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Abstract

This paper presents stylized facts on energy-intensity developments for 19 OECD countries and 51 sectors over the period 1980−2005. A principal aim of this paper is to introduce and discuss a new database that combines the recently launched 'EU KLEMS Growth and Productivity Accounts' with physical-energy data from the International Energy Agency (IEA). We do so by means of an empirical analysis consisting of the following components at various levels of sectoral detail. First, we document per country the growth rates of energy use, value added and energy intensity (i.e. the ratio of energy use to value added). Second, we compare levels of energy intensity across countries and analyze the evolution of the observed cross-country differences over time. Third, by means of a decomposition analysis we calculate for each country to what extent aggregate energy-intensity trends can be explained from, respectively, shifts in the underlying sectoral structure and efficiency improvements within individual sectors. Finally, we identify issues and areas of research within the field of energy economics where these data may be applied fruitfully.

Keywords: Energy Intensity, Convergence, Decomposition, Sectoral Analysis
JEL codes: O13, O47, O5, Q43

Abstract in Dutch

Deze studie presenteert de ontwikkeling van energie-intensiteit in 19 OESO-landen en 51 sectoren gedurende de periode 1980−2005. Een belangrijk doel van de studie is het introduceren en bespreken van een nieuwe dataset die de recent verschenen 'EU KLEMS Growth and Productivity Accounts' combineert met fysieke energiegegevens van het Internationaal Energie Agentschap (IEA). Wij doen dit door middel van een empirische analyse op verschillende niveaus van aggregatie die bestaat uit de volgende componenten: in de eerste plaats berekenen we per land de groei van energieconsumptie, toegevoegde waarde en energie-intensiteit (de verhouding tussen energieconsumptie en toegevoegde waarde). In de tweede plaats vergelijken we niveaus van energie-intensiteit tussen landen en analyseren hoe de verschillen tussen landen zich ontwikkelen over de tijd. In de derde plaats berekenen we door middel van een decompositieanalyse voor elk land in hoeverre de ontwikkeling in de geaggregeerde energie-intensiteit kan worden verklaard uit enerzijds verschuivingen in de onderliggende sectorstructuur en anderzijds efficiëntieverbeteringen binnen specifieke sectoren. Ten slotte identificeren wij onderwerpen en onderzoeksterreinen binnen het veld van de energie-economie waar deze data vruchtbaar kunnen worden gebruikt.

Steekwoorden: Energie Intensiteit, Convergentie, Decompositie, Sectorale Analyse
JEL codes: O13, O47, O5, Q43

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1. Introduction

Accurate projections of future energy demand and greenhouse gas emissions require careful evaluation of historic trends in the relationship between energy use and economic activity. In this paper we present new evidence on the empirics of this relationship, for the period 1980–2005. We do so by analyzing and comparing the development of energy intensity (i.e. the ratio of energy input to economic output) across 51 sectors and 19 OECD countries. More specifically, our analysis comprises 25 Manufacturing sectors (10 main sectors, 15 subsectors), 23 Services sectors (9 main sectors, 14 subsectors), as well as the sectors Transport, Agriculture and Construction; it includes 16 EU member countries, the USA, Japan and South Korea. Distinctive features of our analysis are its combination of a cross-country perspective with a high level of sectoral detail, the inclusion of a wide range of Service sectors and the quality of our dataset. Regarding the latter, we make use of the recently launched 'EU KLEMS Growth and Productivity Accounts' database, which we link to physical energy data from the International Energy Agency (IEA). To the best of our knowledge, we are the first to explore the 'EU KLEMS Growth and Productivity Accounts' database in the field of energy studies. The principal aim of this paper is to show its value for cross-country empirical analyzes in the field of energy economics in general, and for studies on trends and determinants of energy intensity (productivity) in particular. The explicit link to physical energy data from the International Energy Agency (IEA) allows us to compare EU KLEMS based figures on energy use and energy intensity with the widely used IEA based figures.

The EU KLEMS database contains industry-level measures of output, inputs and productivity for a range of European countries, the USA, Japan and South Korea. This includes information on energy inputs, derived from a consistent framework of national accounts and supply-and-use tables and processed according to agreed procedures. Hence, in contrast to most existing empirical cross-country studies on the energy-economy nexus (see, for example, Markandya et al. 2006, Miketa 2001, Miketa and Mulder 2005, Mulder and De Groot 2007, Nilsson 1993, Schipper et al. 2001, Smulders and De Nooij 2003), the EU KLEMS database does not rely on study-specific *ad hoc* combinations of energy input and economic output measures from different sources to analyze trends in energy intensity or energy productivity – thus facilitating replication and comparability of studies. Another major advantage of the EU KLEMS database is that it moves beneath the aggregate economy level by providing a breakdown of industries to a common detailed level. Typically, cross-country studies of productivity and growth come at the price of limited sectoral detail. This is a serious drawback, given the existence of substantial heterogeneity in output and productivity growth across industries (see, for example, Bernard and Jones 1996; Dollar and Wolff 1993). Also in the area of energy studies, it has been shown that aggregate trends of energy intensity (productivity) mask considerable differences across industries (see, for example, Huntington 2010, Jorgenson 1984, Mulder and De Groot 2003). The high level of sector detail in the EU KLEMS database allows for examination of productivity performance of individual industries and their contribution to aggregate growth.

Our analysis includes the following components. First, we document per country the growth rates of energy use, value added and energy intensity (i.e. the ratio of energy use to value added) at the aggregate economy level as well as for the aggregate Manufacturing sector and the aggregate Service sector. In doing so, we compare EU KLEMS based figures with figures derived from combining the widely used OECD Structural Analysis (STAN) database (economy data) with IEA energy data (see, for example, Mulder and De Groot 2007 and Smulders and De Nooij 2003). Also, we analyze average annual growth rates of energy intensity changes for all 51 sectors included in

our dataset, distinguishing different time periods. Second, at various levels of sectoral detail, we compare levels of energy intensity across countries and analyze the evolution of the observed cross-countries differences over time. Third, by means of a decomposition-analysis we calculate for each country to what extent aggregate energy intensity trends are to be explained from, respectively, shifts in the underlying sectoral structure and efficiency improvements within individual sectors.

The first component of our analysis is closely related to numerous empirical studies documenting trends in energy use, energy intensity and emission intensity (see, for example, Berndt 1978, Mulder and De Groot 2003, Neelis et al. 2007, Nilsson 1993, Sue Wing 2008, Worell 2004 and Schipper et al. 2001). The second component of our analysis relates to recent work on cross-country convergence of energy- or emission intensities (see, for example, Aldy 2006, Markandya et al. 2006, Liddle 2009, Miketa and Mulder 2005, Mulder and De Groot 2007, Romero-Avila, 2008). Convergence can be understood both in terms of levels and growth rates, which translates into a distinction between so-called σ-convergence and β-convergence (e.g., Barro 1991, Barro and Sala-i-Martin 1992). The former refers to a decreasing variance of cross-country differences in productivity or intensity levels, while the latter refers to a tendency of countries with relatively high (low) initial intensity (productivity) levels to grow relatively fast, building upon the proposition that growth rates tend to decline as countries approach their steady state. In this study we limit ourselves to the descriptive analysis of σ-convergence and leave a β-convergence analysis for future work. A comprehensive analysis of the latter requires integrating empirics in a theoretical framework defining the dynamics of economic growth and cross-country interaction. This is beyond the scope of this study, which has as its principal aim introducing the integrated EU KLEMS – IEA database into the field of energy economics. The third and final component of our analysis fits in the research area known as index number decomposition analysis (see Ang and Zhang 2000 and Liu and Ang 2007 for recent surveys). Research in this area focuses on decomposing changes in aggregate trends into a so-called structure effect and an efficiency effect. The structure effect measures the change in the economy's energy intensity due to the changing composition of activities within the economy. The efficiency effect, in contrast, measures changes due to efficiency improvements within each sector.

It is both the coverage – in terms of countries, sectors and years – and the quality of our data that sets this study apart from the aforementioned contributions to the literature. Most energy decomposition studies focus on the Manufacturing sector with an emphasis on heavy industry, due its traditionally large share in aggregate energy consumption and the (consequently) readily available data. Only since recently, energy-extensive sectors such as light industries and Services start to become subject of rigorous decomposition analysis (Florax et al. 2010, Huntington 2010, Mairet and Decellas 2009, Ramírez et al. 2005). As noted before, we include both energy-intensive and energy-extensive sectors, including 23 Service sectors. The level of sectoral detail included in most published studies is primarily determined by data availability, which obviously is more of a limiting factor in cross-country studies than in country-specific studies. Hence, country-specific analyzes make up for most of the decomposition studies, with an emphasis on the USA, various EU-15 countries (most notably Germany, UK, The Netherlands and Denmark), Canada, Japan, South Korea and increasingly also China. Recent examples include Fisher-Vanden et al. (2004), Huntington (2010), Lescaroux (2008), Metcalf (2008) and Ma and Stern (2008). In the majority of these studies the number of sectors included varies from a few to about 30 sectors, with some exceptions comprising a very high level of sector detail (see Ang 1995a;b, Ang and Zhang 2000 and Liu and Ang 2007 for

reviews). Cross-country studies predominantly focus on high-income countries, often categorized in terms of their membership of IEA, EU or OECD, and typically cover 7 to 15 countries. Examples include Eichhammer and Mansbart (1997), Howarth et al. (1991), Liddle (2009), Mulder and De Groot (2003), Unander et al. (1999) and Park et al. (1993). These studies in general contain less than 10 sectors. An exception is Mulder and De Groot (2003) who distinguish 14 sectors in total, of which 10 are manufacturing sub-sectors. In this study we combine a cross-country perspective with a relatively high level of sectoral detail, identifying the role of 51 different sectors in driving aggregate energy intensity trends.

The paper proceeds as follows. In Section 2 we describe the database and discuss its unique features. In Section 3 we briefly describe and motivate the index number decomposition methodology that we apply. In Section 4 we present the results of all three components of our analysis (growth rates, cross-country level differences, decomposition) at the aggregate economy level. In Section 5 and 6 we repeat this analysis for the Manufacturing and Service sectors, respectively. Section 7 concludes and indicates directions for future research that may benefit from the integrated EU KLEMS – IEA database.

2. Data

The dataset we use and present in this study combines the recently launched EU KLEMS database (March 2008 release) with energy data from the International Energy Agency (IEA). Primary objective of the EU KLEMS database is to support empirical and theoretical research in the area of economic growth, studying patterns of productivity and its principal determinants such as skill formation, technological progress and innovation (O'Mahony and Timmer 2009). The database includes measures of output and input growth as well as derived variables such as multi-factor productivity, organized around the growth accounting methodology rooted in neoclassical production theory. However, the data collected are also useful in other contexts, as the EU KLEMS database provides many basic input data-series that are derived independently from the assumptions underlying the growth-accounting method. They include various categories of capital, labour, energy and material. The database has been constructed on the basis of data delivered by EU KLEMS consortium partners with cooperation of national statistical offices, and processed according to agreed procedures. The approach taken is a two-step procedure. First, the most recent and revised series by industry on gross output, value added and total intermediate input were taken from National Accounts. These series are extended and broken down into more industry-detail if needed. In a second step total intermediate inputs were broken down into energy, materials and services based on supply-and-use tables.[1]

We measure energy intensity by the ratio of intermediate energy input to gross value added – thus being the inverse of energy productivity. Value added data have been converted to constant 1997 US$, using a new and comprehensive dataset of industry-specific Purchasing Power Parities (PPPs) for 1997. These PPP series were constructed in the EU KLEMS project by double deflation of gross output and intermediate inputs within a consistent input-output framework. The price concepts for gross output (basic prices) and intermediate inputs (purchasing prices) have been harmonized across countries. As these series are often short (as revisions are not always taken back in time) different vintages of the National Accounts were bridged according to a common link-methodology (O'Mahony and Timmer 2009). Depending on country and sector, these value added series can differ from those available in the STAN database, even though STAN is also based on National Account series. Two issues explain the differences. First, STAN makes use of aggregate country-specific PPPs, whereas in EU KLEMS PPP's have been constructed at the industry-level – a major step forward. Second, in harmonizing long-term nominal and price series for output and intermediate inputs STAN and EU KLEMS employ different vintages of National Accounts as well as different sector classifications.

The EU KLEMS energy data that we employ are also derived from a harmonized system of National Accounts. They consist of expenditure based intermediate inputs that encompass all energy mining products, oil refining products and electricity and gas products. Using detailed supply-and-use tables, energy expenditures at the industry-level have been deflated by the relative price index of each fuel (energy carrier). As mentioned before, this implies that the intermediate energy input series and value added series are mutually consistent. Hence, to construct a value added based energy intensity indicator one does no longer need to rely on different sources, with its inherent complications. However, somewhat unfortunately the intermediate energy data series in EU KLEMS are provided in

[1] For a more detailed description and discussion of the EU KLEMs database we refer to (O'Mahony and Timmer 2009). In addition, methodological background papers are available at the EU KLEMS website (www.euklems.net). The EU KLEMS data series are also publicly available at this website.

terms of volume indices only. Consequently, unlike energy intensity growth rates the original EU KLEMS database does not allow exploring energy input *levels* across countries and across sectors. For this reason we enriched the EU KLEMS database by establishing a link with physical energy data from the IEA, according to the following simple two-step procedure. First, for the year 2005 we matched the EU KLEMS energy volume index number with IEA final energy consumption data in kilo tonnes of oil equivalent (ktoe). Second, we used the EU KLEMS energy input volume indices to (re)calculate energy consumption in ktoe back in time. Guided by the sectoral classification that the IEA uses in its Energy Balances, the first step could be done straightforwardly for 10 Manufacturing sectors as well as the aggregate Service, Transport, Agriculture and Construction sectors. For the remaining sub-sectors, we applied proportions of sub-sectoral intermediate energy input expenditures (at purchasing prices), as given in EU KLEMS, to IEA final energy consumption data at the aggregate sector level, again for the year 2005. This procedure rests on the assumption that in 2005 average energy prices *within* a specific industry are identical across sub-sectors. This would require the same fuel price levels as well as the same fuel mix across subsectors within an industry. This requirement is met in all Service sectors (that exclusively consume electricity) as well as in most Manufacturing sectors, except for the aggregate sector Non-Specified Industry (see Table 2.1). Hence, our figures for this industry require careful interpretation as – depending on the country – they might suffer from some degree of bias, predominantly due to differences in fuel mix across its subsectors. In general, it has to be borne in mind that our data do not allow to account for the role of fuel input mix in driving aggregate energy intensity developments since the EU KLEMS database only provides volume indices of aggregate intermediate energy inputs, defined as an expenditure based aggregate of all energy carriers.

It is to be noted that, except for 2005, physical energy consumption series in our dataset – which are ultimately based on EU KLEMS energy input volume indices – can deviate from final energy consumption series reported by the IEA. Differences between the two sources arise from two methodological issues. First, for the most part IEA energy consumption data are based on 'mini questionnaires' received from national administrations of OECD countries as well as on monthly oil questionnaires, whereas within the EU KLEMS framework energy is defined as an intermediate input that is derived from national accounts and supply-and-use tables. Second, the EU KLEMS intermediate energy input series include energy used for transformation and own use, whereas this is excluded from IEA final energy consumption data. For most sectors, only a (very) small part of intermediate energy input reflects energy used for transformation and own use. However, the picture might be different in those sectors that make use of large-scale cogeneration of heat and power (CHP) and/or are characterized by a relatively large amount of non-energy use, i.e. fuels that are used as raw materials (feedstock). Regarding CHP, the IEA and EU KLEMS definitions are identical insofar end-use sectors consume fuel to produce heat and power for own use. But when an end-use sector consumes fuel to produce heat and power for sale to other sectors and/or the general grid the two databases differ: in the IEA statistical system this fuel is included in the transformation sector whereas EU KLEMS includes these fuels in the concerning end-use sector. The issue of non-energy (feedstock) use plays an important role in the Chemical sector, with the Petrochemical industry consuming large quantities of fuel as feedstock. Again, this consumption is included in EU KLEMS intermediate energy inputs but excluded from IEA final energy consumption data.

Table 2.1 Sector classification

Sector	NACE rev1 code
MANUFACTURING	**15t22, 24t37**
FOOD, BEVERAGES AND TOBACCO	15t16
Food and beverages	15
Tobacco	16
TEXTILES, LEATHER AND FOOTWEAR	17t19
Textiles	17t18
Leather and footwear	19
WOOD AND CORK	20
PULP, PAPER, PRINTING AND PUBLISHING	21t22
Pulp and paper	21
Printing, publishing and reproduction	22
CHEMICALS	24
NON-METALLIC MINERALS	26
BASIC METALS	27
MACHINERY	28t32
Fabricated metal	28
Machinery not elsewhere classified (nec)	29
Office, accounting and computing machinery	30
Electrical engineering	31t32
TRANSPORT EQUIPMENT	34t35
Motor vehicles, trailers and semi-trailers	34
Other transport equipment	35
NON-SPECIFIED INDUSTRY	25,33,36t37
Rubber and plastics	25
Medical, precision and optical instruments	33
Manufacturing not elsewhere classified (nec); recycling	36t37
SERVICES	**GtH, J, LtO, 64,**
WHOLESALE AND RETAIL TRADE	G
Sale, maintenance and repair of motor vehicles and motorcycles; retail sale of fuel	50
Wholesale trade and commission trade, except of motor vehicles and motorcycles	51
Retail trade, except of motor vehicles and motorcycles; repair of household goods	52
HOTELS AND RESTAURANTS	H
POST AND TELECOMMUNICATIONS	64
FINANCIAL INTERMEDIATION	J
Financial intermediation, except insurance and pension funding	65
Insurance and pension funding, except compulsory social security	66
Activities related to financial intermediation	67
RENTING, COMPUTER, R&D and OTHER BUSINESS	71t74
Renting of machinery and equipment	71
Computer and related activities	72
Research and development	73
Other business activities	74
PUBLIC ADMIN AND DEFENCE; COMPULSORY SOCIAL SECURITY	L
EDUCATION	M
HEALTH AND SOCIAL WORK	N
OTHER COMMUNITY, SOCIAL AND PERSONAL SERVICES	O
Sewage and refuse disposal, sanitation and similar activities	90
Activities of membership organizations nec	91
Recreational, cultural and sporting activities	92
Other service activities	93
TRANSPORT	**60t62**
AGRICULTURE, HUNTING, FORESTRY AND FISHING	**AtB**
CONSTRUCTION	**F**

As mentioned before, a key feature of the EU KLEMS database is its high level of sector-detail. At the lowest level of aggregation, the EU KLEMS database includes 71 sectors, classified according to the European NACE revision 1 classification. However, due to data limitations the level of detail varies across countries, industries and variables. Obviously, in our case the energy input measure is a key variable and as a result of limitations in its availability our dataset distinguishes 51 sectors in order to ensure international comparability of the data. Table 2.1 provides a list of the sectors, including higher aggregates. This industry division is considerably more detailed than the 2-digit level that has been used so far in most cross-country energy intensity analyses. Consequently, our dataset makes it possible to move further beneath the aggregate economy level when analyzing energy intensity developments across countries. Compared to other studies this is a substantial improvement that is particularly relevant for properly separating technology and composition effects in aggregate intensity developments. Nevertheless, when using this data in the field of energy economics four caveats are to be borne in mind. First, the Chemicals sector combines the energy-intensive sub-sector Basic Industrial Chemicals and the energy-extensive sub-sector Pharmaceuticals. Although EU KLEMS provides here a breakdown at the lowest level of aggregation, limited data availability allowed us to only include the 2-digit industry level in order to secure comparison across countries. Second, the Basic Metals sector is an aggregate of the subsector Non-Ferrous Metals and the sub-sector Iron and Steel. Here, EU KLEMS does not provide a further breakdown – making it the only sector with less industry detail than previously available (for example, by combining STAN and IEA data or in the dataset developed by Mulder and De Groot 2003, 2007). Third, energy consumption in the IEA Transport sector covers all transport activity (in mobile engines) – including aviation, road, rail and domestic navigation – regardless of the economic sector to which it is contributing. It also includes household demand for transport fuels while for many countries the domestic/international split in aviation fuel data incorrectly excludes fuel used by domestically owned carriers for their international departures. Value added data in our Transport sector refer to carrier (commercial) transportation and do not include personal transportation, since the latter is not part of National Accounts. Hence, energy intensity indicators for the Transport sector should be interpreted with caution. Fourth, the focus of EU KLEMS on productive sectors precludes the analysis of households and the personal transport sector, since they predominantly involve non-market activities that are excluded from National Accounts. In short, our dataset deals with non-residential energy use. This is important to keep in mind, particularly because in some countries (especially the USA) personal transportation is a substantial factor in explaining aggregate energy consumption.

In terms of country coverage, our dataset includes the following countries: 12 EU-15 countries (Austria, Belgium, Denmark, Finland, France, Germany, Italy, the Netherlands, Portugal, Spain, Sweden and the United Kingdom), 4 new EU member states (Czech Republic, Hungary, Poland, Slovakia), the USA, Japan and South Korea.[2] In general, for the EU-15 countries, the USA and Japan data are available for the period 1970−2005, whereas for the new EU member states series are available from 1995 onwards. Exceptions include France and Germany for which data are available from 1978 onwards; Austria, Belgium and Japan for which data are available from 1980 onwards; and the Netherlands and Sweden for which data are available as from 1987 and 1993, respectively. Table 2.2 provides an overview of country- and time coverage.

[2] The original EU KLEMS database also includes Australia, Cyprus, Estonia, Greece, Ireland, Latvia, Lithuania, Luxembourg, Malta and Slovenia. Limited data availability made us decide to not include these countries in the final dataset.

Table 2.2 List of countries in the database

	Data availability			Grouping used in this study						
	Country	Code	Years	OECD19	OECD11	EU16	EU15	EU12	EU11	EU4
1	Austria	AUT	1980−2005	✓	✓	✓	✓	✓	✓	
2	Belgium	BEL	1980−2005	✓	✓	✓	✓	✓	✓	
3	Czech Republic	CZE	1995−2005	✓		✓	✓			✓
4	Denmark	DNK	1970−2005	✓	✓	✓	✓	✓	✓	
5	Finland	FIN	1970−2005	✓	✓	✓	✓	✓	✓	
6	France	FRA	1978−2005	✓	✓	✓	✓	✓	✓	
7	Germany	GER	1978−2005	✓		✓	✓	✓	✓	
8	Hungary	HUN	1995−2005	✓		✓	✓			✓
9	Italy	ITA	1970−2005	✓		✓		✓		
10	Japan	JPN	1980−2005	✓	✓					
11	South Korea	KOR	1970−2005	✓	✓					
12	The Netherlands	NLD	1987−2005	✓		✓	✓	✓	✓	
13	Poland	POL	1995−2005	✓		✓	✓			✓
14	Portugal	PRT	1980−2005	✓		✓	✓	✓	✓	
15	Spain	SPA	1980−2005	✓	✓	✓	✓	✓	✓	
16	Slovakia	SVK	1995−2005	✓		✓	✓			✓
17	Sweden	SWE	1993−2005	✓	✓	✓	✓	✓	✓	
18	United Kingdom	UKD	1970−2005	✓	✓	✓	✓	✓	✓	
19	United States	USA	1970−2005	✓	✓					

To ensure comparability of data across countries, our analysis covers the period 1980−2005. Often we distinguish the period 1980−1995 (14 countries) from the period 1995−2005 (19 countries). Moreover, we group countries in various clusters, according to the classification provided on the right-hand side of Table 2.2. For a more detailed description of the data we refer to O'Mahony and Timmer (2009).

3. Decomposition approach

Changes in energy intensity at the aggregate economy level result not only from technology-driven efficiency improvements in individual sectors, but also from changes in the sector composition of the economy. The latter is caused by the fact that sectors differ inherently in terms of their requirement of energy inputs relative to other inputs like capital and (skilled) labor. By using index number decomposition (or shift-share) analysis, we are able to decompose changes in aggregate energy intensity into a so-called structure effect and an efficiency effect. The structure effect measures the change in the economy's energy intensity due to the changing composition of activities within the economy. The efficiency effect, in contrast, measures changes due to efficiency improvements within each sector. In the field of energy studies this methodology has been widely used to decompose aggregate changes in energy use, energy intensity, or emission intensity (see Ang and Zhang 2000 and Liu and Ang 2007 for reviews).

To describe the essence of index number decomposition methodology algebraically, let *i* denote the sectors of the economy and let *Y* and *E* represent output (value added) and energy consumption. Aggregate energy intensity *I*, defined as the ratio of energy to output, can then be calculated as:

$$I = \frac{E}{Y} = \sum_i \frac{E_i}{Y_i}\frac{Y_i}{Y} = \sum_i I_i S_i \tag{1}$$

In this equation, I_i represents the within-sector intensity; S_i is the share of the sector in total value added. The efficiency effect is derived by controlling aggregate energy intensity for adjustments in the economy's structure. In other words, the efficiency effect equals the isolated within-sector intensity effect, which is (supposedly) largely driven by technological improvements. Since both the structure effect and the efficiency effect change over time, it is necessary to establish appropriate weights in order to measure the contribution of each effect. Decomposition analysis in the field of energy studies have used a variety of weights, which translates into a range of applied decomposition approaches (see Ang et al. 2003, Ang 2004, Ang et al. 2004, Boyd and Roop 2004, and Zhang and Ang 2001, for reviews and details). In this study we use the so-called log mean Divisia index method (LMDI I) as introduced by Ang and Liu (2001), which in its additive form decomposes a change in aggregate energy intensity (ΔI_{tot}) between period 0 and *T* into an efficiency effect (ΔI_{eff}) and a structure effect (ΔI_{str}) according to:

$$\Delta I_{eff} = \sum_i w_i \ln\left(\frac{I_i^T}{I_i^0}\right) \tag{2}$$

$$\Delta I_{str} = \sum_i w_i \ln\left(\frac{S_i^T}{S_i^0}\right) \tag{3}$$

where w_i is the weighting function defined as $w_i = L(V_i^T, V_i^0)$, with $V_i = \sum_i I_i S_i$ and *L* the logarithmic average of two positive numbers *a* and *b* given by $L(a,b) = (a-b)/\ln(a/b)$. [3]

The choice for this approach is primairly motivated by its ability to satisfy the factor-reversal test, i.e. it provides perfect decomposition results without a residual. Moreover, this approach can handle zero values effectively, the results are invariant to scaling and it satisfies the time-reversal test, i.e. estimated values between

[3] A simple relationship exists between the additive and multiplicative form, which thus can be easily related to each other.

period 0 and *T* and period *T* and 0 are equal (in absolute terms). In the two-factor case, this approach is equivalent to the Fisher ideal index method that is defined as the square root of the product (i.e. geometric average) of the Laspeyres and Paasche indices (Ang 2004, Boyd and Roop 2004).[4] For the aforementioned reasons the LMDI and Fisher ideal index methods have emerged as the preferred methods in energy decomposition analysis (Ang 2004).

By definition, decomposition of energy intensity requires combining energy data with indicators that measure output or activity. The latter can be expressed either in terms of engineering or physical indicators – like metric tonnes, kilometers or square meters of floor space – or in terms of economic indicators – such as value added or gross output. Examples of decomposition analysis using physical indicators can be found in Farla and Blok (2000), Neelis et al. (2007), Ramírez et al. (2006a,b), Worell et al. (1997) – all focusing on energy intensity developments in the Netherlands. The main advantage of using a physical indicator is that it often establishes a straightforward relationship between output and energy inputs, irrespective of changes in the mix and characteristics of products and feedstock and changes in market-based product prices. However, its application is hindered by difficulties of aggregation across sectors and limited data availability, which of course is particularly true in sectors with a large variety of products and a large degree of processing, as well as in a cross-country setting. In contrast, an economic indicator such as value added facilitates comparison of energy intensity across countries and across sectors, as well as interpretation within an economic framework that includes other inputs like capital and labor. For these reasons we have chosen in this study to express activity levels in economic terms, using value added as our measure.

