A Learning Perspective On The Role Of Natural Resources In Economic Development

Andersen, Allan Dahl

Published in:
The Global Network for the Economics of Learning, Innovation, and Competence Building Systems

Publication date:
2011

Document Version
Early version, also known as pre-print

A learning perspective on the role of natural resources in economic development – scrutinizing the resource curse

Allan Dahl Andersen
DTU Management
Technical University of Denmark
adah@man.dtu.dk

Abstract
Natural resource-based industries are in economics often is understood as being unable to stimulate growth and development. The latter point has been put forward in the form of the 'resource curse' and is epitomised by inter alia Reinert (2007) who sees natural resource-based industries as detrimental to growth and development. Still, it will be argued here that Reinert's approach is unsuitable for grasping the full role of natural resources in economic development because important aspects of industrial dynamics are ignored. In pursuit of the latter research aim two topics in economic research will be integrated: (i) the area of learning, innovation, capability building and economic development; (ii) with the area of natural resources and economic development. Such integration will be a contribution to both topics.

Hence, this paper seeks to address the question: how can we understand the role of natural resources in the process of economic development from a learning perspective? The latter is sought answered by use of logic and historical examples of natural resource-based development. The tentative answer given is that natural resources must be understood as dynamic, and as being subject to learning processes of natural resource creation, extension and obsolescing that are enabled or blocked by institutions.

Keywords:
Natural resources; development; learning perspective; structural change; institutions

1. Introduction

As a basic point of departure this work shares the views of Kenneth Boulding on economic production and development. Boulding himself described the essence of his work with a remarkable study anecdote: "*my Oxford philosophy tutor, who had the curious habit of crawling under the table while giving his tutorials, commented in a high British voice coming from underneath the table on a paper I had given on evolution, 'It is all very well to talk about evolution, Mr. Boulding, but what evolves, what evolves, what evolves? After 40 years I have at least a glimmering of the answer. What evolves is something very much like knowledge*" (Boulding 1978, p. 33).

A learning perspective

The economic impact of learning in production often takes the form of innovations that are to be understood as 'something' qualitatively novel in its context. Learning is here understood in a broad sense; as a process leading to new knowledge, to new combinations of old knowledge, or to putting old knowledge into new heads (Johnson 1992). There is a selection mechanism that implies that not all knowledge is equally useful in an economic sense. Therefore not all learning processes leads to innovation, but innovation is not possible without learning activities. If one sees development as a process that involves creation of new resources, knowledge and activities, it must necessarily involve innovation – thus innovation and development are in fact inseparable concepts. The latter implies that human learning is the main source of economic development, and that to understand development it is necessary to understand the process of innovation.

Text Box 1: A learning perspective.

The point is made more explicit in his view of the production process. Boulding (1981) argues that economic production should be seen as a process that requires energy, material and knowledge. The production process consists of processing and transforming material and in the process adding value to it – this process requires knowledge, energy, space and time. The processing is planned according to available knowledge, and there are feedback loops between the factors in the process (e.g. material processing and knowledge or between energy scarcity and knowledge) which can be called learning. Boulding perceives material, energy, time and place as 'limiting factors', without which production would not be possible, while knowledge is the 'enabling factor' of the process because it coordinates the limiting factors. Consequently, economic development can be seen as a process of learning where knowledge is accumulated, and products and production processes are qualitatively changed. The materials and energy required to produce an iPhone were present on the planet 100 years ago, but the knowledge was not. Given the enabling importance of knowledge in development, processes of learning are placed at the centre of economic development – such an approach can thus be labelled a 'learning perspective', cf. Text Box 1. The above perception of production also illustrates that factors of production are interdependent, and thus that economic performance is a systemic phenomenon. Moreover, the learning feedback mechanisms in production are most often supported/blocked by the given institutional set-up which is thus important for knowledge accumulation, and ultimately development; cf. text box 2 for definitions.

Institutions: definition, distinctions and learning

I will follow the definition of institutions given by Edquist and Johnson (1997) that see institutions as sets of common habits, routines, established practices, rules, or laws that regulate the relations and interactions between individuals and groups. A main point is that institutions provide an incentive structure for human behaviour, which in turn will determine the attainable economic outcome in a given context (Sokoloff and Engerman 2003). This structuring view of institutions underlies the often-used phrase that institutions are the *rules of the game*. The latter can be misleading because institutions have a broader impact. They are e.g. also about how to change the rules, about whether the rules are followed and how they are sanctioned, the nature of the players, and the normative purpose of the game. Hence,

institutions influence human behaviour, but institutions can also be influenced and changed by human behaviour. In its most basic form institutions are social norms and habits that emerge in all social groups. Such basic social rules are sources of information with respect to predicting the behaviour of other people - such that we do not need to start from scratch every day. The regulation of social behaviour supplies stability to societies – a stability that is mandatory for its reproduction (Johnson 1992).

Given this definition, institutions obviously constitute a very complex network of norms and rules. Hence, a basic typology could be helpful. I will mention two useful distinctions. (i) Organisations and institutions should be seen as distinct although they interact and affect one another. Organisations are actors such as firms, universities and states. Institutions on the other hand influence how actors behave. Institutions either develop spontaneously without specific purpose, or are deliberately designed – the state is an important 'rule-setter'. Policy can be defined as purposeful institutional change. Thus, in such cases policy and institutional change are indistinguishable. Organisations are in principle always created with a purpose where e.g. firms seek profits (Edquist and Johnson 1997). (ii) Institutions can be divided into formal and informal. Formal institutions are typically viewed as rules and laws. They have been written down, are visible and easy to codify, and can be easily expressed and explained to others. Thus, formal institutions are explicit in nature. Informal institutions are the unwritten common practices of a society such as common law, norms, traditions and customs that are usually non-explicit in nature. These two types of institutions are seen as interacting, complementary and interdependent.

Institutions can influence learning activities in a number of ways that are relevant for understanding the process of development. Hodgson (1998) argues that information is always culturally processed because institutions (as informal cultural rules) will undoubtedly influence the way people perceive the world, its problems and potential solutions. Thus, informal institutions make up a social filter for basic cognition and information processing, which implies that institutions influence ideals and values in societies (Johnson 1992). Closely related to the latter, one can argue that the incentives to engage in learning have a social aspect. Also, these attitudes and ideals are important for legitimising learning policies (Arocena and Sutz 2000b). Formal institutions also influence the incentives for learning e.g. via education policy and pecuniary incentive structures for learning efforts (e.g. appropriability). These 'structural features' are thus likely to influence the 'learning behaviour' of individuals and firms in processes of economic development. The institutions affecting learning can thus be called 'learning institutions'. Also, the alteration of institutions in pursuit of stimulating learning and development can be called 'institutional learning'.

Text Box 2: Institutions: definition, distinctions and learning.

The topic of natural resources and development also holds significant non-academic relevance. According to Ross (1999) twenty-seven of the thirty-six states in the World Bank's most troubled category – severely indebted low-income countries – are primary commodity exporters. A better understanding of the role of natural resources in development could have far reaching consequences for such countries. Moreover, the issue of natural resources and development is currently an extremely interesting topic because the world is witnessing a 'new scramble for natural resources'. Developed countries have realised that knowledge is not sufficient to thrive in the knowledge economy – natural resources are a necessary foundation for production and consumption – as pointed out by Boulding. Concerns about climate change and global warming have generated an overall search for 'greener' and energy-efficient solutions, and our current era seems to have a 'green' window of opportunity including bio-energy, bio-materials and other "green' solutions. Many natural resource-based industries can also be characterized as biomass industries, and they are currently receiving renewed attention due to their future potential. For the same reason we are also witnessing increasing land purchases in Africa by China and other countries (Knaup and Mittelstaedt 2009). Thus, there are many interrelated issues that are tied together by land, and land's ability to produce biomass. A learning approach to natural resources has the potential to cast light on how less developed countries can or ought to respond to the increased demand for their natural resources.

In the literature on natural resources and economic development there are broadly speaking two different understandings of the relationship between natural resources and development. Some argue that exploitation of natural resources has and can stimulate emergence of several other types of activities via linkages such as services and manufacture, and via a process of diversification of the economy generate economic development. It is thus argued that natural resources in certain circumstances are an advantage (Innis 1930; Watkins 1963). Others argue that natural resources often are harmful for, or at least can not stimulate, economic development because they are subject to a 'pathological disorder' (Gunton 2003). Natural resources are consequently seen as a disadvantage – a position which has given rise to the term 'resource curse' (see e.g. Sachs and Warner 1995; Auty 2001).

As a representative for the latter view Reinert (2007) argues that natural resource-based industries in general, and agriculture in particular, are subject to decreasing returns to scale, have very few linkages, that innovation and learning is scarce, and that specialisation in these industries is equivalent to specialising in poverty. Policy consequences of the latter obviously are that natural resource-based industries should be abandoned in favour of more developmental industries. Reinert's (2007) position is in line with a large part of economic theory because it is a fundamental part of the dominating conceptual model of structural change and development. According to this model, structural change has followed a pattern where the role of natural resource-based industries has been diminishing which, for some, translates into that these industries are 'bad' for development. The latter establishes a connection between (a) perception of natural resources and (b) perception of economic development. The arguments put forward by Reinert (2007) and resource-curse proponents will be scrutinised from a learning perspective to get a clearer picture of the relationships between natural resources and learning. In this process an explicitly 'learning approach' to natural resources will be presented. The latter opens up for the presentation of an alternative, conceptual model of structural change, which explicitly emphasises the links between natural resources, innovation and structural change.

Discussions in the literature specifically on natural resources and development are according to Bridge (2008) currently in a stalemate. Recent debate has predominantly focused on the resource curse which suggests that successful natural resource-based development is an exception rather than the rule. Both proponents and critics of the potential for natural resource-based development agree that most unsuccessful cases of natural resource-based development can be explained by *state failure*. On the other hand they disagree on whether such failures are owed to context and contingency or to structural and deterministic features of natural resources. Irrespective of the latter, a consensus on policy has emerged between them; it is to focus on the capacity of the state which most often implies 'good governance' and 'sound' institutions (UNCTAD 2007). It is striking that the relations between institutions and learning is completely absent; just as the importance of context factors (Bridge 2008). A learning perspective on which kinds of institutions are needed to achieve natural resource-based development could be very fruitful. It could contribute to moving focus from '*whether natural resources*' to learning and knowledge accumulation, and thus contribute to this discussion.

Hence, this paper seeks to address the question: how can we understand the role of natural resources in the process of economic development from a learning perspective? The tentative answer given is that natural resources must be understood as dynamic, and as being subject to learning processes of natural resource creation, extension and obsolescing that are enabled or blocked by institutions.

The disposition of the paper is: (i) clarification of key terms used; (ii) natural resources in economic theory and the link to the understanding of structural change; (iii) natural resources as advantage; (iv) natural resources as disadvantage; (v) core issues and institutions; (vi) a learning approach to natural resources.

2. Setting the Stage

Natural resources

In economic theory a resource is anything that can contribute to economic activity – an input to the production process. It is normal to distinguish between natural resources, human resources and capital. This rather broad and loose definition makes it difficult to draw a clear line between what constitutes a resource and what does not. In this understanding of resources it is clear that a resource only exists in relation to a social context of production – for example human skill is only a resource so far it contributes to production. Also, producers need knowledge about how to identify, acquire and apply a resource in order for it to actually be a resource. It is thus partly a social construct.

In more common terms natural resources are, according to the Oxford dictionary of Economics, defined as factors of production provided by nature which includes agriculture, forestry and fishing, and extractive industries producing fuels, metals and other minerals. This is also the definition of the primary sector which is contrasted with the secondary sector, producing manufactures and other processed goods, and the tertiary sector producing services (Black 2003). A similar definition is used to investigate the link between natural resources and development in recent econometric exercises, cf. Text Box 3.

Natural resource-based industries

Sachs and Warner (1997) define primary products or natural resource industries as “fuels” and “non-fuel primary products” from the World Data 1995. Non-fuel primary products corresponds to SITC categories 0, 1, 2, 4 and 68, and fuels corresponds to SITC category 3:

- 0 - Food and live animals
- 1 - Beverages and tobacco
- 2 - Crude materials, inedible, except fuels
- 3 - Mineral fuels, lubricants and related materials
- 4 - Animal and vegetable oils, fats and waxes
- 6 - Manufactured goods classified chiefly by material

Text Box 3: Definition of natural resource-based industries.

According to Bakker and Bridge (2006) there are in social science, broadly speaking, the following different ways of perceiving natural resources: (i) they are completely exogenous to human activity and affect human activity, not vice versa; (ii) they are purely social constructs and human activity affects natural resources, not vice versa; and (iii) they are both – natural resources exist independently of humans but are only identified as resources, and thus ascribed value, in relation to human activities. Natural resources in a given context are likely to influence human behaviour but humans will also influence the ‘material world’. Branch (iii) can be characterized as a Realist/evolutionary perception of natural resources – one that will dominate this paper.

The difference between the positions is of major importance. It is the difference between understanding natural resources as finite and exogenous, and as flexible and endogenous to the

economy. When seen as endogenous, the knowledge stock in a given country determines to which extent it is capable of identifying natural and energy resources. Such an understanding transforms natural resources from a static to a dynamic concept. For example oil and minerals have been in the earth's crest as long as Homo sapiens have inhabited the planet, but it was only very recently that we identified oil as a valuable source of energy.

