Title: Capabilities for production and technological innovation: The role of applications in a developing country.

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Abstract:

The main point of this paper is analytical, in respect of making a case for a applying a theory of production based on 'capabilities'. By stretching the concept of capabilities to the production arena and building on innovation studies work, we can reinterpret the activity of production and its history. We argue producer capabilities complement consumer capabilities as part of the freedoms people have to live in ways they value. As a result, we propose systems alignment as a policy strategy to enhance producer capabilities and build regional systems of innovation, which – we believe - could be the basis for the rise of environments favouring human development. We use as exemplars two case studies, namely copper mining and fruit growing in Chile.

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1. Introduction

The paper presents the concept of producer capabilities, defined by von Tunzelmann and Wang (2007), as part of the freedoms people have to lead lives they can value. By applying the concept of capabilities to production and building on innovation studies, we answer why producer capabilities are important. We use the cases of copper mining and fruit growing in Chile, and examine the historical development of these sectors and the employment of doctoral graduates in these industries, from a producer capabilities perspective. Comparison of these cases allows a revision of our propositions. As a result of our analysis, we propose systems alignment as a policy strategy to enhance producer capabilities and build regional systems of innovation. We believe that this could become the basis for environments that favour human development.

Section 2 presents the case of producer capabilities from a conceptual perspective; Section 3 looks at the historical development of producer capabilities in copper mining and fruit growing in Chile and reviews our initial argument. Section 4 concludes with some policy recommendations.

2. Definition of producer capabilities

If as consumers we exert capabilities which give us utility from products and services, as producers we also depend upon our capabilities to obtain profitability from transforming productive resources, the same applies to individuals and organisations (von Tunzelmann, 2009). In each case, the diversity of these capabilities explains in part the diversity of the utilities and profitability obtained. The roles of consumer and producer are related since they can be performed by the same individual or organisation; consumers' utility and producers' profitability both contribute to living our lives in more valuable ways.

Our understanding of producer capabilities in this paper implies some revision of production theory. In what follows we discuss producer capabilities in relation to production theory and consumer capabilities. We present von Tunzelmann's (2009) three-fold model as an integration of the concept of producer capabilities with economic theory. The section concludes with a discussion of the relationship between competencies and capabilities and why producer capabilities are important.

2.1. Production theory

One of the motivations for this study is to overcome the limitations of production theory. The dominant economics approach to production is based on the assumption that firms always attempt to produce the maximum possible from the resources available and aim at maximising economic profit (Samuelson and Nordhaus, 1998). The maximum production from each level of inputs is represented by a production function. Each product or service has an associated production function which depends on the state of technological development. As pointed out by von Tunzelmann and Wang (2007) production theory in neoclassical economics has several limitations in that it ignores time, is supply driven and has difficulties to deal with the issues of quality and process innovation.

The production function does not include time and time is considered only indirectly in evaluative measures (e.g. in terms of resources per year or products per week). However, time is crucial to make sense of production in a practical way. Decisions about production are often related to time saving, for example, to be first to the market, or to meet production deadlines. Of course, time saving decisions may be based on an evaluation of the alternatives, which may include cost-benefit analysis in order to decide whether to adopt labour intensive or capital intensive production strategies. Saving time and saving money may be related, but also can constitute individual aims. The timelessness of neoclassical economics makes it difficult to interpret phenomena where time is a decision factor. In our view, time is crucial for learning processes and, therefore for explaining change. A static economic theory cannot deal with change.

Neoclassical production theory focuses on representations and analysis of supply. Producer behaviour is explained by the notions of optimisation and equilibrium, which does not leave room for producer diversity: all are assumed to produce to their maximum ability (represented by the production function), which is determined by the availability of technology.

Representations of price-based, market systems have difficulty in accommodating the notions of quality and process innovation. Neoclassical production theory works better with homogenous and discrete variables rather than the shades of grey related to quality. Price-based models focus on outputs (supply, production quantities, etc.); processes are hidden to the production function.

Production possibilities are dynamic, both generally and for each individual producer. Changes that can affect the general context for producers include new environmental regulations that lead to the disappearance of a production possibility, or a new technology

that enables production that previously was not possible. Changes in firms' conditions may change their production possibilities by enabling an improved process without a corresponding capital investment.

Because production capabilities take account of differences amongst producers, and of time – particularly the time required for learning and accumulating producer capabilities - we propose production capabilities as a bridge between production possibilities and production results and benefits.

2.2. Producer capabilities and consumer capabilities

Individuals and their organisations can play different roles. For example, in the economic system they may be consumers, suppliers and producers either separately or simultaneously at different moments in time. Since the same actor may take on all three economic roles, then even from a strictly economic point of view, the actor's overall well-being will depend on his or her overall experience. Sen's (1985) work pays special attention to the role of the consumer and how it contributes to the happiness of the individual. His remarkable work added a new dimension to economic understanding which we believe could be extended building on von Tunzelmann and Wang's (1997) understanding of producer capabilities as analogous to consumer capabilities.

Sen (1985) defines consumer capabilities as the real choices made by the individual to achieve forms of being. 'Real choices' are determined by the individual's way of life, command over goods, and life circumstances. Similarly, producer capabilities represent the real choices made by the individual to transform resources into profits, choices that are constrained by the individual's values, life circumstances or being, and command over resources. The process of transformation itself constitutes a form of 'being'. Production is a means to obtain profit and, therefore, access to goods and services, but production may also

be valuable in itself. The profit achieved may have various manifestations, the most obvious being enhanced consumer capabilities and enhanced access to goods.

This representation of consumer capabilities is mirrored in von Tunzelmann's (2009) definition of the outcomes for producers –firms or individuals- using nested vectors.[1] Individuals as producers– the focus in this paper – have access to a vector of resources, y_j, with certain characteristics. Giving his or her personal attributes and circumstances, the individual producer has a choice of transformations to the vector of resources. The production transformations for y_j are represented by the vector $t(y_j)$ and moderated by an efficiency function $g(t(y_j))$. The efficiency function acts as a moderator by providing a space for the various outputs achieved by the individual from the transformation of a set of resources. The vectors t_j correspond to the individual's production posibilities from a set of resources $y_{j,}$ the vectors g_j correspond to the individual's producer capabilities . Each individual has a specific set of vectors $y_{j,}$ t_j and g_j associated with their personal lifestyle and circumstances and historical context. Production possibilities and producer capabilities are historical, therefore, the vectors $y_{j,}$ t_j and g_j represent the picture at a given moment in time along a continuum of values for these vectors throughout the life of the individual. The transformation of resources will result in a profit for the individual producer represented by $p(g(t(y_j)))$. The producer capabilities of an individual m can be represented as $R_m(Y_m)$ for some $g_j \in G_m$ and some $y_j \in Y_m$

where:

G_m is the set of the individual production possibilities

Y_m is the set of the individual's command over resources

[1] The following formal analysis is extracted from von Tunzelmann and Wang, 2007, and von Tunzelmann 2009.