Finally, apart from method and type of indicators, a more important factor that influences decomposition results is the level of sectoral detail that is used. The more sectoral detail is included in the decomposition exercise, the more the calculated efficiency effect represents a technology-driven efficiency improvement. With less degree of sector detail, the calculated efficiency effect becomes less precise because it increasingly includes changes in the activity- or product mix *within* the sector, thus including what essentially are disaggregated sector effects. As noted before, our dataset enables the inclusion of a level of sector detail that is relatively high in comparison to existing energy decomposition analyses, especially those that exhibit a cross-country perspective (Liu and Ang 2007). Consequently, the efficiency effects that we report in this study are a relatively accurate approximation of technology-driven efficiency improvements. Yet it is appropriate to mention one caveat here. Since the EU KLEMS database provides volume indices of aggregate intermediate energy inputs only (including all energy mining products, oil refining products and electricity and gas products), we are not able to correct our efficiency effect for changes in the fuel input mix. The latter might have an impact because energy carriers (natural gas, electricity, coal, etc.) differ in terms of available energy, i.e they differ in terms of quality or efficiency in delivering energy services (Berndt 1978, Cleveland et al. 2000).

[4] The generalized Fisher approach has its roots in studies by Siegel (1945) and Shapley (1953); see De Boer (2008).

4. Aggregate economy level

This section analyzes the development of energy intensity at the aggregate economy level (Macro), defined as the sum of the sectors Manufacturing, Services, Transport, Agriculture and Construction. We also examine energy intensity developments in each of these five sectors, including their role in driving aggregate trends. In Section 4.1 we explore trends in energy intensity by documenting growth rates and levels, including an analysis of the evolution of cross-country differences across time. In Section 4.2 we assess to what extent the observed energy intensity developments at the aggregate economy level are driven by, respectively, changes in the structure of the economy and changes in energy efficiency within each of the aforementioned five sectors.

4.1 Trends

We start our analysis with presenting in Table 4.1 per country and for two different time periods (1980–2005 and 1995–2005) the average annual growth rate of energy intensity and its components: energy use and value added. To facilitate comparison and interpretation of our data, we also provide the average annual growth rates of, respectively, energy use according to IEA data, value added according to STAN data, and energy intensity according to the combination of these two data sources. Table 4.1 leads to a couple of important observations. First, according to our data, changes in aggregate energy intensity differ substantially across countries; varying from a 1.3% average annual increase in Austria to a 2.4% decrease in France, Germany and the USA, between 1980 and 2005. Also, the Table illustrates the difference between an emerging economy like South Korea, with a large increase in both energy use and value added, and a highly developed economy like Japan with its relatively small increase in energy use and value added, especially since 1995. Second, in most countries growth in value added outpaces growth in energy use, resulting in decreasing energy intensity levels. Exceptions are Austria with a drastic increase in energy intensity, as well as Belgium and the United Kingdom, where energy intensity levels have marginally increased between 1980 and 2005, and South Korea, Poland and Spain where aggregate energy intensity has increased since 1995. Third, according to our data, aggregate non-residential energy use increased over the past several decades in most countries, but particularly since 1995 aggregate energy input has decreased in various countries – most notably Denmark, France, Germany and Italy. In Germany and France this is mainly caused by decreasing energy use in Manufacturing. In Italy it results from decreasing energy use in Services. And in Denmark it is a combination of both. Underlying reasons might be the adoption of energy efficient technologies or specialization in relatively energy-extensive sectors or production processes, or both. We return to this issue in Section 4.2, as well as in Sections 5 and 6 where we analyze the Manufacturing and Service sector in greater detail. Fourth, after 1995 aggregate energy intensity levels decreased relatively fast. Underlying data indeed reveal a remarkable slowdown in energy intensity decrease between 1980 and 1995. This trend has not gone unnoticed in the literature and is linked to the relatively low and decreasing energy prices since the mid 1980s, after a period of high prices induced by the energy crises of the 1970s and subsequent energy efficiency improvements (IEA 2004).

Table 4.1 Change in energy use, value added and energy intensity at the aggregate economy level.

Average annual growth rates	Energy Intensity						Energy Use						Value Added					
	1980−2005		1980−1995		1995−2005		1980−2005		1980−1995		1995−2005		1980−2005		1980−1995		1995−2005	
	EUK	IEA/ STAN	EUK	IEA/ STAN	EUK	IEA/ STAN	EUK	IEA	EUK	IEA	EUK	IEA	EUK	STAN	EUK	STAN	EUK	STAN
Austria	1.3	-0.6	0.4	-1.2	2.6	0.4	3.4	1.6	2.6	1.0	4.6	2.6	2.1	2.2	2.2	2.2	2.0	2.1
Belgium	0.3	--	1.8	--	-1.9	-1.0	2.1	1.2	3.4	1.4	0.2	1.1	1.8	--	1.6	--	2.1	2.1
Czech Republic	--	--	--	--	-1.4	-1.8	--	-0.9	--	-1.8	0.8	0.6	--	--	--	--	2.2	2.5
Denmark	-2.0	-1.6	-1.3	-1.7	-3.2	-1.5	-0.3	0.1	0.3	-0.1	-1.2	0.4	1.8	1.8	1.6	1.7	2.1	1.9
Finland	-0.5	-1.0	1.7	-0.4	-3.7	-1.9	2.0	1.1	3.2	1.0	0.3	1.3	2.5	2.1	1.5	1.4	4.0	3.3
France	-2.4	--	-1.7	--	-3.4	--	-0.9	0.8	-0.6	0.6	-1.4	1.1	1.5	--	1.2	--	2.0	--
Germany	-2.4	--	-2.4	--	-2.2	-0.5	-0.7	0.0	-0.5	-0.3	-1.0	0.4	1.6	--	2.0	--	1.1	1.0
Hungary	--	--	--	--	-4.6	-2.1	--	-0.3	--	-1.6	-0.1	1.6	--	--	--	--	4.6	3.8
Italy	--	--	--	--	-3.9	0.4	--	1.4	--	1.1	-2.5	1.7	1.7	--	1.8	--	1.4	1.3
Japan	-0.8	-0.3	-0.6	-0.2	-1.0	-0.5	1.8	1.8	2.8	2.7	0.5	0.5	2.6	2.1	3.4	2.9	1.5	1.0
South Korea	-0.8	-0.2	-2.7	0.1	2.2	-0.8	6.0	6.2	5.4	8.5	6.9	3.0	6.8	6.5	8.4	8.3	4.5	3.8
The Netherlands*	-0.9	-1.3	1.5	-1.7	-2.8	-1.1	1.7	1.2	3.9	0.8	-0.1	1.5	2.6	2.6	2.4	2.5	2.7	2.6
Poland	--	--	--	--	1.0	--	--	-1.0	--	-1.2	5.7	-0.6	--	--	--	--	4.6	--
Portugal	--	--	--	--	0.1	0.8	--	3.9	--	4.4	2.8	3.0	2.5	--	2.7	--	2.2	2.2
Spain	-1.1	0.2	-2.4	0.1	1.0	0.4	1.8	3.1	0.0	2.5	4.5	4.0	2.9	2.9	2.5	2.4	3.5	3.6
Slovakia	--	--	--	--	-4.1	-2.8	--	-0.4	--	-1.2	-0.2	0.8	--	--	--	--	4.0	3.8
Sweden	--	--	--	--	-4.0	-3.0	--	0.0	--	0.3	0.8	-0.3	--	--	--	--	4.9	2.8
United Kingdom	0.1	--	0.9	--	-1.0	-2.2	2.7	0.7	3.0	0.8	2.1	0.7	2.6	--	2.2	--	3.2	3.0
USA	-2.4	-1.8	-2.3	-2.1	-2.6	-1.4	0.5	0.8	0.3	0.4	0.8	1.4	3.0	2.6	2.6	2.5	3.5	2.8
EU12	--	--	--	--	-2.2	-0.8	--	--	--	--	0.0	1.2	--	--	--	--	2.2	2.0
EU4	--	--	--	--	-1.4	-2.9	--	-0.8	--	-1.4	2.6	0.1	--	--	--	--	4.1	3.2

Notes: *Initial year 1987 instead of 1980.

As regards the different data sources, Table 4.1 reveals that for most countries the use of EU KLEMS compared to IEA leads to considerably different trends in energy use, without a clear cross-country pattern (France being a notable exception). These differences are likely due to the fact that non-energy use of fuels is included in EU KLEMS intermediate energy inputs, but excluded from IEA final energy consumption data. In contrast, for most countries value added series derived from the EU KLEMS compared to the STAN database are highly comparable (exceptions being Finland, Hungary, Japan, Korea and Sweden). Furthermore, the IEA database provides a more extensive coverage than EU KLEMS in terms of energy use data, while the opposite is true regarding value added data where coverage by EU KLEMS is more extensive than by STAN. In terms of internationally comparable energy intensity series, EU KLEMS provides a more extensive coverage than the IEA-STAN combination.

Next, we move beneath the aggregate economy level by presenting in Table 4.2 annualized growth rates of energy intensity in the sectors Manufacturing, Services, Transport, Agriculture and Construction for selected (groups of) countries. The Table shows that also at the individual sector level changes in aggregate energy intensity differ substantially across countries. For example, with 6.3% our data reveal a particularly sharp average annual decline in US Manufacturing energy intensity between 1995 and 2005, which contrasts with a 2.5% and 1.4% average annual decline in the Manufacturing sector of Japan and the EU12 region, respectively. Furthermore, Table 4.2 shows that the decrease of energy intensity accelerated again considerably after 1995, except for the Services sector. Moreover, Japan is an exception in that energy intensity increased considerably in all sectors, except Manufacturing (and Agriculture after 1995). Finally, except for Transport, since 1995 energy intensity levels decrease relatively fast in the Eastern European EU4 region, suggesting evidence of catch-up. Recall that care is required in interpreting energy intensity changes in the Transport sector (see Section 2). We refer to Table A1 in the Annex for listing of energy intensity growth rates in individual sectors per country, differentiated for the periods 1980−2005, 1980−1995 and 1995−2005.

Table 4.2 Average annual growth rates energy intensity by sector.

	USA		**JPN**		**EU12**	**EU4**
	1980–2005	1995−2005	1980−2005	1995−2005	1995−2005	1995−2005
MACRO	-2.4	-2.6	-0.8	-1.0	-2.2	-1.4
Manufacturing	-3.7	-6.4	-2.5	-2.5	-1.4	-5.2
Services	-1.8	-1.3	1.8	0.8	-0.8[†]	-2.4
Transport	-1.5	-0.7	0.6	0.7	-2.3	3.4
Agriculture	-5.3	-2.3	0.9	-0.4	-2.3	-4.4
Construction	0.6	0.8	1.9	3.3	-1.4	-1.9

* *Excluding Poland;* [†] Excluding Italy

We continue our descriptive analysis by taking a closer look at the development of energy intensity *levels* over time. In Figure 4.1 we show for each main sector the development of energy intensity levels in Japan (since 1980) and two EU regions (since 1995), relative to the USA (index: USA 1980=100).

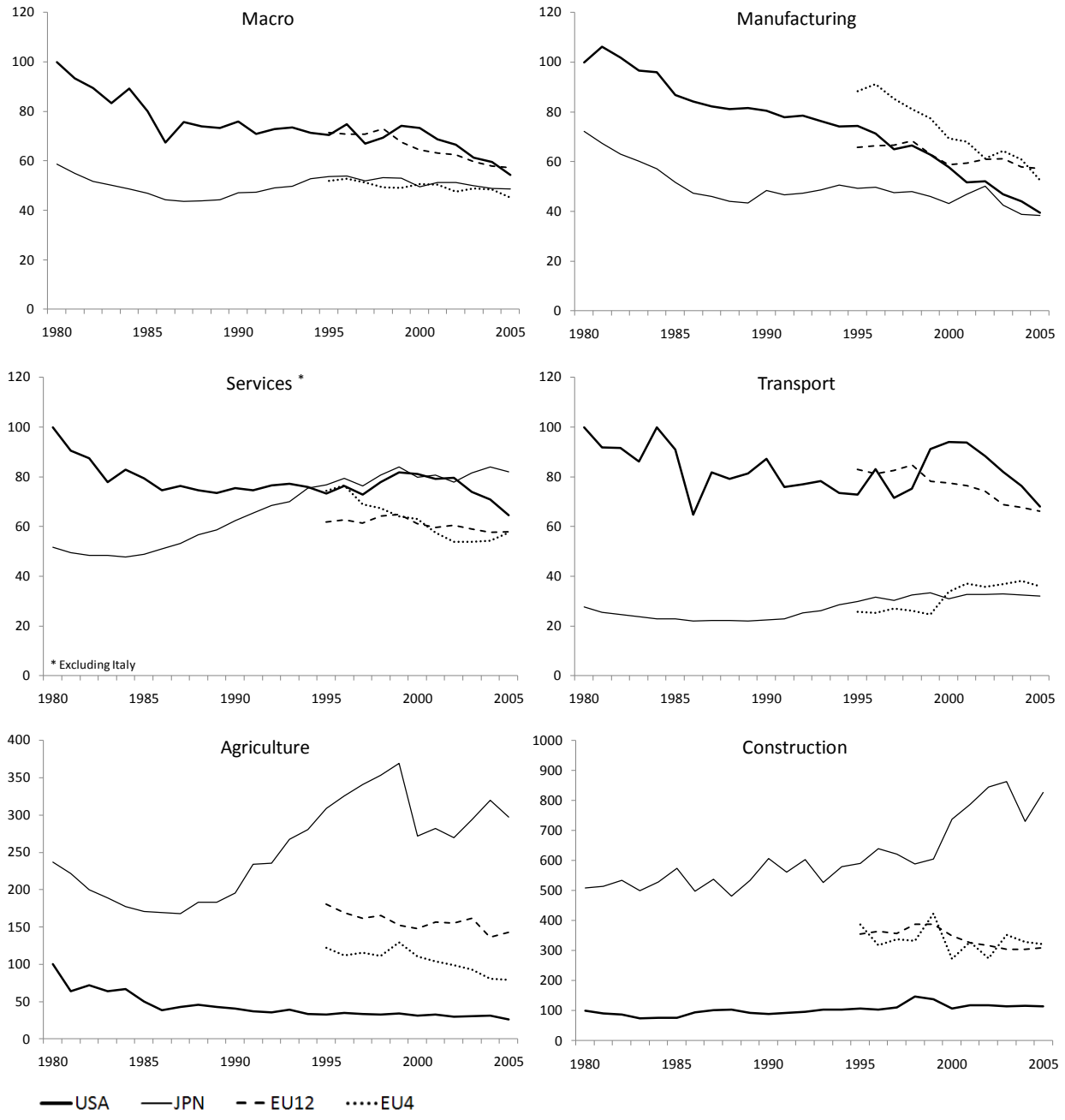

Figure 4.1 Energy Intensity Levels relative to USA (Index; USA 1980=100)

The Figure shows for the aggregate economy level (Macro) an overall decrease in energy intensity levels, reflecting the growth rates presented before. In Japan, the aggregate energy intensity level increased since the late 1980s, and started to fall slightly only after 1995. From the Figure it can be seen that this pattern results from substantial increasing energy intensity levels in the Japanese Service, Transport and Agricultural sectors. Also, it can be seen that at the aggregate economy level, our data reproduce the well-known stylized fact that in Japan and the EU countries (on average) energy intensity levels are lower than in the USA, except for Agriculture and Construction.

Regarding the Manufacturing sector, Figure 4.1 clearly illustrate catching-up of Eastern European countries (EU4) through a sharp decline in energy intensity levels, confirming evidence reported by Markandya et al. (2006). Moreover, the data reveal a remarkable catch-up of U.S. Manufacturing, with energy intensity levels falling below the average EU12 level by the end of the period under consideration. In Section 5 this result will be investigated more in depth, including more country-specific details.

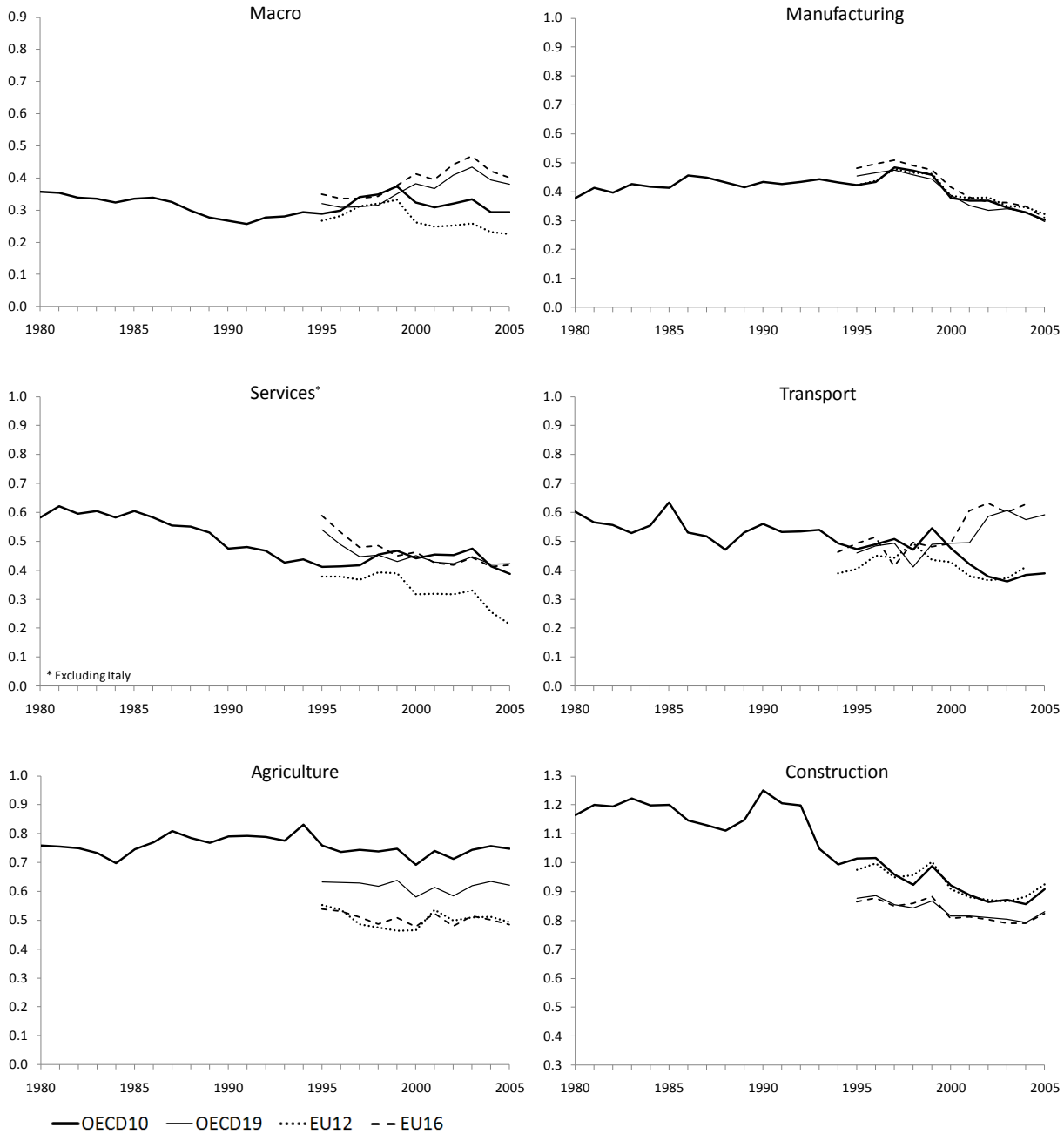

Figure 4.2 σ-convergence analysis, measured as standard deviation of log(energy intensity)

We conclude our exploration of energy intensity trends at the aggregate economy level by examining cross-country differences in energy intensity over time. As argued in Section 1, we examine this issue by means of a so-called σ-convergence analysis, calculating for each sector the unweighted cross-country standard deviation of the log of energy intensity over time. Decreasing variance in energy intensity levels among countries is then taken as evidence for convergence. We conducted our analysis for different samples of countries (see Table 2.2), and the results of this exercise are summarized in Figure 4.2. In general, Figure 4.2 shows that especially in the sector Manufacturing (after 1995), Services and Construction, cross-country variation in energy intensity levels has decreased over time, indicating σ-convergence. Evidence of σ-convergence is much weaker in Transport, while absent in Agriculture and at the aggregate economy level. These findings confirm the results obtained by Mulder and De Groot (2003) for the period 1980−1990. More specifically, we find the following trends. In Manufacturing, cross-country differences in energy intensity levels increased slightly between 1980 and 1995 but decreased considerably afterwards. In the Service sector, cross-country variance decreases substantially, but after 2000 only for the EU-12 sample; within other samples of countries, cross-country variance stagnates after 2000. In Transport, cross-country variance decreases slightly, while after 2000 it increases considerably for samples including Eastern European countries. In Agriculture and Construction, cross-country differences in energy intensity levels are relatively high; since 1980 they have been more or less constant in Agriculture whereas in Construction they have decreased sharply. As a result of these sectoral developments, at the aggregate economy level cross-country variance in energy intensity levels eventually has decreased only marginally – in spite of some fluctuations in the period in between. Once we include Eastern European countries, cross-country variation at the aggregate economy level in 2005 is larger than in 1980 or 1995.

4.2 Decomposition

As argued in Section 3, changes in energy intensity at the aggregate economy level result not only from technology-driven efficiency improvements in individual sectors, but also from changes in the sector composition of the economy. By using index number decomposition (or shift-share) analysis, we are able to decompose changes in aggregate energy productivity into a so-called structure effect and an efficiency effect. The structure effect measures the change in the economy's energy intensity due to the changing composition of activities within the economy. The efficiency effect, in contrast, measures changes due to efficiency improvements within each sector at a constant sector structure. In Table 4.3 we present the results of our decomposition analysis, for each country and two time periods (1980−2005 and 1995−2005). We differentiate between the average annualized energy intensity growth rates before decomposition (gross) and after decomposition (net), i.e. after correcting for the impact of structural changes.

Table 4.3 Decomposition of average annual growth rate of energy intensity at the aggregate economy level.

	Average annual growth rate				% Contribution of Efficiency and Structure Effect			
	1980–2005		1995–2005		1980–2005		1995–2005	
	Gross	Net	Gross	Net	Efficiency Effect	Structure Effect	Efficiency Effect	Structure Effect
Austria	1.3	1.7	2.5	3.2	133	-33	128	-28
Belgium	0.3	0.3	-1.9	-1.8	93	7	-95	-5
Czech Republic	--	--	-1.4	-2.6	--	--	-185	85
Denmark	-2.1	-1.8	-3.2	-3.7	-86	-14	-114	14
Finland	-0.5	-1.5	-3.7	-5.0	-330	230	-135	35
France	-2.4	-3.6	-3.4	-5.3	-148	48	-154	54
Germany	-2.4	-2.1	-2.2	-2.0	-90	-10	-89	-11
Hungary	--	--	-4.6	-4.2	--	--	-93	-7
Italy	--	--	-3.9	-3.7	--	--	-94	-6
Japan	-0.8	-0.4	-1.0	-0.4	-59	-41	-44	-56
South Korea	-0.8	-1.1	2.2	1.1	-139	39	52	48
Netherlands	-0.9	-1.0	-2.8	-2.5	-116	16	-89	-11
Poland	--	--	1.0	0.1	--	--	11	89
Portugal	--	--	0.6	1.8	--	--	278	-178
Spain	-1.1	-0.9	1.0	1.6	-82	-18	164	-64
Slovakia	--	--	-4.1	-3.8	--	--	-93	-7
Sweden	--	--	-4.0	-4.5	--	--	-112	12
United Kingdom	0.1	0.7	-1.0	0.0	678	-578	1	-101
USA	-2.4	-2.3	-2.6	-2.4	-95	-5	-95	-5
EU12	--	--	-2.2	-2.2	--	--	-99	-1
EU4	--	--	-1.4	-2.1	--	--	-147	47

From Table 4.3 it can be seen that in general changes in energy intensity at the aggregate economy level have been influenced more by (technology-driven) efficiency improvements within sectors than by structural change. This finding corresponds with the findings of most energy decomposition studies (cf. Liu and Ang 2007). Nevertheless, in various countries structural change has a large influence on aggregate energy intensity changes, either positively or negatively. For example, in Finland, France, South Korea, the Netherlands and the EU4 region structural changes have contributed substantially to *increases* in the aggregate energy intensity. Measured over the period 1995-2005 this also holds for the Czech Republic, Denmark, Poland and Sweden, but no longer for the Netherlands. On the other hand, especially in Austria, Japan, Portugal, the UK, and Spain (particularly after 1995), structural changes contributed substantially to *decreases* in the aggregate energy intensity. The most extreme case in this respect is the UK, where structural changes are by far the principal source of reductions in aggregate energy intensity, offsetting an average decrease in energy efficiency within sectors. The latter is also true for Portugal and

Spain after 1995. The increasing energy intensity level in Spain has also been reported in other recent studies; see for example Marrero and Ramos-Real (2008), and Mendiluce et al. (2010).[5]

While it is beyond the scope of this paper to discuss all country-specific results in detail, we do take a closer look at the USA for two reasons. First, its huge share in world energy consumption and economic output make it an important country to study when evaluating historical trends in the relationship between energy use and economic development. Second, the USA is unique in that recent research on energy intensity of the U.S. economy allows for a comparison between our results and related studies. Table 4.3 shows that our data entail an average annual decline in U.S. aggregate energy intensity of 2.4% for the period 1980-2005 and 2.6% for the period 1995−2005. This result corresponds well with the findings of various recent studies (see, for example, IEA 2004, Huntington 2010, Metcalfe 2008).[6] However, in comparison with these studies, our data reveal a considerably smaller role for structural change in explaining aggregate energy intensity reductions. According to our data, only about 5% of the reduction in U.S. aggregate energy intensity is due to changes in the sectoral composition of the U.S. economy. In contrast, using a similar three-sector and four-sector decomposition approach, Metcalfe (2008) and Huntington (2010) find, respectively, a 14% and 18% contribution of structural change in the periods 1970−2003 and 1972−2006.[7] Given similarity in decomposition methods used, these differences are to be attributed to differences in sectoral detail and data used. For example, our analysis does not include mining and residential activities. In addition, we measure transport sector activity in terms of GDP, while Huntington (2010), for example, uses highway vehicle miles.

In order to examine the role of individual sectors in the results presented above, we identify per individual sector the percentage contribution of the total efficiency effect and the total structural effect to the aggregate growth rate of energy intensity. The results are presented in Table 4.4, again for the periods 1980−2005 and 1995−2005. The bottom lines in Table 4.4 confirm that during these periods aggregate energy intensity decreased in the USA, Japan and the EU regions and that changes in aggregate energy intensity are predominantly influenced by changes in within-sector efficiency levels in the USA and the EU12 region, whereas in Japan and the EU4 regional structural changes explain a substantial part of the change in aggregate energy intensity level. The sectoral breakdown

[5] Based on a similar four-sector decomposition analysis (including Agriculture, Manufacturing, Construction and Services) Marrero and Ramos-Real (2008) also find that this is mainly due to decreasing within-sector efficiency, while structural changes contributed to decreasing aggregate energy intensity. In contrast, using a 15-sector decomposition analysis (including Energy, Agriculture, 10 Manufacturing sectors, Transport, Tertiary and Residential) Mendiluce et al. (2010) conclude that strong transport growth is the key driver of Spain's increasing aggregate energy intensity, whereas within-sector efficiency improvements caused decreases in aggregate energy intensity.

[6] IEA (2004): −2.5% per year for the period 1973−2000 (50% decline over 27 years); Huntington (2010): −2.3% for the period 1972−2006; Metcalfe (2008): −1.7% for the period 1985−2004 (27% decline over 19 years). Although the rates of decline in Metcalfe (2008) are somewhat lower, our results largely reconcile with these findings once we consider the different time periods: the decline in energy intensity accelerated after the first oil price shock of 1973 and slowed down since the mid 1980s with the fall in energy prices, thus explaining the difference with our findings for the period 1980−2005.

[7] If we extend our decomposition analysis for the USA to the period 1970-2005 we still find a small contribution of structure effects to aggregate energy intensity changes, in line with our finding for the period 1980-2005.

provided in Table 4.4 shows that the efficiency effect is mainly realized within Manufacturing, and for the USA and the EU12 region also in Transport. The source of the structural effects is mixed: in the USA and Japan it is mainly driven by a declining share of Transport in aggregate value added whereas in the EU regions is it is mainly determined by a decrease (EU12) or increase (EU4) in the relative size of the Manufacturing sector. We refer to Tables A2 and A3 in the Appendix for more country-specific details.

Table 4.4 Percentage contributions of sector-specific efficiency and structure effects to aggregate energy intensity change.