Zimmermann (1972) points out that a natural resource is defined by its *function*. Coal is a resource in as much as it serves the function of generating energy for various operations. Without this function coal would still be coal, but it would not be a resource. These remarks open the floor for a conflict between the viewpoints of natural science and social science - "*if nature is thought of as the universe, it may be considered constant…Nature in that sense is the topic of natural science. The social scientist is concerned, not with the totality of the physical universe, but with the meaning of nature for man, with that ever-changing portion of nature that is known to man and affects his existence. That portion is both expanding and contracting. It expands in response to increase in knowledge and improvement of the arts. Nature reveals herself gradually to man, but no faster than he can learn*" (Zimmermann 1972: p. 80). It is therefore straightforward to denote the natural scientist's view of nature as *nature*, and denote the social scientist's view as *natural resources* (Wicken 2009). In the interface between nature and natural resources there are ongoing processes of resource creation, resource obsolescing and resource extension. The conversion process from nature to natural resources should be understood as part of the production of natural resources.

Natural science (nature)	**Social science (natural resources)**
Constants of natural science	'relatives' of social science
The world a bundle of hay – zero sum game	Non zero sum game
Natural resources *are*	Natural resources *become*
Abstract or physical perception of natural resources. Nature exists only because it exists, there is no function behind the existence of our planet and its characteristics.	Functional perception. A natural resource is a mean to an end, an end defined by man and society, which makes it functional.
Static perception of natural resources	Dynamic perception of natural resources
Land supply is given and fixed	Land: its function, yield and supply must be interpreted in relation to time, space and knowledge.
Nature = natural resources	Nature is converted to natural resources in a process of learning and knowledge accumulation

Table 2-1: Nature and natural resources.

On the basis of the above natural resources are related to processes of identification, production, processing and use. All of these processes are coordinated by available knowledge, and are likely to be altered as a result of learning.

Natural resource-based development

Since the concept of natural resource-based development is central to this work it should be properly defined. Firstly it is relevant to consider how development or production can be *based on* something else. In the 'Bouldingian' view on the production process we operate with three factors of production; material, energy and knowledge. Every of these factors are required for production and can not be based on only one of them (which is also true for standard factors of production as labour and capital). The interdependency between factors of production implies that they can not be perfect substitutes for each other – that would be equivalent to making the same cake with half the natural ingredients but with two kitchens (Daly 1997), or making a product only using knowledge. Still, it can be meaningful to use the formulation 'based on' if one factor of production is dominant in a given setting.

From a learning perspective natural resource-based development must be a production process wherein a natural resource is the dominant factor of production, which over time stimulates processes of learning, innovation and competence building. In a straightforward way anyone can imagine that skill-development is required to hunt down a gazelle or make equipment to catch a fish. In such cases the presence of a natural resource stimulates learning that might be said to be natural resource-based. Also, it is likewise obvious that the absence of easy-accessible natural resources will stimulate learning in order to develop substitutes or find methods to get access to e.g. fish under ice. More contemporary arguments would be that the natural-resource rich Americas have an advantage over natural-resource poor Asia with respect to development, but the relative absence of natural resources in Asia has stimulated other types of activities that maybe are better in some sense. Thus, according to these simple examples both abundance and scarcity of natural resources can stimulate learning. It is therefore difficult to really argue that development in any sense can be based on natural resources. If based on anything at all, both processes of production and development are based on learning and knowledge accumulation; this is what evolves.

Despite the difficulty of clear definitions, I will stick to the above definition of natural resource-based development understood as types of production where a natural resource is the dominant factor of production, and that over time induces processes of learning and knowledge accumulation within and around the production. Moreover, types of production where a natural resource is the dominant factor of production qualify as a natural resource-based industry. In the following the types of production listed in the previous section will – even though not exhaustive – be the empirical definition of natural resource-based industry in the following.

3. Natural resources in economic theory

Naturally the perception of natural resources and their role in economic development has varied over time and across economic theories. I will in the following present a selection of contributions.

An early influence on the link between natural resources and development was presented by Thomas Malthus (1798). As part of his work on population dynamics he argued that agricultural production was subject to decreasing returns to scale. The argument has two aspects: (1) good land is scarce and when inferior lands are included in production, as production increases, the yield per unit of land will gradually diminish; (2) since land is fixed in quantitative terms by nature, it will inevitably be subject to diminishing returns to scale as all land is used. Even though Malthus did not write explicitly on natural resources his understanding of them has influenced economic thinking to this day. It is the idea that natural resources, in general, are finite – and thus exhaustible, and thus subject to diminishing returns to scale. On the other hand, in manufacturing the intensive use of capital (machines can produce machines – land can not produce land) would generate increasing returns to scale, and facilitate capital accumulation[1].

[1] *Returns to scale* versus *diminishing returns*: 'returns to scale' refers to a situation where an increase in output is associated with a proportionate increase in input – this would be constant returns to scale. The point with this concept is that it concerns the 'whole scale' – all inputs increase proportionally, and the derived effect on output decides whether we are talking about decreasing, increasing or constant returns to scale. 'Diminishing returns' concerns the change in output derived from a change in 1 factor of production while all other factors of production are held constant. It can be thought of as continuing adding an extra man to work a piece of land; at some point the extra benefit (return) of adding an extra man will start to diminish even though total output continues to increase. Malthus argued that because land is finite, then when all land is used, adding additional men to attend it will lead to diminishing returns on labour which in reality is caused by the finiteness of land. This is thus an *indirect* diminishing returns caused by natural resources. There is also a *direct* diminishing return to

In the time before World War 2 access to and control of natural resources (as energy and material) was seen as mandatory for development and national wealth. Still, based on the analysis of Malthus, there was concern that land scarcity would prove a limit to growth. Most economists (in the pre-war era) were of the opinion that increased capital accumulation and technological progress would hinder land scarcity from becoming a constraint to global growth (Auty 2006). The latter is one reason why natural resources did not figure explicitly in the theoretical developments on economic growth at the time, as for example the Solow growth model (Solow 1957).

It might be helpful to distinguish between dominant theoretical branches in the post war period, and their ideas about natural resources. I will follow Palma (2008a) and divide the area into three groups. The division is based on a distinction between *sector* (what you do - e.g. manufacture, primary production) and *activity* (how you do it - e.g. R&D, education). (1) The first group is made up by (mainly) neoclassical models of growth – a tradition started by Robert Solow. This group perceives the process of economic growth as both *sector-indifferent and activity-indifferent*. Problems are only defined as market imperfections and the market will know the answer. (2) The second group consists of models that are *sector-indifferent* but *activity-specific*. It is includes the work of Endogenous Growth Theory and Neo-Schumpeterians. Here R&D activities (knowledge production) are seen as stimulating the process of growth, but it is not related to any specific sector as e.g. manufacturing. (3) The third group (Neo-Keynesian, Schumpeterian and structuralist approaches) sees growth as both *activity-specific* and *sector-specific* (specific activities matter only/mostly in the sense that they are special for the sector in question). The growth process is about developing new activities and subsequently new sectors/industries. Especially manufacturing is thought to have special growth enhancing effects because 'learning-by-doing', dynamic economies of scale, increasing returns, externalities and spillover effects are more prevalent in the manufacturing sector than elsewhere in the economy (Palma 2008a). Here, as opposed to groups (1) and (2), there is a direct link between economic performance and the size, strength and depth of the manufacturing sector. In groups (1) and (2) the role of natural resources is in principle not different from the role of any other factor of production nor is natural resource-based industry really different from other industries. Within group (3) sector differences are acknowledged, or put differently, the industrial structure and specialisation matters for economic performance, but the primary sector and natural resources are not seen as progressive areas.

Group (3) has been the least dominant branch of theory in the post war years but was initially strong in development economics. It can be linked to what has been called "high development theory" (Krugman 1997). High development theory, whose prime was in the 1950s, argued that structural change (with manufacturing as engine) is the key parameter for explaining economic development[2] (Cimoli, Porcile et al. 2005). It is worth noting that development economics as a discipline was born in a period where many former colonies became independent nation states. Many of these new

land because the quality of it decreases with expansion. Hence, because of direct and indirect diminishing returns it is not possible to increase the 'whole scale' of factor inputs infinitely in agriculture. According to this line of thought agriculture is subject to both the law of diminishing returns and decreasing returns to scale. Even though this is on the limit of conceptual confusion, I will apply these terms in this chapter, because the scholars I cite apply them in this fashion. I will thus make liberal use of these concepts, but trust that misunderstandings have now been avoided.

[2] Famous authors related to this trend were inter alia Raul Prebisch, Albert Hirschman, Celso Furtado and Hans Singer. They argued that economic activities are qualitatively different and have different impacts in terms of growth potential, employment generation, value added and ability to generate increasing returns to scale. What these authors failed to acknowledge was that technical development does not happen automatically – it seems that they did not pay sufficient attention to the learning divide (Cimoli, Porcile et al. 2005).

states, and most Latin American countries, were rich in natural resources and at the same time had a variety of problems that at times could be related to this industry structure. Hence, development economics from its birth saw manufacturing as the engine of development (and industrialisation), while natural resource-based industry was seen as dangerous left-over from the colonial past (Singer 1950).

The latter perception of natural resources (primary sector being very different from secondary sector) reflects a conceptual model of historical structural change and implicitly a theory of development. In the New Palgrave Dictionary of Economics, Matsuyama (2008) defines structural change as: "*a complex, intertwined phenomenon, not only because economic growth brings about complementary changes in various aspects of the economy, such as the sector compositions of output and employment, the organisation of industry, the financial system, income and wealth distribution, demography, political institutions, and even the society's value system, but also because these changes can in turn affect the growth processes*". Early work on structural change identified patterns of development followed by most countries. The conclusion was that: "*as the economy grows, the production shifts from the primary to the secondary to the tertiary sector*" (Matsuyama 2008). The main point is that the tripartite interpretation of structural change put forward here, implicitly states that economic development demands a similar pattern of structural change[3]. Additionally the Oxford Dictionary of Economics states that the primary sector is usually most important in less developed countries (Black 2003). The implicit normativeness further cements the position of natural resource-based industry at the bottom of the hierarchy with respect to economic development.

This perception of structural change is also supported by the findings of Kuznets (1971) who searched for characteristics of economic growth in the period between 1850 and 1950 in now-developed countries[4]. To get an overview of structural change he categorizes production in three sectors: (A) includes agriculture and related industries like fisheries, forestry and hunting; (I) includes mining, manufacturing, construction, electric power, gas and water, transportation, storage and communication; (S) includes trade, finance, insurance and real estate, income from dwellings, and a variety of personal, professional, recreational, educational and governmental services[5]. As can be seen from the table below the shares of (A) and (I) changed significantly during the period.

Sector	Share of GDP 1850/1900	Share of GDP 1950
A	More than 40%	Less than 10%
I	22-25%	40-50%
S	No general trend besides a modest increase, especially in governmental services.	

Table 3-1 Structural Change in now developed countries.

The majority of the increase in (I) was accounted for by manufacture (around 70%). Within manufacturing metal fabricating and chemical-petroleum branches rose *conspicuously* while industries in decline were textile and clothing, and wood and leather. In terms of employment the (A) sector went from employing 50-60% of the workforce in 1850 to employing 10-20% in the early 1960s. The share of the work force employed in sector (I) grew less than the fall in sector (A), hence sector (S) employed still more people. These large, but well-known, changes in production

[3] Tripartite classification refers to the division of production into primary, secondary and tertiary sectors.
[4] 15-18 Western European countries plus Japan
[5] This is classification is not identical to the tripartite classification discussed earlier though it is similar. In any case similarities between these classifications are not of relevance at this point.

structure and the high rate of growth of production per capita and productivity were historically fast, extensive and radical.

In order to further analyse the pattern of structural change Kuznets (1971) focuses on the most dynamic sector (I) in economy of the United States in the period 1880 to 1948. He finds strong diversity in growth rates of different groups of manufacturing activities that he interprets to be consequences of technological change with the logic that economic growth is strongest in the industries with most innovation. From Kuznets' seminal account of structural change and development it seems obvious to infere that innovation is the driver of growth, and that a large part of what I have defined as natural resource-based industries do not innovate, and therefore become less important. The latter forward statement touches upon a problem of separating the categories of production, cf. Text Box 4.

The tripartite classification

The classification most often used to find patterns of structural change in history is the tripartite classification. However, there have always been ambiguities regarding the demarcation lines between the primary, secondary and tertiary sectors. For example, when reviewing problems of definition in Australia and New Zealand, Fischer (1939) explained that the basic idea is to draw a dividing line on the basis of 'substantial alteration' in form and character of primary materials. This was to be done through manufacturing operations where the end product would be classified as a secondary product. Still, as later observed by Fisher, it is not easy to determine the precise stage in the conversion of milk into butter or cheese when this work ceases to be primary and becomes secondary (Fisher 1952). The fuzziness of demarcation lines was reflected by frequently changing official definitions in New Zealand (1890-1921), cf. table.