Production possibilities and producer capabilities change over time, that is, they are dynamic. Individual production possibilities may change as a result of technology changes or improved ability to recognise opportunities not previously identified. D'Agata (1997) refers to 'Adaptive Learning' to describe the process of dynamic changes to the utilisation function, in our case, production possibilities. The advances he makes by formalising a dynamic capabilities model that includes time could be applied also to producer capabilities. Changes to producer capabilities can be explained as result of learning processes, particularly those occurring as a result of interaction in several networks. Examples of such interactions include those between the education system and the production system aimed at learning how to use a new technology through formal training and practical on-the-job training, or interacting with suppliers to improve a production process. Section 2.4 examines interactions with the education system in the discussion on competencies and capabilities.

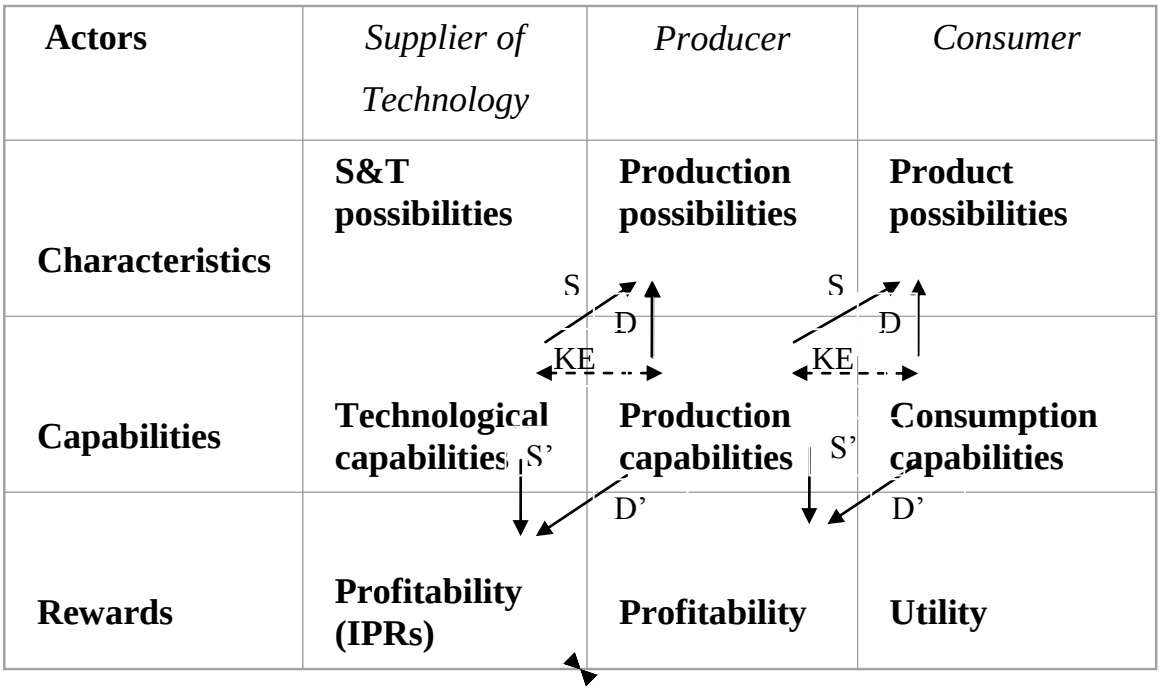
Extending Sen's approach to conceptualise producer capabilities overcomes some of the limitations of the dominant production theory. Consumer diversity can be matched to the diversity of the products available on the market and the heterogeneity of producers. Section 2.3 presents von Tunzelmann's (2009) threefold framework for understanding production from a capabilities perspective.

2.3. The threefold model: supplier – producer – consumer

Although Sen has reflected on the relationship between consumer capabilities and work, there is not a conceptual framework to link the benefits –utilities and profits – obtained by individuals in their roles of producers and consumers. However, he does acknowledge the importance of this relationship for the capabilities approach. For example, Sen (1997) identifies the damage wrought by unemployment beyond its effects on income and Sen (2000) looks at the relationship between work and human rights. The introduction in Sen's

(1999) *Development as Freedom* tells a moving story of a man who has to choose between looking for work in a hostile area and starvation for his family to illustrate lack of freedom in economic transactions. In choosing work the man finds death. His resources were his labour, but circumstances made it impossible either for him to profit from his resources or to do or be something that he and others might have valued. Thus, consumer capabilities and producer capabilities can be understood as two sides of the same coin; the achievements of one person occupying two different roles. Von Tunzelmann (2009) proposes a threefold model (see Figure 1) to understand the relationship between supplier, producer and consumer from a capabilities perspective: the capabilities schema. A capabilities perspective distinguishes Sen's three levels of characteristics of the goods and resources actors can access (1st row), their freedom to transform or consume them (2nd row) and the utilities or profits they obtain (3rd row).

Figure 1: The capabilities schema



Source: Von Tunzelmann (2009)

In this three-fold model of production each producer – individual or organisation - acts as a

consumer of resources (and goods and services) and as a supplier of goods and services to clients and customers. Their contribution is expressed in the diversity of the products offered, their capabilities to transform or use the resources and products, and the benefits (profits and utilities) they receive. The model shows the active relations among the actors and the complementary relations in the different roles assumed by individual actors more or less simultaneously. These relations promote learning and capabilities accumulation which change the situation over time. The threefold model can be used as a tool to understand and interpret new situations and different actor behaviours, in the context of policy making and government planning. However, it needs some development and more information is required to measure the various concepts.

The capabilities schema shows that production possibilities are influenced by producer and consumer capabilities (Supply and Demand arrows); to be able to develop a product is not enough if there is no consumer capable of obtaining marginal utility from that product. In this model, the technology supplier is an example of one of the actors in the supply chain; more columns could be added to the left to represent other actors. The possibilites for the suppliers of technology – and by analogy of other suppliers - to obtain profits, depend on their producer capabilities, but also on the capabilities of consumers (Supply' and Demand' arrows). Universities and university scientists could be the suppliers of technology, and their possibilities for engaging in long term projects would depend on their producer capabilties, and long term commitment on the demand side. The innovation studies literature has for long argued about the convergence of technology (supply side) and demand for successful product innovations (Rothwell et al., 1974; Tidd et al., 1997).

The upstream situation is similar. Production possibilities depend upon both technological capabilities and production capabilities. There is a large body of research in innovation studies that reaches the same conclusion. Expansion of production possibilities and higher

profits requires both technological capabilities and producer capabilities. A related concept that encapsulates some of the findings in this area is 'absorptive capacity' (Cohen and Levinthal, 1990). Producer capabilities determine supplier profitability by generating demand. In particular, producer capabilities and technology exchange drive the demand for jobs and define what those jobs will be. Producer capabilities are not homogeneous, the model allows for diversity in production efficiency, which is reflected in the impact of production capabilities and technological capabilities on profitability (Supply' arrows). Profitability may be different for different producers within the same context. The particular alignment of producer and consumer capabililies can result in innovation leadership while mismatches between technological and producer capabilities can result in reduced productivity. The solid arrows in the capabilities schema are market interactions, but these are not the only interactions that occur. The elements of the capabilities schema can produce several interactions resulting, for example, in the exchange of knowledge (Knowledge Exchange arrows). Actors learn by exchanging knowledge, learning which has an impact on their capabilities. For example, producers learn from suppliers and learn from using different suppliers' technologies/products. This learning drives the transformation of producer capabilities and other interactions, which are explored below.

