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EMPLOYMENT, PRODUCTIVITY, WAGES AND IMPORTS IN CHILE (1996-2008): AN ANALYSIS IN TERMS OF VERTICALLY INTEGRATED AND VERTICALLY HYPER-INTEGRATED SECTORS

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Abstract

El objetivo de esta tesis consiste en estudiar la evolución de la estructura productiva de Chile, entre los años 1996 y 2008, empleando el enfoque de los sectores *Verticalmente Integrados* y *Verticalmente Hiper-Integrados* desarrollado por Pasinetti (1973; 1981; 1984; 1988), también conocido como enfoque de subsistemas. A partir de matrices Insumo-Producto construimos indicadores sintéticos que dan cuenta de la cantidad de trabajo directa e indirectamente necesaria para la producción de una unidad de producto neto. A posteriori, medimos el número de trabajadores directa e indirectamente empleados en el total del producto neto de una determinada actividad y estimamos cambios en la productividad física de su proceso de producción. Además del análisis del empleo y la productividad, el alcance de la metodología se amplía al estudio de la distribución funcional del ingreso y de los insumos importados. El enfoque de subsistemas permite captar eficazmente las interrelaciones sectoriales de una forma generalmente soslayada por lo enfoques convencionales y supera las limitaciones de la medición neoclásica de la productividad. Los principales resultados del trabajo ponen en evidencia cómo los sectores más dinámicos en la economía fueron diversificados entre sí y que éstos no coinciden exclusivamente con actividades basadas en recursos naturales que son las que más se han incentivado en Chile desde la esfera público-privada a través del Sistema Nacional de Innovación.

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Contents

1. Introduction

Following the end of the Pinochet dictatorship, Chile recorded a dynamic growth of output. GDP increased at an annual average rate of 7.6% between 1991 and 1998 and 3.8% between 1999 and 2008. Exports grew at an annual average rate of 11.0% in the period 1992-2005. Exports are predominantly based on primary goods that, at the beginning and the end of the same period, represented respectively 88.1% and 86.1% (Guardia, 2009: 210). It is generally believed that different aspects have contributed to this pattern of growth. On the one hand, factorial specialization characterized by abundant natural resources (such as copper) and suitable conditions for the expansion of other activities (like grapes and wine production). On the other hand, public policies are considered to have had an important role in giving support to these activities.

This performance attracted the attention of numerous academics with different orientations. A relevant group of studies of the Chilean performance rose around the so called New-Developmentalism (ND) approach. Similarly to Developmentalism of authors in the 1950s and 1960s, ND maintains that the State has an active role in the process of development. However, while traditional Developmentalism advocated for a direct intervention of the public sector in the economy (e.g. public enterprise ownership), ND advocates for a subsidiary intervention, mainly through the establishment of norms, support of Research and Development and the provision of adequate infrastructure. Differently from traditional Developmentalism, ND stresses the importance of budget equilibrium, a competitive and steady real exchange rate and trade surplus that is necessary to avoid external constraint. According to this view, Chile took advantage of its resource endowment and was able to develop dynamic sectors that incorporated technological upgrading which allowed increasing its participation in the global market of goods such as fish and wine.

There is little doubt that natural resource based sectors have increased their importance and that they have modernized in the last two decades. However, some questions arise in relation to the characteristics of this pattern of growth. To which extent have these industries contributed to job creation and technical upgrading? Has their contribution been constant over time or, contrarily, uneven? How has the wage component evolved in the last two decades? As most analysis, ND analysis usually focus on direct employment creation (destruction) without taking into consideration indirect relations and inter-industry links that take place in the productive structure. Therefore, it is worth considering what the interaction of these activities with other industries in the economy is. These questions are fundamental in understanding the potentiality of a resource based and export-oriented pattern of development.

We will address these issues by applying Vertically Integrated (VI) and Vertically Hyper-Integrated (VHI) subsystem analysis. This approach revives the classical analysis of the circular flow of production in which each good can be either consumed or re-enters the productive cycle as input of production. Within this framework, the economy can be divided into as many subsystems as the number of goods produced. Each commodity is produced by means of itself, other commodities and labour. VI and VHI approach, whose roots can be found in Input-Output (IO) analysis elaborated by Leontief and in the concept of subsystem elaborated by Sraffa, was mainly developed by Pasinetti in a number of works that appeared between the mid-seventies and the end of the eighties (Pasinetti, 1973; 1981; 1984; 1988). Even though it is not materially possible to divide the economic system into as many activities as produced commodities, IO tables provide a reasonable approximation that allows empirical application of this approach.

We do not depart from the idea that export performance is the only aspect to consider to achieve a successful development strategy. It does not mean ignoring the importance of external constraint. Instead, our intention is to focus on other aspects that from our point of view, need to be part of the development debate but that usually are not taken into account by ND studies. For instance, it is necessary to consider the implications that fully advocating export led strategies of growth has on other activities (that focuses on domestic demand). How does the development of export-oriented activities impact on employment creation? To what extent export-oriented growth strategies that, at least in the case of Latin American economies, focuses mainly on the exploitation of natural resources are feasible ways to reach the levels of employment and productivity of developed countries? On which conditions?

The approach we propose contemplates inter-industry relations in the economy that can be identified and expressed in concise form at the VI and VHI level. We will maintain that, in order to assess an effective development strategy, it is important to consider the linkages of any individual activity with the rest of the productive structure. Secondly, our approach allows the construction of synthetic indicators that are capable of identifying changes in employment, productivity and technical change. The subsystem analysis provides an appropriate device to assess physical changes in productivity and goes beyond the shortcomings of estimation of technical change that derives from the use of the neoclassical concept of Total Factor Productivity (e.g. see De Juan and Febrero, 2000 and Wirkierman, 2010). Thirdly, by assessing how the wage component has evolved in VI and VHI terms for each subsystem, it will be possible to differentiate between industry wages and subsystem wages, as well as to compare wages and employment evolution at the subsystem level, which gives a proxy of relative real wage level among activities. Finally, by considering import needs of the production process it will be possible to identify direct and indirect import requirements of the production process, contrarily to standard analysis. We maintain that the subsystem analysis provides a better tool to analyse productive inputs if compared to standard analysis of direct import requirements.

Therefore, the general objective of this work is to study the evolution of employment, productivity and functional distribution of income in Chile using VI and VHI subsystems between 1996 and 2008. We formulate the hypothesis that, even though resource based activities have attracted much attention in literature, a relevant portion of employment creation and productivity gains can be attributed to other activities.

From this general commitment, four specific objectives can be outlined:

1. Establish which subsystems have been more dynamic in terms of job creation and productivity in Chile.

2. Analyse the evolution of wages at the VI and VHI level and establish links between wage evolution and Chilean productive structure.

3. Identify import necessities by subsystem and compare them with measurements in direct terms.

4. Establish if the subsystems that performed better in terms of employment creation and productivity gains are the same as those identified by the ND approach.

From these considerations we formulate the hypothesis that, even though resource based activities have attracted much attention in literature, a relevant portion of employment creation and productivity gains can be attributed to other activities.

The empirical analysis will be fulfilled using IO tables of Chile of 1996, 2003 and 2008. This span of time is relevant since it embraces a period of growth (even though lower than that at the beginning of the nineties) and consolidation of the productive pattern and it concludes just before the last international economic crisis that affected Latin America in 2009.

The work is organized into five sections. After this introduction, section 2 exposes the theoretical contributions of ND and the subsystem approach. This section is divided into three parts. Section 2.1 presents the ND approach covering its main macroeconomic aspects as well as the microeconomic ones. Some sectoral cases are presented since they have attracted considerable attention in literature and are often presented as Chilean success stories. Section 2.2 provides a critical assessment of ND while section 2.3 presents the subsystem analysis, showing their theoretical importance and describing VI and VHI labour and wage coefficients. In section 3 the empirical methodology is explained. We departed from Supply and Use (commodity x activity) tables at current prices and transformed them into (activity x activity) Input-Output (IO) tables at constant prices. In this section we will also display the construction of deflators and the vector of direct employment that we employed in the analysis. Section 4 presents empirical results regarding the evolution of employment, productivity and wage evolution at the subsystem level and compares them with direct measurement. It also provides the analysis of imported input and investment needs by industry and subsystem. Section 5 summarizes and discusses the main results.

2. Theoretical approach.
New-developmentalism and the subsystem approach

In order to approach the study of the productive structure in Chile, we first need to consider the state of the current debate on development strategy in the region. In this section we will address some recent contribution to the literature, focusing on the so-called (ND) approach. We decided to concentrate on this stream of thought because, since that the Washington Consensus reduced its influence, many Latin American countries have followed economic policies which are compatible with ND recommendations. Therefore, before discussing our theoretical approach (i.e. subsystem analysis) and the empirical results, we will review some ND contributions. The aim of the first part of section 2.1 is that of identifying the main features of this theoretical approach, differentiating between the macroeconomic and microeconomic (or productive) dimension. In section 2.1.1, we will characterize the evolution of some sectors that in Chile have attracted the attention of a considerable number of academic researches and in section 2.2 we will provide a critical assessment of ND. In section 2.3 we will present the subsystem approach, underlying the differences with ND theories and arguing why this approach is a more accurate tool to study the productive structure of an economy.

2.1. New-Developmentalism

It is not easy to find a unified view of ND. First, contributions are far from being a homogenous group of literature. Secondly, there is not a clear definition of ND is and the category is often used as a synonymous of the term Neo-Structuralism. For these reasons, it will be proposed a definition of ND which, we believe, summarizes the main characteristics of this approach. In the following analysis we largely focus on the works of Bresser-Pereira, the economist who first introduced the term ND. We will also use contributions that are not explicitly labelled as ND but whose positions are in line with the core thinking of ND approach.

As a first approximation, Bresser-Pereira maintains that

> [ND] is not an economic theory but a national strategy of development. Unlike developmentalism of the fifties it does not promote measures to protect the infant industry and, even though it gives a central role to the State, it believes that in order to reach its goals, the State should have a sound finance and should have an efficient administration. On the other hand, in contrast to the economic mainstream, new-developmentalism does not think that markets are able to fix it all, neither that institutions should only be worried by guaranteeing property rights (Bresser-Pereira, 2007: 110; Translation of the author).

Going back in time, the origins of ND can be found in the ECLAC's contributions appeared at the beginning of the nineties. In the document "*Changing production patterns with social equity*" published in 1990 there are some elements that will be later the backbone of the so-called "New ECLAC" contributions (or Neo-Structuralism). Following Bielchowsky (2009), in this document it is proposed the idea of a gradual and selective trade liberalization complemented with a low and stable exchange rate in order to foster international competitiveness. From this broad characterization, it is necessary to provide further clarification in order to grasp the main characteristics of ND. To attain this task, we will separate macroeconomics measures from the microeconomics (or productive) ones.

As to the former group, export led growth strategy is the main element that characterizes ND strategy. The development of productive sectors should be functional to increase export in order to deal with balance of payment constraints. Given this external projection, exchange rates should be stable and low in order to foster exports, coherently to what is usually known as a "competitive real exchange rate (RER)" (Frenkel, 2006). The central bank has two roles: "to control inflation and to keep the balance of payments in balance" (Bresser-Pereira, 2006: 30). High inflation would endanger the stability of the exchange rates since higher prices would force a devaluation in order to maintain the level of the RER.

Interest rates should have a double function. On the one hand, they should reach a level which is sufficient to control inflation; but, at the same time, they should also be "moderate" (in opposition to the Washington Consensus recipes which advocated high interest rates) to avoid the appreciation pressures on RER that capital inflows could create (Bresser-Pereira, 2007). In some particular contexts (e.g. booming phases) capital controls could be necessary in order to avoid appreciation of the RER and maintain macroeconomic stability. However, capital controls do not need to be permanent since "they have to do their job only in a booming phase, and we now know well that booming phases do not last forever" (Frenkel and Rapetti, 2007: 30).

Another requisite of ND is public spending equilibrium. Budget equilibrium is considered as a necessary piece of economic policy and is strictly associated with trade surplus. As maintained by Bresser-Pereira (2006), while economic orthodoxy aims at obtaining primary surplus, ND purses positive public savings[1]: ND "wants to control public deficit and […] to achieve positive public savings capable of financing all, or a significant portion, of the public investments required" (Bressers-Pereira, 2006: 30-31). Hence, public savings is a necessary piece to maintain trade surplus.[2] An expansive fiscal policy would increase domestic demand which would stimulate imports, worsening the trade account. At the same, time additional domestic demand would create inflationary pressures, jeopardizing RER stability.

In the view of Dammil and Frenkel a competitive and stable RER has an expansive effect on the economy and contributes to a rapid expansion of private consumption (Dammil and Frenkel, 2009: 4). To contrast this trend, a restrictive fiscal policy is needed in order to compensate inflationary pressures due to higher levels of internal demand, avoiding overheating the economy (Frenkel, 2008; Dammil and Frenkel, 2009).

[1] Primary surplus do not consider interests paid on government debt.

[2] This can be easily grasped by considering the identity $X - M \equiv (T - G) + (S - I)$. With full employment and equilibrium between saving and investment an increasing trade surplus has to be balanced by a greater public saving $(T - G)$.

The foregoing macroeconomics requirements can be associated to what Katz (2007) calls the "fundamentals" of structural change and economic development. Following this author, these measures are a necessary condition to improve development but not a sufficient one. They must be associated with a process of "institutional changes and maturation of technological and productive capacity of the economic agents so that the development of the productive forces could be a tangible reality" (Katz, 2007: 74; Translation of the author). This process of transformation of the industry has to do with the microeconomic sphere.

With respect to the microeconomic contributions of ND, the main concern is that of achieving productivity gains and sectoral technological upgrading in export-oriented sectors. ND emphasizes the role of innovation and technical change as well as the role of public sector and the virtuous relation that can be established with the private sector in order to boost economic development. Developing countries should aim at reducing their technological gap with developed ones in order to be more competitive on the international ground. This aspect has similarities with Neoschumpeterian and Evolutionary authors that place the learning process and technical innovation at the centre of their analysis. However, ND is not fully coherent with these approaches, since most of Neoschumpeterian contributions do not rely on comparative advantages (see Dosi and Soete, 1988). Rather, ND position is closer to the concept of Ricardian Efficiency (RE). ND embraces the idea that sectors with some kind of comparative advantage (which, for most of developing countries, coincide natural resources based industries) are more likely to be fostered in order to catch up with the productivity levels of developed countries. The ECLAC's document above mentioned is quite illustrating in this sense. The section dedicated to the strength of the productive links (ECLAC, 1990: Section V.C) focuses exclusively on the Agriculture and Resource Based industry and some Services and Financial Sectors linkages. No space is usually given to other industries. The presence of quasi-rents in these sectors constitutes a stimulus for technical change (Katz, 2007). Industrial policy in ND "is still significant but strategic, and must be applied to specific sectors and to enterprises able to compete internationally" (Bresser-Pereira, 2012: 362) that in most developing countries means natural resource based industries, which are seen as key sectors to promote innovation.

Public sector has an active role in promoting development of these activities through different ways: universities, research centres, public-private agreements and so on. This virtuous environment is usually labelled as National Innovation System (NIS). A NIS can be broadly defined as a "network of institutions in the public and private sectors whose activities and interactions initiate, import, modify and diffuse new technologies" (Freeman, 1987: 1)[3]. In this view, not only public action should be focused on specific sectors "able to compete internationally", but the State should not promote industrial policy through direct inference since its role is conceived in a rather indirect way.

Coherently with this framework, in Chile there are institutions and initiatives that are explicitly devoted to improve the collaboration of the public and private sector and to promote innovation. As an example, the Chilean Economic Development Agency (CORFO) was created in 1938 and since its creation, it has been involved in different modalities of intervention such as direct investment, credit assignment and Research and Development promotion. Nowadays CORFO focuses on these last two assignments (since it is not involved in the administration and support of public enterprises anymore) and constitutes the main source of funding for private sector innovation (Katz and Spence, 2008). Apart from CORFO, different specific funds are funded by the Ministry of Science and Technology such as the National Fund for the Development of Science and Technology (FONDECYT), the Science and Technology Development Research Fund (FONDEF) and the Bicentenary Program which were the most important programs in 2007 (Katz and Spence, 2008). In 2005 it was created the National Council for Innovation and Development (CNID), a public-private institution which has "the mission of advising the President in the identification, design and promotion of policies and measures that promote innovation and competitiveness in Chile, as key elements for the development of the country" (CNID, 2015: 2; Translation of the author). The CNID identified eight

[3] Different definitions of NIS are collected in OECD (1997).

priority areas in which it focuses the development strategy: Mining, Fish culture, Pork and Aviculture, Processed Food, Fruit Culture, Tourism, Offshoring Services and Financial Services. Note that five of them are resource based industries while three of them are services activities, denoting compatibility with the development strategy outlined above. In addition to these agencies, ProChile (a public institution that depends from the Foreign Ministry) has the explicit commitment to promote Chilean products in foreign markets and to attract FDI. ProChile has several national and international offices that provide counseling to Chilean exporters and facilitate their insertion into international markets.

From this general framework, it is useful to give some elements to understand the sectoral evolution of some of the productive activities that in the last years have received much attention from the literature. The next subsection covers this aspect.

2.1.1. Sectoral background

With respect to productive policies put in place in Chile, there is certain homogeneity among the different contributions in the identification of key sectors. In this section we present the case of fish farming, copper and wine productions. All these sectors match the characteristics of the ND thought. In every one of these cases, the NIS played an important role in promoting public-private agreement, attracting FDI and favouring innovation. We will not discuss in depth the evolution of these activities neither examine all the existing contributions. Rather, we will present the main achievements and the salient features for each case. The aim is that of providing some elements to understand the main aspects of these sectors and the reasons that are usually employed to justify their importance since these activities are often presented as successful cases of the ND strategy, and this is why they interest us. It does not imply that in our empirical analysis we will only focus on these sectors. IO analysis, by definition, puts in relation all the productive sectors of the economy. However, it is our intention not to lose sight from those sectors that attracted much attention of ND literature in Chile.

The first activity we take into consideration is fish farming which is usually picked as the success case of cooperation between the public and private sector. In particular, salmon farming occupies a lead role being the 95% of the total aquiculture. The fact that in few decades Chile managed to introduce salmon farming and expand its production up to becoming the second world producer (after Norway) already in 1995 (Perez-Aleman, 2005), justify the attention that this sector has received.

Katz (2007) describes the development of aquaculture in three stages. In the first one, salmon culture began through import of genetic material. This period was characterized by a "trial and error" activity. The process of learning and technology appropriation was supported by public policies though CORFO and the creation of the Chile Foundation a public-private organization composed by the government and BHP-Billiton mining company. The second stage was characterized by a rapid expansion of the sector, both in terms of output and in number of firms. In this period the public sector changed its role, concentrating its intervention on environment regulation issues, provision of public goods and infrastructures and negotiations in the international ground. During the third stage the success of the industry attracted large quantities of FDI (UNCTAD, 2006). The arrival of a considerable number of foreign investors also had an important role in the introduction of new technology. In this period the number of producers did not expand anymore and the participation of foreign firms increased, consolidating in a mature oligopolistic market. Production continued to rise while the number of firms decreased. The role of public sector was directed to the consolidation of public-private initiatives. The Chile Foundation organized seminars aimed at fostering technological catch up as well as it promoted the formation of local expert in developed countries with the goal of introducing more efficient techniques of production.

A fourth stage can be added. In 2007 the Infectious Salmon Anemia (ISA) virus appeared in some salmon farms and rapidly spread through most of the farms. The effects on production were especially marked between 2008 and 2010. Even though there has been a recovery in the production, the rather optimistic analysis on salmon farming have been substituted by more cautious contributions. In this fashion, Katz and Iizuka (2011) pointed out the lack of Research and Development of the private firms and to an insufficient regulatory framework of the institutions as factors that contributed to the outspread of the ISA virus and the decline in salmon production.

A second group of studies was dedicated to wine production in Chile. Grapes and wine production grew rapidly in the last two decades, being the production of wine 481 millions of litres in 1996 and 869 in 2008, while the planted area increased in the same period from 56 thousands of hectares to 118 (GAIN Report, 2013). Most of this increase was absorbed by exports which represented 62% of the production in the period between 1995 and 1999, and 86% in 2005-2007 (Cusmano et al., 2010).

Most of the literature attributes the success of the wine industry to a combination of external and internal forces. Among the external forces, FDI is considered a key element in the developing of wine production. FDI (mostly proceeding from USA, followed by France and Canada) began to operate in the 1980s and increased rapidly during the 1990s. During this period it was directed at the creation of new foreign owned companies or at the creation of joint ventures with local partners (Visser, 2004). Another determinant factor in the improvements of the industry was the involvement of external consultants which have been a key element of knowledge transmission (Cusmano et al., 2010). As to the internal role, of public-private initiatives and the links among local institutions and universities with wine producers had a significant function. External projection is consolidated by the participation of international fairs and the promotion Chilean wine. Private organization (such as "Wines of Chile") and public ones (such as "ProChile") worked closely in order to enhance the "brand Chile" in the global market. Although the overall performance of the wine sector has been satisfactory, some studies show that there is a certain level of heterogeneity among wine producers with core-periphery relation among firms and asymmetric cohesion and knowledge diffusion (Giuliani, 2010).

A final sector worth considering is the case of copper. As it is well known, Chile has the largest copper reserves worldwide and concentrate one third of the global production. Copper production increased from 3115 thousands of tons in 1996 to 5328 in 2008 (Cochilco, 2011). This meant nearly 5% of nominal GDP at the beginning of the nineties and around 12% in 2008 with peaks that reached almost 20% of the GDP in 2006 and 2007 (Arellano, 2012). In 2008 mining products represented 57.5% of exports while in 1996 were 40.8% (BCC, 2003; 2009). The mining sector counts with the increasing presence of private enterprises that entered in the activity since the first half of the eighties. This process is usually known as copper "denationalization". Even though the military dictatorship began this process, it is under the democratic governments of the nineties that it intensified. During these years CODELCO's output only recorded little increases, while most of the increase is due to private companies. As table 2.1 shows, the public owned company CODELCO controlled 60% of the total of copper production in 1992. In 1995, private companies surpassed CODELCO's production and in 2008 the public company only produced 27% of the total.

Table 2.1. Copper production by company (Th. of tons of Copper Content)

	1992	**1996**	**1999**	**2001**	**2003**	**2006**	**2008**
CODELCO	1156	1221	1508	1592	1563	1676	1467
Other Producers	776	1895	2884	3147	3342	3685	3861

Source: Cochilco, 2011

Revenues proceeding from copper increased sharply in the last decade. In 2003 these were less than one billions of dollars but, since 2004, they grew rapidly and reached 14 billions of dollars and in 2008 they fell to 10 billions of dollars (Arellano, 2012). Copper revenues constituted 6% of total fiscal revenues in 2003 and 32% in 2007 (26% in 2008) (Consejo Minero de Chile, 2013). There are two factors to take into consideration while analyzing this increase. On the one hand the evolution of international prices and production. On the other hand, the introduction of the "Economic and Social Fund of Stability" (ESFS) coincides with the rapid increase of copper revenues. The ESFS was introduced in 2007 with the idea of funding "possible fiscal deficits that could generate during periods of low growth and/or low price of copper. This fund helps to reduce fluctuations in fiscal expenditure that arise during economic cycles" (Ministerio de Hacienda, 2010: 15; Translation of the author). Therefore, the ESFS is an anti-cyclical fund aimed to support the economy during periods of lower fiscal revenues and to provide positive savings in periods of high revenues. As maintained by Ocampo (2007) the introduction of the ESFS is part of a "cautious" fiscal policy and from what we saw in the previous paragraphs, coherent with ND.

The three sectors above mentioned coincide with the features highlighted by ND. All these activities are primary based in which comparative advantages and natural abundance played a main role. In this view, an active NIS encouraged a prolific collaboration between public and private sectors, even though some weaknesses are stressed by different authors. Local research institution (public and private) have an important role in the innovation process. Sectoral organizations also have an active actor. Moreover, FDI is another important piece in the Chilean puzzle. All the above sectors counted with a relevant role of foreign investors who had the double function of providing capital and knowledge to the development of these activities.

Summing up the previous sections, ND can be identified as a set of contributions that, from the macroeconomic side propose public budget equilibrium, a competitive and stable exchange rate and low inflation in order to foster international competitiveness (i.e. exports). Macroeconomic policies are all oriented to this final target. In this sense, low fiscal stimulus (in order to contain internal demand), capital controls and low inflation rates are fundamental public measures to reach this goal. Exports are mostly focused on natural resource based sectors since many developing countries count with RE in these activities. As to productive policies, the public sector has an active role (although indirect) in promoting innovation, technological upgrading and linkages in the productive structure through the promotion of an efficient NIS. In this sense, Chile has developed a number of institutions which are relevant for the consolidation of the NIS and have been focused on the development and innovation of resourced based sectors and its insertion into external markets. Public action do not involve direct intervention (except in the case of copper) but rather it aims at providing a proper framework to foster productive activities, creating infrastructure, capacitating human capital, providing credit and promoting exports. This is a key difference with traditional structuralist approach, which proposed direct intervention and management of investment by the State.

2.2. New-Developmentalism, a critical assessment

Before introducing our theoretical approach, it is worth considering some implications that emerge from the previous paragraphs. As to macroeconomic stances, the first aspect to focus on is external competitiveness as the final goal of the ND's recipe, since, as we stressed in section 2.1, macroeconomic policies can be read in the light of this target. These measures are oriented at promoting sectors that can compete internationally while no attention is given to the impact of a low RER on internally oriented sectors. In a context of lower exchange rates, sectors that are more dependent on imports would face increased production costs, reducing their competiveness compared with more dynamic activities. This can lead to an increase in the heterogeneity of the productive structure of the economy with a group of sectors highly competitive and other sectors lagging behind, which can eventually disappear. If this process takes place, lagging sectors would expel workers at the same time that relative participation in employment of the most competitive sectors increases. Duality of the productive sectors is not taken into account by ND authors while the only focus is on externally oriented sectors. From these considerations it is essential to establish to what extent an export led growth can be enough to foster national development. From our perspective, if a polarization of the productive structure takes place, workers expelled from lagging sectors should be absorbed by dynamic sectors in order not to increase unemployment. Most analysis that study changes in the sectoral composition of employment only take into consideration direct employed in a given sector. However, the impact of an industry on employment goes beyond the generation of direct employment. Some industries have more spillovers on other activities than others. Therefore, to assess changes in the composition of employment it is better to look at the relation of a given activity with the rest of the productive sectors. This is what we will try to do in the next sections.

Another aspect to note is that in ND analysis there is no room for domestic demand in the process of development.[4] In this sense, expansive fiscal policies should be

[4] To my knowledge, only recently internal demand is considered as a significant element of (although of secondary importance). Ocampo (2015) points out the importance of internal demand in developing countries. Countercyclical policies should take into consideration "the opportunities offered by

avoided since it would endanger the stability of the RER. Higher internal demand is believed to promote inflationary forces that would reduce international competitiveness and may lead to devaluations of the local currency. This idea basically lies on the belief that the economy operates at full employment level of the productive factors, which is a very strong assumption, especially for a developing country. With excess of capacity there would be no necessary relation between greater domestic demand and price variation (see Garegnani, 1983, Serrano, 1995). At the same time, ND authors do not mention the distributive role of depreciations and low exchange rates on the determination of real wages. A low RER in countries highly dependent on imported inputs of production and capital goods means higher production costs and higher consumer prices (determining real wage erosion). In addition, the idea that devaluation increases competitiveness of peripheral countries is controversial. Fiorito et al. (2013) find no correlation between devaluation and economic growth. Among ten countries, only German (a developed one) shows a positive relation between these two magnitudes. As to the other countries of the sample, devaluation is followed by increases in the costs of production, trough the mechanism just specified. Similarly, Bernat (2015) find no statistical significance between RER and export volumes among South American countries. The RER level has an impact only on manufactory with low technological intensity but has no effect on more technological intensive sectors, which support the idea that a low exchange rate does not boost structural change. These considerations lead to formulate a concern that will be fundamental in our analysis. It is necessary to wonder to what extent an external oriented growth model based on the specialization on natural resource based industries can be sufficient to foster technical change and guarantee adequate levels of employment. This point is strictly related with another group of considerations belonging to the microeconomic sphere.