Year	Definition of primary production
General speak	Agricultural and pastoral production
1891	Agricultural, pastoral, mineral and other primary producers
1896	All persons mainly engaged in cultivation or acquisition of food products, and in obtaining other raw materials from natural sources – and including persons engaged in forestry, water conservation and supply, mines and quarries.
1901	Back to more narrow definition of 1891
1921 – broader again	Agricultural and pastoral farming, market gardening, poultry and bee farming, fruit growing, fishing and trapping, mining and quarrying, bush saw-milling, scrub cutting and gum-digging.

Table 3-2: Definition of primary production.

Fisher (1939) indicated that the changing definitions was partly a result of farmers/producers vanity – that they exercised political influence in order to be classified as belonging to primary production, because this meant being most important - being primary, while secondary had a negative connotation. These ambiguities cast doubt on the tripartite classification, and the usefulness of analyses based upon it. Moreover, a critical comment that is valid for both the tripartite classification and generally industry classifications, is that they lack qualitative indicators that would be able transmit product and production process heterogeneity.

Text Box 4: The tripartite classification.

This picture of history indicates that economic development implies moving out of and away from natural resources. Still, there is not a complete consensus on what lies behind these patterns of structural change and what, if any, the role of natural resource-based industries have been in the process. Cohen and Zysman (1987) argue that the dominance of the outlined model of structural change and development is problematic because even though it is only a hypothesis it helps

coordinate the way economists think. It satisfies "*a popular understanding of how an economy works and ought to work: it is simply clear as a bell that a country that does brain surgery and computer programming is, in a fundamental way, ahead of a country that does not and can not. But it is a slippery path from that hard truth to a model of development—and worse, a policy for development—based on those categories which now become analytical categories though they embody no real theory, though they do not square with the realities of economic organisation and linkages, and which, like the Brand X candies in the M&M's ads, melt in your hand when you try to use them*" (Cohen and Zysman 1987: p. 9).

With a specific focus on natural resources there are at least two relevant opinions on the matter: (1) some argue that exploitation of natural resources stimulated the emergence of several other types of production such as services and manufacture. It is even argued that natural resources are an (comparative) advantage; (2) Others are more sceptical about the potential of natural resource-based activities, and argue that they are subject to a pathological disorder (Gunton 2003). I will present the two traditions in the following sections.

4. Natural resources as advantage

Intuitively natural resources should have a positive effect on economic development – it is an advantage – a gift that other nations do not have. Holding an abundance of natural resources would be an advantage in the sense that this abundant natural richness can easily be traded with other types of products desired. The theory can be placed in the theory group (1) where it does not matter what you produce or how you do it; except that you need perfect competition for factor price equalisation. The latter position is not so helpful in understanding the processes of structural change outlined above, though. Still, it has inspired more explicit thinking about the role of natural resources in economic growth and development – one example is the staple theory of economic growth.

The staple theory tradition is a Canadian innovation. It was founded by Harold Innis in his studies of fishery and fur trade (Innis 1930; Innis 1940). According to Gunton (2003) the staple theory is a theory of export-led growth based on staple products that in turn are defined as being based on natural resource extraction and requiring little processing prior to export to industrial countries where they are used in the production of manufactured products. A staple industry is thus approximately identical to a natural resource-based industry. This definition is obviously motivated by specific historical circumstances – those of Canada initially after colonisation. Therefore Watkins (1963) argues that the theory is only valid for certain contexts such as that of a 'new' country where there is abundance of 'empty' land which yields favourable man-land ratios, and where there is absence of 'inhibiting' traditions. In this situation the production and export of the staple is the leading sector in the economy and set the pace for economic growth. Export is emphasized because at first there will be very limited domestic demand. Thus, given 'factor proportions' the new country has a comparative advantage in natural resource-based export industries. The natural-resource abundance imply that demand, capital, and entrepreneurship are available internationally due to interest for the staple product, instead of being restrained by regional consumption and savings rates (Gunton 2003). In this situation economic development will take the form of a process of diversification around the export base. Staple-led growth can thus be seen as a sequence of spread effects around the export sector.

Related to the staple theory, Rollins (1971) more explicitly refers to less developed countries, and argues that they can also benefit from natural resource-based industries via spread-effects. During

the 1960s developed countries faced severe natural-resource scarcity which created interest in the natural resources of less developed countries. On the other hand less developed countries needed foreign capital investments to undertake economic development and thereby utilize their rich natural resources. In this sense an 'imbalance' of labour surplus and capital scarcity could be 'balanced'. Hence, natural-resource rich less developed countries should be better situated for earning foreign income via export to use for investments in e.g. manufacturing (Ross 1999). In the case of foreign investment in a less developed country, such a project could create employment which, through wages, would increase demand in local markets and thus stimulate economic activity. It could also lead to productivity increases on the supply-side in the natural resource-based industry, and facilitate spillover of knowledge to workers which they can apply elsewhere in the economy (Rollins 1971).

Still, according to both Watkins (1963) and Rollins (1971) there are some conditions that must be met for the spread-effects to unfold. They are influenced by the nature of the 'production function' of the staple which "*defines the degree of factor substitutability and the nature of returns to scale*" (Watkins 1963: p. 144). In other words, if production can be mechanised then there will be demand for capital goods (technology) which will create the spread effects by the establishment of new, related industries. Given demand for the staple output, there are other context-specific conditions that influence whether these spread-effects materialize – these can be conceptualized as linkages. Watkins (1963; 1977) – inspired by Hirschman (1958) – distinguishes between (1) backward, (2) forward, (3) demand and (4) fiscal linkages, cf. Text Box 5. (1) Spread-effects and diversification of the economy will be largest if it is possible to produce capital inputs to staple production domestically. It is often seen that staple producers import technology which inhibits spread-effects. Watkins indicates that the transport system needed to collect and transport the staple is one of the most important backward linkages in general. (2) Staples differ in terms of further processing potential and this must be assessed according to a given context. (3) The income earned by workers should add to domestic demand to stimulate further spread effects. (4) The income generated from the staple in the form of tax on income and export should be reinvested in the country and contribute to domestic demand instead of potentially accumulate abroad. The state may use the extra revenue to stimulate economic activity by increasing public expenditure by e.g. increasing credit and credit availability and thereby stimulate private investments or simply increase public investments (Rollins 1971).

Linkages

Linkages are in economics general understood as couplings or relations between actors. Most often linkages are seen as channels of transactions for goods. Linkages are important because they are thought to be the basis for inter-sectoral dynamics which in turn stimulates structural change and development. Without linkages a sector can in principle never generate structural change – it may finance it, but it cannot 'create' it. Here I will distinguish between (a) vertical linkages (Ciccone 2008), but also (b) demand linkages and (c) fiscal linkages are important (Watkins 1963; Watkins 1977; Hirschman 1981). I will mainly focus on vertical linkages.

(a) Vertical linkages mainly focus on inter-industrial demand with a distinction between backward (upstream) and forward (downstream) linkages – these can be understood as production linkages. There are two points to be made in this respect: (i) Multiplier demand effects, and (ii) linkages investment effects. (i) With vertical linkages one industry can create growth in other industries via its demand for intermediate goods as inputs to production. (ii) Vertical linkages are also related to investment decisions. An investment decision in industry A (technological upgrading) will not necessarily lead to higher profits, unless industry B also makes investments or else the demand for industry A's output will not rise. Industry A is dependent on industry B in order to fulfil the potential of its investment. Thus, the above reflects that investment decisions (and economic performance) are complementary and interdependent, and that economic structure influences investment incentives (Richardson 1990). This is what Hirschman (1958) analysed as

'dynamic incentive structures'.

(b) Demand linkages refer to the characteristics of demand regarding a specific production entity (in this case an industry or sector). It has two aspects: (i) how do employees in the industry spend their income? (ii) What is the nature of the demand for the industry's output? An often-seen characteristic of staples is that production is severely dependent on international demand which establishes a dependency relation to the international economy that can generate uncertainty and instability.

(c) Fiscal linkage refers to how the income generated by an industry, e.g. via export, is distributed and used – is it for example reinvested in the industry or country? The fiscal linkages can be weak e.g. in a situation where staple producers are foreign firms, or if domestic producers have taken up large loans internationally to finance investment in equipment.

Text Box 5: Linkages.

With respect to the *possibility* of domestically producing capital inputs and technology Watkins (1963) argues that a successful staple – one that manages to build strong linkages – will start by importing technology but gradually start to become self-sufficient via experimentation and innovation. In the successful case, the economy will eventually grow and diversify to the point where it can no longer be characterized as a staple economy. The latter implies a 'well-developed' manufacturing sector that serves the domestic and possibly foreign markets. The trade composition will change such that revenue from staple export and expenditure on manufacture imports will decrease as a share of GDP. On the other hand, if spread-effects do not materialize, the economy will end up in the 'staple trap'. The staple trap refers to a situation where an economy is completely dependent on export of a staple product, which according to Watkins (1963), is not a viable long-term strategy for economic growth and development. The reason is that staples are vulnerable on the demand side due to competition from synthetic substitutes, from cheaper suppliers, and due to low income elasticity of foreign demand or because of changing tastes. On the supply side staples – and natural resource-based industries in general – are subject to the *law* of decreasing returns to scale in the long run regardless of technological improvements. Watkins (1963) clearly believes that the staple trap is avoidable through policy measures while others argue that it is not – that it is an inherent quality of natural resources; that they are cursed. In either case the staple theory clearly has linkages as a central issue – in the words of Hirschman (1981) it is part of the *linkage approach* to economic development. Gunton (2003) consequently distinguishes between a 'good' staple that has 'strong' linkages and a 'bad' staple which has 'weak' linkages.

5. The paradox of plenty

The resource-curse literature is a branch of literature in economics that argues that natural-resource abundance tends to be associated with meagre economic performance on the country level. While the staple theory sees a positive potential – and thus an active role in structural change – for natural resources, the resource curse insists that natural resources in general can not generate development.

Reinert (2007) is a proponent of this more sceptical view on natural resources. He accepts that linkage dynamics is a basic mechanism in economic development – as proposed in the staple theory – but he argues that primary products in general, and agriculture in particular, is not part of this process. The starting point for his analysis is that economic growth is industry-specific; that some industries are better than others. He identifies manufacturing industries as 'good' types of

production and agricultural industries as 'bad' types of production[6]. Reinert bases this dichotomy on the historical observations listed in the table below (2007: p. 261-62).

'Good' (manufacture)	**'Bad' (agriculture)**
Increasing returns to scale	Decreasing returns to scale
Dynamics imperfect competition	Perfect competition
Large diversity and high division of labour	A minimum of diversity and low division of labour
Stable prices	Extreme price fluctuations
Generally skilled labour	Generally unskilled labour
Create middle class	Creates feudalist class structure
'sticky' wages	Reversible wages
Technical change increases price for producer	Technical change lowers price to consumer
Create large synergies (linkages, clusters)	Create few synergies (no linkages)

Table 5-1: Good and bad types of production.

The different properties of the two types of production especially have consequences for development when they are related to international trade. Looking at a simplified world where less developed countries are specialized in primary production (decreasing returns to scale) and developed countries in secondary and tertiary production (increasing returns to scale) gives you a theory that clearly explains why poor countries should industrialize. Thus, according to Reinert (2007), less developed countries can escape poverty only by changing the productive structure away from the primary sector. Given these propositions "*specialisation in agriculture, is specialisation in poverty*" (Reinert 2007: p. 154). This simple dichotomy is not new; it was, according to Anderson (1998), also put forward by inter alia Marshall (1890). Moreover, the link to trade theory has also been promoted by inter alia Prebisch (1950), Singer (1950) and more recently by Krugman (1979).

The dichotomy described is closely related to more recent research on natural resources and economic development because the arguments used against the possibility of natural resource-based development are virtually identical. The propositions made by Reinert (2007) nearly all fall within the category of the resource-curse literature. According to Gunton (2003) the term 'resource curse' was first used by Richard Auty (see e.g. Auty 2001) in the early 1990s when he, on the basis of several large research projects, concluded that natural resources seemed to be a curse rather than a blessing – also called 'the paradox of plenty'. Moreover, several other researchers have found results that support Auty's findings (see e.g. Sachs and Warner 1995; Gylfason 2001; Sachs and Warner 2001). Sachs and Warner (1995) for example finds a negative relation between annual growth rate of GDP in the period 1971-1989, and the share of primary-product export of GDP in 1970, in a sample of 97 less developed countries. The latter results stands out as a point of reference ofr the resource-curse literature, but one should be observant to the general method of measurement, though, as it can easily lead to misunderstandings, see Text Box 6.

Ross (1999) presents the main arguments for causality between the correlations observed by the latter scholars. I will review his and Reinert's (2007) arguments below which includes: (i) deteriorating terms of trade; (ii) lack of investment due to dependence on instable commodity markets[7]; (iii) absence of linkages; and (iv) the Dutch disease.

[6] Reinert (2007) does not clearly distinguish between agriculture and other forms of natural resource-based industry, but he uses the term 'primary sector' interchangeably with 'agricultural sector'. I will, despite risk of imprecision, take latter terms to be equivalent to my definition of natural resource-based industries. Additionally, the content of that definition is also approximately covered by the term staple industry. These terms will be used interchangeably.

[7] A commodity is a standardized good, which is often traded in large volumes and whose units are interchangeable. They are normally outputs from the primary sector such agriculture, mining and semi-processed products.

