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Restructuring of the international clothing and textile trade network: the role of Italy and Portugal

Marlies Hanna Schütz*  and Nicole Palan

*Correspondence:
marlies.schuetz@uni-graz.at
Graz Schumpeter Centre,
University of Graz,
Universitätsstraße 15/FE,
8010 Graz, Austria

Abstract

Since the 1990s, the clothing and textile (C&T)-industry has been tremendously affected by changes in technology, trade costs, and the institutional environment. This paper studies the restructuring of C&T-trade from the perspective of Europe's two most prominent C&T-goods producing countries—Italy and Portugal. We explore these two countries' situation in a global context and concentrate our analysis to two distinct economic variables, C&T-value added and C&T-labor. Moreover, we contribute to the existing literature by distinguishing between domestically and internationally traded C&T-goods as well as between trade in intermediate and final demand C&T-goods, which enables us to give a more full-fledged picture on restructuring of C&T-trade. We show that international C&T-production became more concentrated between 1995 and 2009. In a further step, we investigate changes with regard to import penetration of C&T-trade, international outsourcing, the distance to final demand for C&T-goods, and another range of country-specific trade patterns. Our main findings reveal that Italy was more oriented toward C&T-production activities which generate high value added, whereas Portugal was less productive and relatively more specialized into the production of labor-intensive C&T-goods. Thus, Portugal was more prone to the rising international pressure from low-wage countries, whereas in Italy restructuring of C&T-trade had comparatively less severe effects.

Keywords: Restructuring, Clothing and textile industry, International trade network, Trade of intermediate and final demand C&T-goods, Directly embodied C&T-value added and -labor, Italy and Portugal

JEL Classification: C67, F14, O12

1 Background

Production processes in recent years have been continuously fragmenting internationally (Jones and Kierzkowski 1990; Johnson and Noguera 2012) leading so to a finer division of labor and a rise in productivity. In addition, this increasing “multi-country nature of single products” (Stehrer et al. 2011: 1) has been accompanied by the establishment of global value chains (Feenstra and Hanson 1996) and worldwide competition thus more and more plays out at the level of production activities *within* industries and hence, at the level of a single commodity, rather than in competitive advantages *between* industries (Fujita and Thisse 2006, 2013).

A prime example for a globalized industry is the clothing and textile (C&T)-industry, where since the early 1990s increased mechanization and automation processes as well as fundamental changes in the institutional environment have been important drivers for the restructuring of production and trade (Kowalski and Molnár 2009). Particularly noteworthy are the changes in the institutional environment, where the replacement of the 1974 Multifibre Agreement by the WTO Agreement on Textile and Clothing by the end of 1994 foresaw a full integration of this industry into WTO/GATT by 2005. These changes have led to strong international competition for the European national C&T-industries from low-wage countries (e.g., China entered the WTO in 2000) as C&T-production is a field in which newly industrializing countries are usually quickly entering due to its low capital content.

In light of the changing institutional environment and the increased international competition for Europe's national C&T-industries, the European Commission tried to implement effective policy measures to stabilize the situation of European C&T-production and -trade. In 2003 the European Commission thus initiated a task force, the so-called High Level Group on Textiles and Clothing (European Commission 2004a, b). Discussing the situation observed in European national C&T-industries, the High Level Group emphasizes: "[w]hile the Euro-Mediterranean Zone provides the conditions necessary to allow the sector to remain an important contributor to European industrial production, policymakers cannot ignore the fact that a permanent process of restructuring and modernisation *will continue to lead to falling employment [and value added]* for some years to come." (European Commission 2004b: 7, emphasis added)

Tying in with this observation, this paper addresses the restructuring of Italy's and Portugal's C&T-trade in an international context between the two years 1995 and 2009. The special interest for the development in Italy and Portugal is owed to the hypothesis that C&T-production and accordingly C&T-trade in these two countries are expected to have faced the most intense restructuring. This is due to first, the C&T-industry's significance for their national economies, and second, these two countries' role in European C&T-production.¹ We focus in our empirical analysis on a meso-level, and our smallest unit of analysis is constituted by C&T-goods at the two-digit level, which are traded both domestically and internationally. We adopt a systemic perspective in our study and to account for the spatial dimension of C&T-trade on a global scale we use a rich country-sample of 40 countries. More precisely, we embed the study of country-specific C&T-trade patterns for our two case study countries into an international setting. This we consider as necessary, since international C&T-trade perceives of a rather integrated structure. We further separate between trade in intermediate demand and final demand C&T-goods which proves beneficial in order to do justice to the increasing global nature of production processes. Our systemic approach mirrors also in the fact that we limit our analysis not to a single economic variable but instead we are interested in two distinct economic variables, namely (1) employment and (2) value added in the C&T-industry. We consider this as a strong point of our approach as it helps to create a more

¹ This reflects for instance in the fact that Italy's share of value-added generation in the EU-15 C&T-industry was 32.5 % and its employment share 31.4 % in 1995. For Portugal, the importance of C&T-production gets evident more in its national economic structure, where the share of C&T-employment in total manufacturing employment in 1995 was 18.3 % and value-added generated in its C&T-industry accounted for 11.3 % in total manufacturing value-added generation.

full-fledged picture of the experienced restructuring of both countries' C&T-trade. In particular, the focus set on employment brings in novel aspects, since this indicator has been neglected to some extent in this type of analysis. This, however, is an unsatisfactory fact, as employment dynamics spurred by restructuring processes should be equally high on the political agenda as changes in value-added generation.

Before we explore country-specific C&T-trade patterns for Italy and Portugal as well as changes therein, we focus on global production of C&T-goods and look at whether it is more concentrated or more dispersed in 2009 compared to 1995. Moreover, we investigate productivity of C&T-workers in different regions around the world and its change between 1995 and 2009. In a next step, we concentrate our analysis to global C&T-trade and Italy's and Portugal's role therein. In detail, we figure out (changes in) spatial trade patterns in terms of C&T-value added and C&T-labor directly embodied in international C&T-trade flows. In a final step, we identify another range of similarities and differences between C&T-trade patterns of Italy and Portugal, where some measures applied let us draw inference about the two countries' C&T-production activities. Aspects addressed include: (1) import penetration of C&T-trade and international outsourcing; (2) specialization patterns with respect to the direct C&T-value-added content and direct C&T-labor intensity of C&T-trade flows; and (3) the distance to final demand for C&T-goods, where we use the economic space for defining proximity.

From an analytical viewpoint, we apply the Hirschman-Herfindahl Index (Herfindahl 1950; Hirschman 1958) and the coefficient of sectoral variation for exploring concentration patterns of C&T-production on a global scale. In a further step, we choose a network-based approach since this allows us investigating the interdependent structure of global trade in C&T-goods. Our analytical starting point are two C&T-trade networks (TNs) one for C&T-value added and the other one for C&T-labor directly embodied in domestic and international C&T-trade flows. We build our networks based on the graph theoretical concept of an edge-weighted directed graph. The main data source for deriving our C&T-TNs are two world input-output tables (WIOTs)—one for 1995 and one for 2009, which we take from the World Input-Output Database (WIOD) (Timmer et al. 2015).

Since we trace multiple aspects of restructuring of C&T-trade and embed the analysis for our two case study countries into an international setting, we contribute to a better understanding of the nature of restructuring of trade in a single commodity—C&T-goods—as triggered by changes in the institutional and technological environment. Moreover, the study of both similarities and differences between restructuring of Italian and Portuguese C&T-trade proves decisive for effective policy design.

The paper proceeds as follows. We start with a discussion on the methods and an explanation of data handling and related preparatory work in Sect. 2. Section 3 reports empirical results, and Sect. 4 concludes.

2 Methods

2.1 Concentration measures

The degree to which the C&T-industry is concentrated, is measured in two different ways: We first investigate absolute concentration, i.e., whether C&T-value added (-employment) is located in a few countries only despite the fact that the C&T-industry

is one of the most prominent examples of a globalized industry. Second, we use a relative concentration index. This concept analyzes to which degree the shares of each country's C&T-industry as a portion of each country's manufacturing sector are different from the share of the international C&T-industry as a portion of the international manufacturing sector. The manufacturing sector contains the industries 15–37 according to the ISIC rev. 3 code (see Appendix 3: Table 6). By applying both concepts of concentration, we gain a more detailed understanding of the underlying forces of the concentration patterns at hand. For instance, the differences with respect to country size in our sample are large, thus facilitating absolute concentration. Since the level of economic development as well as wage levels are quite diverse as well, the shares of the C&T-industry could also be very heterogeneous, implying relative concentration.

We capture absolute concentration by the Hirschman-Herfindahl Index (HHI) (Herfindahl 1950; Hirschman 1958). The HHI takes the following form for C&T-value added and C&T-labor (denoted by 1 and 2, respectively):

$$\text{HHI}^1 = \sum_{h=1}^k \left(\frac{v_h}{\sum_{i=1}^k v_i} \right)^\alpha \quad (1a)$$

$$\text{HHI}^2 = \sum_{h=1}^k \left(\frac{l_h}{\sum_{i=1}^k l_i} \right)^\alpha \quad (1b)$$

Based on a vector v of dimension $k \times 1$, in Eq. (1a), for k countries with $i, h = 1, \dots, k$ a generic element v_i , respectively v_h , of this vector contains value added in the C&T-industry of a single country i , respectively h . In Eq. (1b), the starting point is vector l of dimension $k \times 1$ and the generic elements l_i and l_h , respectively, contain hours worked in the C&T-industry. Most empirical studies on concentration choose $\alpha = 2$ (Davis 1998; Storper et al. 2002; Aiginger and Pfaffermayr 2004; Beine and Coulombe 2007), and we follow this approach. The maximum level of absolute concentration would be reached if total C&T-value added (-employment) would occur in one country only; the lower bound of absolute concentration would occur if all countries (irrespective of their country size) were characterized by the same amount of value added (number of hours worked). In our case, the HHI can thus range between 1 and 0.025.