2.4. Capabilities and competences

Producer and consumer capabilities change over time. As von Tunzelmann and Wang (1997) note, Sen refers to the role of learning in changing consumer functionings, although it is not an area he explores in depth. In the case of producer capabilities, changes to transformation processes are related to both radical and incremental innovation, and to changes to working routines. We suggest that new production possibilities should be understood as the result of changes to producer capabilities, and we explore how these may emerge.

One of the sources of changes to producer capabilities is the dynamic relationship between the accumulation, conversion and transposition of competences and capabilities. In our perspective there is a complementary relationship between the attributes of individuals in relation to professional performance (which we call competencies), and the actual professional practice or process of doing through which these attributes are developed, which results in the accumulation of what we call producer capabilities. Competencies – in contrast to producer capabilities - correspond to a stage of potential and to the enhancement of the resources that could be exploited in production; capabilities relate to actual usage of skills and enhancement of the services thus provided (von Tunzelmann, 2009).

Von Tunzelmann (2009) illustrates the differences between competencies and capabilities using the case of doctoral graduates in Moscow acting as taxi-drivers because this was the most lucrative employment they could find. The case of formal education and work practice exemplifies the relationship between competences and capabilities in terms of time. An individual that studies for a degree in chemical engineering developscompetences that potentially are applicable to several productive sectors. The first job may be in a technical position in the mining sector. Over the course of 10 years, she develops capabilities orientated to the mining sector; she exploits her potential and accumulates experience based knowledge. Up to this point, competence precedes capabilities development. During the 10 years experience as a technical engineer, managerial responsibilities are accumulated through supervision of a group of engineers and technicians and responsibility for the laboratory's budget. Management capabilities oriented to satisfying the firm's requirements (output oriented) are accumulated on the job. Over time, this experience in management becomes a competence that can be transferred to another context or used to apply for a job with management responsibilities. At this point, capabilities precede competence. The individual may decide to improve her management skills by enrolling in a formal postgraduate

programme in business administration. Her experience as a laboratory manager informs her formal management learning and practice is re-examined in light of new findings. Learning is accumulated by searching and reading for the course which results in a credential validating her competence. At this point, competence and capabilities interact synchronously. Of course, this journey may not be straightforward: it may be a struggle to achieve promotion or secure funding for further study. However, struggles can become the drivers of a dynamic process of competencies and capabilities accumulation.

Competencies and capabilities are simultaneously in place in the dynamics of transformation of one into the other, which may occur simultaneously also or with different leads and lags. We propose some integration with the capabilities approach in education (see Robeyns, 2006; Unterhalter, 2005); we would suggest that education is concerned – at least to some extent - with the development of competencies. In the case of universities, the subjects they teach became a measure of their capabilities, while at the same time they contribute to building competences in their students. The distinctions made here allow for an exploration and understanding of the lags and leads between the acquisition of competencies and the accumulation of producer capabilities.

2.5. Why are producer capabilities important?

There are four reasons why producer capabilities are important. First, is the need to advance the theorisation of production and, in our view, focusing on producer capabilities is a way forward. We believe that the transformation of resources into products is the crux of producer capabilities. The process of transformation process articulates demand and supply and, therefore, should be at the centre of economic theory. Producers need to be Janus-faced: focusing on the supply of resources and the demand for their products or services.

Second, producer capabilities correspond to a stage of realisation when the enhancement of resources begins to influence human development. Human capital theory focuses on potential, on preparing an input for production in the linear understanding of production (from inputs to outputs). By focusing on producer capabilities we move from an individual to a collective and contextual focus. While acquiring a competence can be seen as an individual effort, producing and developing producer capabilities is a collective process that occurs in a particular historical context. The ability to develop producer capabilities depends (at least) on technological/supplier capabilities and consumer capabilities, as proposed in the three-fold model.

Third, there is the issue of time. Producer capabilities are dynamic and accumulate over time as a result of learning. The process of building producer capabilities follows different patterns depending, for example, on the producer's circumstances.

The fourth reasons concerns human development. Our proposition builds on the indivisibility of the roles of producer and consumer in human experience. Producing constitutes doing and, to an extent, implies a way of living. The advice of the Nobel prize winning Chilean poet Gabriela Mistral (1931) is to find a job that gives one a living and a life. Choosing one's trade is the first condition for loving one's trade (Mistral, 1927). An individual's producer capabilities express that person's freedom to participate in the processes of transformation. Although not everyone is a member of the labour force, participation in it has implications for an extended group, for example, the household. The breadwinner's job may determine the place of residence and the number of hours that children and parents/carers enjoy together. In this paper, the focus is on production in a market economy, but resources are transformed into products by individuals in other contexts (e.g. in the domestic process of cooking).

Producer capabilities can enhance consumer capabilities by providing access to goods, services and new, more valuable functionings. Enhanced producer capabilities can allow individuals to do jobs they love and to be part of a worker community. Since production is a social process that often involves a collective, it can be difficult to interpret production capabilities using an individualistic approach. Below, we describe two case studies of historical developments of producer capabilities in copper mining and fruit growing in Chile.

3. Historical development of producer capabilities

The historical development of copper mining and fruit growing in Chile is used to explain and review the theoretical proposition in this paper. These examples illustrate how producer capabilities are related to human development and how our theoretical proposition relates to practice. Innovation studies research examines technological learning processes in organisations and sectors over time, and other disciplines have looked at individual's learning processes, but do not connect the individual and collective analytical levels in the context of production and technological change. The analytical focus in this paper is on individual actors and the history of industry sectors from the perspective of the individual workers, with special attention to doctoral graduate employees.

3.1. Use of case studies

The cases studied are copper mining and fruit growing in Chile. We use the cases to provide 'contextualized explanations' (Welch et al., 2011), which are used to provide an alternative to inductive theory-building. The cases interconnect with the theory by illustrating and identifying gaps and contradictions. Since producer capabilities development is contextual, we examine the cases from a historical perspective.

We have presented producer capabilities as the real choices made by a person or a firm about transforming resources into profits. As already noted, they are constrained by the individual's way of life, command over resources, and circumstances. We would suggest that we need to take account of the context of producer capabilities accumulation which will necessarily be tied to location and history. A case study research strategy embraces context by examining a phenomenon in its historical and geographical setting (Ragin, 1992). Our interpretative approach attempts to produce a holistic and particularised explanation of each case. Comparison of the cases allows a dialogue with the theory.