Aspects of measurement

Regarding measurement I find it relevant to comment on: (i) definition of 'natural-resource abundance'; (ii) fallacy of aggregation; (iii) and the periods of time under consideration.

(i) 'natural-resource abundance' can inter alia be defined as natural resource-based industry in share of GDP, share of value-added, share of employment, share of export earnings or share export value-added at one point in time or over a period of time. These are the most often-used measurement indicators. Still, the indicators do not say anything about physical 'natural-resource abundance'. They reflect a given country's industrial structure and/or export composition – it illustrates the absence of the secondary and tertiary sectors, which is a 'negative' definition of natural resources. This set-up of data indicates the implicit understanding that the relative absence of manufacturing industries is a result of a rich nature. However, there is not necessarily a strong relation between industrial structure and physical endowment. There can be many reasons why a given industrial structure has or has not emerged. A country does not need to have a relatively spectacular richness in natural resources to have an industrial/trade structure characterized by natural resource-based industry (Denmark is historically an example of this). Nor is natural richness a guarantee that a country will specialize in natural resource-based industry (USA). Hence, 'natural-resource abundance' in the following is to be understood as an industrial structure dominated by natural resource-based industry – not as a relatively large physical endowment of natural resources. I will use the term 'natural-resource rich/poor' about physical endowments. Still, it is unclear when a country is rich in natural resources. Such an evaluation would be dependent on a resource-population ratio on what exactly constitutes a natural resource in a given context.

(ii) There is a general fallacy of aggregation in the resource-curse literature. It has been shown that processes of learning and capability building differs across firms, industries, place and time (Dosi 1988). It is highly likely that important differences exist between natural resource-based industries as for example mining, agriculture and fishery, and also within these categories there are differences in terms of crops, climate, topography, species and extraction – differences that require specific knowledge. This is also noted by Bridge (2008) who points out that it is remarkable that in the discussion of natural resources and development the nuances of specific and contextual arguments have gone missing. This is inter alia seen by an almost exclusive focus on the *national level* which again ignores other types of foci such as sector differences, organisation of firms or capability building.

(iii) It is relevant to pay attention to the periods of time of measurement due to: (a) considerations about the pace of structural change and what can be expected in short vis-à-vis longer time spans. Statistical evidence for resource curse is often based on only a few decades of observation, but structural change may take longer, and will most likely not be visible in aggregate statistics (Wright and Czelusta 2002); (b) importance of 'external' events that might influence the observed phenomenon.

Text Box 6: Aspects of measurement.

Deteriorating terms of trade

The terms of trade is a central element in the Latin American structuralist school[8] (Palma 2008b). It was noted by both Prebisch (1950) and Singer (1950) that the terms of trade of less developed countries was deteriorating vis-à-vis the developed countries. They saw this as a main obstacle to economic development in Latin America. Classical economists, following Ricardo, claimed that terms of trade for primary products would improve over time due to the inelastic supply of them[9], which is a positive side of seeing natural resources as subject to decreasing returns to scale. Prebisch was one of the first to alter this perception, by claiming that the terms of trade were

[8] Terms of trade refers to the ratio of an index of a country's export prices to an index of its import prices. The terms of trade are said to improve if this ratio increases, so that each unit of export pays for more import and vice versa. Focus is only unit value of traded goods and not volume. In terms of the theory of comparative advantage this implies that the index for terms of trade reflects the relative purchasing power or exchange relation between two actors. In a framework with two goods and one factor of production, labour, then the ratio reflects the exchange relation of labour hours.

[9] The sincerity or stronghold of this perception was reflected by that W. S. Jevons kept an enormous stock of coal in the basement of this house (Findlay 2008).

deteriorating for primary products (Hadass and Williamson 2001). The premise for the argument is – in accordance with Reinert's (2007) trade hypothesis – that in the primary sector prices will not increase as much as in the secondary sector because of (i) labour market asymmetries and/or (ii) differences in innovation, (iii) in competition, (iv) and in structure of demand.

(i) The argument comes in two versions. (a) In developed countries unions are strong, so in economic upturns prices rise and real wages rise, and they become sticky due the power of unions in economic downturns. In less developed countries unions are weak. Therefore wages (and thus prices) will not rise as much here in upturns, but will fall more in downturns (they are not sticky). (b) Labour markets in less developed countries are characterized by an unlimited pool of labour. This implies that wages (and hence prices) will not grow and remain at the 'subsistence wage'. This is not the case in developed countries where workers will demand higher wages that will push up prices (Hadass and Williamson 2001).

(ii) The 'fact' that productivity growth, positive externalities and innovation are stronger in the secondary sector (Palma 2008b), implies that primary producers' exchange relation worsens over time. Also, innovation often results in more efficient use of raw material, and thus less demand for primary products, which leads to a relatively poorer exchange situation for primary producers.

(iii) Markets for primary products are characterized by 'perfect' competition because the product is assumed to be easy to imitate, and thus substitute. The latter keeps prices low and implies that competition mostly takes place on the basis of low wages. In the secondary sector there is 'imperfect' competition because it is assumed that products are not easy to imitate, so prices can easier increase. Here competition takes place on the basis of innovation. Moreover, even if innovation takes place in a less developed country it will often not stimulate economic development. Due to the labour market institutions technical progress will lower prices for consumers due to price competition while technical progress in developed countries result in higher prices. This further worsens the exchange relation for primary producers.

(iv) It is well documented that the share of a house hold's income allocated to food purchases decreases as income rises – this known as Engel's Law (Browning 2008). Consequently, the (international) demand for food products will not rise significantly as income levels increase. This will limit market growth and hinder price increases. According to Scitovsky (1976) Engel's Law is not thought to be valid for manufacture and especially service products where innovation and novelty continuously attracts consumers, which ensures a high income elasticity. The structure of demand – or nature of demand linkages – thus also negatively affects terms of trade for food products. Still, it is not obvious that one can aggregate from food products to commodities, energy and raw materials.

The empirical results for the 'Prebisch-Singer hypothesis' have been mixed but currently there is a consensus on that price volatility has been more significant than a downward price trend, which implies that the conclusion one can reach depends on what time period one is looking at (Findlay 2008; Baffes and Haniotis 2010). On the level of the product groups you get another picture because terms-of-trade trends vary both across time periods, and across and within primary-product groups as food, metals and textiles (Kjeldsen-Kragh 2007). Looking at price movements between 1900 and 1983, only five commodities had significant negative trends; five others had positive trends and sixteen were trendless. Among the five with negative trends, three were wheat, maize and hides (Ross 1999). Another finding that questions the power of the terms-of-trade argument is

that during the last 15 years it has been the terms of trade for manufacturing that has been declining (Ferranti, Perry et al. 2002).

The ambiguous empirical results most likely reflect that arguments for Reinert's dichotomy are too general and imprecise to describe experiences with natural resources in general. Also, none of the mentioned characteristics of natural resources are given by law. They are rather heavily influenced by contextual factors as in the case of labour market institutions and regulation of competition. Also, even though innovation activities may be stronger in manufacturing it seems peculiar to completely ignore such activities in natural resource-based.

Instability in natural-resource income

The argument is that markets for primary products are more instable than other markets, which can make a country more vulnerable and instable. According to Ross (1999) there is a consensus among researchers, that markets for primary products are exceptionally unstable. This leaves two aspects to consider – (i) wherefrom the volatility arises, and (ii) what the consequences of volatility are.

(i) Sources of price volatility in markets for natural resources are often grouped into three sources: (a) demand side changes; (b) supply side changes; or (c) speculation in the futures market. (a) Heavy export specialisation in natural resources implies dependency on international demand which can fluctuate for various reasons. Still, any export good is dependent on foreign demand, but the main problem here seems to be lack of economic diversification and not necessarily natural resources per se[10]. (b) natural resource-based industry often depends on ecological conditions. The vulnerability to relatively unpredictable changes in climatic, natural or disease conditions as e.g. drought, flood, animal virus or temperature swings have added much volatility to the industries affected. (c) Whether speculation destabilizes or stabilizes the futures market is not straightforward to determine[11]. On one side a volatile market creates a demand for speculators who are willing to bear the risk. On the other hand the expectations of speculators, and subsequent actions, may affect price movements. Also, the presence of speculators might lure producers into more risky investment projects that, despite potential volatility, might improve overall 'welfare' (Newbery 2008). In general it is a controversial matter whether speculation tends to bring stability or volatility to a market (Black 2003).
(ii) Ross (1999) reports that there is not agreement on whether instability in markets for primary products is a problem for economic performance. In favour of a positive relation between instability and growth, it is argued that price booms induce unusually high levels of investments inter alia because exporters try to protect themselves against future shocks. This can stimulate capital accumulation and economic growth. On the other hand according to Singer (1950) such 'booms' tend to diminish incentives to diversify the economic structure because 'things' are going well, and but incentives increase in natural-resource 'busts' when the penalty for lacking economic diversification is felt hardest. This is what he refers to as institutional short-sightedness. Also in favour of a negative relation, it is argued that instability makes private investment more risky and

[10] In this case diversification can be in (a) number of goods exported, and (b) number of buyers.
[11] A future is a special type of 'forward contract' wherein two agents agree on a transaction for delivery at a specified future date. In the futures market contacts are characterised by being standardized which minimizes transaction cost and facilitates high liquidity such that contracts can be bought and sold several times during their lifetime. The standard explanation for a futures market is that it helps to spread, and thus reduce, risk for both buyer and producer. Speculation is mainly carried out for certain products as commodities and financial assets because they are exceptionally standardized and liquid, and can therefore be traded rapidly as response to any changes in expectations.

thus hinders it, which in turn slows growth[12]. The empirical results on the link between volatility and economic performance are inconclusive (Ross 1999). Still, it is true that most natural resource-based industries are more dependent on ecological conditions than manufacturing activities, but these can often be mitigated and managed via competence building. Also, given that price volatility is severe in primary products there is room for policy measures. Lack of diversification and poor management through bust and boom periods can hardly be ascribed solely to natural resources; instead it is an institutional and policy challenge.

Natural Resources and Linkages

It is in economics generally thought that industries in the primary sector have fewer, or no, linkages to other industries compared to industries in the secondary and tertiary sectors. For example Humphreys, Sachs and Stiglitz (2007: p. 4) recently argued that: "*…unlike other sources of wealth, natural resource wealth does not need to be produced. It simply needs to be extracted. Since it is not a result of a production process, the generation of natural resource wealth can occur quite independently of other economic processes that take place in a country; it is in a number of ways, enclaved… without major linkages to other industrial sectors*". This is in stark contrast with the positive version of the staple theory. The quote reflects a position that acknowledge the importance of linkage dynamics (often termed externalities or spill-overs), but does not believe that natural resource-based industries are relevant in that respect, cf. theory group (3). I will in this section elaborate on why this is so. There are, at least, two arguments for why linkages can be weak, few or absent in primary production: (i) one argument is that foreign ownership hinders linkages; the enclave argument; (ii) another argument is that – as formulated by Gunton (2003) – natural resources are subject to a pathological disorder that hinders linkage building.

The enclave argument

Absence of linkages in natural resource-based industry was not broadly problematised before World War 2. At this time most less developed countries were highly specialized in producing natural resources as a consequence of the colonial economy, where these areas had been used as suppliers of raw material. In Latin America and Africa the natural resource-based industries were often the property of colonisers or local elites who were oriented both culturally and economically towards the colonial powers. The popular book 'Open veins of Latin America', which describes the 'economic bloodletting' of the continent, was a result of such experiences (Galeano 1971).

On the basis of mineral economies in Latin America in the 1960s Rollins (1971) argues that the linkage-dynamics can not take place in natural resources in less developed countries; instead a staple trap will prevail. With this historical context as point of departure Rollins considers: (i) creation of employment (demand linkage); (ii) productivity increases; (iii) spillover of knowledge; (iv) backward linkages and (v) fiscal linkages. (i) Creation of employment for locals could be limited since natural resource-based industry is often very capital intensive. Also, the jobs will most likely be for unskilled labour with low wages. (ii) Productivity increases are naturally expected, but these will most likely not benefit the local economy, cf. terms of trade. (iii) Knowledge spillovers to the national economy via workers is likewise unlikely because local/national employees perform unskilled work. (iv) Backward linkages will not exist because machinery purchase and service is

[12] Another source of volatility is possible accumulation of debt. In natural resource booms the credit ratings of less developed countries improve, and they tend to lend money that may indebt them when the boom goes bust and prices, and income, fall again. It might be a good idea if loans are invested wisely in infrastructure etc. Still, it is a big 'if' because the nature of natural-resource abundance makes natural-resource rich countries subject to corruption, theft and incompetence, according to Humphreys, Sachs et al. (2007).

likely to be imported from abroad because the host country does not have an advanced secondary sector. (v) Fiscal linkages are likely to be weak because in competition for foreign investment project less developed countries have often used low taxes to attract foreign investment, and thus tried to trade the fiscal linkage for demand linkages, that rarely exist. This implies that profits accumulate in the source country, and thus will not benefit the host country. In general host countries have been surprisingly poor at putting up demands for property rights, taxation, knowledge transfer, environmental regulation and work conditions.