With respect to microeconomic stances, there are some aspects that are worth mentioning. The first one has to do with the idea of technical upgrading and learning

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domestic markets. Obviously, the return to "inward oriented" growth strategies is not desirable, neither viable […]. However, given the perspectives of low growth of international trade, domestic markets provide opportunities that should not be discarded […]" (Ocampo, 2015: 97; Translation of the author).

process which is an aspect that, as mentioned in section 2.1, is shared with Neoschumpeterian authors. However, there are some difference between these contributions and ND. As ND, Neoschumpeterian authors also stress the importance of technical upgrading and country's specificity of this process (due to tacit and non transferable knowledge), but they also take into consideration the role of Schumpeterian efficiency (SE) in the process of upgrading. Catela and Porcile (2012) maintain that

> [SE] captures the ability of each country to adjust to changes in demand patterns and technology. This ability is a function of the country's technological capabilities, which provides the basis for creating new markets and sustaining international competitiveness as new goods, new processes, and new actors continuously challenge the prevailing distribution of market shares (Catela and Porcile, 2012: 780).

According to SE, potential technical upgrading is different for each activity, therefore sectoral specialization patterns matters. A growth strategy based on natural resource sectors can give good results in the short run, but in the long run negative outcomes can appear if these activities show a slower technical change than other activities, undermining the convergence process (Abeles et al., 2013). Coherently with this idea, Cimoli and Di Maio (2004) argue that the current specialization pattern of Chile can have important limitations in the process of catching up in the long run.

These aspects bring us to the idea of Keynesian Efficiency (KE). In developing countries, KE introduces the role of growth generated by final demand and relates it with foreign constraint as it is formulated by Thirlwall's law. In its simplest formulation, this law states that potential GDP growth is positively related with export's global income elasticity and negatively related with import's domestic income elasticity. From this view, both internal dynamics (and imports needs) and external performance are an important piece of the analysis. Recently, structural heterogeneity has been explicitly introduced in a version of Thirlwall's law (ECLAC, 2007). As much as the degree of heterogeneity of the productive structure increase developing countries would face high import's income elasticity, constraining potential growth. This heterogeneity tends to "consolidate a rudimentary specialization pattern, concentrated on a relatively small group of products, [...] associated to the exploitation of natural resources, or in a number of industrial activities with few productive linkages" (Abeles et al., 2013: 33; Translation of the author). In conclusion, while the idea of KE is associated to both external and internal requirements, ND only focuses on the external side. Differently from ECLAC's contribution of the fifties and sixties, the aim is not that of reducing import elasticity through direct public intervention, but it is that of creating the conditions to increase external competitiveness. An export-led and natural resource based model of growth grounded on the RE may be insufficient in the medium-long run if we take into account NE and KE, especially in the case of developing countries (Barletta et al., 2011).

Once we have presented the main characteristics of the ND approach and their critical aspects we move to the subsystem approach. Even though these sectors have attracted a lot of attention, few attempts have been put forward to estimate productive linkages of these sectors with the rest of the productive structure. From our point of view, it is important to investigate the performance of natural based sectors from innovative perspectives. In the next sections we will maintain that the subsystem approach is capable of grasping new elements, providing additional aspects to evaluate a productive development based on natural resources.

2.3. Vertically Integrated and Vertically Hyper-Integrated Subsystems approach

So far, we have exposed the main theoretical features of the ND and some applications to the study of the productive structure in Chile. We also briefly presented some critics that considered both theoretical and empirical objections. In order to enrich the debate we aim at reach a deeper knowledge of the productive structure and provide new elements to assess the role of export-oriented activities in development strategy. By focusing uniquely on an export led-resourced based growth model *cum* fiscal discipline ND do not grasp some aspects that, from our perspective, are important in order to assess a national strategy of development. In this section, we will describe the VI and VHI subsystems, highlighting their theoretical foundation and capacity to assess changes in the productive conditions.

A main property of the subsystem analysis is that it allows to identify direct and indirect requirements (of labour and productive inputs) for the production of one unit of final good, in a fashion that has close similarities with the classical concept of circular flow of production. Differently from ND, we do not depart stressing the importance of external oriented sectors. Growth of final demand (both internal and external), creation (destruction) of employment in the whole economy, changes in productivity per each activity are the key variables of our analysis. Each activity will be studied following the evolution of these parameters. The evolution of employment and productivity in each subsystem, we argue, is essential to observe changes in the productive structure and to create the material possibilities for wage expansion. VI and VHI analysis is also a good tool to assess technical change since it allows singling out changes on employment requirement that are needed in the production of one unit of final demand. From our perspective, an expansion of export activities alone may not be beneficial for development *per se* if it is done at expenses of labour expulsion from that activity or from related ones or if it can lead to the introduction of a greater import component. Moreover, it will be possible to isolate between domestic and imported inputs and between direct and indirect ones.

As it will be exposed in the next subsection, the main difference between VI and VHI sectors is that the former was first conceived to analyse a static framework, while the latter focuses on a growing economic system. Moreover, VHI sectors differ from VI ones since new capital goods re-enter into the circular flow and are not considered as part of the net output.

2.3.1. The subsystems approach: Origins and implications in terms of employment, productivity and technical change

Classical economics approach is useful to address to our analysis both theoretically and, we will see in the next sections, empirically. In general terms, a classical reproduction scheme can be thought as a system in which each commodity is consumed as final good or re-enters as input in the production of a different commodity. Commodities are produced by means of other commodities and labour. In its simplest representation, the economy can be conceived as a subsistence one: the entirety of the product of an economy re-enters as input of production in the following period. In absence of technical change this is a static economic system in which the same amount of inputs are used to produce the same amount of output period by period. In other words, the economy is only capable of reproducing itself. If the gross output does not re-enter entirely in the circular flow the economy produces a surplus which can be consumed or employed in the expansion of production in the next period.

During the 20th century, Wassily Leontief (1951; 1985) resumes the idea of the economy as a circular flow developing IO analysis. Coherently with a classical perspective, in IO analysis the gross output of the economy is divided between goods that are used in the production as inputs for the production of themselves and other goods and commodities which are devoted to final demand (i.e. net output). Following this idea a production economy can be represented in matrix terms as[5]

$$\mathbf{Xe} + \mathbf{y} = \mathbf{x} \tag{2.1}$$

Where $\mathbf{X}$ is a nxn matrix where each columns shows the input requirements (expressed in monetary units) of commodity i necessary in the production of good j. **e** is the nx1 unitary vector, so that **Xe** is a vector (nx1) which expresses the quantity of each commodity i that is used in the productive process. **x** is the vector (nx1) of gross output and **y** is the vector (nx1) of net output which includes consumption goods and new investment goods. Trough a simple manipulation it can be obtained

$$(\mathbf{I} - \mathbf{A})\mathbf{x} = \mathbf{y} \tag{2.2}$$

$$\mathbf{x} = (\mathbf{I} - \mathbf{A})^{-1}\mathbf{y} \tag{2.3}$$

Where $\mathbf{I}$ is the identity matrix and $\mathbf{A}$ is the input requirements matrix, or technical coefficients matrix, in which each a_{ij} shows the (monetary) requirement of good i

[5] In the foregoing analysis, we denote matrices with capital bold letters and columns vectors with lowercase bold letters. Row vectors are identified as transposed vectors and diagonalized vectors are indicated as "^".

which is needed in the production of *one* (monetary) unit of good *j* (*j* = 1,2,…,m).[6] $(\mathbf{I}-\mathbf{A})^{-1}$ is the so-called "Leontief inverse matrix" and plays a fundamental role in IO analysis. Each column of this matrix shows a heterogeneous set of commodities which enter directly and indirectly in the production on activity *j* (say food). In other words, Leontief inverse matrix considers the direct requirements of a given input (say copper) necessary for the production of food, but also considers the indirect requirements; that is, other inputs used in the production of the amount of copper needed for the final production of one unit of food.

Therefore, each column of matrix **A** shows the amount of good *i* that is necessary, directly and indirectly, for the production of the output of each activity *j*. Note that the Leontief's inverse matrix can be represented as a geometric series

$$(\mathbf{I}-\mathbf{A})^{-1} = \mathbf{I} + \mathbf{A} + \mathbf{A}^2 + \mathbf{A}^3 + \cdots \qquad (2.4)$$

This development can be interpreted as the representation of different stages of the productive process that are all necessary for the production of the final product. **I** is the identity matrix, indicating that in order to produce one unit of net output it is necessary to produce at least one unit of the corresponding gross product. **A** is the amount of goods that are needed for the production of **I**, $\mathbf{A}^2$ are the input needed to produce quantity **A** and so on. As long as we go back in the stage of production, matrix $\mathbf{A}^n$ is increasingly smaller, indicating that, as we go back in the production process, the production of a given final commodity embodies increasingly lower quantities of a given input (Pasinetti, 1984: 91-92).

The concept of subsystem is introduced by Sraffa who, in an appendix of his 1960's book states

> The commodity forming the gross product […] can be unambiguously distinguished as those which go to replace the means of production of those which together form the net product of the system.

[6] Formally, each a_{ij} is obtained as $\frac{x_{ij}}{x_j}$.

> Such a System can be subdivided into as many parts as there are commodities in its net product, in such a way that each part forms a smaller self-replacing system the net product of which consists of only one kind of commodity. These parts we shall call “sub-systems” (Sraffa, 1960: 89).

Given the classical framework of analysis, labour is conceived to be directly and indirectly (through the use of productive inputs) in the production of each commodity of the net product.

Leontief’s and Sraffa’s contributions are keys for Pasinetti’s subsequent development of VI analysis. In Pasinetti’s words “I linked up Sraffa’s direct and indirect quantities of labour with the ‘direct and indirect’ requirements’ emerging from Leontief’s inverse matrix” (Pasinetti, 1988: 125).

Turning to the works of Pasinetti, the first aspect to highlight has to do with the analysis he departs from. His approach moves within a theoretical background that is defined as a pre-institutional “pure production model”. In order to understand the subsystem analysis it is necessary to describe the main features of this pre-institutional framework. Pasinetti maintains that

> [My purpose is] to develop first of all a theory which remains neutral with respect to the institutional organisation of society. My preoccupation will be that of singling out, to resume Ricardo's terminology, the ‘primary and natural’ features of a pure production system. And these ‘primary and natural’ features […] will simply emerge as necessary requirements for equilibrium growth (Pasinetti, 1981: 25).

Thus, it is in these “primary and natural” features of the production system that reside the pre-institutional analysis. In other words, this approach aims at investigating and describing

> the very primary relations physical-technological nature of the production process in any *industrial* system, to be intended as the *production of commodities by means of commodities*, i.e. the employment

of capital goods as intermediate commodities, to be used together with labour, and accumulated, for the production process to take place (Garbellini and Wirkierman, 2010 5; emphasis in original).

Therefore, Pasinetti's purpose is that of providing a toolkit to think how the productive (industrial) system works, independently from the institutional set up of the society. This distinction from institutional analysis is usually known as "separation". A pure production model is characterized as a productive system in which each commodity is produced by other commodities and labour. This aspect does not imply that institutions have no role in contemporary economies or that they cannot be introduced into the Pasinettian scheme. They simply do not enter at this stage of the analysis. However, "this does not mean avoiding at all cost any reference to specific institutions. […] The investigation of problems associated with particular institutions may themselves be introduced later on" (Pasinetti, 1981: 25).[7] Moreover, it is important to highlight that, contrarily to neoclassical economics no positive implication derives from this form of reasoning even though the economy can operate in *equilibrium*, which is defined a situation in which there is full employment and full utilization of the productive capacity (Pasinetti, 1981: 49). The fact that the economy can be thought as operating at full employment does not lead to any recommendation regarding elimination of "market imperfections" as usually suggested by mainstream economics.

From this general framework, Pasinetti develops the idea of VI sector analysis that is formally introduced in his 1973 paper. As we saw, in the classical idea of the economy as a circular flow we find the concept of direct and indirect requirements of production.[8] Given Sraffa's definition of subsystem, the productive system can be divided into as many parts as there are commodities in its net product. Commodities are produced by means of commodities and

[7] In a more recent work, Pasinetti states that "our separation theorem is not meant to deny the possibility of a ranking of the various types of institutions and organizations. The natural theorem scheme in not incompatible with such a possibility" (Pasinetti, 2007: 324).

[8] In his book, Sraffa uses two methods to asses to the direct and indirect quantities of labour. On the one hand, he presents the method of "reduction to dated quantities of labour" (presented in Chapter VII) which can only be employed in case of single production. On the other hand, the subsystem tool (that we previously presented) does not have such limitation (Pasinetti, 1986).

labour. Following Pasinetti (1973) and using the same nomenclature as before, the productive system for a given year is represented as (for simplicity, we omit temporal indicators)

$$(\mathbf{I}-\mathbf{A})\mathbf{x}=\mathbf{y} \tag{2.5}$$
$$\mathbf{a}_{\mathrm{n}}^{\mathrm{T}}\mathbf{x}= L \tag{2.6}$$
$$\mathbf{A}\mathbf{x}=\mathbf{s} \tag{2.7}$$

Equation 2.5 has the same interpretation as 2.2 with the difference that here all magnitudes are expressed in physical quantities and not in monetary ones. $\mathbf{a}_{\mathrm{n}}^{\mathrm{T}}$ is the vector of direct labour coefficients. Each a_j is the coefficient of direct labour requirement that represents the direct quantity of labour necessary in the production of one physical unit of commodity produced in industry *j* (*j* = 1,2,…,m).[9] *L* is total employment and **s** is the vector of capital stock that denotes the quantity of capital goods required at the beginning of the period to begin production. The economy is composed of *m* subsystems, one per each final good. If we focus on one given subsystem *i*, by modifying the previous system 2.5-2.7 we obtain

$$\mathbf{x}^{(\mathrm{i})}=(\mathbf{I}-\mathbf{A})^{-1}\mathbf{y}^{(\mathrm{i})} \tag{2.8}$$
$$L_v^{(i)}=\mathbf{a}_{\mathrm{n}}^{\mathrm{T}}(\mathbf{I}-\mathbf{A})^{-1}\mathbf{y}^{(\mathrm{i})} \tag{2.9}$$
$$\mathbf{s}^{(\mathrm{i})}=\mathbf{A}(\mathbf{I}-\mathbf{A})^{-1}\mathbf{y}^{(\mathrm{i})} \qquad i=1,2,\dots,m. \tag{2.10}$$

Where each element of vector $\mathbf{y}^{(\mathrm{i})}$ is equal to zero except for the *i*th element and $L_v^{(i)}$ that is the number of occupied in subsystem *i*. We can define

$$\mathbf{a}_{\mathrm{n}}^{\mathrm{T}}(\mathbf{I}-\mathbf{A})^{-\mathbf{1}} \equiv \mathbf{v}^{\mathrm{T}} \equiv [v^{(i)}] \tag{2.11}$$
$$\mathbf{A}(\mathbf{I}-\mathbf{A})^{-\mathbf{1}} \equiv \mathbf{H} \equiv [\mathbf{h}^{(\mathrm{i})}] \tag{2.12}$$

So that 2.9-2.10 can be written as

$$L_v^{(i)}=\mathbf{v}^{\mathrm{T}}\mathbf{y}^{(\mathrm{i})}= v^{(i)}y^{(i)} \tag{2.13}$$
$$\mathbf{s}^{(\mathrm{i})}=\mathbf{H}\mathbf{y}^{(\mathrm{i})}= \mathbf{h}^{(\mathrm{i})}y^{(i)} \tag{2.14}$$

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[9] Where $a_j = \frac{l_j}{x_j}$. l_j is the number of occupied in industry *j* expressed in work hours or men.

$\mathbf{v}^{\mathrm{T}}$ is the vector of *VI labour coefficients* and each $v^{(i)}$ "expresses in a consolidated way the quantity of labour directly and indirectly required in the whole economic system to obtain one physical unit of commodity i as final good" (Pasinettti, 1973: 6). Similarly, $\mathbf{H}$ is the matrix of VI productive capacity where each column $\mathbf{h}^{(\mathrm{i})}$ shows "the series of heterogeneous physical quantities of commodity 1,2,…,m, which are directly and indirectly required as stocks, in the whole economic system, in order to obtain one physical unit of commodity *i* as final good" (Pasinetti, 1973: 6).

To fully grasp the meaning of the VI coefficients it is important to remember the role of the Leontief inverse matrix. In this matrix, a portion of the gross output of each commodity is "spread" in the other activities as it enters as input in the production of the other commodities, since each column shows physical quantities of each commodity that are needed for the production of one physical unit of good j. By multiplying each one of these physical quantities for the corresponding direct labour coefficient (a_j) and summing them up (to obtain each $v^{(i)}$ coefficient) we obtain the direct and indirect labour requirements needed in the production of one unit of final good (Pasinetti, 1976). In this way, we find a correspondence that relates direct and indirect labour requirements (as in Sraffa's subsystem) and direct and indirect input of production (from Leontief's inverse matrix).

In a following paper, Pasinetti (1988) extends the concept of VI sectors to a growing economy to what he defines as VHI sectors[10]. These subsystems are more exhaustive since they include "not only the labour and the means of production for the reproduction of each subsystem, but also the labour and the means of production necessary to its expansion" (Pasinetti, 1988: 126-127) which make them more suitable for a dynamic context. The economic system expands at a rate (g + r_{i}). g is the rate of growth of population. *Ceteris paribus*, if population grows at a rate g also production must expand at a rate g to satisfy final demand. r_{i} is the per capita rate of

[10] Even though VHI sectors are formally introduced in the 1988's paper, Garbellini and Wirkierman (2010) maintain that (although not explicitly) Pasinetti in his 1981's book developed his analysis in terms of VHI sectors.

growth of commodity *i* and can be positive or negative. Differently fromVI analysis, at the VHI level the net output vector only takes into consideration consumption goods and not new investments. This is not a trivial matter. New investment goods have to re-enter in the circular flow of production in order to expand the capacity of production. Considering these modifications, equations 2.5-2.7 are modified and expressed as (again, we omit temporal indicators)

$$\mathbf{Dx} + (g + r_i)\mathbf{Dx} + \mathbf{c} = \mathbf{Bx} \qquad (2.15)$$

$$\mathbf{a}_{\mathrm{n}}^{\mathrm{T}}\mathbf{x} = L \qquad (2.16)$$

$$\mathbf{Dx} = \mathbf{s} \qquad (2.17)$$

Where, **c** is the final consumption (i.e. the net output vector at the VHI level) vector and **B** is the output interindustry matrix. **D** is the input matrix at the VHI level and is similar to matrix **A** in equation 2.5 at the VI analysis. However, matrix **D** includes inputs of production *and* new investment (not only inputs of production as **A**). $(g + r_i)\mathbf{Dx}$ shows the necessity of expansion of the production structure to meet changes is final demand. Analogously to the VI analysis, per each VHI sector we obtain

$$\mathbf{x}^{(\mathrm{i})} = [\mathbf{B} - (1 - g + r_i)\mathbf{D}]^{-1}\mathbf{c}^{(\mathrm{i})} \qquad (2.18)$$

$$L_{\eta}^{(i)} = \mathbf{a}_{\mathrm{n}}^{\mathrm{T}}[\mathbf{B} - (1 - g + r_i)\mathbf{D}]^{-1}\mathbf{c}^{(\mathrm{i})} \qquad (2.19)$$

$$\mathbf{s}^{(\mathrm{i})} = \mathbf{D}[\mathbf{B} - (1 - g + r_i)\mathbf{D}]^{-\mathbf{1}}\mathbf{c}^{(\mathrm{i})}, i = 1,2, \dots, m. \qquad (2.20)$$

By redefining

$$\mathbf{a}_{\mathrm{n}}^{\mathrm{T}}[\mathbf{B} - (1 - g + r_i)\mathbf{D}]^{-1}\mathbf{c}^{(\mathrm{i})} \equiv \boldsymbol{\eta}^{\mathrm{T}} \equiv [\eta^{(i)}] \qquad (2.21)$$

$$\mathbf{D}[\mathbf{B} - (1 - g + r_i)\mathbf{D}]^{-1}\mathbf{c}^{(\mathrm{i})} \equiv \mathbf{M} \equiv [\mathbf{m}^{(i)}] \qquad (2.22)$$

We have

$$L_{\eta}^{(i)} = \boldsymbol{\eta}\mathbf{c}^{(\mathrm{i})} = \eta^{(i)}c^{(i)} \qquad (2.23)$$

$$\mathbf{s}^{(\mathrm{i})} = \mathbf{Mc}^{(\mathrm{i})} = \mathbf{m}^{(\mathrm{i})}c^{(i)} \qquad (2.24)$$

$\boldsymbol{\eta}^{\mathrm{T}}$ is the vector of *VHI labour coefficients*, where each coefficient $\eta^{(i)}$ is a synthetically indicator of direct, indirect and *hyper-indirect* labour needed for the production of one unit of net product $c^{(\mathrm{i})}$, where hyper-indirect labour indicates the amount of labour directly and indirectly needed for the expansion of the productive capacity. Each column $\mathbf{m}^{(\mathrm{i})}$ of matrix **M** is a unit of VHI productive capacity, i.e. an indicator of direct, indirect and *hyper-indirect* capital needed for the production of one unit of net product. $L_{\eta}^{(i)}$ is the number of occupied in subsystem *i*. Differently from **A** in the VI system, **M** expresses the productive capacity needed for the reproduction *and* expansion of the economy.

So far, we presented a system that can be thought as a closed economy. In an open economy, matrices of VI and VHI productive capacity can be conceived to be composed of a mix of domestic and imported inputs. As we will see in the next section, if imported input matrices as available, it is possible to differentiate between domestic and imported means of production, both in direct terms and at the subsystem level of analysis. In this case, the interpretation of the matrices of imported input (and capital) have the same interpretation of the domestic one.

Once we have introduced VI and VHI sector it is useful to spend some words analyzing their differences. Both the VI and VHI level of analysis identify direct and indirect labour and capital requirements for the production of one unit of final good, being the treatment of new investment the more visible difference between the two approaches. However, VHI adapt better in a dynamic context. As Garbellini (2010), points out

> [When] we introduce growth, the *m* vertically integrated sectors conforming the economic system as a whole fail to be independent of each other, having to exchange part of their net output – that devoted to new investments – with the others.
>
> On the contrary, vertically hyper-integrated sectors continue to be self-replacing systems through time when growth is introduced, since they produce all the intermediate commodities they need not only to replace what has to be used up in the current period to carry on the production process, but also to expand their productive capacity in line with the

expansion of demand for the corresponding consumption good (Garbellini, 2010: 51).

From what we have just presented, further and important implication of the VI and VHI sector can be observed. Since $\mathbf{v}^{\mathrm{T}}$ and $\boldsymbol{\eta}^{\mathrm{T}}$ express the direct, indirect (and hyper-indirect) labour needed in the production of one unit of physical final good, they have a straightforward connection with the concept of productivity. Lower (higher) $v^{(i)}$ and $\eta^{(i)}$ mean that less (more) labour is needed in the production of one unit of net output. At the subsystem level, productivity is estimated as the quantity of labour necessary in the production of one unit of final demand in each subsystem:

$$\alpha_v^{(i)} = \frac{y^{(i)}}{L_v^{(i)}} = \frac{y^{(i)}}{v^{(i)}y^{(i)}} = \frac{1}{v^{(i)}} \qquad (2.25)$$

$$\alpha_\eta^{(i)} = \frac{c^{(i)}}{L_\eta^{(i)}} = \frac{c^{(i)}}{\eta^{(i)}c^{(i)}} = \frac{1}{\eta^{(i)}} \qquad (2.26)$$

Thus, productivity indexes at the VI and VHI level for each subsystem are just the reciprocal of $v^{(i)}$ and $\eta^{(i)}$. These coefficients are also useful to assess technical change. To do so it is enough to observe the evolution of each $1/v^{(i)}$ and $1/\eta^{(i)}$ coefficient through time. An increase in productivity is associated with a change in the technique in use for the production of a given commodity. Remember that changes of $v^{(i)}$ and $\eta^{(i)}$ do not show only changes in the direct requirements of labour needed in the production of on unit of net output but they also take into consideration technical change that takes place in industries which generates productive inputs (and new capital goods at the VHI level). If technical change occurs in a given industry *j*, this will be reflected, at the VI and VHI level, in those activities that use the output *j* as productive input since less labour is embodied in it (De Juan and Febrero, 2000). A numerical example aimed at clarify this point is exposed in Appendix A.1.

Other important aspects emerge from equations 2.25-2.26. As we mentioned, net output at the VI level ($y^{(i)}$) consists of the sum of consumption needs and new investment goods. The latter are treated as exogenous with respect to technology. In a dynamic context new capital goods have to be redistributed among economic activities in order to expand productive capacity so that are not part of the net output but constitute new capital goods to carry out production:

> as soon as we consider the *evolution of subsystems through time*, they cease to be completely autonomous. Allowing for a true separation between changes in technique and dynamics of net output requires gross investments to be included among the means of production […]. Hence, hyper-integrated productivity measures reflect comprehensive though disaggregated surplus generating capacity in physical terms, within a set of subsystem-specific *expanding* circular flows. (Garbellini and Wirkierman, 2014a: 168; emphasis in original)

Therefore, the evolution of $\frac{1}{\eta^{(i)}}$ is more suited to express productivity changes at the subsystem level.

In the light of the previous paragraphs it can be easily inferred that productivity gains (i.e. technical change) are the vehicle that allow increasing the net output of the economy since with the same amount of labour it is possible to obtain greater quantity of net output. In Pasinetti's scheme real wages rise at the same pace of average per capita productivity so that changes in productivity are the only way to increase real wage Consequently, the only way to increase real wages is through improvements in the technique in use, i.e. technical change. Prices reflect the quantity of labour embodied in the production of each final good so that productivity gains are converted into lower prices. However, technical change does not operate uniformly in all subsystems. Some will be increasing their productivity faster than others so that relative prices will be changing through time. Those subsystems that show higher productivity gains will be more competitive and will record more pronounced price decrease in the natural system. In a closed economy, all productivity gains benefit domestic economy. However, in an open market the analysis is different. In presence of international trade, it is relevant to determine in which subsystems productivity gains are greater. If the subsystem with greater productivity gains is oriented to exports, this would benefit other countries through lower import prices but not the country in which productivity gains took place. For this reason:

> productivity will have to be speeded up in the *non-exporting* industries. In this way, the underdeveloped countries would gain not only from these technical improvements, but also from becoming able to retain inside the country the productivity increases that take place in the exporting industries and now are leaked abroad (Pasinetti, 1981: 267; emphasis in original).