1980–2005	**USA**			**Japan**			**EU12**			**EU4**		
	Efficiency Effect	Structure Effect	Total Effect	Efficiency Effect	Structure Effect	Total Effect	Efficiency Effect	Structure Effect	Total Effect	Efficiency Effect	Structure Effect	Total Effect
Manufacturing	-46.8	-3.9	-50.7	-136.0	27.9	-108.1	--	--	--	--	--	--
Services	-12.0	1.5	-10.5	38.5	7.7	46.2	--	--	--	--	--	--
Transport	-32.3	-4.2	-36.5	27.7	-47.2	-19.5	--	--	--	--	--	--
Agriculture	-3.6	1.4	-2.2	5.9	-22.0	-16.1	--	--	--	--	--	--
Construction	0.0	-0.1	-0.1	4.9	-7.3	-2.5	--	--	--	--	--	--
MACRO	-94.7	-5.3	-100.0	-59.1	-40.9	-100.0	--	--	--	--	--	--

1995–2005	**USA**			**Japan**			**EU12**			**EU4**		
	Efficiency Effect	Structure Effect	Total Effect	Efficiency Effect	Structure Effect	Total Effect	Efficiency Effect	Structure Effect	Total Effect	Efficiency Effect	Structure Effect	Total Effect
Manufacturing	-71.0	6.2	-64.8	-91.6	15.4	-76.1	-21.8	-8.8	-30.5	-149	105	-44
Services	-8.6	-0.1	-8.7	16.4	9.7	26.1	-28.3	2.5	-25.8	-36	-9	-45
Transport	-13.7	-11.5	-25.2	26.8	-65.0	-38.2	-44.8	7.4	-37.4	69	-37	31
Agriculture	-1.3	0.0	-1.3	-1.7	-9.2	-10.8	-3.4	-2.0	-5.4	-29	-11	-40
Construction	0.0	-0.1	-0.1	6.1	-7.1	-1.0	-0.5	-0.4	-0.9	-1	-2	-3
MACRO	-94.6	-5.4	-100.0	-43.9	-56.1	-100.0	-98.7	-1.3	-100.0	-147	47	-100

5. Manufacturing

This section analyzes the development of energy intensity in the Manufacturing sector, defined as the sum of 19 Manufacturing subsectors. We also examine energy intensity developments in each of these 19 subsectors, including their role in driving aggregate trends. In Section 5.1 we explore trends in energy intensity by documenting growth rates and levels, including an analysis of the evolution of cross-country differences across time. In Section 5.2 we assess to what extent the observed energy intensity developments at the aggregate Manufacturing level are driven by, respectively, changes in the structure of the manufacturing sector and changes in energy efficiency within each of the aforementioned 19 subsectors.

5.1 Trends

We start our analysis of the Manufacturing sector with presenting in Table 5.1 per country and for two different time periods (1980–2005 and 1995–2005) the average annual growth rate of Manufacturing energy intensity and its components: energy use and value added. To facilitate comparison and interpretation of our data, we also provide the average annual growth rates of, respectively, energy use according to IEA data, value added according to STAN data, and energy intensity according to the combination of these two data sources. Table 5.1 leads to a couple of important observations. First, according to our data also at the aggregate Manufacturing level changes in energy intensity differ substantially across countries; varying from a 0.2% average annual decrease in Austria to a 3.7% decrease in the USA, between 1980 and 2005. Particularly in this sector and at this level of aggregation, the difference between an emerging economy like South Korea and developed economies such as Japan are illustrated clearly by differences in both energy use and value added changes. Second, in most countries growth in value added outpaces growth in energy use, resulting in decreasing Manufacturing energy intensity levels. Major exceptions include Italy, the Netherlands before 1995, and Spain after 1995. Third, while in most countries aggregate Manufacturing energy use increased over the past several decades, it decreased in several countries – most notably Denmark, Finland, France, Germany and the USA. In the remaining part of this Section we consider these findings in more detail. Fourth, after 1995 aggregate Manufacturing energy intensity levels decreased relatively fast, especially in the USA (6.4%) and the EU4 region (5.2%). Similar to the aggregate economy level, underlying data reveal a slowdown of the energy intensity decrease between 1980 and 1995.

Table 5.1 Change in energy use, value added and energy intensity at the aggregate Manufacturing level.

Average annual growth rates	Energy Intensity						Energy Use						Value Added					
	1980−2005		1980−1995		1995−2005		1980−2005		1980−1995		1995−2005		1980−2005		1980−1995		1995−2005	
	EUK	IEA/ STAN	EUK	IEA/ STAN	EUK	IEA/ STAN	EUK	IEA	EUK	IEA	EUK	IEA	EUK	STAN	EUK	STAN	EUK	STAN
Austria	-0.2	-1.2	0.0	-1.4	-0.6	-0.9	2.2	1.1	2.1	0.4	2.4	2.0	2.5	2.3	2.1	1.9	3.0	2.9
Belgium	-0.2	--	0.3	--	-1.0	-1.5	1.9	0.3	2.6	0.4	0.8	0.2	2.1	--	2.3	--	1.8	1.8
Czech Republic	--	--	--	--	-4.6	-6.5	--	-3.1	--	-3.7	1.0	-2.3	--	--	--	--	5.7	4.5
Denmark	-1.4	-1.1	-2.0	-1.5	-0.5	-0.5	-1.1	-0.5	-1.6	-0.6	-0.5	-0.5	0.2	0.6	0.4	1.0	-0.1	0.1
Finland	-3.8	-0.7	-0.1	0.7	-7.8	-2.9	1.5	2.7	2.9	3.3	-0.6	1.8	4.5	3.4	3.1	2.5	6.6	4.9
France	-1.0	--	0.9	--	-3.1	--	-1.2	-0.8	-1.3	-1.1	-1.1	-0.4	-0.5	--	-2.2	--	2.2	--
Germany	-2.4	--	-2.2	--	-2.6	-0.7	-1.4	-1.2	-1.5	-2.4	-1.4	0.6	1.0	--	0.8	--	1.2	1.3
Hungary	--	--	--	--	-7.8	-6.1	--	-3.3	--	-4.6	-0.6	-1.3	--	--	--	--	7.4	5.2
Italy	--	--	--	--	0.5	1.2	--	0.2	--	-0.3	0.9	1.0	1.2	--	2.0	--	0.1	-0.3
Japan	-2.5	-1.1	-2.5	-1.0	-2.5	-1.2	0.6	0.6	1.4	1.1	-0.6	-0.2	3.1	1.7	4.0	2.1	1.9	1.0
South Korea	-2.2	-3.0	-2.8	-3.4	-1.4	-2.4	7.8	5.5	8.8	7.1	6.4	3.1	10.3	8.8	11.9	10.9	7.9	5.7
Netherlands*	-0.2	-1.5	1.1	-3.7	-1.3	0.2	2.1	0.6	3.8	-1.2	0.8	2.1	2.3	2.2	1.4	1.4	2.1	1.8
Poland	--	--	--	--	-3.4	--	--	-2.6	--	-2.4	5.7	-2.9	--	--	--	--	9.3	--
Portugal	--	--	--	--	2.0	-0.3	--	1.9	--	2.3	3.4	1.4	1.2	--	1.0	--	1.4	1.7
Spain	-0.9	-0.1	-4.0	-1.1	3.8	1.4	1.4	1.9	-1.8	0.4	6.4	4.2	2.3	2.1	2.2	1.5	2.4	2.8
Slovakia	--	--	--	--	-8.8	-7.2	--	-2.3	--	-3.9	-1.1	0.3	--	--	--	--	7.8	8.0
Sweden	--	--	--	--	-8.4	-4.7	--	0.0	--	0.8	1.1	-1.1	--	--	--	--	10.0	3.8
United Kingdom	-0.9	--	-0.9	--	-0.9	0.0	-0.1	-0.7	0.4	-1.4	-0.8	0.4	0.8	--	1.2	--	0.2	0.3
USA	-3.7	-2.9	-2.0	-4.3	-6.4	-0.7	-1.1	-1.3	-0.3	-2.4	-2.3	0.5	2.6	1.7	1.7	2.0	4.1	1.2
EU12	--	--	--	--	-1.4	-1.6	--	--	--	--	0.3	0.9	--	--	--	--	1.6	2.6
EU4	--	--	--	--	-5.1	-7.1	--	-2.8	--	-3.1	2.5	-2.2	--	--	--	--	8.0	5.3

Notes: *Initial year 1987 instead of 1980.

As regards the different data sources, Table 5.1 reveals that for most countries the use of EU KLEMS compared to IEA leads to considerably different trends in energy use, without a clear cross-country pattern; notable exceptions include Japan and to a lesser extent France. As argued before, these differences are likely due to the fact that non-energy use of fuel is included in EU KLEMS intermediate energy inputs but excluded from IEA final energy consumption data. In contrast to the aggregate economy level, for various countries substantial differences exist between value added series derived from the EU KLEMS and STAN databases. This is particularly true for Finland, Hungary, Japan, South Korea, Sweden and the USA. As discussed in Section 2 these differences arise from the fact that STAN and EU KLEMS employ different vintages of National Accounts as well as different sector classifications. Furthermore, for the Manufacturing sector EU KLEMS provides a more extensive coverage than the IEA-STAN combination in terms of internationally comparable energy intensity series, notably for Belgium, France, Germany and Portugal before 1995 – this is primarily due to better coverage of value added data by EU KLEMS as compared to STAN.

Next, we move beneath the aggregate Manufacturing level by presenting in Table 5.2 annualized growth rates of energy intensity in all Manufacturing subsectors for selected (groups of) countries. In the USA all 25 sectors (10 main sectors and 15 subsectors) exhibit negative growth rates of energy intensity, except for Tobacco. In Japan and the EU regions the picture is more diverse, with positive growth rates of energy intensity in various sectors, most notably in the sectors Food, Textile, Printing etc. and Medical Instruments. In general, the largest decreases in energy intensity have been realized in the sectors Office/Accounting/Computing Machinery and Electrical Engineering as well as in the energy intensive sector Non-Metallic Minerals. We refer to Table B1 in the Appendix for a listing of growth rates of individual Manufacturing sectors per country, differentiated for the periods 1980−2005, 1980−1995 and 1995−2005.

Table 5.2 Energy intensity growth rates by Manufacturing subsector.

	USA		JPN		EU12	EU4
	1980–2005	1995−2005	1980−2005	1995−2005	1995−2005	1995−2005
MANUFACTURING	-3.7	-6.4	-2.5	-2.5	-1.4	-5.1
FOOD , BEVERAGES AND TOBACCO	-2.4	-2.3	2.9	1.3	0.7	-2.7
Food and beverages	-3.1	-3.3	2.7	0.9	0.1	-2.9
Tobacco	5.3	8.5	0.7	1.1	1.1	0.9
TEXTILES, LEATHER AND FOOTWEAR	-3.3	-5.2	3.9	4.8	0.3	-3.0
Textiles	-3.6	-5.4	3.9	5.0	0.1	-2.3
Leather and footwear	-0.3	-2.4	6.0	2.6	1.1	-8.1
WOOD AND CORK	-2.5	-1.6	--	--	1.7	-0.1
PULP, PAPER , PRINTING AND PUBLISHING	-2.5	-5.2	0.7	0.0	-0.4	0.3
Pulp and paper	-3.3	-7.4	-0.1	-1.2	-1.8	-0.2
Printing, publishing and reproduction	-1.2	-2.1	2.4	2.0	-0.5	-0.5
CHEMICALS	-2.9	-5.4	-5.3	0.3	-2.9	5.2
NON-METALLIC MINERALS	-2.8	-2.6	-2.3	-1.4	-0.2	-11.4
BASIC METALS	-3.3	-4.8	-1.5	-0.3	0.2	0.2
MACHINERY	-4.8	-8.6	-2.7	-4.6	-2.5	-9.8
Fabricated metal	-1.9	-2.7	0.1	0.9	-1.1	-8.4
Machinery nec	-1.6	-3.0	-0.4	-1.7	-1.2	-8.2
Office, accounting and computing machinery	-10.4	-15.5	-7.2	-5.4	-8.5	-17.6
Electrical engineering	-10.1	-14.8	-7.9	-8.9	-5.5	-10.1
TRANSPORT EQUIPMENT	-2.2	-4.8	-0.9	-1.5	-1.3	-10.5
Motor vehicles, trailers and semi-trailers	-3.5	-8.1	-1.4	-1.7	-1.2	-14.4
Other transport equipment	-0.9	-1.2	2.3	0.0	-2.5	-1.1
NON-SPECIFIED INDUSTRY	-2.5	-3.0	1.2	0.7	-0.3	-6.7
Rubber and plastics	-4.1	-4.2	0.6	-0.7	-0.6	-6.2
Medical, precision and optical instruments	-2.3	-1.9	1.1	2.8	-3.5	-0.5
Manufacturing nec; recycling	-2.4	-2.7	1.6	0.3	1.6	-7.6

We continue our descriptive analysis by taking a closer look at the development of Manufacturing energy intensity *levels* over time. In Figure 5.1 we show for each country within the EU12 group the development of aggregate Manufacturing energy intensity levels since 1980, relative to the USA (index: USA 1980=100).

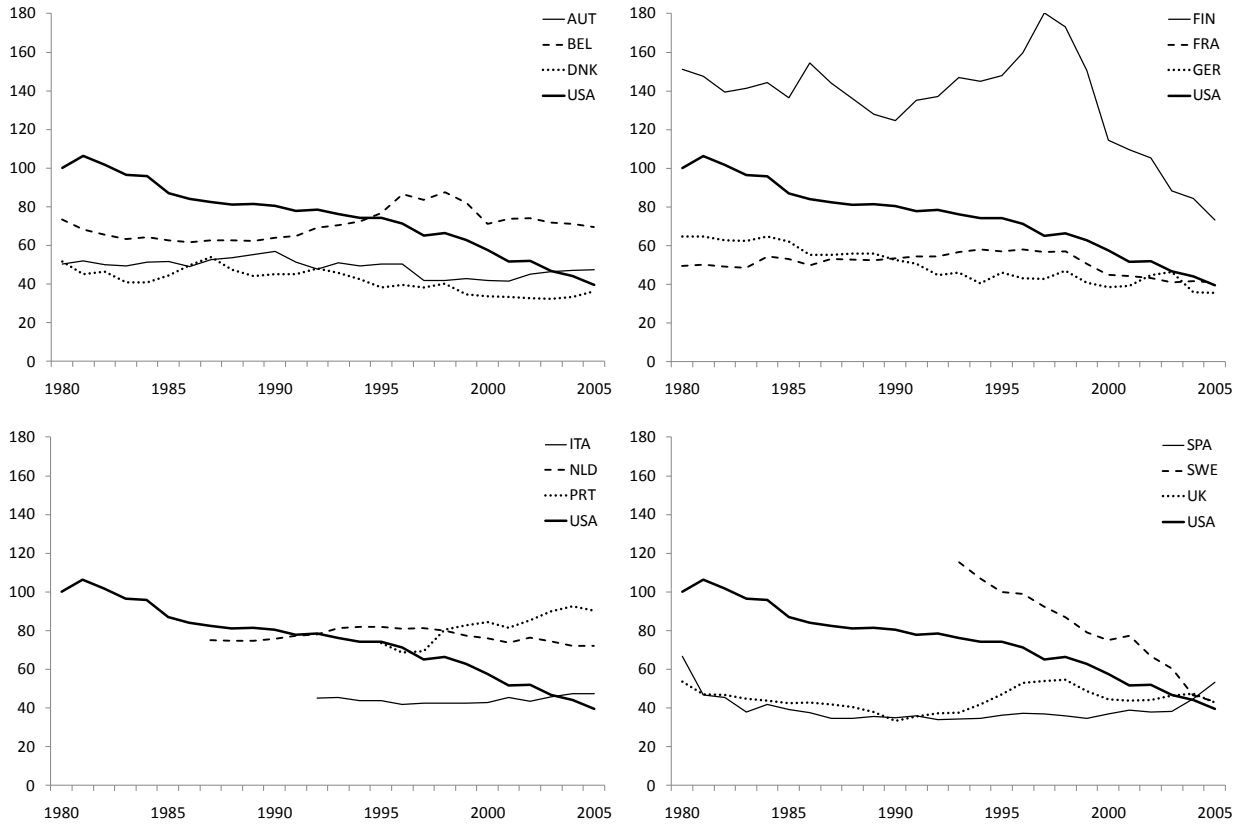

Figure 5.1 Indexed Energy Intensity Levels relative to the USA (USA in 1980=100)

The Figure shows again the aforementioned remarkable catch-up of USA to EU levels in terms of aggregate manufacturing energy intensity. Furthermore it reveals that during the period 1980−2005 the highest levels of Manufacturing energy intensity can be found in Finland while by the end of this period Denmark, Germany, Italy and Sweden exhibit the lowest levels of manufacturing energy intensity. It is beyond the scope of this paper to analyze all these patterns in detail. However, we summarize here a number of key points. The outstanding poor performance of Finland is mainly caused by high energy intensity levels in the sectors Pulp and Paper and Non-Specified Industry. From Figure 5.1 it can be seen that Manufacturing energy intensity performance in Finland is improving strongly after 2002, which is mainly due to improved performance in Machinery. In spite of its outstanding good performance, our data also indicate that Manufacturing energy intensity in Denmark has considerably increased after 1997, which is caused by relatively poor performance in the sectors Textiles, Basic Metal Industry, Transport Equipment and Machinery. The relatively large decrease in Manufacturing energy intensity level in Sweden results mainly from improved performance of the sectors Machinery, Chemicals and Non-Metallic Minerals. Finally, the substantial increase in Spanish Manufacturing energy intensity level is, according to

our data, mainly due to increasing energy intensity levels in the sectors Food, Non-Metallic Minerals, Basic Metals, Transport Equipment and Machinery (see Table B1 in the Appendix).

We finish our exploration of energy intensity trends at the Manufacturing level by examining cross-country differences in energy intensity over time. Again we do so by means of a σ-convergence analysis for different samples of countries (see Table 2.2). Our analysis comprises 10 Manufacturing subsectors (2-digit level); the results are depicted in Figure 5.2. The Figure reveals that by 2005 the largest degrees of cross-country variation in energy intensity are to be found in the sectors Non-Specified Industry and Pulp and Paper, whereas cross-country differences are smallest in the sectors Wood and Cork and Non-Metallic Minerals. Moreover, the Figure shows that in most sectors the standard deviation of the log of energy intensity decreases over time, indicating the existence of σ-convergence. This pattern is particularly strong in the sectors Textiles and Leather (before 1995), Basic Metals and Machinery (before 2000). In contrast, evidence of σ-divergence is found in the sector Non-Specified Industry as well as the sector Machinery after 1995. In the other sectors cross-country variation in energy intensity levels remains more or less constant over time.

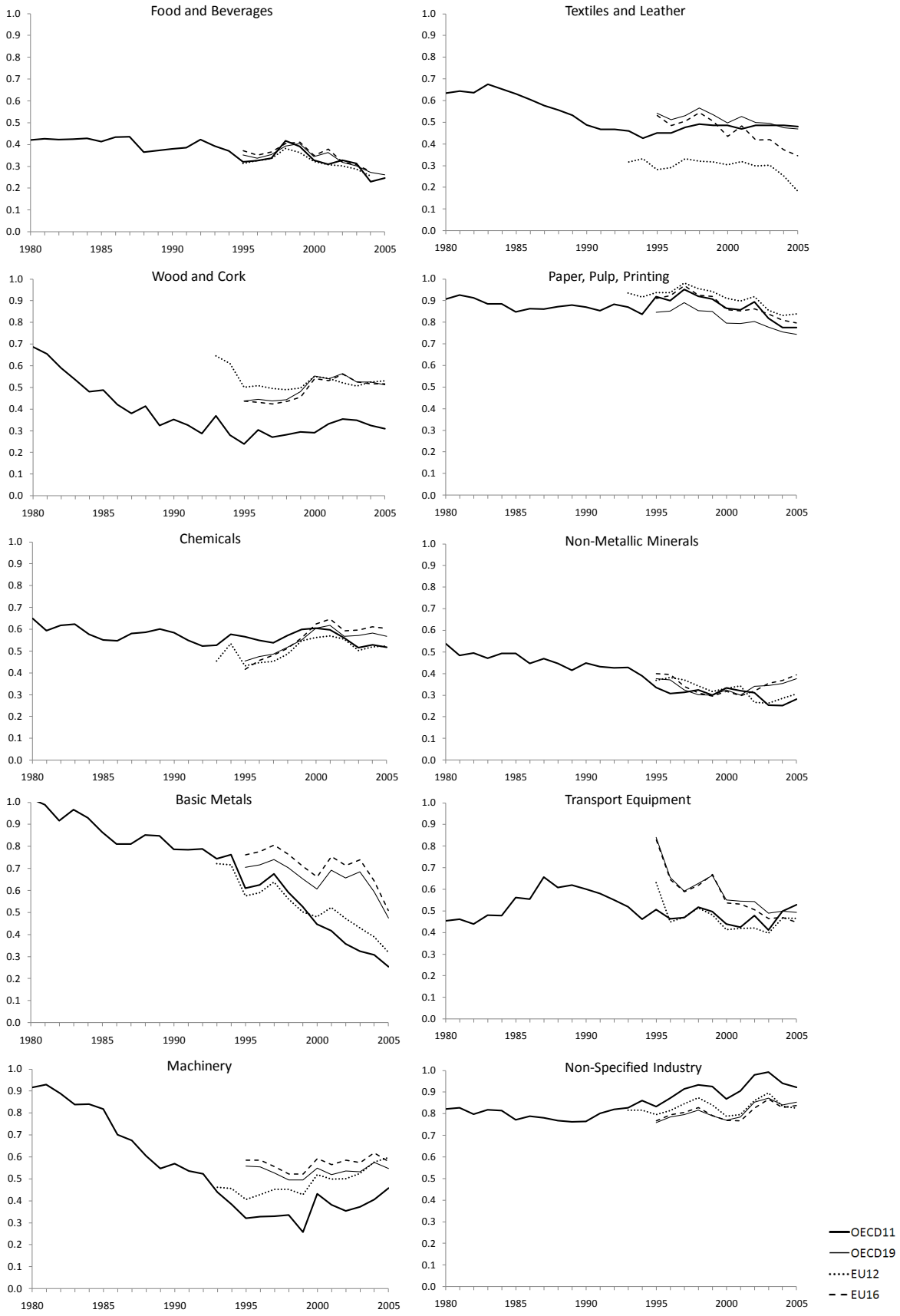

Figure 5.2 Manufacturing σ-convergence analysis, measured as standard deviation of log(energy intensity)

5.2 Decomposition

Changes in aggregate Manufacturing energy intensity can also be decomposed into a so-called structure effect and an efficiency effect, using the same methodology that we applied at the aggregate economy level (Section 4.2). In this case the structure effect measures the change in aggregate Manufacturing energy intensity due to the changing composition of subsectors *within* Manufacturing. The efficiency effect, in contrast, measures changes due to efficiency improvements within each Manufacturing subsector at a constant subsector structure. In Table 5.3 we present the results of our decomposition analysis, again for each country and two time periods (1980−2005 and 1995−2005). We differentiate again between the average annualized energy intensity growth rates before decomposition (gross) and after decomposition (net), i.e. after correcting for the impact of structural changes. From Table 5.3 it can be seen that after correcting for the impact of structural changes most countries in our dataset have a negative growth rate of energy intensity, i.e. a decreasing ratio of energy input to economic output – exceptions are South Korea and after 1995 also Italy, Portugal and Spain. Furthermore, it can be concluded that Manufacturing energy intensity changes result from both within-sector (technology-driven) efficiency improvements and structural changes, with the latter playing an important role. In fact, in a range of countries the structure effect is even stronger than the efficiency effect (especially after 1995). This is in contrast to the aggregate economy level, where we found the efficiency effect to dominate the structure effect. Moreover, from Table 5.3 it can be seen that, measured over the period 1980–2005, in most countries the within-sector efficiency effect contributed to decreases in aggregate energy intensity (except South Korea) while structural changes have led to either decreases or increases in aggregate energy intensity. For the period 1995−2005 in most countries structural changes also contributed to decreases in aggregate manufacturing energy intensity (Austria and the Netherlands being the exceptions).

Regarding the USA, our results correspond well with the findings of various recent studies (see, for example, IEA 2004, Lescaroux 2008 and Huntington 2010).[8] It is worth mentioning that reductions in U.S. Manufacturing energy intensity have accelerated considerably after the mid 1990s, to an average of about 6% per year during the period 1995−2005. Also, our results regarding the role of structural change in explaining these reductions are in line with what other studies have reported. According to our data, about 18% to 22% of the reduction in U.S. aggregate energy intensity is due to changes in the sectoral composition of the U.S. economy. Using a similar two-digit decomposition approach Metcalfe (2008) and Lescaroux (2008) find an 18% and 17% contribution of structural change in the periods 1974−1997 and 1974−1998, respectively.[9] Using a 65-sector structure Huntington (2010) finds that structural changes explain about 39% of U.S. manufacturing energy intensity reductions between 1997 and 2006. Again, given similarity in decomposition methods used, this difference is to be

[8] Our data: −1.97% for the period 1980−1995, −3.72% for the period 1980−2005 and −6.35% for the period 1995−2005. IEA (2004): −2.7% for the period 1973−1998; Lescaroux (2008): −2.2% for the period 1974−1998 (41.9% decline over 24 years); Huntington (2010): −5.75% for the period 1997−2006. Again, it is be noted that our results largely reconcile with these findings if we consider the different time periods: the decline in energy intensity accelerated after the first oil price shock of 1973 and slowed down since the mid 1980s with the fall in energy prices.

[9] Lescaroux (2008) finds that 7% of a total 41.9% decline is to be explained from structural change.

attributed to differences in sector detail and data used. A lower degree of disaggregation obscures shifts from energy intensive to energy extensive subsectors, which consequently will show up as efficiency improvements.

Table 5.3 Decomposition of average annual growth rate of Manufacturing energy intensity.

	Average annual growth rate				% Contribution of Efficiency and Structure Effect			
	1980–2005		1995–2005		1980–2005		1995–2005	
	Gross	Net	Gross	Net	Efficiency Effect	Structure Effect	Efficiency Effect	Structure Effect
Austria	-0.2	-0.6	-0.6	-0.7	-310	210	-109	9
Belgium	-0.2	-0.7	-1.0	-0.7	-320	220	-74	-26
Czech Republic	--	--	-4.6	-1.6	--	--	-34	-66
Denmark	-1.4	-0.8	-0.5	0.0	-59	-41	-6	-94
Finland	-3.8	-2.5	-7.8	-3.8	-67	-33	-49	-51
France	-1.0	-4.2	-3.1	-2.3	-537	437	-68	-32
Germany	-2.4	-2.3	-2.6	-2.2	-94	-6	-83	-17
Hungary	--	--	-7.8	-2.6	--	--	-34	-66
Italy	--	--	0.5	0.6	--	--	126	-26
Japan	-2.5	-1.2	-2.5	-0.3	-48	-52	-13	-87
South Korea	-2.2	0.3	-1.4	2.2	12	-112	162	-262
Netherlands	-0.2	-0.5	-1.3	-1.9	-234	134	-146	46
Poland	--	--	-3.4	-1.4	--	--	-40	-60
Portugal	--	--	2.0	2.2	--	--	107	-7
Spain	-0.9	-0.8	3.8	4.0	-90	-10	103	-3
Slovakia	--	--	-8.8	-7.7	--	--	-88	-12
Sweden	--	--	-8.4	-1.5	--	--	-18	-82
United Kingdom	-0.9	-0.9	-0.9	-0.5	-97	-3	-58	-42
USA	-3.7	-3.0	-6.4	-4.9	-82	-18	-77	-23
EU12	--	--	-1.4	-1.0	--	--	-67	-33
EU4	--	--	-5.3	-2.7	--	--	-52	-48

In order to examine the role of individual Manufacturing sectors in the results presented above, we identify per individual Manufacturing sector the percentage contribution of the total efficiency effect and the total structure effect to the growth rate of aggregate Manufacturing energy intensity. The results are presented in Table 5.4, again for the periods 1980−2005 and 1995−2005. The bottom line in Table 5.4a confirms that during the period 1980−2005 aggregate Manufacturing energy intensity decreased in the USA and Japan and that changes in aggregate Manufacturing energy intensity result from both within-sector (technology-driven) efficiency improvements and

structural changes. The latter play a relatively important role in Japan where they explain about 40% of the change in aggregate Manufacturing energy intensity levels. The sectoral breakdown provided in Table 5.4a shows that the efficiency effect is mainly realized within the energy intensive sectors Chemicals, Non-Metallic Minerals, Basic Metals, and to a lesser extent also in Electrical Engineering. Detailed country figures indicate that this pattern can be found in quite a number of countries, with the United Kingdom as an important exception (see Table B2 in the Appendix). The structure effect is driven by diverse developments. In the USA they consist mainly of a shift away from Pulp and Paper, Chemicals and Basic Metals towards Electrical Engineering, Office Machinery, Motor Vehicles and Rubber and Plastics. In Japan the structure effect is mainly driven by a shift from Non-Metallic Minerals and Basic Metals towards Chemicals (presumably primarily Pharmaceuticals) and Electrical Engineering.