Thus, according to Rollins (1971) foreign investment projects are likely to be harmful for the economic development of the host country. The apparent inescapable causality of the latter is based on that the host country lacks capital and that natural resource-based industry is capital-intensive, so therefore the industry is often build by large multinational enterprises that have a bias for establishing backward and forward linkages to their home economies rather than to the local one (Gunton 2003). Even though Rollins's (1971) analysis is based on few specific cases, the points have been confirmed by other studies (Auty 2001; Humphreys, Sachs et al. 2007). Still, in its essence, the arguments have more to do with what we can call institutions and economic management – 'weak' linkages – than it has to do with natural resource-based industry per se. It is not an argument against investing in natural resource-based industry, but it is a lesson on how such investment should be carried out.

The Nature of natural resources

Even though the work of Hirschman (1958) on linkages is closely related with the staple theory, he excluded primary production from the important linkage dynamics. Hirschman (1958: p. 109-110) argued: "*the lack of interdependencies and linkages is of course one of the most typical characteristics of underdeveloped economies…agriculture in general and subsistence agriculture in particular, are of course characterized by the scarcity of linkages effects. By definition, all primary production should exclude any substantial degree of backward linkage*[13]*…the case for inferiority of agriculture to manufacturing has most frequently been argued on grounds of comparative productivity. While this case has been shown not to be entirely convincing, agriculture certainly stands convicted on the count of its lack of direct stimulus to setting up new activities through linkage effects: the superiority of manufacture in this respect is crushing. This may yet be the most important reason militating against any complete specialisation of underdeveloped countries in primary production*".

Thus, the argument is that *backward linkages* are thought to be few because natural resource-based industry does not demand inputs. The input needed is nature, and nature is just there to be taken. It is assumed that the natural resources are directly available in nature. Also, backward linkages to science and capital goods are thought to be weak, because natural resource-based industry is assumed to be straightforward to manage. In the primary sector there is not application of sophisticated knowledge and no innovation. However, as also pointed out by Hirschman above, this is only true for the simplest perception possible of agriculture, as for example picking an apple from a tree. Still, today apple production is extensively mechanised and has linkages to science. Relevant knowledge bases are inter alia agronomy, precision agriculture, vaccines, and biotechnology. Also,

[13] Hirschman does acknowledge that "the introduction of modern methods does bring with considerable outside purchases of seeds, fertilizers and, and other current inputs, not to speak of machines and vehicles. We may say that the more primitive the agricultural and mining activities, the more truly primary they are" (Hirschman 1958: p. 109-110). This does not change his main point, though.

as pointed out by Watkins (1963), backward linkages to infrastructure and especially transport are often very important.

Forward linkages are thought to be few because end products go directly to the consumer or are used as input to other industries in the form of raw materials. Raw materials per definition do not need processing – they are grown right out of the earth's crust wherefrom they are easily collected. If they were processed they would not be primary products. But these are simplifying assumptions rather than facts. Still, as pointed out by Fischer (1952) it is not easy to determine the precise stage in the conversion of milk into butter or cheese when this work ceases to be primary and becomes secondary. The products produced by natural resource-based industries, as defined in this work, are most often processed even though it may not be to the same degree as secondary products. Besides, demand for natural resources has risen over the past decades to volumes that were earlier unimaginable in the form of food, raw materials and energy due to growth in global GDP and population.

Despite the obvious objections listed above, the understanding of primary production as exposed by Hirschman (1958) (mainly based on subsistence agriculture or enclave industries) is currently part of the resource curse thesis as illustrated by inter alia Reinert (2007), Gylfason (2004) and Humphreys, Sachs and Stiglitz (2007). Combined these studies have contributed to transforming context-specific experiences into a general conceptual model for understanding natural resources which is in accordance with the tripartite model of structural change. The latter stereotypic understanding ignores that the nature of economic activities tends to differ across time and place, and tends to underestimate or dismiss learning activities in natural resource-based industries.

In this respect it is interesting to note that later Hirschman (1981) acknowledged that the lack of linkages in natural resource-based industry as compared to manufacture was not a consequence of natural resources per se. It was rather because the actors involved in these industries often were not capable of establishing new activities related to e.g. agriculture, and thus creating new linkages, that were significantly distant from the ongoing activities in terms of knowledge and technology. Thus, according to Hirschman (1981) the real barrier to development was inability to build capabilities and 'strong' linkages around the resource base. His change of mind has not influenced the general understanding of natural resources, though.

The Dutch Disease

The Dutch Disease is really neither a disease nor Dutch. It is, according to Gylfason (2008), rather a recurring phenomenon that involves a reallocation of resources – for example from high-tech, skill-intensive service and manufacturing industries to low-tech, low-skill primary production – with lasting harmful effects on economic growth and diversification. The name remains in use because the Netherlands was the first patient to be diagnosed. The Dutch-disease model describes a situation where an economy suddenly receives windfall earnings from an unexpected discovery of natural resources – it is named after the Dutch discovery of natural gas in the North Sea in the 1960s. A gas export boom led to an appreciation of the Dutch Guilder, and subsequently total exports from the Netherlands decreased. The causality of the argument goes as this: (i) an export boom (of natural resources) leads to appreciation of the exchange rate which gives worse terms for manufacture to export; (ii) the export boom will draw capital and labour from manufacturing sectors. This reallocation of resources will increase cost of labour and materials (because initially the economy was in equilibrium) and thus increase cost for all sectors, which will increase the general price level; (iii) because of the latter, and currency appreciation, export of manufacture decreases and the

price of non-tradeables rises; (iv) foreign income from natural-resource export will in turn be used to import now cheaper foreign manufactured goods (spending effect). So, as the natural resource-based industry grows it attracts key labour inputs from the rest of the economy, which benefits natural resource-based industry and non-tradeables sector.

Since the starting point is that natural resource based industry can not lead growth and development (decreasing returns to scale), the process will inhibit long-term economic development in the country by negatively affecting the manufacturing sectors. In general the Dutch Disease has given precedence to a range of so-called crowding-out explanations for the resource curse. Scholars state that some factor *x* is positive for economic growth, and that 'natural-resource abundance' in some way crowds out *x*. Such arguments have been put forward regarding foreign direct investment, social capital, human capital, saving, investment, financial depth and inflation (Gylfason 2004). Several objections can be made to the argumentation but the most important is that even if we accept that natural resource-based industry is inferior to manufacture, then there are several degrees of freedom for the government to take counteracting measures. The Dutch Disease is basically describing bad policy management. This part of the argument is strongly related to issues of institutions rather than to a problem with natural resource-based industry per se. In general it can be argued that the scholars operating within this part of the resource-curse literature are confusing demand effects and supply effects. Demand swings that can lead to windfall earnings and tempt governments into unsound policy are different from the processes of industrial dynamics that are behind long-run supply and technological learning (Wright and Czelusta 2002).

The foundation of the argument is the negative perception of natural resources which is here apparently unrelated to the issue of linkages. Instead, an acceptance of Malthus' argument (decreasing returns to scale) and the vast number of historical examples of staple traps have played an important role in establishing a consensus in economics, which states that in these activities there is very limited innovation and productivity growth, and therefore they can not lead development. The point is reflected in the method of argumentation used by Matsuyama (1992) on the role of agricultural productivity, where he at the outset assumes learning by doing in manufacturing and no learning in agriculture. One could argue that when operating with such assumptions, conclusions are given a priori.

On the one hand this negative perception is related to the idealising of manufacturing industries as growth poles. To explain the negative aspects of de-industrialisation, Palma (2008) states that "*…manufacturing is an activity considered by many as the most effective engine of growth – either because it is a crucial driver of outward shifts of the production frontier, or due to its capacity to set in motion processes of cumulative causation based on increasing returns*". Therefore de-industrialisation is thought to have long-term negative effects on growth, investment and employment. One could question this logic of arguing backwards – if manufacturing is good, then what is not manufacturing is bad – a crowding out of the 'good'. On the other hand the Malthusian perception of natural resources as a fixed stock also feeds the negative perception. For example Gylfason (2008) argues that "*natural resource wealth is a fixed factor of production that hampers economic growth because it causes a growing labour force and a growing stock of capital to go into diminishing returns*".

As an auxiliary explanation Gylfason (2001) finds that in 'natural-resource abundant' countries investment in education is relatively poor[14]. From this he inferes that employees in natural resource-based industry tend to have a relatively low level of education. Seeing human capital as a source of growth Gylfason (2001: p. 856) further inferes that "*natural resource-based industry as a rule is less high-skill labour intensive than other industries, and thus confers relatively few external benefits on other industries…primary production and primary exports tend to impede learning by doing, technological advance and economic growth*". Even if one acknowledges the latter crowding-out explanation on the national level, it is still not obvious that learning and innovation do not take place at the industry level in primary production, as a rule. Moreover, the argument does not fit well with the fact that some countries have *moved* from being natural resource-based economies to being considered advanced, knowledge-based economies, as e.g. most Scandinavian countries and the US; see Text Box 7 and Text Box 8. Moreover, according to Smith (2007), it is a misunderstanding that all natural resource-based economies are poor. On the contrary, some of the richest, and/or fastest growing, economies today are resource based. These economies include Norway, Sweden, Finland, Canada, New Zealand, Australia and the Netherlands.

A general objection to this perception that could be made is that the obvious omission in Malthus' argument is the role played by technological progress, which has continuously increased agricultural productivity. Ferranti, Perry et al. (2002) show that productivity growth in agriculture has outpaced that of manufacturing in both developed and less developed countries during the 20th century. More precisely, they find that in the period 1967 to 1992 total factor productivity growth was significantly higher in agriculture than in manufacture; especially in developed countries. On this basis the authors conclude that "*natural resource-based activities can have high productivity growth, technical spillovers, and forward and backward linkages as much as modern manufacturing…the view that manufacturing has something special must be called into question*" (p. 4-7). The latter point indicates that the proponents of the negative perception of natural resources tend to confuse historical coincidences with universal laws.

Natural resources in Norway

Norway has historically been specialized in natural resource-based industries. In the 19th century Norway responded to demands from the leading economy of the time, England, by increasing export of salted/dried fish and timber. The increasing transport of natural resources from Norway to England stimulated the development of shipping and shipbuilding industries as a backward linkage – by the 1880s Norway had against all likelihood the world's third largest shipping fleet. As a response to the growing natural resource-based industries several linkages to what we can call manufacturing appeared. Shipbuilding technology improved significantly, and production of intermediate products related to ship transport took off. Also, saw mills improved their equipment and implemented stream-driven saws in the 1870s. Norway actually started to export pulp and paper machinery in the 1890s. With respect to the fishing industry, whaling and canning took hold. In the 20th century new natural resource-based industries appeared. These were based on access to cheap energy. Due to development of capabilities in chemical and electronic engineering Norway had succeeded in exploiting its waterfalls for production of hydroelectricity, which attracted foreign investments in energy-intensive products as zinc, artificial fertilizers and aluminium (Cappelen and Mjøset 2009).

During the developments in the 19th century foreign capital played an important role, and foreigners had a strong presence in many areas. After independence from Sweden in 1905 Norway nationalized many parts of economy that were dominated by foreigners. Politicians implemented 'concession laws' that gave Norwegian authorities control over the relevant water resources. Still, the law changes allowed for joint ventures between national and foreign enterprises, which according to Cappelen and Mjøset (2009) was aimed at developing a Norwegian knowledge base for the

[14] In a sample of 52 natural-resource abundant countries he inter alia finds that gross secondary-school enrolment in the period 1980-1997 is significantly negatively correlated with stock of natural capital in 1994 (defined similarly to 'natural-resource abundance').

relevant engineering supply industries. Subsequently, manufacturing of turbines and machinery for power production became significant backward linkages from hydropower. Also, after World War 2 production of components for automobile production developed as a forward linkage from the production of aluminium.

After World War 2 another natural resource-based industry was added to Norway's portfolio – oil and gas. At the time when Norway discovered oil and gas it did not posses the capabilities necessary to develop an oil industry, which stimulated a process of foreign capital inflow and suggested a dominant role of multinational enterprises. In the spirit of the earlier concession laws Norway created a national oil company, Statoil, in 1972 which was put in control of oil extraction and distribution. The state in Norway had from the start a strategy on knowledge acquisition from foreign firms, and actually one of Statoil's main tasks was to organise learning and technology transfers. Also, universities started up activities as research and education in areas relevant for the oil industry. According to Cappelen and Mjøset (2009) policy was targeted at developing linkages between the oil industry and suppliers. For example Statoil would exercise public procurement by placing orders with several old and new Norwegian firms, which resulted in that old shipyards were restructured into producers of oil-related technology. Mainly due to the rough Norwegian waters a new design for oil platforms was developed. Norway developed several product innovations that would later be internationally competitive. Also special engineering, ICT and other business services have benefitted from the development of the oil industry in Norway. It is moreover remarkable to note that other countries as England, Denmark and the Netherlands also discovered oil and gas in the same period as Norway. While such discoveries were associated with harmful economic effects (to manufacturing) in the Netherlands, it actually strengthened manufacturing activities in Norway (Fagerberg, Mowery et al. 2009).

The above reflects that the Norwegian state was actively building institutions and linkages to avoid a dependency and 'enclave' situation with the international division of labour in mind – and also that it is possible to do so. The institution building facilitated processes of capability building in several complementary areas related to oil production. It is an example of how co-evolution between natural resource-based industry and manufacturing contributes to economic development, and where natural resource-based industry is actually 'leading' the process.

