FIW Research Report N° 009 / Export of Services
June 2008

Producer Services and Competitiveness of Manufacturing Exports

Wolfmayr, Y.

Abstract

The paper examines the role of service inputs in shaping the competitiveness of the manufacturing sector. It first estimates an export market share function of 18 manufacturing industries for 16 OECD countries over the period 1995 to 2000. The service linkage variables are derived from Input Output tables. The results point to a positive and highly significant impact of international service linkages in high skilled, technology driven industries that explains about 40 percent of the overall increase in the market share. While there is a clear differential impact across the different types of (consuming) manufacturing industries, the type of service input is not relevant. The second part of the paper estimates the impact of outsourced services as well as in house services on total factor productivity growth in Austrian manufacturing, based on an approach suggested by Feenstra Hanson (1999). The results suggest a positive and significant impact of services outsourcing on TFP growth that is higher in the high skilled intensive manufacturing industries. In contrast to the findings for export market shares, the distinction between the types of service inputs is highly relevant for the results on TFP growth, which stresses the role of knowledge intensive business services (KIBS) as important producers and transmitters of technology, innovations and knowledge (technological and knowledge spillovers). The impact of in house services could not be precisely estimated.

The FIW Research Reports show the results of the three thematic work packages ‘Export of Services’, ‘Foreign Direct Investment’ and ‘Competitiveness’, that were commissioned by the Austrian Federal Ministry of Economics and Labour (BMWA) within the framework of the ‘Research Centre International Economics” in November 2006.

WIFO
ÖSTERREICHISCHES INSTITUT FÜR WIRTSCHAFTSFORSCHUNG
AUSTRIAN INSTITUTE OF ECONOMIC RESEARCH

Producer Services and Competitiveness of Manufacturing Exports

Yvonne Wolfmayr

June 2008

Austrian Institute of Economic Research
Commissioned by Federal Ministry of Economics and Labour
Arbeitspaket N 1 Dienstleistungsexport: Modul 4, Teilmodul 4.2 •
Projektkoordination: Yvonne Wolfmayr, Irene Langer
Internal review: Michael Pfaffermayr

Abstract

The paper examines the role of service inputs in shaping the competitiveness of the manufacturing sector. It first estimates an export market share function of 18 manufacturing industries for 16 OECD-countries over the period 1995 to 2000. The service linkage variables are derived from Input-Output tables. The results point to a positive and highly significant impact of international service linkages in high-skilled, technology-driven industries that explains about 40 percent of the overall increase in the market share. While there is a clear differential impact across the different types of (consuming) manufacturing industries, the type of service input is not relevant. The second part of the paper estimates the impact of outsourced services as well as in-house services on total factor productivity growth in Austrian manufacturing, based on an approach suggested by Feenstra – Hanson (1999). The results suggest a positive and significant impact of services outsourcing on TFP growth that is higher in the high-skilled intensive manufacturing industries. In contrast to the findings for export market shares, the distinction between the types of service inputs is highly relevant for the results on TFP growth, which stresses the role of knowledge intensive business services (KIBS) as important producers and transmitters of technology, innovations and knowledge (technological and knowledge spillovers). The impact of in-house services could not be precisely estimated.

Please refer to: yvonne.wolfmayr@wifo.ac.at

2008/351-1/SF/WIFO project no: 2806

Medieninhaber (Verleger), Herausgeber und Hersteller: Österreichisches Institut für Wirtschaftsforschung,
Wien 3, Arsenal, Objekt 20 • Postanschrift: A-1103 Wien, Postfach 91 • Tel. (+43 1) 798 26 01-0 • Fax (+43 1) 798 93 86 • http://www.wifo.ac.at/ •
Verlags- und Herstellungsort: Wien

Verkaufspreis: 20,00 € • Kostenloser Download: http://www.wifo.ac.at/wwa/jsp/index.jsp?fid=23923&id=34225&typeid=8&display_mode=2

Producer Services and Competitiveness of Manufacturing Exports

Contents **Page**

Producer Services and Competitiveness of Manufacturing Exports

Yvonne Wolfmayr
Address: Arsenal Objekt 20, A-1030 Vienna
Phone: + 43-1-798 26 01 – 253
Fax: + 43-1-798 93 86
E-mail: Yvonne.Wolfmayr@wifo.ac.at

Das Wichtigste in Kürze

Die Vernetzung von Produktions- und Dienstleistungsaktivitäten: Entscheidender Wettbewerbsfaktor im Warenexport?

Produktionsnahe Dienstleistungen (wie Planung und Beratung, Instandhaltung, Schulungen des Kunden, Wartung, Planung und Produktentwicklung usw.) werden immer stärker als Instrument der Produktdifferenzierung und als Wettbewerbsfaktor genutzt. Industrieprodukte werden auch im Export vermehrt als Systempaket mit hohem Dienstleistungsanteil angeboten und sollten so viel eher zum Markterfolg führen. Wie stark ist die Vernetzung zwischen Produktions- und Dienstleistungsaktivitäten in Österreich? Sind Dienstleistungen ein entscheidender Wettbewerbsfaktor in OECD-Ländern und wie wirkt sich die steigende Dienstleistungsverflechtung auf die Produktivität im Sachgüterbereich aus? Diese Fragen stehen im Mittelpunkt dieser Studie. Die im industriellen Produktionsprozess benötigten Dienstleistungen können dabei sowohl im Industrieunternehmen selbst erstellt, als auch von anderen Unternehmen zugekauft werden (Outsourcing). Erstmals wird neben der Bedeutung von zugekauften Dienstleistungen (Input-Output Tabelle) auch die Bedeutung von Dienstleistungen, die innerhalb der Industrieunternehmen erbracht werden, errechnet (Mikrozensus). Neben der Unterscheidung zwischen extern zugekauften und unternehmensintern erbrachten Dienstleistungsaktivitäten wird auch zwischen verschiedenen Dienstleistungsarten unterschieden und insbesondere auf die Rolle so genannter wissensintensiver Dienstleistungen (F&E, Computerdienstleistungen und unternehmensbezogene Dienste wie etwa Management und Consulting Dienste) geachtet.

Die Bedeutung extern zugekaufter Dienstleistungsinputs in der österreichischen Sachgüterindustrie

Die Bedeutung zugekaufter unternehmensexterner Serviceinputs und deren Veränderung über die Zeit wurden auf Basis der österreichischen Input-Output Tabellen für die Jahre 1995, 2000 und 2003 berechnet. Input-Output Tabellen stellen alle volkswirtschaftlichen Güterströme und Lieferverflechtungen zwischen den Sektoren der österreichischen Wirtschaft dar und können daher für die Messung des Grades der sektoralen Verflechtung zwischen der Industrie

und den Dienstleistungen verwendet werden. Dabei wurde auch zwischen dem Zukauf von Dienstleistungen aus heimischen Quellen und importierten Dienstleistungsinputs unterschieden. Wegen ihrer großen Bedeutung wurde besonderes Augenmerk auf die Vorleistungsverflechtung der Industrie mit so genannten wissensintensiven Dienstleistungen (KIBS: "knowledge intensive business services") gelegt. Diese umfassen die Dienstleistungssektoren, F&E, Computer und unternehmensbezogene Dienste wie etwa Management und Consulting Dienste. Die deskriptive Analyse zeigt

- eine steigende Vorleistungsverflechtung zwischen der Industrie und Dienstleistungen, die den Trend zur Tertiärisierung der österreichischen Wirtschaft untermauert. Der Dienstleistungsanteil an der Gesamtvorleistungsnachfrage der Industrie stieg von 25,1% (1995) auf 30,5% (2003);
- eine Ausweitung der Verflechtung der Sachgüterindustrie vor allem mit dem Großhandel, Transportdiensten und dem Kreditwesen und weniger mit den KIBS;
- innerhalb der KIBS einen vermehrten Zukauf vor allem bei unternehmensbezogenen Diensten (Consulting, Beratung). Der Zukauf von Computerdiensten sowie F&E-Leistungen nimmt einen noch sehr geringen Anteil ein, entwickelt sich aber, ausgehend vom niedrigen Niveau sehr dynamisch. Auffallend ist die besonders dynamische Entwicklung bei den Importen von F&E-Leistungen;
- dass die intensivste Nachfrage nach KIBS vor allem von technologieintensiven Industriebranchen kommt: medizinische und andere Kontroll- und Messinstrumente, Nachrichtentechnik, Büromaschinen und Chemie;
- die Dominanz heimischer Zulieferer, während der Anteil importierter Dienstleistungsinputs in der Gesamtvorleistungsnachfrage der Sachgütererzeugung mit 3,3% noch sehr gering ist, sich aber in der Periode 1995 bis 2003 mit durchschnittlich jährlich 5,6% dynamisch entwickelt hat.
- den höchsten Anteil importierter Dienstleistungen im Druck- und Verlagswesen, der Nachrichtentechnik, der Chemieindustrie und der Herstellung von medizinischen und anderen Kontroll- und Messinstrumenten.

Der internationale Vergleich auf Basis von OECD Input-Output Tabellen für die Jahre 1995 und 2000 ergibt

- eine herausragende Stellung Irlands, als Land mit extrem hohem Zukauf an unternehmensexternen Dienstleistungen und gleichzeitig dem höchsten Importanteil an zugekauften Dienstleistungen. Erklärbar sind diese Resultate durch den hohen Anteil ausländischer Direktinvestitionen und die besondere Stellung Irlands im Netzwerk multinationaler Unternehmen;
- die intensivste Verflechtung zwischen der Sachgüterindustrie und Dienstleistungsaktivitäten in Schweden und Großbritannien mit einem

Dienstleistungsanteil an den Gesamtvorleistungen von deutlich über 20%. Österreich liegt mit einem entsprechenden Anteil von 18% etwa im Durchschnitt der OECD-Länder;

- mit Ausnahme von Portugal und Kanada, in allen untersuchten Ländern eine Ausweitung der Vorleistungsverflechtung zwischen der Industrie und den Dienstleistungsaktivitäten, die in Schweden, Großbritannien, Belgien am stärksten ausfiel und in Österreich im internationalen Vergleich eher verhalten war;
- die stärkste Verflechtung der Industrie mit wissensintensiven Dienstleistungen (KIBS) in Frankreich, Deutschland, den Niederlanden und Finnland. Österreich ist unter den Ländern mit der geringsten Verflechtung sowie auch dem geringsten Zuwachs in der Verflechtung mit Dienstleistungen;
- die Dominanz heimischer Zulieferer, während der Anteil importierter Dienstleistungsinputs in der Gesamtvorleistungsnachfrage der Sachgütererzeugung im Jahr 2000 in keinem Land die 3%-Marke übersteigt;
- mit Ausnahme von Frankreich und Finnland einen deutlichen Anstieg der Rolle importierter Dienstleistungsinputs, der auch in Österreich überdurchschnittlich hoch ausfiel, sich aber auf andere Dienstleistungsbereiche als auf KIBS bezog.

Die Bedeutung unternehmensinterner Dienstleistungen in österreichischen Industrieunternehmen

Die Analyse der Bedeutung von Dienstleistungen, die innerhalb der Industrieunternehmen erbracht werden, erfolgt auf Basis der Tätigkeitsstrukturen der Beschäftigten in einzelnen Industriebranchen. Da die relevanten Tätigkeitsbereiche in der Beschäftigungsstatistik nicht direkt abgefragt werden war es notwendig, die in den relevanten Statistiken ausgewiesene Gliederung der Beschäftigten nach Berufen (so genannte ISCO-Gliederung) in eine Gliederung nach funktionalen Tätigkeitsbereichen überzuführen. Dabei wurde zwischen folgenden Tätigkeitsbereichen unterschieden: reine Fertigungstätigkeiten; produktionsnahe Dienstleistungen mit direktem Bezug zur Produktion, wie etwa die Wartung oder die Kontrolle des mechanischen Produktionsprozesses; Forschung und Entwicklungstätigkeiten; Distribution, als Bereich, der Verkauf und Logistik umfasst; Unternehmenssteuerung zu der Managementtätigkeiten, Beratungstätigkeiten (Consulting, Finanzierung, Werbung) sowie allgemeine Verwaltungsfunktionen und einfache Bürotätigkeiten gezählt werden; personenbezogene Tätigkeiten (Gesundheit, Kantine, Bildung).

Eine detaillierte Darstellung der Beschäftigung nach Branchen und Tätigkeiten ist allerdings nur auf Basis der erfragten Merkmale im österreichischen Mikrozensus (vierteljährliche Befragung, von Haushalten auf Stichprobenbasis) möglich. Auf Basis dieser Zuordnung von Berufen auf Tätigkeitsfelder wurde aus dem österreichischen Mikrozensus eine Branchen/Tätigkeitsmatrix erstellt und daraus die Anteile der Dienstleistungsbeschäftigung nach funktionalen Tätigkeiten an der Gesamtbeschäftigung je Branche berechnet. Da der Mikrozensus keine Vollerhebung ist, wurde diese Anteilsmatrix den Beschäftigungsdaten des

Hauptverbands der österreichischen Sozialversicherungsträger übergestülpt, um Abweichungen zu offiziellen Daten der Beschäftigungsstatistik zu vermeiden.

Die ersten Auswertungen zeigen folgende Ergebnisse:

- Einen Anstieg des Anteils von Dienstleistungsberufen in der gesamten Industrie von 33,5% im Jahr 1995 auf 38,6% im Jahr 2003. Die meisten Dienstleistungsaktivitäten entfallen dabei auf Steuerungsfunktionen und F&E, jene Funktionen, die aus strategischen Gründen auch weniger oft ausgelagert werden.
- Auf Branchenebene ergeben sich die höchsten Anteile von Dienstleistungsberufen in der Chemieindustrie sowie im Verlagswesen, der Druckerei und Vervielfältigung. Überdurchschnittlich hoch ist der Dienstleistungsanteil aber auch in den Sektoren Büromaschinen, Nachrichtentechnik sowie Medizin-, Mess- und Regeltechnik, der Nahrungsmittelindustrie, der Holzindustrie und dem Maschinenbau.
- Abgebaut werden Fertigungstätigkeiten und personenbezogene Tätigkeiten, am stärksten ausgeweitet werden Managementtätigkeiten sowie Forschung und Entwicklung. Der Beschäftigungsanteil von Distributionsberufen entwickelt sich positiv, aber deutlich schwächer. Spiegelbildlich erhöht sich der Zukauf von Transportdienstleistungen sowie Handelsleistungen laut Input-Output Tabellen. Dies legt für diesen Bereich Outsourcingaktivitäten – die Substitution vormals unternehmensintern erbrachter Dienstleistungen mit zugekauften Leistungen - nahe.
- Innerhalb dieser Hauptgruppen findet teilweise ein interessanter Funktionswandel statt: Im Steuerungsbereich gewinnen vor allem Leitungs- und Managementfunktionen an Bedeutung während allgemeine Verwaltungsfunktionen, die auch einfache Bürotätigkeiten umfassen, eher an Gewicht verlieren. Im Distributionsbereich verschiebt sich das Gewicht immer mehr weg von den Transport- und Logistiktätigkeiten hin zum Verkauf.
- Während die Verlagerung von den Produktionstätigkeiten hin zu mehr F&E sowie Leitungs- und Managementfunktionen ein allgemeiner Trend quer über alle Industrien ist, bleibt der beschriebene Funktionswandel innerhalb der Hauptgruppen auf einige Branchen beschränkt. Einfache Verwaltungstätigkeiten wurden vor allem in der Metallindustrie, der Chemiebranche, im Maschinenbau, bei Nachrichtengeräten sowie der Medizin-, Mess- und Regeltechnik abgebaut. Die Verschiebung im Distributionsbereich von Transport- und Logistiktätigkeiten zu reinen Verkaufstätigkeiten ist in der Papierindustrie, dem Chemiesektor sowie der Möbel- und Textilbranche besonders ausgeprägt.
- Die größte Zunahme in den Beschäftigungsanteilen von F&E-Tätigkeiten zeigt sich für die Elektroindustrie, die Fahrzeugindustrie sowie die Papierindustrie. Ein dynamisches Wachstum dieser Funktionen zeigt sich aber auch in der Textil- und Holzindustrie.
- Der Trend zur Verlagerung der Tätigkeitsstrukturen innerhalb der Industrieunternehmen weg von reinen Fertigungstätigkeiten hin zu Dienstleistungen wird durch einen klaren

Wandel in der Skillstruktur der Beschäftigten begleitet. Mittlere Qualifikationen und hohe Qualifikationen erhalten deutlich mehr an Gewicht.