With regard to relative concentration, we apply the coefficient of sectoral variation (CV) which is based on the well-established Krugman Index (Krugman 1991a) but corrects for the (evolving) size of the industry and thus makes intertemporal comparisons more robust. For value added and labor, the CV reads as:

$$\text{CV}^1 = \frac{1}{k} \sum_{h=1}^k \frac{\left| \frac{v_i}{v_{\text{manuf}}} - \frac{\sum_{i=1}^k v_i}{\sum_{i=1}^k v_{\text{manuf}}} \right|}{\frac{\sum_{i=1}^k v_i}{\sum_{i=1}^k v_{\text{manuf}}}} \quad (2a)$$

$$\text{CV}^2 = \frac{1}{k} \sum_{h=1}^k \frac{\left| \frac{l_i}{l_{\text{manuf}}} - \frac{\sum_{i=1}^k l_i}{\sum_{i=1}^k l_{\text{manuf}}} \right|}{\frac{\sum_{i=1}^k l_i}{\sum_{i=1}^k l_{\text{manuf}}}} \quad (2b)$$

In Eqs. (2a) and (2b), v_i^{manuf} and l_i^{manuf} correspond to value added, respectively, employment in the manufacturing sector of a single country i . With regard to relative concentration, the reference level is the share of the worldwide C&T-industry as a portion of the worldwide manufacturing sector. Therefore, if all countries have the same share of C&T-industries measured as a percentage of their manufacturing sectors, there would be no relative concentration. This indicates the lower bound of concentration and the index would thus take the value zero. The upper bound of the index cannot be unambiguously defined as it depends not only on the number of countries k in the sample but also on the relative size of the other manufacturing industries and the relative size of the countries under study.

2.2 International C&T-trade networks

Our analytical network-based approach resides at the crossroads of two strands of the literature which have a similar research focus—the study of structural properties of production and trade on a global scale. The first strand of the literature is anchored in multiregional input–output analysis, and the second one can be associated with the study of “socio-economic systems in the framework of network analysis” (Fagiolo et al. 2010: 480), or alternatively, as Prell et al. (2014: 405) describe it, with “world systems theory”. In the field of multiregional input–output analysis there exists a range of papers (e.g., Stehrer 2012; Stehrer et al. 2012; Los et al. 2014, 2015a), where the research focus is primarily on the global dimension of production. For instance, they analyze the factor content of global trade linkages or factor income components and value added directly and indirectly embodied in global trade flows. We depart from this literature from a conceptual viewpoint as we concentrate our analysis to only C&T-labor and C&T-value added directly embodied in C&T-trade flows. Related to this, another difference is that we isolate C&T-trade flows and do not work on the ‘full’ production structure as reflected in a (multiregional) input–output table. We do so, since we seek to obtain an as detailed as possible picture on the structure of trade in C&T-goods only. With respect to this latter difference to multiregional input–output analysis, we are closer to the second strand of the literature, where in recent years an extensive body of papers has been published. On the one side, there are several works which focus primarily on topological characteristics of global TNs in either an aggregate or a commodity-specific context, such as Serrano and Boguñá (2003), Barigozzi et al. (2010), Fagiolo et al. (2010), or De Benedictis et al. (2014). On the other side, there exist several works (e.g., Kali and Reyes 2007; Reyes et al. 2010; Benedictis and Tajoli 2011; Amighini and Gorgoni 2014) which put the exploration of specific economic phenomena related to international trade into the foreground. Main differences to our paper are: (1) in all of these works no trade in directly embodied value added or factor inputs of a single commodity is examined, which we consider as a crucial issue to understand the nature of restructuring of C&T-trade. (2) In none of these works a distinction between intermediate and final demand goods is made, which, however, proves important as shown *inter alia* by Miroudot et al. (2009). (3) In some of these works either binary or even undirected graphs are investigated. On the contrary, since both the direction and the intensity of trade do reflect important properties of C&T-trade, we work on an edge-weighted directed graph. We add thus to this existing literature in several different ways.

The basic concept for constructing each of our international C&T-TNs is an edge-weighted directed graph G . Following partly the definition of Harary et al. (1965), a directed graph consists of a pair (V, X) where V is a finite and non-empty set of elements i, h called nodes and X is a finite set of elements e_{ih} called edges, with $i, h = 1, \dots, k$. An edge-weighted directed graph is described by two functions $f_1, f_2 : X \rightarrow V$ and to each $e_{ih} \in X$ finally a weight $w_{ih} > 0$ is assigned. In our case, each node of V corresponds to a single country, while the set of edges X contains trade linkages between the nodes, which are weighted by C&T-trade volumes w_{ih} . As explained in more detail in Appendix 1, we derive two adjacency matrices A^1 and A^2 for each year, 1995 and 2009, from the basic edge-weighted directed graph G to map our C&T-TNs, where the first adjacency matrix A^1 shows flows of C&T-value added directly embodied in domestically and internationally traded C&T-goods, and the second one A^2 refers to C&T-labor directly embodied in domestic and international C&T-trade flows. These two adjacency matrices are the starting point for exploring a range of quantitative and qualitative properties of restructuring of C&T-trade. Moreover, to concentrate our analysis on international C&T-trade patterns and to explore the spatial dimension of C&T-trade on a global scale, in one case we slightly modify our two adjacency matrices A^1 and A^2 through setting all elements on the main diagonal to zero.

2.3 Strength centrality

There exist multiple measures in network analysis for characterizing the structure of a network. In general, one can distinguish between *local* and *global* measures, where the former describe node-specific characteristics and the latter are used to specify topological characteristics of the whole network. We focus on a node-specific measure, since this allows us analyzing the restructuring from the perspective of our two case study countries. At the same time we do not lose sight of the entire network structure (i.e., the international environment). One class of local measures are centrality measures,² which provide information on the status of a single node within a network according to some topological characteristic. In the following we apply strength centrality to the C&T-TNs as explained in more detail in Appendix 2. We decide for this measure, since it constitutes a simple but convenient metric to determine and compare the importance of single countries in the C&T-TNs, according to the overall intensity of C&T-trade linkages they share.

The overall intensity of C&T-trade linkages is defined by the volume of (1) C&T-value added and (2) C&T-labor directly embodied in traded C&T-goods, both domestically and internationally. As the adjacency matrices are not symmetric, in-strength centrality $s_i^{1,IN}(s_i^{2,IN})$ identifies the position of a single country i in the C&T-TNs according to the volume of C&T-value added (C&T-labor) directly embodied in domestically and internationally purchased C&T-goods, whereas out-strength centrality $s_i^{1,OUT}(s_i^{2,OUT})$ does so according to the volume of C&T-value added (C&T-labor) directly embodied in its domestic and C&T-deliveries to other countries.³ The economic interpretation of

² Depending on the characteristics of the graph, a diversity of centrality measures exists. They include strength (in the weighted case) or degree centrality (in the unweighted, binary case), eigenvector centrality, closeness, and betweenness centrality measures. See, e.g., Borgatti (2005) for a comprehensive discussion.

³ Note that in the following we refer to flows associated with in-strength centrality as 'inflows', and in an analogous manner, to flows associated with out-strength centrality to 'outflows'. Moreover, C&T-inflows of a single country from abroad are denoted as 'imports' and alike, C&T-goods which a single country delivers to other countries are called 'exports'.

strength centrality pertains to the following: By comparing strength centrality scores across countries, this provides information on the ‘global players’ in the respective network and allows us distinguishing between those countries which dominate global C&T-trade and those which are less engaged in global C&T-trade. Moreover, by adding a time component to our analysis this enables us to figure out shifts in country rankings.

In a next step, we decompose strength centrality into its sectoral components and calculate ‘partial strength centralities’ for C&T-value added (C&T-labor) directly embodied in *intermediate demand* and *final demand* C&T-goods. We do this by using matrix W (see Appendix 1). Matrix W is derived just by summing over matrix Z (showing intermediate demand C&T-trade flows) and matrix F (mapping final demand C&T-trade flows). It follows that the adjacency matrices A^1 and A^2 are also composed of both intermediate and final demand deliveries of C&T-goods. Let $\bar{Z} \equiv Z \oslash W$ and $\bar{F} \equiv F \oslash W$ be two matrices of dimension $k \times k$, where the symbol \oslash indicates elementwise division, and hence, one generic element $\bar{z}_{ih}(\bar{f}_{ih})$ with $i, h = 1, \dots, k$ of matrix \bar{Z} (\bar{F}) corresponds to the share of intermediate (final) demand C&T-trade flows in total C&T-trade flows from country i to country h . Using this definition, partial strength centralities for each variable C&T-value added and C&T-labor can be derived as follows:⁴

$$s^{\cdot, \text{IN}} = \underbrace{e^T (\bar{Z} \otimes A^{\cdot})}_{s_Z^{\cdot, \text{IN}}} + \underbrace{e^T (\bar{F} \otimes A^{\cdot})}_{s_F^{\cdot, \text{IN}}} \quad (3a)$$

$$s^{\cdot, \text{OUT}} = \underbrace{(\bar{Z} \otimes A^{\cdot})e}_{s_Z^{\cdot, \text{OUT}}} + \underbrace{(\bar{F} \otimes A^{\cdot})e}_{s_F^{\cdot, \text{OUT}}} \quad (3b)$$

In Eqs. (3a) and (3b), the symbol \otimes denotes elementwise multiplication, subscripts Z and F refer to intermediate, respectively, final demand, and e is a summation vector of dimension $k \times 1$. Studying the different versions of strength centrality with respect to intermediate ($s_Z^{\cdot, \text{IN}}$ and $s_Z^{\cdot, \text{OUT}}$) and final demand ($s_F^{\cdot, \text{IN}}$ and $s_F^{\cdot, \text{OUT}}$) for C&T-goods, we gain deeper knowledge about restructuring of C&T-trade as we can figure out differential characteristics of C&T-trade patterns for single countries. In doing so, we again separate between directly embodied C&T-value added and C&T-labor.

