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The Share of Employment Potentially Affected by Offshoring: An Empirical Investigation

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Working Party on the Information Economy

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FOREWORD

This report was presented to the Working Party on the Information Economy (WPIE) at its meeting in June 2005, as part of its work on global value chains and ICT skills and employment and as a contribution to the Organisations work on growth and services issues. It was recommended to be made public by the Committee for Information, Computer and Communications Policy in October 2005.

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THE SHARE OF EMPLOYMENT POTENTIALLY AFFECTED BY OFFSHORING: AN EMPIRICAL INVESTIGATION

1. Introduction and summary

Rapid advances in Information and Communication Technologies (ICTs), combined with continuing efforts to liberalise international trade and investment in services, have increased the tradability of services and created new types of tradable services. This, in turn, has led to a new wave of globalisation in the services sector, with the offshoring of particular types of services activities now becoming increasingly common, as it has been for many years in manufacturing. New technological developments now allow many service activities to be carried out independently of their geographical location, and their production and delivery do no longer have to take place in the same location. As a result, many white collar jobs that were shielded from international competition now face competition from abroad.

Despite the widespread media attention given to the apparent offshoring of service sector jobs, little is known about the extent of this phenomenon, or the extent to which it is related to other economic and structural developments. This paper draws upon and extends a previous detailed analysis of occupational data for selected OECD countries that sought to determine the share of total employment that could potentially be affected by the international sourcing of IT and ICT-enabled services (van Welsum and Vickery, 2005a). Including both the low and the high skill white collar occupations potentially affected by global services sourcing, that analysis suggested that close to 20 % of total employment could potentially be affected by ICT-enabled offshoring of services. The work also found that sectors such as business services *(e.g.* accounting, consulting), financial services and research and development have a relatively high share of such employment. It is important to keep in mind that "potentially affected by offshoring" refers to activities that could be coming into a country as well as those leaving a country, as well as those generated domestically. Incoming offshored services activities would bring about an increase in the share of employment potentially affected by offshoring, whereas services activities that leave the country would bring about a relative decline in the share.

This report takes the analysis one step further by examining the relationship between the share of employment potentially affected by offshoring and other economic and structural developments, using some simple descriptive regressions on a panel of OECD economies between 1996 and 2003. In particular, first estimates are provided of the statistical association between the share of employment potentially affected by service sector offshoring, trade in business services and foreign direct investment. Contrary to popular belief, the analysis in this paper does not find any systematic evidence that net outward investment or imports of business services are associated with significant declines in the share of employment potentially affected by offshoring, at least at the aggregate level. Exports of business services are found to have a positive statistical association with the share of employment potentially affected by offshoring, suggesting that increases in demand and production have also raised demand for these types of ICT-using occupations. Other key factors positively associated with the share of employment potentially affected by offshoring are found to be the comparative size of the service sector, the growing share of ICT investment in total fixed investment, and human capital.

Although there are no direct official data measuring the extent of offshoring, it is commonly believed that it has the potential to grow substantially even if it is still a relatively small phenomenon.. This paper

aims to contribute to the debate surrounding offshoring by looking in detail at some of the trade in services and employment data that may reveal further insights about its current extent, as well as by performing a simple descriptive econometric analysis of the factors statistically associated with movements in the aggregate share of employment that could potentially be affected by ICT-enabled offshoring of services.

The paper is organised as follows. The next section gives the background from the literature in which the analysis is rooted. Section 3 briefly looks at what is known about the extent of offshoring and lays out the starting point of the analysis. The subsequent section describes the statistics underlying the analysis and the data and the model employed. A summary of the results is presented in Section 5 and the final section offers concluding remarks. The detailed analysis and results can be found in the Technical Appendix.

2. Background of the analysis in the literature

The relatively new phenomenon of offshoring of services activities, and the wider globalisation of the services sector, has generated considerable debate among economists and policy makers (see for example *Business Week*, 2004; Brainard and Litan, 2004). Economic theory predicts that in the long run, as flexible economies adjust, every economy should gain from this new form of globalisation and the increased specialisation it brings about. Even though some jobs could be lost initially in the domestic economy, ultimately the changes should increase growth and productivity and bring new employment opportunities. Indeed, the efficiency and productivity gains achieved through offshoring should enhance the overall growth and employment opportunities of both the domestic and host economies (see for example Amiti and Wei, 2006; Abramovsky and Griffith, 2005; Global Insight, 2004; Mann, 2003). In addition, jobs created offshore generate demand for developed country goods and services exports, both for ICT equipment and communications services and, over time, for a wide range of other goods and services. At the same time, wages and prices in offshore locations are likely to rise, creating wealthier host country consumers and reducing international wage cost differentials and arbitrage opportunities.

However, some now question whether new forms of globalisation will be necessarily beneficial. Samuelson (2004) argues that this may not be the case if the terms of trade turn against developed countries as skill levels and technological capabilities in countries such as India and China continue to rise.[1] Rapid technological advances in ICTs (in particular broadband and the Internet), and trade and investment liberalisation have enabled the emergence of a global labour market for (white collar) skilled workers and have contributed to the emergence of trade patterns that cannot easily be reconciled with standard theoretical predictions.[2] An increased availability of skilled workers in lower income countries, whose output can be traded globally with the help of ICTs, is starting to change traditional patterns of specialisation; one result is firms from these countries compete in areas where firms from developed countries are generally thought to have a comparative advantage, such as knowledge and high-skill intensive goods and services. Even though it is generally thought unlikely, there remains a possibility that developed countries will suffer "the immiserating effects of trade" (Bhagwati, 1968) whereby countries may continue to grow while becoming relatively poorer, as relatively lower wages lead to lower export prices leading to a deterioration of their terms of trade. Either way, just like globalisation in general, the globalisation of the services sector will bring about both winners and losers, at the level of the individual, firms and countries, with the key question for policy-makers being the design of mechanisms to ensure that the winners compensate the losers. See OECD (2005b) for an analysis of trade and structural adjustment issues.

Evidence for the United States does point to some cost to workers (in the manufacturing sector) from import competition, both in terms of job displacement and earnings losses following job displacement. Kletzer (2001, 2002, as reported in OECD, 2005c, Table 1.2) finds that about two-thirds of laid-off workers are back in employment after three years, over one-third earning the same income or more, but on average those re-employed earn about 10% less. OECD (2005c) finds that re-employment rates are

considerably lower in European countries than in the United Sttes (between 50-60%) implying that workers tend to find it more difficult to find a new job following trade-related displacement in Europe than in the United States. Furthermore, like for the United States, European trade-related displaced workers tend to run a greater risk of earnings losses than people who lose their job for other reasons, but the average size and variability of the earnings losses is greater in the United States than in Europe.

Nevertheless, the main overall long-run impact of trade and investment on labour markets has been to raise average real wages (OECD, 2005c). However, shifts in the composition of employment have occurred at the occupational and industry level. There is no evidence to suggest that aggregate employment performance has suffered any negative impact from increased economic integration. However, to date there is very little evidence on the labour market effects of offshoring in the services sector with most studies still focussing on the manufacturing sector (see OECD, 2005c, and the references therein). One exception is Amiti and Wei (2005) who find no evidence of a negative impact of services sourcing on employment at the sectoral level (using data for the United Kingdom). Furthermore, Bhagwati *et al* (2004) argue that offshoring of services is essentially a trade phenomenon and that its effects on jobs and wages can therefore be expected to be similar to those observed for trade in goods. This would imply that offshoring in the services sector will bring about similar adjustments within occupations and within the services sector as the evidence for the manufacturing sector suggests.

Even though the formal analytical literature of the offshoring phenomenon, especially in the services sector, is still very thin, the analysis carried out in the present paper is related to several other strands of the existing literature, such as research on the relationship between trade in services and international production relocation (Pain and van Welsum, 2004, van Welsum, 2004), on explaining deindustrialisation (Rowthorn and Ramaswamy, 1997) and the growing importance of the services sector in the economy (Nickell *et al*, 2004) and in employment (Messina, 2004), and the role of IT in changes in demand for labour (Autor *et al*, 2003; Falk and Koebel, 2004).

Trade in services and international production relocation

As offshoring is related to both trade in services and foreign direct investment (FDI), its effects on employment may also be affected by the interaction between these two related phenomena. However, the relationship between trade and FDI, particularly in services, is not a straightforward one and generally depends on the level of aggregation and the categories of services under consideration. Indeed, the results in Pain and van Welsum (2004) indicate that there is considerable heterogeneity in the relationship between trade and production relocation across different categories of services and across the sector in which production relocation takes place. They find a significant positive relationship between exports and international production relocation in the majority of non-service sectors. This would imply that some export growth in service industries may occur as a result of offshoring in the manufacturing sector when this takes place through FDI. However, a significant negative relationship is found with relocation in service sectors, which means that the domestic country may experience slower export growth as a result of some offshoring of services activities when this takes place through FDI. Intra-firm exports of affiliate services is the only category of trade raised by additional outward investment in all sectors; in this case, exports of this type of services may increase as a result of some offshoring when it takes place through FDI (international insourcing in Figure 1).

Van Welsum (2004) finds a clear effect from production relocation on US imports of services. She finds that outward investment in US-owned service sector affiliates has a positive impact on import volumes. This is consistent with what might be expected if one motivation for such investments is to internationally source activities previously undertaken within the United States. Inward investment in the US service sector is found to reduce imports of services, so other things being equal this should have a

positive effect on employment in the domestic economy. Inward investment in non-service sectors is found to stimulate imports of services, but no hypotheses can be made, *a priori*, about the effect on employment.

Finally, as both trade and investment in services can be expected to increase over time with income and development levels, the share of the workforce exposed to international competition is also likely to increase. Indeed, the rapid globalisation of the services sector, enabled by technological advances in ICTs, means that an increasing global pool of workers will face greater competition and will be affected by changes in the international division of labour. This is the case both for developed countries, where the services sector already accounts for large shares of total employment, and for developing countries, where there will also be a relative increase in the share of the workforce employed in services sectors (Mann, 2005).

Explaining deindustrialisation and the growing importance of the services sector[3]

Rowthorn and Ramaswamy (1997) argue that deindustrialisation is not a negative phenomenon but rather a natural part of successful economic development. Relative employment losses in manufacturing are largely unrelated to "north-south trade" but essentially reflect the fact that productivity growth has been more pronounced in manufacturing than in services. Cross-country differences in employment structures however may in part be explained by the pattern of trade specialisation.

Messina (2004) analyses the share of "services employment", referring to employment in the services sector rather than employment in services occupations which can be found throughout the economy. He finds a positive relationship between the share of services sector employment in total employment and GDP per capita, the size of the government sector and the degree of urbanisation, while barriers to the creation of new firms, and labour market institutions such as unions and more co-ordinated wage-setting systems are found to have a negative impact.

Nickell *et al* (2004) investigate cross-country differences in the share of GDP accounted for by the services sector, as well as the differential pace at which changes brought about by deindustrialisation have taken place. They find that changes in technology (differences in industry productivity), changes in relative prices and factor endowments (educational attainment in particular), as well as levels of employment protection, explain the varying pace of change of countries' production structures.

Information Technology and changes in demand for skills and tasks

Autor *et al* (2003), using a "tasks framework", find that computer technologies substitute for workers performing routine tasks that can readily be described with programmed rules – those that can easily be digitised and/or codified. Some of the occupations that technology is making redundant are also potentially affected by ICT-enabled offshoring of services (see above, and van Welsum and Vickery, 2005a) which may lead to a decline of the share of these types of occupations in total employment. On the other hand, computer technologies were found to act as a complement to workers that perform non-routine tasks "demanding flexibility, creativity, generalised problem-solving capabilities and complex communications". Thus, occupations intensive in these kinds of skills are not likely to disappear as a result of increased diffusion of computer technology, although they can still be candidates to be affected by offshoring if they satisfy the "offshorability attributes". Trends reducing the types of tasks found at the lower end of the skills spectrum, in favour of tasks requiring higher skills, are found to be dominated by within-industry shifts, *i.e.* the shift takes place towards higher skills (as lower skilled tasks are being digitised and codified) but across all industries. Also, many of the changes within education groups are explained by cross-industry patterns of computer adoption. Thus, it appears there is a generalised set of skills that is not industry or even firm specific, contrary to what is often observed in the manufacturing sector. Changes in tasks within

occupations (a move away from standardised tasks to relatively more non-routine tasks) were found to be taking place throughout the economy, but especially so in industries that have adopted computer technologies most rapidly.

Autor *et al* (2003) also find that the decline in the price of computer capital is the causal force through which computer technology affects skill demand throughout the economy. Their model predicts that industries employing a relatively large share of people performing routine tasks will make relatively larger investments in computer capita; this in turn would substitute for the kind of jobs intensive in routine tasks, while increasing the demand for people performing complementary non-routine tasks.

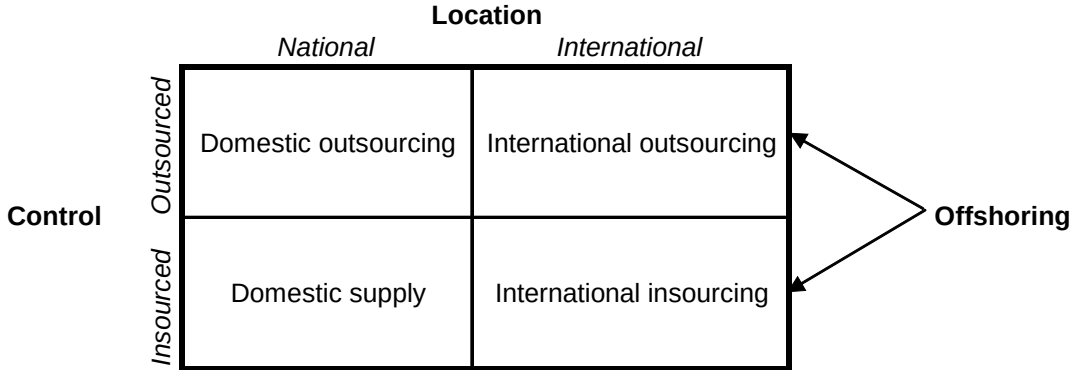
Similarly, Falk and Koebel (2004), in a study for Germany, find that computers increase demand for highly-skilled labour and, to some extent, medium-skilled labour in both manufacturing and non-manufacturing industries. Computer capital is found to significantly decrease demand for unskilled labour in non-manufacturing sectors.

With the previous sections having set the stage for the analysis by examining the literature in which the analysis is rooted, the next stage looks at what is known about the extent of potential offshoring and forms the starting point of the analysis.

3. The extent of potential offshoring

Under the definition of offshoring adopted in this paper, offshoring includes both international outsourcing (where activities are contracted out to independent third parties abroad) and international insourcing (to foreign affiliates). This is illustrated in Figure 1. The cross-border aspect is the distinguishing feature of offshoring, *i.e.* whether services are sourced within the domestic economy or abroad – not whether they are sourced from within the same company or from external suppliers (outsourcing). Offshoring is often confused with outsourcing, but only some part of offshoring is made up by outsourcing – which in fact takes place on a much larger scale domestically. Offshoring is also often interpreted as referring to the purchase of intermediate services, even though the distinction between final and intermediate services is a difficult one to make in some cases. It may also not be very meaningful in the case of certain types of services.[4] Some reports take offshoring to be equivalent to imports of services or outward foreign direct investment – but both of these approaches are erroneous. For example, while the offshoring of services activities should result in a flow of trade in services, not all trade in services is related to offshoring and it is also not possible to distinguish which part of it is. Similar problems apply to the analysis of FDI as it is not possible to determine what share of FDI is directly related to offshoring.

