Chapter 4
The Value Added by Technology

4.1 Comparing Economic Activity Sectors

Following Fernandes [1], the proposed KTC model will now be applied, computing the knowledge, technology, and capital indexes of different economic sectors and divisions within one economy. The Portuguese economy was chosen because all the necessary data were readily available from INE, including depreciation values per different types of assets. This economy will be characterized in what concerns its sectors' dependence on knowledge, technology, and capital by computing the values added by the uses of knowledge, technology, and capital. For comparing economic activity sectors, the algorithm proposed in Chap. 3 was applied using data from years 1996 to 2003. This analysis considered the universe of firms with more than 20 employees for 49 divisions of CAE[1] rev. 2 (NACE 1.1 or ISIC rev. 3). The divisions that are not covered in this study, because reliable data were not available, are the following: In the secondary sector, divisions 10 Mining of Coal and 11 Extraction of gas and petroleum; in the Tertiary, are not considered one large division (75 public administration), four very small divisions (73 Research & development, 91 Activities and membership organizations NEC; 95 private households; and 99 extra-territorial organizations), and the financial activity (65 financial intermediation; 66 Insurance; 67 activities auxiliary to financial). The data and financial maps needed for this study are the following: The profit and loss account, from where the standard identity for the GVA can be computed; the balance sheet, with both gross and net values of assets and accumulated depreciations; the depreciation map, with detailed depreciation values per each type of assets.

For the year 2000, the results for indexes KI, TI, and CI are shown in Fig. 4.1 for the primary (divisions 1–5), secondary (10–45, except 10 and 11), the tertiary (50–99, except 65–67, 73, 75, 91, 95 and 99) and the sum of the three, named Total.

[1] Classificação de Actividade Económica (Classification of Economic Activity).

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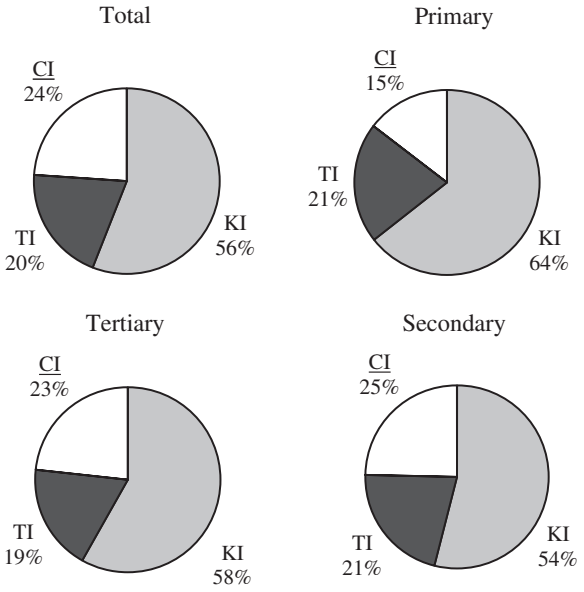

Fig. 4.1 Knowledge, technology, and capital indexes. Primary (NACE 1.1 divisions 1–5), secondary (10–45, except 10), tertiary (50–99, except 65–67, 75, 91, 95, and 99) and total (year 2000, universe of Portuguese firms with more than 20 employees) (Reprinted from Fernandes [1], Copyright (2012) reproduced with permission from Elsevier)

The results show that, for the total activity, the knowledge index is 56 %, whereas the technology index is 20 % and the capital index is 24 %. The direct contribution of knowledge accounted for more than half the total GVA and almost two-third in the primary sector, what makes this sector highly dependent on labor and thus on the direct use of knowledge. The TI is not very different in the three sectors. Still, the primary and the secondary use relatively more technology that the tertiary. As for CI, the highest value is found in the secondary, where the capital borrowed, the buildings' depreciation values and profits seem to be higher. The indexes evolved within this period as shown in Figs. 4.2, 4.3, and 4.4, a period that was characterized as an expansion from 1996 to 2000 and a recession up to 2003.

Next, results for a few sectors are described in Fig. 4.5, indexes are shown for section D (Manufacturing–divisions 15–37), division 32 (Manufacturing radio, etc.), division 40 (Electricity), and division 45 (Construction). It is interesting to compare the high TI and CI of electricity, which are, respectively, 34 and 42 %, with the much lower ones of construction, which are, respectively, 15 and 19 %. Electricity is commonly known as a capital-intensive sector, which is corroborated by these results, and construction, as expected, shows a high dependence on labor.