Numerous studies (e.g. Malerba, 2004) identify the relevance of sectoral characteristics for the development of productive activities, but pay little attention to the relationship between sector and an individual's possibilities for learning. In what follows we analyse the history of a particular type of worker in Chile, the doctoral graduate, to explore how sector dynamics and history determine the direction of individual learning processes and the accumulation of producer capabilities at the personal, organisational and sectoral levels. We use the case of Chile because we are interested in the country and the region. The cases were selected on the basis of their similarities in terms of being well established industries with internationally good economic results. Since the study is based on a single country, many of the regulatory and infrastructure issues are similar. The decision to focus on doctoral graduates' histories was based on the assumption that these individuals are likely to have more options in terms of producer capabilities, for example, several alternatives occupations (unemployment among doctoral graduates in Chile is very low). It has been noted that human capital theory tends to overlook the relevance of context in relation to education. We explore the issue by looking at the relationship between individuals with the highest qualification in the formal education system, and the context. Our study of doctoral graduates illustrates the how individuals could

value a job as a way of life, even as part of their identity. Coevolution of governance and technology

We apply the ideas of historical co-evolution and alignment of systems proposed by von Tunzelmann (2003, 2010). Using historical evidence, von Tunzelmann proposes that technology creation and application are somehow aligned with governance over the histories of industry sectors. Governance refers to the organisation of collective action and includes the issues of structure – how decisions are made, control – the power to make decisions within structures, and process – the implementation of structure and control (von Tunzelmann, 2003: 366). Von Tunzelmann interprets industrial history as consisting of three industrial revolutions, and analyses technological breakthroughs and dominant modes of governance. He presents a table with a simplified overview of their main characteristics to compare epochs (von Tunzelmann, 2003: 371). His depiction inspired the historical interpretation of copper production and fruit growing in Chile in this paper. von Tunzelmann deals with the phenomenon of industrial revolutions involving different locations and economic sectors; this framework is adapted to interpret the history of particular sectors in a single location, Chile. Matching governance changes and technological changes seems useful to identify the characteristics of these two dimensions chronologically, and look for relationships, not in terms of cause and effect, but to understand how technological changes and governance changes align over time. The result suggest relationships in both directions and describe some drivers of change, for example, new production processes on the technology side, and new actors and structures on the governance side.

The data were obtained from historical accounts by academic researchers and papers on the development of the industries written from economics, and technology and innovation perspectives. Sources were searched to identify commonality among events regarded as relevant in the development of the sectors including the promulgation of laws and breaks in

production and export trends, ordered along a timeline. The distinctions proposed by von Tunzelmann suggested a focus for the search, for example: What process type was in place? What type of capitalism was dominant? The search process was informed by empirical research into the work histories of a group of eight doctoral graduates in each sector. Their work histories were constructed as case studies based on work history interviews, Internet and document searches, and workplace observation. Interview narratives were especially helpful for searching for sector history. Interviewees described events in their work history that they considered particularly significant, for example, nationalisation of the copper industry, agrarian reform, establishment of a research institute and laws related to research funding. Interview transcripts were coded in relation to historical events. The cases raised other questions about context, for example, the timing of the first university programmes in mining engineering and who invested in technological research and development during agrarian reform?

The first stage search for historical events produced a timeline of milestones, which were used to fill von Tunzelmann's table, and summarized the co-evolution of systems of governance and technology over long periods of time. It was an iterative process of revisiting sources to fill in gaps and searching for debates on the development of the main events. While organising the findings and deciding how to identify epochs (comparable to von Tunzelmann's) it appeared important to understand – or at least achieve some interpretation of - how events emerged. Event in isolation lacked process: how can we understand the nationalisation of copper or agrarian reform without investigating their origins? The second stage search involved extending the most significant events back to their origins and forward to their consequences, and identifying transition periods. The picture that emerged became a continuum of events (now understood as processes) running into one another. The last stage

involved distinguishing epochs and the transitions from one to another, and reviewing the results.

3.2. Chile

Chile has 17 million inhabitants and belongs to the group of middle income countries. It is a small, open economy with good economic performance in the context of the Latin American region. International evaluations consider Chile's macroeconomic management and stability since 1990 to be important assets; its economic growth has had positive effects on alleviating poverty, although the distribution of income remains very unequal (OECD, 2007: 9). The Chilean government designed a strategy for long-term competitiveness and innovation, to enable sustainable economic growth and development and double the national income by 2021 (CNIC, 2007). This strategy is based on fostering innovation in a group of strategic clusters, including copper mining and fruit growing. In 2009, Chile joined the OECD group of countries; it ranks 45 in the Human Development Index (improving between 1980 and 2010 and above average for Latin America and the Caribbean, UNDP, 2010).

Chile is a long, thin country with hugely contrasting geography and climate. Copper mining is concentrated in the north of Chile, and is the main economic activity in most northern regions, while the fruit growing area is mainly in the valley regions in the centre of the country. Copper: a history of catching up

Chile is the world's main copper producer, accounting for a third of global production. Copper is central to Chile's economy, representing more than 20% of GDP and around 60% of total exports (COCHILCO, 2006). Despite copper's economic and cultural significance, in 2002 mine workers accounted for only 1% of the work force (INE, 2003). Copper industry workers have the highest average years of schooling among the productive sectors in the Chilean economy (11.6 years in 2002; Ibarra, 2006), and this sector has the highest

percentage of unionisation and pays the highest salaries. Official statistics count only workers employed in copper producing firms and do not include workers in other organisations indirectly involved with the production of minerals. Katz et al. (2000: 30) estimate that in 1996, a total of more than 8,000 professionals were employed in engineering firms serving the copper industry in Chile.

The majority of Chile's copper output comes from the Great Copper Mining (GMC - Gran Mineria del Cobre), managed by the public company CODELCO and some big private companies owned by local investors and subsidiaries of international mining companies. There is a group of small firms that is technologically backward and dependent on state subsidies which come under the umbrella of the public owned processing company, ENAMI, and are engaged only in mineral extraction. Table 1 presents three epochs of dominant systems of governance and technology and their characteristics.

Table 1: Characteristics of stages in the history of copper mining in Chile

Characteristics	Early Period	GCM Development	Expansion and Catching up
Approximate dates	1820's-1880's	1920-1973	1975-1999
Location of leaders	UK etc.	US...	Chile, Australia, US, Canada, South Africa
Role of Chile Internationally	Important producer - unstable	Important producer - stable	Main producer
Chilean Strategy 'Copper for the country'	Source of government funding. Individual basis- govt as host	Source of government funding – ownership basis -	Source of government funding – more complex tax/finance

		tax system + 'cash cow' attitude	system –role of market failure etc.
Demand	Demand from UK	World champions	Global
Technology leaders	Small and medium firms, some imports	Big business	International
Technologies	Rudimentary	Standard, kept by the investors	Complex, information and communication technology, biotech, environmental solutions
Automation	of transformation	of extraction	of control (at a distance)
Process Type	Labour	Capital	Information/knowledge
Size of firm	Small/medium	Big/GCM	GCM and network
Advantages	High ore grade	Internal integration	External integration
Organisation	Entrepreneurial	Multidivisional	Networked
Industry structure	Competitive	Oligopolistic	Mixed
Type of Capitalism	Personal	Managerial	Collaborative
Property	Mostly Chileans	From mostly foreign to 100% public	Hybrid
Mode of Governance	Markets	State	Hybrid; market rules; regulation development