2.4 Strength centrality-based measures: node analysis

After having obtained information on the status of single countries within the networks, we excavate strength centrality and derive another range of measures from it. Even if some of these metrics are not conventional in network analysis, they allow us figuring out multiple characteristics of the structure of the C&T-TNs from the perspective of single countries. The economic interpretation of our measures pertains to (1) the degree of import penetration and of international outsourcing; (2) the direct C&T-value-added content and C&T-labor intensity of C&T-trade; and (3) the distance to final demand for C&T-goods.

⁴ Note that in the following the dot-symbol ‘ \cdot ’ is used to indicate that the formulae refer to variable 1 (C&T-value added) and likewise to variable 2 (C&T-labor).

2.4.1 Import penetration and international outsourcing

To obtain information on the degree to which a single country i is integrated in the network with respect to vertical interaction with adjacent nodes, we calculate a centrality coefficient. Similar to a measure introduced by De Backer and Yamano (2008), this centrality coefficient from an economic viewpoint enables us to identify the import content of C&T-absorption of a single country i and hence, the degree of ‘import penetration’. The centrality coefficient to figure out this property is determined by:

$$c_i^{\cdot, \text{IN,for}/(\text{IN,for}+\text{OUT,dom})} = \frac{s_i^{\cdot, \text{IN,for}}}{\left(s_i^{\cdot, \text{IN,for}} + s_i^{\cdot, \text{OUT,dom}}\right)} \quad (4a)$$

In Eq. (4a), $s_i^{\cdot, \text{IN,for}}$ corresponds to the volume of C&T-value added (C&T-labor) directly embodied in C&T-imports of a single country i and $s_i^{\cdot, \text{OUT,dom}}$ refers to C&T-value added (C&T-labor) directly embodied in domestic C&T-deliveries (see Appendix 2). The higher the centrality coefficient, the lower the degree to which a single country’s domestic absorption of C&T-goods is satisfied by domestic C&T-trade and vice versa, the more dependent it is on C&T-imports with respect to directly embodied C&T-value added and/or C&T-labor.

In order to figure out the degree of international outsourcing we again follow De Backer and Yamano (2008), who build on the outsourcing measure introduced by Feenstra and Hanson (1996, 1999). We break down the measure to our single commodity—C&T-goods—and we calculate a second centrality coefficient, which is given by the following formula:

$$c_{Z_i}^{\cdot, \text{IN,for}/\text{IN}} = \frac{s_{Z_i}^{\cdot, \text{IN,for}}}{s_{Z_i}^{\cdot, \text{IN}}} \quad (4b)$$

In Eq. (4b), $s_{Z_i}^{\cdot, \text{IN,for}}$ denotes the volume of C&T-value added (C&T-labor) directly embodied in intermediate demand C&T-imports of a single country i and similarly, $s_{Z_i}^{\cdot, \text{IN}}$ shows the volume of C&T-value added (C&T-labor) directly embodied in intermediate demand C&T-inflows, including those of a domestic and foreign origin. The higher the centrality coefficient in Eq. (4b), the higher the degree of international outsourcing. On the contrary, the lower the centrality coefficient, the lower is the volume of C&T-value added (C&T-labor) directly embodied in intermediate demand C&T-imports of a single country i relative to intermediate demand C&T-inflows and the lower is its dependence on foreign C&T-production activities.

2.4.2 Direct C&T-value-added content and direct C&T-labor intensity

For the next indicator, we focus on differences between C&T-value added and C&T-labor directly embodied in C&T-trade flows in order to examine specialization patterns in C&T-trade. Since nodes are the same for the two C&T-TNs, we are able to compare strength centralities derived from A^1 with those of A^2 in order to figure out the direct C&T-value-added content or, on the opposite, the direct C&T-labor intensity of C&T-trade from the perspective of single countries. As a measure for detecting this qualitative property of C&T-trade we suggest using the ratios between in-strength centralities as

well as those between out-strength centralities of the two C&T-TNs. Formally for a single country i :

$$q_i^{\text{IN}} = \frac{s_i^{1,\text{IN}}}{s_i^{2,\text{IN}}} \quad (5a)$$

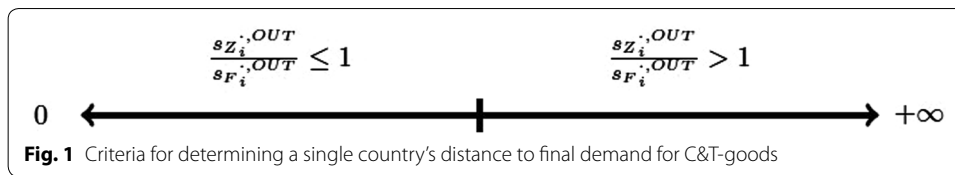
$$q_i^{\text{OUT}} = \frac{s_i^{1,\text{OUT}}}{s_i^{2,\text{OUT}}} \quad (5b)$$

The higher q_i^{IN} (q_i^{OUT}) for a single country i , the higher is the direct C&T-value-added content, respectively, the lower is the direct C&T-labor intensity of its C&T-inflows (C&T-outflows). From an economic point of view, if then for a single country i it holds that $q_i^{\text{IN}} \leq q_i^{\text{OUT}}$, this indicates that the C&T-goods which a country delivers both domestically and to other countries perceive of a relatively lower direct C&T-labor intensity than the C&T-goods it acquires from both the domestic and international market. On the contrary, they then have a relatively higher direct C&T-value-added content which can be associated with high-quality products. Vice versa, if a country is characterized by C&T-inflows which have a relatively higher direct C&T-value-added content than outflows and therefore $q_i^{\text{IN}} > q_i^{\text{OUT}}$, it specializes in trade of C&T-goods which are more C&T-labor-demanding, commonly associated in C&T-production with lower-quality goods.

2.4.3 Distance to final demand for C&T-goods

In a final step, we investigate a country's trade patterns with respect to the distance to final demand for C&T-goods, or vice versa, the proximity to intermediate demand for C&T-goods. From this distance measure we again draw inference about C&T-production patterns in a single country. For defining proximity with respect to the final demand sector or the intermediate demand sector, we use the economic space as the domain. To derive our measure, we use only partial out-strength centralities. Based on the mathematical procedure for constructing our two C&T-TNs, as discussed in Appendix 1, at this point it makes no difference whether we take partial out-strength centralities for C&T-value added or for C&T-labor to measure the distance to final demand, as both deliver the same result. Figure 1 summarizes the criteria for determining the distance to final demand.

If it holds for a single country i that $\frac{s_{Z_i}^{\text{OUT}}}{s_{F_i}^{\text{OUT}}} > 1$ then a relatively larger proportion of its C&T-outflows is directed toward the intermediate demand sector than to final demand, which means a country is expected to be closer to the production of intermediate demand than to final demand C&T-goods. On the contrary, if $\frac{s_{Z_i}^{\text{OUT}}}{s_{F_i}^{\text{OUT}}} \leq 1$ and hence, C&T-outflows are to a larger extent final demand C&T-goods then a country's distance to final demand is smaller than to intermediate demand. Similar to an idea put forth by De Backer and Miroudot (2013), the higher the distance to final demand, the more a country i is involved in C&T-production activities which are located upstream; whereas the closer a country i is to final demand the more it is specialized on downstream C&T-production activities. Changes in values of partial out-strength centralities over time then indicate shifts in the distance to final demand: If the gap to final demand shrinks then a country moves into a downstream direction, and vice versa this indicates a move into an upstream direction.



2.5 Data

We decided to use data from the WIOD (Timmer et al. 2015) on various grounds: Its main advantage over other datasets is that it includes a wide range of different indicators within a single database. Since we take both value-added and employment data from the WIOD, we avoid differences in methodology and limited comparability—which could be the case if mixing databases. WIOD also fits our research purpose since it offers detailed data on an industry-level (classified according to ISIC Rev. 3, two-digit level into 35 industries) for a rich country-sample of 40 countries. The large country-sample is beneficial to our empirical analysis, since different from other databases in this field of research (e.g., OECD STAN 2015), major C&T-producing countries such as India, China, and Indonesia are included. We decided against using the UN Comtrade Database (UN Comtrade Database 2015), which provides a more comprehensive country-sample at a more disaggregated product-level (five-digit code). The reason is that this database is not appropriate for our research purpose as no trade data on employment or value added are available and moreover it allows no distinction between trade in intermediate and final demand goods. Our decision is supported by recent research which emphasized problems in using only gross output data for measuring international trade (Daudin et al. 2014; Jones et al. 2013). Beyond, also the WTO highlights the importance of focusing on both employment and value-added data for reaching trade policy recommendations (Elms and Low 2013).

For our empirical analysis, the C&T-industry and manufacturing industries value-added and labor data are taken from the 2012 version of the WIOD socioeconomic accounts (Erumban et al. 2012). Specifically, we use hours worked, since this is the best measure available for the actual amount of labor used in a specific industry. The value-added data provided in the socioeconomic accounts have been slightly modified: Since it is expressed in national currencies, we used the exchange rate table provided by the WIOD to convert values into US\$. The WIOD also provides WIOTs⁵ on an annual basis (values are expressed in current prices and denoted in US\$), where we take the two tables for 1995 and 2009 as the basis for constructing our C&T-TNs. WIOTs are harmonized with the socioeconomic accounts data and cover again 35 industries and 40 countries as well as one extra region called ‘rest of the world’ (RoW), which we exclude from the analysis throughout.⁶

⁵ See Dietzenbacher et al. (2013) for a detailed explanation on the construction and structure of WIOTs.