This last point expresses the importance of domestic markets. In the pure production model, productivity gains must be retained internally in order to benefit the economy. Yet, heterogeneity of the productive structure matters. To clarify this point, imagine two countries: a central one where productivity increase at roughly the same pace in all activities (export and domestic oriented) and a peripheral country where productivity rises in the export activities are the same as those in the externally oriented activities of the central country, but domestic oriented activities are rather stagnant in terms of productivity. In this situation, central countries would face steady relative prices while the peripheral country would face rising relative prices in the domestic oriented sectors compared to externally oriented ones. If this happens the peripheral country would transfer abroad productivity gains obtained in the externally oriented activity (Pasinetti, 1981: 267). Recalling Pasinetti's line of thought, Halevi (1996) maintains that even though some heterogeneity in the productive system is normal in the development process, technical change should take place also in non-exporting industries: "development must, in the end, be concerned with the home market" (Halevi, 1996: 170).

2.3.2. Formalization of Vertically Integrated and Vertically Hyper-Integrated Wages

Most empirical studies that have employed the subsystem approach were focused on changes in productivity and employment at the subsystem level, in a similar fashion to that of the foregoing analysis (see Rampa, 1981; Elmslie and Milberg, 1992 and 1996; De Juan and Febrero, 2000 and Wirkierman 2012 for studies at the VI level and Garbellini and Wirkierman, 2014a for the VHI level). In this section we propose to broaden the application of the subsystem approach to study functional income distribution. What follows is an extension of VI and VHI sector to analyse wage dynamics.

The basic idea is that of applying the same tools to analyze the wage requirements needed for the production of one unit of net output. Remember that in the previous paragraphs we obtained the vector of VI and VHI labour from the number of occupied in each industry. If, instead of the vector of direct employment we introduce the vector of total wages by industry we obtain the vector of VI Wages ($\mathbf{u}^{\mathrm{T}}$) and VHI Wages ($\boldsymbol{\omega}^{\mathrm{T}}$) that are obtained as

$$\mathbf{z}_{\mathrm{n}}^{\mathrm{T}} = \mathbf{w}_{\mathrm{n}}^{\mathrm{T}}\hat{\mathbf{x}}^{-\mathbf{1}} \quad \text{or} \quad \mathbf{z} = \hat{\mathbf{x}}^{-1}\mathbf{w}_{\mathrm{n}}^{\mathrm{T}} \tag{2.27}$$

$$\mathbf{u}^{\mathrm{T}} \equiv \mathbf{z}_{\mathrm{n}}^{\mathrm{T}}(\mathbf{I}-\mathbf{A})^{-\mathbf{1}} \tag{2.28}$$

$$\boldsymbol{\omega}^{\mathrm{T}} \equiv \mathbf{z}_{\mathrm{n}}^{\mathrm{T}}[\mathbf{D}-(1-g+r_i)\mathbf{A}]^{-\mathbf{1}} \tag{2.29}$$

Where $\mathbf{z}_{\mathrm{n}}^{\mathrm{T}}$ is the vector of direct wages requirement in which each element z_j is the share of wages contained in one unit of net output. The interpretation of $\mathbf{u}^{\mathrm{T}}$ and $\boldsymbol{\omega}^{\mathrm{T}}$ is straightforward. Each $u^{(i)}$ and $\omega^{(i)}$ represents wages that are directly and indirectly (and hyper-indirectly in the VHI case) embodied for the production of one unit of net output $y^{(i)}$ ($c^{(i)}$in case of VHI analysis). In other words, each element $u^{(i)}$ and $\omega^{(i)}$ indicates the amount of direct and indirect (and hyper-indirect) worker retribution needed for the production of one unit of final good. That is, the amount of each final good that “goes” to wages in each subsystem. In dynamic terms, an increasing $u^{(i)}$ (and $\omega^{(i)}$) along time is associated with a greater part of the output which goes to wages, while a decreasing $u^{(i)}$ (and $\omega^{(i)}$) means that, for each final good, a lower portion of the output goes to wages.

We obtain total wages per subsystem by premultiplying the vector of vertically (and vertically hyper-) integrated wages coefficient for the diagonalized vector of net output:

$$\bar{\mathbf{t}}_{u}^{T} = \mathbf{u}^{T}\hat{\mathbf{y}} \quad (2.30)$$

$$\bar{\mathbf{t}}_{\omega}^{T} = \boldsymbol{\omega}^{T}\hat{\mathbf{c}} \quad (2.31)$$

Where $\bar{\mathbf{t}}_{u}^{T}$ and $\bar{\mathbf{t}}_{\omega}^{T}$ are the vectors of total wages at the VI and VHI level.

Concluding this section it is useful to highlight the advantages of VI and VHI sector approach. Even though Pasinetti's analysis is carried out in a pure production model, there are important features that can be taken into consideration in a real economic system. A given activity (say *a*) may perform well at the direct level: gross output, employment and productivity can be rising in a given period. However, these aspects do not tell us anything about the way in which this activity relates with other industries. In fact, the underlying technical change in *a* may be carried out by the introduction of more productive foreign machines (and productive inputs) at the expenses of national providers. This would mean that technical change that takes place in *a* would determine expulsion of workers from other domestic sectors. Moreover, the subsystem approach shows that if productivity gains are not compensated by risings in final demand, there would be expulsion of work force since fewer labour would be needed for the production of a given output. In terms of development strategy it implies that the evolution of final demand, employment and productivity are all important factors, since expulsion of workers from more dynamic sectors would not be an ideal situation unless it is compensated by the creation or expansion of other activities capable of absorbing labour. In this line of thought, it is also important to assess the role of imported inputs with respect to technical change and, more in general, changes in the techniques in use. If the pace of imported inputs rises faster than exports it would increase pressures on external balance. A desirable scenario would be that of a subsystem that substitutes imported inputs for domestic ones at the same time it increases productivity and employment.

For this reasons domestic structure of the economy is important. Polarization of the productive structure is a key issue since in the subsystem analysis all sectors are connected to each other. It does not mean that all activities must evolve equally. Changes in the composition of output are normal phenomena. What we want to highlight is that it is important not to forget how the expansion of an activity (or bunch of activities) affects the potential development of the economy. In the light of this consideration, the process of development is the result of interindustry relation that have to do with final demand, employment, productivity, wages and the use of imported input of production.

The analysis of these variables is at the basis of the subsequent analysis. $v^{(i)}$ and $\eta^{(i)}$ are synthetic indicators which are able to identify technical change dynamics in a synthetic form. Hence, VI and VHI sectors are useful constructs that allow distinguish direct and indirect relations in labour and capital requirements and also to extended the analysis to the study of imports and salaries. From our point of view, the ultimately factor to take into consideration is not export performance alone but the capacity of a subsystem to generate employment and technical change. Together, these two features guarantee the possibility for greater increases in real wages for a larger portion of the population. This fact does not have to lead to deterministic interpretations. This fact does not mean that changes in productivity will automatically imply real wage movements given that in the classical tradition income distribution is ultimately determined by historical and political factors. However, technical change is at the basis in the improvement of consumption possibilities. Even if there were no profits in the economy, real income cannot increase in absence of technical change. Our intention is not that of ignoring external constraint but is that of seeing the potentialities of a development based on resource based-external oriented activities.

Summing up, in the previous paragraphs we argued that the evolution of a given activity should be studied in relation with the rest of the economy. Our approach provides a different and broader focus on the productive structure than ND where the performance of externally oriented sectors is not the key element of the analysis. Export performance as such is not the ultimate goal for development. Rather, in the following sections of this work we will focus on the evolution of output, employment, productivity wages and import needs dividing the economy of Chile in 24 subsystems. This will allow us to establish whether externally oriented activities are those that entail more technical change, that permit greater expansion of employment and that provide better conditions for wage rising. From our approach, these are key aspects in order to establish to which extent a development strategy based on natural resource based activities can be successful in the long run. Moreover, by taking into account import necessity of each subsystem we could obtain useful information about de external dependence for production in each subsystem.

3. Methodology

Before undertaking the estimation of the coefficients of labour and wages at the VI and VHI level, it is necessary to manipulate original data to obtain square IO tables from original Supply and Use tables.

Original data and sources are presented in section 3.1. To obtain variables at constant prices we created 24x1 price index vectors so that original data (expressed in current prices) are modified into constant magnitudes in order to assess *physical* changes of productivity. These passages are detailed in Appendix B.1.

As to employment, the Chilean National Statistics Institute (NSI) publishes monthly data with a disaggregation level of nine activities.[11] This disaggregation is quite limited, especially in the light of the purposes of this work. However, we further decomposed data on Manufactory thanks to the INDSTAT4 Database provided by the UNIDO. In this way Manufactory is disaggregated into nine branches that, summed to the initial eight activities from the NSI (being Manufactory the ninth), allows obtaining employment data for 17 activities. To increase the level of detail of the analysis we further divided employment data of five original activities into eleven sub-activities by assigning a conversion coefficient to each sub-activity according to their participation in gross output.[12] This procedure is fully explained in Appendix B.2.

Moreover, we converted domestic and investment matrices from Consumer Prices (CP) to Basic Prices (BP). Commodity x activity Make and Use tables were transformed into activity x activity IO tables and commodity x 1 vectors of final demand components needed to be transformed into activity x 1 vectors. Original

[11] These industries are Primary Non-Extractive; Mining; Manufactory; Electricity, gas and water; Construction; Trade; Transports and communications; Financial services; Social and Communal services.

[12] Primary Non-Extractive has been divided into five branches: Agriculture; Fruit culture; Livestock; Silviculture; Fishing. Mining has been divided into two branches: Copper; Other mining. Transports and communications has been divided into two branches: Transports; Communications. Trade has been divided into two branches: Trade; Restaurants & hotels.

dimensions have been reduced to make them compatible with the number of elements of our price index vector, i.e. 24 activities. Once we obtained squared 24x24 IO tables, 24x24 capital formation matrices and 24x1 final demand vectors we converted them into constant values. A detailed exposition of this procedure can be found in Appendix B.3.

Finally, by creating 24x24 IO matrices in constant terms it is possible to compute VI and VHI labour coefficients as well as determine VI and VHI wage coefficients and imported input and capital requirements per subsystem. See section 3.2 for details.

All computations have been carried out with MATLAB R2014a.

3.1. Data sources and description.

The System of National Accounts (SNA) of Chile is our main source of data. The SNA provides square (73x73 - commodity x activity) Make and Use tables for years 1996, 2003 and rectangular (176x111 - commodity x activity) Make and Use tables for 2008. Data in the SNA are expressed at consumer prices (CP) and basic prices (BP). Investment matrix (domestic and imported) are also available (with the same dimensions) at CP only. Vectors of labour compensation (1xn) are available at a 73 (for 1996 and 2003) and 111 activities disaggregation (for 2008). Original data are all provided exclusively at current price.

Final demand (**y**) is a 73x1 (1996 and 2003) and 176x1 (2008) vector composed of the sum of the vector **g** that is of "sources of expenditure that do not re-enter the circular flow of re-production as productive capacity" (Garbellini and Wirkierman, 2014: 158), the vector gross fixed capital formation (**k**) and the vector of inventories variations (**sc**). In matrix terms, we have[13]

$$\hat{\mathbf{p}}\mathbf{y} = \hat{\mathbf{p}}\mathbf{g} + \hat{\mathbf{p}}\mathbf{k} + \hat{\mathbf{p}}\mathbf{sc} \qquad (3.1)$$

[13] All vectors are column vectors except if it they are represented as transposed. "^" symbol indicates that a diagonalized vector.

$\hat{\mathbf{p}}$ is the diagonalized price component vector that premultiplies all vectors since original data are given in current terms. $\mathbf{g}$ is equal to the sum of households consumption ($\mathbf{g}_{\mathrm{c}}$), Government consumption ($\mathbf{g}_{\mathrm{g}}$), No-Profits Organizations consumption ($\mathbf{g}_{\mathrm{np}}$) and exports ($\mathbf{g}_{\mathrm{ex}}$), so that $\hat{\mathbf{p}}\mathbf{g} = \hat{\mathbf{p}}\mathbf{g}_{\mathrm{c}} + \hat{\mathbf{p}}\mathbf{g}_{\mathrm{g}} + \hat{\mathbf{p}}\mathbf{g}_{\mathrm{np}} + \hat{\mathbf{p}}\mathbf{g}_{\mathrm{ex}}$.

The SNA also provides vectors of output at constant prices that will be used to compute price index vectors. As we mentioned above, employment data are provided by the NSI and the INDSTAT4 database of the UNIDO.

In the foregoing analysis we shall identify current magnitudes with the symbol "‾" while constant magnitudes do not bear it. For simplicity the term "industry" will be used exclusively to indicate an activity at the direct level of analysis while the term "activity" or "sector" can refer to both the direct and subsystem level of analysis.

3.2. Vertically Integrated and Vertically Hyper-Integrated analysis

3.2.1. Vertically Integrated and Vertically Hyper Integrated labour coefficients.

Once we obtained the activity x activity IO tables (see Appendix B.3) it is possible to establish some basic relations.[14] Gross product is the sum of newly produces input requirements and net output. In other words, net output (i.e. the surplus of the economic system) is what remains from gross production once input requirements have been discounted. As we obtained in appendix B total output by industry is $\mathbf{x} = \mathbf{V}^{\mathrm{T}}\mathbf{e}$ and $\mathbf{X} = \mathbf{\Lambda}\hat{\mathbf{x}}$, where $\mathbf{X}$ is the input matrix (activity x activity) and $\mathbf{\Lambda}$ the matrix of input coefficients.[15] We created a new variable $\mathbf{y} = \mathbf{g} + \mathbf{K}\mathbf{e} + \mathbf{s}\mathbf{c}$ that is the vector of final demand (activity x 1). Therefore

$$\mathbf{V}^{\mathrm{T}}\mathbf{e} = \mathbf{X}\mathbf{e} + \mathbf{y} \tag{3.2}$$

$$\mathbf{x} - \mathbf{\Lambda}\mathbf{x} = \mathbf{y} \tag{3.3}$$

$$(\mathbf{I} - \mathbf{\Lambda})\mathbf{x} = \mathbf{y} \tag{3.4}$$

[14] Differently from Appendix B, the analysis is conducted exclusively with 24 activities so, for simplicity, we will omit all "24" subscript.

[15] As exposed in appendix B.3, $\mathbf{V}^{\mathrm{T}}$ is the transposed make matrix and $\mathbf{\Lambda}$ is the input requirement matrix.

$$\mathbf{x} = (\mathbf{I} - \mathbf{\Lambda})^{-1}\mathbf{y} \tag{3.5}$$

Matrix $(\mathbf{I} - \mathbf{\Lambda})^{-1}$ is the Leontief's matrix and equations 3.2-3.4 have close similarities with equations 2.1-2.3.[16] Direct labour coefficients can be computed as

$$\mathbf{a}_{\mathrm{n}}^{\mathrm{T}} = \mathbf{l}^{\mathrm{T}}\hat{\mathbf{x}}^{-1} \quad \text{or} \quad \mathbf{a}_{\mathrm{n}} = \hat{\mathbf{x}}^{-1}\mathbf{l} \tag{3.6}$$

Where $\mathbf{a}_{\mathrm{n}}$ is a 24x1 vector where each element *i* defines the direct labour requirements necessary in the production of one unit of final good of industry *i*. In other words, $a_n^{(i)}$ is the standard measure of productivity, which relates total output at constant prices with the number of workers directly necessary to produce it. Following equations 2.11 it is possible to calculate the vector of vertically integrated labour coefficients

$$\mathbf{v}^{\mathrm{T}} = \mathbf{a}_{\mathrm{n}}^{\mathrm{T}}(\mathbf{I} - \mathbf{\Lambda})^{-1} \tag{3.7}$$

As in section 2.3, $\mathbf{v}^{\mathrm{T}}$ is the 24x1 vector of vertically integrated labour where each element *i* shows the direct and *indirect* labour requirements in the production of one physical unit of output of subsystem *i*. Similarly, to 2.13-2.14 the vector of total labour per VI sector and total labour in the economy, respectively defined as

$$\mathbf{e}^{\mathrm{T}}\mathbf{L}_{\mathrm{v}} = \mathbf{v}^{\mathrm{T}}\hat{\mathbf{y}} \tag{3.8}$$

$$L_v = \mathbf{v}^{\mathrm{T}}\mathbf{y} \tag{3.9}$$

Each $L_v^{(i)}$ element of vector $\mathbf{e}^{\mathrm{T}}\mathbf{L}_{\mathrm{v}}$ represents the number of the total direct and indirect occupied in subsystem *i*.

At the VHI level, the vector of final demand do not imply gross fixed capital formation, which re-enters into the circular flow of production. We created a new vector of final demand that takes into consideration these modifications. $\mathbf{c} = \mathbf{g} + \mathbf{sc}$ is the vector of final demand (activity x 1) at the VHI. Therefore

$$\mathbf{x} = (\mathbf{I} - \mathbf{\Lambda} - \mathbf{\Lambda}_{\mathrm{K}})^{-1}\mathbf{c} \tag{3.10}$$

Analogously to 2.21 the vector vertically hyper integrated labour is

[16] Differently from section 2.3.1 we are now operating with volumes not physical quantities.

$$\boldsymbol{\eta}^{\mathrm{T}} = \mathbf{a}_{\mathrm{n}}^{\mathrm{T}}(\mathbf{I} - \boldsymbol{\Lambda} - \boldsymbol{\Lambda}_{\mathrm{K}})^{-\mathbf{1}} \tag{3.11}$$

Where each element i of $\boldsymbol{\eta}^{\mathrm{T}}$ is the labour coefficient of direct and indirect hyper integrated labour. Similarly to 3.8-3.9, total labour per VHI and for all the economy is respectively

$$\mathbf{e}^{\mathrm{T}}\mathbf{L}_{\eta} = \boldsymbol{\eta}^{\mathrm{T}}\hat{\mathbf{y}} \tag{3.12}$$

$$L_{\eta} = \boldsymbol{\eta}^{\mathrm{T}}\mathbf{y} \tag{3.13}$$

Where $L = L_{v} = L_{\eta}$. Similarly to expression 3.9, each element $L_{\eta}^{(i)}$ indicates the number of the total direct, indirect and hyper-indirect occupied in subsystem i

Once we established these relations, it is possible separate the employment originated by each different element of final demand. To illustrate this point we differentiate changes in inventories from the other components of final demand (as we will see in the next section this separation has important implications). Since $\mathbf{y} = \mathbf{g} + \mathbf{k} + \mathbf{sc}$ and $\mathbf{c} = \mathbf{g} + \mathbf{sc}$ we can decompose $L_{\boldsymbol{v}}^{(i)}$ and $L_{\eta}^{(i)}$ into

$$L_{v}^{(i)} = L_{v(sc)}^{(i)} + L_{v(g+k)}^{(i)} = \underbrace{\mathbf{v}^{\mathrm{T}}\mathbf{sc}^{(\mathrm{i})}}_{L_{v(sc)}^{(i)}} + \underbrace{\mathbf{v}^{\mathrm{T}}(\mathbf{g}^{(\mathrm{i})} + \mathbf{K}^{(\mathrm{i})}\mathbf{e})}_{L_{v(g+k)}^{(i)}}; \tag{3.14}$$

$$L_{\eta}^{(i)} = L_{\eta(sc)}^{(i)} + L_{\eta(g)}^{(i)} = \underbrace{\boldsymbol{\eta}^{\mathrm{T}}\mathbf{sc}^{(\mathrm{i})}}_{L_{\eta(sc)}^{(i)}} + \underbrace{\boldsymbol{\eta}^{\mathrm{T}}\mathbf{g}^{(\mathrm{i})}}_{L_{\eta(g)}^{(i)}} \tag{3.15}$$

Where $L_{v(sc)}^{(i)}$ ($L_{\eta(sc)}^{(i)}$) is the quantity labour devoted to the production of inventory changes per subsystem i and $L_{v(g+k)}^{(i)}$ and $L_{\eta(g)}^{(i)}$ is the quantity of labour devoted to the production of that part of the net output different from inventory changes in the same subsystem.

Productivity dynamics

As we mentioned in the theoretical section, productivity of each VI and VI sector is given by $\frac{y^{(i)}}{L_v^{(i)}} = \frac{y^{(i)}}{v^{(i)}y^{(i)}} = \frac{1}{v^{(i)}}$ and $\frac{c^{(i)}}{L_\eta^{(i)}} = \frac{c^{(i)}}{\eta^{(i)}c^{(i)}} = \frac{1}{\eta^{(i)}}$. In order to have a term of comparison we also calculated what Pasinetti (1981, 102-103) calls the *standard rate of growth of productivity* (SRGP) of the economy. The SRGP provides a weighted average of productivity according to the number of worker employed in each subsystem (and industry) so that the SRGP is useful to compare the productivity dynamics of each subsystem and industry with that of the economy. Similarly to Garbellini and Wirkierman (2014a), this measure is given by

$$\rho_{dir} = \frac{\sum_{t=1}^{n} L^{(i)} \Delta\%\alpha_{dir}^{(i)}}{\sum_{t=1}^{n} L^{(i)}} = \sum_{t=1}^{n} \frac{L^{(i)}}{L} \Delta\%\alpha_{dir}^{(i)}; \tag{3.16}$$

$$\rho_{v} = \frac{\sum_{t=1}^{n} L_v^{(i)} \Delta\%\alpha_{v}^{(i)}}{\sum_{t=1}^{n} L_v^{(i)}} = \sum_{t=1}^{n} \frac{L_v^{(i)}}{L} \Delta\%\alpha_{v}^{(i)}; \tag{3.17}$$

$$\rho_{\eta} = \frac{\sum_{t=1}^{n} L_\eta^{(i)} \Delta\%\alpha_{\eta}^{(i)}}{\sum_{t=1}^{n} L_\eta^{(i)}} = \sum_{t=1}^{n} \frac{L_\eta^{(i)}}{L} \Delta\%\alpha_{\eta}^{(i)}. \tag{3.18}$$

Where ρ_{dir}, ρ_v and ρ_η respectively stand for the SRGP at the direct, VI and VHI level.

3.2.2. Wages at the vertically and vertically hyper-integrated level

As we saw in section 2, the basic idea is that of substituting the vector of wages to that of direct labour to obtain a unit of VI (and VHI) wage. Since the $v^{(i)}$ ($\eta^{(i)}$) indicates the labour force directly and indirectly necessary for the production of one unit of net output *i*, $u^{(i)}(\omega^{(i)})$ is the quantity of wages directly and indirectly contained in one unit of VI (VHI) net output. In formal terms we have

$$\mathbf{z}_\mathrm{n}^\mathrm{T} = \overline{\mathbf{w}}^\mathrm{T}\hat{\hat{\mathbf{x}}}^{-1} \quad \text{or} \quad \mathbf{z}_\mathrm{n} = \hat{\hat{\mathbf{x}}}^{-1}\overline{\mathbf{w}} \tag{3.19}$$

Where $\mathbf{z}_\mathrm{n}^\mathrm{T}$ is the (1x24) vector of direct wages requirements. Note that data are reported in current values, similarly from 2.27 the price effect cancels out since

$\mathbf{z}_{\mathrm{n}}^{\mathrm{T}} = \overline{\mathbf{w}}^{\mathrm{T}}\hat{\hat{\mathbf{x}}}_{\mathbf{24}}^{-\mathbf{1}} = \mathbf{w}^{\mathrm{T}}\hat{\mathbf{p}}(\hat{\mathbf{x}}\hat{\mathbf{p}})^{-\mathbf{1}}$. From the vector of direct wages requirements it can be found the vectors $\mathbf{u}^{\mathrm{T}}$ and $\boldsymbol{\omega}^{\mathrm{T}}$ (1x24). Both are given as

$$\mathbf{u}^{\mathrm{T}} = \mathbf{z}_{\mathrm{n}}^{\mathrm{T}}(\mathbf{I} - \boldsymbol{\Lambda})^{-1} \tag{3.20}$$
$$\boldsymbol{\omega}^{\mathrm{T}} = \mathbf{z}_{\mathrm{n}}^{\mathrm{T}}(\mathbf{I} - \boldsymbol{\Lambda} - \boldsymbol{\Lambda}_{\mathrm{K}})^{-1} \tag{3.21}$$

Analogously with the labour analysis, the vector of total wages per subsystem can be found as

$$\mathbf{t}_{\mathrm{u}}^{\mathrm{T}} = \mathbf{u}^{\mathrm{T}}\hat{\hat{\mathbf{y}}} \tag{3.22}$$
$$\mathbf{t}_{\boldsymbol{\omega}}^{\mathrm{T}} = \boldsymbol{\omega}^{\mathrm{T}}\hat{\hat{\mathbf{c}}} \tag{3.23}$$

Where each $u^{(i)}$and $\omega^{(i)}$ is the total wage per subsystem *i*.

3.2.3. Imports matrices

In order to grasp the characteristics of the Chilean productive structure it is worth analyzing the structure of imported inputs and investments (i.e. new capital goods). As we mentioned in section 2, imported input matrices (and, we can add now, matrices of imported fixed capital) have similar interpretation to domestic ones.

From the matrices of the coefficients of imported input and capital at basic prices that we obtained in Appendix B.3 we can compute

$$\overline{\mathbf{X}}_{\mathrm{dirimp}} = \boldsymbol{\Lambda}_{\mathrm{imp}}\,\hat{\hat{\mathbf{x}}} \tag{3.24}$$
$$\overline{\mathbf{K}}_{\mathrm{dirimp}} = \boldsymbol{\Lambda}_{\mathrm{Kimp}}\hat{\hat{\mathbf{x}}} \tag{3.25}$$

$\overline{\mathbf{X}}_{\mathrm{dirimp}}$ ($\overline{\mathbf{K}}_{\mathrm{dirimp}}$) is the matrix direct imported input requirements (direct imported capital requirements). Each column expresses the direct *monetary* quantity that each activity *i* spends in imported inputs (imported capital) for the production of its *total* gross monetary output ($x^{(i)}$). Analogously we have

$$\overline{\mathbf{X}}_{\mathrm{vimp}} = \boldsymbol{\Lambda}_{\mathrm{imp}}\,(\mathbf{I} - \boldsymbol{\Lambda})^{-1}\hat{\hat{\mathbf{y}}} \tag{3.26}$$
$$\overline{\mathbf{K}}_{\mathrm{vimp}} = \boldsymbol{\Lambda}_{\mathrm{Kimp}}(\mathbf{I} - \boldsymbol{\Lambda})^{-1}\,\hat{\hat{\mathbf{y}}} \tag{3.27}$$
$$\overline{\mathbf{X}}_{\eta\mathrm{imp}} = \boldsymbol{\Lambda}_{\mathrm{imp}}(\mathbf{I} - \boldsymbol{\Lambda} - \boldsymbol{\Lambda}_{\mathrm{k}})^{-1}\,\hat{\hat{\mathbf{c}}} \tag{3.28}$$
$$\overline{\mathbf{K}}_{\eta\mathrm{imp}} = \boldsymbol{\Lambda}_{\mathrm{Kimp}}(\mathbf{I} - \boldsymbol{\Lambda} - \boldsymbol{\Lambda}_{\mathrm{k}})^{-1}\,\hat{\hat{\mathbf{c}}} \tag{3.29}$$

$\overline{\mathbf{X}}_{\text{vimp}}$ and $\overline{\mathbf{K}}_{\text{vimp}}$ are, respectively, the imported input requirements and the imported capital requirements at the VI level, while $\overline{\mathbf{X}}_{\eta\text{imp}}$ and $\overline{\mathbf{K}}_{\eta\text{imp}}$ express the same magnitudes at the VHI level. Each column of $\overline{\mathbf{X}}_{\text{vimp}}$ ($\overline{\mathbf{X}}_{\eta\text{imp}}$) represents the direct and *indirect* (and hyper-indirect) imported input required needed for the production of total gross monetary output of each subsystem at the VI (VHI) level expressed in monetary units. Similarly, each column of $\overline{\mathbf{K}}_{\text{vimp}}$ ($\overline{\mathbf{K}}_{\eta\text{imp}}$) represents the direct and *indirect* (and hyper-indirect) imported capital required in the production of total gross monetary output of each subsystem at the VI (VHI) level expressed in monetary units. From these definitions, a key difference emerges with respect to the analysis in direct terms. For instance, suppose that activity *j* do not require any imported input of activity *i* and, at the same time, *i* is directly imported by activity *z* and output of activity *z* is demanded as inputs for the production of activity *j*. Matrix $\overline{\mathbf{X}}_{\text{dirimp}}$ would not reflect imports of *i* from activity *j* (since it is not directly imported). However, matrices of imported inputs and capital at the subsystem level reflects direct and indirect import requirement. Matrices $(\mathbf{I}-\boldsymbol{\Lambda})^{-1}\hat{\bar{\mathbf{y}}}$ and $(\mathbf{I}-\boldsymbol{\Lambda}-\boldsymbol{\Lambda}_{\text{k}})^{-1}\,\hat{\bar{\mathbf{c}}}$ intrinsically express all the direct and indirect relations in the productive system. By premultiplying these matrices for the matrices of imported input and capital requirements we "isolate" the participation of the imported component in each subsystem.