Power	Landowning	Capital	Knowledge
Skills	Physical	Professional	Specialised/expert
Education	Development of primary education system Foundation of universities	Massification of primary and secondary education Professionalisation	Massification of higher education; Foundation of the postgraduate system
Governance Actors	Small and medium firms; some foreign investment	SONAMI mining engineers; government agencies; unions	CODELCO Large international and national players; Small firms less important

The historical review starts shortly after Chile's independence in 1810. Mining was always important to the Chilean economy. Salazar and Pinto (2002) argue that following incorporation of the Chilean territory with the imperial Spanish system, economic growth was driven by exports. After independence, gold mining declined and Chile became an important producer of silver and copper. Copper mining represented more than 80% of Chile's exports between 1859-1875 when Chile commanded some 44% of the world market (Salazar and Pinto, 2002:116). The 19th century was a period of slow technological change in the copper industry in Chile compared to international competitors, and was much less labour intensive than in other countries (Collier and Sater, 2004: 79). The industry comprised mainly small and medium sized firms controlled by Chilean entrepreneurs, and a few British-owned copper concerns (Collier and Sater, 2004: 80).

In the 1880s, copper production in Chile began to decline and did not begin to recover until the 1920s. During the intervening period the country was sustained by the nitrate mining boom, which was the main source of state revenue and allowed for infrastructural developments (Meller, 1996). The decline in Chile's copper production coincided with increased demand for copper internationally due to industrialisation and the growth of electrical, and telegraph and telephone systems. The historical reasons proposed for this decline are that Chilean producers did not embrace technological change and update their production methods to exploit large deposits of lower grade ore (Collier and Sater, 2004: 139, 160). The new technological system for mining was based on large scale, capital intensive processes. Copper mining in Chile collapsed, unable to compete with European and US firms with superior technology and greater capital endowments (Salazar and Pinto, 2002: 118; Collier and Sater, 2004: 140). By the end of the 19th century Chile's share of the world market for copper had fallen from over 30% to just 10%. In 1911 Chile's share of the world market was only 4% (Collier and Sater, 2004: 160).

The two forces that shaped the 20th century copper mining industry in Chile were foreign investment and state intervention. A new form of capital intensive mining, GMC, emerged, characterised by huge mines. At the beginning of the 20th century the copper industry was in need of an injection of capital investment, but local capital was directed to the shorter term profitability nitrate industry (Collier and Sater, 2004: 160). Nitrate production was at its peak between 1900 and 1920 (Meller, 1996: 42) before declining and collapsing with the onset of Great Depression in Chile in 1930. The end of the nitrate era left a painful legacy of unemployment, famine and misery.

The lack of interest in copper among local investors was not shared by foreign investors. The copper industry began to grow at the beginning of the 20th century based on massive US capital investment (Salazar and Pinto, 2002: 119; Meller, 1996:31). The explanation given for

the process of ‘copper denationalisation’, is the capital intensive nature of copper mining and the long investment required (Meller, 1996: 34).

Following the nitrate mining experience, there was concern about how mining revenues would be appropriated, and the prominence of foreign investments was controversial. There are accounts of debates as early as 1916 calling for state intervention (Salazar and Pinto, 2002: 124). By the 1950s, copper industry taxes and regulation had increased (Meller, 1996: 36). There is little information on the strategic development of the copper mining industry pre 1955, and there was an enclave of international investors with few relations to local actors (Salazar and Pinto, 2002: 126). There were tensions between the state and international investors, which were resolved by nationalisation of the industry in 1966 and Chileanisation in 1971. Nationalisation was the acquisition by the Chilean state of 51% of the GMC companies. Chileanisation was a law voted in unanimously by parliament, which implied state ownership of 100% of the GMC, organised as the public company CODELCO. Shortly after that was a military coup and huge transformations to the economy. According to Salazar and Pinto (2002: 129), the high symbolic value of the nationalisation process meant that the copper mining sector was much slower to privatise under the new economic system. In addition, a percentage of CODELCO revenues was allocated to the armed forces by law, which aligned military interests to public ownership of CODELCO.

The Chilean copper industry grew steadily between 1974 and 1999, with the highest growth rates in the 1990s. The mining sector was a determinant of faster economic growth during the 1990s, accounting for 8% of GDP and 46% of total exports. Chilean mining grew at 11% over the 1990s (Katz et al., 2003). The global copper industry had undergone a process of technological change in the 1970s (Urzúa, 2010) and was considered mature with low rates of innovation; 40 years later, in 2010, it is research, development and innovation intensive. Growth indicators and its position in the global industry show that Chile successfully caught

up with the new technological wave. First, production activity was concentrated in CODELCO. Changes to the law opened participation to private companies in the GMC, to operate as mining project concessions. The participation of private companies increased at the beginning of the 1990s and at the end of the decade, CODELCO accounted for a third of total national production. Copper production continues to grow with several mergers and acquisitions involving the big producers and suppliers. The industry players have become stronger and interactions more complex involving national and international actors.

In the first epoch, when technology was rudimentary, it is unlikely that producer capabilities developed. There was little investment in the sector which was operated by – often isolated - entrepreneurial miners. With the GMC and domination by big foreign companies, it is likely that national workers learned to follow procedures and standards, and respect hierarchy and discipline. The participation of foreign firms makes it unlikely that the capabilities for design, research and development were developed. However, foreign companies generally provided on-the-job training for local workers to take on managerial positions. After nationalisation of the industry, local engineers had to learn and develop the capabilities to design, build and run new mining projects. The case study interviews included stories about opportunities to work in the newly created research institutes and on research projects funded by CODELCO and private companies. Some graduates were involved in technologically path-breaking projects, such as bioleaching. Some participated in projects to improve technologies and develop solutions to production problems. As the sector expanded, so did the opportunities to work on applying and creating new technologies. It is likely that capabilities were accumulated and embodied in individuals and organisations before being transformed into physical and economic capital. There was accumulation of capabilities that produced social capital in the form of networks that have been maintained over time. Interviewees provided some examples

of these processes of conversion. Capabilities development and accumulation are facilitated by a favourable alignment between technological change and governance.

Doctoral graduates with mining specialties identify with the sector by describing themselves as miners. They tend to remain in the sector because there are interesting projects. Three interviews had expertise that was not directly related to mining and moved into the copper industry because of the opportunities it presented in terms of access to funding and innovative projects. One interviewee, specialised in bio-molecular research expressed the wish that he had spent more time in the copper sector. His involvement with international funding bodies to obtain research money has taken his research in new directions.

The career patterns of the graduates interviewed show that networks are built and new projects performed based on accumulated expertise. The sector presents a history of producer capabilities accumulation up to 2000, which can be the basis for continuous accumulation but not a guarantee. The richness of the sector depends on maintaining alignment amongst the different actors and that is a dynamic process dependant on the situation of global markets, technology and governance systems. A pattern of capabilities accumulation may seem logical in a successful sector, but does not apply to the fruit sector.