Ergebnisse der ökonometrischen Analyse

Die ökonometrische Analyse untersucht im ersten Teil den Einfluss zunehmender Dienstleistungsverflechtung auf Exportmarktanteile in der Sachgüterindustrie. Dazu wird eine Exportmarktfunktion für ein Panel von 18 Industriebranchen, für 16 OECD-Länder in der Periode 1995 bis 2000 geschätzt. Es lassen sich folgende wichtige Ergebnisse zusammenfassen:

- Neben der eigenen Forschungstätigkeit der Industrie, als die wichtigste Einflussgröße, ist auch die zunehmende internationale Dienstleistungsverflechtung der Sachgüterindustrie ein entscheidender positiver Einflussfaktor für das Wachstum der Exportmarktanteile. Der steigende Import von Dienstleistungsaktivitäten der Sachgüterindustrie trug im Durchschnitt der untersuchten OECD-Länder mit 0,02 Prozentpunkten pro Jahr zum Marktanteilswachstum bei. Dies entspricht einem Beitrag von etwa 18% zum Gesamtwachstum der Marktanteile zwischen 1995 und 2000.
- Die Verflechtung der Industrie zu heimischen Dienstleistungsanbietern spielt für die Marktanteilsentwicklung in den OECD-Ländern keine Rolle.
- Die Ergebnisse weisen keinen wesentlichen Unterschied in den Auswirkungen zunehmender internationaler Verflechtung unterschiedlicher Dienstleistungsarten aus. Der Zukauf von internationalen Transport- und Vertriebsdiensten, Handelsleistungen und Finanzdiensten bis hin zu Wartungsleistungen ist ebenso wichtig für den Exporterfolg, wie der Zukauf von KIBS (Planung und Beratung, Schulungen des Kunden, Anpassen des Produkts an Kundenwünsche im Ausland). Produktbegleitende Funktionen der Dienstleistungen, die die "Vermarktung" des Exportprodukts unterstützen und eher direkt aus dem Exportmarkt zugekauft werden, stehen dabei offensichtlich mehr im Vordergrund als die wissens- und informationsgebende Funktion verschiedener Dienstleistungen (insbesondere der KIBS), die direkt als Inputs in den Produktionsprozess des Industriegutes einfließen ("Wissensspillover").
- Besonders wichtig ist die Unterscheidung der Ergebnisse nach Typ des Industriesektors. Der positive Zusammenhang zwischen einer Zunahme der internationalen Dienstleistungsverflechtung und Exporterfolg kann nur für den technologieintensiven Teil des Industriesektors nachgewiesen werden. Über den betrachteten Zeitraum von 1995 bis 2000 trugen importierte Dienstleistungsinputs rund 40% zum Gesamtwachstum der Marktanteile in technologiegetriebenen Industrien bei.
- In arbeitsintensiven Industrien und allgemein in Industrien mit einem hohen Anteil niedrig qualifizierter Arbeitskräfte sind die relativen Lohnstückkosten die wichtigste Bestimmungsgröße für die Marktanteilsentwicklung, die Dienstleistungsverflechtung hat keinen signifikanten Einfluss.

Im zweiten Teil der ökonometrischen Analysen erfolgt eine Schätzung des Zusammenhangs von Produktivitätswachstum und Dienstleistungsinput in der österreichischen Sachgüterindustrie. Die Arbeit unterscheidet dabei zwischen dem Zukauf von Dienstleistungsaktivitäten ("Outsourcing") und den unternehmensintern erbrachten Dienstleistungen. Es zeigen sich folgende Ergebnisse:

- Ein deutlich positiver Zusammenhang zwischen zugekauften Dienstleistungsinputs und dem Produktivitätswachstum gemessen an der totalen Faktorproduktivität (TFP), der in skill-intensiven Industriebereichen am stärksten ausgeprägt ist.
- Kein statistisch signifikanter Einfluss von unternehmensinternen Dienstleistungen auf das Produktivitätswachstum.
- Im Unterschied zur Analyse der Bestimmungsfaktoren von Exportmarktanteilen, ist für das Produktivitätswachstum einer Industrie die Unterscheidung zwischen verschiedenen Typen von Dienstleistungsinputs von entscheidender Bedeutung. Nur die zunehmende Verflechtung mit unternehmensexternen wissensintensiven Dienstleistungsinputs (KIBS) übt einen signifikanten Einfluss auf das Produktivitätswachstum aus und unterstreicht damit die Rolle der KIBS als Träger, Vermittler und Produzent von Wissen und neuen Technologien (Technologie-, Wissensspillover).

Interpretation und einige wirtschaftspolitische Schlussfolgerungen

Die internationalen und nationalen Analysen, die im Rahmen dieses Projekts durchgeführt wurden, bestätigen somit insgesamt die für die Wirtschaftspolitik interessante These: Dienstleistungen bestimmen zu einem nicht unwesentlichen Teil den Exporterfolg und die Produktivitätsentwicklung, insbesondere in den technologiegetriebenen und skill-intensiven Branchen der Sachgüterindustrie. In der modernen arbeitsteiligen Wirtschaft kommt daher der effizienten Vernetzung von Produktion und Dienstleistungen oft die entscheidende Bedeutung im Wettbewerb zu.

Die Analyse der Exportmarktanteile unterstreicht dabei vor allem Wichtigkeit "produktbegleitender" Dienstleistungen. Der technologische Vorteil alleine reicht nicht, auch innovative und neue Produkte brauchen Dienstleistungen für die Vermarktung am Exportmarkt. Als wichtig für den Exporterfolg eines Sektors hat sich dabei die internationale Dienstleistungsverflechtung, also der Zukauf importierter Dienstleistungen herausgestellt. Zu beachten ist dabei, dass diese Importe auch Zulieferungen aus heimischen Dienstleistungsunternehmen mit ausländischen Niederlassungen (Direktinvestitionen) im Exportmarkt enthalten können. Diese unterstützen mit dem entsprechenden Know-how die heimischen Industrieunternehmen vor Ort, die erbrachten Dienstleistungen werden aber in der Statistik als Dienstleistungsimport verbucht.

Die weitere Liberalisierung des Dienstleistungshandels und Förderung von Internationalisierungsaktivitäten von Dienstleistungen ist daher auch für den Warenexport von großer Bedeutung. Detaillierte Vorschläge zur verstärkten Internationalisierung

unternehmensnaher Dienstleistungsbereiche hat das WIFO erst kürzlich im WIFO-Weißbuch erarbeitet (*Wolfmayr et al.*, 2006).

Die Analyse zu Bestimmungsfaktoren der Produktivitätsentwicklung hebt vor allem die Rolle von technologischen Spillovereffekten extern zugekaufter KIBS hervor. Die Effizienz und Innovationsorientierung des Dienstleistungssektors bestimmen damit zu einem wesentlichen Teil auch die Produktivitätsentwicklung und Konkurrenzfähigkeit der Industrie. Gerade für Österreich lässt die im internationalen Vergleich mäßige Produktivitätsentwicklung des Dienstleistungsbereichs auf noch erhebliche Spielräume für effizienzsteigernde Maßnahmen schließen (*Wolfmayr et al.*, 2006). Auch hier hat das WIFO im WIFO-Weißbuch (*Wolfmayr et al.*, 2006) detaillierte Vorschläge erarbeitet. Folgende Aspekte sind dabei für die Wirtschaftspolitik von besonderer Bedeutung:

- Die Innovation im Dienstleistungsbereich schließt auch nicht-technologische Aspekte (neue Betriebs- und Arbeitsorganisation, effizientere Koordination innerbetrieblicher Netzwerke oder externer Netzwerke mit Subauftragnehmern, Managementinnovationen etc.) mit ein. Dieser immaterielle Aspekt der Innovationen im Dienstleistungsbereich muss auch in den entsprechenden Förderprogrammen verankert werden.
- Nach neueren Analysen (*Dachs - Leo*, 1999; *Falk - Leo*, 2004) basieren Innovationen im österreichischen Dienstleistungssektor in hohem Maße auf zugekaufte, externe Technologie und wenig auf eigene F&E. Kurzfristig kann dies zwar ebenfalls Vorteile verschaffen, langfristig kann diese Strategie aber problematisch werden, weil nur Eigenforschung zum Aufbau firmenspezifischen Know-hows und zur Sicherung der Lernfähigkeit und Adaptionsfähigkeit komplexen, externen Wissens des Unternehmens beitragen können und damit wirkliche Zukunftsinvestitionen darstellen.
- Hemmnisse im Innovationsprozess sind weniger Umfeldfaktoren, wie Informationsmängel, Fehlen qualifizierten Personals oder Finanzierungsbeschränkungen, sondern vielmehr Defizite im unternehmensinternen Know-how, in der Planung und in der organisatorischen Umsetzung der Innovationsprojekte (*Dachs - Leo, 1999; Kaufmann - Tödtling, 2003; Falk - Leo*, 2004). Die genannte Ressourcenbeschränkung ist vor allem bei kleineren Dienstleistungsunternehmen besonders relevant.

Zusammenfassung

Die Studie untersucht den Zusammenhang zwischen Wettbewerbsfähigkeit und Dienstleistungsinput in der Sachgüterindustrie. Sie untersucht im ersten Teil den Einfluss zunehmender Dienstleistungsverflechtung auf Exportmarktanteile in der Sachgüterindustrie. Dazu wird eine Exportmarktfunktion für ein Panel von 18 Industriebranchen für 16 OECD-Länder in der Periode 1995 bis 2000 geschätzt. Auf Basis von Input-Output Tabellen wird zwischen der internationalen und der nationalen Dienstleistungsverflechtung unterschieden. Die Analysen ergeben einen deutlich positiven Effekt der internationalen Dienstleistungsverflechtung auf den Marktanteil technologieintensiver Branchen der Sachgüterindustrie, der von 1995 bis 2000 mit rund 40% zum Gesamtwachstum der Marktanteile im Durchschnitt der untersuchten OECD-Länder beitrug. Die weitere Liberalisierung des Dienstleistungshandels ist daher auch für den Warenexport von großer Bedeutung. Darüber hinaus weisen die Ergebnisse keinen wesentlichen Unterschied in den Auswirkungen zunehmender internationaler Verflechtung mit unterschiedlichen Dienstleistungsarten (Wissensintensive Dienstleistungen – KIBS, sonstige Dienstleistungen) aus und unterstreichen dabei vor allem die Wichtigkeit der "produktbegleitenden" Funktion von Dienstleistungen, die vom Ausland zugekauft werden. Im zweiten Teil der Studie erfolgt eine Schätzung des Zusammenhangs von Produktivitätswachstum (TFP) und Dienstleistungsinput in der österreichischen Sachgüterindustrie. Die Ergebnisse deuten auf einen klaren positiven Effekt von unternehmensextern zugekauften Dienstleistungsaktivitäten auf das Produktivitätswachstum hin, der wiederum in skill-intensiven Branchen der Industrie am stärksten ist. Allerdings ist die Unterscheidung nach der Art des Dienstleistungsinputs von entscheidender Bedeutung, denn nur der Zukauf von besonders hochwertigen, wissensintensiven Dienstleistungen (KIBS) wirkt sich signifikant auf das Produktivitätswachstum der Industrie aus. Die Analyse zu den Bestimmungsfaktoren der Produktivitätsentwicklung heben damit vor alle die Rolle von technologischen Spillovereffekten extern zugekaufter KIBS hervor.

Abstract

The paper examines the role of service inputs in shaping the competitiveness of the manufacturing sector. It first estimates an export market share function of 18 manufacturing industries for 16 OECD-countries over the period 1995 to 2000. The service linkage variables are derived from Input-Output tables. The results point to a positive and highly significant impact of international service linkages in high-skilled, technology-driven industries that explains about 40 percent of the overall increase in the market share. While there is a clear differential impact across the different types of (consuming) manufacturing industries, the type of service input is not relevant. The second part of the paper estimates the impact of outsourced services as well as in-house services on total factor productivity growth in Austrian manufacturing, based on an approach suggested by Feenstra - Hanson (1999). The results suggest a positive and significant impact of services outsourcing on TFP growth that is higher in the high-skilled intensive manufacturing industries. In contrast to the findings for export market shares, the distinction between the types of service inputs is highly relevant for the results on TFP growth, which stresses the role of knowledge intensive business services (KIBS) as important producers and transmitters of technology, innovations and knowledge (technological and knowledge spillovers). The impact of in-house services could not be precisely estimated.

1. Motivation

The service sector in the developed economies comprises about 70 percent of total employment and is thus the largest and most important sector of an economy. Not only do economies derive the bulk of their employment and income from services, but many services are also vital intermediate inputs for other goods and services and thus can have a significant impact on productivity and growth in many other sectors of the economy as well. Apart from the use of services as intermediate goods (*Francois*, 1990) services have become increasingly intertwined with manufacturing activities for a number of other reasons. One of them is, that increased fragmentation of production processes into parts that are then outsourced domestically or internationally, increases the complexity in the organization of manufacturing production and enhances the demand for service links such as co-ordination, administration and transportation (*Jones - Kierzkowski*, 1990). However, modern industrial production is not only characterized by a high degree of vertical fragmentation and international outsourcing, but also a shift from mass production to "value" production, changing the nature of business by emphasizing specialized, customized solutions, and services over goods as the major sources of productivity growth and competitiveness (*Reich*, 1991). The fast and flexible adaption of goods to specific customer preferences calls for intensified efforts in planning and product engineering. Modern, flexible but highly automated production depends on the existence of specialized software. Moreover, services are increasingly used as an instrument for product differentiation. Thus, competition less and less takes place on the basis of the manufactured good itself but on the package of services that come with the good (planning, consultancy, maintenance and repair, personal instruction and training etc). As a result, manufactured goods are increasingly exported as system packages with a high services content to enhance market success.

Furthermore, while services have long been considered as lagging behind in terms of innovation, technology developments and adoption, it is now widely recognized that some service industries, in particular knowledge intensive business services (R&D, Computers, Consulting), are not only important users but also important vehicles for the diffusion of technology across sectors (*Tomlinson*, 2002).

While firms are outsourcing service activities once performed inside manufacturing firms, producer services also represent an increasing share of the remaining activities still performed within manufacturing firms (*Mesch*, 2005; *Miles - Miozzo*, 2003). The decision to outsource service tasks relies on costs, strategic aims, the nature of the service, the size of firms as well as the sector affiliation of firms. Cost advantages of external service providers bear on specialization advantages and economies of scale. On the other hand, services of core importance to the competitive advantage of firms, such as R&D, are less likely to be outsourced.