Figure 1. Offshoring, outsourcing and insourcing – An illustrative matrix



Source: van Welsum and Vickery, 2005a; OECD, 2004a.

To date there are no official data measuring the extent of offshoring so it is necessary to use indirect measures such as data on trade in services, employment data, input-output tables, and trade in intermediates. Evidence from company surveys can also be a useful complement (see for example Marin, 2004). This paper will use information from both trade and employment data.

To get an idea of the "outer limits" of employment potentially affected by offshoring, van Welsum and Vickery (2005a) calculate the share of people employed who are mainly performing the type of functions that could potentially be carried out anywhere, using data on employment by occupation by industry. The classifications were not harmonised internationally, but the same methodology and rationale were applied to the individual country data sources.[5] As this analysis was carried out in order to obtain an order of magnitude on the share of people employed performing tasks that could potentially be carried out anywhere, no additional assumptions were made as to what proportion of each occupational group was actually likely to be affected by offshoring in practice. Thus, the whole of each selected occupation was then included in the calculations.

Occupations were selected by examining detailed occupational and task descriptions on the basis of the following four criteria, or "offshorability attributes": *i)* intensive use of ICTs, *ii)* an output that can be traded/transmitted enabled by ICTs, *iii)* high codifiable knowledge content, and *iv)* no face-to-face contact requirements. The occupational selections that resulted from this exercise are reported in the Appendix Tables 1 - 4. For further details on the methodological background see van Welsum and Vickery (2005a), van Welsum and Vickery (2005b) and OECD (2004a). This analysis, using occupational data for several OECD countries, suggests that around 20 % of total employment carries out the kinds of functions that are potentially geographically footloose as a result of rapid technological advances in ICTs and the increased tradability of services, and could therefore potentially be affected by international sourcing of IT and ICT-enabled services. Nevertheless, as classifications are not harmonised internationally, the levels of these estimates are not directly comparable.

Other studies have taken a similar approach. Blinder (2005), and as quoted in Mankiw and Swagel, (2005), finds a similar estimate of around 20% of total employment potentially affected by offshoring in the United States in 2004. He uses the concept of "personally deliverable services" and "impersonally deliverable services". However, the estimates of employment potentially affected by offshoring vary widely. For example, Bardhan and Kroll (2003) produced estimates of 11% of total employment in the United States in 2001 as potentially affected by offshoring, and Forrester Research, as reported by Kirkegaard (2004) up to 44% of total employment. The differences in these estimates can be explained by the selection criteria that are applied to the occupational data. Thus, Bardhan and Kroll (2003) only included occupations in which at least some offshoring was already known to have taken place or being planned, yielding a more conservative estimate of the share of employment potentially affected, whereas the Forrester study used less detailed occupational categories resulting in a larger estimate of jobs potentially affected. A different but related approach was taken by Jensen and Kletzer (2005) looking at tradable versus non-tradable occupations based on Gini coefficients. The list of tradable occupations they find for the United States overlaps with the list in van Welsum and Vickery (2005a) used in this thesis, but the methodology of Jensen and Kletzer (2005) identifies a larger set of tradable occupations. According to their methodology, around 30% of employment in the United States can be considered as "tradable". They find little evidence of slower employment growth in tradable occupations (and activities).

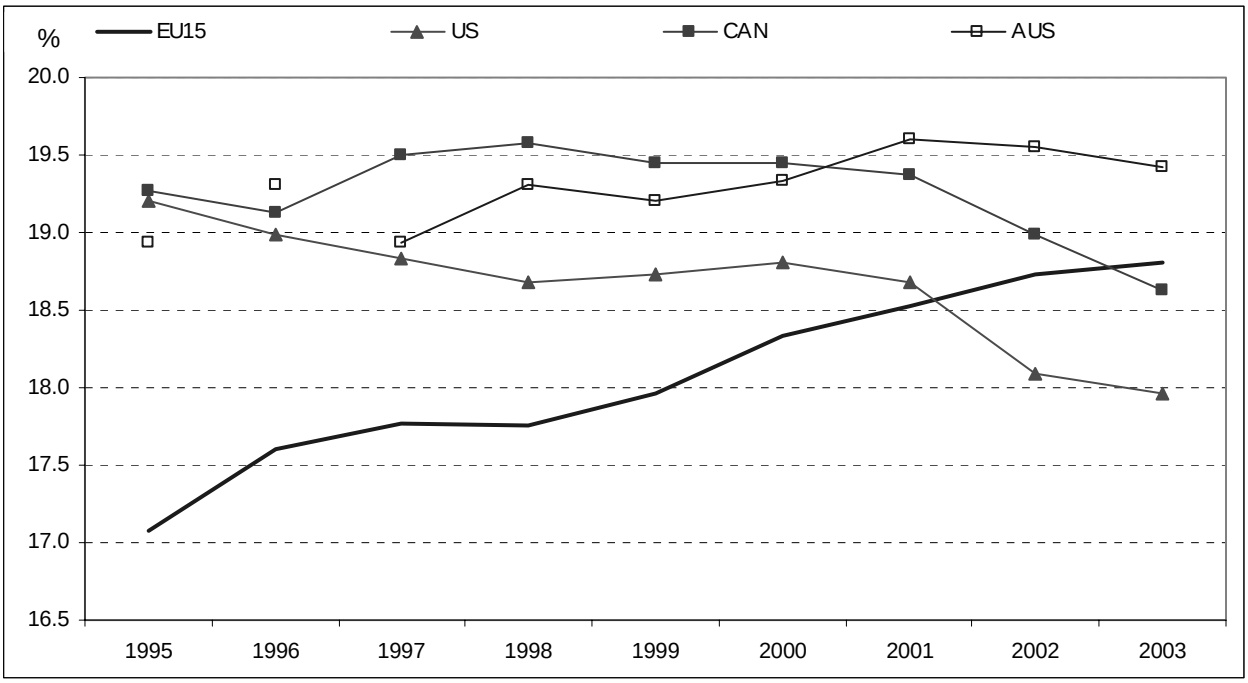
The evolution over time of the share of employment potentially affected by offshoring is illustrated in Figure 2 below. Even though the levels of these shares are not directly comparable, the evolution of the trends is interesting. The share of occupations potentially affected by offshoring in the EU15 increased from 17.1% in 1995 to 19.2% in 2003. For Canada it was more or less flat around 19.5% until 2001, after which it declined to 18.6% by 2003. For the United States the share declined by more than a percentage

point from 19.2% in 1995 to 18.1% in 2002.[6] In Australia, the share increased between 1996 and 2001 (except in 1999) but started to decline in 2001.

While it is difficult to draw inferences from these trends without further analysis, since the trends are affected by a multitude of factors, the evolutions shown in these trends are consistent with some casual observations on the ICT-enabled offshoring that is taking place. For example, Canada has served as an offshoring location for the USA, but has become less important as other locations, *e.g.* India, have started to emerge. Similarly, Australia possibly also experienced competition for attracting, or keeping, activities that can be sourced internationally from India and other emerging locations in the region. Thus, the declining share in the United States, Canada and Australia towards the end of the period could be consistent with the offshoring of IT-related and backoffice activities (with some "potential offshoring" having become "actual offshoring"), for example, even though this is unlikely to account for all of the decline. Another possible explanation could be a differential pace of technological change with a relatively more rapid adoption and integration of new technologies, leading to relatively more jobs disappearing sooner as they become automated and/or digitised.[7] The increasing share for Europe is compatible with an overall increase in services employment as well as the finding from surveys that European firms tend to offshore within Europe (see Millar, 2002, and Marin, 2004, for example). At least one EU country, Ireland, is also a major destination country of offshoring activities from the US (IT-related activities in particular). Other factors could also be important, *e.g.* cyclical developments and changes in labour supply and labour quality.

Figure 2. The share of ICT-intensive using occupations potentially affected by offshoring in total employment: EU15, US, Canada, and Australia 1995-2003[1]

(percentages)



Note: 1. Includes estimates where a full data set was not available. Because of classification changes, the number for the US for 2003 is also an estimate. There is a break in the data for Australia, with data for 1995 and 1996 in ASCO first edition and subsequent data in ASCO second edition. Due to differences in classifications the levels are not directly comparable.

Source: Author's calculations and van Welsum and Vickery (2005a), based on EULFS, US Current Population Survey, Statistics Canada and Australian Bureau of Statistics (2004/5).

Offshoring does not necessarily have to result in a decline in services employment though. Many existing services sectors have expanded, new services have emerged, and with ongoing technological developments and services trade liberalisation it is likely yet more are to be created. Furthermore, with the elasticity of demand of internationally traded services greater than one (*e.g.* Pain and van Welsum, 2004; van Welsum, 2004; Mann, 2004), rapid growth in countries such as India and China should also lead to reinforced exports from OECD countries. The offshoring phenomenon itself will also create new jobs in the domestic economy. However, it could be that certain types of occupations will experience slower growth than they otherwise might have done.

As the trends in Figure 4 are expressed as shares, there are several possibilities to explain changes in these trends. For example, a decline in the share could be explained by an absolute decline in the number of people employed in the categories identified as potentially affected by offshoring. Alternatively, it could be that this selection of occupations is growing at a slower pace than total employment. The relatively slower growth of employment potentially affected by offshoring is in fact what explains most of the declines observed in the trends, except for the United States where the absolute number of people employed in the categories identified as potentially affected by offshoring has declined (further details below). These observations would therefore tend to support the idea that offshoring may lead to slower growth of employment in occupations potentially affected by offshoring and not necessarily to actual declines in employment.

4. Descriptive statistics

This section looks in detail at some of the data that may provide some insights about the possible current extent of the offshoring phenomenon and that are part of the analysis.

Trade data

There are currently no official data measuring the extent of the offshoring and outsourcing phenomenon directly as there are many challenges involved in tracking offshoring activities. Difficulties result from definitional and data collection complications and because there are a number of modes of offshoring. For example, if international sourcing implicitly refers to activities that were previously carried out in the home country and within the firm (in the case of outsourcing), this raises the question of "when outsourcing stops being outsourcing", *i.e.* when does it become just another intermediate purchase? Trade in services provides one possible proxy for offshoring.

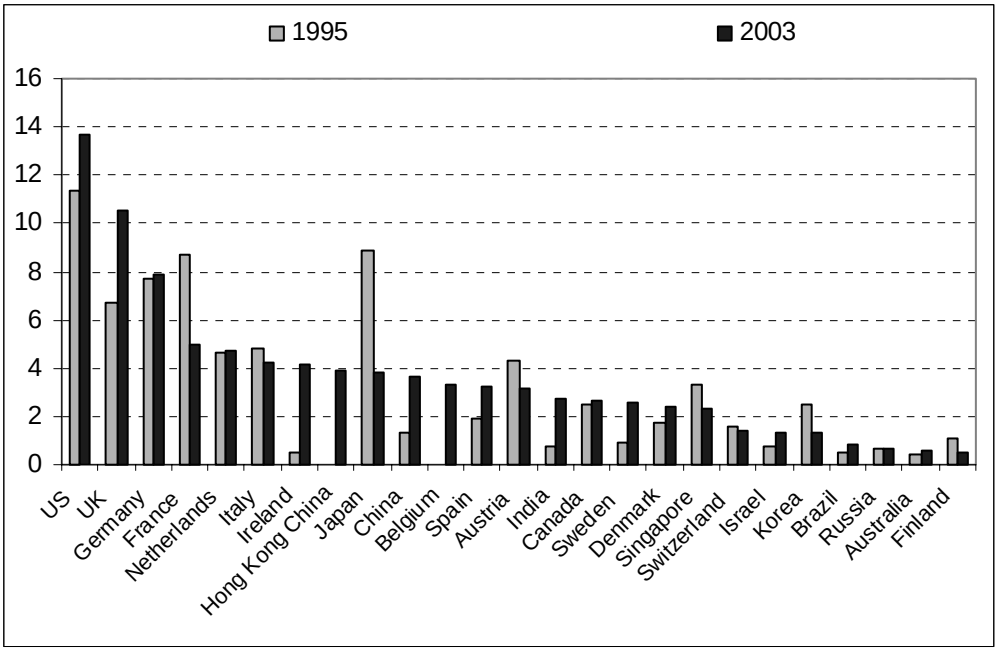
If offshoring of activities is taking place between countries then some of it should result in a flow of trade in services, exports from the country receiving the offshored activities and imports for the source country (OECD (2004a) and van Welsum and Vickery (2005a) examine exports of services, while Schultze (2004) and van Welsum (2004) analyse offshoring and imports of services). Some research equates offshoring to trade in services, but this is erroneous as not all trade in services is related to offshoring, and it is not possible to identify the share of trade in services that is directly related to offshoring.

The extent of international trade in IT and ICT-enabled business process services in international statistics is approximated by summing the IMF Balance of Payments categories "computer and information services" and "other business services" (see Appendix Table 5 for details on which services are included in these categories). These data contain information on international outsourcing and international insourcing combined, and it is not possible to identify the proportion of this trade that results directly from offshoring. Data on computer and information services are not available for all countries. For some, such as India, they are included under "other business services", along with other services.[8] The "other business services" category may have variable shares of IT and ICT-enabled services in different countries. Moreover, the data are reported in current USD and will be affected by currency movements.

Most exports of other business services and computer and information services still originate in OECD countries although their share has declined over time, from 83.1% in 1990, to 80.3% in 1995 and 79.1% in 2003.[9] The 20 countries that accounted for the largest value shares in 2003, as well as some selected other economies, are shown in Figure 3. OECD countries had the top seven shares of these services exports in 2003, with Hong Kong China; China; India; Singapore and Israel the six non-OECD countries in this top 20. Nevertheless, some non-member developing economies are experiencing rapid growth in exports (Figure 4), although most are starting from very low levels. Ireland is the only country among the 10 countries with the largest share (in 2003) and the fastest growth rates (China, Denmark, India, Ireland, Israel, Spain, Sweden and the United Kingdom are among the 20 countries with highest shares in 2003 and the fastest growth rates).