⁶ The latter region is added for balancing and calculation purposes (Dietzenbacher et al. 2013) and serves as a proxy for countries not included in the sample. It is therefore not amenable to interpretation (Timmer 2012). A consequence of omitting RoW from our empirical analysis is that we create an upward bias in the technology structure underlying the WIOT. After deflating our data, we therefore make a few corrections to mitigate this bias: The value-added vectors and the labor vectors, referring initially to the whole country-sample including RoW, are down-scaled by the share of the reduced real gross output vector (excluding then intermediate and final demand deliveries of the 40 countries to RoW) in total real gross output (including RoW). Down-scaling implies that in 1995 just 87.3 % of actual trade in C&T-goods are covered. Similarly, calculated based on nominal figures, 82.8 % of trade in C&T-goods are included in 2009.

Since the WIOD reports price indicators for various variables we are able to deflate all the data. The deflation procedure was accomplished row-wise, using multiple price indexes.⁷ Since real gross output is no longer equal to the sum of real intermediate and real final demand deliveries after row-wise deflation, the sum of real intermediate and real final demand is used as a corrected version of real gross output for the analysis.

To concentrate our analysis on Italy and Portugal, the other countries are clustered into country groupings (i.e., regional blocks). In line with other studies, the most appropriate classification for our research purpose is the grouping of countries according to trade costs (Baldwin 2006; Chortareas and Pelagidis 2004). In addition, the recent debate on the ‘distance puzzle’ proves a classification as per mere distance measures inferior to a grouping according to trade costs (Bosquet and Boulhol 2015). One database that tries to capture the variety of factors influencing the level of trade costs is the ESCAP World Bank Database on International Trade Costs (ESCAP World Bank 2015).⁸ This is the most suitable database for our purpose since it provides bilateral trade costs for all countries in our sample but Taiwan (for which the trade costs of China are taken as a proxy) and data are available on an annual basis between 1995 and 2009.⁹ However, since data are not available at the industry-level, we use data for the manufacturing sector as a proxy. The task is to assign the individual 40 countries in such a manner that those within a regional block are characterized by a more similar level of bilateral trade costs with Italy and Portugal, respectively, compared to the other countries in the sample. In order to achieve homogeneous clubs, thus the deviations between the levels of bilateral trade costs within a club must be sufficiently small. At the same time, we require the level of bilateral trade costs to be sufficiently different from those in other clubs. Then, for each group we calculate the unweighted average level of bilateral trade costs and the standard deviation for both 1995 and 2009. For our sample, the coefficients of variation in bilateral trade costs between country pairs could be minimized by clustering countries in the following way (see Appendix 3: Table 7):

- Central Europe (CE): Austria, Belgium, France, Germany, Italy, Netherlands, Slovenia, Spain, and UK;
- Periphery West and North Europe (PWNE): Denmark, Finland, Greece, Ireland, Luxembourg, Malta, Portugal, and Sweden;
- Periphery East Europe (PEE): Bulgaria, Czech Republic, Hungary, Poland, Romania, Slovakia;
- Baltic and Eurasian Countries (BEC): Cyprus, Estonia, Latvia, Lithuania, Russia, and Turkey;

⁷ Intermediate demand levels are deflated using the intermediate demand industry-level price index. The industry gross output, respectively, value-added vectors are deflated by using the corresponding gross output, respectively, value-added price index. Since there are no price indexes for final demand components (except for gross fixed capital formation), final demand vectors were deflated using the corresponding intermediate demand industry-level price index.

⁸ International trade costs in this setting capture all additional costs involved in trading goods bilaterally, relative to those involved in trading goods domestically. These additional costs are shipping and logistic costs, both tariff and non-tariff costs (such as costs with trade procedures and regulations) as well as costs which arise from differences in language, culture, and currencies.

⁹ The drawbacks of other databases are the following: For instance, in the CEPII database bilateral trade costs are held constant over time (Mayer and Zignano 2011). The OECD database on Maritime Transport Costs (OECD 2015) provides annual data at the industry-level, but data are not available for country pairs, i.e., EU-15 is treated as an entity for imports and exports. Furthermore, there does not exist data for non-OECD countries, above all the Eastern European countries. No figures are reported for Canada.

- Americas (A): Brazil, Canada, Mexico, and the USA;
- East Asia and the Pacific Region (EAPR): Australia, Indonesia, Japan, South Korea, and Taiwan;
- China and India (CI).

3 Results and discussion

3.1 Restructuring on a global scale

3.1.1 Descriptive statistics, concentration patterns, and labor productivity

Global C&T-employment increased from 1995 to 2009, whereas C&T-value added declined, as illustrated in Table 1. The changes in our two key variables were not evenly distributed across the regional blocks and there are remarkable differences with regard to C&T-value added and C&T-employment, giving further motivation to study the development of both variables. Whereas less than 15 % of global C&T-value-added generation occurred in China and India in 1995, almost two-thirds of global working hours already were concentrated in this regional block. By 2009, 4 out of 5 C&T-working hours in the world were carried out in these two countries and even more noteworthy is that the share in C&T-value added more than tripled in 15 years, signaling a massive reallocation toward this regional block.

Turning to the other three main global C&T-producing regional blocks with respect to C&T-value added in 1995, it is noteworthy that while Central Europe could almost maintain its share in worldwide C&T-value added, East Asia and the Pacific Region as well as Americas each lost about half of their shares over the investigation period. With regard to C&T-employment, Central Europe already had a negligible share in 1995 and this dropped even further. Also, for East Asia and the Pacific Region and Americas, shares in C&T-employment levels decreased by 50 % within 15 years.

As regards labor productivity, changes were rather heterogeneous across regional blocks as well. Central Europe was by far the most productive regional block in the

Table 1 Descriptive statistics, relative and absolute concentration of the global C&T-industry and labor productivity patterns, 1995 and 2009. Data Source: Timmer et al. (2015). Authors' own calculations

	Productivity		C&T-value added		C&T-employment	
	1995	2009	1995	2009	1995	2009
World	2.99	2.11	256,242	234,849	85,576	111,562
% of world C&T						
CE	7.03	15.50	25.93	21.55	3.69	1.39
PWNE	3.16	5.59	3.29	2.57	1.04	0.46
PEE	0.6	1.06	2.03	1.57	3.39	1.48
EAPR	2.6	2.33	23.11	10.10	8.92	4.33
BEC	0.81	0.26	4.17	0.70	5.18	2.74
A	2.2	1.73	26.85	14.54	12.23	8.41
CI	0.22	0.6	14.63	48.97	65.55	81.20
CV			0.772	1.040	0.427	0.600
HHI			0.096	0.207	0.233	0.335

Note that nominal figures are expressed in constant prices of million US\$, where 1995 = 100. C&T-employment is expressed in million hours worked

international C&T-industry in both years and could even increase its lead in labor productivity. Periphery West and North Europe substantially improved its level and became the second most productive regional block in the world and also the regional block China and India almost tripled its labor productivity. For Americas and East Asia and the Pacific Region, C&T-value added dropped even more than C&T-employment, implying that labor productivity in these regional blocks decreased over the investigation period. The reason for labor productivity to decline on a global scale is, however, to be found in the fact that large parts of worldwide C&T-value added were reallocated toward the far less productive countries—China and India.

Analyzing absolute concentration, the level for C&T-value added was near the lower bound in 1995 implying that C&T-value added was rather equally distributed across the 40 countries (see Table 1). With regard to C&T-employment, absolute concentration was more than double as high compared to C&T-value added in 1995. Similar to results which were obtained for absolute concentration, relative concentration also increased between 1995 and 2009 for both variables. Yet, whereas absolute concentration was higher with regard to C&T-employment and was driven mainly by large countries such as China, relative concentration was more pronounced with regard to C&T-value added and was more influenced by countries with high shares in global C&T-value added such as Portugal or Turkey. As both absolute and relative concentration indexes with regard to both C&T-employment and C&T-value added increased significantly over time, it becomes evident that institutional changes and the reduction of transportation costs facilitated concentration as predicted in models of economic geography (Krugman 1991a, b).

3.1.2 Spatial trade patterns of C&T-goods

As regards the distribution of C&T-trade volumes on a global scale, we observe that international trade got more important relatively to domestic trade in terms of directly embodied C&T-value added, whereas for C&T-labor the change prevailed in the opposite direction. Results show thus that for C&T-value added a comparatively stronger global integration took place, whereas C&T-labor got more integrated within national borders over the investigation period (see Appendix 3: Table 8).

Even if only a comparatively low fraction of both C&T-value added and C&T-labor were directly embodied in internationally traded C&T-goods compared to domestically traded ones, it is interesting to look in a next step at the spatial dimension of international C&T-trade. Figure 2 shows the C&T-TN in terms of C&T-value added directly embodied in international C&T-trade flows in 1995 (upper panel) and in 2009 (lower panel). Likewise, Fig. 3 maps the C&T-TN in terms of C&T-labor directly embodied in internationally traded C&T-goods in 1995 (upper panel) and in 2009 (lower panel). Note that the darker the color, the more intense is the respective international trade relation between any two regional blocks.