Text Box 7: Natural resources in Norway.

6. The nature of natural resources and institutions

The review of the logical foundations of the resource curse has resulted in the following: (i) several aspects of the arguments can be ascribed to specific contexts and institutions, but not be aggregated to be valid universally; (ii) subtracting the latter there still remain a core understanding of natural resources as inferior to other types of economic activities. It is based on a perception of natural resources as being finite and exogenous. These points will be considered in reverse order below.

Finiteness and exogeneity

This issue takes us back to the dynamic perception of natural resources and distinction between nature and natural resources; see Table 2-1. When the 'stock' of natural resources at any given time is a result of accumulated knowledge, then it is problematic to understand this stock as fixed. Still, it is a rather counterintuitive thought that natural resources are infinite, and that is because they are not – they are and they are not at the same time. Obviously the issue of finiteness must be considered in relation to time. According to the laws of thermodynamics the (very) long run availability of energy and matter to humans is finite (Georgescu-Roegen 1975). This is an important perspective, but for understanding processes of economic development, we must focus on shorter time horizons. One could argue that in the short-run natural resources are finite, in the medium-run they are non-finite, and in the very long run they are also finite.

The most economically important sources of energy and material, and the production process behind, have changed several times since global economic growth and development took off about 250 years ago, and there are no indications of that this pattern of changing sources will disappear.

Rosenberg (1976) argues that successful processes of resource creation and extension have been the foundation of countries' capability to follow the shifts in energy sources and materials that have characterized economic development. 'Knowledge explosions' have historically undermined the tendency to diminishing returns in natural resource-based industries. Production of rubber is one example of these processes. Rubber from the Amazons had been known to westerners for centuries but it was not until Charles Goodyear discovered 'vulcanisation' in 1839, that rubber became a resource (creation). It became a resource because his discovery made it possible to satisfy human wants with the use of rubber. Eventually rubber production from the Amazon region was overtaken by producers in South-East Asia (obsolescing/extension), and both were later overtaken by production of synthetic rubber (obsolescing/creation), which was developed during World War 2 (Zimmermann 1972). Obviously, these processes are characterized by learning and capability building.

Rosenberg (1976) suggests that learning in relation to natural resource-based activities inter alia take place according to the following parameters: (1) raising output per unit of resource input; (2) development of new materials – synthetic fibres, plastic; (3) productivity increase in extraction process; (4) productivity increase in process of exploration and resource discovery; (5) development of techniques to reuse waste and by-products; (6) development of techniques for the exploitation of lower-grade, or other more abundant, resources. Learning is, according to Smith (2007), often initiated due to competitive transformation pressures that call for improvements in mechanisation, automation, economies of scale, transport, and infrastructure that are increasingly 'science-based'.

Natural resources are not infinite but perceiving them as finite gives an unsatisfactory understanding of them because they can be, and are constantly, subject to processes of creation, extension and obsolescing – processes that necessarily are characterized by learning and knowledge accumulation. The arguments above seriously question that natural resources are fixed, finite, and thus, per definition, subject to decreasing returns to scale as assumed in e.g. Reinert's (2007) dichotomy[15].

Minerals and oil in the US

According to Wright and Czelusta (1997; 2002; 2004) the US was 1913 the world leader in production of virtually every mineral. And this was not because of a proportional natural endowment of natural resources – instead it was a result of learning. Between 1900 and 1914 the US produced 10 times more copper than Chile even though Chile had, and has, a much larger geological endowment. The US mineral industries advanced in 1870s and 1880s due to huge capital investments, but the major breakthroughs took place in metallurgy and improved conversion processes as e.g. the Bessemer process which allowed for a far higher exploitation rate of the mineral. Moreover, according to Wright and Czelusta (2002) there is reason to believe that the US leadership in minerals was a significant factor in shaping, if not propelling, the US path to world leadership in manufacture. The US had significant 'materials-using bias' in technical change in 9 of 20 USA manufacturing industries between 1850 and 1919: "*Nearly all USA manufactured goods were closely linked to the natural-resource economy in "one way or another": petroleum products, primary copper, meat packing and poultry, steel works and rolling mills, coal mining, vegetable oils, grain mill products, sawmill products, and so on. These observations by no means diminish the country's industrial achievement, but they confirm that American industrialisation was built upon natural resources*" (p. 5). Among key explanatory factors for the US's experience in minerals are; (a) liberal and softly enforced legal environment; (b) investments in infrastructure and public knowledge as geological surveys; (c) education and research in mining, minerals, geology and metallurgy in which the US was world leader at the time.

[15] The distinction between renewable energy and non-renewable energy is not irrelevant here (stock and flow), but it is mitigated by the possibility to argue that renewable energy is also finite in a natural scientific way – again it is a matter of time perception. Still, given energy scarcity, prices and political priorities is it often preferable to be dependent on natural resources that are renewable in the short and medium run.

Oil is an extreme example of the mechanisms just described. The discovery of oil as a valuable natural resource was made in the US despite the country's relatively poor natural endowment of oil. The first oil well was established in 1859. Gradually the US built up the "American way of life" based on cheap oil and automobiles. By 1913 the US production of oil amounted to a bit more than 60% of world production despite the majority of known oil resources were located in the Middle East (Mousdale 2008). Often American geologists were employed as consultants by oil firms to help locate deposits of oil in the ground. The industry quickly saw the value of scientific knowledge which created linkages between academia and industry. Young geologists used the national US geological survey to apply the novel anti-clinical theory which successfully was used to locate oil deposits. The use of new theory resulted in better search methods. In general the oil industry invested in the accumulation of knowledge in geology to serve its activities which is reflected by the establishment of the Berkley and Stanford Universities that are children of the oil boom in California. Also, there emerged an important linkage to the chemical industry. Actually, with the development of petrochemicals in the 1920s, one may say that oil was instrumental in the transition of manufacturing in USA from traditional mass production to science-based technologies. Until the 1920s the base material in chemical industry had mostly been coal, but this changed radically in the following years. The shift from coal to oil as raw material brought the US to the world frontier in chemical industries. A drive for diversification created important forward linkages wherein new industries were created on the basis of new knowledge.

The paragraph indicates that (i) it was not abundance of natural resources per se (in terms of deposits) that was the reason for American leadership, but learning and capability building; (ii) that the development of manufacturing industry in some way was related to the development of natural resource-based industries.

Text Box 8: Minerals and oil in the US.

To understand natural resources as exogenous to the economic system is equivalent to stating that they do not have linkage potential for development. It implies that growth of natural resource-based industries will not lead to diversification; but instead to a staple trap. As argued above natural resources have, in principle, linkages of all kinds. Natural resources must be produced, and are not freely available in nature, see Text Box 9. It requires development of technology and knowledge to build ships to go fishing, to extract minerals, to exploit wind energy and to improve agricultural yields. This argument strongly relates to the points of extending and creating natural resources, and illustrates the necessity of understanding natural resources as dynamic.

Mineral discovery in Australia

Compared to the US, countries as Chile, Russia, Canada and Australia started very late with their natural resource exploitation. Australia is a special case. It was a British colony and part of the British Empire in the same sense as the US in terms of institutions, but it was lacking behind most developed countries in income, education and technology. In USA people had the true entrepreneurship spirit to go out and create, take risks and look for fame and fortune. In Australia there was a largely pessimistic feeling about the size and value of natural resources which lasted up until the 1950s. At one point Australian politicians even put export limits on minerals in order to save some for the future. Due to changes in policy and 'attitude exploration and exploitation of minerals took off and led to many new discoveries after 1960. Canada has a similar story. In 1966 Canada was not seen as a country rich in natural resources (Wright and Czelusta 2002). This shows us that informal institutions and knowledge are important for perceiving value of nature. It also illustrates that natural resources should be partly understood as a dynamic, endogenous concept.

During the 1990s the Australian mineral industry increased capital stock and production while the deposits of known resources have grown as a result of more and better exploration. These activities have according to Wright and Czelusta (2002: 26) stimulated other economic activities: "*The surge in production of mineral inputs has carried a number of new and old industries along in its wake. In the decades following the onset of Australia's most recent minerals boom, leading manufacturing industries had obvious connections to minerals: metal and steel products, autos, industrial equipment, petroleum products, ships, and chemicals*". Also, Australian firms are world leaders in mining software systems, and in general mining firms export services and equipment. Also, based on experience in mining activities, Australian firms have built capabilities in cleaning up air, water and soil, recycling waste and eliminate pollution. These capabilities have proven increasingly relevant as environmental concerns increase. According to Smith (2007) linkages need not be directly into related manufacturing industries, but can also lead to

service sector development. In Australia the major financial markets in Sydney are heavily focused on specialised finance for the natural resource sector. Mining involves major risks, and the investment banking and equity markets in Australia are heavily involved in managing the risk spreading portfolio problems of the industry. This has over time, led to Sydney evolving into one of the major financial centres of the world which is partly owed to its background in natural resource-based industry (which continues to be one of its major specialisations). The Australian example also illustrates that there can be seemingly important linkages between primary, secondary and tertiary sectors. Also here the importance of search and related learning was seen

Text Box 9: Mineral discovery in Australia.

Institutional aspects and status quo

The institutional dimension of the resource-curse literature is the collection of arguments about why policy makers are not able to avoid the Dutch Disease, regulate labour markets, manage risk in relation to volatility in income, build linkages and diversify the productive structure. They are what Ross (1999) calls political explanations of the resource curse that complements the economic explanations.

Resource curse proponents have a central argument that comes in several versions. The core of it is that 'natural-resource abundance' leads to myopia among private and public decision makers. The argument is ironically captured in the following quote by Jean Bodin: "*Men of a fat and fertile soil, are most commonly effeminate and cowards; whereas contrariwise a barren country makes men temperate by necessity and by consequence careful, vigilant, and industrious*" (Ross 1999: p. 6). This phenomenon has also been denoted "sugar mentality" and "boom-and-bust psychology", which reflects that long-term planning and economic diversification are not on the agenda of decision makers in the presence of natural resource profits. Even though there seems to be little logical support for this argument it is proposed on several occasions by both Sachs and Warner (1995; 2001) and Gylfason (2001; 2004; 2008) when analysing the Dutch Disease. Furthermore, Humphreys, M., J. D. Sachs, et al. (2007) report that corruption is more widespread in 'natural resource abundant' countries because the short run availability of large financial assets increases the opportunity for the theft of such assets by political leaders. Also Auty (2001) argues for a negative relation between 'natural-resource abundance' and 'developmental states'[16] (Woo-Cumings 1999) because: (a) high scarcity of land will force those in power to include the poor - there will be more pressure for redistribution; (b) scarcity of resources invites efficient use of them; (c) resource-scarce countries are less prone to trade policy closure and Dutch disease events because raw materials booms will not affect these economies much; (d) diversification into competitive manufacturing comes easier to resource poor nations due to (i) fewer opportunities in primary production, (ii) awareness of that a small natural resource-based industry can not support the rest of society.

Thus, the basic argument is that 'natural-resource abundance' will give you 'bad' institutions. Still, some would argue that the absence of a developmental state causes 'natural-resource abundance' (absence of manufacture) and not the other way around – in other words that the 'poor' institutions are causes, and not results, of 'natural-resource abundance'.

This brings us back to the measurement of 'natural-resource abundance' – the value share of natural resource export in GDP. The denominator in this ratio is the size of the economy, and both the size of the economy and export specialisation is likely to be affected by past policy and institutions. This

[16] A developmental state is seen as benevolent, capable and autonomous, and it seeks broad social welfare as part of a national vision without corruption and opportunistic rent-seeking behaviour.

implies that the measure is endogenous. Brunnschweiler and Bulte (2008) sets out to test the resource curse propositions but adding institutional indicators to the regression[17]. They find a strong negative correlation between institution quality and 'natural-resource abundance' which they interpret to reflect that countries with poor institutions are unlikely to develop non-natural resource export goods. Thus, their finding is the reverse of the resource curse. Also, when controlling for the effects of institutions they find no significant (negative) correlation between 'natural-resource abundance' and income growth[18]. These findings, that are also supported by Mehlum, Moene et al. (2006), lead the Brunnschweiler and Bulte (2008) to conclude that the resource curse is a 'red herring'.

Despite these findings there is still disagreement on the direction of causality – an issue which has caused much debate on the primacy of institutions (Rodrik, Subramanian et al. 2004) versus geography (Diamond 1997; Gallup, Sachs et al. 1998; Sachs 2001). This is, according to Bridge (2008) and Gunton (2003), approximately where the discussion of natural resources and development stands today. Both proponents and critics agree that the correlation between 'natural-resource abundance' and poor economic performance is primarily due to 'state failure' or 'governance failure' (institutions). They disagree, though, on whether such failures are owed to context and contingency or to structural and deterministic features of natural resources. The consensus has implied that most debate on this issue pivots around the term 'good governance' and market-supporting institutions. Due to methodological problems with and the complex nature of institutions the research agenda has, according to Bridge (2008) and Gunton (2003), reached a stalemate. According to Gunton (2003) the consequence is that it remains undecided whether natural resources can lay the foundations for development or whether the structural limitations of natural resources will inevitably undermine development.