Figure 3. Share of the value of reported total[1] exports of other business services and computer and information services, selected countries, 1995 and 2003

Decreasing order of the total reported value share in 2003, percentages

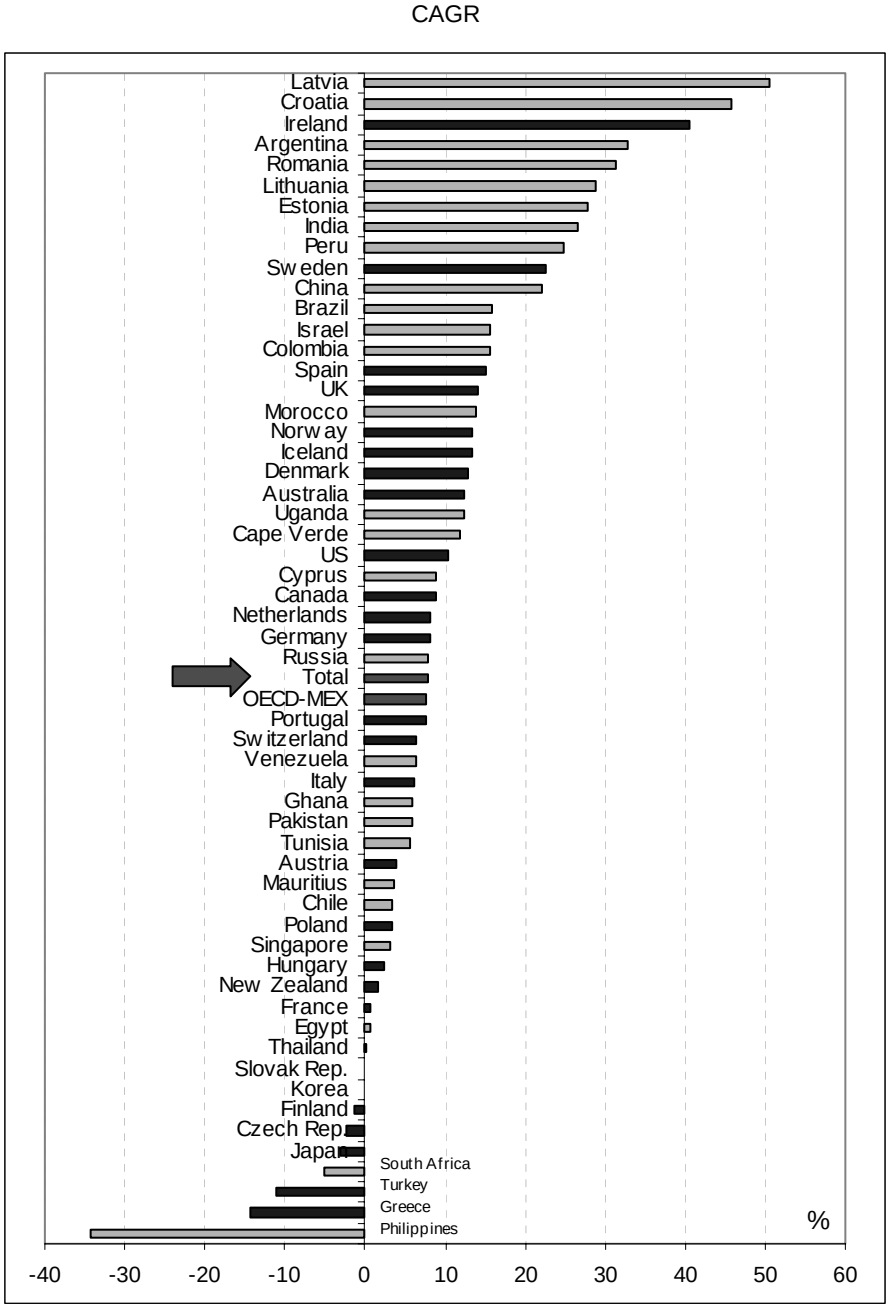


1. The reported total for all countries does not necessarily correspond to a world total. For some countries, such as India, it is not possible to isolate other business services and computer and information services. As a consequence, for India, the category includes total services, minus travel, transport and government services (*i.e.* including construction, insurance and financial services as well as other business services and computer and information services).

Source: Authors' calculations, based on IMF Balance of Payments Database (August 2005).

The average annual growth rate of exports of other business and computer and information services (in current USD) over the period 1995-2003 is given in Figure 4. It shows that many of the countries often mentioned as low-cost locations for offshored services activities (such as India, China, Brazil, but also Eastern European countries such as Latvia, Lithuania and Estonia for example) have indeed experienced rapid growth of these exports, which may confirm their emergence as offshoring locations in recent years. However, some of these countries are growing from a very low level, and some of the rapid growth is explained by their economic development.

Figure 4. Average annual growth of the value of exports of other business and computer and information services, selected countries, 1995-2003



Notes: OECD countries in dark shading. Excludes individual data for Belgium, Luxembourg and Mexico. The OECD aggregate shown excludes data for Mexico.

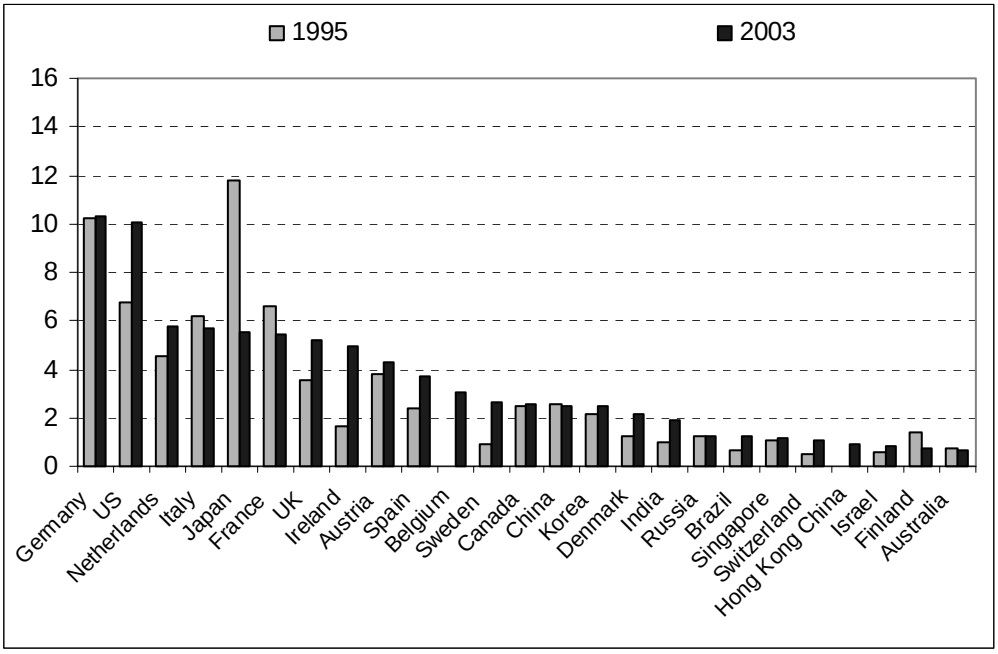
Source: Authors' calculations based on IMF Balance of Payments Database (August 2005).

In contrast to the decline observed in the OECD export share, the share of imports accounted for by OECD countries has increased over time, from 71.9% in 1990, to 75.1% in 1995 and 81.1% in 2003. OECD countries account for the top 13 shares, with China, India, Russia, Brazil and Singapore the five non-OECD countries among this top 20. Again, Ireland is the only country among the 10 countries with the largest share (in 2003) and the fastest growth rates. Brazil, Denmark, India, Ireland, Spain, Sweden, the

United Kingdom and the United States are among the 20 countries with highest shares in 2003 and the fastest growth rates.

Figure 5. Share of the value of reported total[1] imports of other business services and computer and information services, selected countries, 1995 and 2003

Decreasing order of the total reported value share in 2003, percentages

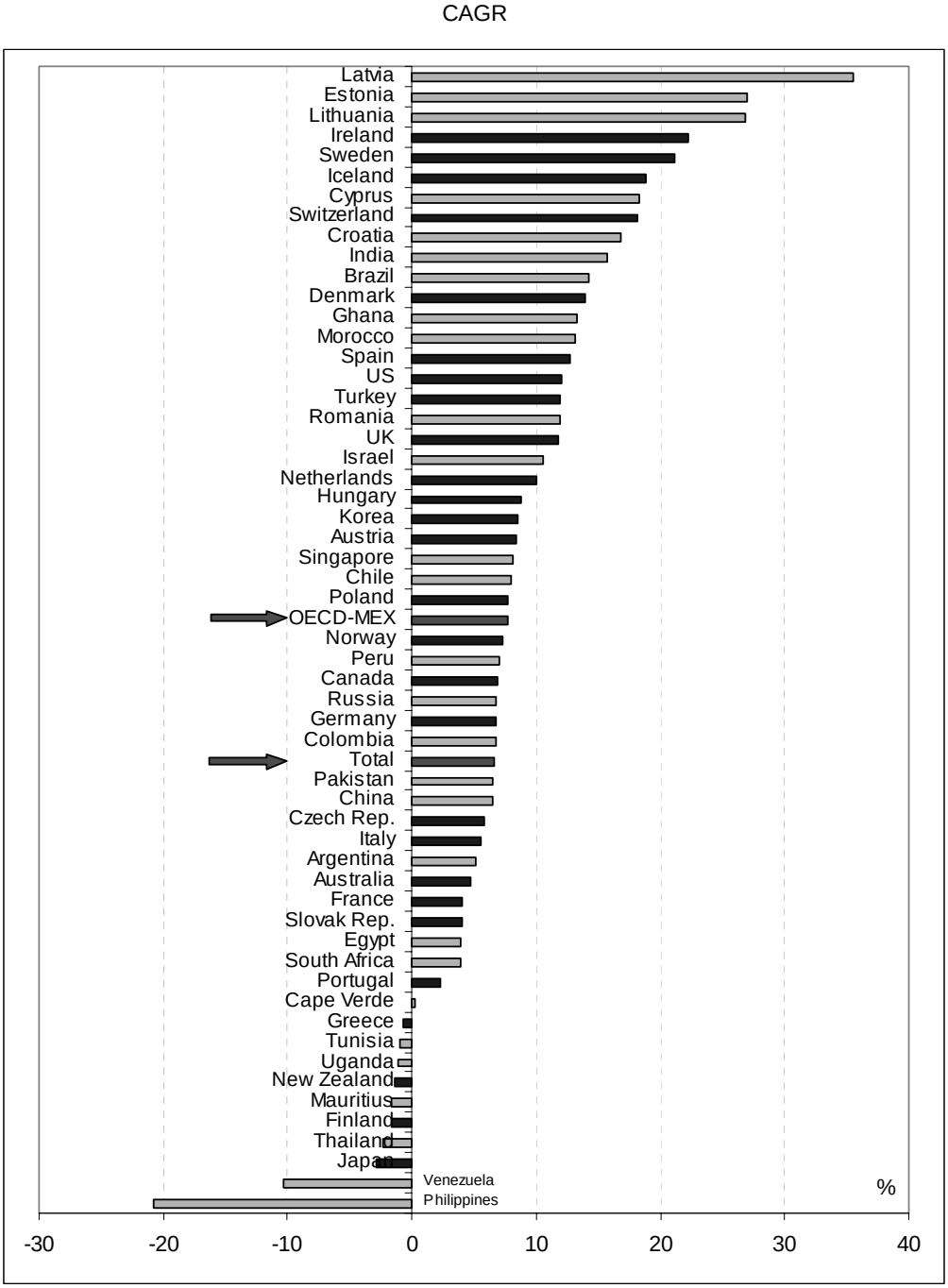


1. The reported total for all countries does not necessarily correspond to a world total. For some countries, such as India, it is not possible to isolate other business services and computer and information services. As a consequence, for India, the category includes total services, minus travel, transport and government services (*i.e.* including construction, insurance and financial services as well as other business services and computer and information services).

Source: Authors' calculations, based on IMF Balance of Payments Database (August 2005).

Most countries with the largest shares of exports are also those with the largest share of imports. Furthermore, many countries that experienced strong export growth over the period have also seen strong import growth (Figure 6), with 15 countries in the top 20 of both export and import growth (see also Table 1 below). The Spearman Rank Correlation coefficient (see the Technical Appendix for details), which looks at correlation between the country ranking of export and import growth (for the 55 countries included in Figures 4 and 6), is equal to 0.62, and is significant at the 1% level. Thus, there is a significant correlation between the country ranking of export growth and that of import growth, meaning that the countries that have had relatively fast export growth (as given by their rank) have also experienced relatively strong import growth.

Figure 6. Average annual growth of the value of imports of other business and computer and information services, selected countries, 1995-2003



Notes: OECD countries in dark shading. Excludes individual data for Belgium, Luxembourg and Mexico. The OECD aggregate shown excludes data for Mexico.

Source: Authors' calculations based on IMF Balance of Payments Database (August 2005).

The finding that many countries with rapid export growth also have experienced rapid import growth is confirmed when looking at the average annual growth of exports and imports of other business and computer and information services in national currencies. In this case, 16 countries are both among the top

20 export growth and import growth countries (Table 1). The Spearman Rank Correlation Coefficient is equal to 0.78 on the sample of 55 countries (those in Figures 4 and 6), and it is significant at the 1% level. Thus, in national currency too there is a significant correlation between a country's rank in terms of export growth and its rank in terms of import growth.

Comparing the rankings of export growth in USD and in national currency (see Table 1), the Spearman Rank Correlation Coefficient is equal to 0.80 and is significant at the 1% level. Similarly, the Spearman Rank Correlation Coefficient for the two import growth rankings is equal to 0.79 and is again significant at the 1% level. This means that there is a significant correlation between a country's trade growth denominated in USD and in national currency. Thus, currency movements have had very little impact on the ranking of countries' export and import growth.

Table 1. Comparison of average annual export and import growth (other business and computer and information services) over the period 1995-2003 using data in USD and in national currencies, selected countries (Top 20)

	USD				National Currency			
	Exports	%	Imports	%	Exports	%	Imports	%
1	Latvia	50.5	Latvia	35.5	Romania	86.0	Turkey	73.2
2	Croatia	45.9	Estonia	27.0	Latvia	52.1	Romania	58.7
3	Ireland	40.5	Lithuania	26.9	Argentina	51.7	Ghana	45.1
4	Argentina	32.8	Ireland	22.2	Croatia	50.5	Latvia	36.9
5	Romania	31.2	Sweden	21.2	Ireland	42.5	Russia	35.6
6	Lithuania	28.7	Iceland	18.9	Venezuela	40.1	Brazil	32.9
7	Estonia	27.9	Cyprus	18.3	Turkey	37.6	Estonia	30.1
8	India	26.6	Switzerland	18.2	Russia	37.0	Ireland	24.0
9	Peru	24.9	Croatia	16.8	Ghana	35.7	Colombia	23.3
10	Sweden	22.7	India	15.8	Brazil	34.6	Sweden	23.1
11	China	22.1	Brazil	14.3	Colombia	33.4	Lithuania	22.7
12	Brazil	15.7	Denmark	14.0	India	32.4	Iceland	21.4
13	Israel	15.7	Ghana	13.3	Peru	31.9	India	21.1
14	Colombia	15.6	Morocco	13.1	Estonia	31.0	Croatia	20.5
15	Spain	15.1	Spain	12.7	Sweden	24.6	Cyprus	20.3
16	UK	14.1	USA	12.1	Lithuania	24.5	Switzerland	20.1
17	Morocco	13.8	Turkey	12.0	Uganda	22.6	Argentina	20.0
18	Norway	13.4	Romania	11.9	China	22.0	Venezuela	18.2
19	Iceland	13.4	UK	11.7	Israel	21.8	Hungary	17.0
20	Denmark	12.8	Israel	10.6	Spain	17.6	Israel	16.4

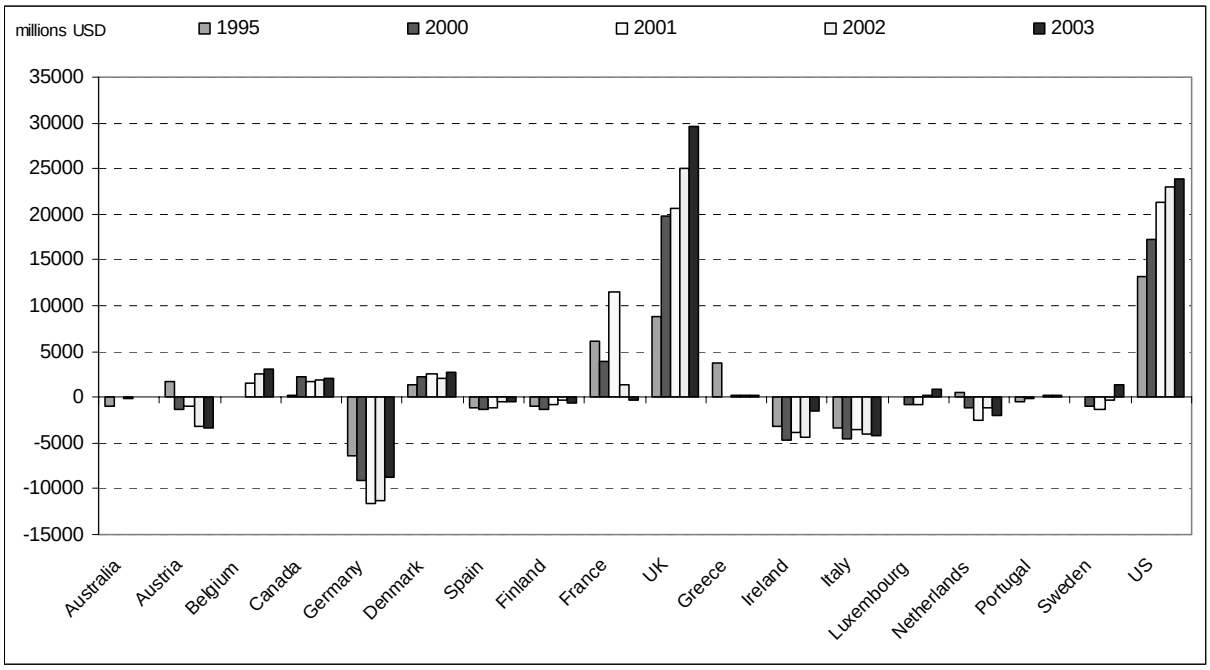
Notes: Excludes data for Belgium, Luxembourg and Mexico.