Results for the period 1995−2005 are presented in Table 5.4b. From the bottom line in Table 5.4b it can be concluded that during this period structural changes play, on average, a substantial role in explaining decreases in aggregate Manufacturing energy intensity. In this period, compositional changes within the Manufacturing sector explain 23% of the decrease in Manufacturing energy intensity in the USA, 87% in Japan, 33% in the EU12 region and 48% in the EU4 region. The sectoral breakdown provided in Table 5.4b shows that this is mainly due to the same trends as described for the period 1980−2005. Detailed country figures indicate that the shift away from Basic Metals has been most notable in the Czech Republic, Italy, Korea, Poland and the UK. For Textiles the structure effect is biggest in Italy, Korea, Portugal and UK, while Finland and Sweden make up a large part of the average structure effect in the Pulp and Paper sector (see Table B3 in the Appendix). The aggregate efficiency effect in the period 1995−2005 stems mainly from the sectors Chemicals, Pulp and Paper, and Electrical Engineering, and for the EU4 region also from Non-Metallic Minerals. Detailed country figures indicate that efficiency improvements in the Chemicals sector have been especially strong in Austria, Denmark, Germany, the Netherlands and the UK. Within the Pulp and Paper the efficiency effect is biggest in Finland, Portugal and USA, while in Electrical engineering the largest efficiency improvements are realized in Denmark and Japan (see Tables B3 in the Appendix).

Table 5.4a Percentage contribution of the efficiency effect (EFF) and the structure effect (STR) by sector to the annual growth rate of Manufacturing energy intensity. GDP-weighted cross-country averages.

1980–2005	**USA**			**Japan**			**EU12**			**EU4**		
	Efficiency Effect	Structure Effect	Total Effect	Efficiency Effect	Structure Effect	Total Effect	Efficiency Effect	Structure Effect	Total Effect	Efficiency Effect	Structure Effect	Total Effect
Food and beverages	-7.8	0.1	-7.6	4.9	-4.2	0.6	--	--	--	--	--	--
Tobacco	0.3	-0.4	-0.2	0.0	-0.2	-0.2	--	--	--	--	--	--
Textiles	-2.8	-1.9	-4.7	3.6	-7.0	-3.4	--	--	--	--	--	--
Leather and footwear	0.0	-0.4	-0.4	0.3	-0.3	-0.1	--	--	--	--	--	--
Wood and Cork	-2.7	-0.9	-3.6	--	--	--	--	--	--	--	--	--
Pulp and paper	-13.3	-3.3	-16.6	-0.2	-5.2	-5.4	--	--	--	--	--	--
Printing, publishing, etc.	-1.5	-2.0	-3.5	2.1	-1.8	0.3	--	--	--	--	--	--
Chemicals	-21.2	-5.1	-26.3	-26.0	24.4	-1.6	--	--	--	--	--	--
Non-Metallic Minerals	-6.2	-0.9	-7.1	-10.8	-10.2	-21.0	--	--	--	--	--	--
Basic Metals	-12.7	-7.1	-19.8	-20.3	-45.9	-66.3	--	--	--	--	--	--
Fabricated metal	-1.2	-0.7	-1.8	0.1	-0.9	-0.9	--	--	--	--	--	--
Machinery NEC	-1.0	-1.3	-2.2	-0.2	0.2	0.0	--	--	--	--	--	--
Office machinery, etc.	-0.7	0.5	-0.3	-0.7	0.8	0.1	--	--	--	--	--	--
Electrical engineering	-5.9	4.2	-1.7	-5.7	6.2	0.5	--	--	--	--	--	--
Motor vehicles, trailers, etc.	-1.5	0.5	-1.0	-1.1	0.8	-0.3	--	--	--	--	--	--
Other transport equipment	-0.3	-0.6	-0.9	0.3	-0.3	0.0	--	--	--	--	--	--
Rubber and plastics	-2.0	1.0	-0.9	2.1	-1.4	0.7	--	--	--	--	--	--
Medical instruments etc.	-0.6	-0.2	-0.7	1.0	-1.8	-0.8	--	--	--	--	--	--
Manufacturing nec; recycling	-0.8	0.1	-0.7	2.6	-4.8	-2.2	--	--	--	--	--	--
MANUFACTURING	-94.7	-5.3	-100.0	-59.1	-40.9	-100.0	--	--	--	--	--	--

Table 5.4b Percentage contribution of the efficiency effect (EFF) and the structure effect (STR) by sector to the annual growth rate of Manufacturing energy intensity. GDP-weighted cross-country averages.

1995–2005	**USA**			**Japan**			**EU10**			**EU4**		
	Efficiency Effect	Structure Effect	Total Effect	Efficiency Effect	Structure Effect	Total Effect	Efficiency Effect	Structure Effect	Total Effect	Efficiency Effect	Structure Effect	Total Effect
Food and beverages	-4.7	-1.8	-6.5	2.3	-5.3	-3.0	0.3	-6.0	-5.7	-6.5	-7.5	-14.1
Tobacco	0.3	-0.5	-0.2	0.0	-0.2	-0.2	0.1	-0.3	-0.2	0.0	-0.1	-0.1
Textiles	-2.3	-2.3	-4.6	5.3	-13.2	-7.9	0.2	-8.8	-8.5	-1.1	-3.4	-4.5
Leather and footwear	-0.1	-0.2	-0.2	0.2	-0.6	-0.4	0.2	-1.2	-1.0	-0.6	-0.9	-1.6
Wood and Cork	-1.0	-1.9	-2.9	0.0	0.0	0.0	2.0	-0.2	1.8	0.0	0.1	0.1
Pulp and paper	-18.4	-2.7	-21.1	-4.3	-9.1	-13.4	-12.6	-2.2	-14.8	-0.2	-1.8	-2.0
Printing, publishing, etc.	-1.7	-2.6	-4.3	2.4	-4.2	-1.8	-1.1	-3.1	-4.1	-0.1	-0.9	-1.0
Chemicals	-25.2	-9.6	-34.8	1.9	-4.1	-2.3	-40.3	8.6	-31.7	16.0	-15.6	0.4
Non-Metallic Minerals	-3.1	-0.7	-3.8	-5.4	-12.0	-17.5	-2.1	-6.0	-8.1	-36.3	16.5	-19.7
Basic Metals	-8.8	-2.5	-11.3	-3.3	-27.8	-31.1	2.7	-23.9	-21.2	0.9	-41.8	-40.9
Fabricated metal	-0.9	-0.7	-1.6	0.7	-2.4	-1.7	-2.2	0.4	-1.8	-4.2	0.8	-3.3
Machinery NEC	-1.0	-0.8	-1.8	-1.1	0.6	-0.6	-2.0	-0.9	-3.0	-4.8	-0.6	-5.4
Office machinery, etc.	-0.7	0.3	-0.3	-0.9	0.5	-0.4	-1.0	0.1	-0.9	-0.2	0.3	0.1
Electrical engineering	-5.3	3.4	-1.9	-9.8	7.1	-2.7	-6.3	5.2	-1.2	-3.0	2.3	-0.7
Motor vehicles, trailers, etc.	-2.2	0.8	-1.5	-1.6	1.3	-0.3	-1.9	1.4	-0.5	-6.8	3.9	-2.9
Other transport equipment	-0.2	-0.2	-0.4	0.0	0.1	0.1	-1.1	0.6	-0.6	-0.2	-1.2	-1.4
Rubber and plastics	-1.4	-0.3	-1.7	-3.5	-3.7	-7.2	-3.2	5.8	2.6	-2.6	1.9	-0.7
Medical instruments etc.	-0.3	-0.3	-0.5	3.4	-6.9	-3.6	-3.1	1.7	-1.3	0.0	-0.1	-0.1
Manufacturing nec; recycling	-0.5	0.0	-0.5	0.6	-6.7	-6.1	4.1	-3.9	0.3	-2.0	-0.1	-2.1
MANUFACTURING	-77.5	-22.5	-100.0	-13.2	-86.8	-100.0	-67.3	-32.7	-100.0	-51.7	-48.3	-100.0

6. Services

This section analyzes the development of energy intensity in the Service sector, defined as the sum of 19 Services subsectors. We also examine energy intensity developments in each of these 19 subsectors, including their role in driving aggregate trends. In Section 6.1 we explore trends in energy intensity by documenting growth rates and levels, including an analysis of the evolution of cross-country differences across time. In Section 6.2 we assess to what extent the observed energy intensity developments at the aggregate Serivces level are driven by, respectively, changes in the structure of the Service sector and changes in energy efficiency within each of the aforementioned 19 subsectors.

6.1 Trends

We start our analysis of the Service sector with presenting in Table 6.1 per country and for two different time periods (1980–2005 and 1995–2005) the average annual growth rate of Services energy intensity and its components: energy use and value added. To facilitate comparison and interpretation of our data, we also provide the average annual growth rates of, respectively, energy use according to IEA data, value added according to STAN data, and energy intensity according to the combination of these two data sources. Table 6.1 leads to a couple of important observations. First, even more so than in the Manufacturing sector, changes in energy intensity in the Service sector differ substantially across countries, varying from a 3% average annual increase in Austria to a 3.6% decrease in Denmark, between 1980 and 2005. Second, contrary to Manufacturing, in a range of countries growth in value added does not keep up with growth in energy use, resulting in increasing energy intensity levels in the Service sector in various countries. This trend is particularly strong in Austria, Finland and Japan, but also in Spain and United Kingdom. Third, in virtually all countries energy use in the aggregate Service sector increased over the past several decades, except for Denmark and Germany and after 1995 also in Hungary, Slovakia and Sweden. In the remainder of this Section we consider these findings in more detail. Fourth, in contrast to the aggregate economy and Manufacturing level, energy intensity levels decreased relatively slowly after 1995.

As regards the different data sources, Table 6.1 reveals that for most countries the use of EU KLEMS or IEA leads to considerably different trends in energy use, with differences being larger than in Manufacturing. This is remarkable since they cannot be assigned to non-energy use of fuel as was the case in Manufacturing. In contrast to Manufacturing, in terms of value added differences between series derived from the EU KLEMS and STAN database are very small. Fourth, also at the level of the aggregate Service sector EU KLEMS provides a more extensive coverage than the IEA-STAN combination in terms of internationally comparable energy intensity series, notably for Belgium, Germany, Portugal and United Kingdom before 1995 – which is again principally due to better coverage of value added data by EU KLEMS as compared to STAN. In contrast, the poor quality of EU KLEMS energy data for Italy (particularly in the sectors Community/Social/Personal Services, Public Administration and Defense, and Education) forced us to drop Italy from our sample.

Table 6.1 Change in energy use, value added and energy intensity at the aggregate Services level.

Average annual growth rates	Energy Intensity						Energy Use						Value Added					
	1980−2005		1980−1995		1995−2005		1980−2005		1980−1995		1995−2005		1980−2005		1980−1995		1995−2005	
	EUK	IEA/ STAN	EUK	IEA/ STAN	EUK	IEA/ STAN	EUK	IEA	EUK	IEA	EUK	IEA	EUK	STAN	EUK	STAN	EUK	STAN
Austria	3.0	-0.1	3.4	-0.9	2.4	1.3	5.3	2.3	5.9	1.5	4.4	3.4	2.2	2.3	2.4	2.5	1.9	2.1
Belgium	0.8	--	2.9	--	-2.5	-0.4	2.6	1.3	4.6	1.0	-0.3	1.8	1.9	--	1.6	--	2.3	2.3
Czech Republic	--	--	--	--	1.8	0.9	--	3.0	--	2.8	3.4	3.1	--	--	--	--	1.6	2.2
Denmark	-3.6	-0.4	-3.1	0.4	-4.3	-1.5	-1.3	1.9	-1.0	2.7	-1.8	0.8	2.3	2.3	2.1	2.3	2.5	2.4
Finland	1.5	3.2	1.7	3.6	1.3	2.6	3.6	5.4	3.2	5.3	4.1	5.5	2.0	2.1	1.5	1.6	2.8	2.8
France	-1.7	--	-2.7	--	-0.3	--	0.5	-1.4	-0.4	-2.5	1.7	0.3	2.2	--	2.4	--	2.0	--
Germany	-2.5	--	-3.1	--	-1.6	-1.5	-0.3	-0.5	-0.3	-0.8	-0.1	-0.1	2.3	--	2.8	--	1.5	1.4
Hungary	--	--	--	--	-6.6	-0.3	--	3.7	--	4.1	-2.6	3.0	--	--	--	--	4.0	3.4
Italy	--	--	-2.6	--	--	2.2	--	7.8	-0.7	10.4	--	4.1	2.0	--	2.0	--	2.0	1.8
Japan	1.8	1.9	2.5	2.8	0.8	0.7	4.9	5.0	6.3	6.8	2.8	2.3	3.0	3.0	3.7	3.9	1.9	1.6
South Korea	0.4	2.0	-2.4	5.6	4.4	-3.2	6.3	8.4	5.0	14.1	8.4	0.4	5.9	6.3	7.5	8.0	3.7	3.6
Netherlands*	0.4	3.2	2.7	9.5	-1.4	-1.5	3.1	6.2	5.1	12.3	1.6	1.5	2.7	2.9	1.2	1.4	3.1	3.1
Poland	--	--	--	--	0.2	--	--	-1.0	--	-4.0	4.1	3.6	--	--	--	--	4.0	--
Portugal	-2.2	--	-2.9	--	-1.1	6.5	0.9	6.7	0.5	5.0	1.6	9.2	3.2	--	3.5	--	2.7	2.6
Spain	0.9	2.3	-2.1	1.7	5.5	3.1	4.0	5.6	0.4	4.7	9.7	6.9	3.1	3.2	2.6	2.9	3.9	3.7
Slovakia	--	--	--	--	-5.7	-7.2	--	-1.8	--	-0.3	-2.6	-4.1	--	--	--	--	3.2	3.3
Sweden	--	--	--	--	-3.1	-3.9	--	4.7	--	8.9	-0.2	-1.2	--	--	--	--	3.0	2.8
United Kingdom	1.0	--	1.6	--	0.1	-3.5	4.1	1.0	4.1	1.7	4.2	0.0	3.1	--	2.5	--	4.1	3.7
USA	-1.8	-1.6	-2.1	-1.4	-1.3	-1.8	1.3	1.4	0.8	1.3	2.1	1.5	3.2	3.0	3.0	2.8	3.5	3.3
EU12	--	--	--	--	-0.8	-1.5	--	--	--	--	2.0	1.0	--	--	--	--	2.6	2.5
EU4	--	--	--	--	-2.8	-0.8	--	--	--	--	1.0	2.0	--	--	--	--	3.5	2.8

Notes: *Initial year 1987 instead of 1980.

Table 6.2 Energy intensity growth rates by Services subsector.

	USA		JPN		EU12	EU4
	1980–2005	1995−2005	1980−2005	1995−2005	1995−2005	1995−2005
SERVICES	-1.8	-1.3	1.8	0.8	-0.8	-2.4
WHOLESALE AND RETAIL TRADE	-3.8	-2.9	0.0	-0.8	-1.0	-5.3
Sale, maintenance, repair motor vehicles and -cycles; retail sale of fuel	-4.6	-5.1	5.0	-0.2	0.3	1.0
Other wholesale trade and commission trade	-4.3	-1.5	-1.9	0.3	-2.6	-8.2
Other Retail trade; repair of household goods	-3.2	-4.2	1.8	-0.5	0.6	-4.6
HOTELS AND RESTAURANTS	-0.3	-1.1	3.5	4.1	0.1	-2.1
POST AND TELECOMMUNICATIONS	-2.6	-3.3	1.5	4.2	-3.3	-9.7
FINANCIAL INTERMEDIATION	-1.3	-1.7	-1.3	0.0	-0.6	0.4
Financial intermediation, except insurance and pension funding	-2.6	-2.8	-1.5	-0.9	-2.3	-3.5
Insurance and pension funding, except compulsory social security	1.0	1.0	-0.6	2.3	5.3	10.1
Activities related to financial intermediation	--	--	--	--	0.2	-11.7
RENTING, COMPUTER, R&D and OTHER BUSINESS	-1.4	0.4	1.0	-1.3	-1.1	-6.8
Renting of machinery and equipment	2.7	3.6	-13.1	-18.8	-0.8	-1.5
Computer and related activities	-3.2	-1.4	3.1	-1.1	-3.0	-2.8
Research and development	-1.9	2.0	2.5	3.9	-0.6	0.5
Other business activities	-1.8	0.2	2.2	0.9	-0.7	-7.8
PUBLIC ADMIN AND DEFENCE; COMPULSORY SOCIAL SECURITY	0.8	0.9	3.0	-0.6	1.0	-0.3
EDUCATION	-0.9	1.0	3.8	3.4	1.4	2.5
HEALTH AND SOCIAL WORK	-0.3	-1.0	2.4	0.6	-2.2	0.5
OTHER COMMUNITY, SOCIAL AND PERSONAL SERVICES	-2.5	-0.9	3.4	1.6	-0.1	2.3
Sewage and refuse disposal, sanitation and similar activities	1.0	0.8	9.0	2.1	2.4	3.3
Activities of membership organizations nec	-2.8	-0.3	-0.3	-0.5	0.2	-1.4
Recreational, cultural and sporting activities	-2.1	-1.1	4.1	1.2	-0.7	-0.1
Other service activities	-3.2	-1.7	1.6	2.1	-0.9	2.4

Next, we move beneath the aggregate Service sector level by presenting in Table 6.2 annualized growth rates of energy intensity in all Services subsectors for selected (groups of) countries. In the USA most subsectors exhibit negative growth rates of energy intensity, especially in the trade and non-commercial Service sectors. In Japan and the EU regions the picture is more diverse. In Japan, especially non-commercial Service sectors exhibit relatively large positive growth rates of energy intensity. We refer to Table C1 in the Appendix for a listing of growth rates for individual Services sectors per country, differentiated for the periods 1980−2005, 1980−1995 and 1995−2005.

We continue our descriptive analysis by taking a closer look at the development of energy intensity *levels* in the Service sector over time. In Figure 6.1 we show for each country within the EU12 group, except Italy, the development of aggregate Service sector energy intensity levels since 1980, relative to the USA (index: USA 1980=100).

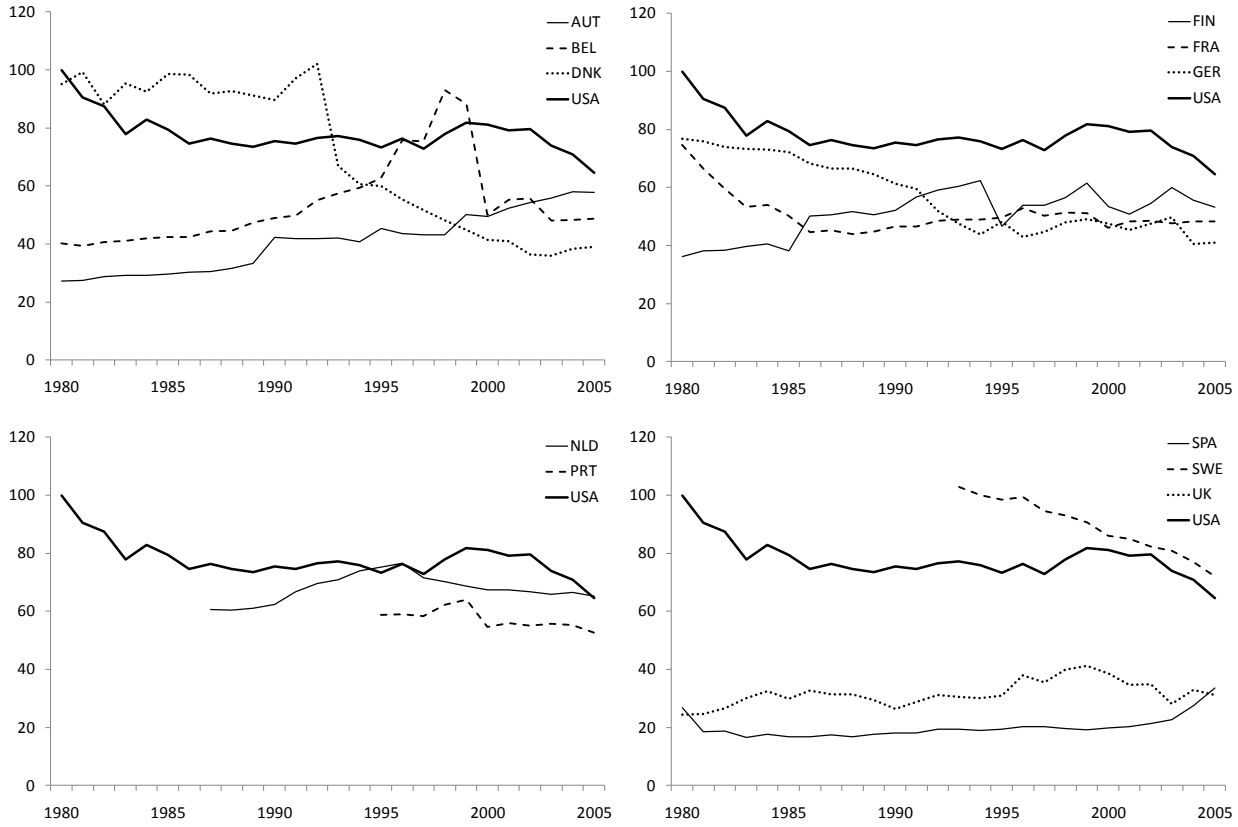

Figure 6.1 Indexed Energy Intensity Levels relative to USA (USA 1980=100)

The Figure shows that, between 1980 and 2005, also in the Services sector energy intensity levels in the USA were at the higher end of the European spectrum and were also fairly constant. In various other countries, however, energy intensity levels in the Service sector changed considerably over time. Most notably, since 1990 they decreased greatly in Denmark, while since 1980 they increased gradually in Austria, Finland and until 1997 also in Belgium. It is beyond the scope of this paper to analyze all these patterns in detail. However, we summarize here a

number of key points. The outstanding increased performance in Denmark is mainly caused by decreased energy intensity levels in the sectors Wholesale and Retail Trade, Post and Telecommunications, Financial Intermediation and Education. The decreased relative performance in Austria stems from relatively poor performance in the sectors Financial Intermediation and Post and Telecommunications, while the decline in relative performance in Belgium is mainly caused by increasing relative energy intensity levels in Financial Intermediation, Public Administration and Defense. The poor performance of the Spanish Service sector comes from relative poor performance in a broad range of Services sectors (see Table C1 in the Appendix).

We finish our exploration of energy intensity trends at the aggregate Service sector level by examining cross-country differences in energy intensity over time. Again we do so by means of a σ-convergence analysis for different samples of countries (see Table 2.2).[10] Our analysis comprises 9 Services subsectors (2-digit level); the results are depicted in Figure 6.2. The Figure reveals that by 2005 the largest degrees of cross-country variation in energy intensity are to be found in the sectors Post and Telecommunication, whereas the lowest degree of variation is to be found in the sectors Wholesale and Retail Trade, Renting etc., Public Administration and Defense, and Education. Moreover, the Figure shows that in most sectors the standard deviation of the log of energy intensity decreases over time, indicating the existence of σ-convergence. This pattern is particularly strong in the subsectors Wholesale and Retail Trade, Public Administration and Education. In contrast, after there is also evidence of σ-divergence, in the sectors Hotels and Restaurants, Post and Telecommunication, Financial Intermediation, and Health and Social Work. In the sector Other Social Services cross-country variation in energy intensity levels remains more or less constant over time.

[10] OECD18 and OECD10 are, respectivly, defined as OECD19 and OECD11 excluding Italy.

Figure 6.2 Services σ-convergence analysis, measured as standard deviation of log(energy intensity)

6.2 Decomposition

Changes in energy intensity at the aggregate Service sector can also be decomposed into a so-called structure effect and an efficiency effect, using the same methodology that we applied in Section 4.2 and 5.2. In this case the structure effect measures the change in energy intensity at the aggregate Service level due to the changing composition of subsectors within Services. The efficiency effect, in contrast, measures changes due to efficiency improvements within each Services subsector at a constant subsector structure. In Table 6.3 we present the results of our decomposition analysis, again for each country and two time periods (1980−2005 and 1995−2005). We differentiate again between the average annualized energy intensity growth rates before decomposition (gross) and after decomposition (net), i.e. after correcting for the impact of structural changes. From Table 6.3 it can be seen that countries as diverse as Austria, Belgium, Finland, Japan, South Korea, the Netherlands, Spain and the UK exhibit positive growth rates of energy intensity in their Services sector (i.e. increasing levels of energy intensity). This result is in sharp contrast with what we found for the aggregate economy level and in the Manufacturing sector, where most countries showed evidence of negative energy intensity growth rates, i.e. a decreasing energy/activity ratio. Table 6.3 also shows that energy intensity changes in the Services sector result from both structural changes and (technology-driven) efficiency improvements within subsectors. In contrast to Manufacturing, however, in virtually all countries energy intensity changes in Services have been influenced more by (technology-driven) efficiency improvements within sectors than by structural change. After 1995, however, in the EU-10 region structure effects become more important. Moreover, from Table 6.3 it can be seen that both within-sector efficiency effects and structural changes have led to either decreases or increases in aggregate energy intensity, depending on the country. Main exceptions include Germany and Portugal where both the efficiency effect and the structure effect contributed to decreases in energy intensity levels in the services sector; after 1995 this is also true for Belgium, Denmark, the Netherlands and Sweden.

Regarding the USA, our results on the average annual decline in energy intensity in the Services correspond well with the findings of Huntington (2010). However, our results as regards the role of structural change in explaining these reductions are in contrast with what Huntington (2010) finds. According to our data, changes in the sectoral composition of the Services sector led to about a 10% increase in the energy intensity of the U.S. Services sector. In contrast, Huntington (2010) finds that structural changes explain about 92% of energy intensity reductions in the U.S. Services sector between 1997 and 2006. Again, given the similarity in decomposition methods used, this difference is to be attributed to differences in sector detail and data used. Obviously, the degree of disaggregation affects the relative importance of efficiency and structure effects. This disaggregation, for example, obscures shifts from energy intensive to non-energy intensive subsectors. As argued before, with lower degree of sector detail such shifts will show up as efficiency improvements.

Table 6.3 Decomposition of average annual growth rate of energy intensity in the Service sector.