Against the background of an increasing services content of many manufactured goods, the paper tries to assess the role of services for the export performance of manufactured goods

as well as manufacturing productivity growth. To this end, market shares and total factor productivity growth (TFP) of manufacturing firms are related to service linkage variables, which capture the importance of services as a supplier to the manufacturing sector and are based on national Input-Output tables and employment figures detailed by their main functional business activities (production, distribution, management). Positive spillovers from the service sector will be more likely the higher the quality and reliability of the service inputs and the more efficient and productive the service sector is. This in turn is directly related to the service sectors' R&D and innovation activity. This latter fact will also be taken into account in the empirical specifications in the paper by including interaction terms between R&D expenditure and innovation activity in the delivering service sectors and the respective consuming manufacturing sector's reliance on inputs from each service sector. In that way we will be able to distinguish between several channels through which services may affect the competitiveness of manufacturing exports, and to further differentiate between the impacts of outsourced versus in-house services, as well as between outsourcing of services to domestic suppliers versus outsourcing of services across borders (service imports).

2. Related empirical literature

In the related empirical literature market shares (or other measures of export performance) are usually explained by measures of cost competitiveness (unit labour costs) and measures of technological competitiveness (R&D spending, innovation counts, patents). *Fagerberg* (1996) gives an overview on some of the earlier empirical works in the field. Examples include *Amable - Verspagen* (1995), *Carlin et al.* (1998, 2001), or *Landesmann - Pfaffermayr* (1997) as well as *Wolff* (1995) who includes measures of productivity. These studies generally report positive relations between technological activity and export performance, which are particularly strong in the R&D intensive industries but are also evident in some of the less high-tech sectors such as metal products, food and drinks. Works including indirect channels of technology transmission through the purchase of intermediary products or capital goods include *Fagerberg* (1995) and *Laursen - Meliciani* (2000). *Fagerberg* (1995) finds that, while both direct and indirect R&D significant impact on export performance, the impact of indirect R&D (through the purchase of intermediates or capital goods) is twice the impact of direct R&D. Also, *Laursen - Meliciani* (2000) add intra-sectoral (own sector) and inter-sectoral (downstream and upstream) linkage variables to measure "technological spillover" effects on export performance. They do not consider international vertical linkages and constrain their analysis to manufacturing linkages. They find the importance of the different factors of competitiveness to differ significantly across sectors and also that linkages do not matter equally for all sectors. R&D imported from other manufacturing sectors through upstream linkages has a significant positive effect on international competitiveness in scale intensive industries only while inter-sectoral linkages are of no significant influence for science-based sectors which rely on "own" sector technology (proxied by patents of the industry).

The first contribution to directly examine the extent to which knowledge-intensive services enhance on international competitiveness through their interaction with all other economic sectors comes from *Windrum - Tomlinson* (1999). In specific, they measure the impact of material inputs and knowledge inputs (from knowledge intensive services) on productivity specifying a labour-based production function. This relationship is estimated for the UK, the Netherlands, Germany and Japan. They find that while the UK experienced the strongest growth of service activities among the compared countries, the spillover effects of knowledge-intensive industries on output and productivity is significant and higher in all of the other countries. It is highest in Japan. The result is explained by the strong linkages between services and non-services in all of these countries but the UK. From this they conclude that "it is important to distinguish between a general increase in the representation of services within a national economy, and the degree of integration between services and other economic activity" (p. 14).

Amiti - Konings (2005) investigate the effect of trade liberalization on producers relying on imported inputs and find a strong positive relationship between trade liberalization in intermediate inputs and firm productivity. A 10 percentage point fall in input tariffs leads to a

3 percent productivity gain for all firms and an 11 percent productivity gain for importing firms. Their analysis is restrained to the manufacturing sector and there is no distinction made between material inputs and services inputs.

Yet another strand of papers focuses on productivity spillover effects of foreign direct investment including intra-industry (horizontal linkages) as well as inter-industry effects (forward and backward linkages). Examples are *Javornik* (2004) for Lithuania and *Girma - Görg - Pisu* (2007) for the UK. Both rely on data for manufacturing firms and do not include services FDI. Both find no evidence of productivity spillovers stemming from multinational presence in manufacturing sectors supplying intermediate inputs (the forward linkage) to domestic firms. Both papers find significant impacts of backward linkages and provide evidence that multinationals can impact their suppliers' productivity. The *Girma - Görg - Pisu* (2007) paper further finds a significant impact of horizontal (intra-sectoral) spillovers from foreign suppliers to domestic exporters, but not to non-exporters and relates this result to the higher absorptive capacity of exporting firms. *Javornik* (2004) does not find any evidence for horizontal spillovers, but also does not distinguish exporting from non-exporting firms.

Finally, there are some papers in the literature with a focus on trade liberalization in the service sector as well as spillovers from FDI inflows into the service sector on performance of downstream users of services in the manufacturing sectors. *Arnold - Javorcik - Mattoo* (2006) base their calculations on firm-level data from the Czech Republic and find strong correlations between service sector reform and the productivity in manufacturing sectors relying on services as intermediate inputs as well as a positive significant relationship between foreign presence in the service sector and downstream manufacturing.

Francois - Wörz (2007) examine the impact of service sector imports and total FDI inflows into the service sector and business service openness on manufacturing export performance for a sample of 30 OECD countries in the period 1994 - 2004. They observe that manufacturing exports are pushing indirect exports of producer services embodied as inputs in the manufactured goods and further find that the services intensity of exports per capita to increase with the income of countries. While they find no significant effects from service imports and business service openness on total manufacturing exports, their results show a significant and positive impact from increased business service openness and imports on exports of technology intensive manufacturing sectors like machinery, motor vehicles, chemicals and electrical equipment. The impact from increased business service imports is negative for labour intensive industries like textiles, clothing, and leather and there is no impact for resource intensive industries.

3. Outsourcing of services in manufacturing: data and stylized facts for Austria

Based on Austrian Input-Output tables for the years 1995, 2000 and 2003 we construct several different measures of services outsourcing to examine the extent to which service activities are interlinked with the rest of the domestic economy. We first distinguish between indicators comprising overall services inputs, imported services inputs and service inputs delivered from domestic suppliers. Then we calculate the same indicators pertaining to knowledge intensive business services (KIBS) including computer services, management and consulting services, research and development, and other business services to take account of their special role as important carriers, transmitters as well as producers of knowledge and new technologies[1]). Tables 1 and 2 summarize the data. We get a number of interesting results.

Firstly, the services share of total intermediary inputs purchased increased between 1995 and 2000, which confirms the general notion of a rising importance of services and the trend towards the tertiarization of the Austrian economy. However, while the most intensive service users are other service sectors, this trend is driven by the manufacturing sector. Services inputs as a share of total intermediates purchased increased from 25.1 percent in 1995 to 30.5 percent in 2003. Second, growth in service inputs other than the KIBS contributed most to the overall increase in services purchased by the Austrian manufacturing sector. A more detailed look at the data reveals that increased services demand from the manufacturing sector has concentrated mainly on financial intermediation services and wholesale trade. Within the KIBS we find the biggest increase in "other business services" in terms of percentage points, but growth from a low starting value has been dynamic in both of the other KIBS sectors (R&D and computers) as well.

Within the manufacturing sector, the sectors publishing and printing, chemicals, non-metallic mineral products, medical and other scientific instruments as well as radio, TV and communication equipment account for the largest services share in total intermediates purchased in 2003. The most intensive users of KIBS, aside of the tobacco industry, are mostly technology intensive manufacturing sectors such as the production of scientific instruments, radio, TV and other communication equipment, office machinery and the chemical sector.

[1]) KIBS comprise the NACE sectors: 72 (computer and related activities), 73 (research and development) and 74 (other business activities) throughout the paper.

Table 1: Purchased service inputs in Austrian manufacturing

		Service inputs	KIBS inputs	R&D inputs	Service inputs	KIBS inputs	R&D inputs	Service inputs	KIBS inputs	R&D inputs
		Persentage shares in total purchased inputs, 2003			Difference in percentage points, 1995/2003			Average annual percentage change, 1995/2003		
NACE										
15	Food, beverages	28.61	5.61	0.06	5.95	1.40	-0.09	2.96	3.66	-10.70
16	Tobacco	31.00	13.09	0.06	-3.89	-4.03	-0.06	-1.47	-3.30	-7.81
17	Textiles	30.53	5.37	0.31	5.33	0.70	0.21	2.43	1.76	15.16
18	Clothing	31.16	5.20	0.20	5.86	0.96	0.13	2.64	2.58	13.15
19	Leather, footwear	28.16	4.49	0.15	4.70	-0.36	0.11	2.31	-0.97	15.91
20	Wood, products, cork	27.55	3.78	0.07	5.67	0.40	-0.02	2.92	1.41	-2.54
21	Pulp, paper	32.80	4.49	0.35	9.09	0.76	0.24	4.14	2.35	15.55
22	Publishing, printing	45.11	5.83	0.07	13.54	-0.13	-0.01	4.56	-0.28	-0.90
23	Coke, refined petrol.	13.23	3.66	0.03	-3.08	1.63	-0.21	-2.58	7.65	-24.00
24	Chemicals	39.44	9.11	1.25	8.56	2.32	0.67	3.11	3.75	10.13
25	Rubber, plastic	34.46	4.66	0.57	3.88	0.21	0.39	1.50	0.57	15.49
26	Non-metallic min. prod.	39.63	7.40	0.20	4.43	0.72	-0.05	1.49	1.28	-2.85
27	Basic metals	24.55	4.47	0.20	6.05	1.13	0.08	3.60	3.70	6.98
28	Fabricated metal prod.	30.54	7.37	0.14	2.41	0.15	-0.05	1.03	0.25	-3.42
29	Machinery	33.36	8.21	0.25	4.73	1.44	0.11	1.93	2.45	7.79
30	Office machinery	26.02	8.55	0.07	-13.66	-2.00	0.07	-5.14	-2.59	58.43
31	Electrical mach.	31.49	6.29	0.23	5.37	1.39	0.14	2.36	3.18	11.89
32	Radio, TV , communic.	33.44	11.50	2.08	8.11	4.85	1.78	3.53	7.09	27.65
33	Scientific instruments	39.04	10.66	0.76	5.27	2.74	0.66	1.83	3.79	29.06
34	Motor vehicles	19.41	3.49	0.50	4.12	0.06	0.46	3.03	0.20	34.45
35	Oth. transp. equipm.	28.41	6.50	0.31	3.53	0.65	0.10	1.67	1.33	5.18
36	Furniture; manuf. n.e.c.	32.15	7.34	0.20	4.78	1.38	0.03	2.03	2.64	2.21
37	Recycling	32.43	5.28	0.26	-5.30	-5.56	-0.10	-1.87	-8.61	-3.93
15 to 37	Manufacturing	30.49	6.25	0.37	5.35	1.14	0.20	2.44	2.56	10.09
50 to 95	Services	68.26	16.80	0.16	1.96	5.56	-0.10	0.36	5.15	-6.01
01 to 95	Total	46.77	11.04	0.22	2.70	3.09	0.02	0.75	4.19	1.45

Source: Input-Output tables from ST.AT, own calculations.

Third, the lion's share of services inputs comes from domestic sources, while the share of imported service inputs is still very small, accounting for 3.3 percent of total intermediate inputs and 10.8 percent of total service inputs in the manufacturing sector (Table 2). However, over the period 1990 - 2003, these shares increased by an average rate of 5.6 percent p.a. and 3 percentage points, respectively. According to the data at hand, most impressive has been the expansion of R&D-outsourcing across the borders. While the overall share of purchased R&D is very low in 2003 (indicating that these services are to a large extent internally provided rather than contracted out) well over 80 percent of total purchased R&D services were imported.

The publishing and printing industry as well as the radio, TV and communications equipment industry, chemicals and the production of medical and scientific instruments stand out as the most Intensive users of imported service inputs. The radio, TV and communications equipment industry, the manufacture of medical and scientific instruments are also among those

industries with the largest increase in service linkages across the borders. Other industries with high growth in services use include the furniture and other consumer goods industry, pulp and paper, publishing and printing and the rubber and plastic industry.

Table 2: Imported service inputs in Austrian manufacturing, 1995 - 2003

	Service imports	KIBS imports	R&D imports	Service imports	KIBS imports	R&D imports
	Percentage shares in total purchased inputs			Percentage shares in total service inputs purchased		
1995	2.13	0.45	0.06	8.47	8.87	35.85
2000	3.08	0.59	0.12	11.68	9.91	61.28
2003	3.29	0.74	0.32	10.79	11.82	85.56
	Average annual percentage change			Average annual percentage change		
1995/2003	5.6	6.3	22.7	3.1	3.6	11.5
	Difference in percentage points			Difference in percentage points		
1995/2003	1.16	0.29	0.25	2.33	2.95	49.71

Source: Input-Output tables form ST.AT, own calculations.

4. Outsourcing of services in manufacturing: an international comparison across OECD-countries

In this chapter we extend the analysis on outsourcing of services to other OECD countries. The database is constructed from OECD Input-Output tables for the two years 1995 and 2000 from which we calculate the same measures as in the preceding chapter. Figure 1 reveals exceptionally high linkages of manufacturing to the service sector in Ireland where the share of service inputs in percent of total production is close to 30 percent and well above the respective shares in the other countries. As a country with a high share of inward foreign direct investments Ireland turns out to be a very specific case where most of the service inputs are purchased across the borders indicating Ireland's specific role within the production network of multinational enterprises. From the rest of the countries considered, linkages to the service sector were most intense in Sweden and the UK with purchased service inputs reaching a share of well above 20 percent. The Austrian share is at about 18 percent.

Ireland, Sweden, the UK, Belgium also stand out as countries with the highest increase in these shares, as well as Italy and Finland. Portugal and Canada are the only two countries with a shrinking importance of service linkages.

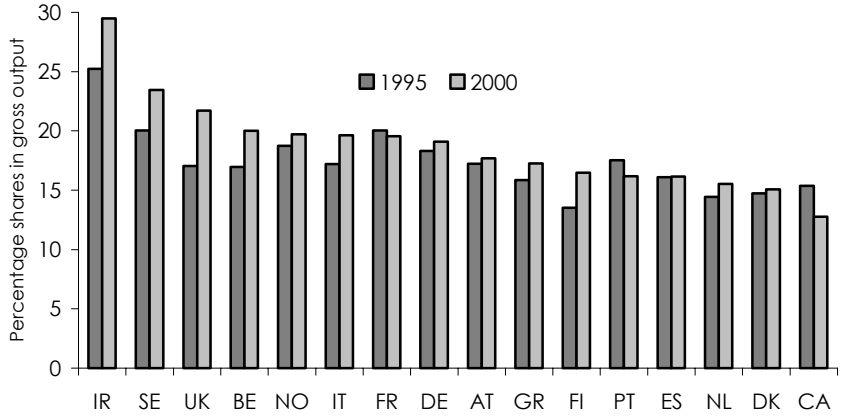
The second picture in figure 1 clearly shows the dominant role of domestic service suppliers for all countries, again with the exception of Ireland. Despite increased tradability of services, proximity to the clients remains to be important for many services. Services outsourcing across the borders is still very small reaching not more than 3 percent of gross output in any of the countries compared (except Ireland). Services offshoring is highest in Sweden, Belgium, Finland and the Netherlands, it is lowest in France.

Linkages measured by the intensity of KIBS purchases by the manufacturing sector (Figure 2), apart from Ireland, give a somewhat different ordering of countries. France, Germany, the Netherlands and Finland are now among the countries in which manufacturing has the strongest linkages to the KIBS sectors. On the other hand, in Belgium, the UK and Norway KIBS linkages of the manufacturing sector are less important relative to total service inputs purchased. Austria is also among the countries with below average linkages to the KIBS sectors. Purchases of KIBS expanded mostly in Sweden, Belgium and Canada.