In Fig. 4.6, a direct comparison is shown among four very different divisions: Retail trade (52), telecommunications (642), computer and related activities (72), and education (80). The KI is very high for education and high for computers, showing their high dependence on knowledge and labor. In retail, KI is close to the country's average and in telecommunications is very low. On the other hand, the TI is high in telecommunications and very low in education and in computers. It is surprising to find out that the division computer and… has a very low

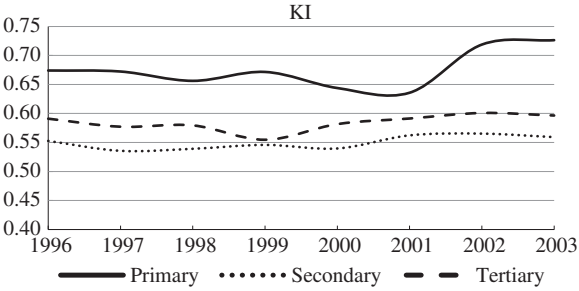

Fig. 4.2 Portugal knowledge index

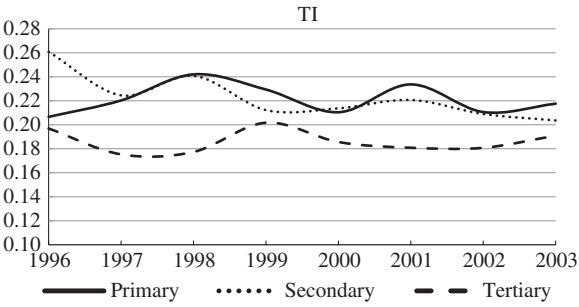

Fig. 4.3 Portugal technology index

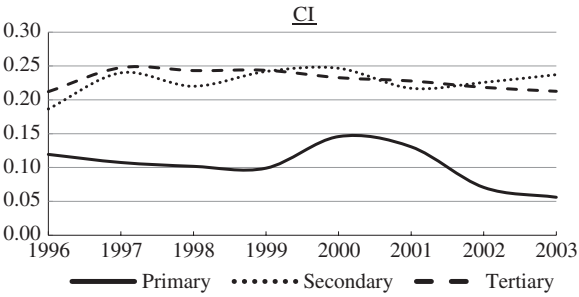

Fig. 4.4 Portugal capital index

technology index, 8 %, which is almost as low as education's 6 %. They are both knowledge-intensive divisions, very far from being high-technology divisions. When comparing divisions like computer and related activities with construction, where KI shows that labor costs are in both the major contribution to GVA, one may be lead to the idea that these divisions have similar characteristics. However, that is not the case, because the former has a number of workers highly paid and the latter has a much larger number of workers but at a much lower average wage. This effect calls for attention to complement the information given by these indexes with other indicators, such as labor productivity.

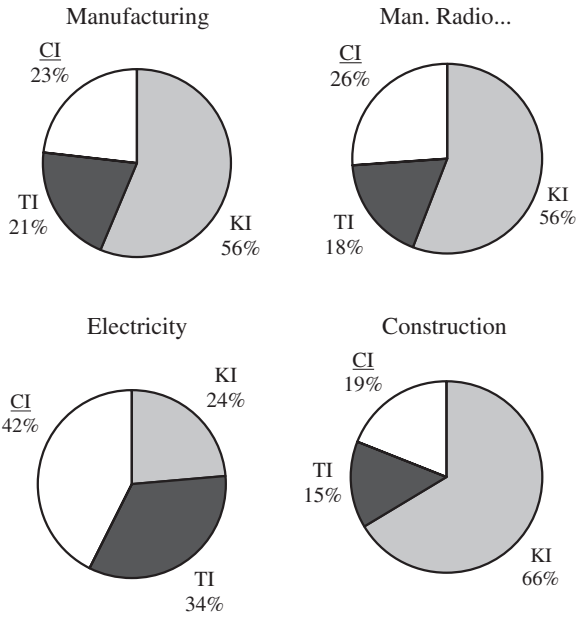

Fig. 4.5 Knowledge, technology, and capital indexes: whole of manufacturing industry (divisions 15–37); to manufacturing of radio, television, and communication equipment (32); electricity… (40); and construction (45) (year 2000, Portuguese firms with more than 20 employees) (Reprinted from Fernandes [1], Copyright (2012) reproduced with permission from Elsevier)