Perspectives on institutions

Even though it is a bad habit to talk of all the things that you do not do, I find it relevant to comment on the recent 'institutional turn' in development economics because I will return to its core later on. Nielsen and Johnson (1998) identify two broad trends within institutional economics: (i) one emphasising institutional analysis with focus on 'allocation of scarce resources', which is related to an equilibrium approach; and (ii) one focusing on the 'creation, distribution and use of new resources'. The former can be denoted new institutional economics and the latter as old institutional economics (Hodgson 1998).

The focus of new institutional economics in relation to topics of economic growth and development has mainly been on transaction costs where the prime goal is to reduce them (Aron 2000). The latter can be conceptualized as market-supporting institutions. Rodrik (2000) identifies property rights, regulatory institutions, institutions for macro stabilisation, institutions for social insurance and institutions for conflict management as important institutions supporting market efficiency. The argument is that these institutions, when 'good', will stimulate growth and development *directly* via diligent and efficient use of resources, and *indirectly* via 'good governance' that will facilitate capital accumulation, investment, political stability, etc. (Aron 2000). Such considerations have stimulated

[17] The authors use two proxies for institutional quality – they distinguish between (i) variable and (ii) invariable institutions. Variable institutions are short-term policy goals as governance while these activities are affected by 'constitutional design' and other 'deeper' framework conditions. The short-term outcomes are to some extent outputs from the deeper causes while the deeper institutions are outcomes of historical processes. The indicators are: (i-a) rule of law (World Bank data) – the quality of contract enforcement, police, courts and likelihood of violence and crime; (i-b) government effectiveness – quality of bureaucracy, and public services; (ii) the look at presidential regime versus parliamentary/majority-rule regimes.

[18] They use per capita income growth 1970-2000 and 'natural-resource abundance' data is averaged over the period 1970-1989.

much research on the importance of institutions which, due to methodological problems, has not been able to conclude much more than 'institutions do matter' (Glaeser, La Porta et al. 2004; Johnson 2008)[19]. The argument suggests that institutions are the root cause of development. This proposition may be true, but new institutional economics tends to focus on a rather limited set of institutions, which does not explicitly involve learning institutions.

If one accepts that economic development is a process characterized by 'creation, distribution and use of new resources', there is reason to be sceptical towards claiming that minimisation of transaction costs is the root cause of development. Instead, one should focus on understanding how institutions affect processes of change, especially those that involve learning and capability building – learning institutions – as emphasized in parts of old institutional economics. Such a focus is needed in research on natural resources and development. Still, the arguments of new institutional economics are not irrelevant – there are obvious overlaps. Institutions contributing to collaboration and trust are relevant both for learning and e.g. low corruption.

Text Box 10: Perspectives on institutions.

A learning perspective on this debate could be fruitful for several reasons. Firstly, one problem with the current stalemate is that the discussion is dominated by new institutional economics that focuses on market-supporting institutions; see Text Box 10. The latter is a barrier for a deeper understanding of natural resource-based development. This approach is inadequate to grasp the dynamics involved in processes of creation and extension of natural resources which implies that researchers are not focusing on the most important parameters. It is strongly indicated in the historical examples that learning institutions are important in natural resource-based development – this calls for a learning perspective on natural resources. Clearly, several institutions that can also be perceived as market-supporting are important for building linkages as e.g. institutions insuring stability, access to credit, presence of human capital, and entrepreneurship.

The above shows that institutions, rather than natural resources per se, to a large extent determine whether natural resource-based development is possible. It also shows that research on the topic unfortunately often focuses exclusively on market-supporting institutions. From a learning perspective such analysis can not address the most important challenges in natural resource-based development – for that a learning approach is required.

7. Different Approaches

This section will illustrate the different approaches and conceptual models for analysing natural resources that can be identified above. In the process a learning approach to natural resources will be explicitly presented. This exercise will make it clear that an alternative conceptual model of structural change is required to understand natural resource-based development.

Endowment and process

From the above review, it is clear that there does not seem to be any a priori reason to expect that natural resource-based industries (i) do not have and/or can not create linkages to other industries; (ii) per definition are subject to decreasing returns to scale due the finiteness of natural resources; (iii) do not experience learning and innovation; (iv), and therefore, can not lead development such

[19] Performance measures are most often applied to indicate institutional quality and its link to economic performance. The performance of institutions can e.g. be indicated by risk measures and by the ease of doing business. This kind of data is obtained through surveys performed by private risk agencies as e.g. the International Country Risk Guide (ICRG - http://www.countrydata.com/datasets/). Data from the ICRG include subjective assessments of risk for international investors along dimensions as law and order, bureaucratic quality, corruption, risk of expropriation by the government and risk of government contract repudiation.

that natural resource-based development is one potential strategy for development among and in combination with others.

The main differences among proponents and critics in perception of natural resources (exogeneity and finiteness) are consequences of different analytical foci. If one perceives natural resources as exogenous and finite, then an obvious analytical focus would be to search for the most efficient use possible of these scarce resources. On the other hand, if one perceives natural resources as endogenous and non-finite such that scarcity changes with knowledge accumulation, then the analytical focus would *also* include a search for understanding the processes of resource creation. If one wants to understand long-term development then it seems that to study allocation of current resources is less important than a dynamic perspective (c.f. 'different perspectives on institutions'). The difference between the approaches can be conceptualized as an 'endowment approach' (static) and a 'process approach' (dynamic), see Table 7-1. To recognise these complementary differences is a first step in a learning approach to natural resources.

Furthermore, in the endowment approach one focuses on the given stocks of resources at ones disposal. These are subject to prices that are mainly set by conditions of scarcity. Considering current and estimated future consumption together with current and estimated decrease in global supply, it is possible to establish a scenario wherefrom one can deduct at what time we will run out of a specific resource, and how price movements will be until then. Based on this information, it is possible to calculate an 'optimal' extraction and sales rate of energy resources, which maximizes income from deposits (see e.g. Hotelling 1931). This view implies that given endowments and demand, the price of energy will rise continuously as will the share of GDP going to energy consumption. Based on such a view W.S. Jevons (1866) argued in his publication 'The Coal Question' that: "*I draw the conclusion that I think any one would draw, that we cannot long maintain our present rate of increase of consumption; that we can never advance to the higher amounts of consumption supposed. But this only means that the check to our progress must become perceptible considerably within a century from the present time; that the cost of fuel must rise, perhaps within a lifetime, to a rate threatening our commercial and manufacturing supremacy; and the conclusion is inevitable, that our present happy progressive condition is a thing of limited duration*". The situation would have looked different in a process approach where it is recognised that (a) deposits of energy often increases significant via improved search, (b) sources of energy has often changed (in modern economies), (c) it is important to search for substitute sources, (d) the ability to change energy sources is partly determined by prior innovation and capabilities, (e) energy is a source of competitiveness wherefore productivity in extraction and conversion is important, and (f) experiences and incomes from the process of energy resource utilisation may be used to build new competences in activities, which are not immediately related to these resources (Rosenberg 1976).

Parameter	Endowment approach	Process approach
Finiteness	Natural resources are finite and thus subject to 'decreasing returns to scale'. The main question to consider is optimal resource management, which implies 'good' governance in order to extract and sell resources such that value is maximized given market prices. Income should be invested in manufacturing or service activities.	Not necessarily finite or exhaustible – would give a wrong perception of natural resources. Natural resources should be understood as a dynamic concept as they can be created, extended and destroyed via knowledge accumulation.
Linkages	Natural resources are freely available in nature, go directly to consumers or as inputs to industrial activities. There is thus very little feedback with industry or production function – even with 'good' institutions.	There are significant linkages across the tripartite classification that differ over time and place in intensity.
Learning	Because of decreasing returns to scale and absence of linkages learning potential is limited.	Natural resources are not freely available. Extension and creation of them requires learning and competence building.
Exogenous or endogenous?	Natural resources should be seen as an exogenous, independent stock of raw material without relevance for the 'societal production function'.	Natural resources are clearly endogenous because of their dependence upon stock of knowledge. In some sense natural resources is a social.

Table 7-1: Endowment versus process approach to natural resources.

Theoretical nuances

In order to give an overview and to illustrate how a learning perspective can contribute to the existing literature on natural resource-based development, further theoretical differences and nuances, and the problems with these will be pointed out, see Table 7-2.

The aspect that separates the staple theory (that sees natural resources as a temporary advantage) and proponents of the resource curse is the different view on linkage potential. However, they share the view on the finiteness of natural resources, and thus the understanding that they are subject to decreasing returns to scale. Both Watkins (1963) and Gunton (2003) are exponents of the latter position[20]. Gunton argues that natural resource-based development (staples) is possible especially in *the early phases* of development. Staple theory acknowledges that primary production can have linkages with secondary and tertiary production, but it tends to underestimate, and maybe ignore, aspects of resource creation, extension, obsolescing and innovation – activities that also call for learning, investment, equipment and thus further linkages. Thus, to keep intact the perception of natural resources as being finite, will exclude part of the linkage potential. Instead, when one views natural resource as a dynamic concept, there is no general argument for why natural resources should not be able to lead a development process over long time periods – also, while other, and maybe unrelated, industries emerge in the national economy.

Furthermore, the resource-curse literature can with respect to institutions be divided into, broadly speaking, two positions: (i) natural-resource abundance gives you bad institutions or (ii) bad institutions give you natural-resource abundance; and poverty. While position (i) argues that natural resources are cursed and will harm your economy, position (ii) argues that natural resources are not cursed as such, but since it is a type of production which is subject decreasing returns to scale, it can

[20] Staple theory contains much diversity (Gunton 2003), which is not reviewed in full here. Nonetheless, I base this proposition mainly on Watkins (1963) and Gunton (2003) who both make literature reviews of prior contributions to staple theory, and reflect the mainstream of writings.

not lead development. Additionally, position (ii) argues that if a country has 'good' (market-supporting) institutions, then it has a chance to export its natural resources to earn foreign income to invest in manufacturing – to escape the resource curse. Regardless of the inclusion of institutions, the nature of natural resources seems to be misunderstood in these arguments.

	(a) Resource curse literature	**(b) Institutional resource curse**	**(c) Staple theory**	**(d) Learning approach**
Is natural resource-based development possible?	No, natural resource-based activities are harmful for development	No, natural resource-based industries can not create development; only finance it	Yes, but only as a transitory in the early phases of development	Yes, the reviewed material suggests the possibility of natural resource-based development
Exogenous or endogenous?	Exogenous	Exogenous	Endogenous (linkages)	Endogenous (linkages)
Are natural resources finite?	Yes, endowment approach + decreasing returns to scale	Yes, endowment approach + decreasing returns to scale	Yes, endowment approach + decreasing returns to scale	No, process approach to natural resources
The role of institutions	Natural-resource abundance leads to 'bad' institutions	'Bad' (market-supporting) institutions lead to natural-resource abundance (specialisation in natural resource-based industry)	Build linkages, avoid caveats (no explicit reference to institutions)	It is important to primarily focus on learning institutions because knowledge is the main barrier to linkage building (Hirschman 1981).
Relationship between natural resources and secondary and tertiary sectors?	Contradiction	Co-existence	Temporary co-evolution	Co-evolution
Policy consequences	Get out of natural resource-based industry	With 'good' (market-supporting) institutions it is possible to avoid the resource curse, and obtain export income to invest in manufacturing.	Staple trap can be avoided with clever policy, invest export earnings in manufacturing.	Be careful with generalisations, and explore the role of natural resources in specific contexts. Focus on linkages, 'good' and learning institutions

Table 7-2: Theoretical approaches to natural resources - an overview.

These differences in perceptions can be seen in Table 7-2. The issue of linkages is formulated as the relationship between natural resource-based industries and the rest of the economic system, and can be defined as one of contradiction, one of co-existence or one of co-evolution. According to the resource curse natural resources are directly harmful for other economic production (contradiction). According to the institutional version of the resource curse, natural resources can not lead development, but can mobilize finance – so the sectors can co-exist without problems. Partly in staple theory and, fully in a learning perspective, natural resources co-evolve with the development of other types of production via processes of linkages building and learning, innovation and competence building.

In the above table Reinert's (2007) dichotomy outlined earlier is accepted only by groups (a) and (b), partly by (c), but fully rejected by position (d). Basically, the shift from a static, exogenous

perception of natural resources to a dynamic, endogenous perception undermines the validity of the dichotomy. Since the dichotomy is also part of the micro foundations for the tripartite conceptual model, then it should be revised to be capable of incorporating the view on natural resources presented above. Moreover, the table above clearly illustrates how and with what a learning perspective can contribute to the literature on natural resources and development.

8. Concluding remarks

The empirical examples and theoretical arguments presented indicate that natural resource-based industries may play an important role in economic development via linkages of different nature and via learning and innovation. The tripartite model has little to say about the process of change. It is too general and relies on co-observation of events rather than posing a causal sequence of events. As was said by Cohen and Zysman (1987) earlier, the latter model is not a theory or an economic model. Instead it is a popular hypothesis without real theory. To get beyond these crude co-observations one must focus on the processes of change to find out what 'drives' structural change and development. As a mean towards that end a learning approach to natural resources has been presented. Its core proposition is that natural resources must be understood as dynamic, and as being subject to learning processes of natural resource creation, extension and obsolescing that are enabled or blocked by institutions.