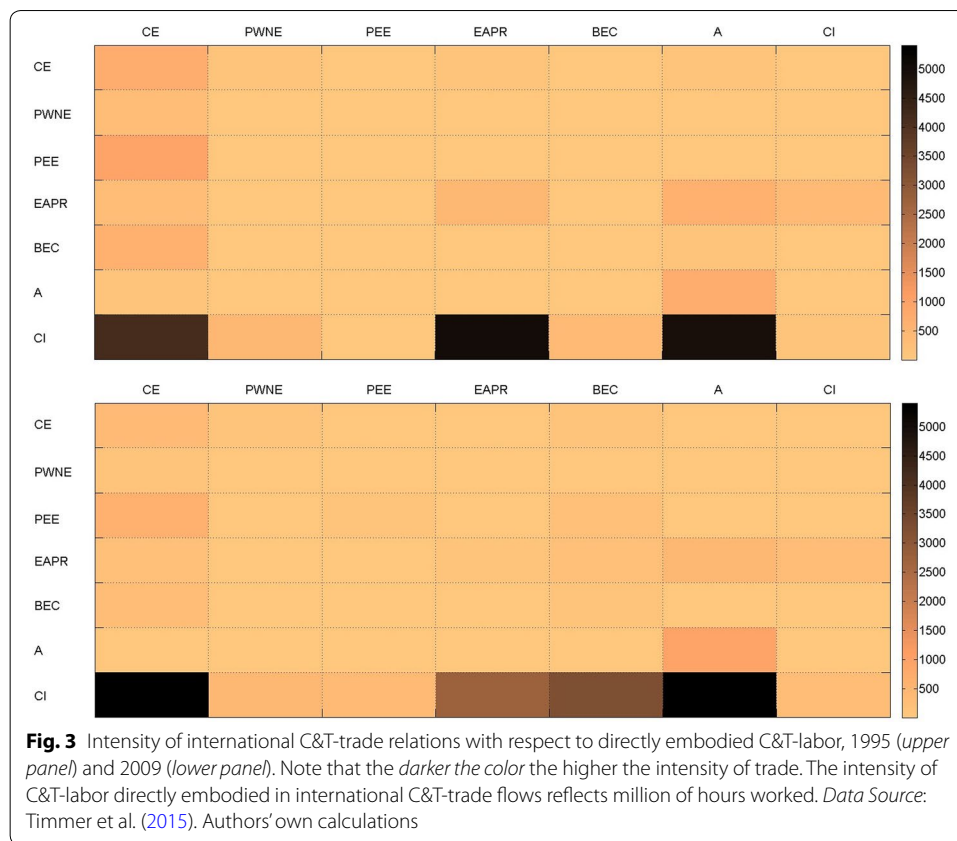
It becomes evident that international trade in neither directly embodied C&T-value added nor directly embodied C&T-labor was evenly distributed across space and only a few trade linkages dominated international trade. As can be seen from Fig. 2, the most intense trade relation in 1995 for directly embodied C&T-value added was trade among Central European countries themselves and no other trade relations were equally



strong.¹⁰ From 1995 until 2009 this trade linkage slightly deteriorated in absolute terms but remained the most intense one. Moreover, the second strongest trade linkage in 1995 was constituted by trade between American countries. By 2009, trade linkages between regional blocks got more important between rather than within regional blocks. Related to this, China and India gained significantly in importance on a global scale, particularly with respect to C&T-value added directly embodied in C&T-exports which increased to all regional blocks.

Different from that, as illustrated in Fig. 3, the most intense trade relation in C&T-labor directly embodied in internationally traded C&T-goods in 1995 was constituted by exports from China and India to East Asia and the Pacific Region. This changed until 2009, where Americas were the most important export destination of China and India in this respect. Furthermore, trade within regional blocks with respect to directly embodied C&T-labor already in 1995 was less important than for directly embodied C&T-value added. If at all traded internationally, directly embodied C&T-labor involved thus larger distances. Overall, international C&T-trade relations were more agglomerated with regard to C&T-labor than with C&T-value added in both years, supporting results from the concentration measures.

¹⁰ It has to be kept in mind, however, that almost a quarter of the countries in our sample belong to this regional block and therefore there can be an upward bias, overestimating the role of trade between countries belonging to this regional block.



From the perspective of our two case study countries, the most important trading partners for Italy were in both years other Central European countries with regard to C&T-value added directly embodied in internationally traded C&T-goods. Hence, bilateral trade with the countries characterized by the lowest level of bilateral trade costs was crucial, which reflected in both imports and exports as reported in Appendix 3: Table 9. Yet, regarding the absolute trade volume with Central Europe, C&T-value added directly embodied in C&T-exports decreased during the observation period and only the amount of C&T-value added directly embodied in C&T-imports from Central Europe increased. Turning to the developments in Portugal, even though being not a member of this regional block, Central Europe was the most important trading partner also for Portugal in terms of C&T-value added directly embodied in both C&T-exports and C&T-imports. This can be explained by the fact that for Portugal bilateral trade costs were lowest with this regional block too. Alike to the Italian situation, the trade volume of C&T-value added directly embodied in C&T-exports to Central Europe decreased between 1995 and 2009, while the amount of C&T-value added directly embodied in C&T-imports evolved into the opposite direction.

With respect to C&T-labor directly embodied in internationally traded C&T-goods, bilateral trade between Portugal and Central Europe constituted for the most intense trade relation in both directions in 1995. Different from that, for Italy only the largest fraction of C&T-labor directly embodied in C&T-exports in 1995 and 2009 was destined to Central Europe, whereas already in 1995 the largest volume of Italian C&T-labor

directly embodied in C&T-imports came from China and India. For Portugal the situation evolved into the same direction: By 2009 Central Europe was no longer its most important import source but this was overtaken by China and India; also the volume of C&T-labor directly embodied in C&T-imports from China and India increased for both countries (see Appendix 3: Table 9).

With respect to the development of less prominent trade relations, differences between Italy and Portugal are observable to a small dimension, whereas intertemporal changes were more significant. Moreover, by comparing international trade of directly embodied C&T-value added with that of directly embodied C&T-labor, it gets evident that intertemporal changes in the latter variable in general were more pronounced for both case study countries. This shows, that even if the share of international trade of directly embodied C&T-labor decreased on a global scale relative to domestic trade, for Italy and Portugal trade patterns of this factor input were exposed to massive changes over the investigation period, whereas for C&T-value added the situation was relatively more stable.

3.2 Local restructuring: the perspective of Italy and Portugal

3.2.1 Italy's and Portugal's status in the C&T-TNs

In a next step, we zoom into our networks and concentrate on country-specific patterns of restructuring of C&T-trade. Table 2 shows strength centrality scores for Italy and Portugal for 1995 and 2009. These figures provide information on the amount of C&T-value added and C&T-labor directly embodied in (1) total C&T-trade flows (both in- and out-flows), (2) intermediate and final demand C&T-goods and (3) domestic C&T-trade flows.¹¹

Italy's position in the networks was more central compared to Portugal's in both years, which, however, is not surprising due to differences in scale between the two countries. In an international comparison, Italy in terms of both in- and outflows of directly embodied C&T-value added ranked among the top 5 in 1995 and its status got even more important. Compared to C&T-value added, in terms of C&T-labor directly embodied in C&T-outflows Italy had a lower status in the network but nevertheless got slightly more central. For C&T-labor directly embodied in C&T-inflows Italy experienced the opposite change and its ranking position in 1995 was 10 and in 2009 the country ranked 11th. Portugal was ranked 18th (16th) in 1995 and 17th (14th) in 2009 with respect to C&T-value added directly embodied in C&T-inflows (-outflows). Portugal could also extend its status in the network in terms of C&T-labor directly embodied in both in- and outflows. Results of centrality positions of our two case study countries relative to other countries show that at least Italy in terms of C&T-value added directly embodied in C&T-outflows was a global player in the respective C&T-TN. On the contrary, even if Portugal's status increased it was less significant compared to other countries. This, however, does not preclude that it's C&T-industry was bound to a serious restructuring between the two years.

Apart from shifts in ranking positions for Italy and Portugal relative to other countries, both experienced substantial changes in volumes of C&T-value added and C&T-labor directly embodied in C&T-trade flows. As can be seen from Table 2, for both countries the direction of changes in absolute trade volumes was almost the same: Volumes of

¹¹ See Appendix 3: Table 8 for strength centrality scores of other countries than Italy and Portugal.

Table 2 Strength centrality scores for Italy and Portugal in terms of C&T-value added and C&T-labor directly embodied in C&T-trade flows, 1995 and 2009. Data Source: Timmer et al. (2015). Authors' own calculations

	Italy		Portugal	
	1995	2009	1995	2009
<i>C&T-value added</i>				
$s^{1,IN}$	19,690 (16,809)	17,948 (14,211)	2637 (1861)	2328 (1455)
$s_Z^{1,IN}$	9635 (7958)	7510 (6497)	1559 (1050)	955 (676)
$s_F^{1,IN}$	10,055 (8851)	10,438 (7713)	1078 (811)	1373 (779)
$s^{1,OUT}$	24,173 (16,809)	20,082 (14,211)	3259 (1861)	2404 (1455)
$s_Z^{1,OUT}$	10,967 (7958)	8139 (6497)	1248 (1050)	814 (676)
$s_F^{1,OUT}$	13,206 (8851)	11,943 (7713)	2011 (811)	1590 (779)
<i>C&T-labor</i>				
$s^{2,IN}$	1756 (868)	1501 (543)	373 (305)	285 (196)
$s_Z^{2,IN}$	795 (411)	524 (248)	217 (172)	134 (91)
$s_F^{2,IN}$	961 (457)	978 (295)	157 (133)	151 (105)
$s^{2,OUT}$	1248 (868)	767 (543)	534 (305)	323 (196)
$s_Z^{2,OUT}$	566 (411)	311 (248)	205 (172)	109 (91)
$s_F^{2,OUT}$	682 (457)	456 (295)	330 (133)	214 (105)

Note that figures in brackets correspond to volumes of C&T-value added and C&T-labor directly embodied in domestically traded C&T-goods. C&T-value added is expressed in constant prices of million US\$, where 1995 = 100 and C&T-labor is expressed in million hours worked

C&T-value added and C&T-labor directly embodied in domestically and internationally traded C&T-goods dropped, apart from two exceptions. C&T-value added directly embodied in both countries' final demand C&T-inflows and Italian C&T-labor directly embodied in final demand C&T-inflows experienced an increase.