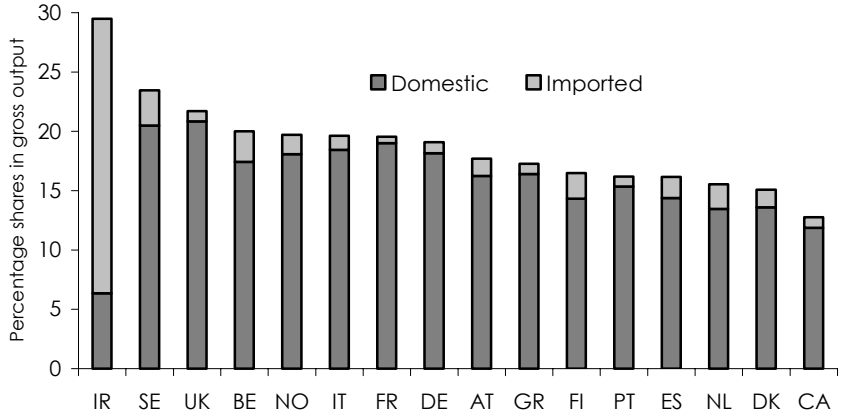
The data for external linkages to the R&D sector mostly replicate the picture given by KIBS outsourcing of the manufacturing sector (Figure 3). The only thing that catches the eye and contrasts the other results is the dominant role of imported R&D inputs in some countries such as Sweden, the Netherlands, Belgium, but also Germany and Austria. Part of this result might be due to the role of multinational enterprises, which import these activities (via intra-firm trade) from their headquarters or from other affiliates within the worldwide network of the firm.

Figure 1: Purchased service inputs in OECD manufacturing

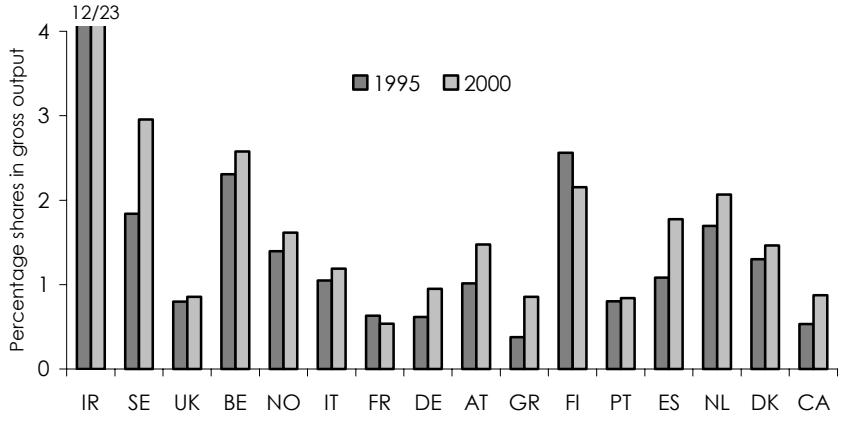
Total 1995 and 2000



Domestic and imported 2000



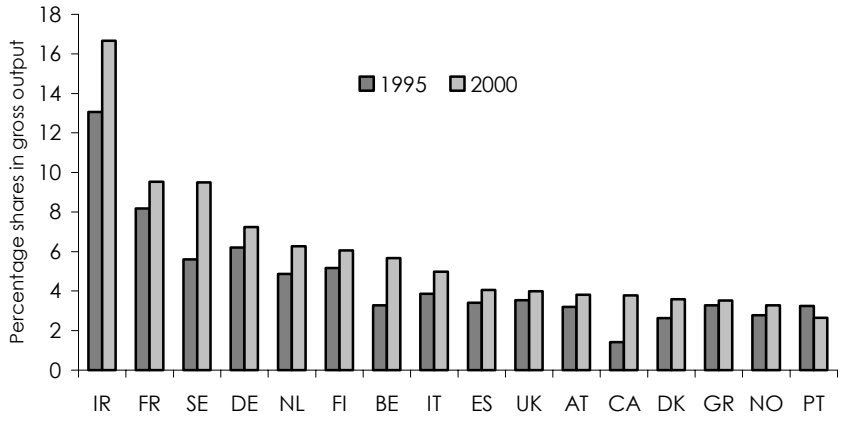
Imported 1995 and 2000



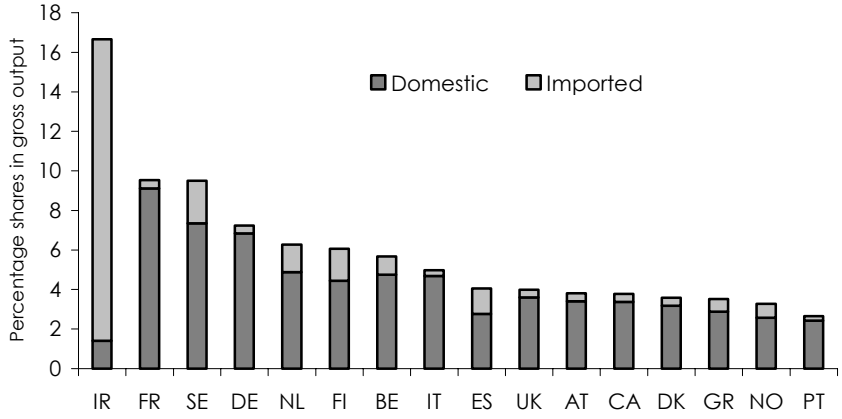
Source: OECD Input-Output tables, own calculations.

Figure 2: Purchased KIBS inputs in OECD manufacturing

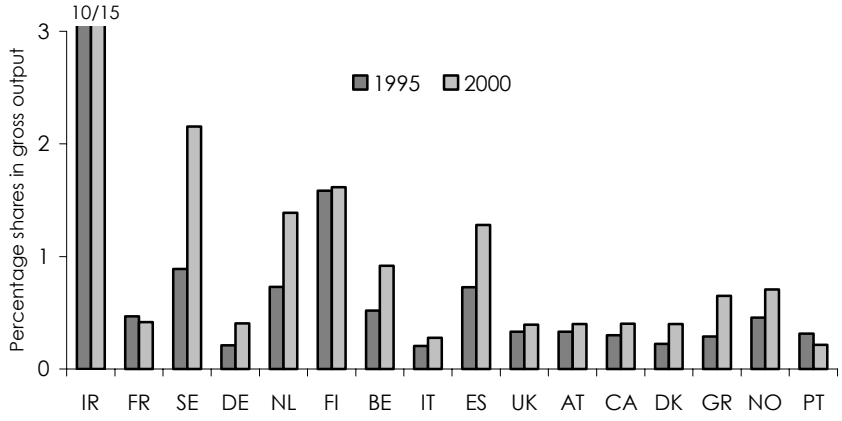
Total 1995 and 2000



Domestic and imported 2000



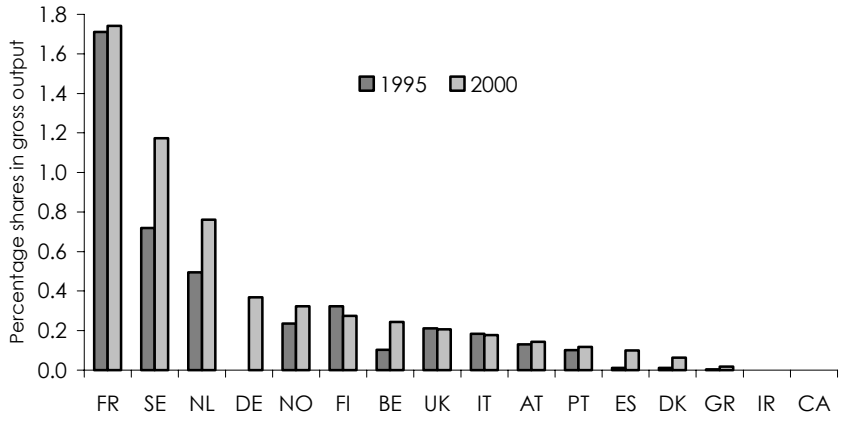
Imported 1995 and 2000



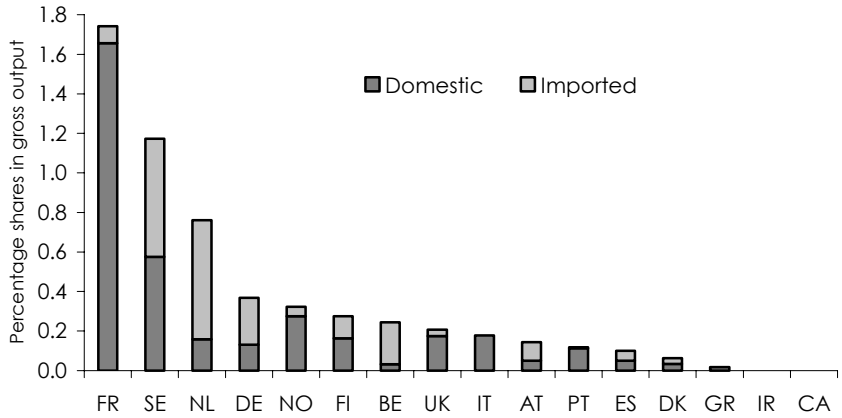
Source: OECD Input-Output tables, own calculations.

Figure 3: Purchased R&D inputs in OECD manufacturing

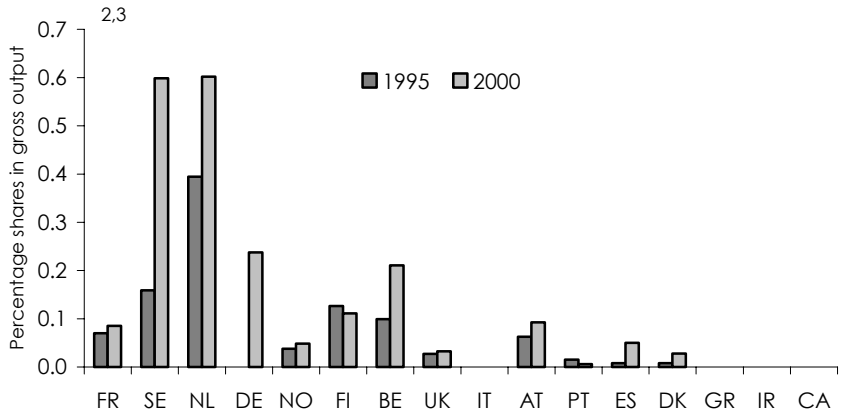
Total 1995 and 2000



Domestic and imported 2000



Imported 1995 and 2000



Source: OECD Input-Output tables, own calculations. – CA, IR: no disaggregated information on purchases of R&D is available; GR, IT: information on imported R&D inputs is missing.

5. The role and structure of in-house services in manufacturing firms: data and stylized facts

While we do not have individual firm data, the data from the Austrian labour force survey ("Microcencus"), which is a quarterly sample survey of households, may be used to measure the role of services performed within manufacturing sectors. The dataset offers the possibility to generate data on employment classified by manufacturing sector (NACE-2digit classification) and occupational group (ISCO-88 classification)[2]). Following *Bade* (1989) and *Gornig* (1990) occupational groups given in the labour force survey were re-classified according to functional fields of business activities and skill groups (level of educational attainment). We re-classified occupational groups according to the following main groups of activities or tasks: production, R&D, corporate governance, distribution and personal services. The result of this re-classification is given in Table A1 in the appendix. Since the ISCO-classification groups occupations according to skill-levels, the ISCO occupational groups can be directly assigned to different skill-levels based on the ISCED-classification system (Table A2 in the appendix)[3]).

Given the sector-activity matrix derived from the Austrian labour force survey, shares for each functional activity in each sector were calculated and imposed on employment records from the Austrian Social Security Administration ("Hauptverband der österreichischen Sozialversicherungsträger") to better conform to official Austrian employment figures.

The analysis has to be restricted to a data set for the period 1995 – 2003 because there have been major changes in the labour force survey since 2004, making the more recent data incompatible to the data in the earlier period.

As with data on service procurement of manufacturing firms we find, that services also represent an increasing share of the remaining activities still performed within manufacturing firms. It can be seen from Table 3, that the services employment share within the manufacturing sector has increased by 5 percentage points, from 33.9 percent in 1995 to 38.9 percent in 2003. Most of these services workers are assigned to corporate governance functions, the second most important service activity in the manufacturing sector are research and development tasks.

The highest services shares can be found in the chemical as well as in the publishing and printing industry, while they are also above average in the electrical machinery, the food and beverages industry, the wood industry and in the machinery and equipment sector (Table 4). The share has increase most in the wood industry, the publishing and printing industry and in the motor vehicles and transport equipment industry.

---

[2]) ISCO stands for International Standard Classification of Occupations 1998. ISCO-88 (COM) is a modified version of ISCO-88, that was implemented as a standard within the EU.

[3]) ISCED stands for "International Standard Classification of Education".

Table 3: In-house services: employment in Austrian manufacturing by main field of business activity

	Percentage shares in total employment 2003	Difference in percentage points 1995/2003	Average annual percentage change 1995/2003
Production	61.1	-5.0	-1.0
Services	38.9	5.0	1.7
R&D	10.6	2.5	3.3
Distributive services	6.9	0.9	1.7
Distribution, customer services	2.0	0.4	2.5
Transport, logistics	4.3	-0.1	-0.3
Corporate governance	19.2	2.1	1.5
Management	6.5	2.2	5.3
Management, consulting	3.4	0.7	2.8
Administration, clerks	9.3	-0.8	-1.0
Personal services	2.1	-0.4	-2.3

Source: Austrian Microcensus and employment records from the Austrian Social Security Administration, WIFO, own calculations.

Looking first at the trends in total manufacturing in more detail, we find that the employment shares of productive tasks as well as personal services are reduced while there has been a strong increase in the shares of occupations in R&D and the field of corporate governance. Distributive tasks increase, but at a lower rate. However, there are some interesting shifts within these main functional categories. For example, within the field of corporate governance activities, management functions clearly gain in importance while administrative tasks including basic and routine office work are reduced. Within the field of distribution there is some tendency of a shift from transport and logistics to distributive tasks and customer services.

While shifts in the employment shares within manufacturing firms from production towards R&D and management jobs is common across industries, with only minor exceptions, most of the other trends are found to differ significantly across industries. Thus, while the employment shares of administrative tasks clearly decrease in industries such as metals production, chemicals (including coke and petrol production), machinery, electrical machinery and scientific instruments, there are some industries such as the motor vehicle industry and the pulp and paper industry which significantly increased this share. Likewise, contrary to the overall trend, within distribution, in-house transport and logistic services clearly gain in importance in the furniture industry and other miscellaneous manufactures.

Analysis at the more detailed sector level further reveals that the biggest increases in employment shares of R&D tasks were in industries such as electrical machinery, motor vehicles, machinery as well as the pulp and paper industry. However, growth of R&D tasks was also dynamic in the textiles and the woods industry.