It is worth noticing another aspect. Remember that

$$(\mathbf{I}-\boldsymbol{\Lambda})^{-1}\bar{\mathbf{y}} = \bar{\mathbf{x}} = (\mathbf{I}-\boldsymbol{\Lambda}-\boldsymbol{\Lambda}_{\text{k}})^{-1}\,\bar{\mathbf{c}} \tag{3.30}$$

The fact that $\bar{\mathbf{y}}$ and $\bar{\mathbf{c}}$ are in their diagonalizad form in 3.26-3.29, implies that

$$(\mathbf{I}-\boldsymbol{\Lambda})^{-1}\hat{\bar{\mathbf{y}}} \neq (\mathbf{I}-\boldsymbol{\Lambda}-\boldsymbol{\Lambda}_{\text{k}})^{-1}\,\hat{\bar{\mathbf{c}}} \tag{3.31}$$

Therefore the resulting matrices from 3.26-3.29 are not equal.

Remember that the inverse matrix coefficients $(\mathbf{I}-\boldsymbol{\Lambda})^{-1}$ (and $(\mathbf{I}-\boldsymbol{\Lambda}-\boldsymbol{\Lambda}_{\text{k}})^{-1}$) reflects the technique in use, that is the requirement per one unit of net output and it is invariant to the quantity produced. On the contrary, matrices of imported input and capital requirements do take into consideration variations of the net output. Hence, they are useful to analyse country's specific productive specialization, i.e. taking into account quantities of production.

If we introduce the vector of net output in 3.26-3.29 ($\mathbf{y}$ and $\mathbf{c}$) instead of the digonalized vector we obtain the vector of monetary imported input requirements and capital. These vectors (that we label $\bar{\mathbf{b}}_{\mathrm{imp}}$ and $\bar{\mathbf{k}}_{\mathrm{imp}}$) are the same at the direct, VI and VHI level since $(\mathbf{I}-\mathbf{\Lambda})^{-1}\bar{\mathbf{y}} = \bar{\mathbf{x}} = (\mathbf{I}-\mathbf{\Lambda}-\mathbf{\Lambda}_{\mathrm{K}})^{-1}\bar{\mathbf{c}}$. Therefore, we have[17]

$$\bar{\mathbf{b}}_{\mathrm{imp}} = \mathbf{\Lambda}_{\mathrm{imp}}\bar{\mathbf{x}} = \bar{\mathbf{X}}_{\mathrm{imp}}\hat{\bar{\mathbf{x}}}^{-1}\bar{\mathbf{x}} = \bar{\mathbf{X}}_{\mathrm{imp}}\mathbf{e} \quad (3.32)$$

$$\bar{\mathbf{k}}_{\mathrm{imp}} = \mathbf{\Lambda}_{\mathrm{kimp}}\bar{\mathbf{x}} = \bar{\mathbf{K}}_{\mathrm{imp}}\hat{\bar{\mathbf{x}}}^{-1}\bar{\mathbf{x}} = \bar{\mathbf{K}}_{\mathrm{imp}}\mathbf{e} \quad (3.33)$$

Where $\bar{\mathbf{X}}_{\mathrm{imp}}\mathbf{e} = \bar{\mathbf{X}}_{\mathrm{dirimp}}\mathbf{e} = \bar{\mathbf{X}}_{\mathrm{vimp}}\mathbf{e} = \bar{\mathbf{X}}_{\eta\mathrm{imp}}\mathbf{e}$ and $\bar{\mathbf{K}}_{\mathrm{imp}}\mathbf{e} = \bar{\mathbf{K}}_{\mathrm{dirimp}}\mathbf{e} = \bar{\mathbf{K}}_{\mathrm{vimp}}\mathbf{e} = \bar{\mathbf{K}}_{\eta\mathrm{imp}}\mathbf{e}$.

[17] Remember that $\mathbf{\Lambda}_{\mathrm{imp}} = \mathbf{X}_{\mathrm{imp}}\hat{\mathbf{x}}^{-1}$ and $\mathbf{\Lambda}_{\mathrm{Kimp}} = \mathbf{K}_{\mathbf{imp}}\hat{\mathbf{x}}^{-1}$.

4. Empirical results

In this section we present the main results of our work. We divide this section into four subsections. Firstly, we analyze employment dynamics at the direct and subsystem level. Secondly, we observe changes in productivity by subsystems and classify each subsystem according to its dynamics. Thirdly, we present results on VI and VHI wage evolution. Finally, we analyze imports dynamics of input of production and capital goods by industry and subsystem.

In some cases, the name of each activity has been shortened to make exposition of results easier. The original name with the corresponding reduced version can be found in table C.1 in Appendix C.

4.1. Employment dynamics

Table 4.1 presents employment participation at the industry, VI and VHI subsystem levels as well as yearly average growth of employment by subsystem between 1996 and 2008[18]. The first element to highlight is the difference in the participation of employment per industry and subsystems. At the subsystem level, employment in the Primary Non-Extractive activities is significantly lower and marked than at the direct one, showing the few linkages that the sector has into the economy. As to the trend, the share of employed in these activities decrease at all levels of analysis, being marked at the subsystem level. Total direct employment lowers from 15.3% of the total in 1996 to11.5% in 2008, while at the subsystem dimension it was 8.1% in 1996 and 4.0% at the end of the period at VI level and 7.8% and 4.0% respectively at the VHI level. Fishing shows a fast growth of employment in the first period, in contrast with results obtained in 2008 that can be computed to the mentioned sectoral crisis in fish farming.

[18] Rates of growth of employment do consider employment used in changes of inventories. Yearly rates of change of employment of each subsystem by sub-period can be found in table C.2 in Appendix C.2.

Table 4.1. Relative participation of employment per industry and subsystem (%) and annual average rate of growth

	$L^{(i)}$			$\Delta\%$ $L^{(i)}$	$L_v{}^{(i)}$			$\Delta\%$ $L^{(i)}_{v(g+k)}$	$L_\eta{}^{(i)}$			$\Delta\%$ $L^{(i)}_{\eta(g)}$
	1996	**2003**	**2008**	**96-08**	**1996**	**2003**	**2008**	**96-08**	**1996**	**2003**	**2008**	**96-08**
Agriculture	4.34	3.52	2.77	-1,65	2.22	1.55	1.43	-1.62	2.16	1.62	1.51	-1.06
Fruit	3.31	2.31	1.94	-2.36	2.65	2.12	1.88	-0.76	2.72	2.17	1.91	-0.81
Livestock	3.72	2.89	3.47	1.50	1.05	0.44	0.64	-2.61	0.72	0.46	0.60	-0.76
Silviculture	1.56	2.07	1.03	-1.38	0.53	0.63	0.37	-3.49	0.44	0.46	0.31	-4.42
Fishing	2.33	2.88	2.29	1.94	1.69	3.16	-0.34	-7.14	1.76	3.29	-0.35	-7.15
Primary N.E.	**15.26**	**13.66**	**11.49**	**-0.28**	**8.14**	**7.90**	**3.99**	**-2.71**	**7.79**	**7.99**	**3.98**	**-2.47**
Copper	1.21	0.92	0.98	0.36	2.74	3.20	3.46	5.92	3.83	5.65	6.79	11.63
Other Min.	0.60	0.45	0.51	0.78	0.69	0.59	0.50	-1.05	0.99	0.81	0.71	-1.20
Mining	**1.81**	**1.37**	**1.50**	**0.51**	**3.43**	**3.79**	**3.96**	**4.43**	**4.83**	**6.46**	**7.50**	**8.83**
Food	4.71	4.40	4.07	0.86	11.34	9.74	11.77	2.55	12.87	10.33	12.61	1.95
Beverages	0.55	0.61	0.51	1.33	1.55	1.66	1.46	1.25	1.89	1.86	1.72	0.96
Textiles	2.66	1.54	0.98	-6.03	2.84	1.82	1.12	-4.07	2.96	1.91	1.18	-4.04
Wood	1.09	0.93	1.01	1.51	1.40	2.11	1.58	3.87	1.38	2.29	1.69	5.06
Paper	0.55	0.95	0.96	6.89	0.92	1.21	1.23	4.78	1.11	1.48	1.44	4.37
Chemicals	2.04	1.93	1.83	1.17	1.28	1.61	1.53	3.93	1.50	1.87	1.83	4.18
Non-Met. Min.	0.73	0.53	0.44	-2.09	0.18	0.12	0.06	-3.72	0.19	0.10	0.07	-3.09
Basic Metals	0.81	0.89	0.90	2.95	0.28	0.50	0.78	21.19	0.29	0.53	0.90	24.01
Equipment	3.18	2.44	2.30	-0.61	1.64	1.40	1.41	1.20	1.36	0.99	1.02	0.13
Manufactory	**16.32**	**14.21**	**12.99**	**0.18**	**21.43**	**20.17**	**20.95**	**1.93**	**23.54**	**21.35**	**22.47**	**1.67**
Energy	0.76	0.45	0.59	0.04	0.43	0.37	0.50	3.93	0.72	0.77	1.03	7.01
Construction	7.89	7.99	8.82	3.06	11.51	10.43	11.82	2.65	-	-	-	-
Trade	15.24	17.22	17.06	3.07	13.86	14.13	13.64	2.29	12.95	13.28	12.64	2.22
Rest.&Hotels	2.57	2.29	2.79	2.80	2.97	2.63	3.59	4.61	3.31	2.80	3.86	4.14
Transports	5.95	6.58	6.30	2.60	4.59	5.45	5.23	3.85	5.05	6.50	5.88	4.11
Communications	1.58	1.78	2.24	5.14	1.22	1.58	1.89	8.23	1.73	1.82	2.27	5.75
Financial Serv.	6.77	8.15	9.16	4.71	5.88	6.20	6.00	2.58	10.33	8.87	8.94	0.93
Comm. Serv.	25.82	26.25	27.03	2.50	26.49	27.32	28.40	3.14	29.66	30.12	31.40	2.99
Services	**66.57**	**70.72**	**74.00**	**3.01**	**66.96**	**68.11**	**71.07**	**3.04**	**63.80**	**64.16**	**66.02**	**2.76**
Total				**2.10**				**2.10**				**2.10**

Source: Own elaboration based on SNA, NSI and INDSTAT4 data

Contrarily to Primary Non-Extractive activities, direct employment in the Mining sector is rather steady along the period while at the subsystem level the participation is higher and shows an upward trend (especially at the VHI level). Within Mining, it is to point out the role of Copper. Unsurprisingly, Copper absorbs most of the employment in the mining sector and, also, records the highest increase in employment generation, especially at the VI and VHI level, while Other Mining show relative decline.

As to direct employment in Manufactory, data show a decline along the period. However, this trend is not present at the subsystem analysis. First, Manufactory shows a much higher participation in employment when analysed at the subsystem level, which reveals that manufacture activities generate more employment if considering direct and indirect relations instead of only considering direct ones. Moreover, relative participation of employment in Manufactory does not show significant changes at the end of the period (even though there is a lower participation in 2003 and then a recovery in the second sub-period) in contrast with the direct analysis. When we analyse individual industrial activities the situation is more heterogeneous. A group of activities show a higher proportion of employment at the subsystem level than at the direct level (Food, Beverages, Textiles, Wood, Paper) while others show the opposite trend (Chemicals; Non-Metallic Mineral Products; Basic Metals; Equipments). This is a clear difference between heavy and light manufactory.

Service activities absorb most of the occupied labour force, both at the direct and subsystem level. However, total participation changes from subsystems to direct measurement. In the latter, participation of all services sectors grows from two third of total of the labour force in 1996 to 74% in 2008. This increase is lower at the subsystems, being 67% and 71% at the VI level and 64% and 66% at the VHI respectively. Thus, when we consider the subsystem level of analysis Services generate fewer jobs than at the direct level. Another interesting aspect is that while in 1996 employment in Services at the direct and VI level had similar values, direct employment increased much faster (+7.5 percentage point in total employment between 1996 and 2008) than at the VI level (+4 percentage points in total employment between 1996 and 2008), which indicates that a considerable portion of the increase of the employment at the direct level was used (indirectly) in the production of other activities than Services. Looking at specific activities, Communal Services absorbs most of the employment, ranging between 25% and 31% and growing along the period in all the estimations. Trade and Financial Services generate less employment at the subsystem level than at the direct level. The contrary occurs with Restaurants & Hotels.

A result that may call the attention is Construction, which shows no workers at the hyper-integrated level. This is because of the characteristics of this sector, whose output is entirely considered, by the NSA, as gross fixed capital formation (i.e. input of other sectors) and not as a final consumption good. Since gross capital formation is not part of final demand at the hyper-integrated level (see previous sections), this factor explains these results. Another aspect to remember is that the vector of employed by subsystem reflects the dynamics of changes in inventories, which can be negative for a given period. In a given subsystem, changes in inventories can be particularly relevant in a certain year and can be greater than consumption and capital formation. If this happens, the element in the final demand vector is negative and so it will be the corresponding creation of net output ($y^{(i)}$ and $c^{(i)}$). This can lead to what may appear as a counterintuive results that is, a subsystem which needs a negative number of workers to produce a final output. This is the case of Fishing subsystem whose net output is negative in 2008. As we showed in equation 3.14-3.15, it is possible to separate employment creation attributable to inventory changes from that attributable to other sources of final demand. Table C.3 in Appendix C.2 shows the results of this decomposition for $L_{v(g+k)}^{(i)}$ and $L_{\eta(g)}^{(i)}$. In this case we obtain strictly positive magnitudes (except for Construction for the reasons mentioned above) since the final consumption vector **g** and the vector of gross fixed capital formation (**k**) are strictly non-negative. Results obtained from this separation do not change significantly the analysis of the previous table, except in the case of Fishing that show a marked decline in labour creation in 2008.

An alternative way of exposing the dynamics of employment can be found in the distribution of labour between industries and subsystems by calculating $L_v^{(i)} - L^{(i)}$ and $L_\eta^{(i)} - L^{(i)}$. If these differences are positive "sector *i* will absorb more labour from other industries than the employment it provides to other subsystems, and given that a subsystem produces only final goods, it means that sector *i* will be relatively closer to final demand" (Garbellini and Wirkierman, 2014b: 64). The opposite if $L_v^{(i)} - L^{(i)} < 0$ and $L_\eta^{(i)} - L^{(i)} < 0$. The signs of this difference are shown in table 4.2.

Table 4.2. Distribution of labour between industries and subsystems

	$L_v^{(i)} - L^{(i)}$	$L_\eta^{(i)} - L^{(i)}$
Agriculture	-	-
Fruit	-	-
Livestock	-	-
Silviculture	-	-
Fishing	- **	- **
Primary N.E.	**-**	**-**
Copper	+	+
Other Min.	+ ***	+
Mining	**+**	**+**
Food	+	+
Beverages	+	+
Textiles	+	+
Wood	+	+
Paper	+	+
Chemicals	-	- ***
Non-Met. Min.	-	-
Basic Metals	-	- ***
Equipment	-	-
Manufacturing	**+**	**+**
Energy	-	+ ***
Construction	+	
Trade	-	-
Rest.&Hotels	+	+
Transports	-	-
Communications	-	+
Financial Serv.	-	+ ***
Communal Serv.	+	+
Services	**- *****	**-**

* The opposite sign for 1996
** The opposite sign for 2003
*** The opposite sign for 2008
Source: Own elaboration based on SNA, NSI and INDSTAT4 data

In most cases it is possible to establish neatly whether our sectors are closer (farer) to final demand. Primary Non-Extractive activities, almost without any exceptions, “provide” more employment to other subsystems than that they absorb from others. Mining, on the contrary, is closer to final demand, being the difference always positive, except for one year. This can appear quite surprising at first sight. However, we ought to consider that copper and, to a letter extent, Other Mining, are mostly exported as row material and, therefore, enter as inputs for the production of foreign goods, in other countries than Chile. In other words, it means that copper is an input of the domestic productive system to a lesser extent than it is exported, which is not surprising after all. Among the Manufacturing subsystems we find the same differences exposed above, with a first group of activities (associated with the elaboration of non-extractive primary goods) that record a positive difference along the period. On the other hand, activities associated with heavy industry, are farer from final demand that means that their workers are mostly indirectly employed in other subsystems.

To resume, the employment dynamic at the subsystem level shows some significant changes respect to the sectoral analysis. Even though there is an increase of the Service subsystems, this increase is lower at the subsystem level than at the direct one. According to this trend, the relative importance of Services sectors (considered as the relative participation of employment) is lower at the subsystem level. On the other hand, activities producers of goods increase their importance at the subsystem level, although there are important differences among them. Primary Non-Extractive sectors have a lower participation in employment creation, expelling workers and lowering their absolute participation. The opposite trend is associated with the Copper subsystem which, within the Mining sectors, is very dynamic, contributing to a rapid creation of employment. Overall, Manufacturing activities are rather steady in terms of employment participation which is in contrast with the decline recorded at the direct level. At the end of the period Manufactory subsystems absorbed almost the double of employers then at the direct level, as a demonstration of interindustry spillovers that these subsystems have with the rest of the economy. At this stage, a preliminary comment on primary based industrial activities can be presented. On the one hand, these activities absorb more employment at the subsystem level then at the direct one. This implies that for each unit of final output there is an important component of indirect embodied labour. On the other hand, these sectors generally show heterogeneous rates of growth of employment. There are subsystem in line with the average rate of growth of employment (Food), below (Beverages and Tobacco) and above it (Wood; Paper and Printing).

4.2. Productivity dynamics

We now turn our view to productivity changes. Table 4.3 shows yearly changes of productivity calculated at direct and subsystem level estimated respectively as $\Delta\%\alpha_{dir}^{(i)} = \Delta\% 1/a_n^{(i)}$, $\Delta\%\alpha_v^{(i)} = \Delta\% \frac{1}{v^{(i)}}$ and $\Delta\%\alpha_\eta^{(i)} = \Delta\% 1/\eta^{(i)}$

Table 4.3. Rates of change of productivity in yearly average percentage points

	$\Delta\%a_{dir}$			$\Delta\%a_v$			$\Delta\%a_\eta$		
	96-03	**03-08**	**96-08**	**96-03**	**03-08**	**96-08**	**96-03**	**03-08**	**96-08**
Agriculture	5.08	7.85	6.23	5.11	6.03	5.49	5.61	5.75	5.67
Fruit	5.97	10.11	7.67	5.10	8.27	6.41	5.45	7.75	6.40
Livestock	5.09	5.64	5.32	4.09	5.92	4.85	5.86	5.32	5.64
Silviculture	5.83	21.67	12.16	-1.06	18.85	6.79	-0.73	19.46	7.24
Fishing	-0.40	7.61	2.86	-0.92	3.42	0.87	-0.87	3.37	0.88
Copper	9.03	-3.04	3.83	2.79	-3.47	0.13	-0.55	-5.52	-2.65
Other Mining	5.00	-9.15	-1.14	4.03	-6.14	-0.33	4.81	-6.95	-0.26
Food	0.92	6.93	3.38	1.36	2.48	1.82	2.32	2.32	2.32
Beverages	4.31	9.33	6.38	5.28	7.51	6.20	6.56	6.38	6.49
Textiles	5.49	6.48	5.90	4.84	6.59	5.56	4.78	6.10	5.33
Wood	5.23	0.35	3.17	0.14	7.07	2.97	0.11	7.71	3.21
Paper	-8.47	7.20	-2.24	-4.01	8.72	1.10	-4.22	9.66	1.34
Chemicals	5.27	1.05	3.49	2.86	1.33	2.22	2.80	0.56	1.86
Non-Met. Min.	4.65	6.91	5.59	3.79	1.93	3.01	4.20	0.95	2.83
Basic Metals	1.56	2.54	1.97	-2.25	1.56	-0.68	-2.55	0.50	-1.29
Equipment	4.66	4.65	4.65	3.55	4.73	4.04	3.57	4.11	3.79
Energy	12.01	-7.08	3.62	6.95	-12.76	-1.76	3.53	-11.46	-3.00
Construction	-0.95	2.23	0.36	-0.06	2.03	0.81	0.01	1.52	0.64
Trade	1.21	4.85	2.71	1.54	4.57	2.79	2.04	4.32	2.98
Rest.&Hotels	1.72	3.12	2.30	2.02	4.27	2.95	2.65	4.12	3.26
Transports	5.48	2.39	4.18	5.58	2.98	4.49	4.36	4.23	4.30
Communications	6.50	3.39	5.19	2.15	2.90	2.46	4.88	2.38	3.83
Financial Serv.	1.66	3.96	2.61	0.69	5.11	2.51	3.69	2.70	3.27
Communal Serv.	1.04	1.50	1.23	0.59	2.04	1.20	0.82	1.98	1.30
SRGP	**2.18**	**3.64**	**2.72**	**1.66**	**3.48**	**2.13**	**2.26**	**2.80**	**2.21**

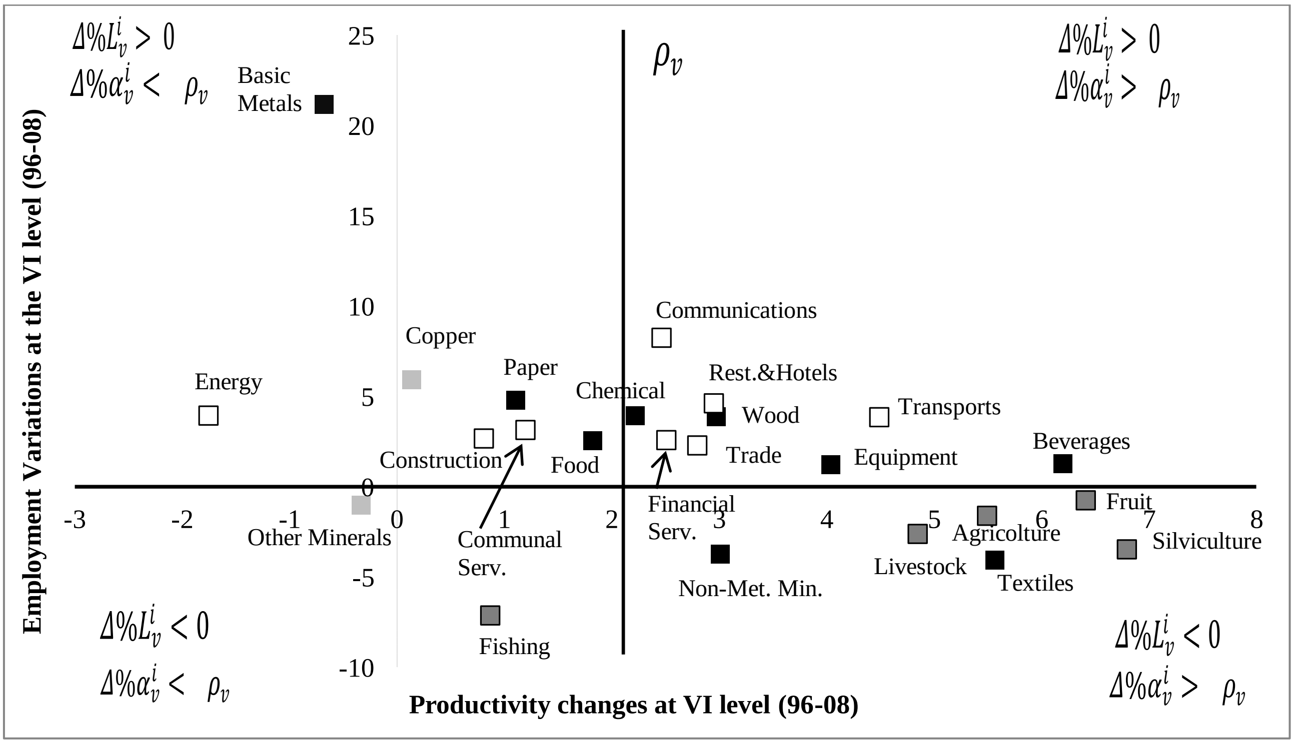
Source: Own elaboration based on SNA, NSI and INDSTAT4 data

Data show that within primary sectors, productivity changes are usually above the SRGP both at direct and at the subsystem level, with the exception of fishing at the subsystem level. Mining records poor productivity increases both in the Copper sector and on Other Mining activities. In the case of Copper, physical productivity increase slowly and well below the SRGP at the VI level and it decreases when analysed at the VHI level. Within the manufactory subsystems, five activities (Beverages; Textiles; Wood; Non-Metallic Minerals; Equipments) show higher increase in productivity than average at the direct and subsystem level. Food subsystem productivity gains are above the SRGP at the direct and VHI level only while Chemicals at the direct and VI level only. Paper and Basic Metals show the worst performance among Manufactory activities, having a lower increase in productivity and, for some periods, a decrease their physical productivity.

From previous data it is possible to develop a joint analysis of productivity and labour dynamics. Subsystems are divided into four groups depending on their productivity and employment trend. Similarly to Garbellini and Wirkierman (2014a) we identify as dynamic subsystems as those with an average productivity above the SRGP and positive employment creation. A second group is composed of subsystems that create employment but whose productivity gains are below the SRGP. The third group includes subsystems that show productivity increases above the SRGP but expel labour force. Finally, lagging subsystems are those expelling labour force and with productivity growth slower than the SRGP. A synthetic picture of these results is shown in pictures 4.1 and 4.2 where each quadrant refers to one of these groups.

Dynamic subsystems are those in the North-East quadrant. We find four industrial (Chemicals, Oil; Wood; Beverages; Equipments) and five Service subsystems (Communications, Trade, Financial Services, Restaurants & Hotels and Transports). It has to be noticed that in some cases the relative participation of the employment in each subsystem is declining or rather steady. Among dynamic subsystems only Wood and Restaurants & Hotels subsystems are growing their relative participation of employment and show higher participation at the subsystem than at the direct level. In the second group (SE quadrant), we find all the Primary subsystems (with the exception of Fishing), and two industrial subsystems (Textiles and Non-Mineral Metallic Products). The third group, that comprises subsystems with positive employment creation but productivity rates of changes below the SRGP, comprises three industrial subsystems: Basic Metals, Paper and Food and Construction, Communal Services and Energy Subsystems. Eventually, in the lagging sector there are Minerals different from Copper and the Fishing subsystem. It is plausible that with the recovery of the activity after the 2008-2009 crisis, Fishing moved to a different quadrant following a trend more similar to the period 1996-2003. Picture 4.2 shows the same analysis at the VHI and do not change the picture substantially.[19] This small difference can be imputed to the relatively little creation of domestic capital that is not part of the vector of final demand at the VHI level.