As regards differences between the two variables, in both countries particularly volumes of C&T-labor directly embodied in C&T-trade flows were exposed to significant changes. We also observe that changes in absolute trade volumes of both variables and equally, of intermediate and final demand levels, were by far more pronounced in Portugal compared to Italy. This signalizes that Portuguese C&T-trade was exposed to relatively more significant changes, whereas in Italy the situation proved to be relatively more stable.

Moreover, crucial differences between our two case study countries are observed with respect to the importance of domestic versus international C&T-trade. Overall, for Italy domestic C&T-trade of directly embodied C&T-value added was by far more important in both years than for Portugal. Apart from one exception—intermediate demand outflows—Portugal was much more dependent on the international market. For directly embodied C&T-labor a different scenario prevailed: The domestic market relative to the international market played a much more significant role for Portuguese inflows and

Table 3 Import penetration and international outsourcing levels for Italy and Portugal, 1995 and 2009. Data Source: Timmer et al. (2015). Authors' own calculations

	Italy		Portugal	
	1995	2009	1995	2009
<i>C&T-value added</i>				
$c_i^{-,IN,for/(IN,for+OUT,dom)}$	0.1463	0.2082	0.2944	0.375
$c_{Z_i}^{-,IN,for/IN}$	0.1741	0.1349	0.3264	0.292
<i>C&T-labor</i>				
$c_i^{-,IN,for/(IN,for+OUT,dom)}$	0.5055	0.6383	0.1823	0.3143
$c_z^{-,IN,for/IN_i}$	0.4828	0.5259	0.2052	0.3223

also for intermediate demand outflows. With respect to C&T-labor directly embodied in final demand C&T-outflows it was, however, again Italy, which was less open to the international market. As regards intertemporal changes, we observe that overall the importance of the domestic market relative to the international market in terms of C&T-value added and C&T-labor directly embodied in C&T-trade flows increased for C&T-outflows and decreased for C&T-inflows for both countries which gives a first hint that outsourcing activities took place. To sum up, our findings also indicate that the relative importance of the domestic versus the international market for directly embodied C&T-value added and C&T-labor could be a source of different degrees of vulnerability to the restructuring of C&T-trade in the two case study countries.

3.2.2 Import penetration and international outsourcing

In a next step, we identify further aspects of the nature of restructuring of C&T-trade for our two case study countries. Table 3 reports levels of the two centrality coefficients, reflecting the degree of import penetration and of international outsourcing.

As regards import penetration, our results show that the corresponding centrality coefficients increased for both countries until 2009 irrespective of whether we focus on C&T-value added or C&T-labor, which supports previous findings of an increased importance of the international market in both countries with respect to C&T-inflows. Accelerating levels of import penetration show that domestic C&T-absorption in the two countries got more dependent on imported C&T-goods, respectively, could be less satisfied by domestic C&T-trade. There are, however, again differences between the two countries observable: For Italy import penetration was much more pronounced for C&T-labor than for C&T-value added, whereas the opposite was true for Portugal. In line with previous results, this signalizes that Italian domestic C&T-absorption was particularly dependent on foreign sources with respect to C&T-labor, whereas for directly embodied C&T-value added international trade played a relatively inferior role for domestic C&T-absorption. On the contrary, to satisfy domestic C&T-absorption Portugal was comparatively more reliant on foreign C&T-value added, whereas C&T-labor seemed to be abundant within the country.

Turning to levels of international outsourcing, the differences between Italy and Portugal, on the one hand, and between C&T-value added and C&T-labor on the other hand, were remarkable. As could have been anticipated by former results, international outsourcing of C&T-value added was much more pronounced for Portugal in both years

Table 4 Direct C&T-value-added content and direct C&T-labor intensity of traded C&T-goods for Italy and Portugal, 1995 and 2009. *Data Source:* Timmer et al. (2015). *Authors' own calculations*

	Italy		Portugal	
	1995	2009	1995	2009
q_i^{IN}	11.2156	11.9542	7.0657	8.1631
q_i^{OUT}	19.362	26.1698	6.0971	7.4411

than for Italy, whereas for C&T-labor it was the other way round. Hence, Portuguese intermediate C&T-demand built by far more on the international market with respect to directly embodied C&T-value added than was the case for Italy. In contrast, Italy outsourced the C&T-labor required for its C&T-production activities to a higher degree. Noteworthy, for both countries outsourcing of C&T-value added decreased until 2009 and together with the observation that Portuguese and Italian international outsourcing of C&T-labor increased also slightly, this indicates that C&T-production in both countries got more productive.

3.2.3 Direct C&T-value-added content and direct C&T-labor intensity

We focus next on results of a more qualitative nature—the direct C&T-value-added content and C&T-labor intensity of traded C&T-goods—and therefore we temporarily set aside partial strength centralities. As illustrated in Table 4, Italy's total C&T-outflows in both years had a higher direct C&T-value-added content than its C&T-inflows. Put in different words, the production of C&T-goods in Italy was characterized by a higher labor productivity than the production of those goods which were imported from the international market. Even if the direct C&T-value-added content of inflows increased, the direct C&T-value-added content of outflows from 1995 to 2009 accelerated at a higher level, which signalizes a growing specialization in C&T-trade of such goods the production of which is highly value added generating and requires relatively little labor. In general, in C&T-production this can be associated with high-level products.

Compared to Italy, for Portugal we find different specialization patterns in C&T-trade in both years, even if they evolved into a similar direction. For both years, its C&T-outflows were more labor-intensive than its C&T-inflows. Hence, different from Italy, Portuguese C&T-production activities were less productive and, moreover, the production of C&T-goods which Portugal imported from the international market involved a comparatively higher level of labor productivity than its domestically traded and exported C&T-goods. Even if the direct C&T-value-added content of its C&T-outflows increased compared to C&T-inflows, they remained relatively labor-intensive. Still, since the increase in the direct C&T-value-added content of C&T-inflows was smaller than the increase in the direct C&T-value-added content of C&T-outflows, this implies that also Portugal slightly specialized more toward trade of high-level C&T-goods. To sum up, together with previous results our findings show that Italy compared to Portugal had a comparative advantage in the production of highly value added generating C&T-goods, which it could even extend. Different from that, Portugal's production activities of C&T-goods were characterized by a high labor intensity and due to the increased pressure

from low-wage countries this comparative advantage deteriorated and severe effects on C&T-employment prevailed within the country.

3.2.4 Distance to final demand for C&T-goods

Another aspect of specialization patterns in C&T-trade pertains to the distance of C&T-production activities in single countries to the final demand sector. Table 5 reports the corresponding distance levels for our two case study countries in 1995 and 2009. Both countries were ranked as downstream producers in both years and were thus relatively closer in their C&T-production activities to final demand than to intermediate demand for C&T-goods. Surprisingly, compared to Italy, Portugal was always slightly more downstream. As regards the direction of changes between the two years, we further observe that both countries moved into an even more downstream direction, and hence, the distance to final demand decreased. For both countries the downstream movement was caused by a slump in intermediate demand C&T-outflows which overcompensates the decrease in final demand C&T-outflows. This indicates that they were almost ‘pushed away’ from intermediate demand C&T-production activities.

As discussed before, the changes in intermediate and final demand C&T-outflows for both directly embodied C&T-value added and C&T-labor were much more pronounced in Portugal than in Italy, signaling that the latter country retrieved to a relatively larger extent from C&T-production and international competition made it harder for Portugal to stabilize the situation in its C&T-production. On the contrary, Italy’s initial downstream position together with a relatively more stable domestic market for final demand C&T-goods proved favorable in this respect.

4 Conclusions

The aim of this paper was to contribute to a better understanding of restructuring of C&T-trade from the perspective of Italy and Portugal between the two years 1995 and 2009. For our empirical analysis, we adopted a systemic perspective and our methodological approach allowed us tracing country-specific patterns of the experienced restructuring, while at the same time we did not lose sight of international developments. Through choosing a network-based approach and combining this with input–output data we were able to map the interdependent structure of C&T-trade on a global scale. Instead of focusing on traditional bilateral trade data, we made use of both C&T-value-added and C&T-employment data in order to gain new understandings of restructuring of global C&T-trade and to highlight that policy advice should focus on both variables. Furthermore, our distinction between these two variables and beyond, between intermediate and final demand C&T-goods proved important since we could uncover another range of country-specific patterns of C&T-trade from which we drew also inference on C&T-production activities.

Table 5 Italy’s and Portugal’s distance to final demand for C&T-goods. *Data Source:* Timmer et al. (2015). *Authors’ own calculations*

	1995	2009
Italy	0.8305	0.6815
Portugal	0.6204	0.5115

Our findings show that in an international context the C&T-industry became more concentrated in absolute and in relative terms and also with regard to both variables, C&T-value added and C&T-labor. The changes in global production patterns and the substantial reallocations toward low-wage countries in our sample, namely China and India, are noteworthy. Hence, restructuring of global C&T-trade between the two years 1995 and 2009 involved *inter alia* a growing dependence of global C&T-demand on C&T-goods being produced in China and India. Going alongside with an increased importance of these two countries in the global C&T-TNs—each country could either maintain its leading centrality position or even extend its status. Moreover, this regional block got more productive, signaling that also the character of the C&T-goods which sourced from these two countries did change and C&T-production activities became slightly more value added generating and less labor-intensive. Nevertheless, the leading positions in labor productivity on a global scale, which partly were also extended, were bound to ‘traditional’ C&T-producing countries. This shows that high-wage countries increasingly came under pressure mainly in those C&T-production activities which could be easily transferred to low-wage countries, i.e., labor-intensive C&T-production tasks. Yet, those C&T-production activities which are ‘highly’ productive and generate high C&T-value added could be maintained relatively more easily. This is confirmed if one glances at international C&T-trade patterns only, where it became evident that for C&T-value added proximity played a much more significant role than for C&T-labor and this factor input could thus relatively more easily be traded internationally.