Source: Authors' calculations based on IMF Balance of Payments Database (August 2005).

The trade balance (in current USD) in the sum of the categories other business and computer and information services is shown in Figure 7 for selected OECD countries and for several years, and as a percent of GDP in Figure 8. The United States have a relatively large and still increasing surplus in trade in these categories, although it is relatively small as a percent of GDP (Figure 8). The United Kingdom also has a large and growing surplus, and the share in GDP is also increasing, in spite of the impression that may be given by the many (media) reports on the extent of offshoring and related imports. Somewhat surprisingly, the data show a rather large deficit for Ireland.

Figure 7. Trade balance in the sum of the categories "other business services" and "computer and information services", selected countries, various years

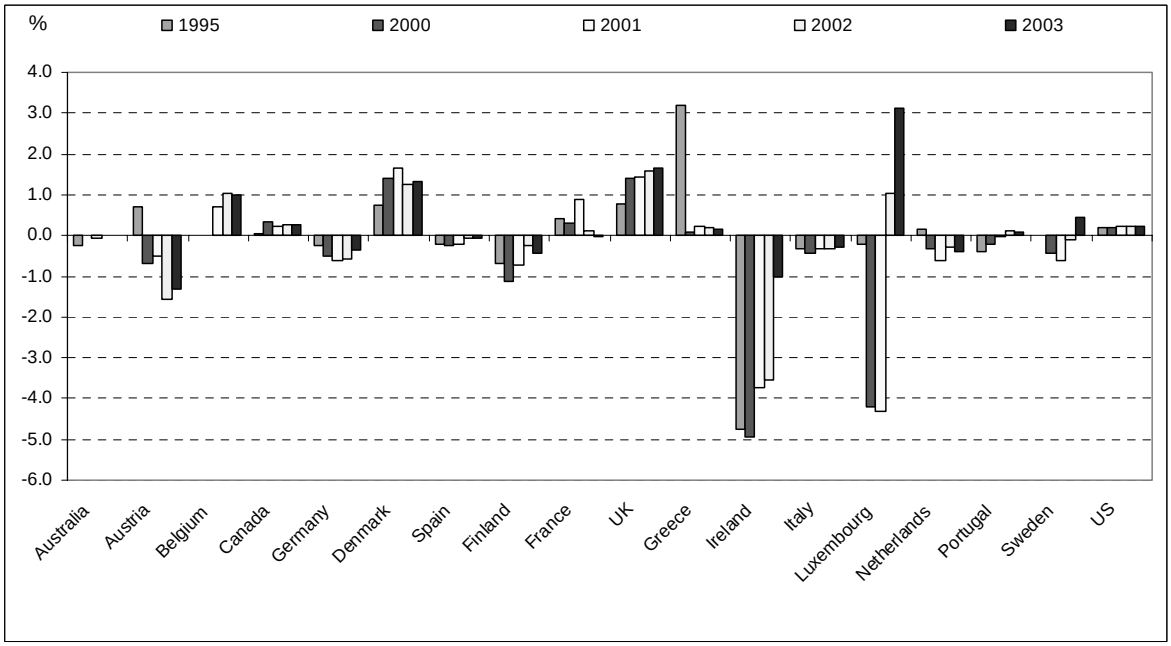
(current USD)



Source: Authors' calculations based on IMF Balance of Payments Database (February 2005).

Figure 8. Trade balance in the sum of the categories "other business services" and "computer and information services" as a percentage of GDP, selected countries, various years

(percentages)



Source: Authors' calculations based on IMF Balance of Payments Database (February 2005).

It remains, however, difficult to interpret these data and link them to different sourcing activities. It is not possible to tell what share of this trade results from international sourcing activities. Offshoring can include unaffiliated trade in services (from international outsourcing) and affiliated trade (from international insourcing), but some of it is also related to foreign direct investment and temporary migration, Mode 4 trade in services under the GATS. But temporary migration is not captured by balance of payments trade data.[10] Furthermore, the quality of the data may be variable and there can be very large discrepancies between reported exports and imports (see OECD, 2004a, Chapter 2, for an example using Indian data). Some of the problems with data on trade in services can be explained by factors such as reporting difficulties, collection methods (company surveys rather than customs records for goods), varying timelines for implementing Balance of Payments (BPM5) methodology and rules, the treatment of certain services categories, and the complexity of the structures and operations of multinational firms (OECD, 2004a).

Employment data

This section describes the employment data underlying the analysis in more detail. The evolution of the dependent variable of the model, the share of employment potentially affected by offshoring in total employment (Figure 2), is examined in more detail in Appendix Figures 1-1 to 1-3. One caveat of these data is that it is not possible to control for differences in the ICT content of occupations within and between countries. Similarly, any possible dynamic adjustments, or changes in qualifications, skill requirements and task descriptions that may take place within occupations over time are not taken into account.

For the EU15 as a whole, the trend increases in all years, except in 1998. The year-on-year rate of change shows that employment potentially affected by offshoring grew faster than total employment in EU15 in all years except in 1998 when it grew slower than total employment. There was no absolute decline in employment potentially affected by offshoring.

For the United States the trend decreases from 1995 to 1998 and from 2001 to 2003. The year-on-year rate of change shows that total employment grew faster than employment potentially affected by offshoring in all years except in 1999 and 2000. The absolute number in employment potentially affected by offshoring declined in the United States in 1996, and 2001, 2002 and 2003. This absolute decline was fairly generalised and not limited to a specific type of occupation or level of skills (see Appendix Box 1 for details).

For Canada the trend decreases in 1995 and 1996 and from 1998 to 2003 – except in 2000. The year-on-year rate of change shows that total employment grew faster than employment potentially affected by offshoring except in 1997, 1998, and 2000. There was no absolute decline in employment potentially affected by offshoring.

For Australia the trend decreases in 1999, 2001-2003. The year-on-year rate of change shows that total employment grew faster than employment potentially affected by offshoring in 1999 and 2002-2003. There was no absolute decline in employment potentially affected by offshoring. Data for 2004 indicate that the trend continues to decline. Data for 1995 and 1996 are not directly comparable with that for the rest of the period as 1995 and 1996 are in ASCO first edition and subsequent data in ASCO second edition.

This information, including for the countries that make up the EU15, is summarised in Appendix Table 6. It supports the idea that it is not so much a decline in certain types of employment that can be expected, but rather slower employment growth in these types of occupations.

Appendix Figures 1-2 and 1-3 show the underlying data for the countries that make up the EU15. The data quality is very poor, especially early in the sample period, for Greece and Portugal. Furthermore, there appears to be a break in the data for Ireland between 1995-1997 and 1999-2003 with a missing data point in 1998.

As technology may have a different effect on workers with different types of skills (Autor *et al*, 2003), the three-year average percentage of clerical workers in employment potentially affected by offshoring, as well as in total employment, is shown in Table 2. The three-year average is used here to take out some of the year-on-year fluctuations, even though in some cases, the United Kingdom in particular, this masks the overall decline that can be observed. Most countries have experienced an overall decline in the share of clerical workers in the selection of occupations potentially affected by offshoring, and most countries have a lower share at the end of the period than at the beginning. This is important as the clerical group includes the types of jobs that can be substituted for by ICTs (through the digitisation and/or automation of certain tasks and types of codifiable knowledge) so differential pace of adoption and integration of technology can have a different effect across countries. Even though the levels are not directly comparable as the classifications are not harmonised, the overall decline appears to be fairly generalised across countries, with English speaking countries (except Canada) as well as Finland and Sweden (important ICT producing countries) showing a relatively low share.

The picture changes a little when looking at the share of clerical workers in total employment. For the United States and Australia, and Canada to a lesser extent, there is an obvious decline. This is consistent both with the destruction of these types of jobs as a result of technological advances and with the offshoring of backoffice activities. For the EU15 countries the evidence is more mixed. In some countries a decline in the share can be observed (Austria, Belgium, Germany, Finland, France, Luxembourg, Portugal; in the Netherlands the share is stable), but in other countries there is an increase (Denmark, Spain, Greece, Ireland, Italy, Sweden and the United Kingdom). It is likely that there are different explanations underlying these evolutions, for example the varying importance of the size of the public sector and the services sector in the economy, and the differential pace of technology adoption and integration. However, it also means that while there are many reports about clerical type occupations being offshored, in some countries at least more still are being created at home.

Table 2. The share of clerical occupations in employment potentially affected by offshoring and in total employment, sample countries, three-year averages[1], 1995-2003

(percentages)

	clerical in offshoring			clerical in total		
	1995-1997	1998-2000	2001-2003	1995-1997	1998-2000	2001-2003
Australia	41.9	39.3	32.8	7.9	7.6	6.4
Canada	42.6	41.2	41.8	8.2	8.0	7.9
United States	34.5	32.2	28.1	6.6	6.0	5.1
Austria	44.6	42.5	39.7	5.0	4.9	4.8
Belgium	38.0	36.7	33.2	5.5	5.7	5.2
Germany	49.1	44.8	42.3	9.1	8.4	8.1
Denmark	38.9	38.3	37.6	6.7	7.3	7.8
Spain	55.7	53.3	51.3	8.0	8.2	8.3
Finland	31.6	30.6	26.6	5.6	5.6	5.2
France	42.0	39.9	36.2	6.3	6.0	5.7
Greece	46.6	51.4	51.5	4.1	5.9	6.0
Ireland	22.0	33.0	30.8	2.7	5.3	5.1
Italy	65.8	62.8	61.9	13.0	12.5	13.4
Luxembourg	57.9	51.9	48.6	12.7	12.7	12.3
Netherlands	42.8	39.4	39.7	8.2	8.1	8.2
Portugal	63.8	67.8	62.9	8.9	7.9	7.6
Sweden	30.3	28.8	28.0	5.5	5.3	6.0
United Kingdom	33.8	31.7		7.1	7.0	

Note: 1. Three years or as many as available. Includes estimates where a full data set was not available. Due to differences in classifications the levels of the shares are not directly comparable between the European and non-European countries. Due to a classification change, detailed data for the UK are not comparable beyond 2000.

Source: Author's calculations, based on EULFS, US Current Population Survey, Statistics Canada and Australian Bureau of Statistics (2004/5).

Even though technology may account for at least some of the relative decline in the occupations potentially affected by offshoring (and absolute declines in the case of the United States – see Appendix Box 1) the possibility that some of these jobs have been offshored cannot be ruled out. For example, Baily and Lawrence (2005) argue that at least some of the declines in low-wage ICT-enabled occupations, a concept close but not equivalent to the group of clerical workers identified above, took place as a result of activities being shifted overseas. Looking at IT specialist occupations they also find that the net loss of computer programmers in the United States was most likely the result of offshoring. Nevertheless, even the largest projections of jobs to be offshored, as often reported in the media, are in fact relatively small compared to annual job churning in OECD labour markets (OECD, 2004b, 2005).

Having examined some of the underlying trade and employment data, the next section presents a simple descriptive empirical model to provide a first indication of the factors associated with aggregate changes in the share of potentially offshorable employment. The detailed results from the analysis can be found in the Technical Appendix.

5. The empirical model and some results

The model

Using panel data estimation techniques, this paper attempts to identify those factors that are associated with the share of employment potentially affected by offshoring in total employment for the United States, Canada, Australia and the EU15 countries (except Greece, Ireland, Luxembourg, and Portugal)[11] over the

period 1996-2003. In the model, the share of potentially offshorable occupations in total employment (OL) is a function of international trade and investment, the industrial structure of the economy, a technology adoption/integration variable, a product market regulations indicator, an employment protection indicator and human capital.[12] The choice of variables is motivated by findings from the background literature (see Section 2 for a review), including studies of the factors determining the overall share of the service sector in the economy, studies of services sector employment, and studies of the effect of trade and technology on employment (see OECD, 2005, for example).

Ideally, it would be appropriate to begin with a simple structural model of the factors affecting the relative demand for ICT-using occupations. Using the first order marginal productivity conditions from an (unknown) production function with two types of labour (ICT and non-ICT labour), such a model might be expected to include measures of the relative output and relative wages of ICT-using occupations. Control variables might also be included to pick-up possible differences in the extent of (labour-augmenting) technical progress in the two broad types of occupations. As in the literature on the demand for skilled and unskilled labour, possible controls are indicators for both trade and technology.

Unfortunately, while it is possible to control for output and technology effects directly, data on occupational wages are not readily available in most countries at the level of detail required. Their effect can be captured only indirectly by including a number of variables that can be expected to have an influence on real wages. It should be noted that although it is not possible to estimate a full structural model, the estimates shown are not a pure reduced form model either, since potentially endogenous current dated terms in output and/or trade and technology remain in the model.

$$OL = f(TRADE, FDI, STRUC, ICT, PMR, union, HK) \quad (1)$$

In particular, trade effects are approximated by including both imports and exports of other business and computer and information services as a share of GDP (current US dollars, IMF Balance of Payments for trade data, OECD ANA database for GDP data). It is expected from the literature on trade related displacement that imports may have a negative association with the share of potentially offshorable occupations, while exports are thought to have a positive relationship. Nevertheless, trade may not have an impact at the aggregate level but rather bring about shifts at the industry and occupation level (see OECD, 2005c, for an overview).

Net foreign direct investment[13] is included as a share of GDP (current US dollar, IMF Balance of Payments for stock data and OECD ANA database for GDP data). The predictions from the literature are ambiguous as to what the overall direction of the relationship between these variables and the share of employment potentially affected by offshoring would look like. Differential effects might be expected to occur for FDI in services and in manufacturing (similar to the way the relationship between trade and FDI depends on the level of aggregation – see Pain and van Welsum, 2004, and van Welsum, 2004), but such differences are hidden in the aggregate measures – only the net effect, which will be dominated by manufacturing FDI, can be picked up as much of the total inward and outward FDI stocks is in manufacturing, and there are relatively few detailed cross-country data that distinguish manufacturing from services FDI over a long time period. However, in further research it will be attempted to include separate indicators for services and manufacturing FDI.

The share of services sector[14] value added in total value added and the share of high-tech industries[15] value added in total value added are included as indicators of the industrial structure of the economy (OECD STAN database; missing values have been estimated using the "60-Industry Database" from the Groningen Growth and Development Centre of the University of Groningen (Netherlands), available at http://www.ggdc.net/dseries/60-industry.html (last accessed 28 April, 2005)). Other things being equal, the

larger the share of the services sector in the economy, the larger the relative demand for ICT-using occupations can be expected to be.