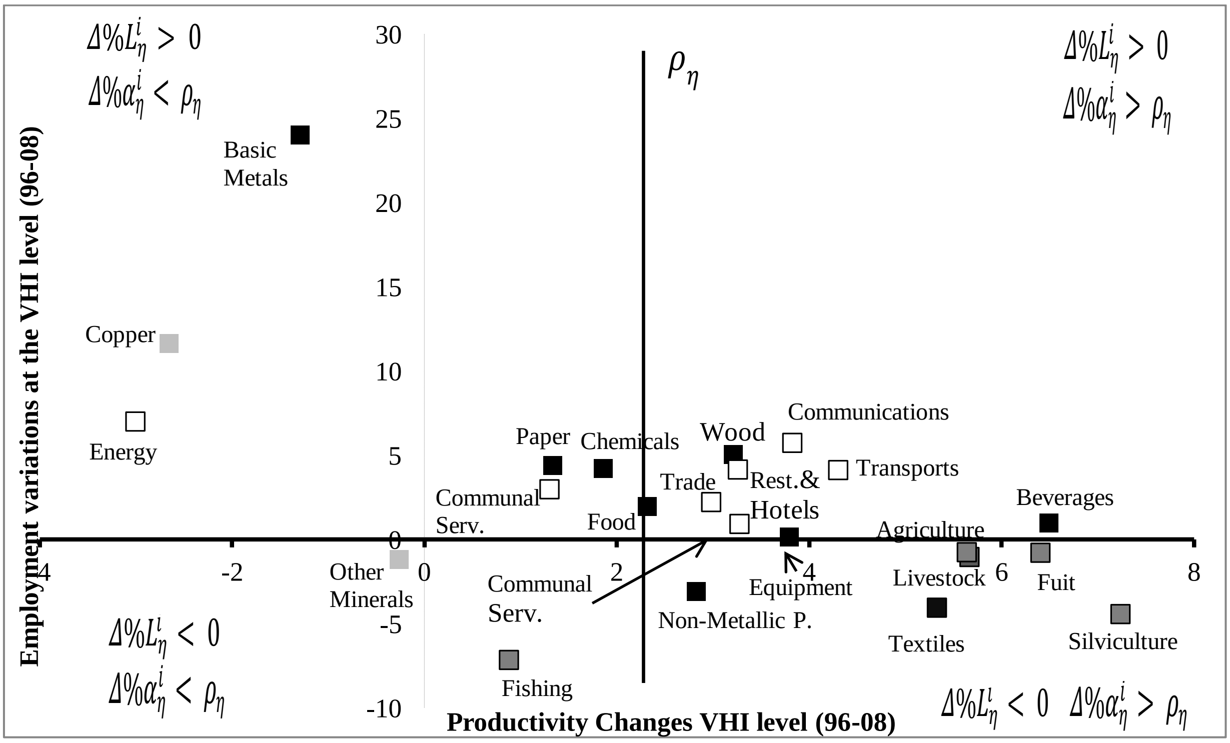
Picture 4.1. Yearly changes in productivity and employment at the VI level (%)



Source: Own elaboration based on SNA, NSI and INDSTAT4 data

[19] Subsystems that are in different groups at the VHI and VI level are: Food (from NW to NE quadrant); Chemicals, Oil and Plastic (from NE to NW quadrant).

Picture 4.2. Yearly changes in productivity and employment at the VHI level (%)



Source: Own elaboration based on SNA, NSI and INDSTAT4 data

4.3. Wage dynamics

We turn now to the evolution of income distribution at the subsystem level. In the previous sections we presented the theoretical concept and the empirical procedure to obtain VI and VHI wage coefficients. As we mentioned, each element of this vector indicates which part for the production of one unit of final good goes to worker retribution. In most activities, wage participation in each subsystem decreases during the period. To facilitate the exposition of the results, table 4.4.a shows only those subsystems that increase their VI and/or VHI wage coefficient along time.[20] Extensive results can be found in table C.4 in Appendix C.3. Table 4.4.a shows that within eight activities out of twenty-four the share received by wages increase. Moreover, there are more subsystems than industries at the direct level that increase their wage coefficients. This is due to the indirect component that is present at the

[20] Table 4.5.a also shows wage participation in one unit of net output in direct terms by industry $w_n^{(i)}$, where $w_n^{(i)} = \frac{\bar{w}^{(i)}}{y^{(i)}}$.

subsystem level that “spread” the direct wage component in different activities. Table 4.4.a show that there is no clear pattern of activities that increase in a greater extent their VI and/or VHI wage coefficient since both primary, industrial and services subsystems can be found. Note that Communal Services is the only sector that increases the units of wages at all three levels of analysis. This aspect may be due to the weight of public workers within this subsystem and to the greater negotiation power of this category.

We can obtain further information on the wage dynamics by observing wage participation of each subsystem in the total. In the previous section we also described how to obtain total wages $\bar{\mathbf{t}}_{\mathrm{u}}^{\mathrm{T}}$ and $\bar{\mathbf{t}}_{\omega}^{\mathrm{T}}$ per subsystem (equations 2.30-2.31). Since these values are expressed in current value it is not possible to observe their evolution alone so that we focus on the evolution of the relative participation of each activity’s total wage ($\bar{t}_{u}^{(i)}$ and $\bar{t}_{\omega}^{(i)}$) in the total ($\bar{\mathrm{W}}$). The vector of wages participation of each subsystem is given by

$$\mathbf{s}^{\mathrm{T}}{}_{\mathrm{v}} = \bar{\mathbf{t}}_{\mathrm{u}}^{\mathrm{T}}\bar{W}^{-1} = \mathbf{t}_{\mathrm{u}}^{\mathrm{T}}\hat{\mathbf{p}}(\mathbf{t}_{\mathrm{u}}^{\mathrm{T}}\hat{\mathbf{p}}\mathbf{e})^{-1} \quad (4.1)$$

$$\mathbf{s}^{\mathrm{T}}{}_{\eta} = \bar{\mathbf{t}}_{\omega}^{\mathrm{T}}\bar{W}^{-1} = \mathbf{t}_{\omega}^{\mathrm{T}}\hat{\mathbf{p}}(\mathbf{t}_{\omega}^{\mathrm{T}}\hat{\mathbf{p}}\mathbf{e})^{-1} \quad (4.2)$$

Where each component *i* of vectors $\mathbf{s}^{\mathrm{T}}{}_{\mathrm{v}}$ an $\mathbf{s}^{\mathrm{T}}{}_{\eta}$ represents the relative participation of wages of subsystem *i* in total wages.

We present these results by comparing wage participation with relative participation of net output and labour per industry and subsystem. Table 4.4.b. below shows the difference between relative participation of wages and relative participation of net product (not considering inventories changes) of each subsystem in the total. A positive difference means that the relative participation of wages of a given subsystem is greater than the participation of its net output, *vice versa* if the difference is negative. Results show that in most cases the relative participation of wages is lower than the corresponding participation in net output. In general, the difference between wage and net output participation in not very marked, being less than one percentage point for most of activities. Services are the only group of activities that shows a positive difference. This is due to the role of Communal Services that show a marked positive difference indicating that this subsystem absorbs more wages than it contributes to net output (see Appendix C.3 for details of each activity).

It is also possible to compare the difference between relative participation of wages and relative participation of labour by industry and subsystem. This comparison is shown in table 4.4.c at an aggregated level and in table C.6 in Appendix C.3 in an extensive way. A positive difference indicates that a given subsystem (industry) absorbs a greater proportion of wages compared to its relative participation of labour, *vice versa* if the difference is negative. In other words, this difference provide a proxy of real wages per subsystem since the bigger (and positive) the difference of a certain activity, the higher the wages that each worker of a given activity in comparison with workers of other activities. In addition, the evolution of the values of this difference indicates the evolution of the gap of wages of a given activity compared with others. For instance, if $t_{u,08}^{(i)} - L_{v,08}^{(i)} > t_{u,96}^{(i)} - L_{v,96}^{(i)}$ it means that that wages received by a single occupied in subsystem i have increased *in relative terms* between 1996 and 2008. Workers employed in subsystems that show a positive difference may have contributed to a greater internal demand while those subsystems with negative differences have demanded lower consumption. In terms of economic policy this may lead to conclude that the expansion of those subsystems with a positive difference may lead to a greater stimulus of internal demand.

From these considerations, it emerges that primary Non-Extractive activities record negative results, indicating that in these activities wage participation is lower than its employment participation. We find a similar trend within Manufactory, showing a negative difference, which is even more pronounced at the subsystem level. This result is mostly due to Food activity showing a marked negative difference, while the rest of industrial activities show reduced differences. Moreover, it appears that this difference is higher at the subsystem level than the industry one. This means that the production of one unit of Food output concentrates in a great extent indirect employment from activities with low compensation.

On the contrary, the difference is positive in the case of Mining, both at the direct and subsystem level, indicating that these activities (especially Copper) receive a greater participation of wages than labour. These differences are quite similar at the beginning and at the end of the period, indicating that labour compensation maintained the gap with other activities. Among services, Financial Services and Communal Services show higher wages compared with other activities, while the rest of services activities record a negative difference or close to zero.

Table 4.4.a. Evolution of direct, VI and VHI units of wages in yearly average points (only activities that record positive variation in at least one level of analysis)

	$\%\Delta z_n^{(i)}$			$\%\Delta u^{(i)}$			$\%\Delta \omega^{(i)}$		
	96-03	**03-08**	**96-08**	**96-03**	**03-08**	**96-08**	**96-03**	**03-08**	**96-08**
Silviculture	-2.59	0.95	-1.13	4.24	-2.56	1.35	3.21	-3.60	0.32
Food	1.72	-2.61	-0.11	0.52	-0.58	0.06	-0.48	-0.61	-0.54
Textile	1.94	-2.71	-0.03	2.34	-1.44	0.74	2.25	-0.87	0.93
Wood	-3.34	-0.17	-2.03	0.94	-0.26	0.44	1.05	-1.17	0.12
Non-Met. Min.	1.93	-2.48	0.07	1.93	-2.36	0.12	1.61	-1.93	0.12
Trade	5.48	-1.85	2.36	3.87	-1.56	1.57	2.82	-1.42	1.04
Rest.&Hoteles	2.61	-0.73	1.20	2.59	-1.81	0.74	1.60	-1.83	0.16
Communal Serv.	0.93	1.15	1.02	1.31	0.50	0.97	0.83	0.27	0.60

Table 4.4.b. Relative wages participation (%) minus Relative output participation (%)

	$\%totw^{(i)} - \%y^{(i)}$			$\%totu^{(i)} - \%y^{(i)}$			$\%tot\omega^{(i)} - \%c^{(i)}$		
	1996	**2003**	**2008**	**1996**	**2003**	**2008**	**1996**	**2003**	**2008**
Primary (N.E.)	1.97	0.33	1.35	-0.01	-0.37	-0.73	-0.08	-0.49	-0.82
Mining	-3.73	-6.62	-3.58	-2.21	-3.89	-1.00	-2.32	-2.47	1.14
Manufactory	-7.30	-8.95	-11.21	-5.34	-6.35	-6.86	-6.55	-7.23	-8.36
Services	9.07	15.24	13.44	7.56	10.61	8.58	8.95	10.18	8.03

Table 4.4.c. Relative wages participation (%) minus Relative employment participation (%)

	$\%totw^{(i)} - \%L^{(i)}$			$\%totu^{(i)} - \%L_v^{(i)}$			$\%totu\omega^{(i)} - \%L_\eta^{(i)}$		
	1996	**2003**	**2008**	**1996**	**2003**	**2008**	**1996**	**2003**	**2008**
Primary (N.E.)	-9.33	-9.32	-7.27	-4.19	-4.26	-1.85	-3.68	-4.07	-1.75
Mining	3.27	2.48	3.28	3.18	2.79	3.40	3.53	3.23	3.59
Manufactory	-2.43	-2.20	-2.63	-5.58	-5.55	-6.24	-5.37	-5.27	-6.19
Services	8.53	9.08	6.65	6.63	7.05	4.73	5.57	6.15	4.37

Source: Own Elaboration based on SNA and NSI data

Focusing only on subsystems most relevant in terms of labour participation (four of them absorb more than 10% of total employment, i.e. Food, Construction, Trade and Communal Services) we observe that Communal Services is the only whose relative compensation between 1996 and 2008 is above average and constantly raising. Relative participation of wages of Construction is greater than its employment participation but this difference is in rapid decline (see Appendix C.3). On the contrary, besides the already mentioned Food subsystem, Trade also shows relevant negative difference.

From the previous analysis, it emerges a variegated picture of the Chilean productive structure. The first aspect to highlight is that there is not a group of activities that clearly differentiate from the others. Employment analysis reveals that, even though tertiary activities are still predominant, Manufactory increases its importance when analyzed at the subsystem level. As to resource based activities, our analysis does not reveal an outstanding performance of this group of sectors. Primary non-extractive activities have constantly expelled labour during the period while they increased productivity. The opposite is true for Copper that absorbed labour at a fast pace but showed stagnant physical productivity. Within manufactory, resource based activities show their closeness to final demand but heterogeneous results in terms of employment and productivity. Labour compensation results are also variegated. While some subsystems among resource based activities concentrate higher wages (such as Copper) others show lower retribution such as Primary Non-Extractive and Food activities.

In terms of economic policies, the ideal situation would be that of fostering dynamic subsystems whose demand is increasing.[21] Information showed in picture 4.1 and 4.2 is complemented in table 4.5 that gives a synthetic picture of the variable analysed so far. Four subsystems (Wood, Equipment, Trade, Restaurants & Hotels show positive signs in all the indicators considered. Overall, none of the indicators that we considered showed a univocal interpretation regarding resource based activities.

[21] We are implicitly assuming that subsystems that demand and technical change would continue to move in the same direction.

Table 4.5. Resume of the main indicators. Sign of the rate of growth between 1996 and 2008

	VI				VHI			
	$y^{(i)}_{(k+g)}$	$\Delta\%$ $L^{(i)}_{v(k+g)}$	$\Delta\%\alpha^{(i)}_{v} > \rho_v$	$\Delta\%u^{(i)}$	$c^{(i)}_{(g)}$	$\Delta\%$ $L^{(i)}_{\eta(g)}$	$\Delta\%\alpha^{(i)}_{\eta} > \rho_\eta$	$\Delta\%\ \omega^{(i)}$
Agriculture	+	-	+	-	+	-	+	-
Fruit	+	-	+	-	+	-	+	-
Livestock	+	-	+	-	+	-	+	-
Silviculture	+	-	+	+	+	-	+	+
Fishing	-	-	-	-	-	-	-	-
Copper	+	+	-	-	+	+	-	-
Other Mining	-	-	-	-	-	-	-	-
Food	+	+	-	+	+	+	+	-
Beverages	+	+	+	-	+	+	+	-
Textiles	-	-	+	+	-	-	+	+
Wood	+	+	+	+	+	+	+	+
Paper	+	+	-	-	+	+	-	-
Chemicals	+	+	+	-	+	+	-	-
Non-Met. Min.	-	-	+	-	-	-	+	-
Basic Metals	+	+	-	-	+	+	-	-
Equipment	+	+	+	+	+	+	+	+
Energy	+	+	-	-	+	+	-	-
Construction	+	+	-	-		-	-	-
Trade	+	+	+	+	+	+	+	+
Rest.&Hotels	+	+	+	+	+	+	+	+
Transports	+	+	+	-	+	+	+	-
Communications	+	+	+	-	+	+	+	-
Financial Serv.	+	+	+	-	+	+	+	-
Communal Serv.	+	+	-	+	+	+	-	+

Source: Own elaboration based on SNA, SNI and Indstat4 data

4.4. Imports analysis

Deepening in the study of the productive sector, we analyze Chilean import structure. This analysis refers only to imports required in the domestic production process so that imports of consumption goods are excluded. In the methodological section we defined matrices of direct, VI and VHI imported input requirements ($\bar{\mathbf{X}}_{\mathrm{dirimp}}$, $\bar{\mathbf{X}}_{\mathrm{vimp}}$and $\bar{\mathbf{X}}_{\mathrm{\eta imp}}$, respectively) and matrices of VI and VHI imported investment ($\bar{\mathbf{K}}_{\mathrm{dirimp}}$, $\bar{\mathbf{K}}_{\mathrm{vimp}}$and $\bar{\mathbf{K}}_{\mathrm{\eta imp}}$).

First, we present the vector of monetary imported input requirements ($\bar{\mathbf{b}}_{\mathrm{imp}}$) and the vector of imported capital ($\bar{\mathbf{k}}_{\mathrm{imp}}$) estimated in 3.32-3.33. A first look to $\bar{\mathbf{b}}_{\mathrm{imp}}$and

$\bar{\mathbf{k}}_{\mathrm{imp}}$ is useful to determine which activity's goods are imported in a greater amount. Since data are elaborated at current values, it has been calculated the relative participation of total imports by activity. Data are shown below in table 4.6.

Table 4.6. Participation (%) of each activity in total import

	$b_{imp}^{(i)}$			$k_{imp}^{(i)}$		
	1996	**2003**	**2008**	**1996**	**2003**	**2008**
Agriculture	2.8	2.2	2.3	0.0	0.0	0.0
Fruit	0.5	0.1	0.0	0.0	0.0	0.0
Livestock	0.1	0.0	0.0	0.0	0.1	0.1
Silviculture	0.2	0.1	0.1	0.0	0.0	0.0
Fishing	0.3	0.0	0.1	0.0	0.0	0.0
Copper	1.2	1.1	4.0	0.0	0.0	0.1
Other Min.	13.1	10.2	19.2	0.0	0.0	0.1
Food	4.7	4.0	4.4	0.0	0.0	0.0
Beverages	0.2	0.3	0.2	0.0	0.0	0.0
Textiles	4.1	2.1	1.1	0.5	0.0	0.0
Wood	0.7	0.8	0.7	0.8	1.1	0.7
Paper	3.8	2.4	1.7	0.6	1.2	0.6
Chemicals	23.1	20.3	30.5	1.8	1.6	2.3
Non-Met. Min.	2.3	1.5	1.2	0.0	0.0	0.0
Basic Metals	5.4	4.2	6.5	4.4	2.0	4.7
Equipment	21.7	17.0	12.7	88.8	93.5	87.4
Energy	0.2	10.3	0.1	0.4	0.1	0.0
Construction	0.0	0.0	0.0	0.0	0.0	0.0
Trade	3.0	4.1	1.5	1.8	0.0	0.0
Rest.&Hotels	0.1	0.2	0.1	0.0	0.0	0.0
Transports	6.1	9.1	6.5	0.8	0.0	0.0
Communications	1.7	1.1	0.5	0.0	0.0	0.1
Financial Serv.	4.0	8.1	5.6	0.0	0.3	3.8
Communal Serv.	0.3	0.7	0.7	0.1	0.0	0.0
Total	100.0	100.0	100.0	100.0	100.0	100.0

Source: Own elaboration based on SNA data

As to the imported inputs, it can be observed that some activities are more relevant than others. Among manufactory activities, heavy industry has a predominant role (Chemicals, Basic Metals and Equipment). These activities absorb about half of total imports during the period (except in 2003, when they represent 43% of total imports). A second important activity is Other Mining which absorbs between 10% and 19% along the period. Some services activities are also important, especially Transports, Trade, Financial Services, Energy (in 2003 only). With respect to imports of capital goods, it is not surprising that is represented by imports of Equipment goods.

However, more interesting results emerge when we analyze the destination of these imports. This is recorded by the matrices of direct, VI and VHI imported inputs and capital. For simplicity, we will focus only on most significant imports, considering three groups of activities: (1) Other Mining; (2) Chemicals and (3) the sum of Non-Metallic Minerals, Basic Metals and Equipment Goods. We label this last group as "Heavy Industry".

Table 4.7 shows direct imports of these three groups of activities by industry. Each column represents the percentage of imports proceeding from a given activity that is directly imported by each industry. Results show that direct imports proceeding from Other Mining are hugely demanded by Manufacturing and, especially, by Chemicals industry which absorbs between 70% and 85% of total imports during the period. Other Mining activities have a low participation with the exception of the Energy industry. This clear polarization is due to the weight of imported crude oil within this group. Chemicals imports are demanded by a more diversified set of activities. Again, it can be observed a certain importance of imports directly demanded by Chemicals that, however, decline along the period from 30% to 16%. It can be inferred that part of this trend is due to lower quantity of imported refined oil products and a higher share of imported crude oil, reflected in the just mentioned upward trend of Other Mining. Primary Non-Extractive industries increase their demand (especially Agriculture) as well as Transports, among services activities. Imports proceeding from Heavy Industry activities are mostly imported by Manufactory and Services activities. As to Manufactory, Equipment is the most demanding industry while among Services, Construction and Trade have the greatest participation. Copper's share of imports is constantly lower than 10%. Overall, the structure of direct imported inputs reflects certain concentration in the manufactory activities. Crude and petroleum derived products have primary responsibility in this trend.

An insightful picture, however, is given by the analysis of the matrices of imported input requirement by subsystem. Table 4.8 below shows the subsystem of destination of these three groups of imported inputs. The interpretation of this table is similar to table 4.7 with the difference that it shows imports by subsystem, not by industry. Each column displays direct and *indirect* (and hyper-indirect at the VHI level) imports by subsystem. As in table 4.7 each row is the quantity demanded by each subsystem as percentage of the total imports of these three groups of inputs.

Primary Non-Extractive subsystems absorb low quantity of imported inputs, both at the VI and VHI level while Mining subsystems absorb considerable imports, especially the Copper one. Actually, Copper subsystem increases its participation in imported inputs of all the three activities shown in table 4.8. This trend is in contrast with the analysis in direct terms. Within manufactory subsystems, a main role is played by Chemicals. This sector absorbs an increasing portion of Other Mining imports, from 31% in 1996 to almost 40% in 2008 (there are no relevant differences between VI and VHI level of analysis). On the other hand, Chemicals are not importing significantly from heavy industry. Besides Chemicals, Food also has a relevant importance in imports.

Services increase their participation in imports at the subsystem level, especially among imports proceeding from Other Mining activity. Among services, Construction plays a relevant role in imports demand. At the VI it absorbs nearly 10% of total imports of Other Mining and Chemicals and it demands almost a third of imports of Heavy industry imports. Since the net output of construction subsystem consists of capital formation, no participation of this subsystem is found at the VHI level. Transports subsystem is also relevant. It can be deduced that the high importance of imports of Chemical is due to the fact that refined oil products play a key role. To a lesser extent, Financial Services and Communal Services are important in the imports proceeding from the Heavy Industry activity.

In the light of these results, imports are more evenly distributed among subsystems than they are at the direct level. This reveals that a great part of imports are indirect ones. That is, imports enter as inputs of activities producing goods that, in turn, are used as inputs in the production of other final goods. This is more evident in activities in which imports have a more pronounced participation at the subsystems level then they have at the direct one, such as Copper, Food, Construction, Financial Services and Communal Services.

Table 4.7. Direct Import by Industry (% of the total of activity's imports)

		Primary Non-Extractive						Mining			Manufactory										Services								
Industry		Agricolture	Fruit	Livestock	Silviculture	Fishing	**Sub Tot.**	Copper	Other Min.	**Sub Tot.**	Food	Beverages	Textiles	Wood	Paper	Chemicals	Non-Met. Min.	Basic Metals	Equipment	**Sub Tot.**	Energy	Construction	Trade	Rest.&Hotels	Transports	Comm.	Financial Serv.	Comm. Serv.	**Sub Tot.**
Other Mining																													
	1996	0.1	0.1	0.0	0.0	0.1	**0.3**	0.2	4.6	**4.9**	0.7	0.0	0.1	0.1	0.2	77.0	1.7	2.9	0.4	**83.1**	9.4	0.3	0.3	0.0	1.3	0.0	0.1	0.2	**11.7**
X_{dirimp}	**2003**	1.7	0.5	0.0	0.0	0.0	**2.2**	1.2	0.5	**1.8**	1.1	0.1	0.3	0.0	0.7	70.4	2.0	6.8	0.2	**81.6**	13.6	0.2	0.1	0.0	0.0	0.0	0.4	0.2	**14.5**
	2008	0.0	0.1	0.0	0.0	0.0	**0.1**	0.2	0.1	**0.3**	0.4	0.1	0.1	0.0	0.2	84.9	1.4	1.5	0.1	**88.6**	10.2	0.3	0.1	0.0	0.3	0.0	0.1	0.0	**11.0**
Chemicals, Oil and Plastic																													
	1996	4.1	2.7	0.6	0.3	0.8	**8.5**	7.6	2.3	**9.9**	4.6	0.5	5.3	1.9	2.6	30.3	1.4	1.1	4.1	**51.9**	0.6	7.0	3.9	0.3	10.1	0.1	2.5	5.1	**29.7**
X_{dirimp}	**2003**	5.7	1.7	0.0	0.2	1.2	**8.8**	5.9	0.6	**6.5**	5.3	1.1	3.1	0.6	2.8	23.8	1.5	0.7	2.5	**41.5**	0.4	3.7	4.2	0.1	24.4	0.1	4.0	6.3	**43.2**
	2008	6.5	3.4	2.1	1.1	0.9	**14.0**	5.3	0.8	**6.1**	3.9	1.0	1.1	1.0	2.3	16.3	1.4	0.4	1.3	**28.7**	6.6	4.0	1.8	0.3	34.5	0.1	1.4	2.6	**51.2**
Heavy Industry (Non-Metallic Mineral Products + Metallic Products + Metallic Products, Machinery and Equipment goods)																													
	1996	0.1	0.1	0.0	0.1	0.7	**1.0**	9.1	2.4	**11.5**	1.5	0.9	0.7	0.7	1.8	3.3	3.4	3.3	22.7	**38.4**	2.2	20.3	6.6	0.1	7.5	0.7	2.7	9.0	**49.1**
X_{dirimp}	**2003**	0.4	0.1	0.1	0.1	0.3	**0.9**	8.0	0.7	**8.7**	2.5	0.9	0.8	0.8	1.7	3.1	1.6	1.0	19.0	**31.5**	1.7	16.4	23.0	0.1	4.2	0.6	6.7	6.2	**59.0**
	2008	0.3	0.4	0.5	0.3	1.1	**2.5**	3.4	0.5	**3.9**	1.7	0.8	0.6	1.3	2.0	2.4	2.6	3.3	22.0	**36.8**	0.6	23.8	10.4	0.3	5.4	2.1	8.6	5.5	**56.8**

Source: Own elaboration based on SNA data

Table 4.8. Imports by subsystem (% of the total of each activity's imports)