Table 4: In-house services: service employment in Austrian manufacturing industries by business function, 2003

		Total services	Total services	R&D	Distributive services			Corporate governance				Personal services
					Total	Distrib., cust. serv.	Transport, logistics	Total	Manage-ment	Managem., consulting	Administr., clerks	
		Percentage shares in total employment	Difference in percentage points 1995/2003									
NACE	Description											
23, 24	Chemical, prod., coke, petrol. pr.	59.1	-3.9	0.6	-2.2	0.7	-3.8	-1.4	0.0	2.0	-3.4	-0.8
22	Publishing and printing	57.1	10.3	-1.6	3.0	0.7	0.3	9.1	3.7	5.3	0.2	-0.2
30 to 33	Electrical machin., scient. instrum.	51.2	2.4	6.6	-0.6	1.0	-1.8	-4.0	1.0	-1.2	-3.7	0.4
15, 16	Food, beverages and tobacco	44.4	9.5	-0.3	2.5	1.0	0.3	8.2	5.4	2.6	0.2	-0.9
20	Wood and prod., cork	41.1	17.0	1.7	2.7	0.4	1.7	10.9	6.3	1.9	2.7	1.7
29	Machinery and equipment	40.5	5.8	4.4	-0.3	-0.7	-0.4	2.2	3.8	0.7	-2.3	-0.4
34, 35	Motor vehicles, oth .transp. equ.	38.5	11.5	4.7	1.7	0.5	1.0	7.2	3.4	0.4	3.5	-2.1
27, 28	Basic metals, fabric. metal prod.	30.5	-2.0	0.9	-0.1	0.2	-0.4	-2.5	0.2	0.4	-3.1	-0.4
25	Rubber and plastic products	29.9	1.6	0.8	0.1	-1.0	0.3	-0.4	-0.4	-1.7	1.8	1.1
17 to 19	Textiles, wearing app., leather	28.1	7.9	1.8	4.2	3.0	0.9	3.3	2.3	-0.6	1.6	-1.5
21	Pulp, paper and products	25.8	-0.5	4.2	-3.4	-0.9	-3.8	0.5	-3.2	-0.1	3.8	-1.8
36, 37	Furniture; manuf. nec, recycling	17.9	1.4	0.3	1.5	-0.1	1.5	-0.1	0.4	-0.2	-0.2	-0.3
15 to 37	Manufacturing	38.9	5.0	2.5	0.9	0.4	-0.1	2.1	2.2	0.7	-0.8	-0.4

Source: Austrian Microcensus and employment records from the Austrian Social Security Administration, WIFO, own calculations.

Looking across functional activities for each manufacturing industry we find the electrical machinery industry, the pulp and paper industry and the motor vehicles industry have expanded mostly the employment shares of R&D personnel. In the textiles industry the major expansion has been in distributive and customer services, while employment growth in the woods industry, in publishing and printing, in the food industry and the motor vehicles industry has concentrated in management services.

Accompanying this movement away from productive tasks towards an increased importance of services in the value chains of the manufacturing process is a clear shift in the skill structure of employment, away from the low skilled workers with low educational attainment towards the medium skilled white-collar workers and high-skilled workers and managers (Table 5).

Table 5: Skill structure of employment in manufacturing sectors, 2003

	Workers with				Managers[1)]	Total
	basic education	a certificate from the dual vocational system	upper secondary education	tertiary education		
	Percentage shares					
Basic metals, fabric. metal prod.	2.1	80.7	10.6	2.5	4.1	100.0
Chemical and pr., coke, petrol. pr.	7.0	56.3	15.5	9.3	12.0	100.0
Machinery and equipment	2.9	67.4	18.4	4.0	7.3	100.0
Electrical machin., scientific instrum.	3.3	58.4	24.4	6.6	7.4	100.0
Motor vehicles, other transport equ.	3.8	75.6	10.7	3.6	6.3	100.0
Food, beverages and tobacco	10.6	72.1	3.6	4.4	9.3	100.0
Textiles, wearing apparel, leather	5.0	82.5	6.4	1.1	4.9	100.0
Wood and prod., cork	5.2	74.3	5.4	2.6	12.4	100.0
Pulp, paper and paper products	4.4	81.7	5.7	4.1	4.2	100.0
Publishing and printing	6.6	57.8	12.0	14.0	9.5	100.0
Rubber and plastic products	6.0	81.0	9.1	1.2	2.8	100.0
Furniture; manuf. n. e. c., recycling	2.0	91.1	3.7	0.7	2.4	100.0
Manufacturing	4.7	73.1	11.3	4.2	6.8	100.0
	Difference in percentage points 1995/2003					
Basic metals, fabric. metal prod.	-1.7	0.6	0.8	0.1	0.2	-
Chemical and pr., coke, petrol. pr.	-0.5	-0.3	-1.4	2.2	0.0	-
Machinery and equipment	-0.6	-7.9	4.5	0.1	3.8	-
Electrical machin., scientific instrum.	0.3	-6.1	3.4	1.4	1.0	-
Motor vehicles, other transport equ.	-1.5	-6.7	3.2	1.7	3.4	-
Food, beverages and tobacco	0.2	-7.9	-1.0	3.2	5.5	-
Textiles, wearing apparel, leather	-2.1	-0.4	0.8	-0.6	2.3	-
Wood and prod., cork	-0.7	-12.0	0.3	2.2	10.2	-
Pulp, paper and paper products	-1.9	2.9	-1.2	3.4	-3.2	-
Publishing and printing	-6.2	-3.5	0.9	5.2	3.7	-
Rubber and plastic products	-2.2	2.6	1.9	-1.9	-0.4	-
Furniture; manuf. n. e. c., recycling	-1.3	1.4	-0.8	-0.1	0.8	-
Manufacturing	-1.3	-3.8	1.4	1.3	2.5	-
	Average annual percentage change 1995/2003					
Basic metals, fabric. metal prod.	-7.2	0.1	1.0	0.6	0.5	-
Chemical and pr., coke, petrol. pr.	-0.9	-0.1	-1.1	3.5	0.0	-
Machinery and equipment	-2.1	-1.4	3.6	0.4	9.7	-
Electrical machin., scientific instrum.	1.2	-1.2	1.9	3.1	1.9	-
Motor vehicles, other transport equ.	-4.1	-1.1	4.5	7.8	10.2	-
Food, beverages and tobacco	0.2	-1.3	-3.0	18.6	11.7	-
Textiles, wearing apparel, leather	-4.3	-0.1	1.7	-5.0	8.2	-
Wood and prod., cork	-1.6	-1.9	0.8	24.9	24.1	-
Pulp, paper and paper products	-4.5	0.4	-2.3	25.5	-6.9	-
Publishing and printing	-7.9	-0.7	1.0	5.9	6.2	-
Rubber and plastic products	-3.9	0.4	2.9	-11.0	-1.8	-
Furniture; manuf. n. e. c., recycling	-5.9	0.2	-2.5	-2.1	5.0	-
Manufacturing	-3.1	-0.6	1.6	4.6	5.8	-

Source: Microcensus, own calculations. – [1]) Not classifiable by education.

6. Service linkages and export market shares in manufacturing in the OECD

6.1 Empirical model and data

In a first step, we look at the effects of increased inter-sectoral linkages to the service sector on manufacturing export market shares. The analysis is based on a panel of 16 OECD countries and 17 industries covering the years 1995 and 2000[4]).

In most empirical analysis on the determinants of export shares, cost and technological competitiveness have been identified as the major explanatory variables. This study introduces inter-sectoral linkages in an empirical model of international market share dynamics. While there are a number of empirical studies trying to explain export market share movements by accounting for price and non-price factors of competitiveness also including technological spillovers, the reliance of the manufacturing sector on services inputs and the inter-sectoral linkages to the services sector have not been incorporated in such a model yet. The papers by *Arnold - Javorcik - Mattoo* (2006) and *Fancois - Wörz* (2007) are most closely related to our research, but do not examine the market share function directly.

To examine the link between services input and the export performance of service users, the basic market share model including cost and technology related variables is augmented by service linkage variables based on national Input-Output tables. The basic model in this paper may then be represented by the equation:

(1) $XMS_{ijt} = \beta_0 + \beta_1 RULC_{ijt} + \beta_2 RPAT_{ijt} + \beta_3 RSERVLINK_{ijt} + \beta_5 T + \mu_i + \mu_j + \varepsilon_{ijt}$,

where the left-hand-side variable, XMS_{ijt} is the export market share of country i in industry j at time t. The data were taken from the UN COMTRADE database. The export market share for a particular industry is calculated by dividing the current dollar values of each country by the sum of the industry's exports for the 16 OECD countries in the sample[5]). $RULC_{ijt}$, denotes relative unit labour costs and proxies cost competitiveness. Unit labour costs are calculated by dividing labour compensation (in current USD) by value added in constant prices and PPP-dollars. Relative unit labour costs are measured relative to the average of the labour unit costs of all 16 OECD Countries in the sample. Data on labour compensation and value added were taken from the OECD STAN database and the EUKLEMS database. $RPAT_{ijt}$, proxies technological competitiveness or innovation output and is defined as the share of

4) The 16 OECD countries include: Austria, Belgium, Canada, Denmark, Finland, France, Greece, Germany, Italy, Ireland, Netherlands, Norway, Portugal, Spain, Sweden, United Kingdom.

5) Such market share calculations take no account of exports from non-OECD countries, which have been growing strongly in some categories. Since for most of non-OECD countries no reliable data on costs and technology variables at the level of disaggregation chosen in the paper as well as Input-Output tables is available, and the explicit aim of the paper is to investigate the comparative export performance of the group of countries this should be a good approximation.

each country in the total patents for each sector, relative to the mean of all countries' shares. Following most of the literature on innovation, the patent data are taken form the United States Patent and Trademark Office (USPTO). Finally, $RSERVLINK_{ijt}$ measures the interconnectivity between the manufacturing sectors and the service sectors by the use of Input-Output tables. The service linkage variable measures the importance of each service sector z as a supplier to the manufacturing sector i and captures all deliveries of services to the manufacturing sectors j as a percent of total output. It is defined as follows:

(2) $SERVLINK_{ijt} = (y_{zj}^{ti} / Y_j^{ti})$ for $j \neq z$,

where y_{zj}^{ti} is a vector of the service deliveries to the manufacturing sector j, and Y_j^{ti} is a vector of gross output of industry j at time t in country i. As with all other variables, the linkage variable is measured relative to the sample mean at any given time and sector (RSERVLINK). The OECD Input-Output tables are the main limiting factor in the database since comparable input-output information was only available for two points in time, 1995 and 2000. In the empirical specification therefore, we estimate the model in differences.

Taking "long differences" between these two points in time we arrive at the following equation:

(3) $\Delta RXMS_{ijt} = \alpha_0 + \alpha_1 \Delta RULC_{ijt} + \alpha_2 \Delta RPAT_{ijt} + \alpha_3 \Delta RSERVLINK_{ijt} + \sum \alpha_i COUNTRY_i + \nu_{ijt}$,

where the new error term, $\nu_{ijt} = \varepsilon_{ijt} - \varepsilon_{ij,t-1}$, has zero mean and constant variance. Δ refers to the average annual (absolute) change in the variables from 1995 to 2000. Time differencing of the time trend generates the constant α_o. Taking "long differences" between two points in time also eliminates all time-invariant characteristics or fixed effects at the level of the country and industry. By including country fixed effects in the model in differences, differences in trends (rather than levels) that are specific to a particular country are controlled for and we will test their joint significance at every stage.

Since it seems reasonable to presume that the gains in the productivity and competitiveness of downstream manufacturing industries will be higher the higher the efficiency, productivity and competitiveness of the service sector we also experiment by including interaction terms between indicators reflecting the quality of services inputs and the variables measuring the strength of the service linkage:

(4)
$$\Delta RXMS_{ijt} = \alpha_0 + \alpha_1 \Delta RULC_{ijt} + \alpha_2 \Delta RPAT_{ijt} + \alpha_3 \Delta RSERVLINK\_RDS_{ijt} + \sum \alpha_i COUNTRY_i + \nu_{ijt}$$

with,

(5) $SERVLINK\_RDS_{ijt} = (y_{zj}^{ti} / Y_j^{ti}) RDS_z^{ti}$,

where RDS_z^{ti} is a vector measuring the R&D intensity (R&D to output ratio) of the service sector z and should reflect the technological content (or quality) of the services inputs delivered to the manufacturing sectors j.

Furthermore, we will distinguish between the impact of purchases of service inputs from domestic suppliers (DOMSERV) versus international purchases of services (service imports; IMPSERV), leaving us with the following specifications:

(6)

$$\Delta RXMS_{ijt} = \alpha_0 + \alpha_1 \Delta RULC_{ijt} + \alpha_2 \Delta RPAT_{ijt} + \alpha_3 \Delta RDOMSERV_{ijt} + \alpha_4 RIMPSERV_{ijt} + \sum \alpha_i COUNTRY_i + \nu_{ijt}$$

or alternatively domestic purchases of services and imported service inputs into manufacturing interacted with the R&D intensity of deliveries from the service sector.

(7)

$$\Delta RXMS_{ijt} = \alpha_0 + \alpha_1 \Delta RULC_{ijt} + \alpha_2 \Delta RPAT_{ijt} + \alpha_3 \Delta RDOMSERV\_RDS_{ijt} + \alpha_4 RIMPSERV\_RDS_{ijt} + \sum \alpha_i COUNTRY_i + \nu_{ijt}$$

The main research question to be examined is whether service inputs into manufacturing industries contribute positively to the export performance of this sector. Apart from the alternative specifications outlined above, distinguishing between different definitions of the service linkage variable and between national and international service purchases a number of other sensitivity and robustness tests are performed. First, we estimate the models separately for purchases of knowledge intensive services industries ("KIBS") and also test for a differential impact of purchases of R&D-services. Second, since some of the empirical literature suggests different impacts of service inputs and inter-sectoral linkages on the export performance of the more high-skilled and technology intensive industries (*Francois - Wörz*, 2007, *Laursen - Meliciani*, 2000) we run separate regressions for two broad industry groups, one comprising the NACE sectors 24, 30, 32, 33 and 34 summarising technology driven, medium-skill to high-skill intensive sectors; and the other including the remaining manufacturing industries[6]). Third, in all the regressions, we account for outliers by introducing outlier dummies whenever the studentized residuals turn out to be greater than 3 in the basic specification (see *Belsley et al.*, 1980). Additionally, to further check for the robustness of results, all regression coefficients are re-estimated using the robust regression method as another way to reduce the impact of extreme outliers that may result from errors in the variables used.

The appendix provides more information on the definitions and the main data sources of the variables we use in the econometric exercise.

6.2 Estimation results: service linkages and export market shares in OECD manufacturing

Table 6 presents regression results for export market shares using different estimation techniques and different specifications. In order to obtain sufficient observations we pool the data across the 16 OECD countries and sectors. For each of the countries we have 17 to 18 industries resulting in a total of 282 observations. Close inspection of the data reveals the presence of some severe outliers. We cope with this problem by introducing outlier dummies

[6]) This classification is based on *Peneder* (2003, 2005).

whenever the studentized residuals turn out to be greater than 3 in the basic OLS regression (upper panel in Table 6). Alternatively, we re-estimate the model using robust regression which is an iterative, weighted least squares procedure controlling for outliers. The results from the robust regression are presented in the lower panel of Table 6. Specification 1 uses the service linkage variable that is based on total service inputs (from national and international sources) into manufacturing, while in specification 2 we distinguish between national and international service linkages of the manufacturing industries. Finally, in specifications 3 and 4 we use service inputs interacted with R&D intensity in the service sector to signal the quality of the inputs used.

Most of the estimated coefficients are consistent across specifications and estimation techniques. The results for the service linkage variable suggest that while there is no impact of total linkages and domestic linkages, international service linkages add significantly and positively to growth of export market shares. This finding again is robust across specifications and estimation techniques.

Based on the estimated elasticities of export market shares evaluated at sample means one can provide an indication of the magnitude of the different sources of market share dynamics. According to these calculations, the observed change in international service linkages from 1995 to 2000 accounted for an increase in the export market share of 0.02 percentage points per year, explaining about 18 percent of the average increase in export market shares over the period. In contrast, the observed increase in patenting activities accounts for an increase in market shares of 0.04 percentage points per year (roughly 30 percent of the total increase of market shares).