To approximate technology adoption or integration, ICT investment (capital expenditure[16]) as a share of gross fixed capital formation and as a share of GDP) are included separately in different versions of the model (detailed results reported in the Technical Appendix). The ICT investment data are from an unpublished OECD database based on national account sources.

The indicator of product market regulation is an average of indicators of regulation in selected non-manufacturing industries.[17] These indicators measure, on a scale of 0 to 6 (from least to most restrictive), restrictions on competition and private governance. The original version of these data is described in Nicoletti and Scarpetta (2003). This indicator is used as a proxy for competitive pressures in the economy. The weaker such pressures are, the less incentive there is for companies to adopt new efficient technologies and new, more productive, ways of working. This would imply that a negative relationship can be expected between the importance of product market regulations in the economy and the share of employment potentially affected by offshoring. Messina (2004) includes a measure of entry-barriers to the creation of new firms in the economy as an indicator of product market regulations and finds a significant and negative effect on the share of services sector employment.

Two variables are included to capture institutional and supply-side influences on (unobserved) real wages – union density and human capital. Trade union density indicators may of course provide information about the degree of flexibility in national labour markets, as well as the relative strength of workers in wage bargaining.[18] A number of existing papers suggest that union density rates are related to the growth of service sector occupations. For example, Messina (2004) finds that a fall in union density rates is associated with an increase in services sector employment. Similarly, Nickell *et al* (2004) find evidence that countries with higher levels of employment protection were slower in reallocating resources from declining sectors (agriculture, manufacturing, and other production) into the services sector, possibly because stronger employment protection makes labour shedding in declining sectors more costly. The analysis in the present paper does not consider employment at the sectoral level, but an analogy can be drawn as labour market inflexibilities are likely to affect occupational shifts as well as sectoral changes. The *a priori* effect of this variable is ambiguous though, as it can both prevent a reallocation of resources into ICT-intensive using occupations, and hinder the speed at which existing ICT-intensive using jobs can be transferred abroad. In the latter case, the share of potentially offshorable occupations in total employment will be at a higher level than it would otherwise have been.

Finally, human capital is approximated by the average years of education per person (de la Fuente and Doménech, 2002a,b, and OECD, 2003). It is expected that this variable is positively related to the share of potentially offshorable occupations as increases in human capital are positively correlated with increases in the supply of ICT-literate people in the workforce. Such increases in supply should help to restrain the growth of real wages of workers in ICT occupations and hence support demand. Nickell *et al* (2004) find a strong positive effect of increases in educational attainment on the output share of the "other services" sector in the economy in Australia, Canada, France, Italy, Japan, Netherlands, Sweden, Germany, the United Kingdom and the United States.[19]

Results

The results using fixed effects and instrumental variables estimation techniques on a sample excluding Greece, Ireland, Luxembourg and Portugal are reported in Table 3 below.[20] Estimation for the basic fixed effects models is for a sample of 14 countries over 1996-2003. The instrumental variables estimates are for the same countries, but over 1997-2003. Columns [1] and [3] of Table 3 show the standard fixed effects results, and [2] and [4] show the results obtained when re-estimating these models using instrumental

variables. A year is dropped from the estimation period for these latter regressions to allow higher order lagged variables to be used as instruments. All current dated terms, with the exception of the product market regulation indicator, are instrumented in columns [2] and [4]. For these variables only instruments dated *t-2* are included in the instrument set. The Sargan tests of the over-identifying restrictions provide support for the validity of the instrument set employed in both models.

In each of the four models (columns [1] to [4]), exports are found to have a positive and significant association with the share of employment potentially affected by offshoring – as expected. The coefficient on imports is negatively signed, as expected, but is not significant at the conventional 5% level in any of the models. Thus, there is no significant evidence that increasing imports of other business and computer and information services are associated with a reduction in the share of employment potentially affected by offshoring at the aggregate level.

Care is needed in drawing strong conclusions from these results though as the trade variables may be endogenous, especially if companies' decisions about international sourcing and employment are made simultaneously. However, as shown in columns [2] and [4] of Table 3, and in the results reported in the Technical Appendix (TA Tables 2 and 3), the basic findings remain even when an instrumental variables estimator is employed.

Net FDI is found to have a positive and significant association with the share of employment potentially affected by offshoring. Thus, contrary to popular belief, there is no evidence that outward investment or net FDI reduce the share of this type of employment at the aggregate level. This effect can probably be explained by the fact that manufacturing activities are much more important in total FDI than they are in the overall share of activities in host and home economies. An increase in the outward stock of FDI can also be expected to increase the relative share of occupations in support functions, as well as marketing, design and general headquarter services. Inward investment is found to be negatively related to the share of employment potentially affected by offshoring. With manufacturing also having a comparatively high weight in the activities of inward investors, it is not necessarily surprising that the relative share of employment in the types of occupations identified as potentially affected by offshoring is reduced. Further research will attempt to disentangle the effects of services versus manufacturing investment.

There are many different factors that might be reflected in the coefficients on the FDI variables. It is also the case that FDI data can, at times, be a poor measure of the actual scale of activities that multinational companies undertake. Although this in itself is not a reason for omitting the FDI variables, it is prudent to repeat the regressions without them to ensure that their inclusion is not serving to significantly bias the coefficients on the other explanatory factors. The results, shown in columns [3] and [4] of Table 3, suggest that the net FDI variable is largely orthogonal to the remaining regressors, with the possible exception of the imports term whose coefficient becomes more negative. However it remains insignificant, at least at the 5% level.

The share of ICT investment in gross fixed capital formation is positively signed, but is not especially significant. The share of services sector value added in total value added has a significant positive association with the share of employment potentially affected by offshoring, as expected, with many services having high shares of ICT-using occupations, but there is no significant relationship with the share of high-tech industries in value added (though the coefficient is positively signed). The indicator of the importance of product market regulations in the economy is negatively signed (except in column [3]) but is not significant.

The two variables that are most likely to affect wages – union density and human capital – both have coefficients of the sign expected given the assumption that wages have a negative effect on employment. Higher levels of union density are associated with slower adjustment into the types of occupations potentially affected by offshoring, and the average years of education per person is significantly positively associated with the share of potentially offshorable employment, consistent with the observation that many such occupations are comparatively skill intensive.

Table 3. Results using fixed effects and instrumental variables

Dependent variable: the share of employment potentially affected by offshoring in total employment (OL_t)

	[1]	[2]	[3]	[4]
$(X/GDP)_t$	0.9086 (5.8)*	0.9298 (2.6)*	0.8977 (5.6)*	1.3139 (3.0)*
$(M/GDP)_t$	-0.2246 (1.4)	-0.1309 (0.3)	-0.3099 (2.0)*	-0.7119 (1.4)
$(NETFDI/GDP)_{t-1}$	0.0384 (3.3)*	0.0435 (3.2)*		
$(ICTI/INV)_{t-1}$	0.1132 (1.8)†	0.0984 (0.8)	0.0968 (1.5)	0.0992 (0.8)
$SERVICES_{t-1}$	0.1649 (3.6)*	0.1716 (3.5)*	0.1852 (3.5)*	0.1961 (3.6)*
$HTECH_{t-1}$	0.1592 (0.7)	0.1760 (0.6)	0.2382 (1.1)	0.3056 (1.1)
PMR_t	-0.1614 (0.7)	0.0171 (0.0)	-0.0348 (0.1)	-0.0105 (0.0)
$UNIONS_{t-1}$	-0.1252 (2.9)*	-0.1298 (2.6)*	-0.0952 (2.1)*	-0.1145 (2.1)*
HK_{t-1}	1.1719 (3.7)*	1.2913 (3.2)*	1.3954 (4.2)*	1.4404 (3.3)*
	Fixed Effects	Fixed Effects IV	Fixed Effects	Fixed Effects IV
Sample Period	1996-2003	1997-2003	1996-2003	1997-2003
Observations	112	98	112	98
Log Likelihood	-70.145		-74.863	
$\overline{R}^2$	0.963	0.960	0.960	0.957
Standard error	0.542	0.563	0.562	0.583
Time Dummies (p-value of joint deletion)	0.193	0.795	0.609	0.853
Sargan test (p-value)		0.112		0.611

Notes: (X/GDP) is the share of exports of other business and computer and information services in GDP, (M/GDP) is the share of imports of other business and computer and information services in GDP (NETFDI/GDP) is the net stock of foreign investment (outward-inward) as a share of GDP (ICTI/INV) is the share of ICT investment in total fixed investment, SERVICES is the share of the services sector in total value added, HTECH is the share of high-tech industries in total value added, PMR is a product market regulations indictor, UNIONS are trade union density rates, and HK is the average years of education per person.
The additional instruments used are drawn from a set comprising $(X/GDP)_{t-2}$, $(M/GDP)_{t-2}$, OL_{t-2}, $(ICTI/INV)_{t-2}$, PMR_{t-1}, PMR_{t-2}, $UNIONS_{t-2}$ and $(NETFDI/GDP)_{t-2}$.
* Significant at the 5% level.
† Significant at the 10% level.

Overall, the results appear robust to different estimation techniques and specifications of the model. The most stable coefficients appear to be those on the ratio of exports of other business and computer and information services to GDP, net foreign direct investment stocks as a share of GDP, the share of the services sector in value added, and the average years of education per person. The full interpretation of these results must await further study. In particular, the development of corresponding data on relative wages should help to separate out demand and supply influences more clearly. Nevertheless, the results from the descriptive regressions in the present paper provide useful indications of the statistical associations that are found between the variables examined and provide guidance for further work in this area.

6. Conclusions

Despite the widespread media attention given to the apparent offshoring of service sector jobs little is known about the extent of this phenomenon, or the extent to which it is related to other economic and structural developments. In particular, an explicit link is often made between trade, the activities of multinational firms and changes in employment but this has not been founded on any solid quantitative evidence.

The present paper builds on previous detailed analysis of trade and occupational data. Trade data show that many of the countries frequently cited as beneficiaries of offshoring have seen rapid growth of their exports of other business and computer and information services. However, many have also seen rapid growth of imports of these services, and the bulk of exports of these types of services still come from OECD countries, although their export share is slowly declining. The analysis of occupational employment data for selected OECD countries sought to determine the share of total employment that could potentially be affected by the international sourcing of IT and ICT-enabled services, drawing on van Welsum and Vickery (2005a). It suggested that close to 20 % of total employment could potentially be affected by offshoring.

The present paper also makes an initial examination of the relationship between the share of employment potentially affected by offshoring and other economic and structural factors using some simple descriptive regressions on a panel of selected OECD economies between 1996 and 2003. In particular, first estimates are provided of the statistical association between the share of potentially offshorable employment and trade in business services and international direct investment. The results indicate that exports of other business services and computer and information services are positively associated with the share of employment potentially affected by offshoring. This suggests that increases in demand and production have lead to a relative increase in the types of ICT-using occupations identified in the analysis. Furthermore, contrary to popular belief, no evidence is found of a significant negative association between imports of these services and the share of employment potentially affected by offshoring. Similarly, no evidence is found that net outward direct investment reduces the employment share of the ICT-intensive using occupations identified as potentially affected by offshoring. Other key factors positively associated with cross-country differences in the employment share are found to be the comparative size of the service sector, the growing share of ICT investment in total fixed investment, and human capital.

These results suggest that in the OECD countries analysed, ICT-enabled services offshoring (as proxied by trade and investment) has not yet led to a relative decline in the occupational share of location independent ICT-using occupations. Overall, this implies that in the long-run the positive benefits of services offshoring outweigh the costs, even though the adjustment process may occasionally be difficult in the short run. Policy reactions to services offshoring should reflect these positive aspects. This includes the policies that contribute to the overall competitiveness of the economy and improve the macroeconomic framework, those policies that contribute to a sound investment climate, and those policies that improve the skills base and flexibility of the workforce.

It is important to take care with the interpretation of these results though, as they are not drawn from the empirical testing of a formal theoretical model of the underlying structural relationships. Thus it is not possible to separate out completely the effects from demand and supply side developments. However, the results provide guidance on the statistical associations that are found to exist between the variables included in these descriptive regressions and to this extent can be used to shape further work and analysis. This could include improvements to the underpinnings of the empirical model, such as the use of separate indicators for services and non-services FDI, and examination of whether there are differences in the factors affecting different groups of ICT-using occupations, such as clerical and non-clerical occupations. It might also be useful to develop an indicator of business adoption of ICTs to try to control for differences in “the use of ICT” or the “ICT content of occupations” across countries.

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NOTES

1 See Wyckoff and Schaaper (2005) for a discussion of the changing dynamics of the global market for the highly-skilled, and of the role of India and China in particular.

2 The standard theoretical prediction being that low income countries should export goods and services that make intensive use of low-skilled cheap labour while developed countries export goods and services intensive in highly skilled labour. Markusen (2005) attempts to build a model that can explain the reversal of the direction of trade (in services).

3 See Schettkat and Yocarini (2003) for a review of the literature on the shift to services. See OECD (2005a) for an analysis of the contribution made by the services sector to employment growth, productivity, and innovation.

4. Take the case of the offshoring of call centre activities where the call centre has a direct relationship with the customer – it would be difficult to classify this type of offshored services as intermediate.

5 The European data are Labour Force Survey data provided by Eurostat. The occupational classification system in those data is the ISCO – International Standard Classification of Occupations, and NACE – the industrial classification system of the European Union – which is used for sectoral classification. For the US, data from the Current Population Survey were used. The Current Population Survey collects information on both the industry and the occupation of the employed and unemployed. However, beginning with data from January 2003, the 1990 Census Industrial Classification System was replaced by one based on the North American Industry Classification (NAICS), and the 1990 Census Occupational Classification was replaced by one derived from the United States Standard Occupational Classification (SOC). Further information is available on the Web site of the U.S Bureau of Labor Statistics at: http://www.bls.gov/opub/hom/pdf/homch1.pdf (accessed November 2004): Chapter 1: Labor Force Data derived from the Current Population Survey. For Canada Labour Force Data provided by Statistics Canada were used. The occupational classification is in SOC91. For Australia data from the Labour Force Survey provided by the Australian Bureau of Statistics were used. The occupational classification is in the Australian Standard Classification of Occupations (ASCO) second edition.

6 The number for 2003 (just under 18%) is an estimate as both the occupational and industrial classification systems were changed in 2003 in the United States

7 A parallel can be drawn here with some of the work undertaken by Autor *et. al.* (2003) and Levy and Murnane (2004). These authors argue that the tasks most vulnerable to being substituted by technology are those where information processing can be described in rules. If a significant part of a task can be described by rules, this increases the likelihood of the task being offshored, since the task can then be assigned to offshore producers with less risk and greater ease of supervision.

8. For India, the category "other business services" includes all services except travel, transport and government services. However, Indian firms are now extensively exporting ICT-enabled services and business process services and the remaining services included in the category are likely to be small in comparison. Furthermore, data on overseas revenues from annual reports of top Indian export firms show patterns similar to the IMF data.

9 The share of some services exporting countries may be understated as they may not have very good data on trade in services to report to the IMF, which will bias their actual share downwards. Furthermore, other countries that export services may not be members and report to the IMF.

10 See van Welsum (2003) for a discussion.

11 These countries were excluded from the sample because of a lack of data.

[12] Even though GDP per capita is a variable found to be an important determinant of the share of services sector employment (Messina, 2004) it is not used here. In a time series context it does not make sense to include the level of GDP per capita in a regression of a bounded variable. The first difference of GDP per capita was found to be insignificant. This is not necessarily surprising as the countries in the sample all have relatively high levels of GDP per capita, so over the sample period (1995-2003) this variable is not found to have an impact on the share of employment potentially affected by offshoring. Nevertheless, with the exception of Austria, the countries with a relatively low share of employment potentially affected by offshoring were also those with the lowest levels of GDP per capita. The role of productivity growth is also not considered here. It is sometimes argued that the decline in certain types of employment, or the lack of new jobs (the jobless recovery), is the result of important productivity increases, but Baily and Lawrence (2005) argue that this is a mistake and that while productivity may have played some role, it should not be considered a fundamental cause. Time dummies pick up common cyclical effects.