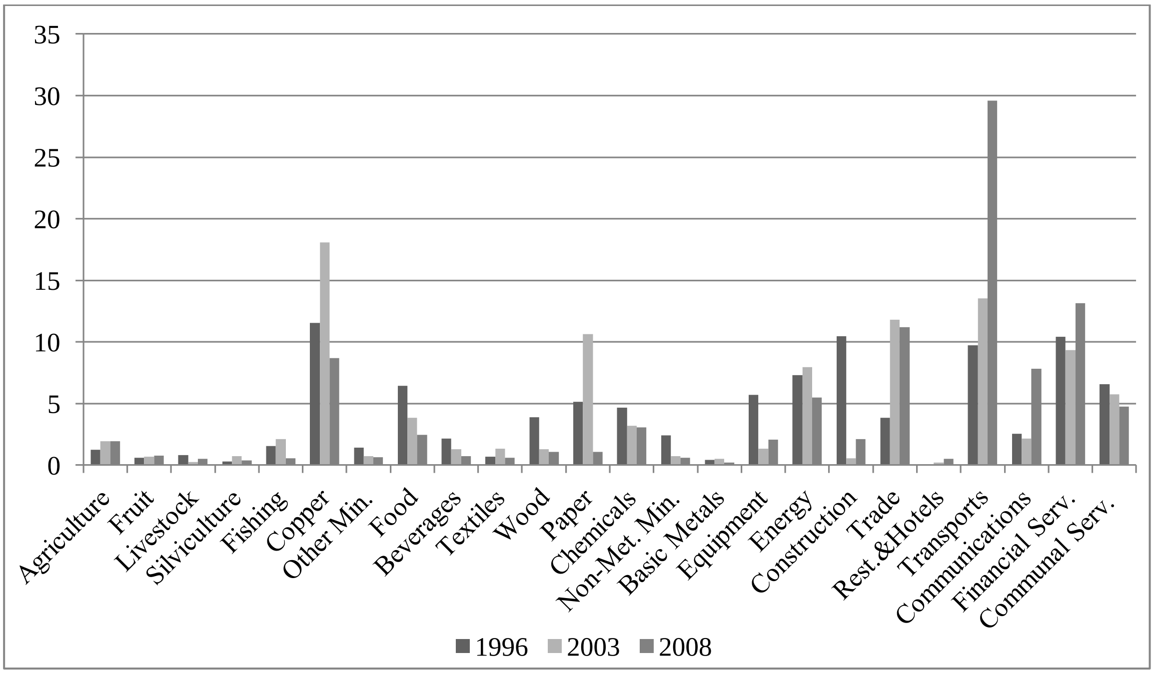
		Primary Non-Extractive						Mining			Manufactory										Services								
Subsystem		Agricolture	Fruit	Livestock	Silviculture	Fishing	**Sub Tot.**	Copper	Other Min.	**Sub Tot.**	Food	Beverages	Textiles	Wood	Paper	Chemicals	Non-Met. Min	Basic Metals	Equipment	**Sub Tot.**	Energy	Construction	Trade	Rest.&Hotels	Transports	Comm.	Financial Ser.	Comm. Serv.	**Sub Tot.**
Other Mining																													
X_{vimp}	**1996**	1.4	1.3	0.3	0.1	1.0	**4.2**	5.3	3.5	**8.8**	6.9	1.5	1.4	1.1	1.5	31.6	0.5	0.9	1.2	**46.6**	3.9	11.2	7.8	1.0	7.4	0.3	2.7	6.1	**40.4**
	2003	1.1	1.3	0.2	0.1	1.5	**4.2**	8.1	1.7	**9.7**	6.3	1.6	0.9	1.6	1.6	34.6	0.4	3.2	1.3	**51.4**	4.7	9.2	4.7	1.0	6.6	0.4	2.8	5.5	**34.7**
	2008	0.5	1.1	0.2	0.1	-0.2	**1.8**	10.3	0.7	**10.9**	6.5	1.5	0.5	1.1	1.9	39.1	0.2	1.7	0.9	**53.4**	6.1	8.4	4.1	1.3	5.4	0.4	1.8	6.4	**33.8**
$X_{\eta imp}$	**1996**	1.4	1.4	0.3	0.1	1.1	**4.2**	6.4	3.8	**10.1**	8.1	1.8	1.5	1.1	1.7	31.4	0.5	0.9	1.0	**47.9**	3.9	-	7.7	1.3	7.9	0.8	6.9	9.1	**37.7**
	2003	1.2	1.4	0.2	0.1	1.6	**4.4**	10.3	1.9	**12.1**	6.8	1.8	0.9	1.7	1.8	34.1	0.3	3.0	0.9	**51.4**	4.7	-	4.9	1.1	7.6	0.6	5.2	8.0	**32.0**
	2008	0.6	1.1	0.2	0.1	-0.2	**1.9**	12.7	0.8	**13.5**	7.2	1.7	0.6	1.1	2.0	38.1	0.2	1.8	0.6	**53.3**	6.5	-	4.2	1.5	5.9	0.7	4.1	8.5	**31.3**
Chemicals																													
X_{vimp}	**1996**	2.5	2.6	0.4	0.2	1.1	**6.5**	9.7	1.9	**10.6**	10.0	1.8	5.3	1.8	2.2	12.7	0.4	0.4	2.2	**34.6**	0.6	13.8	8.2	1.3	8.6	0.3	3.5	8.5	**48.3**
	2003	2.0	2.0	0.2	0.1	2.1	**5.2**	9.4	1.2	**16.4**	9.5	2.4	2.5	1.7	2.6	13.6	0.3	0.6	1.5	**29.9**	0.4	8.3	7.8	1.1	16.4	0.4	3.9	9.9	**48.5**
	2008	2.1	2.6	0.4	0.3	-0.2	**4.2**	15.3	1.1	**9.7**	10.2	2.3	0.8	1.7	2.4	10.3	0.1	1.0	1.0	**51.4**	4.3	8.4	5.9	1.5	19.5	0.5	2.2	6.2	**34.7**
$X_{\eta imp}$	**1996**	2.5	2.7	0.3	0.2	1.1	**6.7**	10.9	2.2	**13.2**	11.5	2.1	5.4	1.7	2.4	12.8	0.3	0.4	1.8	**38.6**	0.9	-	8.4	1.7	9.1	0.9	8.5	12.0	**41.6**
	2003	2.1	2.0	0.2	0.1	2.2	**6.6**	11.4	1.4	**12.7**	10.0	2.5	2.6	1.7	2.8	13.6	0.2	0.6	1.0	**35.0**	0.7	-	7.6	1.3	17.3	0.6	6.0	12.1	**45.6**
	2008	2.1	2.6	0.4	0.3	-0.2	**5.2**	17.6	1.3	**18.8**	10.9	2.4	0.9	1.8	2.6	10.2	0.1	1.0	0.7	**30.6**	4.6	-	5.7	1.7	19.9	0.7	4.3	8.3	**45.4**
Heavy Industry (Non-Metallic Min.+ Basic Metals + Equipment goods)																													
X_{vimp}	**1996**	0.3	0.4	0.1	0.1	0.7	**1.6**	11.4	1.9	**13.3**	4.3	1.5	1.1	0.9	1.5	2.0	0.6	1.0	9.6	**22.4**	1.1	30.0	8.6	0.7	6.2	0.7	4.0	11.3	**62.6**
	2003	0.5	0.6	0.1	0.1	1.1	**2.2**	13.1	1.2	**14.2**	4.9	1.8	1.2	1.4	1.8	2.9	0.3	0.8	8.6	**23.8**	1.0	22.6	18.6	0.9	5.0	1.0	6.6	11.3	**66.9**
	2008	0.2	0.5	0.1	0.1	-0.2	**0.9**	11.0	0.8	**11.8**	4.9	1.5	0.6	1.3	1.8	2.2	0.2	4.3	9.4	**26.2**	0.8	30.1	8.5	1.1	4.6	1.5	5.9	8.6	**61.1**
$X_{\eta imp}$	**1996**	1.4	1.6	0.2	0.1	1.0	**4.3**	12.7	2.4	**15.1**	8.9	2.2	3.2	1.4	2.1	7.0	0.5	0.8	5.1	**31.2**	1.4	-	9.4	1.6	8.1	1.5	11.7	15.7	**49.4**
	2003	0.7	0.7	0.1	0.1	1.3	**2.8**	17.2	1.5	**18.7**	5.8	2.1	1.4	1.7	2.2	3.2	0.2	0.8	5.5	**22.9**	1.7	-	17.1	1.2	6.8	1.4	11.3	16.1	**55.6**
	2008	0.5	0.7	0.2	0.1	-0.2	**1.4**	18.8	1.2	**20.0**	6.7	2.1	0.9	1.6	2.2	3.0	0.2	4.5	6.4	**27.7**	2.0	-	9.6	1.7	6.2	2.4	13.3	15.8	**51.0**

Source: Own elaboration based on SNA data

We turn now our attention to the analysis of imported capital requirements ($\mathbf{K}_{\mathrm{dirimp}}$, $\mathbf{K}_{\mathrm{vimp}}$and $\mathbf{K}_{\eta\mathrm{imp}}$). It is convenient to focus only on the row corresponding to Equipment goods since they absorb around 90% of imports of investment goods. Graphs 4.3-4.5 below show in which activities and in which proportion Equipment goods are employed in each sector. In other words, these pictures show $\mathbf{K}_{\mathrm{dirimp}}^{(\mathrm{Equip.})}$, $\mathbf{K}_{\mathrm{vimp}}^{(\mathrm{Equip.})}$ and $\mathbf{K}_{\eta\mathrm{imp}}^{(\mathrm{Equip.})}$ through time. The analysis in direct terms reveals that most capital goods imports are demanded by Services, in particular Energy, Transports, Trade, Financial Services, Communal Services and Construction (in 1996). Copper is also important, while, capital imports within Manufactory are not particularly pronounced with the exception of some particular year (e.g. 2003 for Textiles industry).

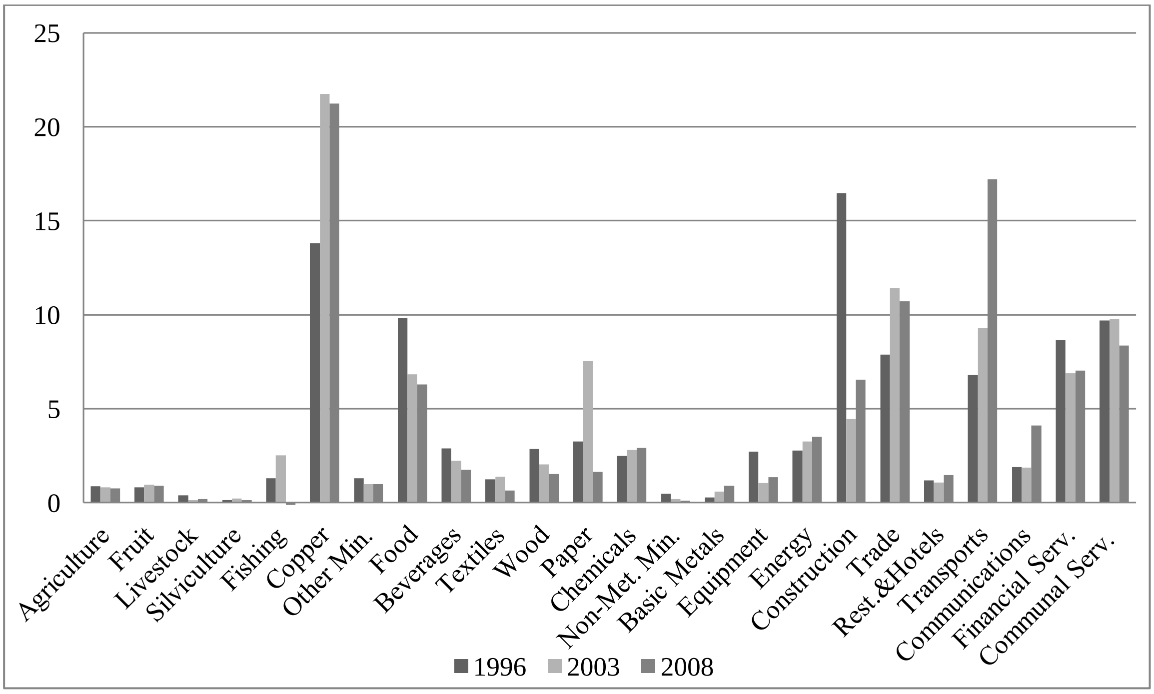
If we move to the subsystem level of analysis things are different. Again, there are no relevant differences between VI and VHI analysis. Copper is the sector which (increasingly) absorbs a greater portion of imported capital goods, being 20% in 2008. This trend is in contrast with direct imports of table 4.7. Service sectors also absorb an important part, especially Transports, Financial Services, Trade, Communal Services and Construction. As to manufactory activities, Food is the most relevant subsystem (even though it seems to be decreasing), followed by Paper and, to a lower extent, Chemicals.

Picture 4.3. Direct imports of Machinery and Equipment Goods by industry. (% of the total)



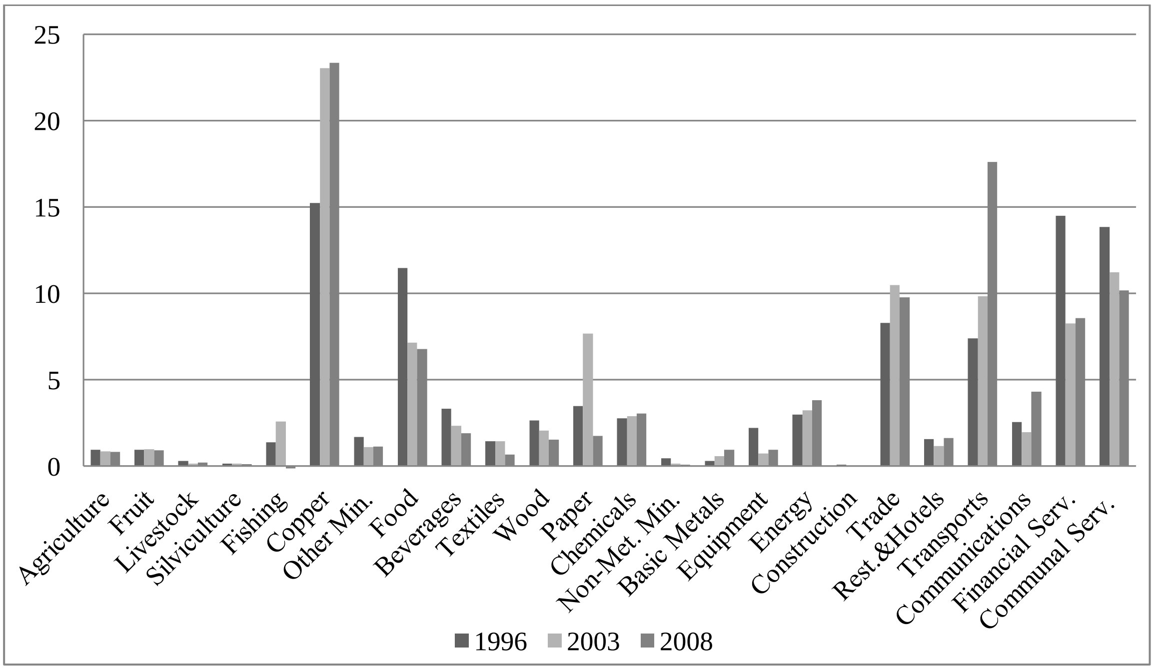
Source: Own elaboration based on SNA, NSI and INDSTAT4 data

Picture 4.4. Imports of Machinery and Equipment Goods by VI sector. (% of the total)



Source: Own elaboration based on SNA, SNI and Indstat4 data

Picture 4.5. Imports of Machinery and Equipment Goods by VHI sector (% of the total)



Source: Own elaboration based on SNA, SNI and Indstat4 data

In conclusion, it can be inferred that the Chilean productive system is more dependent on imports of Other Mining, Chemicals and Heavy Industry (and within this category, especially on Equipment goods) activities. Some activities, such as Copper, increase significantly their imports when analyzed at the subsystem level. A relevant portion of imports is due to oil (crude and derived) so that it seems difficult to reduce import dependency of these sectors. On the other hand, Equipment goods subsystem constitutes a considerable portion of imports both as circulating and fixed capital. At the same time this subsystem does not markedly rely on oil imports for the domestic production. In other words, the development of Equipment goods would potentially reduce total imports dependency and without pushing imports of those activities in which is Chile is highly dependent. Of course, this idea has to face with the technological and physical capacity for a small country as Chile of successfully implementing equipment goods sector to an extent capable of reducing these imports. At the subsystem level Services increases their share of imports, showing values comprised between approximately one third and two third of imports. This is relevant at the light that Services barely generates exports.

Moreover, import results must be taken warily. The analysis covers only a limited number of years and may not reflect adequately the actual trend of imports, especially those of fixed capital. A given activity may face high levels of fixed capital imports in a reduced span of time in order to increase its capacity of production or renovate the existing fixed capital. In other words, a peak in a given year may not be reflected by an analogous the trend.

In addition, it has to be considered that the analysis has not taken into consideration relative participation of each subsystem in total production. That is, data show the absolute imports by activity and not by unit of produced output. This may lead to think that this latter form of estimation would be more appropriate. However, in macroeconomics terms it makes sense to work with aggregate variables since it is the total imports of an activity (subsystem), and not the quantity of import per unit of output, to be relevant in the trade balance.

In conclusion to this section, from our approach it emerges that Primary Non-Extractive activities show high increase of physical productivity but a strong reduction of employment and low retribution. Mining and traditional Manufactory are closer to final demand, generating more employment at the subsystem than at the direct level. This trend can be associated with higher spillovers with the rest of the productive structure. In spite of this greater participation of employment, many subsystems created labour at a pace in line or below average. On the contrary, other activities among Manufactory and Services have been more dynamic in terms of employment creation. As to labour compensation, most of resource based subsystems concentrate lower relative wages while Copper and some Services are better off. Primary Non-Extractive activities reduce their negative retribution gap with respect of the rest of the activities. Part if this trend may be due to the increase in productivity recorded by these activities.

In terms of economic policy the analysis provides useful insights. Dynamic subsystems are those that allow to incorporate a higher degree of technical change an expand employment. Public policies can have an important role in fostering dynamic activities and, at the same time, trying to reduce bottlenecks or reducing import dependency. With respect to technical change, in the theoretical section we argued that productivity gains provide the material base to increase real wages. Even though changes in real wages can be due to changes in distribution, it is straightforward that the concentration on activities of higher productivity represents a condition to improve the material standards of living of the society. An important aspect that emerges from our work is that these dynamic sectors do not necessarily coincide with resource based activities.

5. Conclusions

The last two decades represented a period of growth, changes and consolidations of the productive structure of Chile. In the theoretical section of this work we summarized the main features of the ND approach both on the macroeconomic and microeconomic ground and we stressed the importance of external projection as a key variable for economic development within this framework of analysis. We also mentioned that ND studies take into consideration only direct relation of production, e.g. employment creation (expulsion) or changes in productivity in a certain industry. In this work we proposed an alternative theoretical approach that is able to grasp innovative elements of analysis and to enrich the discussion on economic development.

The main objective of this dissertation was to assess changes in the Chilean productive structure that took place between 1996 and 2008. In particular, to evaluate the Chilean pattern of growth we focused on changes of employment, productivity, wages and import structure using VI and VHI sectors which were first developed by Pasinetti (1973). We set the hypothesis that resource based sectors has not been the most dynamic ones, in spite of the attention that they have received by part of the literature. The relevance of this study is manifold. Firstly, this theoretical framework has been barely used in the region and it is the first one that has focused on Chile. Secondly, it contributes to analyze aspects related with productive specialization from an innovative perspective. From our conception export performance alone is not enough to assess the effectiveness of development strategy but that other factors need to be taken into consideration, such as domestic demand and productive linkages among productive sectors. Thirdly, as in the classical economic theory, we consider the economy as a circular flow, both at the theoretical and empirical level. Therefore, in the production of a given unit of *final* product it is not only important the technique of production of that single industry, but the techniques used in *all* the industries that enter as productive inputs. Thereby, a main feature of VI and VHI sectors is that through them it is possible to identify direct and indirect relations within the productive system. Fourthly, even though the subsystem approach has been mostly used to assess employment dynamics and technical change, we introduced the concept of VI and VHI analysis to study wages and the import structure.

As mentioned above, in order to accomplish with the objective of this study, we focused our empirical analysis on four different dimensions. As to employment, the analysis has been fulfilled at the industry and subsystem level. While the former is the usual way of measuring employment by activity, the latter takes into account the productive linkages among different sectors and provides an estimation of the amount of labour needed for the production of one unit of net output in the whole economic system. As to productivity, the construction of each VI and VHI vector of labour coefficient embodies information that permit to assess changes in physical productivity, providing useful insights on technical change and overcoming limitations of standard measures of productivity based on the neoclassical concept of Total Factor Productivity. As to wages, we extended the analysis to income distribution through the construction of vectors of VI and VHI wage coefficients in order to identify the wage component at the subsystem level. As to the imports, we analyzed the structure of imported productive inputs and new gross fixed capital by subsystem.

It is important to notice that due to the lack of more disaggregated information, our sectoral analysis could not be as specific as the ND is. Only in the case of Copper we have been able to grasp the same level of analysis, while for the other cases, such as Wine production, we used as reasonable approximations the corresponding aggregated sector, Beverage activities.

By keeping this in mind, our main findings, in relation to our specific objectives, can be resumed as follows:

As presented in section 4.1, in terms of employment absorption from the VI and VHI analysis, it emerges that Manufactory has a more important role than it is usually believed, even though Services are increasing their importance. This result denotes the considerable number of spillovers that Manufactory has with the rest of sectors of the economy. In terms of rates of growth of employment, Mining and Services created jobs at the fastest pace while Manufactory's subsystems shows a variety of situations (with some activities growing above average and others below or expelling workers), which implies that relative importance of each activity has been changing through time.

From the productivity analysis, as showed in section 4.2, a variegated picture is also found reveling that the activities with major technical change do not necessarily share the same characteristics. Primary Non-Extractive (except Fishing) sectors have increased their productivity at a fast pace while Mining and natural resource based Manufactory have more dispersed results. In theoretical section 2.2 we proposed the idea that a development based on natural resources may embody a lower degree of technical change respect to other activities, in accordance with the concept of SE. Even though this study is not sufficient to draw definitive conclusions on the subject, our findings provide some significant hints in this sense, as in the case of Fishing subsystem (and its crisis) that arose some concerns on the possibility of constantly expanding this type of activity. Similarly, the case of Copper showed poor results in terms of physical productivity gains along the period.

As to wage evolution, from the concept of VI and VHI wages we derived total compensation per subsystem and presented these results in section 4.3. Copper and some Services subsystems show higher relative wages while, most of resource based activities concentrate lower labour compensation. Within Manufactory, Food has the greatest (negative) difference which indicates that it concentrates productive inputs proceeding from activities whose workers receive lower compensation than the average. This result provides useful elements in policy terms. Fostering a certain sector not only has consequences on employment and productivity, but also distributive ones.

The analysis of import structure at the VI and VHI has some different important aspects. At this stage of analysis imports are determined by the production of final good and not the industry that directly imports it. The empirical analysis, presented in section 4.4, shows that imported inputs at the subsystem level are not as concentrated in a reduced number of activities as at the industry level. The increased participation of imported productive inputs in some activities goes in hand with greater participation of employment at the VI and VHI level (such as Copper, Food and, to a lesser extent, Construction, Financial Services and Communal Services) while in other cases the opposite occurs (e.g. Trade and Transports). As to imports of capital and equipment goods, Services and Copper are the most relevant activities.

In general terms, this dissertation provides an original contribution for the understanding of the sectoral development by means of Pasinetti approach applied to the economy of Chile. By means of the VI and VHI analysis, our analysis suggests that resource based activities have not performed better than others. Among dynamic subsystems (i.e. those subsystems with positive employment creation and productivity gains above the SRGP) there are resource based manufactures as well as heavy industry and services activities. At the light of these results there are some aspects to consider. As we described in the theoretical section, public policies have almost entirely been addressed to resource based activities. It can be assumed that these measures have positively contributed to improve their performance. However, we showed that some sectors that are usually not prioritized by national development policies (such as some Manufactory or Services) also showed a good performance. Consequently, a main concern that arises from our analysis is to wonder what the performance of these activities would have been if they had received explicit support through productive policies (as in the case of those sectors that received public support, e.g. fishing, wine production and copper). Ultimately, our analysis shows that there is no proof that resource based sectors is more indicated than others to boost the economic activity.

Finally, regarding future research lines, this work also provides useful hints to extend the scope of this methodology. Further research should aim to assess the dynamicity of each specific sector and its spillovers in the rest of the economy. As to the Chilean case, the specific role of exports, domestic private demand and the potentialities of public expenditure on employment and productivity can be studied through the disaggregation of the vector of final demand. At the same time, the analysis of the wage dynamics could be further implemented to assess the role of each industry in the evolution of total workers compensation by subsystem. Complementation of these elements with the analysis of import structure provides useful elements to the design of hypothetical development strategy that aims at the improvement of the trade account, creation of employment and productivity increases. In this sense, advances in data provision would sensitively broaden the effectiveness of this approach. If more disaggregated data were available with (especially for employment data by activity), the subsystem approach could be an extremely useful tool in the identification of specific bottlenecks in the productive structure. Beyond national borders, a wider diffusion of IO tables of Latin American countries would have a great potential to address at issues like regional integration, productive complementarities and trade policies.

Appendix A

A.1. Technical change and the subsystem analysis: a brief example

We present a short and simple example in order to reach a better understanding of the theoretical paragraph 2.3. The aim is that of illustrating the concept of direct and indirect labour requirements and their implications in productivity estimation. For simplicity we refer only to a VI level of analysis, omitting the VHI one. However, conclusions do not change substantially.

Suppose a simple production scheme in which two commodities (fish and copper) are produced by employing themselves and labour. There are no capitalists in the economy and the labour force is composed by four workers that are evenly distributed among the two industries. Let's consider two periods of time, t=0 and t=1. Between t=0 and t=1 technical progress takes place in the copper industry. A simple IO of this economy can be represented as

t=0	**X**		**x**	**y**
	Fish	Copper		
Fish (tons)	10	5	20	5
Copper (tons)	4	8	20	8
Labour force (men)	2	2		

t=1	**X**		**x**	**y**
	Fish	Copper		
Fish (tons)	10	5	20	5
Copper (tons)	4	8	30	18
Labour force (men)	2	2		

Source: Own elaboration

As it can be seen, we are supposing that the productive inputs of the economy (matrix **X**) do not change. Technical change in the copper industry allows increasing the gross product in the copper industry keeping constant the production input. As a result, net output of copper also increases, expanding the surplus of the economy. This greater surplus is completely translated into real wages since we are supposing there are no capitalists.

