equipment
		35.3	Aircraft & spacecraft
DN	Other manufacturing	36.1	Furniture
		36.2 to 36.3	Jewellery & related products
		36.4 to 36.5	Sports goods & toys
		36.6 to 37	Miscellaneous manufacturing nec & recycling
E	Energy	40.1	Electricity production & distribution
		40.2 to 40.3	Gas distribution
		41	Water supply
F	Construction	45	Construction
G	Distribution	50	Motor vehicle distribution & repair, automotive fuel retail
		51	Wholesale distribution
		52	Retail distribution
H	Hotels	55	Hotels, catering, pubs etc.
I	Transport services	60.1	Railway transport
		60.2 to 60.3	Other land transport
		61	Water transport
		62	Air transport
		63	Ancillary transport services
		64.1	Postal & courier services
		64.2	Telecommunications
J	Finance	65	Banking & finance
		66	Insurance & pension funds
		67	Auxiliary financial services

K	Business services	70.1	Owning & dealing in real estate
		70.2	Letting of dwellings
		70.3	Estate agent activities
		71	Renting of machinery etc.
		72	Computer services
		73	Research & development
		74.11	Legal activities
		74.12	Accountancy services
		74.13 to 74.15	Market research, management consultancy
		74.2 to 74.3	Architectural activities & technical consultancy
		74.4	Advertising
74.5 to 74.8	Other business services		
L	PAD	75	Public administration & defence
M	Education	80	Education
N	Health	85.1 to 85.2	Health & veterinary services
		85.3	Social work activities
O	Other services	90	Sewage & sanitary services
		91	Membership organisations
		92	Recreational services
		93	Other service activities
P	Domestic services	95 to 97	Private households with employed persons

Source: National Statistics

Note: The 117 industry/product groups here are constructed from the 123 industry/product groups in the detailed UK Input-Output tables.

# Annex B: Technology assumptions

## The requirement matrix

The calculations underlying the numbers reported in chapters 3 and 4 are set out here, based on the derivations in Chentrens (2005) and the information available in Groshen *et al.* (2005). The supply and use tables of the Input-Output tables published by the Office for National Statistics (ONS)<sup>11</sup> define:

- $q$ : Total product output (product-by-one vector).
- $y$ : Total industry output (industry-by-one vector).
- $U$ : Intermediate portion of the use matrix in which each column shows for a given industry the amount of each product used in production (product-by-industry matrix).
- $V$ : Supply matrix in which each row shows for a given product the amount supplied by each industry (product-by-industry matrix).
- $\hat{\cdot}$ : A symbol that when placed over a vector indicates a square matrix in which the elements of the vector appear on the diagonal and off-diagonal elements are zero.
- $B$ : Direct input requirement matrix in which each column shows for a given industry the amount of each product used in production per £ of output of that industry (product-by-industry matrix).

$$B = U\hat{y}^{-1} \quad (B1)$$

- $D$ : Market share matrix in which each column shows for a given product the amount supplied by each industry as a share of total (domestic) production (industry-by-product matrix). It is assumed that the total output of each product is supplied by industries in fixed proportions (industry based technology assumption).

$$D = V'\hat{q}^{-1} \quad (B2)$$

- $i$ : A vector in which each entry is equal to one.
- $I$ : The identity matrix.
- $f$ : Final demand purchases for each product (product-by-one vector).
- $m$ : Total imports for each product (product-by-one vector).
- $x$ : Total exports for each product (product-by-one vector).
- $e$ : Total industry employment (industry-by-one vector).