[13] This is done by imposing equal and opposite signs on outward and inward FDI, a restriction accepted by the data.

[14] ISIC Rev.3 categories 50-99: 50-55: Wholesale and retail trade; repairs; hotels and restaurants; 60-64: Transport, storage and communications; 65-74: Finance, insurance, real estate and business services; 75-99: Community, social and personal services.

[15] ISIC Rev.3 categories: 2423: chemicals excluding pharmaceuticals; 30: office, accounting and computing machinery; 32: radio, television and communication equipment; 33: medical, precision and optical instruments; 353: aircraft and spacecraft.

[16] ISIC Rev.3 categories: 30: office, accounting and computing machinery; 3130: Insulated wire and cable; 3210: Electronic valves and tubes and other electronic components; 3220: Television and radio transmitters and apparatus for line telephony and line telegraphy; 3230: Television and radio receivers, sound or video recording or reproducing apparatus, and associated goods; 3312: Instruments and appliances for measuring, checking, testing, navigating and other purposes; 3313: Industrial process control equipment; 5150: Wholesale of machinery, equipment and supplies; 6420: Telecommunications; 7123: Renting of office machinery and equipment (including computers); 72: computer and related activities.

[17] We use a preliminary unpublished version of this product market regulation indicator.

[18] The data on trade union density rates come from OECD Labour Force Statistics Indicators and OECD 2004c (Table 3.3). Factors other than union density rates, including union coverage and hiring and firing restrictions, may also be important but are not included here.

[19] But in the sector “business services” they found a greater role for changes in relative prices.

[20] Country fixed effects and year time dummies are included in all models.

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APPENDIX

Appendix Table 1. Europe: Occupations potentially affected by offshoring

3 Digit ISCO-88
123: Other specialist managers
211: Physicists, chemists, and related professionals
212: Mathematicians, statisticians and related professionals
213: Computing professionals
214: Architects, engineers, and related professionals
241: Business professionals
242: Legal professionals
243: Archivists, librarians, and related information professionals
312: Computer associate professionals
341: Finance and sales associate professionals
342: Business services agents and trade brokers
343: Administrative associate professionals
411: Secretaries and keyboard-operating clerks
412: Numerical clerks
422: Client information clerks

Note: Occupations in shading have been classified as clerical.
Source: van Welsum and Vickery (2005a), based on EULFS (2004).

Appendix Table 2. United States: Occupations potentially affected by offshoring

CPS categories			
accountants and auditors	23	Archivists and curators	165
underwriters	24	Economists	166
other financial officers	25	Urban planners	173
management analysts	26	Authors	183
architects	43	Technical writers	184
aerospace engineer	44	Editors and reporters	195
metallurgical and materials engineers	45	Air traffic controllers	227
mining engineers	46	Computer programmers	229
petroleum engineers	47	Tool programmers, numerical control	233
chemical engineers	48	Supervisors and Proprietors, Sales Occupations	243
nuclear engineers	49	Insurance sales occupations	253
civil engineers	53	Real estate sales occupations	254
agricultural engineers	54	Securities and financial services sales occupations	255
Engineers, electrical and electronic	55	Sales occupations, other business services	257
Engineers, industrial	56	Supervisors, computer equipment operators	304
Engineers, mechanical	57	Supervisors, financial records processing	305
marine and naval architects	58	Chief communications operators	306
engineers, n.e.c.	59	Computer operators	308
surveyors and mapping scientists	63	Peripheral equipment operators	309
computer systems analysts and scientists	64	Secretaries	313
operations and systems researchers and analysts	65	Typists	315
Actuaries	66	Transportation ticket and reservation agents	318
Statisticians	67	File clerks	335
Mathematical scientists, n.e.c.	68	Records clerks	336
Physicists and astronomers	69	Bookkeepers, accounting, and auditing clerks	337
Chemists, except biochemists	73	Payroll and timekeeping clerks	338
Atmospheric and space scientists	74	Billing clerks	339
Geologists and geodesists	75	Cost and rate clerks	343
Physical scientists, n.e.c.	76	Billing, posting, and calculating machine operators	344
Agricultural and food scientists	77	Telephone operators	348
Biological and life scientists	78	Bank tellers	383
Forestry and conservation scientists	79	Data-entry keyers	385
Medical scientists	83	Statistical clerks	386
Librarians	164		

Note: Occupations in shading have been classified as clerical.
Source: van Welsum and Vickery (2005a), based on US Current Population Survey.

Appendix Table 3. Canada: Occupations potentially affected by offshoring

SOC91 Canada			
A121	Engineering, Science and Architecture Managers	C012	Chemists
A122	Information Systems and Data Processing Managers	C013	Geologists, Geochemists and Geophysicists
A131	Sales, Marketing and Advertising Managers	C014	Meteorologists
A301	Insurance, Real Estate and Financial Brokerage Managers	C015	Other Professional Occupations in Physical Sciences
A302	Banking, Credit and Other Investment Managers	C021	Biologists and Related Scientists
A303	Other Business Services Managers	C031	Civil Engineers
A311	Telecommunication Carriers Managers	C032	Mechanical Engineers
A312	Postal and Courier Services Managers	C033	Electrical and Electronics Engineers
A392	Utilities Managers	C034	Chemical Engineers
B011	Financial Auditors and Accountants	C041	Industrial and Manufacturing Engineers
B012	Financial and Investment Analysts	C042	Metallurgical and Materials Engineers
B013	Securities Agents, Investment Dealers and Traders	C043	Mining Engineers
B014	Other Financial Officers	C044	Geological Engineers
B022	Professional Occupations in Business Services to Management	C045	Petroleum Engineers
B111	Bookkeepers	C046	Aerospace Engineers
B112	Loan Officers	C047	Computer Engineers
B114	Insurance Underwriters	C048	Other Professional Engineers, n.e.c.
B211	Secretaries (except Legal and Medical)	C051	Architects
B212	Legal Secretaries	C052	Landscape Architects
B213	Medical Secretaries	C053	Urban and Land Use Planners
B214	Court Recorders and Medical Transcriptionists	C054	Land Surveyors
B311	Administrative Officers	C061	Mathematicians, Statisticians and Actuaries
B312	Executive Assistants	C062	Computer Systems Analysts
B412	Supervisors, Finance and Insurance Clerks	C063	Computer Programmers
B512	Typists and Word Processing Operators	C152	Industrial Designers
B513	Records and File Clerks	C172	Air Traffic Control Occupations
B514	Receptionists and Switchboard Operators	E012	Lawyers and Quebec Notaries
B521	Computer Operators	E031	Natural and Applied Science Policy Researchers, Consultants and Program Officers
B522	Data Entry Clerks	E032	Economists and Economic Policy Researchers and Analysts
B523	Typesetters and Related Occupations	E033	Economic Development Officers and Marketing Researchers and Consultants
B524	Telephone Operators	F011	Librarians
B531	Accounting and Related Clerks	F013	Archivists
B532	Payroll Clerks	F021	Writers
B533	Tellers, Financial Services	F022	Editors
B534	Banking, Insurance and Other Financial Clerks	F023	Journalists
B553	Customer Service, Information and Related Clerks	F025	Translators, Terminologists and Interpreters
B554	Survey Interviewers and Statistical Clerks	G131	Insurance Agents and Brokers
C011	Physicists and Astronomers		

Note: Occupations in shading have been classified as clerical.
Source: van Welsum and Vickery (2005a), based on Statistics Canada.

Appendix Table 4. Australia: Occupations potentially affected by offshoring

ASCO 4-digit	
1221 Engineering Managers	2521 Legal Professionals
1224 Information Technology Managers	2522 Economists
1231 Sales and Marketing Managers	2523 Urban and Regional Planners
1291 Policy and Planning Managers	2534 Journalists and Related Professionals
2111 Chemists	2535 Authors and Related Professionals
2112 Geologists and Geophysicists	3211 Branch Accountants and Managers (Financial Institution)
2113 Life Scientists	3212 Financial Dealers and Brokers
2114 Environmental and Agricultural Science Professionals	3213 Financial Investment Advisers
2115 Medical Scientists	3294 Computing Support Technicians
2119 Other Natural and Physical Science Professionals	3392 Customer Service Managers
2121 Architects and Landscape Architects	3399 Other Managing Supervisors (Sales and Service)
2122 Quantity Surveyors	5111 Secretaries and Personal Assistants
2123 Cartographers and Surveyors	5911 Bookkeepers
2124 Civil Engineers	5912 Credit and Loans Officers
2125 Electrical and Electronics Engineers	5991 Advanced Legal and Related Clerks
2126 Mechanical, Production and Plant Engineers	5993 Insurance Agents
2127 Mining and Materials Engineers	5995 Desktop Publishing Operators
2211 Accountants	6121 Keyboard Operators
2212 Auditors	6141 Accounting Clerks
2221 Marketing and Advertising Professionals	6142 Payroll Clerks
2231 Computing Professionals	6143 Bank Workers
2292 Librarians	6144 Insurance Clerks
2293 Mathematicians, Statisticians and Actuaries	6145 Money Market and Statistical Clerks
2294 Business and Organisation Analysts	8113 Switchboard Operators
2299 Other Business and Information Professionals	8294 Telemarketers
2391 Medical Imaging Professionals	

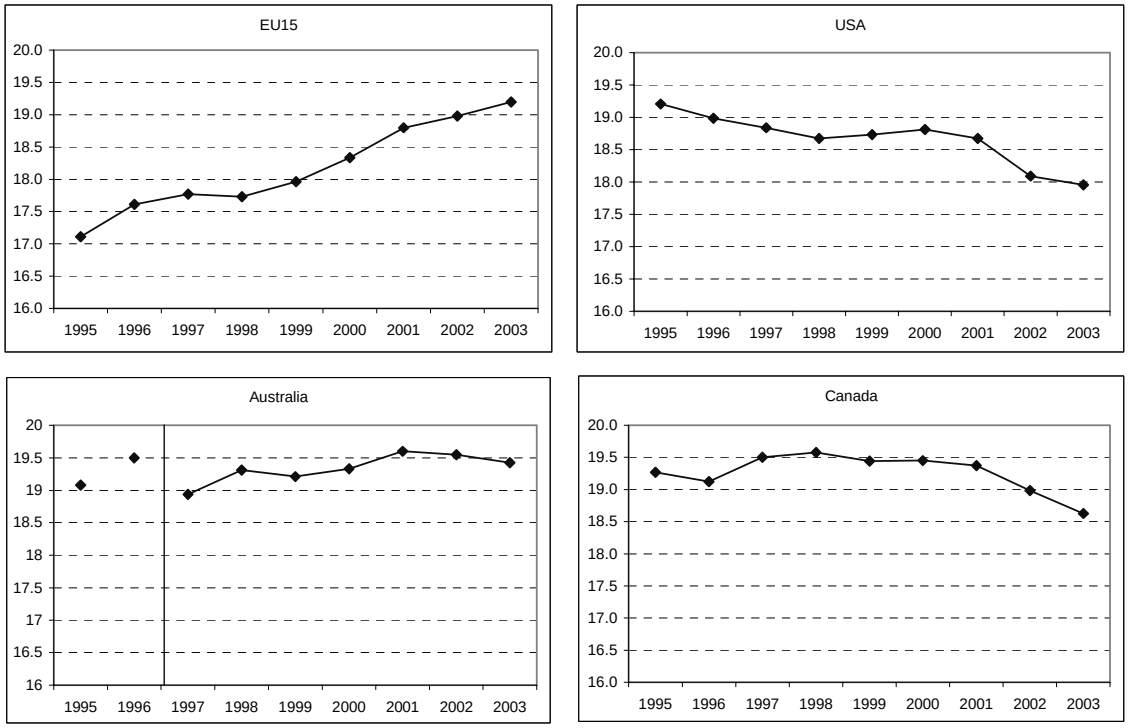
Note: Occupations in shading have been classified as clerical.
Source: van Welsum and Vickery (2005a), based on Australian Bureau of Statistics.

Appendix Table 5. IMF balance of payments categories

7.	**Computer and information services**
7.1	Computer services
7.2	Information services
7.2.1	News agency services
7.2.2	Other information provision services
9.	**Other business services**
9.1	Merchanting and other trade-related services
9.1.1	Merchanting
9.1.2	Other trade-related services
9.2	Operational leasing services
9.3	Miscellaneous business, professional, and technical services
9.3.1	Legal, accounting, management consulting, and public relations
9.3.1.1	Legal services
9.3.1.2	Accounting, auditing, bookkeeping, and tax consulting services
9.3.1.3	Business and management consulting, and public relations
9.3.2	Advertising, market research, and public opinion polling
9.3.3	Research and development
9.3.4	Architectural, engineering, and other technical services
9.3.5	Agricultural, mining, mining, and on-site processing services
9.3.5.1	Waste treatment and depollution
9.3.5.2	Agricultural, mining and other on-site processing services
9.3.6	Other business services
9.3.7	Services between related enterprises, n.i.e.

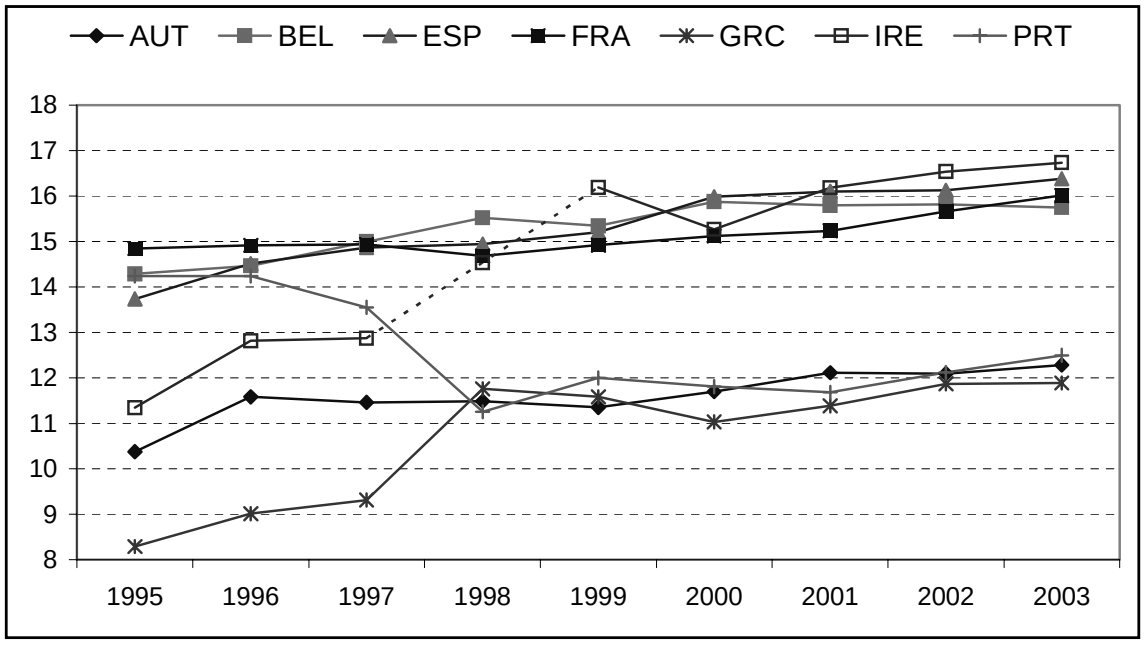
Source: OECD (2002).