	Average annual growth rate				% Contribution of Efficiency and Structure Effect			
	1980–2005		1995–2005		1980–2005		1995–2005	
	Gross	Net	Gross	Net	Efficiency Effect	Structure Effect	Efficiency Effect	Structure Effect
Austria	3.0	3.1	2.4	2.4	103	-3	100	0
Belgium	0.8	0.9	-2.5	-2.3	119	-19	119	-19
Czech Republic	--	--	1.8	-0.1	--	--	21	79
Denmark	-3.6	-3.5	-4.3	-3.9	-100	0	-86	-14
Finland	1.5	1.4	1.3	1.3	98	2	104	-4
France	-1.7	-1.9	-0.3	-0.4	-779	879	-278	178
Germany	-2.5	-2.3	-1.6	-1.5	-92	-8	-85	-15
Hungary	--	--	-6.6	-6.8	--	--	-103	3
Italy	--	--	--	--	--	--	-98	-2
Japan	1.8	2.1	0.8	0.9	117	-17	161	-61
South Korea	0.4	-0.6	4.4	3.9	-182	282	98	2
Netherlands	0.4	0.6	-1.4	-1.0	147	-47	-69	-31
Poland	--	--	0.2	-0.2	--	--	-368	468
Portugal	-2.2	-1.6	-1.1	-0.5	-71	-29	-32	-68
Spain	0.9	0.9	5.5	5.5	101	-1	101	-1
Slovakia	--	--	-5.7	-6.4	--	--	-112	12
Sweden	--	--	-3.1	-2.7	--	--	-87	-13
United Kingdom	1.0	1.1	0.1	0.5	105	-5	460	-360
USA	-1.8	-2.1	-1.3	-1.3	-115	15	-110	10
EU12	--	--	-0.8	-0.6	--	--	-80	-20
EU4	--	--	-2.6	-3.2	--	--	-127	27

In order to examine the role of individual Service sectors in the results presented above, we identify for each individual Service sector the percentage contribution of the total efficiency effect and the total structure effect to the growth rate of aggregate Services energy intensity. The results are presented in Table 6.4, again for the periods 1980−2005 and 1995−2005. The bottom lines in the Table 6.4a and 6.4b confirm that, measured in both periods, aggregate Services energy intensity decreased in the USA and the EU regions but increased in Japan. Moreover, it shows that, changes in aggregate Services energy intensity result mainly from within-sector (technology-driven) efficiency changes, but that after 1995 in Japan structure effects start to play a prominent role. In the USA and in the EU4 region structural changes contributed to increased energy intensity levels, whereas the opposite is true in Japan and the EU12 region. The sectoral breakdown provided in Table 6.4 shows that the efficiency effect is mainly realized within the various Wholesale and Retail sectors, Post and Telecommunication and Financial Intermediation

and Other Business Activities. In Japan and the EU12 region to some extent these achievements were undone by decreasing within-sector efficiency in the sectors Public Administration and Defense, Education and Health and Social Work (for country-specific details see Tables C2 and C3 in the Appendix). In addition, the sectoral breakdown provided in Table 6.4 shows that the positive aggregate structure effect is mainly caused by a shift towards the sectors Post and Telecommunications, Computer and Related Activities and Other Business Activities in combination with a shift away from the sectors Hotels and Restaurants, Public Administration and Defense and Education. Detailed country figures indicate that this trend has been especially strong in France and Poland (see Tables C2 and C3 in the Appendix).

Table 6.4a Percentage contribution of the efficiency (EFF) effect and the structure (STR) effect by sector to the annual growth rate of Services energy intensity. GDP-weighted cross-country averages.

1980–2005	**USA**			**Japan**			**EU12**			**EU4**		
	EFF Effect	STR Effect	TOT Effect	EFF Effect	STR Effect	TOT Effect	EFF Effect	STR Effect	TOT Effect	EFF Effect	STR Effect	TOT Effect
Sale, maintenance, repair motor vehicles and -cycles; retail sale of fuel	-22.8	12.2	-10.6	1.8	-0.5	1.3	--	--	--	--	--	--
Other wholesale trade and commission trade	-39.3	12.5	-26.9	-8.4	5.4	-3.0	--	--	--	--	--	--
Other retail trade; repair of household goods	-31.1	4.7	-26.4	12.1	-10.2	1.9	--	--	--	--	--	--
Hotels and restaurants	-1.6	-7.1	-8.7	29.0	-19.4	9.6	--	--	--	--	--	--
Post and Telecommunications	-2.6	1.3	-1.4	3.5	7.4	11.0	--	--	--	--	--	--
Financial intermediation, except insurance and pension funding	-4.2	4.8	0.6	-1.6	2.4	0.8	--	--	--	--	--	--
Insurance and pension funding, except compulsory social security	0.3	-0.8	-0.4	-0.4	0.3	-0.1	--	--	--	--	--	--
Activities related to financial intermediation	0.0	0.0	0.0	0.0	0.0	0.0	--	--	--	--	--	--
Renting of machinery and equipment	2.9	-1.3	1.7	-3.9	4.0	0.1	--	--	--	--	--	--
Computer and related activities	-1.0	2.2	1.2	3.7	-0.4	3.3	--	--	--	--	--	--
Research and development	-0.7	0.8	0.1	2.4	1.6	4.0	--	--	--	--	--	--
Other business activities	-6.7	2.1	-4.6	3.7	2.7	6.3	--	--	--	--	--	--
Public administration and defence; Compulsary social secturity	5.6	-14.7	-9.0	20.7	-1.5	19.1	--	--	--	--	--	--
Education	-0.7	-0.6	-1.2	12.2	-4.4	7.9	--	--	--	--	--	--
Health and social work	-0.9	-2.1	-3.0	19.9	2.5	22.5	--	--	--	--	--	--
Sewage and refuse disposal, sanitation and similar activities	1.2	-2.5	-1.4	2.1	-0.9	1.2	--	--	--	--	--	--
Activities of membership organizations nec	-6.1	1.8	-4.4	-0.1	-0.8	-0.9	--	--	--	--	--	--
Recreational, cultural and sporting activities	-3.1	2.3	-0.8	16.3	-5.0	11.3	--	--	--	--	--	--
Other service activities	-4.4	-0.4	-4.8	4.4	-0.8	3.6	--	--	--	--	--	--
SERVICES	-115.3	15.3	-100.0	117.4	-17.4	100.0	--	--	--	--	--	--

Table 6.4b Percentage contribution of the efficiency (EFF) effect and the structure (STR) effect by sector to the annual growth rate of Services energy intensity. GDP-weighted cross-country averages.

1995–2005	**USA**			**Japan**			**EU12**			**EU4**		
	EFF Effect	STR Effect	TOT Effect	EFF Effect	STR Effect	TOT Effect	EFF Effect	STR Effect	TOT Effect	EFF Effect	STR Effect	TOT Effect
Sale, maintenance, repair motor vehicles and -cycles; retail sale of fuel	-32.3	23.2	-9.0	-0.2	0.8	0.6	1.6	-2.4	-0.8	1.9	2.2	4.1
Other wholesale trade and commission trade	-15.9	-4.5	-20.4	3.1	-10.7	-7.6	-60.5	9.6	-50.9	-79.1	31.6	-47.4
Other retail trade; repair of household goods	-51.4	25.5	-25.9	-9.6	-63.1	-72.7	8.4	-6.9	1.5	-24.1	2.5	-21.5
Hotels and restaurants	-7.1	-8.1	-15.2	82.5	-45.4	37.2	1.1	-6.6	-5.5	-4.2	-7.3	-11.5
Post and Telecommunications	-4.6	3.8	-0.8	25.1	28.2	53.2	-18.5	26.7	8.2	-13.4	6.9	-6.6
Financial intermediation, except insurance and pension funding	-7.5	7.0	-0.5	-2.5	1.7	-0.8	-6.6	5.3	-1.3	-2.8	3.5	0.6
Insurance and pension funding, except compulsory social security	0.5	-1.4	-0.9	3.5	-5.0	-1.5	9.2	-9.5	-0.2	4.6	2.7	7.2
Activities related to financial intermediation	--	--	--	--	--	--	0.1	1.6	1.7	-1.3	0.7	-0.6
Renting of machinery and equipment	6.9	-4.4	2.5	-13.9	13.4	-0.5	-1.1	2.0	0.9	-0.3	0.3	0.0
Computer and related activities	-1.0	2.7	1.7	-4.4	3.1	-1.3	-5.0	9.1	4.1	-0.7	2.3	1.5
Research and development	1.1	0.2	1.3	11.4	1.7	13.0	-1.0	-1.6	-2.6	0.3	-3.9	-3.7
Other business activities	1.0	1.4	2.5	4.7	4.9	9.6	-6.1	6.4	0.3	-20.1	2.3	-17.8
Public administration and defence; Compulsary social secturity	9.3	-26.7	-17.5	-13.7	-11.2	-24.9	15.8	-26.6	-10.7	-1.3	-0.1	-1.4
Education	1.0	-1.1	-0.1	29.6	-11.2	18.4	15.4	-18.6	-3.3	7.1	-2.7	4.4
Health and social work	-5.4	-0.7	-6.1	14.0	48.5	62.6	-33.0	-0.6	-33.6	1.5	-9.8	-8.3
Sewage and refuse disposal, sanitation and similar activities	1.4	-4.7	-3.3	2.1	-2.0	0.1	5.5	-4.6	0.9	4.9	0.2	5.0
Activities of membership organizations nec	-1.0	-2.6	-3.5	-0.2	-0.8	-1.0	0.4	-3.3	-2.9	-0.8	0.0	-0.8
Recreational, cultural and sporting activities	-2.4	1.4	-1.0	14.9	-9.2	5.6	-4.1	2.8	-1.3	-0.1	-0.1	-0.2
Other service activities	-2.7	-1.0	-3.7	14.4	-4.3	10.1	-1.6	-2.9	-4.5	1.4	-4.5	-3.2
SERVICES	-110.1	10.1	-100.0	160.8	-60.8	100.0	-79.9	-20.1	-100.0	-126.6	26.6	-100.0

7. Conclusions

Decreasing energy intensity (i.e., the ratio of energy input to economic activity) is crucial in addressing present-day concerns about greenhouse gas emissions and energy security. Both academic research and policy making in this area require insight in historic trends and determinants of this ratio, across countries and across sectors. Against this background we introduced and discussed in this paper a new database that combines the recently launched 'EU KLEMS Growth and Productivity Accounts' with physical energy data from the International Energy Agency (IEA). The EU KLEMS database contains industry-level measures of output, inputs and productivity, derived from a harmonized system of National Accounts. It includes information on energy inputs that – in combination with IEA data – enables detailed sectoral analysis of energy intensity developments (both in terms of growth rates and levels) for 19 OECD countries, during the period 1980–2005.

The principal aim of this paper is to show the value of this dataset for cross-country empirical analysis in the field of energy economics in general, and for studies into trends and determinants of energy intensity (productivity) in particular. We did so by means of an empirical analysis consisting of the following components. First, we documented per country the growth rates of energy use, value added and energy intensity (i.e. the ratio of energy use to value added) at the aggregate economy level as well as for the aggregate Manufacturing sector and the aggregate Service sector. In doing so, we compared EU KLEMS based figures with figures derived from combining the widely used OECD Structural Analysis (STAN) database (economy data) with IEA energy. Also, we analyzed average annual growth rates of energy intensity changes for all sectors included in our dataset, distinguishing different time periods. Second, at various levels of sectoral detail, we compared levels of energy intensity across countries and analyzed the evolution of the observed cross-countries differences over time. Third, by means of a decomposition analysis we calculated for each country to what extent aggregate energy intensity trends are to be explained from, respectively, shifts in the underlying sectoral structure and efficiency improvements within individual sectors. Our analysis comprised 25 Manufacturing sectors (10 main sectors, 15 subsectors), 23 Services sectors (9 main sectors, 14 subsectors), as well as the sectors Transport, Agriculture and Construction; it included 16 EU member countries, the USA, Japan and South Korea.

We found that between 1980 and 2005 in most countries energy intensity decreased at the aggregate economy level and at the level of the aggregate manufacturing sector. In contrast, at the level of the aggregate services sector a range of countries displays increasing levels of energy intensity. Moreover, we document considerable sectoral heterogeneity in average energy intensity growth rates across countries, at all levels of aggregation. Our data also show a remarkable slow down in energy intensity decreases between 1980 and 1995 for most non-Service sectors. Supposedly, after increases in energy efficiency invoked by the energy crises of the (late) 1970s, further improvements during the period 1985−1995 faded away in an era of relatively low and decreasing energy prices. Finally, for most countries the use of EU KLEMS or IEA leads to considerably different trends in energy use, without a clear cross-country pattern, while differences in value added series derived from the EU KLEMS and STAN database are small, except for Manufacturing in some countries. Regarding levels of energy intensity, we document substantial cross-country differences at all levels of aggregation. Nevertheless, we found that energy intensity levels tend to converge across OECD countries at all levels of aggregation. This pattern of so-called

σ-convergence is particularly strong in the Manufacturing and Services sector, and much less strong in Agriculture and Construction. Our decomposition analysis revealed that at all levels of aggregation reductions in energy intensity have been influenced more by within-sector energy efficiency improvements than by changes in the composition of activities, respectively within the economy or within the aggregate Manufacturing or Service sector. At the same time, our results show that structural changes play an increasingly important role in driving aggregate changes in energy intensity - either positive or negative. Within the Manufacturing sector the efficiency effect is mainly realized within the energy intensive sectors Chemicals, Non-Metallic Minerals, Basic Metals, and to a lesser extent also in Electrical Engineering. Within the Service sector the efficiency effect is mainly realized within the various Wholesale and Retail sectors, Post and Telecommunication and Financial Intermediation and Other Business Activities. In the Manufacturing sector, the structure effect is driven by diverse developments, depending on the country. In the Service sector the structure effect in most country is mainly driven by a shift towards the sectors Post and Telecommunications, Computer and Related Activities and Other Business Activities in combination with a shift away from the sectors Hotels and Restaurants, Public Administration and Defense and Education.

The relationship between economic activity and energy use is notoriously complex because it involves a variety of issues, each with its own dynamics. As a result, a vast body of literature is devoted to study trends and determinants of energy intensity and the relationship between energy and economic growth. Most of these studies rely on study-specific databases compiled by researchers on their own, making replication and comparability of studies difficult. In contrast, the EU KLEMS database addresses these issues by providing comprehensive cross-country data series at a detailed sector level, derived from a consistent framework. Additional distinctive features of the database are the inclusion of a wide range of Service sectors, the high quality of the data and the fact that the energy data are mutually consistent with a range of industry-level measures of output, inputs and productivity. Limitations of the database include omission of data on energy use by households (including personal transportation) and fuel specific energy inputs, as well as data on energy use in the Chemical and Basic Metal industries at a 3-digit level (which also holds for the widely used IEA database). Notwithstanding these drawbacks, we think that this dataset is a valuable source of information for future empirical work in energy economics. Directions for future research include (empirical) studies of biased technology change, production functions and production factor substitution elasticities, and the role of energy in economic growth processes.

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Appendix A – Macro

Table A.1 Average annual growth rates energy intensity by sector for the periods 1980−2005, 1980−1995 and 1995−2005.

	AUT	BEL	CZE	DNK	FIN	FRA	GER	HUN	ITA	JPN	KOR	NLD	POL	PRT	SPA	SVK	SWE	UKD	USA
MACRO																			
1980-2005	1.3	0.3	--	-2.1	-0.5	-2.4	-2.4	--	--	-0.8	-0.8	-0.9	--	--	-1.1	--	--	0.1	-2.4
1980-1995	0.4	1.8	--	-1.3	1.7	-1.7	-2.5	--	--	-0.6	-2.7	1.5	--	--	-2.5	--	--	0.9	-2.3
1995-2005	2.5	-1.9	-1.4	-3.2	-3.7	-3.4	-2.2	-4.6	-3.9	-1.0	2.2	-2.8	1.0	0.1	1.0	-4.1	-4.0	-1.0	-2.6
MANUFACTURING																			
1980-2005	-0.2	-0.2	--	-1.4	-3.8	-1.0	-2.4	--	--	-2.5	-2.2	-0.2	--	--	-0.9	--	--	-0.9	-3.7
1980-1995	0.0	0.3	--	-2.0	-0.1	0.9	-2.2	--	--	-2.5	-2.8	1.1	--	--	-4.0	--	--	-0.9	-2.0
1995-2005	-0.6	-1.0	-4.6	-0.5	-7.8	-3.1	-2.6	-7.8	0.5	-2.5	-1.4	-1.3	-3.4	2.0	3.8	-8.8	-8.4	-0.9	-6.4
SERVICES																			
1980-2005	3.0	0.8	--	-3.6	1.5	-1.7	-2.5	--	-6.5	1.8	0.4	0.4	--	-2.2	0.9	--	--	1.0	-1.8
1980-1995	3.4	2.9	--	-3.1	1.7	-2.7	-3.1	--	-2.6	2.5	-2.4	2.7	--	-2.9	-2.1	--	--	1.6	-2.2
1995-2005	2.4	-2.5	1.8	-4.3	1.3	-0.3	-1.6	-6.6	--	0.8	4.4	-1.4	0.2	-1.1	5.5	-5.7	-3.1	0.1	-1.3
TRANSPORT																			
1980-2005	4.2	1.0	--	-0.5	1.3	-6.1	-1.5	--	-2.9	0.6	-1.0	-2.3	--	0.4	-1.2	--	--	2.5	-1.5
1980-1995	0.8	3.2	--	2.6	3.8	-4.6	-1.6	--	-3.9	0.5	-3.2	0.4	--	-0.9	-1.8	--	--	3.7	-2.1
1995-2005	9.3	-2.5	-1.9	-5.2	-2.3	-8.4	-1.2	3.2	-1.5	0.7	2.3	-4.5	7.6	2.4	-0.3	7.7	-0.6	0.6	-0.7
AGRICULTURE																			
1980-2005	-1.9	-0.3	--	-3.6	-1.7	-2.2	-4.5	--	-2.9	0.9	1.2	-1.1	--	0.0	-0.8	--	--	1.8	-5.3
1980-1995	-1.0	-2.0	--	-3.8	0.0	-2.3	-3.5	--	-0.8	1.8	1.2	-2.4	--	-2.4	-1.1	--	--	2.1	-7.4
1995-2005	-3.2	2.3	-5.7	-3.1	-4.2	-2.0	-6.0	-10.1	-6.0	-0.4	1.3	-0.1	-2.8	3.6	-0.2	-5.1	3.4	1.3	-2.3
CONSTRUCTION																			
1980-2005	-0.5	-3.2	--	-5.2	2.4	-3.0	-2.7	--	-0.9	1.9	0.2	2.8	--	1.3	-1.8	--	--	2.6	0.6
1980-1995	0.4	1.0	--	-7.8	2.7	-3.8	-2.3	--	-1.9	1.0	-1.4	6.2	--	0.4	-4.0	--	--	3.7	0.4
1995-2005	-1.8	-9.5	-0.5	-1.3	2.0	-1.7	-3.4	-0.5	0.5	3.3	2.7	0.2	-0.3	2.6	1.4	-8.7	-1.0	0.8	0.8

Table A.2 Percentage contribution of the efficiency effect (EFF) and the structural effect (STR) by sector to the average annual growth rate of energy intensity per country, for the period 1980−2005.

1980-2005	**Austria**			**Belgium**			**Denmark**			**Finland**			**France**		
	EFF Effect	STR Effect	TOT Effect	EFF Effect	STR Effect	TOT Effect	EFF Effect	STR Effect	TOT Effect	EFF Effect	STR Effect	TOT Effect	EFF Effect	STR Effect	TOT Effect
Manufacturing	-6.5	10.6	4.0	-33.4	40.7	7.3	-18.5	-20.0	-38.5	-400.0	262.0	-138.0	-9.4	-24.8	-34.2
Services	33.9	0.9	34.8	35.7	1.7	37.4	-37.3	5.1	-32.2	26.2	-8.6	17.6	-12.2	5.0	-7.2
Transport	116.7	-36.1	80.6	106.8	-31.0	75.9	-9.5	-0.1	-9.6	58.4	16.9	75.3	-122.5	68.9	-53.6
Agriculture	-8.1	-5.8	-13.9	-2.9	0.0	-2.9	-11.8	3.2	-8.6	-23.0	-31.7	-54.8	-2.4	-0.2	-2.5
Construction	-2.5	-3.0	-5.5	-12.9	-4.8	-17.7	-8.8	-2.2	-11.1	8.9	-9.0	-0.1	-1.8	-0.7	-2.4
MACRO	133.4	-33.4	100.0	93.4	6.6	100.0	-86.0	-14.0	-100.0	-329.6	229.6	-100.0	-148.3	48.3	-100.0
	Germany			**Japan**			**Korea**			**Netherlands**			**Spain**		
	EFF Effect	STR Effect	TOT Effect	EFF Effect	STR Effect	TOT Effect	EFF Effect	STR Effect	TOT Effect	EFF Effect	STR Effect	TOT Effect	EFF Effect	STR Effect	TOT Effect
Manufacturing	-43.0	-12.0	-54.9	-136.0	27.9	-108.1	-99.5	141.7	42.1	-7.9	-9.5	-17.4	-31.9	-20.3	-52.3
Services	-17.2	4.2	-12.9	38.5	7.7	46.2	10.0	-22.5	-12.5	7.4	2.4	9.8	6.7	1.4	8.1
Transport	-23.7	-0.9	-24.6	27.7	-47.2	-19.5	-53.9	-62.3	-116.2	-104.4	24.5	-80.0	-52.8	5.4	-47.4
Agriculture	-5.2	-1.1	-6.3	5.9	-22.0	-16.1	4.6	-17.4	-12.8	-12.4	-0.7	-13.0	-2.9	-4.8	-7.8
Construction	-0.6	-0.7	-1.2	4.9	-7.3	-2.5	0.2	-0.8	-0.6	1.6	-0.9	0.6	-1.0	0.3	-0.7
MACRO	-89.6	-10.4	-100.0	-59.1	-40.9	-100.0	-138.6	38.6	-100.0	-115.8	15.8	-100.0	-81.9	-18.1	-100.0
	United Kingdom			**USA**											
	EFF Effect	STR Effect	TOT Effect	EFF Effect	STR Effect	TOT Effect									
Manufacturing	-356.5	-676.8	-1033.3	-46.8	-3.9	-50.7									
Services	122.1	64.5	186.6	-12.0	1.5	-10.5									
Transport	888.3	47.6	935.9	-32.3	-4.2	-36.5									
Agriculture	14.2	-11.8	2.4	-3.6	1.4	-2.2									
Construction	9.5	-1.1	8.4	0.0	-0.1	-0.1									
MACRO	677.6	-577.6	100.0	-94.7	-5.3	-100.0									

Table A.3a Percentage contribution of the efficiency effect (EFF) and the structural effect (STR) by sector to the average annual growth rate of energy intensity per country, for the period 1995−2005.

1995-2005	Austria			Belgium			Czech Republic			Denmark			Finland		
	EFF Effect	STR Effect	TOT Effect	EFF Effect	STR Effect	TOT Effect	EFF Effect	STR Effect	TOT Effect	EFF Effect	STR Effect	TOT Effect	EFF Effect	STR Effect	TOT Effect
Manufacturing	-8.6	14.5	5.9	-23.0	-7.0	-30.0	-144.5	105.8	-38.7	-3.5	-15.2	-18.7	-118.5	41.3	-77.2
Services	17.2	-0.7	16.5	-21.4	1.3	-20.1	19.4	-7.4	12.0	-25.7	2.8	-22.9	2.7	-2.6	0.1
Transport	129.7	-38.3	91.4	-49.1	3.9	-45.2	-44.7	-7.1	-51.8	-78.0	29.1	-48.9	-14.8	0.2	-14.6
Agriculture	-5.5	-2.2	-7.7	3.3	-2.6	0.7	-15.2	-2.3	-17.5	-6.5	-2.1	-8.6	-5.3	-3.6	-8.9
Construction	-4.8	-1.3	-6.1	-5.2	-0.2	-5.4	-0.5	-3.6	-4.1	-0.7	-0.2	-0.9	0.8	-0.2	0.5
MACRO	128.0	-28.0	100.0	-95.4	-4.6	-100.0	-185.5	85.5	-100.0	-114.4	14.4	-100.0	-135.1	35.1	-100.0
	France			**Germany**			**Hungary**			**Italy**			**Japan**		
	EFF Effect	STR Effect	TOT Effect	EFF Effect	STR Effect	TOT Effect	EFF Effect	STR Effect	TOT Effect	EFF Effect	STR Effect	TOT Effect	EFF Effect	STR Effect	TOT Effect
Manufacturing	-27.5	1.6	-25.9	-46.9	1.8	-45.1	-48.6	16.5	-32.1	6.5	-10.3	-3.8	-91.6	15.4	-76.1
Services	-1.3	-0.2	-1.5	-12.2	2.7	-9.5	-50.3	-4.2	-54.5	-79.8	3.6	-76.2	16.4	9.7	26.1
Transport	-123.5	54.3	-69.2	-23.7	-14.1	-37.9	20.2	-19.7	0.6	-14.9	1.0	-13.9	26.8	-65.0	-38.2
Agriculture	-1.6	-0.8	-2.4	-5.9	0.0	-5.9	-14.3	0.3	-13.9	-5.5	-0.6	-6.1	-1.7	-9.2	-10.8
Construction	-0.6	-0.5	-1.0	-0.7	-1.0	-1.7	0.0	0.0	0.0	0.0	0.0	0.0	6.1	-7.1	-1.0
MACRO	-154.5	54.5	-100.0	-89.4	-10.6	-100.0	-93.0	-7.0	-100.0	-93.7	-6.3	-100.0	-43.9	-56.1	-100.0
	South Korea			**Netherlands**			**Poland**			**Portugal**			**Spain**		
	EFF Effect	STR Effect	TOT Effect	EFF Effect	STR Effect	TOT Effect	EFF Effect	STR Effect	TOT Effect	EFF Effect	STR Effect	TOT Effect	EFF Effect	STR Effect	TOT Effect
Manufacturing	-26.2	60.4	34.2	-14.6	-7.5	-22.1	-130.3	169.2	38.9	104.7	-40.4	64.3	133.2	-39.1	94.1
Services	40.9	-7.2	33.7	-8.9	2.1	-6.8	2.5	-9.9	-7.4	-27.1	12.8	-14.3	48.6	2.6	51.2
Transport	34.7	0.2	35.0	-65.7	0.8	-64.9	183.7	-23.0	160.6	172.9	-127.5	45.4	-17.5	-15.6	-33.2
Agriculture	1.5	-4.0	-2.5	-0.3	-5.5	-5.8	-44.2	-45.7	-89.9	19.4	-19.1	0.3	-1.1	-12.8	-13.9
Construction	0.9	-1.3	-0.4	0.0	-0.4	-0.4	-0.2	-2.0	-2.2	8.4	-4.1	4.2	0.8	0.9	1.7
MACRO	51.8	48.2	100.0	-89.5	-10.5	-100.0	11.5	88.5	100.0	278.3	-178.3	100.0	163.9	-63.9	100.0

Table A.3b Percentage contribution of the efficiency effect (EFF) and the structural effect (STR) by sector to the average annual growth rate of energy intensity per country, for the period 1995-2005.

	Slovakia			**Sweden**			**United Kingdom**			**USA**		
	EFF Effect	STR Effect	TOT Effect	EFF Effect	STR Effect	TOT Effect	EFF Effect	STR Effect	TOT Effect	EFF Effect	STR Effect	TOT Effect
Manufacturing	-98.2	41.7	-56.4	-95.3	53.7	-41.6	-32.6	-102.3	-134.9	-71.0	6.2	-64.8
Services	-36.1	-4.7	-40.8	-14.3	-8.5	-22.8	1.8	12.4	14.2	-8.6	-0.1	-8.7
Transport	45.3	-44.4	0.8	-4.9	-30.1	-35.0	30.1	-8.2	21.9	-13.7	-11.5	-25.2
Agriculture	-2.7	0.3	-2.3	2.1	-2.5	-0.3	1.2	-2.4	-1.2	-1.3	0.0	-1.3
Construction	-1.4	0.1	-1.3	-0.1	-0.3	-0.4	0.4	-0.4	0.0	0.0	-0.1	-0.1
MACRO	-93.0	-7.0	-100.0	-112.4	12.4	-100.0	1.0	-101.0	-100.0	-94.6	-5.4	-100.0

Appendix B – Manufacturing

Table B.1a Average annual growth rates energy intensity by sector for the periods 1980−2005, 1980−1995 and 1995−2005.