3.3. Fruit growing: a history of cheap labour

Chile is an important producer of numerous fresh fruits and one of the main exporters of grapes and apples. Most production goes to international markets. There are two epochs in the history of agriculture in Chile based on the prevalent system of governance and rate of technological change. Traditional agriculture characterised the sector until 1960, followed by agribusiness, which started around 1980 and has produced an agriculture boom, with fresh fruits the most successful products. Table 2 presents the characteristics of these two epochs.

Table 2: History of agriculture and fruit growing in Chile

	Traditional	Agribusiness (fruit)
Approximate dates	1810-1960	1980-1999
Location of leaders	US, Canada, Australia, Argentina, Europe (depending on product)	US, Europe, Argentina, Brazil (depending on product)
Role of Chile internationally/ main products	Wheat and cereals, related to international favourable market conditions; from 1930 oriented to internal market	Ranked 1st for world producer of grapes, 2nd for apples; important player
Chilean strategy 'Land for the country'	Basis of the social system and stability; social prestige in landownership; problem sectors to be integrated with the market	Diversification of exports; a new way of organising society
Demand	Changing with opportunities: Peru, Australia, US during gold fever boom (both short), Great Britain; domestic from the 1940s	Increased demand for fresh fruits from northern hemisphere countries
Technology leaders		Multinationals (US, Europe)
Technologies	Rudimentary	Standard, to be bought and transferred (machinery, chemicals, production systems);

		complex, information and communication technologies, biotech, environmental solutions
Automation	Very limited for transformation	of transformation
Process Type	Labour	Capital; information and knowledge
Size of firm	Big haciendas	Big distribution firms Big integrated producers; medium sized producers
Advantages	Cheap labour, counter-season, availability of land	Cheap labour
Organisation	Big haciendas	Entreprenurial; integrated
Industry structure	Oligopolistic	Oligopolistic (distribution) mixed
Type of Capitalism	Personal	Entreprenurial; managerial
Property	Mostly Chileans	Hybrid
Mode of governance	National and international markets; subsidies	International market
Power	Landowning	Capital; knowledge
Skills	Physical	Professional; specialist/expert
Education	Development and massification of primary and secondary education; professionalisation	Massification of higher education; foundation of postgraduate system
Governance	Landowners; state and government	Large international and national

actors	agencies	players; few small firms
Associated infrastructure	Railways and ports; irrigation systems	Information and bio-technology

In contrast to other countries in Latin America, the Chilean agriculture sector was formed before independence in 1810. During its colonial foundations it became clear that gold deposits were scarce and economic activity in the valleys of the central regions turned to agriculture and ranching (Collier and Sater, 2004:7). The land was worked by tenant-farmers who rented subsistence plots in exchange for services to the big landowners. The tenant-workers arrangement was characteristic of rural society in the valleys of the central region in the 1800s but there were also some independent small landowners struggling to survive against the predominance of the large haciendas (Collier and Sater, 2004:11). In the 1860s, the majority (over 70%) of Chileans worked in agriculture (Rojas, 1993). Throughout the first epoch the situation of tenant-workers and other rural workers was poor: they received the lowest salaries and their contracts were often informal (Meller, 1996). Technology was rudimentary and technological change virtually absent. Governance was based on the operation of the market and was dominated by the powerful landowners. In the 20th century the state played a bigger role and there was some technological change, explained by Rojas (1993) as consequence of new policy introduced after the Great Depression. The development strategy was one of externally oriented growth to establish a position in the international economy. The Great Depression in the 1930s had a huge effect on Chile and revealed the fragility of this strategy. The new policies favoured internal development – import substitution and internal production protected by tax regimes and price policies. The new development policy fostered the industrial sector and gave a supporting role to other

economic sectors, in particular agriculture. Agriculture production decreased in the 1930s and 1940s and became a threat to industrial development. The situation of discomfort with the sector's performance prepared transition to a new system marked by Agrarian Reform, a transformation that changed the organisation of the agriculture sector (Collier and Sater, 2004; Rojas, 1993).

The mode of governance after Agrarian Reform was based on national and international markets (depending on the product). There were subsidies and price fixing policies, but government intervention was subsidiary to market rule. Rojas (1993) argues that regulatory measures had divergent effects and there was some transfer of benefits from the agriculture to the industry sector. Measures such as price fixing, for example, benefited the consumer, the urban population needed for industrial development. Although there was no government support for agriculture, the tax system did favour landowners (Rojas, 1993). Apart from some work on improving fertilisers and hybrid seeds, there were no major changes in the 1950s in terms of governance and technology. The export balance in relation to agriculture was negative, exacerbating dissatisfaction with the performance of the sector.

Agrarian Reform in Chile marked a change in the most stable and traditional economic sector which influenced the organisation of Chilean society (Collier and Sater, 2004; Salazar and Pinto, 2002). The process began in the early 1960s and consisted of changes to the regulation on landownership concentration. It was ended by a law passed in 1974. The period between 1960 and 1980 was one of transition between the two epochs here identified.

From the 1980s agriculture in Chile was in a state of transformation to an internationally competitive producer of table fruits and other agricultural and forestry products, described as 'non traditional' exports. Since the 1980s, fruit growing has been an important activity and

there has been technological change marked by ongoing technological change. Governance of the sector is based on global market dynamics, where the main actors are big export firms.

The development of Chilean agribusiness for the global markets is considered an economic success or an economic miracle. Historical accounts highlight different reasons for the success of agribusiness exports. The lack of agreement originates from the different economic policies of rival political regimes. On the one hand, success is seen as proof of the effectiveness of the neoliberal policies during the military regime (1973-1990); on the other hand, success is explained as a result of Agrarian Reform and the effects of developmental policies pre and during the 1960s (Meller, 1996; Rojas, 1993). Less popular are explanations related to issues identified by Salazar (2002) such as availability of financial capital from the reformed pensions system, foreign investment and privatization of public companies and a cheap and flexible labour force. During the 1980s, policy focused on reducing the external disequilibrium (Meller, 1996) and a strategy of exporting based economic growth and regular payment of the external debt, which resulted in a relatively better macroeconomic position in the 1990s compared to other Latin American countries. Internal disequilibrium was left to market forces, which implied high rates of unemployment, increased individual and firm debt and negative redistribution effects.

Agribusiness development was externally oriented and benefited from policies fostering exports. Its development was favoured by increases in the international demand for fresh fruit from the northern hemisphere (Gomez, 1994). The sector grew during the 1980s at a rate of 20% per year, and the 8,000 producers and 300 distributers were the main employers in the central valley regions (Gomez, 1994). Until 1981, the main exporters were national distributor firms, a few producer cooperatives and some distributors-producers firms. Concentration of distribution can be explained by the economies of scale from refrigeration chains, shipping and contacts with distribution firms in end markets. At the end of the 1980s

there was capital accumulation in orchards and infrastructure, entrepreneurial capacity and a skilled work force in the central valley (Gomez, 1994). There was diffusion of new technologies, such as drip irrigation, refrigeration and sulphurisation to prevent fruit decay. Expansion in fruit growing drove demand for labour, but mostly temporary employment based on production cycles. According to Rojas (1993), only 20% of work placements in fruit growing were stable in the 1980s - and this probably continues to be the case. Rojas identifies the new group of temporary workers with the excluding character of the process of modernisation in the agriculture sector.