The latter suggests that there is no a priori hierarchy of industries. Therefore the resource curse is not really about natural resources but about learning – or the absence of it. Natural resources do not make countries poor, but weak learning systems do. These insights do not disqualify all insights from the resource curse, though. It is important to avoid 'enclave industries' with weak demand and fiscal linkages, and with limited backward and forward linkages. Still, these considerations do, at best, allow for perceiving natural resources and e.g. manufacturing as co-existing activities. One needs a learning perspective to perceive the potential for co-evolution and development in natural resource-based industries.

Seen from this perspective it is crucial to understand how learning takes place in natural resource-based industries and how these affect structural change and development. As pointed to by Hirschman (1981) and indicated by the successful examples of natural resource-based development, knowledge accumulation and linkage building are crucial factors in the process. This makes it obvious to focus on the causality between development, structural change and innovation. Given the systemic nature of learning the innovation system approach might be well-suited for approaching the latter challenge (see e.g. Lundvall, B.-Å., J. Vang, et al. 2009).

9. Literature

Andersen, E. S. (1992). Approaching National Systems of Innovation from the Production and Linkage Structure. National systems of innovation : toward a theory of innovation and interactive learning. B. Å. Lundvall, London: Pinter.

Anderson, K. (1998). "Are resource-abundant economies disadvantaged?" The Australian Journal of Agricultural and Resource Economics **42**(1).

Arocena, R. and J. Sutz (2000b). "Looking at National Systems of Innovation from the South." Industry and Innovation **7**: 55-75.

Aron, J. (2000). "Growth and institutions: A review of the evidence." World Bank Research Observer **15**(1).

Auty, R. M. (2001). "The political economy of resource-driven growth." European Economic Review **45**.

Baffes, J. and T. Haniotis (2010). Placing the 2006/08 Commodity Price Boom into Perspective. Policy Research Working Paper, The World Bank.

Bakker, K. and G. Bridge (2006). "Material worlds? Resource geographies and the 'matter of nature'." Progress in Human Geograpy **30**(1).

Black, J. (2003). Oxford dictionary of economics, Oxford University Press.

Boulding, K. E. (1978). Ecodynamics: A New Theory of Societal Evolution, Sage Publications.

Boulding, K. E. (1981). Evolutionary Economics. London, Sage Publications.

Bridge, G. (2008). "Global production networks and the extractive sector: governing resource-based development " Journal of Economic Geography **8**.

Browning, M. (2008). Engel's Law. The New Palgrave Dictionary of Economics Online. S. N. Durlauf and L. E. Blume., Palgrave Macmillan.

Brunnschweiler, C. N. and E. H. Bulte (2008). "The resource curse revisited: A tale of paradoxes and red herrings." Journal of Environmental Economics and Management **55**.

Cappelen, Å. and L. Mjøset (2009). Can norway be a role model for natural-resource abundant countries? Research paper, UNU-WIDER.

Ciccone, Antonio (2008) *Linkages*. The New Palgrave Dictionary of Economics, Eds. Steven N. Durlauf and Lawrence E. Blume, Palgrave Macmillan.

Cimoli, M., G. Porcile, et al. (2005). Cambio Estructural, Heterogeneidad Productiva y Tecnología en América Latina, CEPAL.

Cohen, S. S. and Zysman, J. (1987). *Manufacturing matters: the myth of the post-industrial economy*. New York : Basic Books.

Coriat, B. and Dosi, G., 1998, The Institutional Embeddedness of Economic Change, in Nielsen, K. and Johnson, B. (eds) *Institutions and Economic Change, New Perspectives on Markets, Firms and technology*, Edward Elgar.

Dahl Andersen, Allan (2009). 'Getting the Economic Activities Right - The Case of the Brazilian Sugarcane-ethanol Industry'. Presented at DRUID-DIME Academy Winter Conference 2009

Daly, H. E. (1997). "Georgescu-Roegen versus Solow/Stiglitz." Ecological Economics **22**.

Diamond, J. (1997). Guns, Germs, and Steel. New York, W.W. Norton & Co.

Dosi, G. (1988). "Sources, Procedures and Microeconomic Effects of Innovation." Journal of Economic Literature **26**(3).

Easterlin, R. A. (2008). Simon Kuznets (1901–1985). The New Palgrave Dictionary of Economics Online. S. N. Durlauf and L. E. Blume., Palgrave Macmillan.

Edquist, C. and B. Johnson (1997). Institutions and Organizations in Systems of Innovation. Systems of Innovation. C. Edquist. London, Pinter.

Fagerberg, J., D. C. Mowery, et al. (2009). "The evolution of Norway's national innovation system." Science and Public Policy **36**.

Ferranti, D. d., G. E. Perry, et al. (2002). *From Natural Resources to the Knowledge Economy*. World Bank Latin American and Caribbean Studies. Washington, D.C., World Bank.

Findlay, R. (2008). Terms of trade. The New Palgrave Dictionary of Economics Online. S. N. Durlauf and L. E. Blume., Palgrave Macmillan.

Fisher, Allan G. B. (1939).'Production, Primary, secondary and Tertiary'. Economic Society of Australia and New Zealand, Economic Record.

Fisher, Allan G. B. (1952). 'A note on tertiary production'. The Economic Journal, vol. 62, no. 244, pp 820-834.

Galeano, E. (1971). Open veins of Latin America, Monthly Review Press.

Gallup, J. L., J. D. Sachs, et al. (1998). Geography and Economic Development. NBER Working Paper.

Georgescu-Roegen, Nicholas (1975). 'Energy and Economic Myths'. Southern Economic Journal, Vol. 41, No. 3.

Glaeser, E. L., R. La Porta, et al. (2004). Do institutions cause growth? NBER working paper, National Bureau of Economic Research.

Gylfason, Thorvaldur (2001).'Natural Resources, Education, and Economic Development'. European Economic Review 45.

Gylfason, T. (2004). Natural resources and economics growth:From dependence to diversification. Discussion Paper. London, Centre for Economic Policy Research.

Gylfason, Thorvaldur (2008). 'Dutch Disease'. The New Palgrave Dictionary of Economics. 2nd edition, 2008.

Hirschman, A. (1958). *The Strategy of Economic Development*. New Haven, Conn., Yale University press.

Hirschman, Albert (1981). 'A generalized linkage approach to development, with special reference to staples'. In *Essays in Trespassing*. Cambridge University Press.

Hodgson, G. M. 1998, The Approaches of Institutional economics, Journal of Economic Literature, , Vol. XXXVI

Hotelling, Harold (1931). 'The Economics of Exhaustible Resources'. The Journal of Political Economy, Vol. 39, pp. 137-175.

Humphreys, M., J. D. Sachs, et al. (2007). What is the problem with natural resource wealth? Escaping the resource curse. M. Humphreys, J. D. Sachs and J. E. Stiglitz. New York, Columbia University.

Innis, H. (1930). The Fur Trade in Canada: An Introduction to Canadian Economic History University of Toronto Press (1999 edition).

Innis, H. (1940). The Cod Fisheries: The History of an International Economy. Toronto, The Ryerson Press.

Jevons, W. S. (1866). The Coal Question: An Inquiry Concerning the Progress of the Nation, and the Probable Exhaustion of Our Coal-Mines. Chapter 12. , London, Macmillan and Co. http://www.eoearth.org/article/The_Coal_Question_%28e-book%29.

Johnson, B. (1992). Institutional Learning. National Innovation Systems: Towards A Theory of Innovation and Interactive Learning. B. Å. Lundvall. London, Pinter.

Johnson, B. (2008). A note on institutions as the root cause of development. Workshop on Institutions, Innovation and Development, Department of Business Studies, Aalborg University.

Kaufmann, D. and Kraay, A. (2007), Governance Indicators: Where Are We, Where Should We Be Going?, Policy Research Working Paper 4370. The World Bank.

Knaup, H. and J. v. Mittelstaedt (2009). The new colonialism - Foreign investors snap up African farmland. Spiegel International.

Krugman, P. (1979). "Increasing returns, monopolistic competition and international trade." Journal of International Economics **9**.

Krugman, P. (1997). Development, Geography, and Economic Theory, MIT Press

Kuznets, Simon (1971). *Economic growth of nations: total output and production structure*. Cambridge (Mass.)London: Belknap Press of Harvard University

Lundvall, B. Å. (2007). "National Innovation Systems Analytical Concept and Development Tool." Industry and Innovation **14**(1).

Lundvall, B.-Å., J. Vang, et al. (2009). Innovation system research and developing countries. Handbook of innovation systems and developing countries - building domestic capabilities in a global setting. B. Å. Lundvall, K. J. Joseph, C. Chaminade and J. Vang, Edward Elgar.

Malthus, Thomas (1798). An Essay on the Principle of Population.

Marshall, Alfred. (1890), The Principles of Economics, Macmillan.

Matsuyama, Kiminori (1992). 'Agricultural productivity, comparative advantage, and economic growth'. Journal of Economic Theory, 58, 317-334.

Matsuyama, K. (2008). Structural change. The New Palgrave Dictionary of Economics. S. N. Durlauf and L. E. Blume, Palgrave Macmillan.

Mehlum, H., K. Moene, et al. (2006). "Institutions and the resource curse." The Economic Journal **116**.

Nielsen, K. and B. Johnson (1998). Institutions and economic change : New perspectives on markets, firms and technology. Cheltenham, Edward Elgar Publishing, Incorporated.

Palma, J. G. (2008a). De-industrialization, 'premature' de-industrialization and the Dutch Disease. The New Palgrave Dictionary of Economics Online. S. N. Durlauf and L. E. Blume., Palgrave Macmillan.

Palma, J. G. (2008b). Raúl Prebisch (1901–1986). The New Palgrave Dictionary of Economics Online. S. N. Durlauf and L. E. Blume., Palgrave Macmillan.

Prebisch, R. (1950). The economic development of Latin America and its principal problems. New York, United Nations Publications.

Reinert, E. (2007). *How Rich Countries Got Rich ... and Why Poor Countries Stay Poor*, PublicAffairs.

Rodrik, D. (2000). "Institutions for high-quality growth: what they are and how to acquire them." Studies in Comparative International Development **35**(3).

Rodrik, D. (2006). "Goodbye Washington Consensus, hello Washington Confusion? A review of the World Bank's Economic growth in the 1990s: Learning from a decade of reform." Journal of Economic Literature **44**(4).

Rodrik, D., A. Subramanian, et al. (2004). "Institutions Rule: The Primacy of Institutions Over Geography and Integration in Economic Development." Journal of Economic Growth **9**.

Rollins, C. E. (1971). Mineral Development and Economic Growth. Imperialism and Underdevelopment. R. I. Rhodes. New York, Monthly Review Press.

Rosenberg, Nathan (1976). *Perspectives on Technology*. ISBN: 0521290112 and 978052129011

Sachs, J. D. and Warner, A. M. (1995). 'Natural Resource Abundance and Economic Growth'. NBER Working paper series, paper no. 5398.

Sachs, J. and A. M. Warner (1997). Natural resource abundance and economic growth, Center for International Development and Harvard Institute for International Development.

Sachs, J. D. (2001). Tropical Underdevelopment. NBER Working Paper.

Scitovsky, T. (1976). The Joyless Economy – An Inquiry into Human Satisfaction and Consumer Dissatisfaction, ISBN: 0-19-501974-1.

Singer, H. W. (1950). "The Distribution of Gains between Investing and Borrowing Countries." The American Economic Review **40**(2).

Smith, K. (2002). What is the 'Knowledge Economy'? Knowledge Intensity and Distributed Knowledge Bases Discussion Paper Series, United Nations University, INTECH.

Smith, K. (2007). Innovation and Growth in Resource-based Economies, Australian Innovation Research Centre, University of Tasmania.

Smith, Keith (2008). 'Climate change and radical energy innovation: the policy issues'. Report to Garnaut Commission on Climate Change, Department of Premier and Cabinet Government of Victoria, Australia.

Solow, R. M. (1957). "Technical change and the aggregate production function." The Review of Economics and Statistics **39**(3).

Spiegel International (2009). 'Foreign Investors Snap up African Farmland'. July 30th. http://www.spiegel.de/international/world/0,1518,639224,00.html

UNCTAD (2007). World investment report - Transnational corporations, extractive industries and development, United Nations.

Watkins, M. H. (1963). "A staple theory of economic growth." The Canadian Journal of Economics and Political Science **29**(2).

Watkins, M. H. (1977). "The staple theory revisited." Journal of Canadian Studies **12**.

Wicken, Olav (2009). 'The theoretical basis of resource based dynamics: Are natural resources endogenous or exogenous of the economy?'. Working paper. TIK. Oslo University.

Woo-Cumings, M. (1999). The developmental state, Cornell University Press.

Wright, G. and J. Czelusta (1997). "Increasing returns and the genesis of american resource abundance." Industrial and Corporate Change **6**.

Wright, G. and J. Czelusta (2002). Exorcizing the resource curse: Minerals as a knowledge industry, past and present. Working Papers, Stanford University, Department of economics. 25 1

Wright, G. and J. Czelusta (2004). "Why economies slow - The myth of the resource curse." Challenge **47**(2).

Zimmermann (1972). World Resources and Industries. Third edition. Harper & Row Publishers, New York.