	AUT	BEL	CZE	DNK	FIN	FRA	GER	HUN	ITA	JPN	KOR	NLD	POL	PRT	SPA	SVK	SWE	UKD	USA
FOOD, BEVERAGES AND TOBACCO																			
1980-2005	0.8	-0.5	--	1.0	-1.1	0.7	-1.1	--	1.4	2.9	0.4	-0.4	--	--	-0.1	--	--	1.0	-2.4
1980-1995	0.8	1.3	--	1.4	-1.8	1.0	-1.5	--	-1.0	4.0	-0.4	0.3	--	--	-3.9	--	--	2.5	-2.5
1995-2005	0.8	-3.2	-4.8	0.3	0.0	0.1	-0.5	-1.4	4.9	1.3	1.5	-1.0	1.3	2.3	5.6	-3.4	-1.4	-1.2	-2.3
Food and beverages																			
1980-2005	0.5	--	--	0.9	-2.4	--	--	--	--	2.7	0.4	-0.3	--	--	-0.3	--	--	1.0	-3.1
1980-1995	0.3	--	--	1.3	-1.9	--	--	--	--	3.8	-0.3	0.5	--	--	-4.3	--	--	2.8	-3.0
1995-2005	0.9	-3.4	-4.7	0.3	-3.3	--	-0.3	-1.9	--	0.9	1.6	-1.0	1.0	2.6	5.6	-4.3	-1.4	-1.6	-3.3
Tobacco																			
1980-2005	7.5	--	--	4.9	-0.6	--	--	--	--	0.7	-1.5	-1.5	--	--	1.3	--	--	0.3	5.3
1980-1995	10.1	--	--	7.6	-2.1	--	--	--	--	0.4	-3.7	-2.3	--	--	1.0	--	--	-7.1	3.1
1995-2005	3.7	-7.5	-9.5	0.8	1.7	--	-4.4	10.3	--	1.1	1.7	-0.9	12.7	-8.5	1.9	9.7	--	11.4	8.5
TEXTILES, LEATHER AND FOOTWEAR																			
1980-2005	4.9	1.4	--	0.8	-0.8	-1.2	0.1	--	2.7	3.9	1.5	-0.1	--	-2.7	-1.2	--	--	0.4	-3.3
1980-1995	7.0	2.0	--	-1.9	-0.4	-0.4	1.1	--	3.4	3.4	0.2	2.6	--	-4.6	-3.7	--	--	0.6	-2.0
1995-2005	1.8	0.6	-2.3	4.8	-1.3	-2.4	-1.4	-13.9	1.5	4.8	3.6	-2.2	3.5	0.1	2.7	-6.1	-1.3	0.1	-5.2
Textiles																			
1980-2005	4.8	1.2	--	0.5	-0.8	-1.3	--	--	2.8	3.9	1.4	-0.3	--	-3.0	-1.3	--	--	0.4	-3.6
1980-1995	7.2	1.8	--	-2.0	-0.2	0.2	--	--	3.7	3.1	-0.2	2.1	--	-4.6	-3.8	--	--	0.4	-2.3
1995-2005	1.2	0.3	-0.7	4.3	-1.7	-3.7	-1.4	-15.2	1.5	5.0	3.8	-2.2	3.6	-0.7	2.6	-4.8	-0.5	0.3	-5.4
Leather and footwear																			
1980-2005	5.6	2.7	--	4.2	-0.4	-2.8	--	--	2.5	6.0	1.8	1.3	--	0.8	-0.2	--	--	-2.1	-0.3
1980-1995	5.4	0.3	--	-1.7	-1.2	-7.3	--	--	2.6	8.2	1.8	6.6	--	-1.2	-2.2	--	--	1.6	1.0
1995-2005	6.0	6.4	-18.5	13.1	0.6	4.0	-2.2	-7.4	2.3	2.6	1.7	-2.9	2.3	3.8	2.8	-13.1	-6.9	-7.6	-2.4

Table B.1b Average annual growth rates energy intensity by sector for the periods 1980−2005, 1980−1995 and 1995−2005.

	AUT	BEL	CZE	DNK	FIN	FRA	GER	HUN	ITA	JPN	KOR	NLD	POL	PRT	SPA	SVK	SWE	UKD	USA
WOOD AND CORK																			
1980-2005	6.1	0.0	--	-1.9	-1.4	-4.3	-1.9	--	2.1	--	1.1	2.5	--	-5.6	0.1	--	--	--	-2.5
1980-1995	5.1	-2.1	--	-1.2	0.1	-7.0	-3.0	--	2.2	--	0.5	6.0	--	-8.8	-0.9	--	--	--	-3.1
1995-2005	7.6	3.0	-2.8	-3.0	-3.6	-0.1	-0.3	-4.9	1.9	--	2.0	-0.4	3.4	-0.8	1.6	-11.6	1.0	2.2	-1.6
PULP, PAPER, PRINTING AND PUBLISHING																			
1980-2005	-0.3	0.3	--	-0.5	-1.9	1.4	-1.9	--	0.2	0.7	2.5	0.3	--	-1.4	-2.3	--	--	0.6	-2.5
1980-1995	-0.6	0.8	--	-1.3	-0.4	2.9	-2.1	--	-1.1	1.1	1.0	1.2	--	-3.5	-5.7	--	--	-1.2	-0.6
1995-2005	0.3	-0.6	-5.4	0.7	-4.1	-0.9	-1.7	-8.3	2.0	0.0	4.8	-0.5	9.6	1.8	2.8	-0.6	0.2	3.2	-5.2
Pulp and paper																			
1980-2005	-0.9	--	--	-2.2	-2.0	3.3	--	--	--	-0.1	0.7	-0.4	--	--	-1.1	--	--	0.6	-3.3
1980-1995	-2.4	--	--	-4.4	-0.5	6.4	--	--	--	0.7	-0.6	2.1	--	--	-5.2	--	--	-3.2	-0.6
1995-2005	1.2	-4.5	-6.6	1.1	-4.1	-1.3	-4.2	-4.6	-0.1	-1.2	2.6	-2.4	9.1	-0.9	5.0	-1.9	-1.2	6.3	-7.4
Printing, publishing and reproduction																			
1980-2005	0.6	--	--	-0.5	-10.9	-0.4	--	--	--	2.4	5.2	0.9	--	--	-2.4	--	--	3.3	-1.2
1980-1995	0.9	--	--	-0.5	-6.9	-0.2	--	--	--	2.6	4.0	1.7	--	--	-4.7	--	--	3.6	-0.5
1995-2005	0.1	4.1	-5.3	-0.5	-16.8	-0.7	-0.9	-13.0	3.6	2.0	7.0	0.2	8.3	0.6	1.1	2.8	2.7	2.7	-2.1
CHEMICALS																			
1980-2005	-5.5	-1.1	--	-3.6	-1.1	-3.6	-4.4	--	-2.7	-5.3	-0.4	-1.3	--	2.3	0.0	--	--	-5.0	-2.9
1980-1995	-3.1	-3.1	--	-3.6	-1.4	-5.4	-3.4	--	-4.3	-9.0	-1.3	0.6	--	1.4	-1.5	--	--	-4.3	-1.2
1995-2005	-9.1	1.9	8.4	-3.4	-0.5	-0.7	-5.9	3.2	-0.4	0.3	0.9	-2.8	5.7	3.7	2.3	-0.8	-6.2	-6.1	-5.4
NON-METALLIC MINERALS																			
1980-2005	1.7	0.1	--	-1.4	-1.3	-3.2	-2.8	--	-2.5	-2.3	1.1	1.0	--	--	-1.8	--	--	-0.8	-2.8
1980-1995	2.8	0.6	--	-2.0	-0.5	-4.0	-3.0	--	-3.7	-2.9	-0.2	2.0	--	--	-6.1	--	--	-0.8	-2.9
1995-2005	0.0	-0.5	-9.1	-0.4	-2.6	-2.0	-2.5	-1.1	-0.8	-1.4	3.1	0.2	-12.7	6.4	4.8	-7.6	-5.3	-0.9	-2.6

Table B.1c Average annual growth rates energy intensity by sector for the periods 1980−2005, 1980−1995 and 1995−2005.

	AUT	BEL	CZE	DNK	FIN	FRA	GER	HUN	ITA	JPN	KOR	NLD	POL	PRT	SPA	SVK	SWE	UKD	USA
BASIC METALS																			
1980-2005	-0.2	-1.1	--	1.8	-0.8	-10.3	-1.9	--	--	-1.5	-1.3	-0.6	--	2.1	-0.3	--	--	-0.2	-3.3
1980-1995	-1.6	0.2	--	-0.9	1.0	-14.6	-3.1	--	--	-2.3	-3.0	2.4	--	4.8	-4.3	--	--	-4.6	-2.2
1995-2005	2.0	-3.0	7.3	5.8	-3.3	-3.8	-0.1	-0.8	1.6	-0.3	1.2	-3.0	-0.7	-2.0	5.6	-11.1	-1.2	6.5	-4.8
MACHINERY																			
1980-2005	1.1	-0.5	--	-1.5	-5.9	1.3	-3.1	--	--	-2.7	-4.0	0.7	--	-1.7	-1.8	--	--	0.2	-4.8
1980-1995	0.8	0.6	--	-2.8	-0.8	5.6	-2.2	--	--	-1.5	-5.4	1.6	--	-0.9	-4.9	--	--	0.5	-2.3
1995-2005	1.5	-2.2	-7.7	0.5	-13.5	-5.1	-4.5	-13.8	1.8	-4.6	-1.8	0.0	-8.0	-2.8	3.0	-9.6	-16.4	-0.3	-8.6
Fabricated metal																			
1980-2005	1.6	-1.7	--	-1.4	-4.7	4.2	-2.6	--	--	0.1	-0.3	0.9	--	0.9	-1.2	--	--	-0.7	-1.9
1980-1995	1.3	-1.0	--	-3.4	-8.2	9.6	-2.9	--	--	-0.4	-3.1	0.8	--	4.1	-4.5	--	--	-0.6	-1.4
1995-2005	2.1	-2.7	-3.0	1.5	0.5	-4.0	-2.1	-10.7	-0.8	0.9	4.0	1.0	-9.2	-4.0	3.8	-10.4	3.1	-0.7	-2.7
Machinery NEC																			
1980-2005	1.5	-1.1	--	0.2	0.5	-6.9	-3.5	--	1.6	-0.4	-0.8	-0.7	--	0.0	-3.1	--	--	1.7	-1.6
1980-1995	2.0	2.2	--	-0.5	1.9	-7.1	-2.2	--	0.3	0.4	-3.1	0.6	--	-2.2	-5.0	--	--	2.9	-0.7
1995-2005	0.9	-6.1	-8.3	1.3	-1.7	-6.7	-5.6	-5.6	3.5	-1.7	2.7	-1.8	-7.0	3.2	-0.3	-9.4	-4.4	0.0	-3.0
Office, accounting and computing machinery																			
1980-2005	-4.6	4.6	--	-2.1	-5.8	-4.2	-5.6	--	--	-7.2	-1.4	-10.3	--	-8.4	-2.0	--	--	-5.0	-10.4
1980-1995	0.4	2.8	--	-1.2	-4.2	3.1	-1.4	--	--	-8.5	-5.9	-20.0	--	-9.4	-4.2	--	--	-3.6	-6.9
1995-2005	-12.1	7.2	-15.5	-3.4	-8.1	-15.3	-12.0	-2.1	12.2	-5.4	5.3	-2.6	4.1	-6.9	1.4	1.0	-0.5	-7.0	-15.5
Electrical engineering																			
1980-2005	0.1	3.0	--	-6.6	-10.1	3.2	-2.5	--	--	-7.9	-2.4	3.4	--	-6.9	-1.4	--	--	-0.4	-10.1
1980-1995	-0.8	2.2	--	-8.5	1.0	7.2	-0.5	--	--	-7.2	-4.5	4.8	--	-9.1	-6.2	--	--	-0.6	-7.0
1995-2005	1.4	4.1	-9.2	-3.8	-26.8	-2.8	-5.5	-15.1	3.0	-8.9	0.7	2.3	-6.4	-3.5	5.8	-9.0	-37.1	0.0	-14.8

Table B.1d Average annual growth rates energy intensity by sector for the periods 1980−2005, 1980−1995 and 1995−2005.

	AUT	BEL	CZE	DNK	FIN	FRA	GER	HUN	ITA	JPN	KOR	NLD	POL	PRT	SPA	SVK	SWE	UKD	USA
TRANSPORT EQUIPMENT																			
1980-2005	0.9	1.0	--	1.2	-0.6	-1.2	-2.0	--	1.5	-0.9	1.6	-2.0	--	--	1.2	--	--	-1.0	-2.2
1980-1995	3.2	1.6	--	-2.0	3.6	-1.5	-1.2	--	1.2	-0.4	0.9	1.0	--	--	-0.4	--	--	-1.1	-0.4
1995-2005	-2.6	0.2	-12.5	6.0	-6.9	-0.8	-3.2	-13.6	1.9	-1.5	2.8	-4.4	-5.7	-10.9	3.6	-17.4	-5.5	-0.9	-4.8
Motor vehicles, trailers and semi-trailers																			
1980-2005	0.5	--	--	-1.1	-0.3	-2.0	-1.5	--	--	-1.4	2.0	-3.8	--	--	0.8	--	--	-1.5	-3.5
1980-1995	2.1	--	--	-1.0	-0.6	-0.4	-1.0	--	--	-1.2	1.6	-5.0	--	--	-1.0	--	--	-3.6	-0.4
1995-2005	-2.0	0.6	-15.2	-1.4	0.1	-4.4	-2.2	-15.1	0.2	-1.7	2.6	-2.9	-10.8	-10.7	3.7	-21.0	-6.6	1.6	-8.1
Other transport equipment																			
1980-2005	1.2	--	--	2.9	-2.8	0.2	-5.7	--	--	2.3	0.6	-0.2	--	--	0.9	--	--	-0.1	-0.9
1980-1995	4.7	--	--	-2.6	4.5	-3.9	-2.8	--	--	3.8	-1.3	5.7	--	--	-0.8	--	--	2.6	-0.7
1995-2005	-4.1	-3.6	0.5	11.2	-13.7	6.5	-10.1	6.5	6.2	0.0	3.4	-4.9	-0.6	-9.6	3.3	-4.3	-0.9	-4.2	-1.2
NON-SPECIFIED INDUSTY																			
1980-2005	1.6	-1.6	--	-0.6	0.9	-7.4	-1.0	--	--	1.2	1.9	0.4	--	-3.4	-0.1	--	--	2.2	-2.5
1980-1995	1.1	0.3	--	-1.2	-0.3	-8.3	-1.4	--	--	1.4	0.5	0.9	--	-5.4	-2.2	--	--	3.0	-2.2
1995-2005	2.4	-4.3	-10.1	0.4	2.7	-6.0	-0.5	-10.6	2.5	0.7	3.8	-0.1	-2.0	-0.4	2.9	-13.1	3.6	1.1	-3.0
Rubber and plastics																			
1980-2005	1.9	-2.1	--	-2.1	-0.3	-10.9	-1.8	--	2.2	0.6	0.9	-1.5	--	-2.5	-0.2	--	--	1.1	-4.1
1980-1995	1.7	0.1	--	-1.9	-1.5	-12.2	-2.5	--	2.5	1.4	-0.5	-2.1	--	-6.3	-2.3	--	--	-0.4	-4.0
1995-2005	2.3	-5.3	-14.0	-2.2	1.4	-8.9	-0.6	-15.7	1.9	-0.7	3.0	-0.9	2.7	3.1	2.9	-10.2	3.4	3.4	-4.2
Medical, precision and optical instruments																			
1980-2005	0.9	-1.4	--	-1.9	1.7	5.0	-1.3	--	--	1.1	-1.6	-0.9	--	-6.1	-1.7	--	--	-3.4	-2.3
1980-1995	2.7	2.9	--	-1.9	2.7	10.5	-0.2	--	--	-0.1	-5.6	-0.7	--	-9.4	-4.7	--	--	-2.3	-2.6
1995-2005	-2.0	-7.7	-0.5	-1.9	0.2	-3.2	-3.0	8.9	1.8	2.8	4.2	-1.1	-3.4	-1.2	2.9	-0.7	-2.4	-5.0	-1.9
Manufacturing NEC; Recycling																			
1980-2005	1.9	-0.2	--	1.5	2.3	5.5	0.5	--	-0.1	1.6	1.7	4.4	--	-4.8	-0.7	--	--	7.1	-2.4
1980-1995	0.4	0.5	--	0.2	0.2	7.1	-0.8	--	-2.7	2.5	0.2	6.6	--	-7.9	-2.8	--	--	11.3	-2.3
1995-2005	4.1	-1.3	-6.3	3.5	5.5	3.1	2.6	-5.9	3.8	0.3	4.0	2.6	-5.0	-0.2	2.4	-20.4	4.9	0.9	-2.7

Table B.2a Percentage contribution of the efficiency effect (EFF) and the structural effect (STR) by sector to the average annual growth rate of Manufacturing energy intensity per country, for the period 1980−2005.

1980–2005	**Austria**			**Belgium**			**Denmark**			**Finland**			**France**		
	EFF Effect	STR Effect	TOT Effect	EFF Effect	STR Effect	TOT Effect	EFF Effect	STR Effect	TOT Effect	EFF Effect	STR Effect	TOT Effect	EFF Effect	STR Effect	TOT Effect
Food and beverages	17.6	-4.9	12.7	-21.6	-33.4	-55.0	16.1	-23.4	-7.3	-1.5	-0.9	-2.4	8.6	16.4	25.1
Tobacco	2.0	-1.4	0.6				1.0	-0.8	0.2	0.0	-0.1	-0.1			
Textiles	39.3	-38.6	0.7	9.5	-12.6	-3.0	0.6	-3.7	-3.1	-0.2	-2.0	-2.2	-3.6	-2.6	-6.2
Leather and footwear	6.1	-5.8	0.4	1.1	-2.8	-1.8	0.5	-1.0	-0.5	0.0	-0.3	-0.3	-1.4	-3.1	-4.5
Wood and Cork	120.2	-30.4	89.9	-0.4	13.4	13.1	-4.9	2.6	-2.2	-1.0	-1.6	-2.5	-17.5	18.4	0.9
Pulp and paper	-76.9	147.3	70.4	5.4	5.3	10.7	-3.8	0.9	-2.9	-25.1	-13.1	-38.3	17.6	-2.2	15.4
Printing, publishing, etc.	11.6	11.9	23.5				-1.3	-3.9	-5.2	-34.8	-9.7	-44.5	-1.4	3.6	2.2
Chemicals	-588.5	208.4	-380.0	-160.6	463.1	302.5	-19.1	22.2	3.1	-1.4	-0.7	-2.1	-96.0	95.6	-0.3
Non-Metallic Minerals	108.6	-113.4	-4.8	7.3	-60.0	-52.7	-31.3	-42.3	-73.6	-1.1	-2.0	-3.1	-68.3	13.4	-54.9
Basic Metals	-17.3	1.3	-16.0	-126.5	-154.4	-280.9	3.2	-1.6	1.6	-1.3	1.4	0.0	-274.2	221.0	-53.2
Fabricated metal	19.4	-0.4	19.0	-10.3	-3.1	-13.3	-4.7	2.8	-1.9	-1.0	0.0	-0.9	19.7	-29.4	-9.7
Machinery NEC	15.0	5.3	20.3	-3.1	-4.0	-7.1	0.7	-2.2	-1.5	0.1	-0.3	-0.3	-23.5	13.2	-10.3
Office machinery, etc.	-0.2	0.6	0.3	0.1	0.0	0.0	-0.1	0.1	-0.1	0.0	0.0	0.0	-1.2	-0.5	-1.7
Electrical engineering	0.6	5.4	6.0	5.4	-2.3	3.1	-12.5	8.0	-4.5	-1.0	1.0	-0.1	4.0	0.7	4.7
Motor vehicles, trailers, etc.	7.5	26.4	33.9	6.0	2.9	8.9	-0.9	-0.7	-1.6	0.0	-0.1	-0.1	-6.7	8.7	2.1
Other transport equipment	3.2	-2.7	0.6				1.7	-2.5	-0.7	-0.3	-0.6	-0.9	0.4	0.7	1.0
Rubber and plastics	10.7	1.6	12.3	-26.0	50.9	24.8	-6.2	3.8	-2.4	-0.5	-1.1	-1.6	-97.0	81.3	-15.7
Medical instruments etc.	0.6	1.7	2.4	-3.0	-1.7	-4.7	-1.1	1.8	0.7	0.2	0.1	0.3	0.7	1.0	1.7
Manufacturing nec; recycling	10.1	-2.0	8.1	-3.1	-41.6	-44.6	2.8	-0.8	2.1	2.3	-3.2	-0.9	2.7	0.6	3.3
MANUFACTURING	-310.3	210.3	-100.0	-319.8	219.8	-100.0	-59.3	-40.7	-100.0	-66.9	-33.1	-100.0	-536.9	436.9	-100.0

Table B.2b Percentage contribution of the efficiency effect (EFF) and the structural effect (STR) by sector to the average annual growth rate of Manufacturing energy intensity per country, for the period 1980−2005.

1980–2005	**Germany**			**Japan**			**South Korea**			**Netherlands**			**Spain**		
	EFF Effect	STR Effect	TOT Effect	EFF Effect	STR Effect	TOT Effect	EFF Effect	STR Effect	TOT Effect	EFF Effect	STR Effect	TOT Effect	EFF Effect	STR Effect	TOT Effect
Food and beverages	-3.3	-4.9	-8.3	4.9	-4.2	0.6	1.2	-15.6	-14.3	-24.0	-38.0	-62.0	-3.3	-4.2	-7.5
Tobacco				0.0	-0.2	-0.2	-0.1	-0.7	-0.8	-2.0	0.5	-1.5	0.3	-1.1	-0.8
Textiles	0.1	-2.6	-2.5	3.6	-7.0	-3.4	10.5	-67.7	-57.2	-1.5	-17.3	-18.8	-6.5	-18.5	-25.0
Leather and footwear				0.3	-0.3	-0.1	2.4	-15.4	-13.0	0.3	-1.3	-1.0	-0.2	-2.0	-2.2
Wood and Cork	-0.9	-0.2	-1.2	--	--	--	0.5	-3.1	-2.6	4.9	-0.3	4.6	0.3	-3.9	-3.5
Pulp and paper	-7.3	-1.3	-8.6	-0.2	-5.2	-5.4	1.0	-3.6	-2.7	-8.2	-14.9	-23.1	-7.4	-3.7	-11.1
Printing, publishing, etc.				2.1	-1.8	0.3	4.4	-3.8	0.6	8.8	-11.4	-2.6	-7.1	6.3	-0.8
Chemicals	-34.1	12.8	-21.3	-26.0	24.4	-1.6	-2.8	3.3	0.5	-235.2	290.7	55.5	0.1	10.5	10.6
Non-Metallic Minerals	-14.0	-4.1	-18.1	-10.8	-10.2	-21.0	6.3	-15.8	-9.5	24.6	-36.4	-11.8	-48.1	28.1	-20.0
Basic Metals	-16.5	-7.7	-24.1	-20.3	-45.9	-66.3	-12.0	0.5	-11.5	-37.0	-13.2	-50.2	-7.1	-36.2	-43.4
Fabricated metal	-2.7	-0.1	-2.8	0.1	-0.9	-0.9	-0.3	-2.4	-2.8	13.3	0.1	13.3	-2.9	1.0	-1.9
Machinery NEC	-3.4	-0.8	-4.2	-0.2	0.2	0.0	-0.4	1.5	1.1	-6.9	4.1	-2.8	-4.5	1.4	-3.1
Office machinery, etc.	-0.2	0.2	0.0	-0.7	0.8	0.1	-0.1	0.3	0.3	-7.5	7.7	0.2	-0.1	0.2	0.1
Electrical engineering	-1.1	0.7	-0.5	-5.7	6.2	0.5	-2.2	7.0	4.7	41.1	-45.1	-4.1	-1.6	1.3	-0.2
Motor vehicles, trailers, etc.	-2.1	1.2	-0.8	-1.1	0.8	-0.3	1.4	3.6	5.0	-8.1	5.3	-2.9	1.4	2.2	3.6
Other transport equipment	-1.2	0.6	-0.6	0.3	-0.3	0.0	0.2	0.6	0.8	-0.4	-1.1	-1.5	0.6	-2.0	-1.4
Rubber and plastics	-7.6	8.4	0.8	2.1	-1.4	0.7	2.0	0.0	1.9	-13.8	5.2	-8.6	-1.3	8.7	7.3
Medical instruments etc.	-1.1	0.3	-0.8	1.0	-1.8	-0.8	-0.1	0.1	0.0	-1.0	2.6	1.6	-0.6	1.3	0.7
Manufacturing nec; recycling	1.3	-8.3	-7.0	2.6	-4.8	-2.2	0.4	-0.9	-0.6	19.1	-3.6	15.4	-1.5	0.1	-1.4
MANUFACTURING	-94.1	-5.9	-100.0	-48.1	-51.9	-100.0	12.1	-112.1	-100.0	-233.6	133.6	-100.0	-89.6	-10.4	-100.0

Table B.2c Percentage contribution of the efficiency effect (Eff) and the structural effect (STR) by sector to the average annual growth rate of Manufacturing energy intensity per country, for the period 1980−2005.

1980–2005	**United Kingdom**			**USA**		
	EFF Effect	STR Effect	TOT Effect	EFF Effect	STR Effect	TOT Effect
Food and beverages	10.3	-1.6	8.7	-7.8	0.1	-7.6
Tobacco	0.0	0.1	0.1	0.3	-0.4	-0.2
Textiles	1.7	-16.5	-14.8	-2.8	-1.9	-4.7
Leather and footwear	-0.5	-1.5	-2.0	0.0	-0.4	-0.4
Wood and Cork	0.0	0.0	0.0	-2.7	-0.9	-3.6
Pulp and paper	2.6	-8.0	-5.4	-13.3	-3.3	-16.6
Printing, publishing, etc.	8.4	1.9	10.3	-1.5	-2.0	-3.5
Chemicals	-143.9	52.5	-91.4	-21.2	-5.1	-26.3
Non-Metallic Minerals	-8.0	-4.1	-12.1	-6.2	-0.9	-7.1
Basic Metals	-2.5	-44.7	-47.2	-12.7	-7.1	-19.8
Fabricated metal	-2.9	1.9	-1.0	-1.2	-0.7	-1.8
Machinery NEC	5.2	-3.9	1.3	-1.0	-1.3	-2.2
Office machinery, etc.	-1.0	1.2	0.2	-0.7	0.5	-0.3
Electrical engineering	-0.6	1.4	0.8	-5.9	4.2	-1.7
Motor vehicles, trailers, etc.	-3.3	-0.1	-3.3	-1.5	0.5	-1.0
Other transport equipment	-0.1	0.7	0.6	-0.3	-0.6	-0.9
Rubber and plastics	13.5	11.7	25.2	-2.0	1.0	-0.9
Medical instruments etc.	-9.5	10.7	1.2	-0.6	-0.2	-0.7
Manufacturing nec; recycling	33.4	-4.8	28.6	-0.8	0.1	-0.7
MANUFACTURING	-97.2	-2.8	-100.0	-81.7	-18.3	-100.0

Table B.3a Percentage contribution of the efficiency effect (EFF) and the structural effect (STR) by sector to the average annual growth rate of Manufacturing energy intensity per country, for the period 1995−2005.