The results from the sample split regressions appear to be consistent with expectations on the relative importance of the different factors of competitiveness in the different sectors (Table 7). In particular, patents (reflecting the sectors' technological competitiveness), clearly play the largest role in the technology driven, high-skilled manufacturing industries, while unit labour costs have a significant, but rather low impact on export market shares. Most importantly however, also service linkages play a significant and dominant role in market share dynamics of these industries. While the coefficient on total service inputs into manufacturing is highly significant, splitting the linkage variable into national and international linkages again reveals that only imported services have a significant impact on market share dynamics in the technology driven manufacturing sectors. On the contrary, market shares in low-tech industries, are mainly driven by relative unit labour costs, while neither technology (sector R&D) nor service linkages appear to play a role. The sample split regressions were also performed using the robust regression method (not shown) as well as for service linkages interacted with R&D in the service sector and produced basically the same results. Again, decomposition analysis of changes in export market shares based on the estimated elasticities reveals that the change in international linkages to the service sectors has increased export market shares by 0.07 percentage points per year in the period 1995 to 2000 in the technology driven industries, explaining about 40 percent of the total increase in relative export market shares over the period in this group of industries. This reveals that

indeed, growing service linkages in technology driven sectors have been an important determinant for international market shares over that period.

Table 6: Regression results – export market share dynamics in OECD manufacturing and linkages to the service sector

	(1)		(2)		(3)		(4)	
	OLS results							
	Coef.	t-value	Coef.	t-value	Coef.	t-value	Coef.	t-value
Δ Unit labour costs	-0.020 ***	-2.83	-0.019 **	-2.41	-0.012 **	-1.96	-0.011 *	-1.74
Δ Patents	0.187 ***	3.00	0.191 ***	3.10	0.162 **	2.20	0.174 **	2.45
Δ Service linkage								
- total	0.043	0.99						
- national linkage			-0.008	-0.17				
- international linkage			0.020 **	2.28				
Δ Service linkage x R&D intensity								
- total								
- national linkage					-0.031	-1.36	-0.029	-1.22
- international linkage							0.027 **	2.15
Constant	-0.001	-0.28	-0.001	-0.25	-0.005	-0.07	0.0009	0.39
Statistics								
N	282		282		211		211	
R^2	0.86		0.87		0.82		0.81	
F-tests								
Country dummies	7.97 ***	(15, 238)	7.62 ***	(15, 237)	4.04 ***	(11, 178)	3.26 ***	(11, 178)
	Robust regression results							
	Coef.	t-value	Coef.	t-value	Coef.	t-value	Coef.	t-value
Δ Unit labour costs	-0.020 **	-2.14	-0.018 **	-1.93	-0.012 *	-1.77	-0.011 *	-1.75
Δ Patents	0.165 ***	3.56	0.167 ***	3.67	0.141 ***	2.92	0.150 ***	3.09
Δ Service linkage								
- total	0.013	0.46						
- national linkage			-0.032	-1.01				
- international linkage			0.016 **	2.18				
Δ Service linkage x R&D intensity								
- total								
- national linkage					-0.040	-1.63	-0.036	-1.48
- international linkage							0.020 **	2.06
Constant								
Statistics								
N	282		282		211		211	
R^2	0.53		0.54		0.30		0.26	
F-tests								
Country dummies	17.63 ***	(15, 263)	17.81 ***	(15, 262)	6.35 ***	(11, 196)	4.72 ***	(11, 195)

Note: (***), (**), (*) denote significance at the 1 percent, 5 percent and 10 percent level respectively. The variables are measured as average annual (absolute) changes. Outlier dummies and country dummies are not reported for reasons of space. t-values are based on robust standard errors. Degrees of freedom in parenthesis.

Table 7: OLS regression results – export market share dynamics in OECD manufacturing and linkages to the service sector, sample split

	Technology driven industries				Other industries			
	(1)		*(2)*		*(3)*		*(4)*	
	Coef.	t-value	Coef.	t-value	Coef.	t-value	Coef.	t-value
Δ Unit labour costs	-0.027 **	-2.27	-0.019 ***	-3.22	-0.138 ***	-3.93	-0.137 ***	-3.87
Δ Patents	0.316 **	1.74	0.634 ***	5.02	0.114	1.39	0.111	1.32
Δ Service linkage								
- total	0.388 ***	6.87			-0.061	-1.35		
- national linkage			0.049	0.81			-0.086	-1.65
- international linkage			0.037 ***	3.16			-0.004	-0.49
Constant	-0.008	-0.73	-0.005	-1.26	-0.003	-0.94	-0.004	-1.18
Statistics								
N	78		78		204		204	
R^2	0.90		0.90		0.87		0.87	
F-tests								
Country dummies	18.0 ***	(15, 50)	17.93 ***	(15, 48)	10.44 ***	(15, 172)	10.41	(15, 171)

Note: (***), (**), (*) denote significance at the 1 percent, 5 percent and 10 percent level respectively. The variables are measured as average annual (absolute) changes. Outlier dummies and country dummies are not reported for reasons of space. t-values are based on robust standard errors. Degrees of freedom in parenthesis.

Regression results for the impact of linkages to the KIBS sectors (NACE 72: computer and related activities; NACE 73: research and development; NACE 74: business services) are summarized in Table 8. Focusing on the interaction between service firms and manufacturing firms KIBS are expected to play a key role as knowledge and ideas become a key factor in shaping competitiveness and are diminishing the role of material inputs. KIBS are primary sources and carriers of information and knowledge (training, consultancy etc.) or are themselves important producers of new technologies (computer, software, R&D). So we would expect a more clear and significant impact of KIBS usage by the manufacturing sector on export market shares. However, the results differ from the basic regressions and the regressions on "other services" only, in that the coefficient on total (domestic and international) KIBS linkages turns significant. Splitting up between national and international linkages we again only find a positive and statistically significant impact of international KIBS linkages. The coefficient of domestic KIBS linkages is positive but not significant. Linkages of manufacturing to the group of "other producer service sectors" appear to be negatively correlated with export market shares as concerns total and domestic linkages. Both of the coefficients are insignificant, however. The coefficient on imported services turns out to be is positive and highly significant also for imported other service inputs.

Furthermore, sample split regressions reveal that for both types of linkages, KIBS linkages and interactions with other service sectors, a significant impact is only to be expected for the technology driven, high-skilled labour intensive manufacturing sectors (Table 9). Again, the

robust regression technique and using alternative definitions of the KIBS linkage variable produce the same results and support the robustness of the results.

Finally, unreported results for the impact of linkages of the manufacturing sector to the R&D service sector indicate that there is no significant impact of either domestic nor international purchases of inputs from the R&D-sector. However, splitting the sample into technology driven manufacturing sectors and other low-skilled sectors again reveals a highly significant positive impact of imported R&D services on market share dynamics for the high-skilled, technology driven sectors, while there is no impact of R&D-linkages in the low-skilled manufacturing sectors.

Table 8: OLS regression results – export market share dynamics in OECD manufacturing and linkages to the KIBS

	KIBS inputs				Other service inputs			
	(1)		*(2)*		*(3)*		*(4)*	
	Coef.	t-value	Coef.	t-value	Coef.	t-value	Coef.	t-value
Δ Unit labour costs	-0.020 ***	-2.79	-0.020 ***	-2.63	-0.020 **	-2.46	-0.022 **	-2.47
Δ Patents	0.185 ***	2.92	0.188 ***	3.00	0.183 ***	2.89	0.179 ***	2.88
Δ Service linkage - KIBS								
- total	0.034 *	1.79						
- national linkage			0.011	0.40				
- international linkage			0.011 **	1.97				
Δ Service linkage - O. serv. sect.								
- total					-0.014	-0.46		
- national linkage							-0.020	-0.53
- international linkage							0.044 ***	7.88
Constant	0.000	-0.01	0.000	-0.10	0.000	-0.06	-0.001	-0.22
Statistics								
N	282		282		282		282	
R^2	0.86		0.86		0.86		0.86	
F-tests								
Country dummies	6.95 ***	(15, 239)	7.04 ***	(15, 238)	8.00 ***	(15, 238)	9.11 ***	(15, 237)

Note: (***), (**), (*) denote significance at the 1 percent, 5 percent and 10 percent level respectively. The variables are measured as average annual (absolute) changes. Outlier dummies and country dummies are not reported for reasons of space. t-values are based on robust standard errors. Degrees of freedom in parenthesis.

Table 9: OLS regression results – export market share dynamics in OECD manufacturing and linkages to the KIBS inputs, sample split

	KIBS outsourcing							
	Technology driven industries				Other manufacturing industries			
	(1)		*(2)*		*(3)*		*(4)*	
	Coef.	t-value	Coef.	t-value	Coef.	t-value	Coef.	t-value
Δ Unit labour costs	-0.022 **	-2.65	-0.022 **	-2.25	-0.139 ***	-3.86	-0.144 ***	-3.94
Δ Patents	0.485 **	1.99	0.467 *	1.81	0.111	1.36	0.109	1.34
Δ Service linkage - KIBS								
- total	0.163 ***	3.82			-0.017	-0.71		
- national linkage			0.058	0.81			-0.040	-1.34
- international linkage			0.041 ***	2.89			0.000	-0.02
Constant	0.000	-0.04	-0.011	-0.53	-0.002	-0.60	0.000	-0.10
Statistics								
N	78		78		204		204	
R^2	0.88		0.86		0.88		0.88	
F-tests								
Country dummies	20.01 ***	(15, 51)	12.83 ***	(15, 50)	10.04 ***	(15, 171)	10.10 ***	(15, 170)

	Outsourcing of other service industries							
	Technology driven industries				Other manufacturing industries			
	(5)		*(6)*		*(7)*		*(8)*	
	Coef.	t-value	Coef.	t-value	Coef.	t-value	Coef.	t-value
Δ Unit labour costs	-0.015 ***	-2.53	-0.017 **	-2.44	-0.113 ***	-3.43	-0.108 ***	-3.26
Δ Patents	0.410 **	1.86	0.458 **	2.34	0.170 **	2.35	0.165 **	2.21
Δ Service linkage - O. serv. sect.								
- total	-0.060	-0.75			-0.020	-0.60		
- national linkage			-0.067	-1.06			-0.019	-0.42
- international linkage			0.045 ***	10.01			-0.009	-0.54
Constant	0.000	-0.09	0.009 **	2.27	-0.001	-0.50	-0.001	-0.32
Statistics								
N	78		78		204		204	
R^2	0.92		0.93		0.86		0.87	
F-tests								
Country dummies	2.27 **	(15, 46)	3.46 ***	(15, 47)	9.78 ***	(15, 173)	10.50 ***	(15, 170)

Note: (***), (**), (*) denote significance at the 1 percent, 5 percent and 10 percent level respectively. The variables are measured as average annual (absolute) changes. Outlier dummies and country dummies are not reported for reasons of space. t-values are based on robust standard errors. Degrees of freedom in parenthesis.

7. Service linkages and total factor productivity in Austrian manufacturing

In this second part of the paper we econometrically test for a relationship between the use of services and productivity growth in the manufacturing sector. A major focus is put on the impact of in-house services versus outsourced service inputs as drivers for competitiveness in the manufacturing sector. While input-output analysis reveals a growing importance of purchasing of services, producer services also represent an increasing share of the remaining activities still performed within manufacturing firms. Indeed, the descriptive analysis on Austrian data in section 5 of this paper already showed that in-house services acquire an increasing share of employment and that in fact some of the key service functions such as R&D as well as management activities are growing in importance. Thus, looking at service linkages based on Input-Output tables alone does not account for the total services content of manufactured goods, since some of the services are supplied within the firm itself.

Basically then, one can distinguish between two sources from which service inputs may have an impact on productivity. The first route is via technological change in the service industries and knowledge spillovers from services. Indeed, while services have long been considered as lagging behind in terms of innovation, technology developments and adoption, it is now widely recognized that some service industries, in particular knowledge intensive business services (such as R&D, Computers, Consulting), are not only important users but also important carriers of information and knowledge (training, consultancy etc.) as well as producers of new technologies (computer, software, R&D) and may thus be major vehicles for the diffusion of technology across sectors (*Tomlinson*, 2002; *DiCagno - Meliciani*, 2005). The ICT revolution has contributed to increasing both the use of services and their technological content. The second route through which service inputs may affect TFP growth in manufacturing is via a re-organizational effect which stems from an increased contracting out of service functions once performed inside manufacturing firms. The argument relates to the phenomenon called "Baumol's disease" and in contrast to the first argument, stresses the low productivity performance in many services sectors relative to the performance in manufacturing sector. The positive re-organizational effect of services outsourcing on *measured* TFP growth in the manufacturing sector then comes from externalizing low productivity, stagnant service activities and a concentration on high productivity, core activities as well as the more knowledge intensive services[7]). Papers analysing the impact of services outsourcing along these arguments include some early work by *Siegel - Griliches* (1992) and laterby *then Ten Raa - Wolff* (2001). The paper by *Ten Raa - Wolff* (2001) provides evidence that "sloughing off sluggish services" has significantly contributed to the recovery of

[7]) Note, that measuring outsourcing by the use of Input-Output tables, it is not directly possible to see to which part the increased importance of purchased services inputs by the manufacturing sector are due to contracting out formerly internally provided inputs (substitution) and to which part increased purchases of services are due to a general increase in the importance of service inputs at the cost of material inputs (additional demand for service inputs).

productivity growth in the US manufacturing in the eighties as well as the 90ies. A working paper by the OECD (*Olsen*, 2006) provides a good summary of the studies.

In this chapter, the impact of purchased (outsourced services) as well a in-house services on total factor productivity growth in manufacturing will be analysed following the approach suggested by *Feenstra - Hanson* (1999) and applied by *Egger et al.* (2001) who test for the impact of cross-border outsourcing on TFP growth. The analysis is based on an industry-time panel for Austria. The choice of this database is dictated mainly by the availability of data on sectoral employment by business functions - on which we base our calculations on the importance of services activities supplied within the firm -, as well as time series data for the input-output information which for the time being are both available to the author only for Austria. We also have to put the focus on productivity growth as a measure for competitiveness since the specification of a market share equation would again require internationally comparable data on employment by business functions which is not readily available.

Apart from considering different impacts from in-house versus outsourced services, the analysis also distinguishes between alternative categories of services inputs that are related to different factor intensities and skills of the sectors. It is important to take account of the great heterogeneity of the services sector as knowledge intensive services are likely to have a differential impact on productivity than other, more low-skilled and less innovative services. Furthermore, to take account of the different sources of technical change across manufacturing sectors the analysis also allows for a distinction of different factor intensities across manufacturing.

7.1 Theoretical background

Our starting point is the following overall measure of technological change or change of total factor productivity, that can be derived from a translog production function (*Feenstra - Hanson*, 1997, 1999; *Caves et al.*, 1982A, 1982B; *Egger et al.* 2001):

(8) $\Delta TFP_{it} = \Delta A_{0it} + \Delta A_{it}' \frac{1}{2}(\ln z_{it-1} + \ln z_{it}),$

where i indexes industry and t time. $z_{it} = (x_{it}, m_{it})$ is a vector of the primary inputs (x_{it}) and intermediate inputs (m_{it}). The scalar A_{0it} captures neutral technical progress, while A_{it} represents non-neutral technical change. While this provides us with a measure of technological change, the parameters A_{0it}, A_{it} may not be directly observed in the data.