From expressions 2.2 and 2.6 we obtain matrix **A** and vector $\mathbf{a}_{\mathrm{n}}$ that when calculated (for t=0 and t=1) gives

$$\mathbf{A}(0) = \begin{bmatrix} 0.50 & 0.25 \\ 0.20 & 0.40 \end{bmatrix}; \mathbf{a}_{\mathrm{n}}^{\mathrm{T}}(0) = [0.10 \quad 0.10]; \mathbf{A}(1) = \begin{bmatrix} 0.50 & 0.17 \\ 0.20 & 0.27 \end{bmatrix}$$

$$\text{and } \mathbf{a}_{\mathrm{n}}^{\mathrm{T}}(1) = [0.10 \quad 0.07]$$

The second columns of $\mathbf{A}(1)$ reflects lower inputs and a lower $\mathbf{a}_{\mathrm{cop}}(1)$ shows improvements in direct labour productivity for the production of one ton of copper that take place at t=1 while $\mathbf{a}_{\mathrm{fis}}(1)$ does not change. This is the standard representation of productivity change per activity expressed in direct terms. However, if we calculate 2.11 we obtain the VI labor coefficients for time t=0 and t=1

$$\mathbf{v}(0) = [0.32 \quad 0.30] \text{ and } \mathbf{v}(1) = [0.26 \quad 0.15]$$

These values show that, following a decline in the production of copper, (direct and indirect) labour requirements decline in both subsystems, not only in the copper one. This simple example shows the implication of employing VI subsystems in a stylized way

- Technical change taking place in the production of one good affects all the subsystems in which that good is employed as input. Technical change is not limited to the productive sector in which it takes place.
- Real wages (the net surplus in our example) increases as technical change takes place. If we do not consider institutional factors, like distributive

conflicts, productivity gains (i.e. technical changes) is the only way to increase real wages.[22]

Appendix B

B.1. Price index vectors

In order to operate with volume changes it is necessary to deflate original Supply and Use table, which are provided at current prices. Chilean SNA provides vectors of gross production expressed at 1996 prices for the years comprised between 1996 and 2004 and at 2003 prices for the years comprised between 2003 and 2009. From these data it is possible to create two price indexes vectors ($\mathbf{d}_{03}$ is the n x 1 price index vector for year 2003 and $\mathbf{d}_{08}$ for 2008). From the general formula used to obtain a price index for a base year *t*, $d_t = \frac{Q_{t+n}}{Qt} = \frac{q_{t+n}p_{t+n}}{q_{t+n}p_t}$, where quantities (*q*) are multiplied by prices (*p*). In matrix terms we have

$$\hat{\mathbf{d}}_{03} = \hat{\mathbf{q}}_{03}\hat{\mathbf{p}}_{03}(\hat{\mathbf{q}}_{03}\hat{\mathbf{p}}_{96})^{-\mathbf{1}} = \hat{\mathbf{p}}_{03}\,\hat{\mathbf{p}}_{96}^{-\mathbf{1}}; \tag{B.1}$$

$$\begin{aligned}\hat{\mathbf{d}}_{08} = {} & \hat{\mathbf{q}}_{08}\hat{\mathbf{p}}_{08}\,(\hat{\mathbf{q}}_{08}\hat{\mathbf{p}}_{03})^{-\mathbf{1}}\,\hat{\mathbf{q}}_{03}\hat{\mathbf{p}}_{03}\,(\hat{\mathbf{q}}_{03}\hat{\mathbf{p}}_{96})^{-\mathbf{1}} = \\ & = (\hat{\mathbf{p}}_{08}\,\hat{\mathbf{p}}_{03}^{-\mathbf{1}})(\hat{\mathbf{p}}_{03}\,\hat{\mathbf{p}}_{96}^{-\mathbf{1}}) = (\hat{\mathbf{p}}_{08}\,\hat{\mathbf{p}}_{96}^{-\mathbf{1}})\end{aligned} \tag{B.2}$$

Where $\hat{\mathbf{q}}_{(t)}$ is the diagonalized vector of quantities produced in year *t* and $\hat{\mathbf{p}}_{(t)}$ is the diagonalized price vector in year *t*. By defining **e** as the unitary vector it can be calculated $\hat{\mathbf{d}}_{03}\mathbf{e}$ and $\hat{\mathbf{d}}_{08}\mathbf{e}$ to obtain the deflator vector $\mathbf{d}_{03}$ and $\mathbf{d}_{08}$.

Table B.1 provides the original classification of the gross output at constant price for the two dataset (1996-2004 and 2003-2010) and the 24 industries classification that it will be used in this work. Between the first classification provided by the SNA (1996-2004) and the second one (2003-2010) there are some changes.

[22] In this example there is no reason to imagine distributive conflicts since all the surplus is appropriated by wages. However, our conclusion would no change in presence of profits.

Table B.1. Original and final classification

	1996-04 Original Classification	2003-2010 Original Classification	Final Classification 1996-2008	
		Primary non extractive		
1	Agriculture	Agriculture	Agriculture	1
2	Fruit culture	Fruit culture	Fruit culture	2
3	Other Primary (Non-Extractive)	Livestock	Livestock	3
4		Silviculture	Silviculture	4
5	Fishing	Fishing	Fishing	5
		Mining		
6	Copper	Copper	Copper	6
7	Other Mining	Other Mining	Other Mining	7
		Manufactory		
8	Food, Beverages and Tobacco	Food	Food	8
9		Beverages and Tobacco	Beverages and Tobacco	9
10	Textiles	Textiles	Textiles	10
11	Wood and Furniture	Wood and Furniture	Wood and Furniture	11
12	Paper and Printing	Paper and Printing	Paper and Printing	12
13	Chemicals, oil and Plastic	Chemicals, oil and Plastic	Chemicals, oil and Plastic	13
14	Non-Metallic Mineral Products	Non-Metallic Mineral Products	Non-Metallic Mineral Products	14
15	Basic Metals	Basic Metals	Basic Metals	15
16	Metallic Products, Machinery, equipments goods	Metallic Products, Machinery, equipments goods and other manufactory	Metallic Products, Machinery, equipments goods and other manufactory	16
	Other Manufactory			
		Services		
17	Electricity, Gas and Water	Electricity, Gas and Water	Electricity, Gas and Water	17
18	Construction	Construction	Construction	18
19	Trade, Restaurants and Hotels	Trade	Trade	19
20		Restaurants y Hotels	Restaurants y Hotels	20
21	Transports and Communications	Transports	Transports	21
22		Communications	Communications	22
23	Financial and Entrepreneurial Services	Financial Services	Financial and Entrepreneurial Services and Household Property	23
		Entrepreneurial Services		
	Household Property	Household Property		
24	Personal Services	Personal Services	Communal and Personal Services	24
	Public Administration	Public Administration		

Source: Own elaboration

Some industries that were aggregated in the first classification were disaggregated in the second one[23], while in one case the opposite is true.[24] This makes the estimation of the deflator vector more difficult, since it is not possible to establish a one to one correspondence for some industries between the two classifications. To overcome this difficulty we attributed the same deflator to those industries which have been "artificially" separated. This means that for some periods we assigned the same price deflators to different industries since original data were at a more aggregated level.[25]

Table B.2 shows numerical values of gross output (at current and constant prices) and the corresponding price index vector. The number of activities we obtained from the tables, together with the number of activities we obtained from employment data are also the maximum number of subsystems it is possible to analyze employment and productivity in VI and VHI terms.

[23] This is the case of Other Primary (non-Extractive);Food, Beverages and Tobacco; Commerce, Restaurants and Hotels; Financial and Entrepreneurial Services

[24] This is the case of Metallic Products, Machinery, Equipments goods and Other manufactories.

[25] That is, industries 3 and 4; 8 and 9; 19 and 20; 21 and 22 for the construction of $\mathbf{d}_{03}$.

Table B.2. Price index vectors construction

Gross Output 2003 (Chilean $)			Gross Output 2008 (Chilean $)			Price index vectors		
	A	B		C	D	E	F	G
Activity Number	Current Prices	Constant Prices (1996)	Act.	Current Prices	Constant Prices (2003)	$\hat{\mathbf{p}}_{03}\, \mathbf{p}_{96}^{-1}$ (A / B)	$\hat{\mathbf{p}}_{08}\, \mathbf{p}_{93}^{-1}$ (C / D)	$\hat{\mathbf{d}}_{03}\, (\hat{\mathbf{p}}_{03}\, \mathbf{p}_{96}^{-1})$ (E * F)
1	1008089	938263	1	1245959	1013894	1,07	1,23	1,32
2	1318922	889725	2	1480601	1450914	1,48	1,02	1,51
3,4	1400330	1222220	3	1729553	1431957	1,15	1,21	1,38
			4	1259124	1022115	1,15	1,23	1,41
5	1496804	1059405	5	1798724	1759295	1,41	1,02	1,44
6	6902164	4928366	6	20581071	7622593	1,40	2,70	3,78
7	1232500	818175	7	2909011	1487695	1,51	1,96	2,95
8,9	7785819	6053763	8	9031575	7092922	1,29	1,27	1,64
			9	3029952	2647663	1,29	1,14	1,47
10	893544	861714	10	1203123	1174428	1,04	1,02	1,06
11	1647186	1303926	11	2066214	1822383	1,26	1,13	1,43
12	2796084	1810968	12	3774401	3447246	1,54	1,09	1,69
13	5708821	3508179	13	10540521	7204339	1,63	1,46	2,38
14	1014019	794431	14	1449079	1194553	1,28	1,21	1,55
15	776729	482579	15	2898927	1285200	1,61	2,26	3,63
16	1948408	1530786	16	4187081	3187013	1,27	1,31	1,67
17	3332753	2586411	17	10666482	4022888	1,29	2,65	3,42
18	7559417	5981988	18	14468536	10080511	1,26	1,44	1,81
19, 20	10218605	8315920	19	16785896	14023561	1,23	1,20	1,47
			20	2375781	1878487	1,23	1,26	1,55
21, 22	9321022	7202195	21	14638589	11344246	1,29	1,29	1,67
			22	4723550	4384369	1,29	1,08	1,39
23	13531935	10637191	23	26706307	21789119	1,27	1,23	1,56
24	12114514	8077468	24	19124179	14956676	1,50	1,28	1,92

Source: Own Elaboration based on SNA

B.2. Occupied by activity

As we mentioned in section 3, the NSI only provides employment data for nine activities. Additional data on employment are provided by INDSTAT4 Database. This database provides highly disaggregated data of the number of occupied by manufactured industry. Given the disaggregation of gross output in constant terms per industry it is possible to decompose Manufactory activities into nine industrial branches. However, another issue must be considered. Total number of occupied in Manufactory of the INDSTAT 4 database do not coincide with that offered by the

NSI, being the former approximately half of those of the NSI. In order not to reduce the disaggregation of our analysis, we decided to keep the total number of occupied in the industry provided by the NSI and multiply this number for the relative participation of each industrial branch proceeding from INDSTAT4 database. In matrix terms we have

$$\mathbf{i} = (\mathbf{i}_{\mathrm{IN}}\mathrm{I}_{\mathrm{IN}}^{-1})\mathrm{I}_{\mathrm{NSI}} \tag{B.3}$$

Where $\mathbf{i}_{\mathbf{IN}}$ is the 9x1 vector of occupied in the industry in which each i^{th} component is the number of occupied in the i^{th} sub-activity according to INDSTAT4 database. $\mathrm{I}_{\mathrm{IN}}^{-1}$ is the inverse of the total number of occupied in the manufactory according to INDSTAT4 database (therefore, the product $\mathbf{i}_{\mathbf{IN}}\mathrm{I}_{\mathrm{IN}}^{-1}$ is the vector 9x1 representing the share of each sub-activity in the total) and $\mathrm{I}_{\mathrm{NSI}}$ is a scalar representing the total number of occupied in manufactory according to the NSI. Table B.3 below shows results of this computation.

Table B.3. Number of occupied per activity in the Manufactory sector

$\mathrm{I}_{\mathrm{NSI(96)}} = 844437;\ \mathrm{I}_{\mathrm{NSI(96)}} = 822529; \mathrm{I}_{\mathrm{NSI(08)}} = \ 862580$

	$i_{IN}^{(i)}$			$\mathbf{i}_{\mathrm{IN}}^{(\mathrm{i})}\mathrm{I}_{\mathrm{IN}}^{-1}$ (%)			$i_{NSI}^{(i)}$		
	1996	**2003**	**2008**	**1996**	**2003**	**2008**	**1996**	**2003**	**2008**
Food	122763	106210	136714	0.29	0.31	0.31	243741	254881	270122
Beverages	14446	14797	17014	0.03	0.04	0.04	28682	35510	33617
Textiles	69404	37055	33059	0.16	0.11	0.08	137799	88924	65319
Wood	28276	22322	34022	0.07	0.07	0.08	56141	53568	67221
Paper	14364	22914	32125	0.03	0.07	0.07	28519	54989	63473
Chemicals	53089	46618	61368	0.12	0.14	0.14	105406	111873	121252
Non-Met. Min.	18938	12666	14772	0.04	0.04	0.03	37601	30396	29187
Basic Metals	21139	21379	30121	0.05	0.06	0.07	41971	51305	59514
Equipment	82891	58791	77373	0.19	0.17	0.18	164577	141085	152875
I_{IN}	425310	342752	436568						

Source: Own Elaboration based on INDSTAT4 database and NSI data

With respect to employment in other activities than Manufactory, some adjustment were made. Since the gross output vector has 24 activities and the vector of employment is now disaggregated in 17 activities (eight activities provided by the original employment vector provided by the NSI and nine manufactory industries obtained in table B.3 above) there are seven activities missing. Thus, we took data proceeding from the original NSI database and disaggregated the Primary non-

Extractive sector into five sub-activities (Agriculture; Fruit culture; Livestock; Silviculture and Fishing), Mining sector into two sub-activities (Copper and Other Mining), as well as Trade (Trade; Restaurant & Hotels) and Transports and Communications (Transport; Communications). Direct employment has been computed by estimating the relative participation of gross output of each sub-activity in the total of the activity and then assigned the same participation of employment to each sub-activity. For instance, it has been calculated the relative weight of the copper activity output in the total Mining output and this proportion has been multiplied by the number of total of direct occupied in the mining sector. In matrix terms we have

$$(\mathbf{q}^{(\mathrm{i})}\mathrm{Q}^{-1})L_{NSI} = \mathbf{l}^{(\mathrm{i})} \tag{B.4}$$

Where $\mathbf{q}^{(\mathrm{i})}$ is the vector (nx1) of gross output by product, Q is the gross output by original product, L_{NSI} is the number of occupied by original activity according to the NSI and $\mathbf{l}^{(\mathrm{i})}$ is the vector of occupied by sub-activity. Results are shown in table B.4 below.

Table B.4. Employment disaggregation.

	1996			2003			2008		
	$\mathbf{q}^{(\mathrm{i})}\mathrm{Q}^{-1}$ (%)	L_{NSI}	$l^{(i)}$	$\mathbf{q}^{(\mathrm{i})}\mathrm{Q}^{-1}$ (%)	L_{NSI}	$l^{(i)}$	$\mathbf{q}^{(\mathrm{i})}\mathrm{Q}^{-1}$ (%)	L_{NSI}	$l^{(i)}$
Agriculture	28.4	789320	224352	25.8	790972	203862	24,1	762760	183851
Fruit culture	21.7		171428	16.9		133600	16,9		128662
Livestock	24.4		192461	21.1		167127	30,2		230230
Silviculture	10.2		80533	15.2		119951	8,9		68186
Fishing	15.3		120546	21.0		166432	19,9		151831
Copper	66.9	93548	62559	67.2	79570	53502	65,8	99378	65350
Other Min.	33.1		30990	32.8		26068	34,2		34028
Trade	85.6	921443	788559	88.3	1129010	996522	86,0	1318132	1133117
Rest.&Hotels	14.4		132885	11.7		132488	14,0		185014
Transports	79.1	389037	307561	78.7	483967	380997	73,8	567281	418574
Communica.	20.9		81475	21.3		102970	26,2		148708

Source: Own Elaboration based on NSI data

Once we have disaggregated the number of employed by activities in sub-activities we have our three vectors (on per year) of direct employment that will be employed in the analysis. From now on, we will make no difference between original activities and estimated sub-activities and refer indiscriminately to each one as *activity* or *sector*.

Table B.5. Labour vector by year

	1996	**2003**	**2008**
Agriculture	224352	203862	183851
Fruit	171428	133600	128662
Livestock	192461	167127	230230
Silviculture	80533	119951	68186
Fishing	120546	166432	151831
Copper	62559	53502	65350
Other Mining	30990	26068	34028
Food	243741	254881	270122
Beverages	28682	35510	33617
Textiles	137799	88924	65319
Wood	56141	53568	67221
Paper	28519	54989	63473
Chemicals	105406	111873	121252
Non-Met. Min.	37601	30396	29187
Basic Metals	41971	51305	59514
Equipment	164577	141085	152875
Energy	39280	25839	39491
Construction	407988	462781	585470
Trade	788559	996522	1133117
Rest.&Hotels	132885	132488	185014
Transports	307561	380997	418574
Communications	81475	102970	148708
Financial Serv.	350371	472035	608588
Communal Serv.	1335488	1519702	1795195

Source: Own elaboration based on SNI, SNA and INDSTAT4

Some critics may be addressed to the construction of the deflators and the labour vector. In the construction of deflators we supposed that two industries undergone the same price changes in a given period. This was necessary because in order to obtain a greater disaggregation of activities to work with. In the case of the labour vector we implicitly supposed that direct employment evolves at the same pace in different industries. Put in another way, we are supposing that the amount of direct employment is a constant portion of gross output along time. Also in this case this decision was taken in order to increase the number of sectors that we would be able to operate with. Note, however, that operating with a higher degree of aggregation would have meant combining at least two different sectors. At the interindustry level of analysis this would have meant loss important information that can be grasped with a more disaggregated analysis. Given the nature of data, this procedure is the best procedure that could be made. We decided to proceed in this way in order not to have to reduce the number of subsystem, which make possible to provide a richer analysis.

B.3. Investment matrices and Input-Output tables creation

Investment matrices creation

As we mentioned in section 3, investment matrices (commodity x activity) are provided at CP. Since we will realize our analysis at BP it is necessary to convert these matrices to BP.

Another aspect that deserves importance is the fact that investment matrices are semi-positive i.e., they contains negative elements. In theoretical terms this fact appears as counterintuitive, since investment is necessarily a positive magnitude. For this reason we needed to transform original investment matrices into strictly semi-positive matrices. To do so we created, for each year, a semi-negative investment matrix containing the negative elements of the original one and added the negative element to inventories variations in order not to lose information proceeding from original investment matrices. In matrix terms we have

$$\bar{\mathbf{\Theta}}_{\mathbf{CP}} = \bar{\mathbf{P}}_{\mathrm{CP}} + \bar{\mathbf{N}}_{\mathrm{CP}} \qquad \text{(B.5)}$$

Where $\mathbf{\Theta}_{\mathrm{CP}}$ is the original investment matrix (commodity x activity) at CP, $\mathbf{P}_{\mathrm{CP}}$ is the semi-positive matrix of investment and $\mathbf{N}_{\mathrm{CP}}$ the semi-negative one. Hence,

$$\bar{\mathbf{N}}_{\mathrm{CP}}\mathbf{e} = \bar{\mathbf{n}}_{\mathrm{CP}} \qquad \text{(B.6)}$$

Where $\mathbf{e}$ is the unitary vector and $\bar{\mathbf{n}}_{\mathrm{CP}}$ is the semi-negative vector (commodity x 1) of investment. By premultiplying the diagonalized vector of $\mathbf{n}_{\mathrm{CP}}$ for the inverse of the diagonalized vector of gross fixed capital formation at CP($\mathbf{k'}_{\mathrm{CP}}$) we obtain a vector ($\boldsymbol{\beta}$) which represents the relative participation of the negative elements in the gross fixed capital formation.

$$\boldsymbol{\beta} = \widehat{\boldsymbol{\beta}}\mathbf{e} = \widehat{\mathbf{n}}_{\mathrm{CP}}\hat{\bar{\mathbf{k}}}'^{-1}_{\mathrm{CP}} \tag{B.7}$$

Since it is a relative participation the CP effect disappears. This enable us to find the equivalent participation of negative elements in the vector of gross fixed capital formation *at BP* and then add them to inventories changes and subtract them from the Gross Fixed Capital Formation (GFCF) vector at BP

$$\bar{\mathbf{n}}_{\mathrm{BP}} = \bar{\mathbf{k}}'_{\mathrm{BP}}\boldsymbol{\beta} \tag{B.8}$$

$$\overline{\mathbf{sc}}''_{\mathrm{BP}} = \overline{\mathbf{sc}}'_{\mathrm{BP}} + \bar{\mathbf{n}}_{\mathrm{BP}} \tag{B.9}$$

$$\bar{\mathbf{k}}''_{\mathrm{BP}} = \bar{\mathbf{k}}'_{\mathrm{BP}} - \bar{\mathbf{n}}_{\mathrm{BP}} \tag{B.10}$$

Where $\overline{\mathbf{sc}}''_{\mathrm{BP}}$ and $\bar{\mathbf{k}}''_{\mathrm{BP}}$ are the new vectors (commodity x 1) of inventories variation and gross fixed capital formation at BP. From this point we proceed to the main aim of this section, i.e. the transformation of the investment matrices from CP to BP. First, we created a vector of conversion which relates GFCF at CP to that at BP. This vector ($\boldsymbol{\gamma}$) is given by

$$\hat{\boldsymbol{\gamma}} = \widehat{\bar{\mathbf{k}}''_{\mathrm{BP}}}(\widehat{\bar{\mathbf{P}}_{\mathrm{CP}}\mathbf{e}})^{-1} \tag{B.11}$$

Where $(\widehat{\bar{\mathbf{P}}_{\mathrm{CP}}\mathbf{e}})^{-1}$ provides the diagonalized vector of GFCF at BP without considering negative elements. It is sufficient to premultiply the diagonalized vector $\boldsymbol{\gamma}$ by $\mathbf{P}_{\mathrm{CP}}$ to obtain the investment matrix at BP

$$\bar{\boldsymbol{\Theta}}_{\mathrm{BP}} = \hat{\boldsymbol{\gamma}}\bar{\mathbf{P}}_{\mathrm{CP}} \tag{B.12}$$

Note that $\bar{\boldsymbol{\Theta}}_{\mathrm{BP}}$ is a semipositive matrix and that $\bar{\boldsymbol{\Theta}}_{\mathrm{BP}}\mathbf{e} = \bar{\mathbf{k}}''_{\mathrm{BP}}$.

An analogous reasoning applies to imported capital formation. If we substitute domestic capital formation matrices with imported ones and operate as it has just been shown, we obtain $\bar{\boldsymbol{\Theta}}_{\mathrm{impBP}}$ and $\bar{\mathbf{k}}''_{\mathrm{impBP}}$ which are the matrix of imported capital goods and the vector of imported GFCF both at basic prices.

From Supply and Use tables to Input-Output tables

So far, we obtained Make and Use tables (at current BP), vectors of final demand, matrices of investment (domestic and imported), the vectors of occupied by activity and the price vectors. These last two group of vectors have 24 elements each one representing a productive activity. Before proceeding with the empirical estimation it is necessary to transform the Make and Use table into square activity x activity IO matrices.

Our point of departure are Make ($\bar{\mathbf{V}}$) and Use ($\bar{\mathbf{U}}$) Matrices (commodity x activity) provided by the SNA. Each element of each row of $\bar{\mathbf{V}}$ represents the total monetary quantity of commodity *i* which is produced by industry *j*. Vertically, each element of each column of $\bar{\mathbf{V}}$ indicates the total monetary quantities of products *i* which is produced by each industry *j*. Each element of row of $\bar{\mathbf{U}}$ indicates the total monetary input requirements of product *i* which is sold to industry *j*. If read by column, $\bar{\mathbf{U}}$ represents the total monetary production of inputs *i* needed in the process of production of each industry *j*. Therefore, it can be obtained

$$\bar{\mathbf{q}} = \bar{\mathbf{V}}\mathbf{e} \tag{B.13}$$

$$\bar{\mathbf{x}} = \bar{\mathbf{V}}^{\mathbf{T}}\mathbf{e} \tag{B.14}$$

$\bar{\mathbf{q}}$ is the vector (commodity x 1) of total monetary output by product and $\bar{\mathbf{x}}$ is the vector (activity x 1) of total monetary output by industry. Put in other words, $\bar{\mathbf{q}}$ provides information about the monetary quantity produced by commodity, while $\bar{\mathbf{x}}$ shows the quantity produced by industry.

Following Eurostat (2008) and Wirkierman (2010), there are at least four different ways of traducing supply-use table to IO tables. Each transformation is based on different assumptions.[26] Here we use model “d” - *Fixed product sales structure assumption* in which “Each product has its own specific sales structure, irrespective of the industry where it is produced” (Eurostat, 2008: 349). Moreover, this model “do not involve any technology assumptions […], do not require the application of sometimes arbitrary methods to adjust for negatives” (Eurostat, 2010: 310), guaranteeing the absence of negative elements in the input requirement matrix. However, this methodology does not guarantee price invariance.

Following Wirkierman (2010) it can be obtained

[26] See Eurostat 2008 for details.

$$\mathbf{\Gamma} = \bar{\mathbf{U}}\hat{\bar{\mathbf{x}}}^{-1} \quad \text{(B.15)}$$
$$\mathbf{D} = \hat{\bar{\mathbf{q}}}^{-1}\bar{\mathbf{V}} \quad \text{(B.16)}$$

Where $\mathbf{\Gamma}$ is a matrix "measures commodity requirements per unit of industry output (in price terms) (Wirkierman, 2010: 280). Each element of each row of matrix $\mathbf{D}$ is the share of product *i* produced by industry *j*. Both $\mathbf{\Gamma}$ and $\mathbf{D}$ are commodity x activity matrices. We further estimate

$$\underset{(axa)}{\mathbf{\Lambda}} = \underset{(axc)}{\mathbf{D}^{\mathrm{T}}}\underset{(cxa)}{\mathbf{\Gamma}} = (\underset{(axc)}{\bar{\mathbf{V}}^{\mathrm{T}}}\underset{(cxc)}{\hat{\bar{\mathbf{q}}}^{-1}})(\underset{(cxa)}{\bar{\mathbf{U}}}\underset{(axa)}{\hat{\bar{\mathbf{x}}}^{-1}}) \quad \text{(B.17)}$$

$\mathbf{\Lambda}$ is the matrix, *i x j*, (activity x activity) of input requirements. Horizontally each coefficient shows the monetary quantity that activity *i* sells to activity *j* as input for the production of one monetary unit of output. Read vertically it shows the monetary coefficient for each activity *i* which is *bought* by activity *j* for its process of production of one unit of output. It is implicitly supposed that each activity produces a uniform commodity. Note that matrix $\mathbf{\Lambda}$ has a similar meaning of matrix $\mathbf{A}$ that we found in the theoretical section above.

The same logic applies for the construction of the matrix of domestic investment and imported inputs and capital. By substituting the use matrix in 3.18 with the matrix of investment ($\bar{\mathbf{\Theta}}_{\mathrm{BP}}$) we obtain

$$\mathbf{\Lambda}_{\mathrm{K}} = \mathbf{D}^{\mathrm{T}}\mathbf{\Gamma} = (\bar{\mathbf{V}}^{\mathrm{T}}\hat{\bar{\mathbf{q}}}^{-1})(\bar{\mathbf{\Theta}}_{\mathrm{BP}}\hat{\bar{\mathbf{x}}}^{-1}) \quad \text{(B.18)}$$

Where $\mathbf{\Lambda}_{\mathrm{K}}$ is the matrix, , *i x j*, of domestic investment coefficients where, horizontally, each element represents the coefficient of monetary amount of output of activity *i* which is sold to activity *j* as capital good while, read by column, each element is the monetary coefficient of capital goods produced by activity *i* that is bought by activity *j* as capital good and used in the production of one unit of output of activity *j*. Similarly, for imported goods it can be computed

$$\mathbf{\Lambda}_{\mathrm{imp}} = \mathbf{D}^{\mathrm{T}}\mathbf{\Gamma}_{\mathrm{imp}} = (\bar{\mathbf{V}}^{\mathrm{T}}\hat{\bar{\mathbf{q}}}^{-1})(\bar{\mathbf{U}}_{\mathrm{imp}}\hat{\bar{\mathbf{x}}}^{-1}) \quad \text{(B.19)}$$
$$\mathbf{\Lambda}_{\mathrm{Kimp}} = \mathbf{D}^{\mathrm{T}}\mathbf{\Gamma}_{\mathrm{imp}} = (\bar{\mathbf{V}}^{\mathrm{T}}\hat{\bar{\mathbf{q}}}^{-1})(\bar{\mathbf{\Theta}}_{\mathrm{BPimp}}\hat{\bar{\mathbf{x}}}^{-1}) \quad \text{(B.20)}$$

With this procedure we also obtain the vector final demand and of inventories variation by activity.

$$\underset{(ax1)}{\mathbf{g}} = \underset{(axc)}{\mathbf{D}^{\mathrm{T}}}\underset{(cx1)}{\bar{\mathbf{g}}} = (\underset{(axc)}{\bar{\mathbf{V}}^{\mathrm{T}}}\underset{(cxc)}{\hat{\bar{\mathbf{q}}}^{-1}})\underset{(cx1)}{\bar{\mathbf{g}}} \tag{B.21}$$

$$\underset{(ax1)}{\overline{\mathbf{sc}}} = \underset{(axc)}{\mathbf{D}^{\mathbf{T}}}\underset{(cx1)}{\overline{\mathbf{sc}}''_{\mathrm{BP}}} = (\underset{(axc)}{\mathbf{V}^{\mathbf{T}}}\underset{(cxc)}{\hat{\bar{\mathbf{q}}}^{-1}})\underset{(cx1)}{\overline{\mathbf{sc}}''_{\mathrm{BP}}} \tag{B.22}$$

Thus, we obtained input and investment coefficients matrices and vectors of final consumption and inventories variations in monetary units. These matrices maintain their original format that is 73x73 for years 1996 and 2003 and 111x111 for 2008[27] and 73x1 and 111x1 respectively. From the matrix of coefficients it can be computed

$$\bar{\mathbf{X}} = \mathbf{\Lambda}\hat{\bar{\mathbf{x}}} \tag{B.23}$$

$$\bar{\mathbf{K}} = \mathbf{\Lambda}_{\mathrm{K}}\hat{\bar{\mathbf{x}}} \tag{B.24}$$

Where $\bar{\mathbf{X}}$ ($\bar{\mathbf{K}}$) is the new activity x activity input (investment) matrix where each row stands for the total quantity (expressed in monetary units) that activity *i* sells to activity *j* as input (capital goods) needed for the production of total gross production of activity *j* and each column expresses the total monetary quantity that each activity *j* buys from activity *i* as inputs (capital goods) in the total production of activity *j*. Note that "the product-mix in each row of the matrix [$\bar{\mathbf{X}}$ and $\bar{\mathbf{K}}$] is the same [and] there are no price-differentials in the sales to different sectors" (Rampa, 1981: 9) By substituting domestic input and capital matrices for imported ones in 3.49-3.50 it can be obtained $\bar{\mathbf{X}}_{\mathrm{imp}}$ and $\bar{\mathbf{K}}_{\mathrm{imp}}$.