Appendix Figure 1-1. The share of employment potentially affected by offshoring



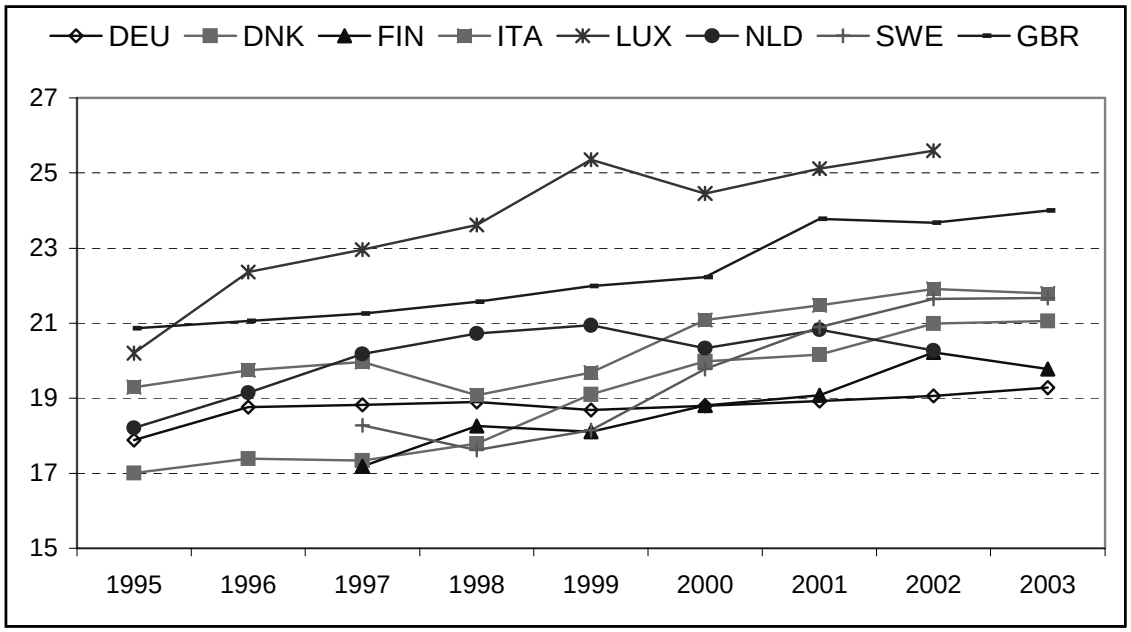
Source: Authors' calculations based on EULFS, US Current Population Survey, Statistics Canada and Australian Bureau of Statistics (2004).

Appendix Figure 1-2. The share of employment potentially affected by offshoring



Source: Authors' calculations based on EULFS.

Appendix Figure 1-3. The share of employment potentially affected by offshoring



Source: Authors' calculations based on EULFS.

Appendix Table 6. Summary information of the trends underlying the dependent variable

	1995	1996	1997	1998	1999	2000	2001	2002	2003
EU15		O	O	T	O	O	O	O	na
USA		T	T	T	O	O	T	T	T
CAN		T	O	O	T	O	T	T	T
AUS		*O*		O	T	O	O	T	T

O = offshorable employment grew faster
T = total employment grew faster

absolute decline in offshorable employment?

	1995	1996	1997	1998	1999	2000	2001	2002	2003
EU15		no	no	no	no	no	no	no	no
USA		yes	no	no	no	no	yes	yes	yes
CAN		no	no	no	no	no	no	no	no
AUS		*no*		no	no	no	no	no	no

	1995	1996	1997	1998	1999	2000	2001	2002	2003
AT		O	T	O	T	O	O	T	O
BE		O	O	O	T	O	T	O	T
DE		O	O	O	T	O	O	O	O
DK		O	T	O	O	O	O	O	O
ES		O	O	O	O	O	O	O	O
FI		T	T	O	T	O	O	O	T
FR		O	O	T	O	O	O	O	O
GR		O	O	O	T	T	O	O	O
IE		O	O	T	T	T	O	O	O
IT		O	O	T	O	O	O	O	T
LU		O	O	O	O	T	O	O	
NL		O	O	O	O	T	O	T	T
PT		O	T	T	O	T	T	O	O
SE		T	T	T	O	O	O	O	O
UK		O	O	O	O	O	O	T	O

O = offshorable employment grew faster
T = total employment grew faster

absolute decline in offshorable employment?

	1995	1996	1997	1998	1999	2000	2001	2002	2003
AT		no	yes	no	no	no	no	no	no
BE		no	no	no	no	no	yes	no	yes
DE		no	yes	no	no	no	no	no	no
DK		no	no	no	no	no	no	no	no
ES		no	no	no	no	no	no	no	no
FI				no	no	no	no	no	yes
FR		no	yes	yes	no	no	no	no	no
GR		no	no	no	yes	yes	no	no	no
IE		no	no			yes	no	no	no
IT		no	no	yes	no	no	no	no	no
LU		no	no	no	no	yes	no	no	
NL		no	no	no	no	no	no	yes	
PT		no	yes	yes	no	yes	no	no	no
SE				yes	no	no	no	no	no
UK		no	no	no	no	no	no	no	no

Note: There is a break in the data for Australia: 1995 and 1996 are in ASCO first edition, subsequent data are in ASCO second edition; there is no year of overlap available.

Source: Authors' calculations based on EULFS, US Current Population Survey, Statistics Canada and Australian Bureau of Statistics (2004).

Appendix Box 1. Detailed analysis of the US occupational data

Looking at the year-on-year change in the occupational data for the US (1995-2002) at the level of the individual occupations shows:

- All of the occupations selected as potentially affected by offshoring experienced at least one year-on-year decline.
- 45 out of the 67 occupations included in the US selection experienced an absolute decline between 2001 and 2002, as did the overall selection of occupations potentially affected by offshoring and total employment.
- The overall selection of occupations potentially affected by offshoring experienced 3 absolute declines between 1995-2002; to compare the individual occupations against the overall selection, the following 47 occupations experienced **at least** 3 absolute declines:

Accountants and auditors	23	Urban planners	173
Architects	43	Authors	183
Metallurgical and materials engineers	45	Technical writers	184
Mining engineers	46	Editors and reporters	195
Petroleum engineers	47	Air traffic controllers	227
Engineers, electrical and electronic	55	Computer programmers	229
Engineers, industrial	56	Supervisors and Proprietors, Sales Occupations	243
Engineers, mechanical	57	Insurance sales occupations	253
Marine and naval architects	58	Real estate sales occupations	254
Engineers, n.e.c.	59	Supervisors, computer equipment operators	304
Operations and systems researchers and analysts	65	Computer operators	308
Actuaries	66	Peripheral equipment operators	309
Statisticians	67	Secretaries	313
Physicists and astronomers	69	Typists	315
Chemists, except biochemists	73	Transportation ticket and reservation agents	318
Atmospheric and space scientists	74	File clerks	335
Geologists and geodesists	75	Payroll and timekeeping clerks	338
Physical scientists, n.e.c.	76	Billing clerks	339
Biological and life scientists	78	Cost and rate clerks	343
Forestry and conservation scientists	79	Telephone operators	348
Medical scientists	83	Bank tellers	383
Librarians	164	Data-entry keyers	385
Archivists and curators	165	Statistical clerks	386
Economists	166		

The estimates for 2003 show a further absolute decline in the selection of occupations potentially affected by offshoring.

TECHNICAL APPENDIX

Correlation tests

1. The Spearman Rank Correlation Coefficient (SRCC) is calculated as follows:

$$r_s = 1 - 6\left[\frac{\sum d_i^2}{N\left(N^2 - 1\right)}\right]$$ where d is the difference in the observations' ranks and N is the sample size.

2. Spearman's Rank Correlation Test is then calculated as follows:

$$t = \frac{r_s\sqrt{N-2}}{\sqrt{1-r_s^2}}$$ with the number of degrees of freedom equal to *N-2*. Then if t is greater than the critical value r_s is significantly different from zero. As the sample size is 55 countries, the critical values for the t-test with 53 degrees of freedom are 2.0 at the 5% level, and 2.4 at the 1% level. Thus, all of the SRCCs reported in the text and in the table below are significant at the 1% level.

Technical Appendix Table 1. Spearman Rank Correlation Coefficients

	SRCC	t-stat
exports and imports in USD	0.62**	5.71
exports and imports in national currency	0.78**	8.94
exports USD and exports nat. curr.	0.80**	9.85
imports USD and imports nat. curr.	0.79**	9.29

** means significant at the 1% level

Detailed results from the empirical analysis

3. The main section of the text presents a summary of the results, the full set of which is reported below. The results using fixed effects, random effects, and instrumental variables estimation techniques[1] on a sample excluding Greece, Ireland, Luxembourg and Portugal are reported in Technical Appendix Tables 2 and 3 below. The results in TA Table 2 use the share of ICT investment in total gross fixed capital formation and the results in TA Table 3 use ICT investment as a share of GDP. All the equations shown include time dummies.[2] Estimation for the basic fixed and random effects models is for a sample of 14 countries over 1996-2003. The instrumental variables estimates are for the same countries, but over 1997-2003. In both TA Table 2 and 3 an initial set of results is shown for a simple model including only the international trade and investment series. These are reported in columns [1] and [2] of the respective tables. The subsequent regressions include the full range of factors set out in equation (1) above. The difference between columns [1] and [2] is that the latter imposes a restriction of net FDI only (equal and opposite

1 See Hsiao (2003) and Smith and Fuertes (2004) for details. The use of random effects is rejected here in favour of fixed effects. However, it is still useful to compare the results from the various estimation techniques to get an idea of the robustness of the main findings. As the levels of the dependent variable are not strictly comparable across countries because classifications are not harmonised, it is better to use the fixed effects models to ensure that the individual effects can pick up any omitted country-specific effects that do not vary over time.

2 The joint inclusion of the time dummies is not significant in any of the models in TA Table 2.

coefficients on the outward and inward FDI stocks). If accepted by data, this restriction is retained in the subsequent models in the respective Table.

Estimates using the ICT investment share in total investment

4. In each of the four basic fixed effects models (columns [1] to [4]), exports are found to have a positive and significant association with the share of employment potentially affected by offshoring – as expected. The coefficient on imports is negatively signed, as expected, but is not significant at the conventional 5% level in any of the models (although it is significant at the 5% level in the model reported in column [4]). Thus, there is no systematic significant evidence in these fixed effects models that increasing imports of other business and computer and information services are associated with a reduction in the share of employment potentially affected by offshoring at the aggregate level.

5. The model in column [1] includes inward and outward FDI as separate variables, but in columns [2] onwards net FDI is included instead. Outward investment and net FDI are found to have a positive and significant association with the share of employment potentially affected by offshoring. Thus, contrary to popular belief, there is no evidence that outward investment or net FDI reduce the share of this type of employment at the aggregate level. This effect can probably be explained by the fact that manufacturing activities are much more important in total FDI than they are in the overall share of activities in host and home economies. An increase in the outward stock of FDI can also be expected to increase the relative share of occupations in support functions, as well as marketing, design and general headquarter services. Inward investment is found to be negatively related to the share of employment potentially affected by offshoring. With manufacturing also having a comparatively high weight in the activities of inward investors, it is not necessarily surprising that the relative share of employment in the types of occupations identified as potentially affected by offshoring is reduced. Further research will attempt to disentangle the effects of services versus manufacturing investment.

6. The share of ICT investment in gross fixed capital formation is positively signed in each of the four models reported, but is not especially significant. The share of services sector value added in total value added has a significant positive association with the share of employment potentially affected by offshoring, as expected, with many services having high shares of the types of occupation potentially affected by offshoring, but there is no significant relationship with the share of high-tech industries in value added (though the coefficient is positively signed in each model). The indicator of the importance of product market regulations in the economy is negatively signed in column [3], as expected, and positive in column [4], but not significant in either. The union density indicator on the other hand is negatively signed and significant, implying that higher levels of union density are associated with slower adjustment into the types of occupations potentially affected by offshoring. Finally, the average years of education per person is significantly and positively associated with the share of employment potentially affected by offshoring, consistent with the fact that many of the occupations under consideration are relatively skill intensive.

7. Columns [5] and [6] show the results from using random effects estimation techniques to estimate the models shown in columns [3] and [4]. Even though the use of random effects is rejected in favour of fixed effects by a Hausman test, the results are reported as they help to illustrate the robustness of the findings to different estimation techniques. The coefficients on the exports ratios are of the same sign and similar magnitude as in the fixed effects models. The coefficients on the imports ratio are of the same sign (negative), are somewhat bigger and are now significant. Net FDI has a similar effect. ICT investment as a share of total fixed investment is still positively signed and is now significant in column [5]. In contrast, the share of the services sector in total value added is no longer significant (except at the 10% level in column [6]), though still with a positive coefficient. The share of high-tech industries in total value added remains insignificant at conventional levels (although significant at the 10% level in column [6]). The coefficient on the indicator of product market regulations is again negative, as expected,

but is now significant at the 10% level in column [5], although not in [6]. The coefficient on union density rates is still negative, but significant at the 10% level only. The coefficient on the variable representing the average years of education per person is still positive but is only significant at the 10% level.

8. The final two columns of Table 2 show the results obtained using instrumental variables estimation techniques to re-estimate the basic fixed effects models in [3] and [4]. A year is dropped from the estimation period to allow higher order lagged variables to be used as instruments. All current dated terms are instrumented in these regressions. The results are fairly similar to those reported in columns [3] to [4]. In particular, the signs are the same for all of the variables, though there are some differences in the magnitude and significance of the coefficients. For example, the coefficient on the exports ratio is larger and greater than one.

Estimates using the ICT investment share in GDP

9. The results from the same exercise using ICT investment as a share of GDP in place of the ICT share of total investment are reported in TA Table 3. Column [2] is empty as the restrictions necessary to impose net FDI (by imposing equal and opposite signs on outward and inward FDI) were not accepted by the data in this case, meaning that outward and inward FDI are picking up different effects in this version of the model. Therefore, in TA Table 3, the model reported in column [3] builds on that in column [1]. However, other than this, the results are broadly similar overall. The coefficient on the share of ICT investment in GDP is positive and significant in each case, except in column [8]. Joint deletion of the time dummies is now rejected in column [3].

10. An increase in the ratio of exports of other business and computer and information services to GDP is again found to have a positive and significant association with the share of employment potentially affected by offshoring. The coefficient on imports of other business and computer and information services is again negative but is now somewhat more significant than in the results shown in TA Table 2. The inward and outward stocks of FDI are again significant, with a positive effect from outward FDI and a negative effect from inward FDI. The restrictions required to include net FDI cannot be imposed in these versions of the model. ICT investment in GDP is significant and positively related to the share of employment potentially affected by offshoring, except in column [8]. The results on the remaining variables are similar to the previous exercise, with a significant and positive coefficient on the share of the services sector in total value added (although this is not significant in the random effects specifications, except at the 10% level in column [6]), a positive but insignificant coefficient on the share of high-tech industries in total value added), a negative but insignificant coefficient on the product market regulations indicator (significant in column [5] only), a negative coefficient on trade union density rates which is significant at the 5% level in columns [3], [4], [7] and [8] and insignificant in the random effects models, and a positive and significant relationship with the average years of education per person (except in column [5]). It is noticeable that the coefficient on this human capital variable varies quite widely across the different specifications, suggesting that it is difficult to pin down the effect of this variable too precisely.

Comparing actual and fitted values

11. Technical Appendix Figure 1 shows actual and fitted values from the models shown in columns [3] and [7] of TA Table 2, using ICT investment as a share of gross fixed capital formation. The fit of the models varies across countries. However, in some countries, for example the United States, Finland and France, end of sample developments can not easily be explained.