Using first order conditions for cost minimization it can be shown that the change in total factor productivity (TFP_{it}) can be represented by the familiar Tornqvist index which subtracts the growth of inputs weighted by observed cost shares (cs_{it}) from total output growth:

(9) $\Delta TFP_{it} = \Delta \ln Y_{it} - \frac{1}{2}(cs_{it-1} + cs_{it})' \Delta \ln z_{it},$

Similar to others (*Feenstra - Hanson*, 1997, 1999; *Egger et al.,* 2001) the two technology change variables $\Delta A_{0it}, \Delta A_{it}$ are assumed to be functions of services outsourcing and other likely determinants of technological change denoted by the vector τ_{it}:

(10) $A_{it} = B\tau_{it} + u_{it}$

(11) $A_{oit} = \beta\tau_{it} + v_{it}$

Inserting into (8) then gives:

(12) $\Delta TFP_{it} = \beta\Delta\tau_{it} + \frac{1}{2}\Delta\tau_{it}'B'(\ln z_{it-1} + \ln z_{it}) + \varepsilon_{it}$

where $\varepsilon_{it} = \Delta u_{it}\frac{1}{2}(\ln z_{it-1} + \ln z_{it}) + \Delta u_{it}$.

The impact of service inputs on TFP can then be isolated from the influence of other structural variables by defining ΔTFP_{ikt} as the amount by which total factor productivity in industry i would be changed if the structural variable k (e.g. services outsourcing or increased in-house service inputs) were added into the calculation of ΔTFP_{it}:

(13) $\Delta TFP_{ikt} = \beta\Delta\tau_{ikt} + \frac{1}{2}\Delta\tau_{ikt}\sum_{j=1}^{M+N} b_{jk}(\ln z_{it-1} + \ln z_{it})$,

where τ_{ikt} is the k[th] element of vector τ_{it}, β_k is element k of vector β, and b_{jk} is element jk of the matrix B.

7.2 Empirical model and data: service linkages and productivity effects in Austrian manufacturing

The empirical specification of the model on the impact of services outsourcing is based on equation (13):

(14) $\Delta TFP_{it} = \beta_0 + \beta_1 OS_{it-1} + \beta_3 OS_{it-1}D_{low-skilled} + \beta_4 OS_{it-1}D_{capital} + \beta_5' X_{it} + \mu_i + \lambda_t + \varepsilon_{it}$,

where i again is the industry index and t the time index. The dependent variable is the Tornqvist index of TFP as implied by equation (9). Purchases of services by the manufacturing sector, that is, outsourcing of services (OS_{it}) enters as the lagged ratio of the manufacturing sector's purchased services relative to total expenditure on intermediate inputs. As a departure from equation (13), we introduce two interaction terms of the services outsourcing measure with dummies indicating (i) the skill-intensitiy and the (ii) capital intensity of the outsourcing industry ($OS_{it}D_{low-skilled}$, $OS_{it}D_{capital}$). This is made necessary by the fact that the interaction terms between outsourcing and inputs (the second term in equation 13), capturing non-neutral technical change due to services outsourcing, are highly collinear. Finally, X_{it} is a matrix of additional controls for other likely influences on productivity. It

includes sector specific R&D-to-output ratios as well as export and import openness, which can all be expected to exert a positive influence on TFP. μ_i and λ_t are fixed industry and fixed time effects controlling for exogenous neutral technological progress and time specific influences like business cycle and technical progress common to all industries.

In the analysis of the productivity effects of in-house services, we proceed likewise and estimate the following function:

(15) $\Delta TFP_{it} = \beta_0 + \beta_1 INTS_{it-1} + \beta_3 INTS_{it-1} D_{low-skilled} + \beta_4 INTS_{it-1} D_{capital} + \beta_5' X_{it} + \mu_i + \lambda_t + \varepsilon_{it}$,

where $INTS_{it}$ captures internally delivered services (in-house services) and enter as the lagged ratio of services employment relative to total employment in the manufacturing sector i.

Apart from considering different impacts from in-house versus outsourced services the analysis also distinguishes between alternative categories of services inputs that are related to different factor intensities and skill intensities of the services supplied. In particular, the analysis will distinguish between knowledge intensive services (KIBS) and R&D services which are most likely to have a differential impact on productivity than other, more low-skilled and less innovative services. We estimate the equations by OLS, but to ensure that the results are robust with respect to outliers, we re-estimate the models using the robust regression method as well as robust median regression techniques. To further assess the sensitivity of the estimates we also perform fixed-effects regressions without the additional control variables.

The data on TFP growth stems from the EUKLEMS database (March 2007 release), which is consistent with the Tornqvist index of TFP in equation (9). The R&D-to-output ratios come from the OECD-BERD statistic and the Austrian "Forschungserhebung". These are available for the years 1993, 1998, 2000 and 2004, so that the values for the in-between years are interpolated. Export openness as well as the indicator on import penetration are both from the OECD STAN Indicators database. The construction of the services outsourcing measure is on based on the Austrian Input-Output and Supply and Use tables which, for the period considered, are only available for some benchmark years. This paper makes use of time series of intermediate flows based on these official tables that were prepared by WIFO for Austria in the framework of the EUKLEMS Project according to the methodology described in *Kratena* (2005). Finally, the data on employment in services functions within the manufacturing firms/sectors is derived from the Austrian labour-force survey (Austrian Microcensus) and employment records of the Austrian Social Security Administration ("Hauptverband der österreichischen Sozialversicherungsträger"). The appendix provides more information on the definitions and the main data sources of the variables we use in the econometric exercise.

7.3 Estimation results: service linkages and total productivity effects in Austrian manufacturing

Table 10 presents the regression results on the impact of services outsourcing on total factor productivity growth in Austrian manufacturing. The estimations are based on a panel of 13

manufacturing industries, covering the period from 1994 to 2003, resulting in a total of 130 observations. Three specifications are estimated. In the first specification we test for the impact of outsourcing of total producer services, while in the two other specifications we examine the effect of outsourcing of knowledge intensive business services (KIBS) and outsourcing of R&D-services, respectively.

From specification 1 we find that outsourcing of producer services (OS_{it}) has a positive and significant impact on TFP growth. Additionally, the interaction terms ($OS_{it}D_{low-skilled}$, $OS_{it}D_{capital}$) are significant and reveal that the positive impact of services outsourcing is more pronounced in high-skilled labour intensive industries than in either capital and low-skilled intensive industries[8]). The coefficient estimated corresponds to elasticities evaluated at the sample mean of 0.24 for the base effect (the high skilled industries), 0.02 for low-skilled intensive industries and 0.08 for capital intensive industries. Overall then, about on fourth of the increase in manufacturing TFP of 1.35 percent on average can be attributed to outsourcing of services.

In specification 2 we also find a positive and highly significant effect of KIBS outsourcing. The interactions terms again indicate that the impact is less pronounced in low-skill intensive industries. The coefficient on the second interaction term for capital intensive industries is negative but not significant. The coefficients correspond to elasticities evaluated at sample means of 0.15 for the base effect, 0.01 for low-skilled intensive industries and 0.07 for capital intensive industries. Taken together, about 17 percent of the overall increase of TFP on average can be attributed to KIBS outsourcing. This lends support to the hypothesis, that KIBS are in fact important transmitters of technology and knowledge as also does a comparison with the results for TFP growth as a consequence of outsourcing of other services (specification 3). While the regressions produce a positive coefficient, this impact is not statistically significant so that we can conclude that this category of "other services" has no impact on TFP growth in manufacturing. A finding that runs contrary to the argument of a strong re-organizational effect as discussed earlier[9]).

[8]) The results for the control variables are not presented in the table 10. R&D-intensity turns out to be positive and highly significant. The openness variables are both insignificant.

[9]) A look at the Austrian data on TFP growth of the services sector seems to support the re-organization and "Baumol disease" argument: productivity in the overall service sector, and the KIBS, in specific, has not only lagged behind productivity increases in the manufacturing sector, but even declined. For the KIBS we find a reduction in TFP by a yearly average rate of -0.83 percent between 1993 and 2003, with an accelleration in the second half of that period (1998-2003) to -1.15 percent! Measurement of productivities in the services sector is a very tricky issue, and these results are very counterintuitive, also in an international comparison. Thus one should not lend too much belief onto these figures. Furthermore, not all what is measured as outsourcing on the basis of Input-Output tables substitutes for internally provided services, so that the re-organizational effect is hard to capture (see footnote 7).

Table 10: OLS regression results - outsourcing of services and total factor productivity growth (TFP) in Austria, 1993 - 2003

	(1) Outsourcing of total producer serv.		(2) Outsourcing of KIBS		(3) Outsourcing of Other Services		(4) Outsourcing of R&D	
	Coef.	t-value	Coef.	t-value	Coef.	t-value	Coef.	t-value
Dependent variable: log change in TFP								
Outsourcing of services:								
- base	0.975 ***	3.84	2.287 ***	3.12	0.113	0.94	-9.808	-1.33
- interaction with $D_{low\text{-}skilled}$	-0.767 ***	-5.82	-1.941 **	-2.51	-0.060	-0.47	2.407	0.69
- interaction with $D_{capital}$	-0.399 *	-1.70	-0.303	-0.43	0.031	0.39	9.132	1.73
Statistics:								
N	130		130		130		130	
R^2	0.60		0.53		0.64		0.61	
σ	0.02		0.02		0.02		0.02	
F-tests								
Time dummies	2.25 ***	(9, 99)	3.76 ***	(9, 100)	2.34 **	(9, 94)	2.67 ***	(9, 97)
Industry dummies	4.33 ***	(12, 99)	1.52	(12, 100)	0.61	(12, 94)	0.49	(12, 97)
Interaction terms	17.10 ***	(2, 99)	3.19 **	(2, 100)	0.17	(2, 94)	1.50	(2, 97)

Note: (***), (**), (*) denote significance at the 1 percent, 5 percent and 10 percent level, respectively. Degrees of freedom in parenthesis. Control variables for export and import openness (all insignificant), R&D-intensity, fixed industry and time effects as well as outlier dummies are not reported. t-values are based on heteroscedasticity-robust standard errors.

Finally, the findings for outsourcing of R&D-functions (specification 4) suggest a negative correlation with TFP growth in manufacturing. However, the coefficient is insignificant and could not be estimated with precision so that it is impossible to draw firm conclusions.

Regression results for the impact of internally provided services – measured by the employment share of services within each sector – are summarized in Table 11. Again the data is pooled across industries and time to obtain sufficient observations. Since we have data on in-house services employment only over the period 1995 to 2003 and for 12 manufacturing industries we end up with a total 96 observations[10]). Overall, the regressions do not produce any significant results. The coefficient on total in-house services suggests a negative impact on TFP growth, which could be in line with the overall presumption of the lower productivity performance of overall services. But since the coefficient is not estimated with precision, no firm conclusion can be drawn. Further experiments with employment data on distributive service functions, services related to corporate governance functions of the firm (management as well as administrative tasks) and R&D-functions always result in negative, albeit insignificant coefficients, except for R&D functions. Internally provided R&D services seem to be positively correlated with TFP growth, but again this effect is not statistically significant.

[10]) NACE 26 (other non-metallic mineral products) is not in the dataset, because the Austrian Microcensus on which the data on employment shares by business function are based, subsumes this sector under the aggragate sector "mining and quarrying".

Table 11: OLS regression results - in-house services – employment and total factor productivity growth (TFP) in Austrian manufacturing, 1995 - 2003

	(1) Total services employment	
	Coef.	t-value
Dependent variable: log change in TFP		
Share of services employment:		
- base	-0.124	-0.91
- interaction with $D_{low\text{-}skilled}$	-0.237	-1.60
- interaction with $D_{capital}$	-0.105	-0.69
Statistics		
N	96	
R^2	0.72	
σ	0.01	
F-tests		
Time dummies	3.84 ***	(7, 63)
Industry dummies	1.91 *	(11, 63)
Interaction terms	1.29	(2, 63)

Note: (***), (**), (*) denote significance at the 1 percent, 5 percent and 10 percent level, respectively. Degrees of freedom in parenthesis. Control variables for export and import openness (all insignificant), R&D-intensity, fixed industry and time effects as well as outlier dummies are not reported. t-values are based on heteroscedasticity-robust standard errors.

8. Conclusions

This paper puts a focus on the interaction between manufacturing industries and the service sector in determining competitiveness. First, a market share function for a sample of 18 disaggregated manufacturing industries for 16 OECD countries for the period 1995 to 2000 is estimated. Distinguishing between domestically sourced service inputs and imports, the analysis finds a clear positive impact of international service linkages on export market shares in manufacturing, while it does not find a significant effect of domestic linkages Thus, international service linkages are more important than national linkages in promoting competitiveness. This result clearly points to the importance of further services liberalization also in favour for manufactured goods trade. Interestingly, we do not find any important differences in the effects between linkages of manufacturing to the KIBS sectors and other services sectors, except that the coefficient for total service linkages (domestic and international) turns significant and the coefficient on the domestic linkage variable turns positive, but is still insignificant with respect to KIBS outsourcing. This seems to highlight the "product-supporting" role of services with respect to export market shares, over their function as carriers and transmitters of information and knowledge, when services are used as inputs in the production process itself.

However, we discover that the magnitude and significance of the international service linkage effect highly differs across the manufacturing industries. Sample split regressions show that a positive and significant impact of imported service inputs is prevalent only in the technology driven, high-skilled labour intensive industries within the manufacturing sectors, explaining about 40 percent of the overall increase in the export market share in this sector, while there is no impact in the rest of the industries. This resembles findings by *Francois - Wörz*, 2007 showing a positive and significant impact of increased business service openness on exports of technology intensive industries. Finally, the results on the impact of relative unit labour costs and patenting activity are very much in line with expectations on the relative importance of the different factors of competitiveness in the different sectors. Export market shares in technology driven industries are thus most effectively affected by the sectors' own innovative activities, while international competitiveness in low-tech, low-skilled industries is driven mostly by relative costs.

In the second part of the study, the focus switches to the impact of service inputs on total factor productivity (TFP) growth in Austrian manufacturing. The analyses is done for purchased services as well as internally delivered, in-house services and finds that purchased services significantly contribute to TFP growth, especially in the high-skilled intensive industries. No such relationship is found for in-house services. In contrast to the findings for export market shares, the distinction between the different types of service inputs (KIBS and other services) is highly relevant for the results on TFP growth and stress the role of KIBS as important transmitters of technology and knowledge (knowledge spillovers).

9. References

Amable, B., Verspagen, B., "The role of technology in market shares dynamics" Applied Economics, 1995, 27(2), pp. 197-204.

Amiti, M., Konings, J., "Trade liberalization, intermediate inputs and productivity: Evidence from Indonesia" CEPR Discussion Paper, 2005, (5104).

Arnold, J., Javorcik, B. S., Mattoo, A., "Does services liberalization benefit manufacturing firms?", CEPR Discussion Paper, 2006, (5902).

Bade, F. J., "Regionale Beschäftigungsentwicklung und produktionsorientierte Dienstleistungen", DIW-Sonderhefte, 1989, (143).

Belsley, D. A., Kuh, E., Welsch, R. E., Regression diagnostics: identifying influential data and sources of collinearity, New York: Wiley, 1980.

Carlin, W., Glyn, A., Van Reenen, J., "Export market share performance of OECD countries: an empirical examination of the role of cost competitiveness", UCL Discussion Paper, 1998, (98.02).

Carlin, W., Glyn, A., Van Reenen, J., "Export performance of OECD countries: An empirical examination of the role of cost competitiveness", The Economic Journal, 2001, (111), pp. 128-162.

Caves. D. W., Laurits, R. C., Diewert, W. E. (1982A), "The Economic Theory of Index Numbers and the Measurement of Input, Output and Productivity", Econometrica, 1982, (50), pp. 1393-1414.

Caves. D. W., Laurits, R. C., Diewert, W. E. (1982B), "Multilateral Comparisons of Output, Input, and Productivity Using Superlative Index Numbers", Economic Journal, 1982, (92), pp. 73-86.