Focusing on the situation in Portugal and Italy, our results revealed both similarities and differences in the nature of restructuring of C&T-trade between them. Both were characterized by a growing dependence on the international market with respect to C&T-inflows, reflecting in increased import penetration and international outsourcing. It is remarkable that the differences in specialization between Italian and Portuguese C&T-trade were quite significant and remained so over the investigation period, signaling a high path-dependency of C&T-production in these two countries. The position of Italy in this respect seemed to be the more sustainable and more rewarding one, however. For Italy our findings show that the production of labor-intensive C&T-goods was outsourced to other countries at a higher scale, whereas production activities of C&T-goods which are highly value added generating remained relatively more within the country. On the contrary, for Portugal which was relatively more engaged in trade of labor-intensive C&T-goods, the competition from low-wage countries was ever becoming fiercer and thus had a direct negative impact on the generation of C&T-value added as well. Moreover, Portugal was not able to move sufficiently toward a more value added oriented way of C&T-production and together with comparatively less stable domestic C&T-trade in this respect, this made the country vulnerable and to suffer a lot under the restructuring of C&T-trade. Last it has to be kept in mind that Italy had easier access to its trading partners compared to Portugal as trade costs for Portugal on average were twice as high than for Italy. Thus, irrespective of the economic policy undertaken, the level of trade costs proves to be a crucial factor as well.

Based on the empirical evidence we conclude that C&T-producing firms in both countries can only stabilize their situation if they are productive, innovative, and able to modernize their production. While Italy seemed to proceed into the right direction,

Portugal's situation constitutes a textbook example of the negative effects of restructuring processes. We suggest that stabilizing the situation in Italy and Portugal requires taking country-specific action. As an essential precondition for effective policy-design we consider the identification of country-specific patterns of C&T-trade and beyond, their relation to international developments, as were identified in this paper.

Acknowledgements

This article was funded by the Austrian Science Fund (FWF) under Grant P24915-G11: "Diffusion Processes in economic systems" and supported by funds of the Oesterreichische Nationalbank, Anniversary Fund, Project No. 15482. The authors like to thank the FWF and the Oesterreichische Nationalbank for financial support. Furthermore, we are grateful to Jacques Thisse, Henryk Gurgul, and Heinz D. Kurz for fruitful discussions on earlier drafts of this paper as well as to Nadia Simoes and Nuno Crespo for helpful comments. Our thanks go to Benjamin Marussig and Stefan Palan for supporting us in this work. Finally, we like to thank two anonymous referees for their valuable hints on how to improve the paper.

Competing interests

Both authors declare that they have no competing interests.

Appendix 1: Derivation of the C&T-TNs

We start constructing our C&T-TNs by assuming that there are k countries indexed by $i, h = 1, \dots, k$ and each produces a certain volume of C&T-gross output denoted by x_i , which it distributes both domestically and internationally to (1) intermediate demand and (2) final demand for C&T-goods. C&T-goods can thus be used domestically in which case $i = h$, or abroad for which it holds that $i \neq h$. Building on Los et al. (2015b), the product market clearing condition for C&T-goods reads as:

$$x_i = \sum_{ih} z_{ih} + \sum_{ih} f_{ih} \quad (6)$$

In Eq. (6), z_{ih} shows the value of intermediate demand deliveries of C&T-goods from source country i to destination country h and similarly, f_{ih} corresponds to the value of C&T-final demand deliveries from country i to country h .

In matrix notation this can be written as:

$$(Z + F)e = x \quad (7)$$

In Eq. (7), e denotes a summation vector of dimension $k \times 1$ and for k countries, matrix Z of dimension $k \times k$ includes total domestic and international intermediate demand C&T-flows and matrix F of equal dimension contains total domestic and international C&T-deliveries to final demand. Finally, vector x of dimension $k \times 1$ has as its elements the value of gross output of C&T-goods in each country.

For constructing the adjacency matrices of the C&T-TNs, the identity given in Eq. (7) is used as a starting point:

Let $W \equiv (Z + F)$ be a concatenated matrix of Z and F of dimension $k \times k$. Matrix W is then normalized along rows, to obtain some type of 'C&T-output coefficients':

$$\overline{W} = (\text{diag}(x))^{-1} W \quad (8)$$

In Eq. (8), $\text{diag}(\cdot)$ is used as the symbol for a diagonalized vector. One generic element \overline{w}_{ih} of \overline{W} reflects the share of C&T-gross output of a single country i in country i 's total C&T-gross output, which it distributes to country h .

As we decide to construct our networks on the basis of C&T- (1) value added and (2) labor directly embodied in C&T-trade flows, matrix \overline{W} has to be weighted with these two variables. First, let v be a vector of dimension $k \times 1$ containing C&T-value added in each country, and second, vector l of the same dimension holds C&T-employment for each country $i = 1, \dots, k$. Combining in a next step \overline{W} with v and l , we obtain the following matrices:

$$A^1 = \text{diag}(v) \overline{W} \quad (9a)$$

$$A^2 = \text{diag}(l) \overline{W} \quad (9b)$$

In Eq. (9a), one element a_{ih}^1 of A^1 denotes the C&T-value added generated within country i which is directly embodied in its C&T-deliveries to country h . Similarly, in Eq. (9b), one element a_{ih}^2 of A^2 signalizes the C&T-labor directly embodied in country i 's deliveries of C&T-goods to country h . Moreover, if it holds for a single element a_{ih}^1 (a_{ih}^2) that $i = h$, this reflects C&T-value added (C&T-labor) directly embodied in domestic C&T-flows. System (9) which shows thus both domestic and international flows of C&T-value added and C&T-labor directly embodied in C&T-trade flows can be interpreted as an edge-weighted directed graph, where the k nodes correspond to countries and (1) C&T-value added and (2) C&T-labor directly embodied in traded C&T-goods define the weighted directed edges of the respective network.

Appendix 2: Derivation of strength centrality

Since the adjacency matrices defined in system (9) are not symmetric in the case of a directed graph, one has to distinguish between in- and out-strength centrality for each adjacency matrix A^1 and A^2 , given by:

$$s^{1,IN} = \left(e^T A^1 \right)^T \quad (10a)$$

$$s^{2,IN} = \left(e^T A^2 \right)^T \quad (10b)$$

$$s^{1,OUT} = A^1 e \quad (10c)$$

$$s^{2,OUT} = A^2 e \quad (10d)$$

In-strength centrality s_i^{IN} for a single country i , as determined by Eqs. (10a) and (10b), refers to the volume of C&T-value added (C&T-labor) directly embodied in domestically and internationally traded C&T-goods, whereas out-strength centrality s_i^{OUT} , calculated in Eqs. (10c) and (10d), signalizes the volume of C&T-value added (C&T-labor) directly embodied in C&T-trade flows which a country delivers both domestically and to other countries. Since we require in some cases for our analysis to distinguish between internationally and domestically traded C&T-goods, we denote by $s^{IN,for}$ and by $s^{OUT,for}$ for the strength centrality vectors, where the respective column-sums and row-sums of the adjacency matrices exclude the element a_{ii} for which it holds that $i = h$ and which show thus C&T-value added or C&T-labor directly embodied in internationally traded C&T-goods. In a similar way, $s^{IN,dom} = s^{OUT,dom}$ correspond to the strength centrality

vectors which include C&T-value added and C&T-labor, directly embodied in domestically traded C&T-goods.

Appendix 3

See Tables 6, 7, 8 and 9.

Table 6 Manufacturing Sector—Industry Classification. Source: World Input-Output Database, www.wiod.org

ISIC Rev.3 Code	Industry
15t16	Food, beverages and tobacco
17t18	Textiles and textile products
19	Leather, leather and footwear
20	Wood and products of wood and cork
21t22	Pulp, paper, printing and publishing
23	Coke, refined petroleum and nuclear fuel
24	Chemicals and chemical products
25	Rubber and plastics
26	Other non-metallic mineral
27t28	Basic metals and fabricated metal
29	Machinery, nec
30t33	Electrical and optical equipment
34t35	Transport equipment
36t37	Manufacturing, nec; recycling

Table 7 Trade costs for Italy and Portugal with regional blocks, 1995 and 2009. Note that the coefficients of variation for the respective clubs are reported in brackets. Missing data for 1995 were estimated by using data from 1996 and 1997. Data for Taiwan are not available, therefore data for China were taken as a proxy. Data source: ESCAP World Bank (2015)

	Italy		Portugal	
	1995	2009	1995	2009
World	102.01 (.30)	87.36 (.34)	208.46 (.33)	183.03 (.28)
CE	64.63 (.10)	56.44 (.27)	97.50 (.22)	82.36 (.35)
PWNE	87.06 (.20)	86.42 (.09)	130.29 (.23)	107.93 (.41)
PEE	98.46 (.08)	62.82 (.20)	210.20 (.08)	118.68 (.29)
EAPR	126.83 (.04)	122.89 (.14)	232.56 (.21)	194.56 (.17)
BEC	144.38 (.17)	101.53 (.22)	230.91 (.27)	167.79 (.18)
A	120.71 (.18)	119.62 (.13)	235.58 (.20)	196.01 (.10)
CI	126.32 (.04)	108.71 (.07)	256.67 (.15)	206.10 (.21)

Table 8 Strength centrality scores—single country values. The figures in brackets correspond to volumes of C&T-value added and C&T-labor directly embodied in domestically traded C&T-goods. C&T-value added is expressed in constant prices of million US\$, where 1995 = 100 and C&T-labor is expressed in million hours worked. Data Source: Timmer et al. (2015). Authors' own calculations