1995–2005	**Austria**			**Belgium**			**Czech Republic**			**Denmark**			**Finland**		
	EFF Effect	STR Effect	TOT Effect	EFF Effect	STR Effect	TOT Effect	EFF Effect	STR Effect	TOT Effect	EFF Effect	STR Effect	TOT Effect	EFF Effect	STR Effect	TOT Effect
Food and beverages	10.7	-16.2	-5.6	-31.1	-8.4	-39.5	-11.4	-13.5	-24.9	15.6	-99.4	-83.8	-0.8	-0.6	-1.5
Tobacco	0.4	-0.1	0.3	-0.1	0.0	-0.1	-0.3	-0.2	-0.5	0.6	-1.9	-1.4	0	0	0
Textiles	3.6	-9.6	-6.1	0.6	-4.4	-3.8	-0.5	-3.7	-4.1	11.4	-13.8	-2.4	-0.1	-0.5	-0.6
Leather and footwear	2.1	-1.4	0.7	0.3	-0.3	0.0	-1.5	-1.3	-2.8	2.8	-3.5	-0.7	0.0	-0.1	-0.1
Wood and Cork	62.2	-11.3	50.9	5.1	3.4	8.5	-1.3	0.2	-1.1	-22.9	12.1	-10.7	-1.1	-0.8	-1.9
Pulp and paper	35.6	-15.0	20.6	-14.3	4.5	-9.8	-8.6	1.7	-7.0	4.5	-2.8	1.7	-30.1	-34.7	-64.9
Printing, publishing, etc.	0.8	10.3	11.1	7.8	-2.8	5.0	-2.1	-0.5	-2.5	-3.2	3.0	-0.1	-11.4	-3.6	-15.0
Chemicals	-288.2	76.5	-211.7	66.2	33.7	99.9	24.2	-9.1	15.1	-55.2	90.9	35.7	-0.4	-2.5	-2.9
Non-Metallic Minerals	1.1	-41.0	-39.9	-5.2	-29.9	-35.1	-34.2	0.5	-33.8	-20.9	-25.4	-46.3	-0.8	-0.6	-1.4
Basic Metals	50.1	-10.2	39.9	-70.3	-31.0	-101.3	36.3	-54.5	-18.2	34.5	-30.1	4.4	-3.9	-1.2	-5.0
Fabricated metal	9.2	-0.8	8.5	-3.0	0.8	-2.1	-2.3	-2.2	-4.5	13.7	-3.1	10.6	0.0	-0.1	-0.1
Machinery NEC	3.4	2.2	5.6	-3.4	0.5	-2.9	-8.1	-1.3	-9.4	14.0	-19.5	-5.5	-0.1	-0.4	-0.5
Office machinery, etc.	-0.3	0.5	0.2	0.0	0.0	0.0	-0.4	0.5	0.1	-0.5	0.3	-0.3	-0.1	-0.1	-0.1
Electrical engineering	3.9	-6.0	-2.0	1.6	0.2	1.8	-4.9	4.9	0.0	-16.1	16.9	0.8	-2.7	1.4	-1.3
Motor vehicles, trailers, etc.	-12.4	28.0	15.5	0.7	0.8	1.6	-9.5	8.1	-1.4	-2.6	1.3	-1.3	0.0	0.0	0.0
Other transport equipment	-3.2	5.6	2.4	-0.4	0.2	-0.2	0.1	-1.4	-1.3	20.1	-24.2	-4.1	-1.0	-0.7	-1.7
Rubber and plastics	5.0	-0.6	4.4	-21.4	9.6	-11.8	-7.5	6.9	-0.5	-19.4	13.3	-6.1	1.2	-3.9	-2.7
Medical instruments etc.	-0.7	0.9	0.2	-3.9	0.9	-3.0	0.0	-0.1	-0.1	-3.8	5.1	1.3	0.0	-0.7	-0.7
Manufacturing nec; recycling	7.8	-2.7	5.0	-3.4	-3.7	-7.2	-2.0	-1.0	-3.1	21.9	-13.6	8.2	2.4	-2.0	0.4
MANUFACTURING	-108.9	8.9	-100.0	-74.1	-25.9	-100.0	-34.2	-65.8	-100.0	-5.7	-94.3	-100.0	-49.0	-51.0	-100.0

Table B.3b Percentage contribution of the efficiency effect (Eff) and the structural effect (STR) by sector to the average annual growth rate of Manufacturing energy intensity per country, for the period 1995-2005.

1995–2005	**France**			**Germany**			**Hungary**			**Italy**			**Japan**		
	EFF Effect	STR Effect	TOT Effect	EFF Effect	STR Effect	TOT Effect	EFF Effect	STR Effect	TOT Effect	EFF Effect	STR Effect	TOT Effect	EFF Effect	STR Effect	TOT Effect
Food and beverages	0.5	-6.0	-5.5	-0.9	-4.2	-5.1	-4.7	-27.3	-32.0	47.3	-10.2	37.1	2.3	-5.3	-3.0
Tobacco				-0.3	-0.1	-0.4	0.1	-0.1	0.0				0.0	-0.2	-0.2
Textiles	-2.3	-2.1	-4.4	-0.7	-2.0	-2.7	-6.4	-4.2	-10.6	12.0	-29.7	-17.8	5.3	-13.2	-7.9
Leather and footwear	0.2	-0.6	-0.4	-0.1	-0.3	-0.4	-0.6	-1.2	-1.8	2.2	-3.0	-0.9	0.2	-0.6	-0.4
Wood and Cork	-0.1	1.6	1.5	-0.1	-0.9	-1.1	-1.1	-0.7	-1.8	2.2	0.6	2.8	0.0	0.0	0.0
Pulp and paper	-2.5	-2.3	-4.8	-10.2	3.6	-6.6	-2.1	-0.6	-2.7	-0.6	9.8	9.2	-4.3	-9.1	-13.4
Printing, publishing, etc.	-0.6	-1.6	-2.2	-0.9	-2.5	-3.4	-2.8	0.2	-2.5	5.4	-1.7	3.7	2.4	-4.2	-1.8
Chemicals	-4.8	-9.6	-14.4	-43.2	11.7	-31.5	7.0	-21.0	-14.0	-6.9	4.4	-2.5	1.9	-4.1	-2.3
Non-Metallic Minerals	-7.7	-4.7	-12.4	-11.0	-10.4	-21.5	-2.4	-6.1	-8.5	-22.8	37.9	15.1	-5.4	-12.0	-17.5
Basic Metals	-23.8	-18.7	-42.5	-0.6	-11.9	-12.5	-2.1	-13.2	-15.3	39.2	-46.4	-7.2	-3.3	-27.8	-31.1
Fabricated metal	-4.2	-1.3	-5.4	-1.8	-0.1	-2.0	-4.5	0.0	-4.5	-3.8	10.2	6.5	0.7	-2.4	-1.7
Machinery NEC	-4.3	1.0	-3.3	-4.5	-0.7	-5.2	-2.2	0.5	-1.7	20.5	2.1	22.6	-1.1	0.6	-0.6
Office machinery, etc.	-1.3	-0.4	-1.6	-0.8	0.3	-0.5	0.0	0.3	0.3	2.9	-2.2	0.7	-0.9	0.5	-0.4
Electrical engineering	-1.4	0.1	-1.3	-2.9	1.0	-1.8	-2.7	2.4	-0.3	10.9	1.6	12.5	-9.8	7.1	-2.7
Motor vehicles, trailers, etc.	-3.5	2.9	-0.6	-3.4	1.3	-2.1	-6.4	4.2	-2.3	0.1	-1.3	-1.2	-1.6	1.3	-0.3
Other transport equipment	2.2	-1.9	0.3	-1.8	1.5	-0.3	0.2	0.1	0.3	1.9	-0.9	1.1	0.0	0.1	0.1
Rubber and plastics	-15.0	11.8	-3.2	-2.9	4.3	1.4	-2.7	0.7	-2.1	8.2	2.9	11.1	-3.5	-3.7	-7.2
Medical instruments etc.	-0.3	0.4	0.1	-2.5	1.6	-0.9	0.1	-0.1	0.1	0.9	0.6	1.5	3.4	-6.9	-3.6
Manufacturing nec; recycling	0.6	-0.4	0.3	5.5	-9.0	-3.5	-0.3	-0.2	-0.5	6.4	-0.6	5.9	0.6	-6.7	-6.1
MANUFACTURING	-68.3	-31.7	-100.0	-83.1	-16.9	-100.0	-33.6	-66.4	-100.0	126.0	-26.0	100.0	-13.2	-86.8	-100.0

Table B.3c Percentage contribution of the efficiency effect (EFF) and the structural effect (STR) by sector to the average annual growth rate of Manufacturing energy intensity per country, for the period 1995-2005.

1995–2005	**South Korea**			**Netherlands**			**Poland**			**Portugal**			**Slovakia**		
	EFF Effect	STR Effect	TOT Effect	EFF Effect	STR Effect	TOT Effect	EFF Effect	STR Effect	TOT Effect	EFF Effect	STR Effect	TOT Effect	EFF Effect	STR Effect	TOT Effect
Food and beverages	5.3	-21.1	-15.8	-13.2	-15.6	-28.8	3.1	-3.0	0.1	14.0	-4.2	9.8	-2.5	-1.1	-3.7
Tobacco	0.1	-0.4	-0.3	-0.2	-0.3	-0.5	0.4	-0.1	0.3	-0.7	0.4	-0.3	0.0	-0.1	-0.1
Textiles	24.6	-53.4	-28.9	-1.9	-3.1	-5.1	1.8	-4.0	-2.2	-3.5	-12.4	-15.9	-1.0	-1.3	-2.3
Leather and footwear	2.2	-16.7	-14.5	-0.1	-0.2	-0.4	0.2	-1.0	-0.8	2.4	-3.5	-1.0	-0.7	-0.2	-0.9
Wood and Cork	1.1	-2.7	-1.7	-0.2	-0.7	-0.9	3.2	0.0	3.2	-1.2	3.4	2.2	-1.7	0.6	-1.1
Pulp and paper	7.1	-18.3	-11.2	-9.3	1.4	-8.0	10.4	-3.8	6.6	-8.1	13.8	5.7	-2.1	-2.7	-4.8
Printing, publishing, etc.	16.6	-27.0	-10.4	0.4	-3.6	-3.2	3.0	-1.8	1.2	2.9	-15.1	-12.2	0.4	-0.6	-0.3
Chemicals	11.9	-9.8	2.1	-92.3	74.1	-18.2	30.1	-19.8	10.4	21.8	-4.1	17.8	-1.4	-15.1	-16.5
Non-Metallic Minerals	33.1	-61.0	-27.9	1.0	-4.4	-3.4	-64.4	42.9	-21.4	97.9	9.4	107.3	-11.1	0.4	-10.7
Basic Metals	20.3	-41.8	-21.5	-32.5	8.4	-24.1	-5.8	-72.2	-78.1	-6.2	-5.7	-12.0	-51.7	3.1	-48.6
Fabricated metal	8.5	-13.5	-4.9	2.7	-2.6	0.1	-5.8	3.0	-2.8	-4.4	1.6	-2.8	-1.6	0.5	-1.1
Machinery NEC	3.4	-1.9	1.4	-3.0	2.2	-0.8	-5.1	-1.2	-6.3	1.4	0.5	1.8	-1.8	0.0	-1.8
Office machinery, etc.	0.7	0.3	1.0	-0.4	-0.3	-0.7	0.0	0.0	0.0	-0.1	0.1	0.0	0.0	0.0	0.0
Electrical engineering	1.4	19.3	20.8	5.2	-10.0	-4.7	-2.2	0.9	-1.3	-1.3	1.7	0.4	-0.9	0.5	-0.4
Motor vehicles, trailers, etc.	7.0	-1.5	5.5	-1.0	1.0	0.0	-7.0	1.9	-5.1	-5.8	7.2	1.4	-4.1	2.1	-2.0
Other transport equipment	2.7	0.4	3.1	-2.1	-0.3	-2.4	-0.2	-2.6	-2.9	-3.3	0.3	-3.0	-0.4	-1.0	-1.4
Rubber and plastics	13.9	-10.3	3.7	-1.5	-0.2	-1.7	1.3	0.9	2.2	1.5	1.1	2.6	-4.0	1.2	-2.7
Medical instruments etc.	0.5	-0.3	0.2	-0.2	0.6	0.3	-0.2	0.0	-0.2	-0.1	0.2	0.1	0.0	0.0	0.0
Manufacturing nec; recycling	1.5	-2.2	-0.8	2.4	-0.1	2.3	-2.4	-0.5	-2.9	-0.2	-1.8	-1.9	-3.0	1.3	-1.7
MANUFACTURING	161.8	-261.8	-100.0	-146.2	46.2	-100.0	-39.6	-60.4	-100.0	107.2	-7.2	100.0	-87.6	-12.4	-100.0

Table B.3d Percentage contribution of the efficiency effect (EFF) and the structural effect (STR) by sector to the average annual growth rate of Manufacturing energy intensity per country, for the period 1995-2005.

1995–2005	**Spain**			**Sweden**			**United Kingdom**			**USA**		
	EFF Effect	STR Effect	TOT Effect	EFF Effect	STR Effect	TOT Effect	EFF Effect	STR Effect	TOT Effect	EFF Effect	STR Effect	TOT Effect
Food and beverages	14.3	-4.9	9.4	-0.7	-4.7	-5.4	-19.5	9.4	-10.1	-4.7	-1.8	-6.5
Tobacco	0.1	-0.1	-0.1	--	--	--	1.3	-0.5	0.8	0.3	-0.5	-0.2
Textiles	2.3	-3.2	-0.8	0.0	-0.7	-0.8	1.1	-22.8	-21.7	-2.3	-2.3	-4.6
Leather and footwear	0.6	-1.0	-0.4	-0.1	-0.1	-0.1	-1.7	-2.3	-4.0	-0.1	-0.2	-0.2
Wood and Cork	1.3	-0.3	1.0	0.5	-2.6	-2.1	--	--	--	-1.0	-1.9	-2.9
Pulp and paper	6.9	-0.5	6.4	-7.0	-42.8	-49.8	21.2	-15.7	5.5	-18.4	-2.7	-21.1
Printing, publishing, etc.	0.9	1.8	2.6	0.9	-4.1	-3.2	9.9	-0.1	9.8	-1.7	-2.6	-4.3
Chemicals	10.6	-3.1	7.5	-6.7	-2.7	-9.4	-153.9	26.5	-127.3	-25.2	-9.6	-34.8
Non-Metallic Minerals	28.7	7.4	36.0	-3.2	-4.7	-7.9	-7.3	5.5	-1.8	-3.1	-0.7	-3.8
Basic Metals	24.5	-3.7	20.8	-2.0	-11.2	-13.3	58.3	-49.4	8.9	-8.8	-2.5	-11.3
Fabricated metal	2.1	0.9	3.0	0.4	-1.0	-0.7	-2.9	7.6	4.7	-0.9	-0.7	-1.6
Machinery NEC	-0.1	0.6	0.6	-0.6	-0.9	-1.4	0.1	-1.9	-1.8	-1.0	-0.8	-1.8
Office machinery, etc.	0.0	-0.2	-0.1	0.0	0.0	0.0	-1.9	1.2	-0.7	-0.7	0.3	-0.3
Electrical engineering	1.7	-0.3	1.4	-1.4	0.9	-0.5	0.0	-2.3	-2.3	-5.3	3.4	-1.9
Motor vehicles, trailers, etc.	2.2	-0.1	2.1	-1.6	-0.2	-1.8	2.6	0.3	2.9	-2.2	0.8	-1.5
Other transport equipment	0.5	0.1	0.6	-0.1	-0.5	-0.6	-6.0	5.3	-0.7	-0.2	-0.2	-0.4
Rubber and plastics	5.2	2.4	7.6	0.7	-1.6	-0.9	48.6	-17.9	30.7	-1.4	-0.3	-1.7
Medical instruments etc.	0.4	0.0	0.3	-0.2	-0.5	-0.7	-16.4	11.7	-4.7	-0.3	-0.3	-0.5
Manufacturing nec; recycling	1.4	0.6	2.0	2.7	-4.1	-1.5	8.3	3.6	11.9	-0.5	0.0	-0.5
MANUFACTURING	103.4	-3.4	100.0	-18.3	-81.7	-100.0	-58.3	-41.7	-100.0	-77.5	-22.5	-100.0

Appendix C – Services

Table C.1a Average annual growth rates energy intensity by sector for the periods 1980−2005, 1980−1995 and 1995−2005.

	AUT	BEL	CZE	DNK	FIN	FRA	GER	HUN	ITA	JPN	KOR	NLD	POL	PRT	SPA	SVK	SWE	UKD	USA
WHOLESALE AND RETAIL TRADE																			
1980-2005	2.7	-1.4	--	-3.1	1.6	-3.3	-1.1	--	0.3	0.0	-2.8	-0.6	--	-5.1	0.3	--	--	2.0	-3.8
1980-1995	4.0	3.2	--	-2.3	1.5	-4.9	-0.9	--	1.3	0.5	-5.7	1.6	--	-8.6	-3.3	--	--	2.0	-4.4
1995-2005	0.8	-8.3	0.0	-4.3	1.9	-1.0	-1.5	-12.8	-1.4	-0.8	1.4	-2.3	-2.0	0.3	5.8	-10.5	-4.9	2.2	-2.9
Sale, maintenance and repair of motor vehicles and motorcycles; retail sale of fuel																			
1980-2005	2.6	3.3	--	3.6	0.9	-0.4	1.2	--	-0.8	5.0	-2.7	1.2	--	-7.4	-2.1	--	--	0.6	-4.6
1980-1995	4.4	2.7	--	7.3	1.4	0.0	2.4	--	0.8	8.5	-5.4	3.8	--	-8.6	-5.6	--	--	-2.2	-4.3
1995-2005	-0.1	4.1	9.7	-1.9	0.2	-0.9	-0.6	-0.6	-3.1	-0.2	1.4	-0.9	-3.2	-5.6	3.1	-2.0	-5.0	4.7	-5.1
Other wholesale trade and commission trade																			
1980-2005	1.9	-3.8	--	-4.8	2.4	-4.3	-3.1	--	-0.6	-1.9	-2.7	-0.5	--	-4.7	-0.4	--	--	3.1	-4.3
1980-1995	2.9	3.3	--	-4.5	2.1	-5.7	-2.1	--	1.0	-3.4	-5.4	1.7	--	-8.6	-3.1	--	--	3.9	-6.2
1995-2005	0.4	-14.5	0.2	-5.3	2.8	-2.1	-4.7	-21.4	-3.0	0.3	1.4	-2.3	-1.0	1.2	3.5	-4.6	-4.9	2.0	-1.5
Other retail trade																			
1980-2005	3.9	1.7	--	-2.9	0.3	-3.2	0.4	--	1.5	1.8	-2.9	0.1	--	1.6	2.9	--	--	1.5	-3.2
1980-1995	5.5	2.4	--	-2.4	0.3	-5.0	-0.3	--	2.1	3.3	-5.8	2.3	--	0.9	-0.8	--	--	1.2	-2.5
1995-2005	1.6	0.6	-8.3	-3.7	0.3	-0.6	1.4	7.3	0.5	-0.5	1.4	-1.6	-3.3	2.8	8.3	-17.8	-5.0	1.8	-4.2
HOTELS AND RESTAURANTS																			
1980-2005	1.9	2.8	--	0.7	0.4	3.1	-1.8	--	4.0	3.5	-5.2	2.1	--	-0.6	-0.7	--	--	0.0	-0.3
1980-1995	1.8	0.7	--	2.3	0.8	4.3	-1.8	--	3.8	3.1	-9.4	4.1	--	1.4	-1.8	--	--	-1.2	0.1
1995-2005	2.0	6.0	-1.9	-1.8	-0.3	1.4	-1.9	-3.2	4.4	4.1	1.1	0.5	-3.1	-3.6	1.0	5.2	-0.7	1.8	-1.1
POST AND TELECOMMUNICATION																			
1980-2005	6.8	0.9	--	-6.9	-8.6	-0.5	-2.1	--	-3.1	1.5	-2.1	-6.3	--	-7.2	0.1	--	--	-1.7	-2.6
1980-1995	2.5	2.6	--	-5.5	-5.1	2.0	-3.0	--	-1.3	-0.2	-1.9	-6.2	--	-9.9	-3.4	--	--	0.1	-2.1
1995-2005	13.3	-1.6	-5.4	-8.9	-13.9	-4.4	-0.9	-7.0	-5.8	4.2	-2.3	-6.3	-14.1	-3.2	5.4	-4.0	-6.1	-4.3	-3.3

Table C.1b Average annual growth rates energy intensity by sector for the periods 1980−2005, 1980−1995 and 1995−2005.

	AUT	BEL	CZE	DNK	FIN	FRA	GER	HUN	ITA	JPN	KOR	NLD	POL	PRT	SPA	SVK	SWE	UKD	USA
FINANCIAL INTERMEDIATION																			
1980-2005	6.8	0.3	--	-8.0	3.8	-0.5	-0.1	--	5.9	-1.3	-0.9	1.3	--	-0.1	-2.5	--	--	0.7	-1.3
1980-1995	4.5	3.7	--	-8.7	3.7	-1.2	-3.1	--	17.8	-2.1	-2.4	4.7	--	3.9	-1.2	--	--	3.5	-1.1
1995-2005	10.2	-4.9	-1.2	-7.0	4.0	0.6	4.4	-3.5	-12.0	0.0	1.5	-1.4	5.6	-6.0	-4.5	-2.7	-3.3	-3.3	-1.7
Financial intermediation, except insurance and pension funding																			
1980-2005	7.1	--	--	-6.6	4.6	-1.8	--	--	--	-1.5	-0.8	1.2	--	--	-3.7	--	--	1.1	-2.6
1980-1995	4.1	--	--	-5.9	5.1	-2.9	--	--	--	-1.8	-2.4	5.0	--	--	-1.9	--	--	6.3	-2.5
1995-2005	11.8	--	-1.6	-7.7	3.8	-0.2	1.3	-3.7	--	-0.9	1.5	-1.9	4.6	-6.4	-6.4	-7.0	-1.3	-6.7	-2.8
Insurance and pension funding, except compulsory social security																			
1980-2005	4.3	--	--	-8.8	0.7	14.6	--	--	--	-0.6	-0.8	1.0	--	--	-3.6	--	--	-0.8	1.0
1980-1995	5.4	--	--	-10.9	-14.4	19.4	--	--	--	-2.6	-2.4	1.6	--	--	-4.9	--	--	-3.4	1.0
1995-2005	2.6	--	11.0	-5.7	23.4	7.4	13.2	-12.6	--	2.3	1.5	0.5	15.6	-4.4	-1.5	9.3	-1.8	3.3	1.0
Activities related to financial intermediation																			
1980-2005	5.7	--	--	-14.0	0.9	-14.9	--	--	--	--	--	2.6	--	--	-0.1	--	--	4.1	--
1980-1995	5.6	--	--	-19.5	-5.2	-20.9	--	--	--	--	--	9.8	--	--	0.0	--	--	6.3	--
1995-2005	5.7	--	--	-5.8	9.9	-6.0	9.0	7.1	--	--	1.5	-3.3	-21.6	1.1	-0.3	--	0.7	0.8	--
PUBLIC ADMINISTRATION AND DEFENCE																			
1980-2005	1.5	10.5	--	-3.3	4.5	-2.0	-2.5	--	-9.1	3.0	7.0	3.8	--	4.9	4.6	--	--	3.8	0.8
1980-1995	1.3	12.5	--	-4.0	4.3	-3.1	-4.7	--	-0.1	5.4	9.9	7.1	--	9.3	3.2	--	--	4.6	0.7
1995-2005	1.9	7.5	2.8	-2.3	4.8	-0.4	0.8	0.3	-22.5	-0.6	2.7	1.1	1.1	-1.7	6.6	-8.6	-2.0	2.5	0.9
EDUCATION																			
1980-2005	9.1	7.6	--	-3.5	2.1	-0.2	-2.5	--	-9.1	3.9	1.9	0.9	--	1.0	3.4	--	--	1.3	-0.9
1980-1995	13.0	7.1	--	-3.6	3.9	-3.5	-3.6	--	-0.7	4.2	-0.5	2.2	--	-0.8	-2.1	--	--	1.9	-2.1
1995-2005	3.2	8.3	3.0	-3.4	-0.6	4.9	-0.8	-2.3	-21.8	3.4	5.6	-0.1	10.5	3.7	11.7	-4.2	-0.9	0.5	1.0

Table C.1c Average annual growth rates energy intensity by sector for the periods 1980−2005, 1980−1995 and 1995−2005.

	AUT	BEL	CZE	DNK	FIN	FRA	GER	HUN	ITA	JPN	KOR	NLD	POL	PRT	SPA	SVK	SWE	UKD	USA
RENTING, COMPUTER, R&D, OTHER BUSINESS																			
1980-2005	3.5	1.1	--	-6.2	-4.5	-2.1	-3.7	--	-3.8	1.0	1.0	0.5	--	-0.5	-1.5	--	--	0.5	-1.4
1980-1995	3.9	1.1	--	-6.6	-4.2	-2.4	-6.4	--	-5.6	2.6	0.1	2.8	--	2.8	-5.3	--	--	1.9	-2.6
1995-2005	2.8	1.2	-4.8	-5.4	-4.9	-1.6	0.4	-7.6	-1.2	-1.3	2.4	-1.4	-3.6	-5.4	4.2	-13.1	-4.0	-1.6	0.4
Renting of machinery and equipment																			
1980-2005	0.1	--	--	-14.3	3.3	9.4	--	--	--	-13.1	7.6	0.4	--	--	0.4	--	--	-1.4	2.7
1980-1995	-1.0	--	--	-20.0	12.5	12.9	--	--	--	-9.4	0.7	1.6	--	--	-2.5	--	--	-1.6	2.2
1995-2005	1.8	--	3.5	-5.8	-10.6	4.2	-3.2	3.8	--	-18.8	17.9	-0.5	-20.7	-3.1	4.7	8.6	-11.3	-0.9	3.6
Computer and related activities																			
1980-2005	-1.2	--	--	-12.1	-5.8	-1.5	--	--	--	3.1	0.3	-2.0	--	--	-4.4	--	--	-0.8	-3.2
1980-1995	2.6	--	--	-10.5	-6.2	-1.2	--	--	--	5.8	-1.2	-1.1	--	--	-5.1	--	--	-0.7	-4.4
1995-2005	-6.9	--	2.9	-14.7	-5.1	-2.0	-4.9	4.4	--	-1.1	2.7	-2.8	-4.9	6.2	-3.4	-6.0	-1.0	-0.9	-1.4
Research and development																			
1980-2005	-0.5	--	--	-3.0	-0.9	0.1	--	--	--	2.5	0.3	2.5	--	--	-3.3	--	--	1.8	-2.0
1980-1995	-2.5	--	--	-3.6	-1.4	-2.6	--	--	--	1.5	-1.2	10.8	--	--	-11.5	--	--	0.4	-4.6
1995-2005	2.5	--	-2.2	-2.0	-0.2	4.1	-5.2	-5.3	--	3.9	2.7	-4.1	6.0	1.2	9.0	-1.2	-7.7	4.0	2.0
Other business activities																			
1980-2005	5.4	--	--	-3.9	-4.8	-3.8	--	--	--	2.2	0.3	1.0	--	--	-1.1	--	--	1.2	-1.8
1980-1995	5.3	--	--	-4.0	-8.6	-4.6	--	--	--	3.1	-1.2	2.3	--	--	-5.4	--	--	3.7	-3.1
1995-2005	5.5	--	-5.5	-3.7	0.8	-2.7	2.8	-9.9	--	0.9	2.7	0.0	-3.3	-6.9	5.3	-20.0	-2.3	-2.4	0.2
HEALTH AND SOCIAL WORK																			
1980-2005	3.4	4.7	--	-3.3	3.8	0.6	-4.1	--	-12.6	2.4	2.9	-0.2	--	2.8	2.0	--	--	-0.9	-0.3
1980-1995	4.6	7.9	--	-2.9	3.7	-0.3	-1.7	--	-7.9	3.6	-2.8	2.5	--	3.2	-0.8	--	--	-1.5	0.2
1995-2005	1.6	-0.2	2.1	-4.0	3.9	1.9	-7.7	-4.4	-19.8	0.6	11.5	-2.3	1.0	2.1	6.2	4.8	-0.6	0.1	-1.0

Table C.1d Average annual growth rates energy intensity by sector for the periods 1980−2005, 1980−1995 and 1995−2005.

	AUT	BEL	CZE	DNK	FIN	FRA	GER	HUN	ITA	JPN	KOR	NLD	POL	PRT	SPA	SVK	SWE	UKD	USA
OTHER COMMUNITY, SOCIAL AND PERSONAL SERVICES																			
1980-2005	3.0	1.3	--	-1.0	1.9	-1.7	-2.1	--	-4.8	3.4	0.9	0.4	--	0.4	0.1	--	--	-0.8	-2.5
1980-1995	3.0	2.0	--	-0.1	2.9	-1.5	-3.3	--	-1.4	4.6	-1.0	1.1	--	-0.8	-3.6	--	--	-0.6	-3.5
1995-2005	3.0	0.3	0.8	-2.4	0.4	-1.9	-0.2	2.8	-9.8	1.6	3.7	-0.1	5.2	2.1	5.8	-6.0	-1.2	-1.2	-0.9
Sewage and refuse disposal, sanitation and similar activities																			
1980-2005	5.4	--	--	0.7	3.6	-16.3	--	--	--	9.0	11.4	-2.7	--	--	3.4	--	--	-2.2	1.0
1980-1995	6.3	--	--	-0.2	-0.2	-19.2	--	--	--	13.6	14.9	-4.8	--	--	1.1	--	--	-3.9	1.1
1995-2005	4.0	--	4.2	2.0	9.3	-11.8	4.7	1.3	--	2.1	6.1	-1.0	2.5	1.4	6.9	5.2	-1.5	0.3	0.8
Activities of membership organizations nec																			
1980-2005	1.4	--	--	-3.7	4.1	-1.5	--	--	--	-0.4	-3.6	0.2	--	--	-1.3	--	--	-0.6	-2.8
1980-1995	0.4	--	--	-3.4	3.4	-2.4	--	--	--	-0.3	-6.5	0.9	--	--	-3.7	--	--	-1.2	-4.4
1995-2005	2.8	--	-7.3	-4.0	5.1	-0.3	-3.2	-3.3	--	-0.5	0.7	-0.4	3.4	4.0	2.4	-20.3	-0.8	0.3	-0.3
Recreational, cultural and sporting activities																			
1980-2005	5.2	--	--	-0.3	0.3	-1.2	--	--	--	4.1	0.7	1.1	--	--	-2.5	--	--	-0.2	-2.1
1980-1995	6.6	--	--	2.2	-0.6	-1.0	--	--	--	6.0	-1.6	4.4	--	--	-7.4	--	--	1.4	-2.8
1995-2005	3.2	--	-0.3	-3.9	1.8	-1.5	0.2	2.2	--	1.2	4.1	-1.6	1.7	4.0	4.8	-4.5	-2.5	-2.5	-1.1
Other service activities																			
1980-2005	4.2	--	--	-3.8	-0.4	1.7	--	--	--	1.7	-0.2	2.5	--	--	2.6	--	--	1.6	-3.2
1980-1995	5.1	--	--	-6.4	12.1	3.8	--	--	--	1.3	-2.1	2.7	--	--	2.0	--	--	2.1	-4.1
1995-2005	2.7	--	5.9	-0.1	-19.2	-1.6	-1.8	4.0	--	2.1	2.8	2.3	-1.4	1.3	3.6	-15.1	-2.9	0.9	-1.7

Table C.2a Percentage contribution of the efficiency effect (EFF) and the structural effect (STR) by sector to the average annual growth rate of Services energy intensity per country, for the period 1980−2005.