In the 1990s, the fruit growing scenario in Chile was clear. It was an established and export oriented production sector. Chile was a global player in grapes and apples and was expanding production of other species including avocados and berries. The industry was dominated by big distributors and producers. There were also numerous small farms, many of which were not integrated to the exports expansion. The sector was highly dependent on external conditions. Multinational distributors took the leadership in the 1990s: the ten biggest distributing companies had 60% of the market in 1994, with the four main ones accounting for 40%. Medium and small producers were highly dependent on the distribution companies (Gomez, 1994:22). Some multinational distributors were integrated with production, although some, for example Dole Co., kept almost exclusively to distribution (Gomez, 1994). Governance was dominated by a market system, with a concentration of distributors and a wider range of producers selling to them. Chile's competitors in the early 1990s (US and Australia) had governance systems based on boards which behave as monopolist sellers (Gomez, 1994).

Doctoral graduates began to be employed in the agriculture sector during the transition period and in the agribusiness epoch. In the 1960s, they were mostly university academics and some were involved in the Agrarian Reform process. A professional degree in of agriculture was

offered by most universities in Chile in the 1950s. Universities implemented policies to send lecturers for doctoral studies abroad in the. By the early 1960s the universities had reviewed their agriculture study programmes and generally had a common understanding of what should be offered. In the context of an ongoing Agrarian Reform, agrarian economics and the role of the state were at the centre of university debates on agriculture. Governance of the system was a major concern and involved the universities. The more forward thinking, perhaps were concerned about how the rural areas would be organized after the reform.

Agrarian Reform and the transition period identified were periods of high uncertainty. They were not conducive to long term investments in technological development. The work of doctoral graduates was concentrated in academia. One interviewee is a specialist in agrarian economics. His work history is related closely to governance. Early in his career he focused on understanding the situations of peasant families and how they might improve their life conditions. He has occupied senior positions in the public sector at the regional and national levels. Another interviewee, a recent graduate, specialises in agrarian economics and is also interested in rural families and the shaping of policy in the public sector. The individual histories include cases of doctoral graduates working on technological developments based in universities and public institutes, where they compete for research funding to enable involvement in research, technology, development and innovation. Most funding is competitive and requires involvement from the private sector. Some graduates engage in entrepreneurial schemes as a marginal activity. One interviewee embarked on an entrepreneurial endeavour but concluded that the risk for producers it too high. He did not considered opportunities in the sector to be attractive and moved away to management consultancy, where he is done a career. One interviewee, a molecular biologist, works on agribusiness topics because it is an application for his subject with potential funding opportunities.

There is no information on the employment of doctoral graduates by sector that allows us to contextualize examples in the overall population. It is plausible that the involvement of the private sector in research, technology and innovation is limited. The work force is composed of a majority of temporary workers with the lowest average years of schooling in the sector (Ibarra, 2006). Producers face high levels of risk due to market changes and weather conditions and many are medium or small sized. Firms with the resources to fund long term projects are likely to be big commercial organisations with upstream integration into production, and producer associations. Most big commercial firms are international and their decisions over investment in research, technology, development and innovation are not related only to Chile. Government funding promotes associations of producers and other actors, such as universities and research centres. The interviewees were involved in the industry through collaborative publicly funded projects.

3.4. A comparison of copper mining and fruit growing development

Copper mining and fruit growing in Chile are both successful in terms of international market share and contribution to the export balance. They are described as successful and valuable in national policy documents. Their future development is considered strategic for the country (CNIC, 2007). They are mature industries and their long term competitiveness is related to industrial regeneration. There is no guarantee that these positions will be maintained in the global market. Our comparison focuses on economic sustainability over the long term.

There are differences between the sectors in terms of accumulation of producer capabilities. Copper mining has developed what Katz et al. (2000) call a ‘mining culture’, which presents a rich network of actors across different systems contributing to copper production. There are good job opportunities, in particular for doctoral graduates. In the case of fruit growing there is a concentration of leadership by exporters. The high levels of temporary work and risk

involved in production make jobs less attractive. The doctoral graduates in our study, who have the possibility to choose among jobs, have opted for positions outside of agricultural production, going to 'safer' positions in research institutions or universities.

There are certain key drivers in both industries in relation to coming technological change and governance. There has been interaction over time between technological change and governance with changes in one area having implications for the other. It would be difficult to represent this process as one of cause and effect, because the dynamics is complex, but we could construct an explanation for the changes in the sectors that focuses on technological change, system governance and markets.

We include markets in our framework: since we investigate particular cases, we need to locate them in their relevant markets. We matched the internal dynamic of technological change and governance with changes in markets. On the one hand, the copper mining and fruit growing industries are globalized. On the other hand, Chile has an open market economy. We needed to relate the cases to their global market context.

In the case of copper mining, technological change corresponds to trends in the international industry, for example, the change in the early 20th century to automated extraction and the 'rejuvenation' that began in the early 1970s. The shift from an entrepreneurial-market driven system in the first period to an oligopolistic structure dominated by big companies changed the system of governance and is related to new capital intensive technologies. There are causal links that could explain changes in both directions; one system does not follow changes in the other. There is some co-determination in the sense that changes in one system determine what it is possible to do at a given moment in the other system, and vice versa.

The sectors do not necessarily converge to an optimum as co-evolution could imply and they are not necessarily aligned in the sense that they may be in conflict at certain stages. Struggle

can be a driver for change, but there are several possible directions of change, some of which may be developmental and some not. Struggle can be managed by aligning the systems.

3.5. Education System

The distinction between competencies and capabilities is applied to analyse the relationship between development of the sectors and the parallel developments in the education system. We explored the dynamics in the transformations among competencies and capabilities embodied in the individuals and in collective action. Education emerges as important in the history of the industrial sectors in several dimensions. We have identified the non-instrumental roles of education – or what Robeyns (2006) calls the intrinsic reasons for education – which were important in shaping the governance of industry systems.

The education system has taken a part as one actor in the sectors studied. The organisation of the professions in the universities developed in parallel to the industry sectors. In the case of copper mining the association of mining engineers was an influential actor in the early discussions in relation to the industry property. At an individual level, doctoral graduates in our study have taken roles directly related to the system governance, for example, leading positions in the government bodies ruling agriculture. Universities have provided trained professionals to the industry, but graduates have participated in a wider range of networks. Their influence has not been limited to being an employee, they have, for example, formed the professional associations and their influence in the sector has been also related to governance. Universities lectures in our study are often consulted by the media as experts on industry topics, having an impact on public opinion. They are also call to Parliament for expert advice.

4. Conclusion: Systems alignment as a policy recommendation

The importance of producer capabilities is exemplified by the case studies in this paper which provide illustrations of different patterns of producer capabilities accumulation. They show how the direction of development over time is the result of complex processes of interaction, in which the main systems involved are technology and governance. The education system has an effect on both: it shapes the competences for technology and governance. Education institutions may become relevant actors in the productive sector.