As previously mentioned, to compute changes in employment and labour at the VI and VHI level it is necessary to operate in constant prices. Thus we need to aggregate IO tables considering the number of elements that compose the vectors of constant output by activity and labour by activity, i.e. 24 sectors. We count with 24 subsystem it is necessary to agglomerate vectors and matrices. Vectors and matrices can be agglomerated by computing

[27] Note that, for the year 2008, we obtained square matrices from rectangular ones, since

$$\underset{(111x111)}{\mathbf{\Lambda}} = \underset{(111x176)}{\mathbf{D}^{\mathrm{T}}}\underset{(176x111)}{\mathbf{\Gamma}} = (\underset{(111x176)}{\mathbf{V}^{\mathrm{T}}}\underset{(176x176)}{\hat{\mathbf{q}}^{-1}}) \quad (\underset{(176x111)}{\mathbf{U}}\underset{(111x111)}{\hat{\mathbf{x}}^{-1}})$$

$$\bar{\mathbf{x}}_{24} = \mathbf{B}\bar{\mathbf{x}} \quad \text{(B.25)}$$
$$\bar{\mathbf{g}}_{24} = \mathbf{B}\bar{\mathbf{g}} \quad \text{(B.26)}$$
$$\overline{\mathbf{sc}}_{24} = \mathbf{B}\overline{\mathbf{sc}} \quad \text{(B.27)}$$
$$\bar{\mathbf{w}}_{24} = \bar{\mathbf{w}}\mathbf{B}^{\mathrm{T}} \quad \text{(B.28)}$$
$$\bar{\mathbf{X}}_{24} = \mathbf{B}\bar{\mathbf{X}}\mathbf{B}^{\mathrm{T}} \quad \text{(B.29)}$$
$$\bar{\mathbf{K}}_{24} = \mathbf{B}\bar{\mathbf{K}}\mathbf{B}^{\mathrm{T}} \quad \text{(B.30)}$$
$$\bar{\mathbf{X}}_{\mathrm{imp24}} = \mathbf{B}\bar{\mathbf{X}}_{\mathrm{imp}}\mathbf{B}^{\mathrm{T}} \quad \text{(B.31)}$$
$$\bar{\mathbf{K}}_{\mathrm{imp24}} = \mathbf{B}\bar{\mathbf{K}}_{\mathrm{Kimp}}\mathbf{B}^{\mathrm{T}} \quad \text{(B.32)}$$

Where $\mathbf{B}$ is a matrix 24xn (where n=73 for 1996 and 2003 and n=111 for 2008) where for each row there is a 1 in correspondence of the activities that are going to be merged and 0 in the rest of the elements. Each vector and matrix has now 24 activities, denoted by the subscript “24”.

It is now possible to convert data into constant magnitudes (i.e. eliminate the price component) by premultiplying each vector and matrix for the price index vector obtained in appendix B.1.

Table B.6. Volume-price separation

2003	2008
$\mathbf{x}_{24} = \hat{\mathbf{d}}_{\mathbf{03}}(\hat{\mathbf{p}}_{\mathbf{03}}\mathbf{x}_{24}) = (\hat{\mathbf{p}}_{03}\ \hat{\mathbf{p}}_{96}^{-1})^{-1}(\hat{\mathbf{p}}_{03}\mathbf{x}_{24})$	$\mathbf{x}_{24} = \hat{\mathbf{d}}_{08}(\hat{\mathbf{p}}_{08}\mathbf{x}_{24}) = (\hat{\mathbf{p}}_{08}\ \hat{\mathbf{p}}_{96}^{-1})^{-1}(\hat{\mathbf{p}}_{08}\mathbf{x}_{24})$
$\mathbf{g}_{24} = \hat{\mathbf{d}}_{03}(\hat{\mathbf{p}}_{03}\mathbf{g}_{24}) = (\hat{\mathbf{p}}_{03}\ \hat{\mathbf{p}}_{96}^{-1})^{-1}(\hat{\mathbf{p}}_{03}\mathbf{g}_{24})$	$\mathbf{g}_{24} = \hat{\mathbf{d}}_{08}(\hat{\mathbf{p}}_{08}\mathbf{g}_{24}) = (\hat{\mathbf{p}}_{08}\ \hat{\mathbf{p}}_{96}^{-1})^{-1}(\hat{\mathbf{p}}_{08}\mathbf{g}_{24})$
$\mathbf{sc}_{24} = \hat{\mathbf{d}}_{03}(\hat{\mathbf{p}}_{03}\mathbf{sc}_{24}) = (\hat{\mathbf{p}}_{03}\ \hat{\mathbf{p}}_{96}^{-1})^{-1}(\hat{\mathbf{p}}_{03}\mathbf{sc}_{24})$	$\mathbf{sc}_{24} = (\hat{\mathbf{p}}_{08}\mathbf{sc}_{24}) = (\hat{\mathbf{p}}_{08}\ \hat{\mathbf{p}}_{96}^{-1})^{-1}(\hat{\mathbf{p}}_{08}\mathbf{sc}_{24})$
$\mathbf{X}_{24} = \hat{\mathbf{d}}_{03}(\hat{\mathbf{p}}_{03}\mathbf{X}_{24}) = (\hat{\mathbf{p}}_{03}\ \hat{\mathbf{p}}_{96}^{-1})^{-1}(\hat{\mathbf{p}}_{03}\mathbf{X}_{24})$	$\mathbf{X}_{24} = \hat{\mathbf{d}}_{08}(\hat{\mathbf{p}}_{08}\mathbf{X}_{24}) = (\hat{\mathbf{p}}_{08}\ \hat{\mathbf{p}}_{96}^{-1})^{-1}(\hat{\mathbf{p}}_{08}\mathbf{X}_{24})$
$\mathbf{K}_{24} = \hat{\mathbf{d}}_{03}(\hat{\mathbf{p}}_{03}\mathbf{K}_{24}) = (\hat{\mathbf{p}}_{03}\ \hat{\mathbf{p}}_{96}^{-1})^{-1}(\hat{\mathbf{p}}_{03}\mathbf{K}_{24})$	$\mathbf{K}_{24} = \hat{\mathbf{d}}_{08}(\hat{\mathbf{p}}_{08}\mathbf{K}_{24}) = (\hat{\mathbf{p}}_{08}\ \hat{\mathbf{p}}_{96}^{-1})(\hat{\mathbf{p}}_{08}\mathbf{K}_{24})$

Source: Own elaboration

New matrices of input and investment coefficients of domestic and imported ($\mathbf{\Lambda}_{24}$, $\mathbf{\Lambda}_{\mathrm{K24}}$, $\mathbf{\Lambda}_{\mathrm{imp}\mathbf{24}}$ and $\mathbf{\Lambda}_{\mathrm{Kimp24}}$) goods are obtained as

$$\mathbf{\Lambda}_{24} = \mathbf{X}_{24}\hat{\mathbf{x}}_{24}^{-1} \quad \text{(B.33)}$$
$$\mathbf{\Lambda}_{\mathrm{K24}} = \mathbf{K}_{24}\hat{\mathbf{x}}_{24}^{-1} \quad \text{(B.34)}$$
$$\mathbf{\Lambda}_{\mathrm{imp}\mathbf{24}} = \mathbf{X}_{\mathrm{imp24}}\hat{\mathbf{x}}_{24}^{-1} \quad \text{(B.35)}$$
$$\mathbf{\Lambda}_{\mathrm{Kimp24}} = \mathbf{K}_{\mathrm{imp24}}\hat{\mathbf{x}}_{24}^{-1} \quad \text{(B.36)}$$

We thus have separated prices from quantities. However, from the compilation of the SNA it is not possible to obtain *pure* quantities. The closest approximation that can be obtained is that of operating in volume terms (Wirkierman, 2010).

Appendix C

C.1. Activities nomenclature

Table C.1. Activities nomenclature

Shortened version	*Original name*
Agriculture	Agriculture
Fruit	Fruit culture
Livestock	Livestock
Silviculture	Silviculture
Fishing	Fishing
Copper	Copper
Other Min.	Other Mining
Food	Food
Beverages	Beverages and Tobacco
Textiles	Textiles
Wood	Wood and Furniture
Paper	Paper and Printing
Chemicals	Chemicals, Oil and Plastic
Non-Met. Min.	Non-Metallic Mineral Products
Basic Metals	Basic Metals and Metallic Products
Equipment	Metallic Products, Machinery, Equipment goods
Energy	Electricity, Gas and Water
Construction	Construction
Trade	Trade
Rest.&Hotels	Restaurants and Hotels
Transports	Transports
Communications	Communications
Financial Serv.	Financial and Entrepreneurial Services
Communal Serv.	Communal and Personal Services

Source: Own elaboration

C.2. Employment data

Table C.2. Rates of change of employment in yearly average percentage points

	$\Delta\%\ L^{(i)}$			$\Delta\%\ L^{(i)}_{\nu(g+k)}$			$\Delta\%\ L^{(i)}_{\eta(g)}$		
	96-03	**03-08**	**96-08**	**96-03**	**03-08**	**96-08**	**96-03**	**03-08**	**96-08**
Agriculture	-1.36	-2.05	-1.65	-3.17	0.72	-1.62	-2.32	0.84	-1.06
Fruit	-3.50	-0.75	-2.36	-1.56	0.41	-0.76	-1.56	0.28	-0.81
Livestock	-2.00	6.62	1.50	-7.68	9.70	-2.61	-4.51	6.57	-0.76
Silviculture	5.86	-10.68	-1.38	0.82	-9.01	-3.49	-2.75	-8.38	-4.42
Fishing	4.72	-1.82	1.94	14.53	-18.58	-7.14	14.43	-18.59	-7.15
Primary N.E.	**0.03**	**-0.72**	**-0.28**	**0.58**	**-7.03**	**-2.71**	**1.40**	**-7.19**	**-2.47**
Copper	-2.21	4.08	0.36	4.23	6.38	5.92	9.05	9.34	11.63
Other Min.	-2.44	5.47	0.78	-0.93	-1.31	-1.05	-1.62	-0.70	-1.20
Mining	**-2.29**	**4.55**	**0.51**	**3.13**	**5.12**	**4.43**	**6.72**	**8.02**	**8.83**
Food	0.64	1.17	0.86	-0.45	6.95	2.55	-1.35	7.25	1.95
Beverages	3.10	-1.09	1.33	2.74	-0.70	1.25	1.39	0.33	0.96
Textiles	-6.07	-5.98	-6.03	-3.77	-6.12	-4.07	-3.75	-6.04	-4.04
Wood	-0.67	4.65	1.51	10.43	-3.07	3.87	13.19	-3.29	5.06
Paper	9.83	2.91	6.89	6.00	2.16	4.78	6.33	1.13	4.37
Chemicals	0.85	1.62	1.17	5.94	0.79	3.93	5.86	1.30	4.18
Non-Met. Min.	-2.99	-0.81	-2.09	-0.46	-8.54	-3.72	-2.56	-4.66	-3.09
Basic Metals	2.91	3.01	2.95	14.15	15.60	21.19	14.25	18.87	24.01
Equipment	-2.18	1.62	-0.61	-0.84	4.30	1.20	-2.81	5.29	0.13
Manufacturing	**-0.37**	**0.96**	**0.18**	**0.86**	**3.22**	**1.93**	**0.32**	**3.49**	**1.67**
Energy	-5.81	8.85	0.04	-0.57	10.67	3.93	2.82	10.75	7.01
Construction	1.82	4.82	3.06	0.20	6.00	2.65	-	-	-
Trade	3.40	2.60	3.07	2.13	2.18	2.29	2.26	1.87	2.22
Rest.&Hotels	-0.04	6.91	2.80	-0.14	11.37	4.61	-0.77	11.64	4.14
Transports	3.11	1.90	2.60	4.67	2.04	3.85	6.29	0.74	4.11
Communications	3.40	7.63	5.14	6.42	7.44	8.23	2.61	8.56	5.75
Financial Serv.	4.35	5.21	4.71	2.57	2.19	2.58	-0.57	3.15	0.93
Communal Serv.	1.86	3.39	2.50	2.20	3.85	3.14	1.95	3.92	2.99
Services	**2.50**	**3.72**	**3.01**	**2.00**	**3.95**	**3.04**	**1.82**	**3.62**	**2.76**
Total	**1.62**	**2.79**	**2.10**	**1.68**	**3.01**	**2.38**	**1.67**	**3.03**	**2.38**

Source: Source: Own elaboration based on SNA, NSI and INDSTAT4 data

Table C.3. Decomposition of employment participation considering final demand only

	$L^{(i)}_{v(k+g)}$			$L^{(i)}_{\eta(g)}$		
	1996	**2003**	**2008**	**1996**	**2003**	**2008**
Agriculture	2.22	1.55	1.39	2.16	1.62	1.47
Fruit	2.66	2.12	1.88	2.72	2.17	1.91
Livestock	1.10	0.45	0.59	0.77	0.47	0.54
Silviculture	0.53	0.50	0.24	0.44	0.32	0.16
Fishing	1.65	2.98	0.18	1.72	3.10	0.19
Primary N.E.	**8.17**	**7.61**	**4.29**	**7.82**	**7.69**	**4.28**
Copper	2.63	3.05	3.49	3.68	5.39	6.86
Other Min.	0.71	0.60	0.48	1.03	0.82	0.68
Mining	**3.34**	**3.64**	**3.98**	**4.71**	**6.20**	**7.54**
Food	11.28	9.78	11.45	12.80	10.38	12.28
Beverages	1.56	1.66	1.40	1.90	1.87	1.65
Textiles	2.81	1.85	1.12	2.94	1.94	1.18
Wood	1.37	2.12	1.56	1.34	2.31	1.67
Paper	0.94	1.20	1.15	1.14	1.47	1.35
Chemicals	1.27	1.61	1.45	1.49	1.88	1.73
Non-Met. Min.	0.15	0.13	0.06	0.15	0.11	0.07
Basic Metals	0.27	0.48	0.74	0.28	0.50	0.85
Equipment	1.70	1.43	1.51	1.43	1.03	1.13
Manufacturing	**21.35**	**20.26**	**20.45**	**23.46**	**21.49**	**21.92**
Energy	0.43	0.37	0.50	0.73	0.78	1.04
Construction	11.56	10.49	11.85	-	-	-
Trade	13.79	14.18	13.67	12.87	13.35	12.68
Rest.&Hotels	2.98	2.64	3.60	3.32	2.82	3.87
Transports	4.61	5.48	5.25	5.08	6.55	5.90
Communications	1.23	1.59	1.90	1.74	1.84	2.28
Financial Serv.	5.91	6.24	6.02	10.39	8.93	8.98
Communal Serv.	26.61	27.48	28.49	29.82	30.35	31.52
Services	**67.14**	**68.49**	**71.28**	**64.00**	**64.62**	**66.26**

Source: Own elaboration based on SNA, NSI and INDSTAT4 data

C.3. Wage data

Table C.4. Wage coefficients per industry and sub system. Yearly percentage change.

	$\%\Delta z_n^{(i)}$			$\%\Delta u^{(i)}$			$\%\Delta \omega^{(i)}$		
	96-03	**96-08**	**96-08**	**96-03**	**96-08**	**96-08**	**96-03**	**96-08**	**96-08**
Agriculture	-3.12	-1.72	-2.54	-0.53	-2.31	-1.28	-0.35	-2.55	-1.27
Fruit	-3.48	0.67	-1.77	-2.34	0.67	-1.09	-2.99	0.97	-1.36
Livestock	-4.43	-1.26	-3.12	-1.52	-1.53	-1.52	-3.47	-0.86	-2.39
Silviculture	-2.59	0.95	-1.13	4.24	-2.56	1.35	3.21	-3.60	0.32
Fishing	-5.63	-7.43	-6.38	-2.22	0.26	-1.20	-1.93	0.43	-0.95
Copper	-5.80	-5.13	-5.52	-2.54	-7.51	-4.64	-0.01	-7.22	-3.08
Other Min.	-7.32	-4.20	-6.03	-4.87	-3.63	-4.36	-5.29	-2.15	-3.99
Food	1.72	-2.61	-0.11	0.52	-0.58	0.06	-0.48	-0.61	-0.54
Beverages	-1.64	-2.54	-2.01	-1.66	-0.66	-1.25	-3.07	-0.11	-1.85
Textiles	1.94	-2.71	-0.03	2.34	-1.44	0.74	2.25	-0.87	0.93
Wood	-3.34	-0.17	-2.03	0.94	-0.26	0.44	1.05	-1.17	0.12
Paper	-3.51	-5.48	-4.34	-1.53	-3.61	-2.41	-0.59	-4.56	-2.27
Chemicals	-3.64	-6.07	-4.66	-2.59	-4.36	-3.33	-2.76	-3.58	-3.10
Non-Met. Min.	-2.47	-7.36	-4.54	-1.43	-0.93	-1.22	-1.81	0.17	-0.99
Basic Metals	-4.83	-14.20	-8.85	0.43	-10.25	-4.17	1.01	-9.26	-3.40
Equipment	1.93	-2.48	0.07	1.93	-2.36	0.12	1.61	-1.93	0.12
Energy	-5.96	-11.70	-8.40	-3.18	-5.33	-4.08	-1.04	-4.71	-2.58
Construction	1.86	-6.86	-1.87	2.05	-5.47	-1.15	2.01	-4.92	-0.93
Trade	5.48	-1.85	2.36	3.87	-1.56	1.57	2.82	-1.42	1.04
Rest.&Hotels	2.61	-0.73	1.20	2.59	-1.81	0.74	1.60	-1.83	0.16
Transports	-2.84	-4.07	-3.36	-2.42	-3.45	-2.85	-1.22	-4.74	-2.70
Communications	-7.36	-3.71	-5.86	-1.34	-1.88	-1.57	-4.09	-0.75	-2.71
Financial Serv.	-0.48	-1.40	-0.86	0.49	-1.84	-0.49	-1.44	-0.86	-1.20
Communal Serv.	0.93	1.15	1.02	1.31	0.50	0.97	0.83	0.27	0.60

Source: Own elaboration based on SNA data

Table C.5. Relative wages participation (%) minus Relative output participation (%)									
	$\%totw^{(i)} - \%y^{(i)}$			$\%totu^{(i)} - \%y^{(i)}$			$\%tot\omega^{(i)} - \%c^{(i)}$		
	1996	**2003**	**2008**	**1996**	**2003**	**2008**	**1996**	**2003**	**2008**
Agriculture	0.19	-0.09	-0.18	-0.15	-0.29	-0.34	-0.11	-0.26	-0.35
Fruit	0.41	0.03	-0.13	0.21	0.08	-0.12	0.21	0.05	-0.18
Livestock	0.69	0.44	0.51	-0.05	-0.07	-0.10	-0.02	-0.09	-0.10
Silviculture	0.36	0.54	0.70	-0.03	0.04	0.07	-0.02	0.06	0.08
Fishing	0.32	-0.59	0.46	0.01	-0.14	-0.23	-0.13	-0.25	-0.27
Primary N.E.	**1.97**	**0.33**	**1.35**	**-0.01**	**-0.37**	**-0.73**	**-0.08**	**-0.49**	**-0.82**
Copper	-3.73	-6.17	-3.55	-2.05	-3.51	-0.96	-2.28	-2.16	1.05
Other Min.	0.00	-0.45	-0.04	-0.16	-0.37	-0.03	-0.03	-0.30	0.09
Mining	**-3.73**	**-6.62**	**-3.58**	**-2.21**	**-3.89**	**-1.00**	**-2.32**	**-2.47**	**1.14**
Food	-5.60	-4.41	-5.41	-1.97	-1.88	-1.91	-2.33	-2.31	-2.64
Beverages	-1.24	-1.81	-1.98	-0.46	-0.95	-1.07	-0.48	-1.12	-1.30
Textiles	-0.74	-0.88	-0.81	-0.40	-0.55	-0.60	-0.70	-0.72	-0.74
Wood	-0.44	-1.22	-1.10	-0.29	-0.48	-0.52	-0.31	-0.47	-0.65
Paper	-0.10	-0.32	-0.95	-0.40	-0.30	-0.72	-0.57	-0.25	-0.87
Chemicals	-0.35	-1.09	-1.12	-1.19	-1.65	-1.37	-1.43	-1.83	-1.50
Non-Met. Min.	0.54	0.29	0.25	-0.03	-0.09	-0.05	-0.03	-0.08	-0.05
Basic Metals	0.20	0.03	-0.23	-0.09	-0.06	-0.04	-0.12	-0.06	-0.02
Equipment	0.43	0.46	0.15	-0.50	-0.39	-0.58	-0.59	-0.38	-0.58
Manufacturing	**-7.30**	**-8.95**	**-11.21**	**-5.34**	**-6.35**	**-6.86**	**-6.55**	**-7.23**	**-8.36**
Energy	0.10	-0.59	-0.02	-0.58	-0.91	-0.29	-0.39	-0.56	0.10
Construction	-1.57	-0.35	-2.61	1.40	1.72	0.30	-	-	-
Trade	-1.71	1.96	1.06	-0.60	0.97	-0.19	-0.90	0.28	-1.07
Rest.&Hotels	-0.31	-0.20	-0.67	0.01	0.12	0.02	-0.05	0.02	-0.22
Transports	0.89	-1.36	-2.36	-0.58	-2.37	-2.88	-1.10	-2.41	-3.66
Communications	-0.03	-0.78	-1.26	-0.30	-0.65	-1.11	0.01	-0.64	-1.16
Financial Serv.	2.63	3.81	4.63	-1.75	-2.25	-3.38	1.05	-1.19	-2.11
Communal Serv.	9.08	12.73	14.67	9.95	13.97	16.12	10.33	14.68	16.16
Services	**9.07**	**15.24**	**13.44**	**7.56**	**10.61**	**8.58**	**8.95**	**10.18**	**8.03**

Source: Own elaboration based on SNA data

Table C.6. Relative wages participation (%) minus Relative employment participation (%)									
	$\%totw^{(i)} - \%L^{(i)}$			$\%totu^{(i)} - \%L_v^{(i)}$			$\%totu\omega^{(i)} - \%L_\eta^{(i)}$		
	1996	**2003**	**2008**	**1996**	**2003**	**2008**	**1996**	**2003**	**2008**
Agriculture	-3.25	-2.85	-2.15	-1.47	-1.07	-0.97	-1.34	-1.03	-0.95
Fruit	-1.63	-1.03	-0.64	-1.16	-0.79	-0.57	-1.11	-0.77	-0.55
Livestock	-2.58	-2.23	-2.63	-0.65	-0.30	-0.42	-0.41	-0.30	-0.37
Silviculture	-0.93	-1.32	-0.12	-0.29	-0.38	-0.10	-0.23	-0.27	-0.08
Fishing	-0.95	-1.89	-1.73	-0.61	-1.73	0.20	-0.60	-1.71	0.20
Primary N.E.	**-9.33**	**-9.32**	**-7.27**	**-4.19**	**-4.26**	**-1.85**	**-3.68**	**-4.07**	**-1.75**
Copper	2.66	2.21	3.23	2.82	2.59	3.34	3.10	3.00	3.51
Other Min.	0.61	0.26	0.05	0.36	0.20	0.06	0.43	0.23	0.08
Mining	**3.27**	**2.48**	**3.28**	**3.18**	**2.79**	**3.40**	**3.53**	**3.23**	**3.59**
Food	-1.77	-1.74	-1.35	-4.78	-4.55	-5.55	-4.89	-4.46	-5.57
Beverages	0.10	0.09	0.14	-0.12	-0.09	0.10	-0.09	-0.07	0.10
Textiles	-0.99	-0.49	-0.40	-0.82	-0.44	-0.33	-0.78	-0.42	-0.32
Wood	-0.06	-0.14	-0.32	-0.22	-0.59	-0.31	-0.18	-0.58	-0.30
Paper	1.25	0.31	0.10	0.58	0.08	0.05	0.61	0.10	0.06
Chemicals	0.26	0.53	0.04	0.18	0.30	0.08	0.24	0.34	0.09
Non-Met. Min.	0.04	-0.01	-0.09	0.02	0.01	0.00	0.02	0.01	0.00
Basic Metals	-0.29	-0.43	-0.51	-0.05	-0.14	-0.21	-0.04	-0.12	-0.20
Equipment	-0.98	-0.32	-0.24	-0.36	-0.13	-0.08	-0.26	-0.08	-0.05
Manufacturing	**-2.43**	**-2.20**	**-2.63**	**-5.58**	**-5.55**	**-6.24**	**-5.37**	**-5.27**	**-6.19**
Energy	0.61	0.49	0.28	0.26	0.25	0.10	0.32	0.30	0.12
Construction	4.83	2.89	0.75	4.18	2.53	0.66	-	-	-
Trade	-5.67	-4.01	-4.24	-3.18	-1.92	-2.08	-2.36	-1.55	-1.74
Rest.&Hotels	-0.80	-0.65	-0.77	-0.88	-0.66	-0.88	-0.84	-0.64	-0.87
Transports	0.17	-0.05	-1.07	0.06	0.08	-0.51	0.17	0.26	-0.48
Communications	-0.02	-0.48	-1.02	0.07	-0.15	-0.52	0.20	-0.10	-0.49
Financial Serv.	9.19	8.51	9.26	5.70	4.39	4.42	6.85	4.86	4.22
Communal Serv.	0.22	2.37	3.45	0.42	2.54	3.54	1.20	3.01	3.62
Services	**8.53**	**9.08**	**6.65**	**6.63**	**7.05**	**4.73**	**5.57**	**6.15**	**4.37**

Source: Own elaboration based on SNA data

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