1980–2005	**Austria**			**Belgium**			**Denmark**			**Finland**		
	EFF Effect	STR Effect	TOT Effect	EFF Effect	STR Effect	TOT Effect	EFF Effect	STR Effect	TOT Effect	EFF Effect	STR Effect	TOT Effect
Sale, maintenance, repair motor vehicles and -cycles; retail sale of fuel	3.3	-2.1	1.3				4.6	-7.5	-2.9	3.0	4.0	7.0
Other wholesale trade and commission trade	5.3	4.7	10.0	-84.3	-85.5	-169.9	-19.0	7.7	-11.3	38.9	-1.7	37.2
Other retail trade; repair of household goods	11.7	0.0	11.7				-7.4	0.1	-7.3	1.4	0.9	2.3
Hotels and restaurants	8.8	-3.0	5.8	19.2	-3.2	15.9	0.7	-2.0	-1.3	0.4	-1.5	-1.1
Post and Telecommunications	6.2	2.3	8.5	4.9	9.6	14.5	-6.5	3.2	-3.3	-13.8	9.3	-4.5
Financial intermediation, except insurance and pension funding	3.3	0.5	3.8				-4.6	2.2	-2.4	14.0	-2.6	11.3
Insurance and pension funding, except compulsory social security	0.5	-0.3	0.2	0.8	7.3	8.1	-3.1	0.7	-2.4	0.4	0.2	0.6
Activities related to financial intermediation	0.3	0.2	0.4				-2.3	0.5	-1.8	0.0	0.4	0.5
Renting of machinery and equipment	0.0	2.1	2.1				-3.6	1.3	-2.3	2.2	-1.1	1.1
Computer and related activities	-0.3	2.0	1.7	19.6	56.2	75.8	-4.0	3.5	-0.5	-3.6	3.3	-0.3
Research and development	0.0	0.2	0.2				-0.9	-0.6	-1.5	-0.3	0.4	0.1
Other business activities	5.1	1.9	7.0				-9.9	3.1	-6.8	-15.7	4.3	-11.4
Public administration and defence; Compulsary social secturity	7.0	-2.9	4.0	74.0	-8.1	65.9	-11.0	-5.8	-16.8	20.3	-4.0	16.3
Education	17.1	-2.2	14.9	30.2	-4.6	25.5	-12.9	-3.3	-16.3	8.6	-4.0	4.6
Health and social work	18.2	2.0	20.1	40.0	3.5	43.5	-17.5	-1.6	-19.1	25.0	-5.2	19.8
Sewage and refuse disposal, sanitation and similar activities	6.3	-4.6	1.8				0.7	-2.0	-1.3	3.3	0.4	3.8
Activities of membership organizations nec	2.7	-2.7	0.0	14.5	6.1	20.6	-1.3	-0.2	-1.4	13.6	-1.8	11.8
Recreational, cultural and sporting activities	5.0	-0.1	4.9				-0.3	0.6	0.3	1.1	0.4	1.5
Other service activities	2.1	-0.7	1.4				-1.3	-0.4	-1.7	-0.2	-0.4	-0.6
SERVICES	102.6	-2.6	100.0	118.8	-18.8	100.0	-99.7	-0.3	-100.0	98.5	1.5	100.0

Table C.2b Percentage contribution of the efficiency effect (EFF) and the structural effect (STR) by sector to the average annual growth rate of Services energy intensity per country, for the period 1980−2005.

1980–2005	**France**			**Germany**			**Japan**			**Korea**		
	EFF Effect	STR Effect	TOT Effect	EFF Effect	STR Effect	TOT Effect	EFF Effect	STR Effect	TOT Effect	EFF Effect	STR Effect	TOT Effect
Sale, maintenance, repair motor vehicles and -cycles; retail sale of fuel	-4.4	2.1	-2.4				1.8	-0.5	1.3	-9.5	6.3	-3.3
Other wholesale trade and commission trade	-415.2	349.3	-65.9	-11.5	-2.3	-13.8	-8.4	5.4	-3.0	-88.8	-32.8	-121.6
Other retail trade; repair of household goods	-138.1	103.6	-34.4				12.1	-10.2	1.9	-74.4	38.7	-35.7
Hotels and restaurants	52.5	-8.5	44.0	-3.7	-3.3	-7.1	29.0	-19.4	9.6	-330.6	2.8	-327.8
Post and Telecommunications	-4.3	50.3	46.1	-2.8	2.0	-0.9	3.5	7.4	11.0	-32.4	157.6	125.3
Financial intermediation, except insurance and pension funding	-11.9	17.0	5.1				-1.6	2.4	0.8	-4.9	17.0	12.1
Insurance and pension funding, except compulsory social security	39.3	-35.0	4.3	-0.2	-1.5	-1.7	-0.4	0.3	-0.1	-0.9	10.5	9.6
Activities related to financial intermediation	-16.5	20.5	4.1				0.0	0.0	0.0	--	--	--
Renting of machinery and equipment	19.3	-9.7	9.7				-3.9	4.0	0.1	30.9	-7.5	23.3
Computer and related activities	-10.1	10.0	-0.1	-14.9	7.7	-7.2	3.7	-0.4	3.3	0.6	12.9	13.5
Research and development	0.5	12.6	13.1				2.4	1.6	4.0	1.1	13.5	14.6
Other business activities	-152.1	139.0	-13.0				3.7	2.7	6.3	3.0	20.1	23.2
Public administration and defence; Compulsary social secturity	-84.1	73.5	-10.6	-15.2	-6.1	-21.3	20.7	-1.5	19.1	133.6	-53.7	79.8
Education	-3.5	20.6	17.1	-14.9	-7.3	-22.2	12.2	-4.4	7.9	51.9	-56.3	-4.4
Health and social work	12.1	37.7	49.8	-21.9	4.3	-17.5	19.9	2.5	22.5	134.0	109.5	243.5
Sewage and refuse disposal, sanitation and similar activities	-35.3	29.8	-5.6				2.1	-0.9	1.2	15.8	1.8	17.6
Activities of membership organizations nec	-5.5	9.6	4.1	-6.8	-1.6	-8.4	-0.1	-0.8	-0.9	-18.4	10.1	-8.3
Recreational, cultural and sporting activities	-25.6	60.3	34.7				16.3	-5.0	11.3	8.3	34.9	43.1
Other service activities	3.8	-3.7	0.1				4.4	-0.8	3.6	-1.0	-3.8	-4.7
SERVICES	-779.2	879.2	100.0	-91.8	-8.2	-100.0	117.4	-17.4	100.0	-181.8	281.8	100.0

*Table C.2c Percentage contribution of the efficiency effect (EFF) and the structural effect (STR) by sector to the average annual growth rate of Services energy intensity per country, for the period 1980−2005.**

1980–2005	**Netherlands**			**Portugal**			**Spain**			**United Kingdom**		
	EFF Effect	STR Effect	TOT Effect	EFF Effect	STR Effect	TOT Effect	EFF Effect	STR Effect	TOT Effect	EFF Effect	STR Effect	TOT Effect
Sale, maintenance, repair motor vehicles and -cycles; retail sale of fuel	12.9	-5.3	7.6				-19.8	-16.2	-36.0	3.0	-0.9	2.1
Other wholesale trade and commission trade	-13.0	66.3	53.3	-99.6	-23.0	-122.7	-6.7	-3.1	-9.8	49.7	-0.8	48.9
Other retail trade; repair of household goods	4.4	-30.9	-26.4				39.2	-1.7	37.5	14.9	4.6	19.4
Hotels and restaurants	49.1	-27.8	21.3	-3.0	-7.7	-10.7	-7.9	-7.3	-15.2	0.1	-6.7	-6.7
Post and Telecommunications	-21.2	17.0	-4.2	-5.2	3.9	-1.4	0.6	14.7	15.3	-6.5	14.5	7.9
Financial intermediation, except insurance and pension funding	5.5	5.9	11.4				-13.1	-1.4	-14.6	2.9	2.1	5.0
Insurance and pension funding, except compulsory social security	2.1	-1.2	0.9	0.0	1.5	1.5	-2.1	1.6	-0.5	-2.6	4.1	1.6
Activities related to financial intermediation	2.4	0.1	2.6				-0.1	0.9	0.8	3.8	0.6	4.4
Renting of machinery and equipment	0.3	3.3	3.6				0.7	1.9	2.6	-2.6	7.8	5.3
Computer and related activities	-3.6	14.1	10.5	-0.9	0.7	-0.2	-1.9	3.3	1.4	-1.8	9.0	7.2
Research and development	7.4	-3.5	3.9				-0.2	0.1	-0.1	1.2	0.0	1.3
Other business activities	13.7	18.7	32.4				-9.2	15.7	6.5	5.4	11.6	17.0
Public administration and defence; Compulsary social secturity	90.6	-42.6	47.9	16.5	-0.3	16.2	58.6	-13.6	45.1	43.4	-35.5	7.9
Education	15.9	-50.5	-34.6	1.7	-1.1	0.6	38.6	7.2	45.8	8.5	-12.4	-3.9
Health and social work	-5.8	-19.5	-25.3	18.0	-2.2	15.8	23.7	-1.7	22.0	-9.1	-4.2	-13.4
Sewage and refuse disposal, sanitation and similar activities	-43.3	27.5	-15.8				13.3	-0.4	12.9	-5.1	-0.4	-5.5
Activities of membership organizations nec	0.8	-3.0	-2.2	1.1	-0.2	0.8	-1.2	1.0	-0.2	-0.2	-0.3	-0.6
Recreational, cultural and sporting activities	17.4	-4.5	13.0				-16.0	-1.1	-17.1	-0.5	1.9	1.4
Other service activities	11.8	-11.7	0.1				4.1	-0.5	3.6	1.0	-0.4	0.6
SERVICES	147.5	-47.5	100.0	-71.4	-28.6	-100.0	100.8	-0.8	100.0	105.5	-5.5	100.0

*Note: USA data are presented in main text; they are excluded here due to limited space.

Table C.3a Percentage contribution of the efficiency effect (EFF) and the structural effect (STR) by sector to the average annual growth rate of Services energy intensity per country, for the period 1995−2005.

1995–2005	**Austria**			**Belgium**			**Czech Republic**			**Denmark**		
	EFF Effect	STR Effect	TOT Effect	EFF Effect	STR Effect	TOT Effect	EFF Effect	STR Effect	TOT Effect	EFF Effect	STR Effect	TOT Effect
Sale, maintenance, repair motor vehicles and -cycles; retail sale of fuel	-0.1	-1.0	-1.1				43.6	-12.0	31.6	-2.1	-2.3	-4.4
Other wholesale trade and commission trade	1.5	3.8	5.4	135.5	-18.6	-154.2	2.3	99.4	101.7	-16.6	4.2	-12.3
Other retail trade; repair of household goods	6.8	2.0	8.8				-30.1	26.2	-4.0	-7.5	-1.3	-8.8
Hotels and restaurants	9.8	0.1	9.9	10.8	-3.6	7.2	-5.2	-19.4	-24.5	-1.9	-4.3	-6.1
Post and Telecommunications	16.3	2.0	18.3	-2.7	3.6	0.9	-8.8	7.0	-1.8	-6.2	3.4	-2.8
Financial intermediation, except insurance and pension funding	7.7	-0.2	7.4				-1.4	1.9	0.6	-4.0	1.8	-2.2
Insurance and pension funding, except compulsory social security	0.5	-1.1	-0.6	-5.8	2.5	-3.4	4.8	-2.1	2.7	-0.9	0.2	-0.7
Activities related to financial intermediation	0.3	0.6	0.9				--	--	--	-0.2	0.0	-0.2
Renting of machinery and equipment	0.9	2.0	2.9				0.7	0.9	1.7	-0.5	0.1	-0.4
Computer and related activities	-3.1	4.7	1.6				0.9	1.8	2.7	-4.6	3.4	-1.2
Research and development	0.2	0.1	0.4	6.6	16.3	22.9	-0.8	-2.0	-2.8	-0.3	0.1	-0.2
Other business activities	7.9	3.5	11.4				-21.8	3.5	-18.3	-7.7	0.2	-7.5
Public administration and defence; Compulsary social secturity	9.5	-7.9	1.6	24.1	-2.2	21.9	11.1	-3.6	7.5	-4.6	-4.9	-9.5
Education	12.2	-2.7	9.5	11.8	-2.6	9.3	9.9	1.2	11.1	-8.3	-3.1	-11.4
Health and social work	12.0	2.4	14.4	-0.7	-1.1	-1.8	8.5	-18.3	-9.8	-15.7	-2.7	-18.4
Sewage and refuse disposal, sanitation and similar activities	5.4	-3.9	1.5				5.8	-3.8	2.0	2.2	-6.6	-4.4
Activities of membership organizations nec	5.3	-3.3	2.0				-2.9	-0.3	-3.1	-1.0	-0.4	-1.5
Recreational, cultural and sporting activities	4.7	-0.6	4.1	1.0	-3.7	-2.8	-0.4	2.5	2.1	-5.6	-1.8	-7.5
Other service activities	1.7	-0.3	1.5				4.3	-3.7	0.6	0.0	-0.5	-0.5
SERVICES	99.8	0.2	100.0	118.8	-18.8	100.0	20.7	79.3	100.0	-85.5	-14.5	-100.0

Table C.3b Percentage contribution of the efficiency effect (EFF) and the structural effect (STR) by sector to the average annual growth rate of Services energy intensity per country, for the period 1995−2005.

1995–2005	**Finland**			**France**			**Germany**			**Hungary**		
	EFF Effect	STR Effect	TOT Effect	EFF Effect	STR Effect	TOT Effect	EFF Effect	STR Effect	TOT Effect	EFF Effect	STR Effect	TOT Effect
Sale, maintenance, repair motor vehicles and -cycles; retail sale of fuel	0.6	10.4	11.0	-14.6	-36.6	-51.2	-1.4	2.4	1.1	-0.2	1.4	1.3
Other wholesale trade and commission trade	48.0	26.7	74.7	-215.0	174.7	-40.3	-38.1	2.2	-35.9	-90.4	6.5	-83.9
Other retail trade; repair of household goods	1.5	7.1	8.6	-29.9	-49.0	-78.9	9.9	-7.0	3.0	8.5	-0.2	8.3
Hotels and restaurants	-0.3	-1.7	-2.0	35.5	-21.0	14.6	-5.0	-2.6	-7.6	-2.3	-2.1	-4.4
Post and Telecommunications	-21.4	11.2	-10.1	-70.3	97.1	26.9	-1.8	4.6	2.8	-2.9	1.9	-0.9
Financial intermediation, except insurance and pension funding	18.5	-23.5	-4.9	-1.5	9.5	8.0	1.5	0.7	2.2	-0.9	0.1	-0.8
Insurance and pension funding, except compulsory social security	5.8	-0.3	5.6	27.5	-26.3	1.2	9.8	-8.3	1.5	-0.6	0.3	-0.3
Activities related to financial intermediation	0.6	0.4	1.0	-9.3	16.6	7.3	2.4	-1.6	0.8	0.2	0.3	0.5
Renting of machinery and equipment	-13.2	3.1	-10.1	15.1	-6.7	8.3	-1.3	1.2	-0.1	0.5	-0.3	0.2
Computer and related activities	-2.6	3.9	1.3	-14.6	19.9	5.4	-2.9	3.7	0.8	0.3	0.9	1.2
Research and development	-0.1	0.2	0.1	40.5	-33.9	6.6	-4.0	1.4	-2.6	-1.4	-0.4	-1.7
Other business activities	1.5	1.9	3.3	-126.2	72.3	-53.9	11.2	-3.4	7.8	-10.1	-0.6	-10.7
Public administration and defence; Compulsary social secturity	28.1	-11.7	16.4	-19.5	-40.0	-59.5	6.1	-12.5	-6.4	0.5	-1.8	-1.3
Education	-3.4	-8.4	-11.8	124.9	-52.7	72.2	-5.8	-8.6	-14.4	-2.4	0.0	-2.5
Health and social work	32.6	-15.9	16.7	55.3	-25.7	29.5	-64.4	17.4	-47.0	-4.4	0.1	-4.4
Sewage and refuse disposal, sanitation and similar activities	9.4	-1.5	7.8	-28.9	14.1	-14.8	2.7	-3.5	-0.7	0.7	0.0	0.8
Activities of membership organizations nec	19.8	-0.5	19.3	-1.3	-3.5	-4.8	-1.7	-0.5	-2.2	-0.4	-0.1	-0.5
Recreational, cultural and sporting activities	6.2	-4.9	1.3	-41.1	72.5	31.4	0.5	0.4	0.9	1.0	-1.7	-0.7
Other service activities	-27.8	-0.4	-28.2	-4.7	-3.2	-7.9	-2.6	-1.3	-3.9	1.0	-1.1	-0.1
SERVICES	103.9	-3.9	100.0	-278.1	178.1	-100.0	-84.8	-15.2	-100.0	-103.3	3.3	-100.0

Table C.3c Percentage contribution of the efficiency effect (EFF) and the structural effect (STR) by sector to the average annual growth rate of Services energy intensity per country, for the period 1995−2005.

1995–2005	**Italy**			**Japan**			**Korea**			**Netherlands**		
	EFF Effect	STR Effect	TOT Effect	EFF Effect	STR Effect	TOT Effect	EFF Effect	STR Effect	TOT Effect	EFF Effect	STR Effect	TOT Effect
Sale, maintenance, repair motor vehicles and -cycles; retail sale of fuel				-0.2	0.8	0.6	0.4	0.0	0.4	-3.0	0.6	-2.4
Other wholesale trade and commission trade	-2.1	-1.5	-3.6	3.1	-10.7	-7.6	2.5	-1.8	0.6	-18.5	18.3	-0.3
Other retail trade; repair of household goods				-9.6	-63.1	-72.7	2.6	-1.7	0.8	-13.8	-9.6	-23.4
Hotels and restaurants	1.5	-0.2	1.2	82.5	-45.4	37.2	3.0	-1.2	1.7	3.6	-14.8	-11.2
Post and Telecommunications	-1.3	1.4	0.1	25.1	28.2	53.2	-4.4	25.6	21.2	-4.5	6.0	1.5
Financial intermediation, except insurance and pension funding				-2.5	1.7	-0.8	0.9	0.5	1.3	-2.8	3.5	0.7
Insurance and pension funding, except compulsory social security	-2.7	-0.1	-2.8	3.5	-5.0	-1.5	0.3	-0.2	0.1	0.3	-1.8	-1.5
Activities related to financial intermediation				--	--	--	0.1	0.2	0.4	-1.3	-0.1	-1.4
Renting of machinery and equipment				-13.9	13.4	-0.5	12.2	-12.6	-0.4	-0.1	0.3	0.1
Computer and related activities	-0.7	1.1	0.4	-4.4	3.1	-1.3	0.6	1.3	1.9	-1.7	4.3	2.6
Research and development				11.4	1.7	13.0	1.0	0.4	1.4	-4.7	-1.4	-6.2
Other business activities				4.7	4.9	9.6	2.4	0.6	3.0	0.2	-1.0	-0.9
Public administration and defence; Compulsary social secturity	-50.8	-1.3	-52.1	-13.7	-11.2	-24.9	6.6	-2.8	3.7	8.8	-13.6	-4.8
Education	-15.0	-0.9	-15.9	29.6	-11.2	18.4	10.4	-2.4	8.0	-0.3	-12.6	-12.9
Health and social work	-23.6	0.7	-22.9	14.0	48.5	62.6	51.9	-6.0	45.9	-22.0	-6.3	-28.3
Sewage and refuse disposal, sanitation and similar activities				2.1	-2.0	0.1	1.8	0.2	2.0	-4.0	2.9	-1.1
Activities of membership organizations nec	-3.8	-0.7	-4.4	-0.2	-0.8	-1.0	0.2	-0.2	0.0	-0.5	-1.7	-2.2
Recreational, cultural and sporting activities				14.9	-9.2	5.6	4.8	2.4	7.2	-7.7	0.8	-6.9
Other service activities				14.4	-4.3	10.1	1.2	-0.6	0.6	3.1	-4.6	-1.5
SERVICES	-98.5	-1.5	-100.0	160.8	-60.8	100.0	98.5	1.5	100.0	-69.1	-30.9	-100.0

Table C.3d Percentage contribution of the efficiency effect (EFF) and the structural effect (STR) by sector to the average annual growth rate of Services energy intensity per country, for the period 1995−2005.

1995–2005	Poland			Portugal			Slovakia			Spain		
	EFF Effect	STR Effect	TOT Effect	EFF Effect	STR Effect	TOT Effect	EFF Effect	STR Effect	TOT Effect	EFF Effect	STR Effect	TOT Effect
Sale, maintenance, repair motor vehicles and -cycles; retail sale of fuel	-120.8	49.7	-71.1	-24.6	-8.6	-33.2	-0.8	2.4	1.6	2.7	-0.4	2.3
Other wholesale trade and commission trade	-116.4	234.5	118.1	12.3	-6.4	5.9	-10.1	9.7	-0.3	7.4	0.2	7.6
Other retail trade; repair of household goods	-327.5	-106.1	-433.6	19.2	7.2	26.4	-59.6	12.8	-46.8	19.1	-0.6	18.5
Hotels and restaurants	-66.5	34.7	-31.9	-41.9	-23.1	-65.0	6.2	-14.2	-8.0	1.7	-1.9	-0.2
Post and Telecommunications	-403.0	172.0	-231.0	-3.9	5.9	2.0	-1.5	0.8	-0.7	4.7	2.3	6.9
Financial intermediation, except insurance and pension funding	54.7	96.0	150.7	-8.5	8.7	0.2	-2.5	-3.5	-5.9	-3.0	0.6	-2.4
Insurance and pension funding, except compulsory social security	187.7	113.6	301.3	-1.2	-0.7	-1.9	0.5	-0.5	0.0	-0.1	0.4	0.3
Activities related to financial intermediation	-57.4	12.5	-44.9	0.0	0.0	0.0	--	--	--	-0.1	-0.3	-0.3
Renting of machinery and equipment	-56.8	34.0	-22.8	-1.9	0.8	-1.1	0.5	-0.4	0.1	1.4	0.1	1.5
Computer and related activities	-17.7	35.6	17.9	3.0	1.2	4.1	-0.9	0.3	-0.6	-0.3	0.6	0.2
Research and development	36.1	-51.6	-15.5	0.3	-0.2	0.1	-0.3	-3.9	-4.1	0.1	0.0	0.1
Other business activities	-100.5	18.1	-82.3	-38.2	-10.1	-48.3	-21.1	10.2	-10.9	6.2	1.2	7.4
Public administration and defence; Compulsary social secturity	53.8	-0.9	52.9	-26.3	-5.4	-31.7	-14.5	6.8	-7.7	17.2	-2.8	14.4
Education	386.0	-63.2	322.8	13.8	-6.9	6.9	-6.5	-0.7	-7.2	22.8	-1.6	21.2
Health and social work	47.8	-167.3	-119.4	41.2	-19.1	22.1	6.2	-7.0	-0.9	12.1	-0.2	11.9
Sewage and refuse disposal, sanitation and similar activities	67.8	134.2	202.0	1.0	0.3	1.4	2.3	-4.1	-1.9	4.7	1.3	6.0
Activities of membership organizations nec	41.7	-14.4	27.4	16.8	-12.0	4.8	-4.7	3.2	-1.5	0.3	0.1	0.4
Recreational, cultural and sporting activities	32.2	32.8	65.0	5.8	-0.2	5.6	-2.5	-1.1	-3.6	3.0	-0.1	2.9
Other service activities	-9.5	-96.1	-105.6	1.2	0.3	1.5	-3.1	1.3	-1.8	1.0	0.3	1.3
SERVICES	-368.3	468.3	100.0	-31.9	-68.1	-100.0	-112.3	12.3	-100.0	100.9	-0.9	100.0

Table C.3e Percentage contribution of the efficiency effect (EFF) and the structural effect (STR) by sector to the average annual growth rate of Services energy intensity per country, for the period 1995−2005.

1995–2005	Sweden			United Kingdom			USA		
	EFF Effect	STR Effect	TOT Effect	EFF Effect	STR Effect	TOT Effect	EFF Effect	STR Effect	TOT Effect
Sale, maintenance, repair motor vehicles and -cycles; retail sale of fuel	-3.7	1.3	-2.4	131.0	-32.1	99.0	-32.3	23.2	-9.0
Other wholesale trade and commission trade	-29.0	10.3	-18.7	253.7	-125.8	127.9	-15.9	-4.5	-20.4
Other retail trade; repair of household goods	-10.5	3.7	-6.8	126.7	-14.5	112.2	-51.4	25.5	-25.9
Hotels and restaurants	-0.7	-0.3	-1.1	74.3	-31.3	42.9	-7.1	-8.1	-15.2
Post and Telecommunications	-7.2	4.2	-3.0	-117.4	157.8	40.4	-4.6	3.8	-0.8
Financial intermediation, except insurance and pension funding	-0.3	0.5	0.2	-157.4	64.7	-92.7	-7.5	7.0	-0.5
Insurance and pension funding, except compulsory social security	-1.1	-1.2	-2.3	73.7	-107.0	-33.2	0.5	-1.4	-0.9
Activities related to financial intermediation	0.0	0.1	0.1	6.2	14.8	20.9	--	--	--
Renting of machinery and equipment	-4.6	1.7	-2.9	-14.2	11.8	-2.4	6.9	-4.4	2.5
Computer and related activities	-0.3	0.9	0.6	-12.9	90.5	77.6	-1.0	2.7	1.7
Research and development	-1.6	1.5	-0.2	17.6	-9.5	8.0	1.1	0.2	1.3
Other business activities	-4.1	-0.9	-5.0	-93.6	106.0	12.5	1.0	1.4	2.5
Public administration and defence; Compulsary social secturity	-10.4	-20.8	-31.1	192.7	-253.6	-60.9	9.3	-26.7	-17.5
Education	-2.0	-3.2	-5.1	19.3	-118.2	-98.9	1.0	-1.1	-0.1
Health and social work	-2.8	-8.5	-11.3	3.8	-56.3	-52.5	-5.4	-0.7	-6.1
Sewage and refuse disposal, sanitation and similar activities	-1.5	2.1	0.6	3.2	-25.6	-22.4	1.4	-4.7	-3.3
Activities of membership organizations nec	-1.3	-4.7	-5.9	0.6	-10.8	-10.2	-1.0	-2.6	-3.5
Recreational, cultural and sporting activities	-5.1	0.0	-5.0	-51.1	-5.2	-56.3	-2.4	1.4	-1.0
Other service activities	-0.6	-0.1	-0.7	4.1	-16.1	-11.9	-2.7	-1.0	-3.7
SERVICES	-86.7	-13.3	-100.0	460.4	-360.4	100.0	-110.1	10.1	-100.0

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