	C&T-value added				C&T-labor			
	In-Strength		Out-Strength		In-Strength		Out-Strength	
	1995	2009	1995	2009	1995	2009	1995	2009
EAPR								
Australia	2660 (1882)	2149 (1035)	2318 (1882)	1234 (1035)	658 (131)	592 (77)	162 (131)	91 (77)
Indonesia	640 (7)	912 (2)	9 (7)	2 (2)	2133 (1955)	2341 (2013)	2468 (1955)	2868 (2013)
Japan	47,625 (41,636)	17,060 (12 828)	43,509 (41 636)	14,440 (12 828)	6399 (2413)	2463 (791)	2521 (2413)	891 (791)
South Korea	6554 (4914)	6289 (5156)	9041 (4914)	6477 (5156)	1834 (1013)	972 (564)	1864 (1013)	708 (564)
Taiwan	2524 (1 823)	876 (516)	4329 (1 823)	1558 (516)	459 (261)	191 (90)	620 (261)	271 (90)
<i>Total</i>	60,003 (50,262)	27,286 (19,537)	59,206 (50,262)	23,711 (19,537)	11,483 (5773)	6559 (3535)	7635 (5773)	4829 (3535)
CE								
Austria	2037 (782)	1496 (272)	1678 (782)	1404 (272)	217 (28)	163 (6)	61 (28)	31 (6)
Belgium	2379 (422)	1904 (317)	2854 (422)	2991 (317)	309 (13)	274 (4)	89 (13)	39 (4)
France	8235 (4465)	7870 (3773)	7771 (4465)	8 311 (3773)	1115 (246)	1260 (73)	429 (246)	161 (73)
Germany	16,285 (6497)	5,678 (−127)	12,033 (6 497)	7432 (−127)	3198 (243)	1922 (−3)	450 (243)	182 (−3)
Italy	19,690 (16,809)	17,948 (14,211)	24,173 (16,809)	20,082 (14,211)	1756 (868)	1501 (543)	1248 (868)	767 (543)
Netherlands	1929 (148)	1579 (62)	1578 (148)	1283 (62)	403 (5)	265 (1)	52 (5)	29 (1)
Slovenia	264 (94)	249 (77)	425 (94)	166 (77)	32 (15)	45 (10)	68 (15)	21 (10)
Spain	6300 (4963)	4388 (1674)	5932 (4963)	3973 (1674)	610 (332)	871 (82)	397 (332)	195 (82)
United Kingdom	10,378 (6653)	6038 (1730)	9995 (6653)	4975 (1730)	1523 (242)	1481 (44)	364 (242)	125 (44)
<i>Total</i>	67,497 (40,833)	47,150 (21,989)	66,439 (40,833)	50,617 (21,989)	9163 (1,992)	7782 (760)	3158 (1,992)	1550 (760)
PWNE								
Denmark	968 (103)	408 (−6)	877 (103)	425 (−6)	262 (4)	98 (0)	31 (4)	11 (0)
Finland	745 (386)	685 (237)	619 (386)	453 (237)	104 (17)	104 (7)	27 (17)	14 (7)
Greece	2670 (1 904)	2527 (1 581)	2386 (1 904)	1837 (1 581)	266 (184)	233 (116)	230 (184)	135 (116)
Ireland	613 (137)	773 (152)	514 (137)	296 (152)	60 (10)	90 (5)	38 (10)	10 (5)

Table 8 continued

	C&T-value added				C&T-labor			
	In-Strength		Out-Strength		In-Strength		Out-Strength	
	1995	2009	1995	2009	1995	2009	1995	2009
Luxembourg	119 (17)	165 (37)	221 (17)	204 (37)	5 (0)	4 (1)	2 (0)	3 (1)
Malta	92 (36)	53 (14)	76 (36)	28 (14)	9 (2)	3 (1)	5 (2)	2 (1)
Portugal	2637 (1861)	2328 (1455)	3259 (1861)	2404 (1455)	373 (305)	285 (196)	534 (305)	323 (196)
Sweden	1087 (191)	716 (17)	482 (191)	388 (17)	266 (9)	149 (1)	22 (9)	16 (1)
<i>Total</i>	8931 (4635)	7655 (3487)	8434 (4635)	6035 (3487)	1345 (531)	966 (327)	889 (531)	514 (327)
PEE								
Bulgaria	300 (285)	97 (19)	342 (285)	31 (19)	267 (265)	179 (170)	318 (265)	274 (170)
Czech Republic	844 (417)	997 (226)	808 (417)	866 (226)	213 (156)	155 (32)	303 (156)	124 (32)
Hungary	593 (418)	555 (63)	585 (418)	163 (63)	204 (185)	82 (45)	259 (185)	115 (45)
Poland	1401 (1137)	1769 (464)	2287 (1 137)	2199 (464)	499 (474)	393 (78)	953 (474)	371 (78)
Romania	849 (502)	1074 (30)	902 (502)	76 (30)	553 (531)	355 (276)	955 (531)	702 (276)
Slovakia	214 (132)	361 (22)	269 (132)	357 (22)	77 (54)	74 (4)	109 (54)	61 (4)
<i>Total</i>	4201 (2891)	4853 (824)	5193 (2 891)	3692 (824)	1813 (1665)	1238 (605)	2897 (1665)	1647 (605)
A								
Brazil	15,127 (14,624)	6625 (6187)	14984 (14,624)	6286 (6187)	5642 (5497)	6058 (5829)	5632 (5497)	5922 (5829)
Canada	4342 (2443)	4977 (2472)	3585 (2443)	3684 (2472)	893 (177)	912 (68)	259 (177)	102 (68)
Mexico	3519 (2266)	2636 (974)	3290 (2 =266)	1521 (974)	1232 (1110)	1669 (1425)	1611 (1110)	2225 (1425)
United States	52,580 (43,290)	26,362 (18,264)	46,945 (43,290)	22,646 (18,264)	8361 (2734)	6517 (910)	2965 (2734)	1128 (910)
<i>Total</i>	75,568 (62,623)	40,600 (27,897)	68,804 (62,623)	34,137 (27,897)	16,128 (9518)	15,156 (8232)	10,467 (9518)	9377 (8232)
BEC								
Cyprus	79 (3)	148 (13)	125 (3)	76 (13)	21 (0)	10 (1)	18 (0)	4 (1)
Estonia	107 (33)	87 (4)	90 (33)	92 (4)	31 (19)	19 (1)	52 (19)	22 (1)
Latvia	99 (55)	135 (26)	100 (55)	56 (26)	34 (27)	20 (9)	50 (27)	19 (9)
Lithuania	116 (50)	246 (35)	168 (50)	251 (35)	43 (30)	29 (8)	100 (30)	59 (8)
Russia	3342 (1611)	5351 (162)	1734 (1611)	163 (162)	2745 (2399)	2778 (1037)	2582 (2399)	1048 (1037)

Table 8 continued

	C&T-value added				C&T-labor			
	In-Strength		Out-Strength		In-Strength		Out-Strength	
	1995	2009	1995	2009	1995	2009	1995	2009
Turkey	5645 (5155)	5573 (821)	8458 (5155)	1016 (821)	1214 (995)	3705 (1535)	1633 (995)	1900 (1535)
<i>Total</i>	9388 (6907)	11,540 (1061)	10,675 (6907)	1654 (1061)	4088 (3470)	6561 (2591)	4435 (3470)	3052 (2591)
CI								
China	21,788 (18,306)	82,010 (78,822)	26,582 (18,306)	98,519 (78,822)	23,509 (23,020)	38,482 (38,034)	33,428 (23,020)	47,538 (38,034)
India	8,865 (8,644)	13,754 (13,273)	10,909 (8,644)	16,483 (13,273)	18,048 (17,960)	34,817 (34,668)	22,666 (17,960)	43,054 (34,668)
<i>Total</i>	30,653 (26,950)	95,764 (92,095)	37,491 (26,950)	115,002 (92,095)	41,557 (40,980)	73,299 (72,702)	56,094 (40,980)	90,592 (72,702)

Table 9 International trade linkages of Italy and Portugal with regional blocks in terms of C&T-value added and C&T-labor directly embodied in C&T-goods. Note that CE at this point excludes Italy and likewise PWNE excludes Portugal. C&T-value added is expressed in constant prices of million US\$, where 1995 = 100 and C&T-labor is expressed in million hours worked. Data Source: Timmer et al. (2015). Authors' own calculations

	Italy		Portugal	
	1995	2009	1995	2009
C&T-value added				
Imports from...				
EAPR	107.5	64.2	6.3	2.3
C&I	353.5	874.8	13.2	41.6
CE	1815.8	2312.7	711.3	808
PWNE	146.2	117.2	19.2	9.9
PEE	186.5	247.1	2.2	4.3
A	91.4	98	15.9	5.6
BEC	180	23.4	8.3	1.1
Exports to...				
EAPR	1299.4	584.5	26.6	25
C&I	243.4	223.4	5.9	10.8
CE	4010.3	2111.3	1079.5	645.8
PWNE	560	345.8	180.3	34.8
PEE	163.4	537.5	1.4	27.7
A	850.8	535.5	94.1	71.4
BEC	236.3	1 533	10.4	133.4
C&T-labor				
Imports from...				
EAPR	30.9	19.4	1.4	3.2
C&I	551.3	657.5	21.7	49.6
CE	83.6	58	34.4	30.4
PWNE	14.5	8.4	0.9	0.4
PEE	134.6	178.6	1.4	1.9

Table 9 continued

	Italy		Portugal	
	1995	2009	1995	2009
A	13.2	10.7	3.6	2.6
BEC	59.4	26	4.7	1.6
Exports to...				
EAPR	67.1	22.3	4.4	3.4
C&I	12.6	8.5	1	1.5
CE	207.1	80.7	177	86.8
PWNE	28.9	13.2	29.6	4.7
PEE	8.4	20.5	0.2	3.7
A	43.9	20.5	15.4	9.6
BEC	12.2	58.6	1.7	17.9

Received: 10 November 2015 Accepted: 16 April 2016

Published online: 25 May 2016

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