Technical Appendix Table 2. Results using ICT investment in total fixed investment

Dependent variable: the share of employment potentially affected by offshoring in total employment

	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]
$(X/GDP)_t$	0.8542 (5.2)*	0.7842 (4.8)*	0.9086 (5.8)*	0.8977 (5.6)*	0.8428 (4.3)*	0.8485 (4.2)*	0.9298 (2.6)*	1.3139 (3.0)*
$(M/GDP)_t$	-0.1425 (0.9)	-0.1282 (0.8)	-0.2246 (1.4)	-0.3099 (2.0)*	-0.4041 (2.0)*	-0.4626 (2.2)*	-0.1309 (0.3)	-0.7119 (1.4)
$(FDIOUT/GDP)_{t-1}$	0.0397 (2.9)*	0.0411 (3.1)*	0.0384 (3.3)*		0.0413 (3.0)*		0.0435 (3.2)*	
$(FDIIN/GDP)_{t-1}$	-0.0489 (3.4)*	-0.0411 (3.1)*	-0.0384 (3.3)*		-0.0413 (3.0)*		-0.0435 (3.2)*	
$(ICTI/INV)_{t-1}$	0.0308 (0.5)	0.0195 (0.3)	0.1132 (1.8)†	0.0968 (1.5)	0.0919 (2.0)*	0.0639 (1.3)	0.0984 (0.8)	0.0992 (0.8)
$SERVICES_{t-1}$	0.1290 (2.1)*	0.1220 (2.1)*	0.1649 (3.6)*	0.1852 (3.5)*	0.0816 (1.3)	0.1204 (1.8)†	0.1716 (3.5)*	0.1961 (3.6)*
$HTECH_{t-1}$	0.2022 (0.8)	0.1854 (0.7)	0.1592 (0.7)	0.2382 (1.1)	0.1837 (1.1)	0.3126 (1.9)†	0.1760 (0.6)	0.3056 (1.1)
PMR_t			-0.1614 (0.7)	-0.0348 (0.1)	-0.4405 (1.9)†	-0.2326 (0.9)	0.0171 (0.0)	-0.0105 (0.0)
$UNIONS_{t-1}$			-0.1252 (2.9)*	-0.0952 (2.1)*	-0.0181 (1.0)	-0.0136 (0.6)	-0.1298 (2.6)*	-0.1145 (2.1)*
HK_{t-1}			1.1719 (3.7)*	1.3954 (4.2)*	0.4408 (1.7)†	0.7381 (1.9)†	1.2913 (3.2)*	1.4404 (3.3)*
	Fixed Effects	Fixed Effects	Fixed Effects	Fixed Effects	Random Effects	Random Effects	Fixed Effects IV	Fixed Effects IV
Sample Period	1996-2003	1996-2003	1996-2003	1996-2003	1996-2003	1996-2003	1997-2003	1997-2003
Obs.	112	112	112	112	112	112	98	98
Log Likelihood	-79.316	-79.812	-70.145	-74.863				
$\overline{R}^2$	0.957	0.957	0.963	0.960	0.001	-0.069	0.960	0.957
Standard error	0.582	0.580	0.542	0.562	2.853	3.091	0.563	0.583
Time Dummies (p-value of joint deletion)	0.675	0.691	0.193	0.609			0.795	0.853
Hausman p-value (H_0:random effects)					0.0000	0.0056		

Notes: (X/GDP) is the share of exports of other business and computer and information services in GDP, (M/GDP) is the share of imports of other business and computer and information services in GDP, (FDIOUT/GDP) is the stock of outward foreign investment as a share of GDP, (FDIIN/GDP) is the stock of inward foreign direct investment as a share of GDP, (ICTI/INV) is the share of ICT investment in total fixed investment, SERVICES is the share of the services sector in total value added, HTECH is the share of high-tech industries in total value added, PMR is a product market regulations indicator, UNIONS are trade union density rates, and HK is the average years of education per person.

* Significant at the 5% level.

† Significant at the 10% level.

Technical Appendix Table 3. Results using ICT investment as a share of GDP

Dependent variable: the share of employment potentially affected by offshoring in total employment

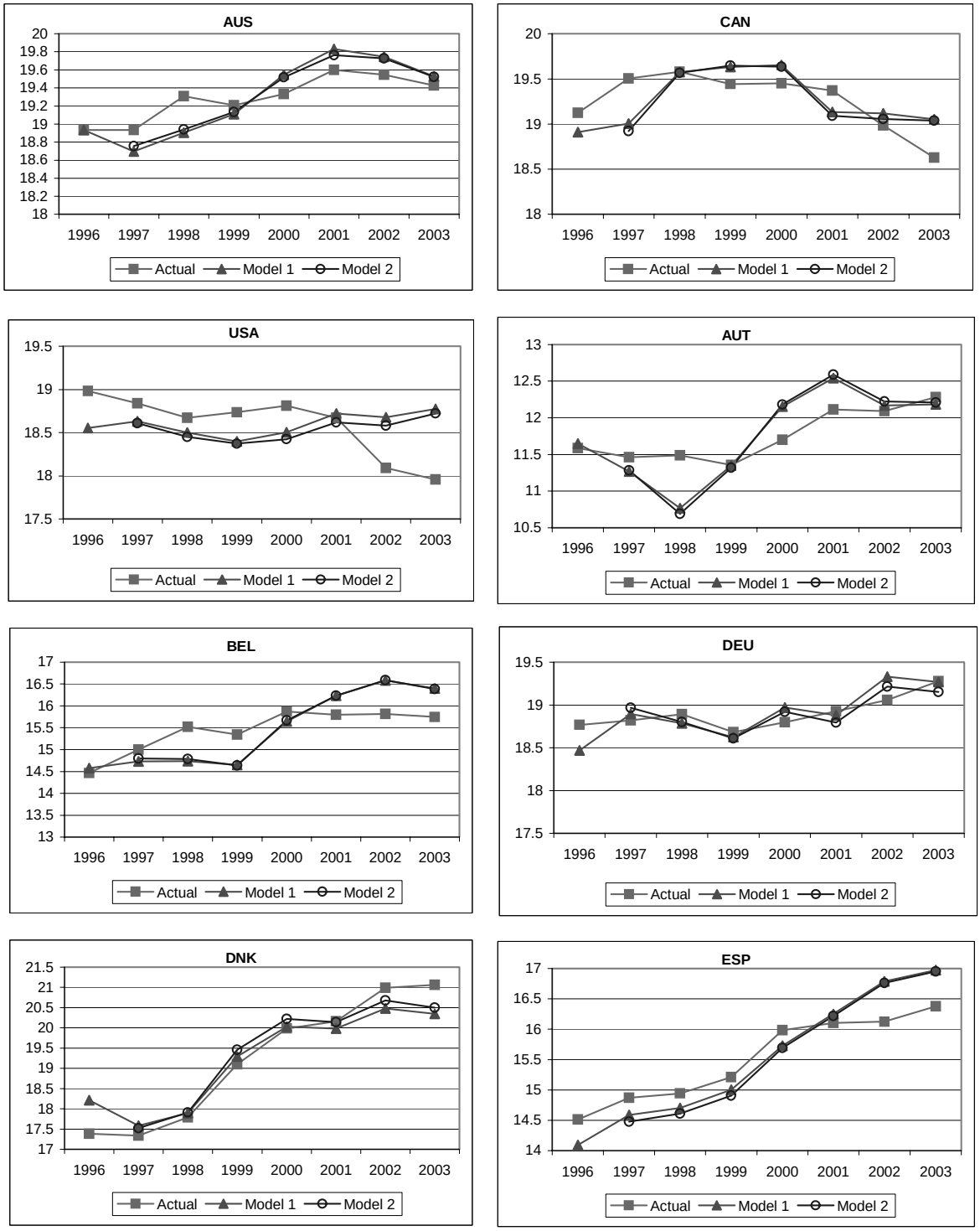
	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]
$(X/GDP)_t$	0.9002 (6.4)*		0.9301 (6.3)*	0.8851 (6.2)*	0.9123 (4.6)*	0.8525 (4.4)*	1.4660 (3.7)*	1.3615 (3.3)*
$(M/GDP)_t$	-0.1574 (1.0)		-0.2826 (1.8)†	-0.3561 (2.4)*	-0.4252 (2.1)*	-0.4889 (2.4)*	-0.7636 (1.8)†	-0.8389 (1.6)
$(FDIOUT/GDP)_{t-1}$	0.0425 (3.0)*		0.0414 (3.3)*		0.0443 (3.3)*		0.0421 (2.8)*	
$(FDIIN/GDP)_{t-1}$	-0.0560 (4.1)*		-0.0467 (3.2)*		-0.0555 (3.3)*		-0.0597 (3.5)*	
$(ICTY/GDP)_{t-1}$	0.8160 (2.3)*		1.1277 (3.3)*	0.9469 (2.5)*	1.0786 (3.8)*	0.8115 (2.8)*	1.4271 (2.5)*	0.9349 (1.5)
$SERVICES_{t-1}$	0.1388 (2.1)*		0.1727 (3.6)*	0.1935 (3.6)*	0.0979 (1.6)	0.1233 (1.9)†	0.1730 (3.4)*	0.2003 (3.7)*
$HTECH_{t-1}$	0.1204 (0.5)		0.1074 (0.5)	0.1936 (1.0)	0.1335 (0.8)	0.2481 (1.5)	0.1299 (0.6)	0.2644 (1.2)
PMR_t			-0.3282 (1.3)	-0.1431 (0.5)	-0.5809 (2.5)*	-0.3199 (1.3)	-0.4715 (1.3)	-0.1317 (0.3)
$UNIONS_{t-1}$			-0.1156 (2.6)*	-0.0928 (2.2)*	-0.0228 (1.2)	-0.0164 (0.7)	-0.1103 (2.1)*	-0.1068 (2.0)*
HK_{t-1}			0.9432 (3.3)*	1.2736 (4.5)*	0.2881 (1.0)	0.6789 (2.4)*	0.8199 (2.4)*	1.2677 (3.4)*
	Fixed Effects		Fixed Effects	Fixed Effects	Random Effects	Random Effects	Fixed Effects IV	Fixed Effects IV
Sample Period	1996-2003		1996-2003	1996-2003	1996-2003	1996-2003	1997-2003	1997-2003
Obs.	112		112	112	112	112	98	98
Log Likelihood	-75.364		-65.042	-71.266				
$\overline{R}^2$	0.960		0.965	0.962	0.025	-0.0472	0.962	0.960
Standard error	0.561		0.522	0.544	2.839	3.082	0.550	0.565
Time Dummies (p-value of joint deletion)	0.119		0.0113	0.192			0.084	0.564
Hausman p-value H_0: random effects					0.0008	0.0025		

Notes: (X/GDP) is the share of exports of other business and computer and information services in GDP, (M/GDP) is the share of imports of other business and computer and information services in GDP, (FDIOUT/GDP) is the stock of outward foreign investment as a share of GDP, (FDIIN/GDP) is the stock of inward foreign direct investment as a share of GDP, (ICTI/GDP) is the share of ICT investment in GDP, SERVICES is the share of the services sector in total value added, HTECH is the share of high-tech industries in total value added, PMR is a product market regulations indicator, UNIONS are trade union density rates, and HK is the average years of education per person.

* Significant at the 5% level.

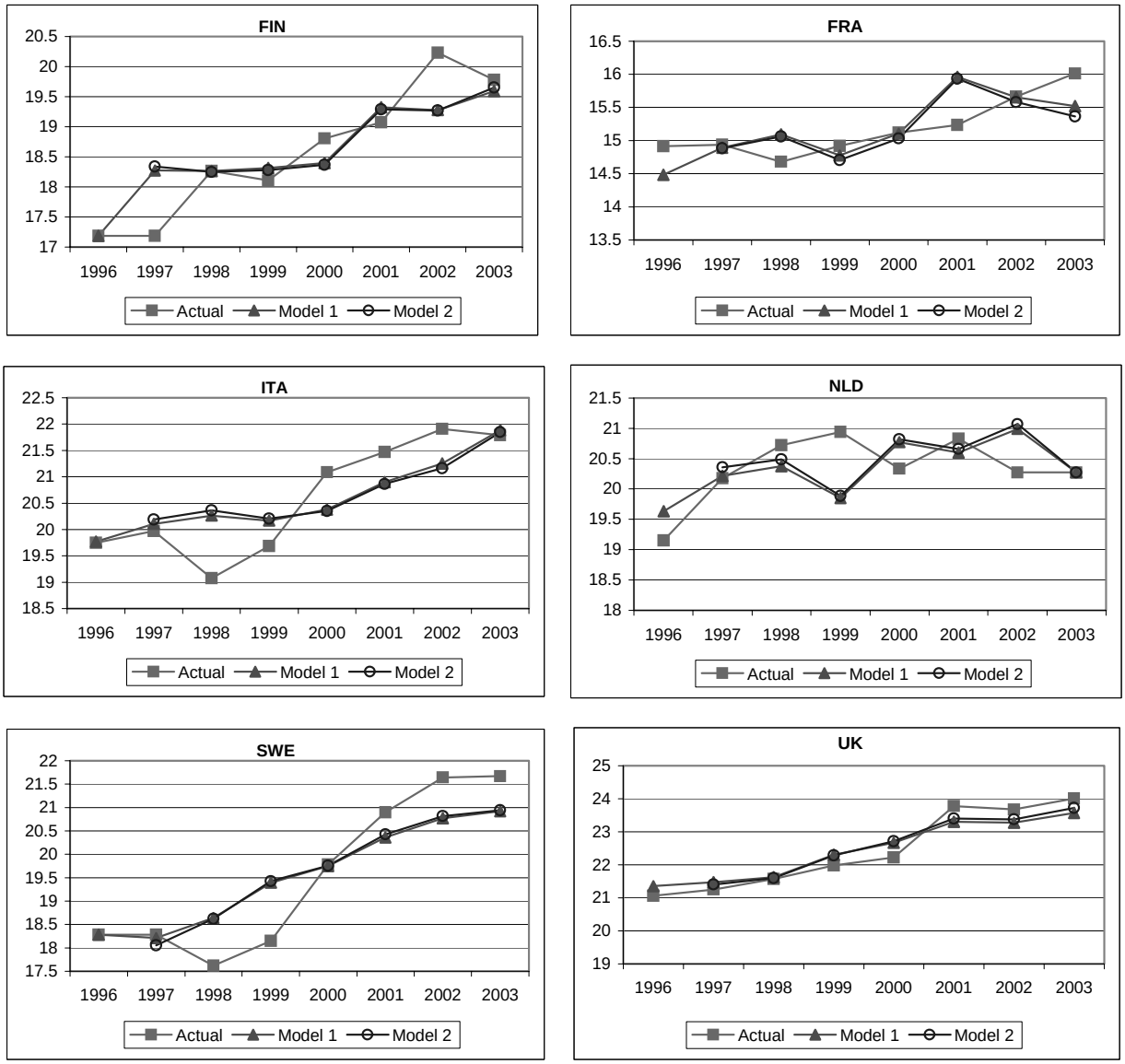
† Significant at the 10% level.

Technical Appendix Figure 1. Actual and fitted values



Note: Model 1: fixed effects, column [1] of Table 3 and column [3] of TA Table 2; Model 2: fixed effects IV, column [2] in Table 3 and column [7] in TA Table 2.

Technical Appendix Figure 1. Actual and fitted values – Continued



Note: Model 1: fixed effects, column [1] of Table 3 and column [3] of TA Table 2; Model 2: fixed effects IV, column [2] in Table 3 and column [7] in TA Table 2.