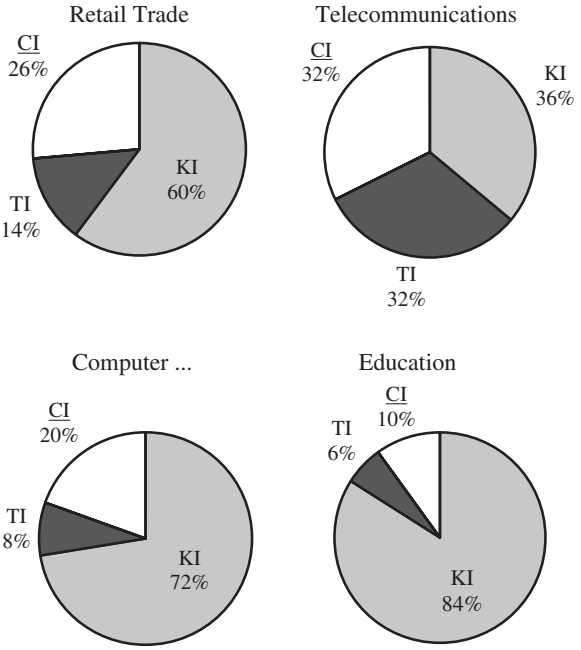

Fig. 4.6 Knowledge, technology, and capital indexes of divisions retail trade (52), telecommunications (642), computer and related activities (72), and education (80) (year 2000, universe of Portuguese firms with more than 20 employees) (Reprinted from Fernandes [1], Copyright (2012) reproduced with permission from Elsevier)

4.2 Comparing Economies

The values L, T, and C, as well as their respective indexes, KI, TI, and CI, were also computed for the manufacturing sector (NACE Rev 1.1) of all the European countries that have the relevant data available in the European communities database BACH: Portugal, Belgium, Germany, Spain, France, Finland, and Poland. All sizes of firms were considered, with the variable sample choice and data spanning the years 1995–2008. The algorithm used in this analysis for computing L, T, and C had a small change compared with the one used for Portuguese data. The reason is that there are no depreciation map accounts in this database. This slightly different and less accurate algorithm builds on what was learned from the algorithm's implementation for the Portuguese data. This was explained in the last part of Chap. 3, Sect. 3.4.

For the manufacturing sector, the results for the indexes KI, TI, and CI are shown in Table 4.1, for the three periods 1995–2000, 2001–2006, and 2007–2008. The values for each period are averages of 6 years' annual index percentage values, for the two initial periods, and an average of 2 years' annual index percentage values, for the last period. Results show different indexes for different countries and important changes along the three periods. The most striking evidence is Germany's very high manufacturing industry dependence on labor contribution to value added (KI). Germany and France are the countries where TI is lower and KI is higher. Economies with lower relative dependence on knowledge have, consequently, higher relative dependences on technology and capital. CI is always higher than TI, especially in less developed economies where investment is typically lower.

Along the period 1995–2008, which covers approximately one business cycle, we may note the following:

- KI: Belgium, Germany, and France decrease their Knowledge Index (the same as unit labour cost), while Portugal, Spain, Finland, and Poland increase it. This,

Table 4.1 Values of indexes KI, TI and CI for different European countries' manufacturing sectors (1995–2008)

	Portugal	Belgium	Germany	Spain	France	Finland	Poland
Average 1995–2000							
KI	0.543	0.628	0.747	0.599	0.660	0.495	0.543
TI	0.209	0.184	0.112	0.138	0.107	0.120	0.209
CI	0.243	0.187	0.127	0.252	0.215	0.378	0.243
Average 2001–2006							
KI	0.565	0.615	0.742	0.620	0.653	0.537	0.496
TI	0.182	0.169	0.118	0.139	0.102	0.129	0.130
CI	0.246	0.216	0.121	0.216	0.224	0.313	0.368
Average 2007–2008							
KI	0.598	0.617	0.708	0.637	0.657		0.493
TI	0.147	0.158	0.122	0.133	0.087		0.118
CI	0.245	0.223	0.144	0.214	0.236		0.372

for the first group of countries, indicates policies giving priority to investment rather than distribution of value.

- TI: Germany and Finland increase their technology index, while the other countries decrease it. This shows that in the two countries it was given priority to investment in technology.
- CI: Portugal, Belgium, Germany, France, and Poland increase their capital index, while the other countries decrease it.

There is a good evidence of the Germany economy's robustness in 2008, as it succeeded, along the previous business cycle, to decrease its unit labor cost (ULC equals KI) and increase both the technology index and the capital index, and thus becoming better prepared for the incoming financial crisis of 2008–2009. From this group, it was the only country where this happened.

At the beginning of this crisis the indexes changed as shown in Table 4.2, for the years 2009 and 2010. All countries show a decrease in the capital index (CI), although Germany shows a very small decrease. The decrease is due to mainly the fall in profits. This index decrease implies an increase on the other two indexes. The knowledge index KI increases in all countries, except for Poland where it remained almost constant. The technology index also increased in all countries, except for Germany where it remained almost constant. The indexes showed in Tables 4.1 and 4.2 are described in Figs. 4.7, 4.8, and 4.9.