From these definitions the following identities can be derived:

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<sup>11</sup> [http://www.statistics.gov.uk/about/methodology\\_by\\_theme/inputoutput/latestdata.asp](http://www.statistics.gov.uk/about/methodology_by_theme/inputoutput/latestdata.asp)

$$q = Ui + f \quad (B3)$$

$$y = V'i \quad (B4)$$

The identity in B3 simply says that total demand equals supply. The identity in B4 says that total industry output equals the sum of industry output of each product. From B1 and B3:

$$q = By + f \quad (B5)$$

From B2 and B4:

$$y = Dq \quad (B6)$$

From B5 and B6:

$$q = (I - BD)^{-1} f \quad (B7)$$

The Leontief inverse  $(I - BD)^{-1}$  needs to be converted to an industry basis to be compatible with the employment data. From B6 and B7:

$$y = D(I - BD)^{-1} f \quad (B8)$$

Now, from the Labour Force Survey, define:

$j$ : Total industry employment embodied in trade (industry-by-one vector).

By identity the amount of employment required to produce one unit of industry output is  $\hat{y}^{-1}e$ . Assuming that net imports flow to final users, using B8, the number of jobs embodied in net imports is then calculated as:

$$j = \hat{y}^{-1}eD(I - BD)^{-1}(m - x) \quad (B9)$$

This is equivalent to the expression in equation (2) in chapter 2, where  $L = D(I - BD)^{-1}$ . The economy wide measure of jobs embodied in net imports is obtained by summing the elements of  $j$ . The equivalent industry sector measure is obtained by summing the elements of  $j$  within the relevant industry sector. Measures of the job content of net imports for a particular occupational group are derived by replacing total employment in  $e$  with employment in the particular occupational group.

## Assumptions in constructing the detailed supply matrix

Due to disclosure concerns the detailed supply matrices ( $V$  above) are not available from the ONS. For the years 1997-2004 the ONS provide a full supply matrix using 30 industry/product groups. The ONS also provide diagonal elements, column and row totals of a supply matrix detailing 123 industry/product groups. Implementing a number of assumptions it is possible to estimate the off-diagonal data elements for the detailed supply matrix using the information available. These are generally small relative to the published diagonal elements. The steps involved in constructing the detailed supply matrices that underlie the calculations in this report are outlined here.

First, missing values in the 30 category supply matrix are estimated so that the matrix cells add up to the published column and row totals. Missing values in the 30 category supply matrix arise due to disclosure concerns and typically have relatively small values. Next, the detailed supply matrix is divided into 30x30 sub-

matrices. The elements of these sub-matrices need to add up to the cells in the 30 category supply matrix. The distribution across sub-matrices of the difference between the cells in the 30 category supply matrix and the sum of these sub-matrix elements is used to allocate the difference between the row total and the diagonal element for each row of the detailed supply matrix into the 30 categories. Within sub-matrices this product row difference is allocated according to the distribution of the difference between the column total and the diagonal element for each column. After this process there remains a difference between the sum of the column elements and the published column total. This is adjusted for by re-allocating values between industries within sub-matrices for the following products: owning & dealing in real estate, letting of dwellings, estate agent activities, retail distribution, wholesale distribution, construction, and hotels, in this order and subject to the constraint that values should not be negative. Much of the residual can be removed by re-allocating values for owning & dealing real estate. The use of owning & dealing real estate as a residual product group is for two reasons: import and export shares of this product are very small and virtually all 30 industry groups contribute to the output of this product.

## Assumptions in constructing the use matrix

The ONS provide detailed intermediate use tables ( $U$  above) in purchasers' prices. For the purposes here these need to be converted to basic prices to match the supply tables. This involves adjusting for margins and product taxes less subsidies (Ruiz, 2002). Because this information is provided only for total supply of each product group, additional assumptions are necessary to estimate the basic price intermediate use matrix.

In this paper, taxes less subsidies on intermediate product use are calculated taking into account the published total for these taxes on intermediate product use, the implied differential in average product taxes rates between intermediate and final product use, the published distribution between intermediate and final use for each product and the published amount of taxes less subsidies on total product supply for each product. For each product taxes less subsidies on intermediate consumption are then subtracted from each industry in proportion to intermediate consumption of the particular product across industries. Margins are also subtracted from each industry in proportion to intermediate consumption of the particular product across industries and are added to retail and wholesale distribution. Margins are assumed to be proportionally distributed between intermediate and final use.