Dachs, B., Leo, H., "Die Innovationsaktivitäten der österreichischen Wirtschaft. Band 2: Dienstleistungssektor", in Leo, H., Die Innovationsaktivitäten der österreichischen Wirtschaft, WIFO, 1999.

DiCagno, D., Meliciani. V., "Do inter-sectoral flows of services matter for productivity growth? An Input-Output analysis of OECD countries", Economics of Innovation and New Technology, 2005, 14(3), pp. 149-171.

Egger, P., Pfaffermayr, M., Wolfmayr, Y., "The international fragmentation of Austrian manufacturing: The effects of outsourcing on productivity and wages", The North American Journal of Economics and Finance, 2001, (12) pp. 257-272.

Fagerberg, J., "Is there a large-country advantage in high-tech?", Working Paper, Norwegian Institute of International Affairs, Oslo, 1995, (526).

Fagerberg, J., "Technology and Competitiveness", Oxford Review of Economic Policy, 1996, 12(3), pp. 39-51.

Falk, M., Leo, H., Die Innovationsaktivitäten der österreichischen Unternehmen. Empirische Analysen auf Basis der Europäischen Innovationserhebung 1996 und 2000, WIFO, Wien, 2004.

Feenstra, R, Hanson, G., "Productivity measurement and the impact of trade and technology on wages: estimates for the U.S., 1979-1990", NBER Working paper, 1997, (6052).

Feenstra, R., Hanson, G., "The impact of outsourcing and high-technology capital on wages: estimates for the United States, 1979-1990", Quarterly Journal of Economics, 1999, 114(3), pp. 907-940.

Francois, J. F., "Producer services, scale, and the division of labor", Oxford Economic Papers, 1990, (42), pp. 715-729.

Francois, J., Wörz, J., "Producer Services, Manufacturing Linkages, and Trade", FIW-Working Paper, 2007, (002).

Girma, S., Görg, H., Pisu, M., "Exporting, linkages and productivity spillovers from foreign direct investment", CEPR Discussion Paper, July, 2007, (6383).

Gornig, M., "Neue Technologien und regionale Beschäftigungstrukturen", Vierteljahreshefte zur Wirtschaftsforschung, 1990, (2/3).

Javornik, B. S., "Does foreign direct investment increase the productivity of domestic firms? In search of spillovers through backward linkages", American Economic Review, 2004, 94(3), pp. 605-627.

Jones, R. W., Kierzkowski, H., "The role of services in production and international trade: a theoretical framework", in Jones, R. W., Krueger, A. (Eds.), The Political Economy of International Trade, Basil Blackwell, Oxford, 1990.

Kaufmann, A, Tödtling, F., "Innovation patterns of SMEs", in Asheim, B., Isaksen, A., Nauwelaers, C., Tödtling, F. (Eds.), Regional Innovation Policy for Small-Medium Enterprises, Edward Elgar, Cheltenham, 2003, pp. 78-118.

Kratena, K., Intrapolating SUT with Bi-Proportional Methods, EU-Klems Background Papers, June 2005.

Landesmann, M., Pfaffermayr, M., "Technological competition and trade performance", Applied Economics, 1997, (29), pp. 179-196.

Laursen, K., Meliciani, V., "The importance of technology-based inter-sectoral linkages for market share dynamics", Weltwirtschaftliches Archiv, 2000, (136), pp. 702-723.

Mesch, M., "Der Wandel der beruflichen Struktur der österreichischen Beschäftigung 1991 bis 2001", in Mesch, M., (Hrsg.), Der Wandel der Beschäftigungsstruktur in Österreich, Branchen – Qualifikation – Berufe, Arbeiterkammer Wien, 2005, pp. 219-285.

Miles, I., Miozzo, M. (Eds.), Internationalization, Technology and Services, Elgar, Cheltenham, 2003.

Olsen, K. B., "Productivity Impacts of Offshoring and Outsourcing: A Review", STI Working Paper, OECD, 2006, (1).

Peneder, M., "Creating Industry Classifications by Statistical Cluster Analysis", Estudios de Economica Aplicada, 2005, 23(2), pp. 451-463.

Peneder, M., "Industry Classifications. Aim, Scope and Techniques", Journal of Industry, Competition and Trade, 2003, 3(1-2), pp. 109-129.

Reich, R., The Work of Nations: Preparing Ourselves for the 21st Century Capitalization, New York, 1991.

Siegel, D., Griliches, Z., "Purchases Services, Outsourcing, Computers, and Productivity in Manufacturing", in Griliches, Z. (ed.), Output Measurement in the Service Sector, University of Chicago Press, 1992.

Ten Raa, T., Wolff, E. N., "Outsourcing of services and the productivity recovery in US manufacturing in the 1980s and 1990s", Journal of Productivity Analysis, 2001, (16).

Tomlinson, M., "A new role for business services in economic growth", in Archibugi, D., Lundvall, B. (Eds.), The Globalizing Learning Economy, Oxford University Press, Oxford, 2002.

Windrum, P., Tomlinson, M., "Knowledge-intensive services and international competitiveness: a four country comparison", MERIT Research Memorandum, 1999, (23).

Wolff, E. N., "Technological change, capital accumulation and changing trade patterns over the long term", Structural Change and Economic Dynamics,1995, (6) ,pp. 43-70.

Wolfmayr, Y., Kratena, K., Mayerhofer, P., Stankovsky, J., WIFO-Weißbuch: Mehr Beschäftigung durch Wachstum auf Basis von Innovation und Qualifikation. Teilstudie 13: Exporte von Waren und Dienstleistungen stärken die Nachfrage, WIFO, Wien, 2006.

10. Appendix

Table A1: Mapping of occupations into major types of business activity

ISCO	*Occupation*	*Business activity*
010	Armed forces	Government officials, soldiers
111	Legislators and senior government officials	Government officials, soldiers
114	Senior officials of special-interest organisations	Government officials, soldiers
121	Directors and chief executives	Management
122	Production and operations managers	Prod. related serv.
123	Other specialist managers	Management
131	Managers of small enterprises	Prod. related serv.; management
211	Physicists, chemists and related professionals	R&D
212	Mathematicians, statisticians and related professionals	R&D
213	Computing professionals	R&D
214	Architects, engineers and related professionals	R&D
221	Life science professionals	R&D
222	Health professionals (except nursing)	R&D
223	Nursing and midwifery professionals	Personal services
231	College, university and higher education teaching professionals	Personal services
232	Secondary education teaching professionals	Personal services
233	Primary and pre-primary education teaching professionals	Personal services
234	Special education teaching professionals	Personal services
235	Other teaching professionals	Personal services
241	Business professionals	Management consulting
242	Legal professionals	Management consulting
243	Archivists, librarians and related information professionals	Management consulting
244	Social science and related professionals	Management consulting
245	Writers and creative or performing artists	Management consulting
246	Religious professionals	Management consulting
247	Public service administrative professionals	Management consulting
311	Physical and engineering science technicians	R&D
312	Computer associate professionals	R&D; management consulting
313	Optical and electronic equipment operators	Production
314	Ship and aircraft controllers and technicians	Transport, logistics
315	Safety and quality inspectors	Personal services; Prod. related serv.
321	Life science technicians and related associate professional	R&D
322	Health associate professionals (except nursing)	R&D; perconal services
323	Nursing and midwifery associate professionals	Personal services
331	Primary education teaching associate professionals	Personal services
332	Pre-primary education teaching associate professionals	Personal services
333	Special education teaching associate professionals	Personal services
334	Other teaching associate professionals	Personal services
341	Finance and sales associate professionals	Distribution
342	Business services agents and trade brokers	Customer services
343	Administrative associate professionals	Administration, clerks
344	Customs, tax and related government associate professionals	Government officials, soldiers
345	Police inspectors and detectives	Personal services
346	Social work associate professionals	Personal services
347	Artistic, entertainment and sports associate professionals	Personal services
348	Religious associate professionals	Personal services
411	Secretaries and keyboard-operating clerks	Administration, clerks
412	Numerical clerks	Administration, clerks
413	Material-recording and transport clerks	Transport, logistics
414	Library, mail and related clerks	Transport, logistics
419	Other office clerks	Administration, clerks
421	Cashiers, tellers and related clerks	Customer services
422	Client information clerks	Customer services
511	Travel attendants and related workers	Personal services
512	Housekeeping and restaurant services workers	Personal services
513	Personal care and related workers	Personal services

Table A1/continued

ISCO	*Occupation*	*Business activity*
514	Other personal services workers	Personal services
516	Protective services workers	Personal services
521	Fashion and other models	Customer services
522	Shop, stall and market salespersons and demonstrators	Customer services
611	Market gardeners and crop growers	Primary production
612	Animal producers and related workers	Primary production
613	Crop and animal producers	Primary production
614	Forestry and related workers	Primary production
615	Fishery workers, hunters and trappers	Primary production
711	Miners, shotfirers, stone cutters and carvers	Production
712	Building frame and related trades workers	Production
713	Building finishers and related trades workers	Production
714	Painters, building structure cleaners and related trades workers	Production
721	Metal moulders, welders, sheet-metal work., structural-metal preparers	Production
722	Blacksmiths, tool-makers and related trades workers	Production
723	Machinery mechanics and fitters	Production
724	Electrical and electronic equipment mechanics and fitters	Production
731	Precision workers in metal and related materials	Production
732	Potters, glass-makers and related trades workers	Production
733	Handicraft workers in wood, textile, leather and related materials	Production
734	Craft printing and related trades workers	Production
741	Food processing and related trades workers	Production
742	Wood treaters, cabinet-makers and related trades workers	Production
743	Textile, garment and related trades workers	Production
744	Pelt, leather and shoemaking trades workers	Production
811	Mining and mineral-processing-plant operators	Production
812	Metal-processing plant operators	Production
813	Glass, ceramics and related plant operators	Production
814	Wood-processing- and papermaking-plant operators	Production
815	Chemical-processing-plant operators	Production
816	Power-production and related plant operators	Production
817	Industrial robot operators	Production
821	Metal- and mineral-products machine operators	Production
822	Chemical-products machine operators	Production
823	Rubber- and plastic-products machine operators	Production
824	Wood-products machine operators	Production
825	Printing-, binding- and paper-products machine operators	Production
826	Textile-, fur- and leather-products machine operators	Production
827	Food and related products machine operators	Production
828	Assemblers1	Production
829	Other machine operators not elsewhere classified	Production
831	Locomotive engine drivers and related workers	Transport, logistics
832	Motor vehicle drivers	Transport, logistics
833	Agricultural and other mobile plant operators	Primary production
834	Ships' deck crews and related workers	Transport, logistics
911	Street vendors and related workers	Personal services
912	Shoe cleaning and other street services elementary occupations	Personal services
913	Domestic and related helpers, cleaners and launderers	Personal services
914	Building caretakers, window and related cleaners	Personal services
915	Messengers, porters, doorkeepers and related workers	Personal services
916	Garbage collectors and related labourers	Personal services
921	Agricultural, fishery and related labourers	Primary production
931	Mining and construction labourers	Production
932	Manufacturing labourers	Production
933	Transport labourers and freight handlers	Transport, logistics

Table A2: Skill-levels (ISCED) of major occupational groups by ISCO88(COM)

Skill-level (ISCED)	Skill-level description	Major groups by ISCO88(COM)	ISCO description
-	Not classifiable	1	Legislators, senior officials and managers
4	Workers with tertiary education	2	Professionals
3	Workers with upper secondary education	3	Technicians and associate professionals
2	Workers with a certific. from the dual vocat. syst.	4	Clerks
		5	Serv. work., shop and market sales work.
		6	Skilled agricultural and fishery workers
		7	Craft and related trades workers
		8	Plant and mach. operat. and assembl.
1	Workers with basic education	9	Elementary occupations

Table A3: List of variables

Description	*Symbol*	*Definition*
Export market share equations for OECD [1])		
Export market share	XMS	Exports in current USD and prices divided by the sum of exports for the 16 OECD countries in the sample
Unit labour costs	RULC	Labour costs (compens. of employees) converted to current USD divided by value added in constant prices and PPP-USD
Patents	RPAT	Share of each country in the total number of patents in the USs relative to the average share over all countries
Service linkage		
- total	RSERVLINK	Value of total service inputs in manufacturing as percent of gross production
- national linkage	RDOMSERV	Domestically sourced service inputs in manufacturing as percent of gross production
- international linkage	RIMPSERV	Imported service inputs in manufacturing as percent of gross production
R&D intensity	RDS	Business enterprise intramural expenditure on R&D at current prices and USD in the linked service sector divided by value added at current prices and USD
Service linkage x R&D intenstity		
- total	RSERVLINK_RDS	Interaction term between the service linkage variable (total inputs) and R&D intensity in the linked service sector
- national linkage	RDOMLINK_RDS	Interaction term between the service linkage variable (domestic inputs) and R&D intensity in the linked service sector
- international linkage	RIMPLINK_RDS	Interaction term between the service linkage variable (imported inputs) and R&D intensity in the linked service sector
Total factor productivity equations for Austria		
Total factor productivity	TFP	Tornqvist index: growth of inputs weighted by cost shares minus total output growth
Export openness		Export share of production
Import penetration		Imports as percent of domestic consumption
R&D-to-output ratio		Business enterprise intramural expenditure on R&D as percent of gross production
Outsourcing of services	OS	Purchases of services by the manufacturing sector as a share of total inputs purchased
Dummy variable for low-skilled intensive ind.	$D_{low\text{-}skilled}$	Value=1 if the industry is classified as low-skilled by the WIFO taxonomy of industries
Dummy variable for capital intensive ind.	$D_{capital}$	Value=1 if the industry is classified as capital intensive by the WIFO taxonomy of industries
In-house delivered services	INTS	Services employment as percent of total employment

[1]) All variables in the export market share equation are expressed relative to sample means.

Table A4: Data sources

Description	Source
Export market share analysis for OECD	
Exports in current prices and USD	UN COMTRADE database
Labour compensation in national currency	OECD STAN
Exchange rate, units of local currency per USD	OECD Economic Outlook
Purchasing power parity (PPP-USD exchange rate)	OECD Economic Outlook and National Accounts
Real value added in national currency	OECD STAN; quantity index converted to value added in levels
Nominal value added in national currency	OECD STAN
Gross production	OECD Input-Output tables
Service inputs (total, domestic, imported) into manufacturing	OECD Input-Output tables
Business enterprise intramural expenditures (BERD) on R&D (current prices and national currency)	OECD BERD
Patents	Newcronos - USPTO; US Patent and Trademark Office
Total factor productivity analysis for Austria	
Total factor productivity; gross output based	EUKLEMS database - March 2007 release; Index: 1995=100
Nominal gross output	EUKLEMS - March 2007 release; mn national currency
Total employment	Employment records of the Austrian Social Security Administration
Employment by business functions	WIFO calculations based on ISCO-classification by occupation in the Austrian Microcencus[1]).
Business enterprise intramural expenditures (BERD) on R&D in national currency	OECD BERD (for the year 1993) and Austrian "Forschungserhebung" (1998, 2002, 2004). Interpolation for in-between years.[2]).
Export openness	OECD STAN
Import penetration	OECD STAN
Outsourcing of services, real values	Statistics Austria, Input-Output and Supply-Use tables; EUKLEMS - Interpolation based on methodology described in Kratena (2005).[3)]

[1]) I would like to thank U. Huemer and H. Mahringer from WIFO who kindly advised me on the use of the data and provided me with adjusted data from the Microcencus. - [2]) I am indepted to A. Reinstaller from WIFO who kindly provided me with some data. -3) Many thanks to K. Kratena from WIFO for providing me with the data.