Table 4.2 Values of indexes KI, TI, and CI for different European countries' manufacturing sectors (2009–2010)

	Portugal	Belgium	Germany	Spain	France	Poland
Average 2009–2010						
KI	0.625	0.627	0.720	0.697	0.688	0.497
TI	0.153	0.171	0.121	0.156	0.095	0.157
CI	0.217	0.203	0.140	0.143	0.192	0.338

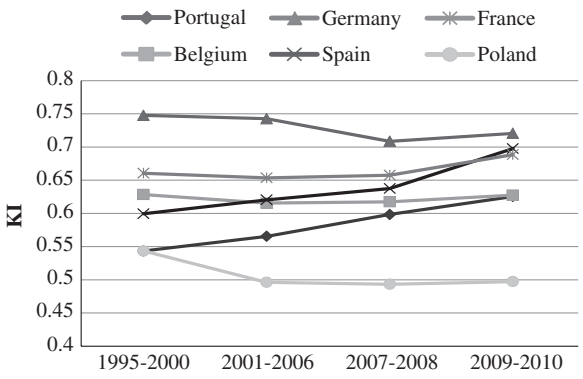

Fig. 4.7 Knowledge index KI for different European countries' manufacturing sectors

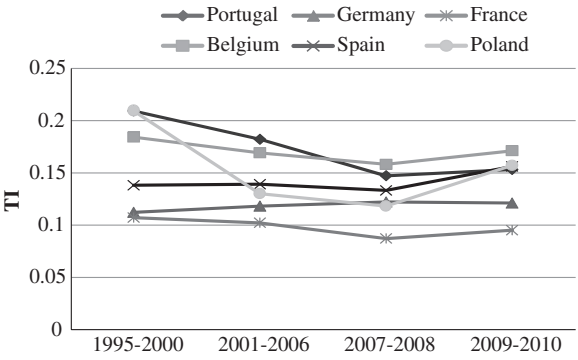

Fig. 4.8 Technology index TI for different European countries' manufacturing sectors

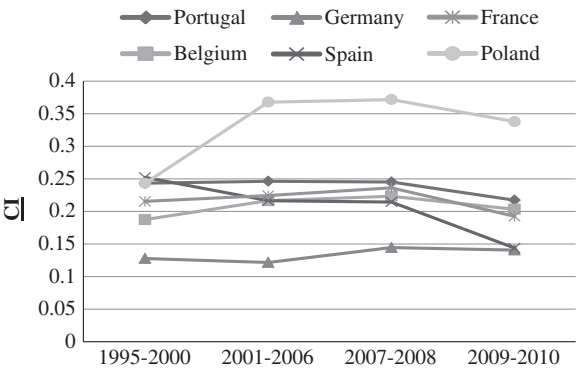

Fig. 4.9 Capital index CI for different European countries' manufacturing sectors

4.3 Conclusions

This chapter shows results of applying the KTC model algorithms to find out how much technology, knowledge, and capital contribute to GVA. These results help to understand the nature of the indexes TI, KI, and CI and how they can help to characterize economy changes and growth. As for any other indexes, they add a new angle through which understanding the whole picture becomes more complete. As they are objectively linked to international standard accounting, it is easier to, through them, describe objectively the technology dependence of a sector, a firm or a whole economy and compare them independently of the year or of the country. There is complementary information that would be important to compute, like the values of used technology per hour worked or per employee, and equally for capital.

Some results are especially important because they challenge some current thoughts and beliefs. A first example is the similar technology index (TI) of sectors like computer and… (72) and education (80). They are both knowledge intensive sectors where labor represents the majority of value contribution to GVA.

Even if R&D and innovation is far greater in the former, the real activity and value added show clearly that the highest dependence is from knowledge, expressed as work, and valued by the corresponding labor. A second unexpected result is finding about the same knowledge dependence on sectors like computer and… (72) and construction (45). The former has fewer employees but each with a larger salary, such that the final picture looks about the same. Finally, a third striking conclusion is that countries like Germany and France, when compared with Portugal, Belgium, Finland, and Poland, show a much lower technology index in their manufacturing sector. At the same time, those two countries show a larger knowledge index. This result shows how these indexes depend on the value distribution policies of the countries. In fact, German and French firms pay their labor higher wages, guaranteeing their competiveness through higher productivities.

Reference

1. Fernandes ASC (2012) Assessing the technology contribution to value added. Technol Forecast Soc Chang 79:281–297