In regional systems, the sum of their competences and capabilities and their alignment constitute the basis for understanding the dynamics of producer capabilities. The cultivation and enhancement of producer capabilities in regional systems could favour technological innovation and provide the conditions for human development. The key issue for regional system governance has been identified as alignment. Alignment involves constructing compatible objectives for all types of agents, in their different roles and levels (individual, organisation, system) and orientating production to the achievement of compatible results. Producer capabilities could be enhanced by combining old strengths with the accumulation of new capabilities (von Tunzelmann, 2009a).

Governments could approach their regulatory, developmental and distributional goals by engaging with policies to direct the development of producer capabilities and the alignment of actors (von Tunzelmann, 2009a). Governments could manage struggles over resources and divergent actors' interests by encouraging actors to pursue mutually compatible aims. The necessary capabilities will differ for producing and implementing policy to overcome market failure (von Tunzelmann, 2009a).

The focus in this paper on producer capabilities in regional systems of innovation reflects concern for the promotion of human development. Since the process of capabilities

accumulation is dynamic it is important that production activities are sustainable over time. Work opportunities may not be tied to one industry in the long term; but what have been learned is tied to the experience in the industries in the region and can be used in other regional opportunities. We need to build strengths to use as a base to move to new learning and accumulation of new producer capabilities. Strengths can include changes to the governance system which may favour industrial development in harmony with quality of jobs. Policies that isolate sectors may not be conducive to strengthen the governance of overall economic activity in a region.

References

CNIC. (2007). Hacia un Estrategia de Innovación para la Competitividad, Volumen I. Santiago de Chile, CNIC

Cochilco (2006): *Yearbook: Statistics of Copper and Other Minerals 1986-2005*, Comisión Chilena del Cobre, Available at: http://www.cochilco.cl.

Collier, S., & Sater, W. F. (2004). *A History of Chile, 1808-2002. Second Edition.* Cambridge: Cambridge University Press.

Cohen, W. M., & Levinthal, D. A. (1990). Absorptive Capacity: A New Perspective on Learning and Innovation. *Administrative Science Quarterly, 35*(1), 128 -152.

D'Agata, A. (2007). Endogenizing Sen's capabilities: An adaptive dynamic analysis. *Journal of Socio-Economics, 36*(2), 177-190.

Gomez, S. (1994). *Algunas Caracteristicas del Modelo de Exportacion de Fruta en Chile. Origines y situacion actual.* (No. 59). Santiago de Chile: Facultad Latinoamerica de Ciencias Sociales, FLACSO.

Ibarra, C. (2006). Analisis exploratorio entre los Censos de 1992 y 2002 respecto del nivel educacional de la fuerza laboral en Chile. *Calidad de la Educacion, 25*, 127-151.

Katz, J., Cáceres, J. and Cárdenas, K. (2000): 'Instituciones y Tecnología en el Desarrollo Evolutivo de la Industria Minera Chilena', Cepal, *Series Reformas Económicas*, 53.

Malerba, F. (2004). Sectoral systems: how and why innovation differs across sector. In Fagerberg et al, *Oxford Handbook of Innovation*, pp. 380-406.

Meller, P. (1996). *Un Siglo de Economía Política Chilena (1890-1990).* Santiago de Chile, Editorial Andrés Bello.

Mistral, G. (1931). Sentido de la Profesión. In Scarpa (ed., 1979), R. *Grandeza de los Oficios*. Editorial Andrés Bello, Santiago de Chile, pp. 17-22.

Mistral, G (1927). Sentido del Oficio. In Scarpa, R. (ed., 1979). *Grandeza de los Oficios*. Editorial Andres Bello, Santiago de Chile, pp. 13-16.

OECD. (2007). *OECD Reviews of Innovation Policy: Chile.* Paris: OECD.

Ragin, C., & Becker, H. (Eds.). (1992). *What is a Case: exploring the foundations of social enquiry*: Cambridge University Press.

Robeyns, I. (2006). Three models of education: Rights, capabilities and human capital. *Theory and Research in Education, 4*(1), 69-84.

Rojas, A. (1993). *Post Reforma y Campesinado en Chile. Bases para el Desarrollo de la Agricultura Familiar*. Santiago de Chile: Instituto de Promocion Agraria (INPROA), Editorial Universidad de Talca.

Rothwell, R., Freeman, C., Horlsey, A., Jervis, V. T. P., Robertson, A. B., & Townsend, J. (1974). SAPPHO updated - Project SAPPHO phase II. *Research Policy, 1974*(3), 258-271.

Salazar, G., & Pinto, J. (2002). *Historia Contemporanea de Chile III. La economia: mercados, empresarios y trabajadores*. Santiago de Chile: LOM Ediciones.

Samuelson, P., & Nordhaus, W. (1998). *Economics* (16th ed.). Boston: Irwin/McGraw-Hill.

Sen, A. K. (1985). *Commodities and capabilities*. Oxford: North-Holland.

Sen, A. (1997). Inequality, unemployment and contemporary Europe. *International Labour Review,* 136(2), 155–171.

Sen, A. (2000). Work and rights. *International Labour Review*, 139(2), 119-129.

Sen, A. (1999). *Development as Freedom*. New York: Anchor Books.

Tidd, J., Bessant, J., & Pavitt, K. (1997). *Managing Innovation. Integrating Technological, Market and Organizational Change*. Chichester: John Wiley & Sons Ltd.

United Nations Development Programme, U. (2010). Human Development Report 2010 - 20th Anniversary Edition.The Real Wealth of Nations: Pathways to Human Development. New York: UNDP.

Unterhalter, E. (2005). Fragmented Frameworks? Researching women, gender, education and development. In S. Aibman & E. Unterhalter (Eds.), *Beyond Access: Transforming Policy and Practice for Gender Equality in Education* (pp. 15-31). Oxford: Oxfam.

Urzua, O (2010). Draft of DPhil Thesis. Unpublished.

Von Tunzelmann, N. (2010). Alignment, Misalignment and Dynamic Network-Based Capabilities. In D. A. Dyker (Ed.), *Network Dynamics in Emerging Regions of Europe* (pp. 3-22). London: Imperial Collegue Press.

von Tunzelmann, N. (2009). Competencies versus Capabilities: A Reassessment. *Economia Politica, 26*(3), 435-464.

von Tunzelmann, N. (2009a). Regional Capabilities and Industrial Regeneration. In M. Farshchi, J. Odile & P. McCann (Eds.), *Technological Change and Mature Industrial Regions. Firms, Knowledge and Policy* (pp. 11-29). Cheltenham: Edward Elgar.

von Tunzelmann, N., & Wang, Q. (2007). Capabilities and production theory. *Structural Change and Economic Dynamics, 18*(2), 192-211.

Von Tunzelmann, N. (2003). Historical coevolution of governance and technology in the industrial revolutions. *Structural Change and Economic Dynamics, 14*, 365-384.

Welch, C., Piekkari, R., Plakoyiannaki, E., & Paavilainen-MÃ¤ntymÃ¤ki, E. (2011). Theorising from case studies: Towards a pluralist future for international business research. *Journal of International Business Studies, 42*(5), 740-762.