Identifying the role of natural resources in knowledge - based strategies of development

Isabel Álvarez
Romilio Labra

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Abstract

Knowledge has adopted a preferential role in the explanation of development while the evidence about the effect of natural resources in countries' performance is more controversial in the economic literature. This paper tries to demonstrate that natural resources may positively affect growth in countries with a strong natural resources specialization pattern although the magnitude of these effects depend on the type of resources and on other aspects related to the production and innovation systems. The positive trajectory described by a set of national economies mainly specialized in natural resources and low-tech industries invites us to analyze what is the combination of factors that serves as engine for a sustainable development process. With panel data for the period 1996-2008 we estimate an applied growth model where both traditional factors and other more related to innovation and absorptive capabilities are taken into account. Our empirical findings show that according to the postulates of a knowledge-based approach, a framework that combines physical and intangible factors is more suitable for the definition of development strategies in those prosperous economies dominated by natural resources and connected activities, while the internationalization process of activities and technologies become also a very relevant aspect.

Resumen

El conocimiento ha venido adoptando un papel preferente en la explicación del desarrollo en las últimas décadas; sin embargo, el efecto de los recursos naturales en el desempeño de los países es un problema que sigue estando sujeto a controversia. En este trabajo se trata de demostrar que los recursos naturales pueden afectar el crecimiento de países con una elevada especialización en éstos aunque el signo y la magnitud de los efectos dependen del tipo de recursos y de otros aspectos vinculados al sistema productivo y de innovación. La positiva trayectoria que han seguido algunas economías basadas en recursos y con predominio de industrias de baja tecnología, invita a analizar cuál es la combinación de factores que funcionaría como motor de un proceso de desarrollo sostenido. Usando datos de panel para el período 1996-2008, se estima un modelo aplicado de crecimiento en el que se incorporan tanto regresores tradicionales como factores relacionados con la capacidad de innovación y absorción de los países. Los resultados muestran que, de acuerdo a los postulados de la economía basada en el conocimiento, la consideración conjunta de factores tangibles e intangibles constituiría un enfoque más adecuado para la definición de estrategias en estas economías, en el que adquieren relevancia los aspectos vinculados a la internacionalización de actividades y tecnologías.

Key words: Development, natural resources, economic growth, institutions, knowledge economy
JEL: O11, O13

Isabel Alvarez. Departamento de Economía Aplicada II & Instituto Complutense de Estudios Internacionales (ICEI). Universidad Complutense de Madrid (UCM). isabel.alvarez@ccee.ucm.es
Romilio Labra. Institute of Agricultural Research. INIA-Chile. Instituto Complutense de Estudios Internacionales (ICEI). Universidad Complutense de Madrid. romilio.labra@estudiante.uam.es

ICEI Instituto Complutense de Estudios Internacionales

INDICE

1. Introduction

There is a broad consensus nowadays about the importance that the capabilities building process, defined by the creation and use of technologies and knowledge in countries, has acquired as a driver mechanism of growth. This explains why innovation is becoming a major concern for policy actions promoting development and even a key aspect that makes possible to overcome poverty in developing contexts (Erika and Watu, 2010). The efforts made by governments to provide those capabilities that enable the generation of wealth and the improvement of people's life conditions to achieve a sustainable development in the long run are very diverse. The evolutionary theory predicts that knowledge is at the core of the development process; nonetheless, some countries have achieved high economic standards even though their economic structures are based on natural resources with a high presence of low-tech industries (Sæther et al., 2011). This opens an opportunity to carry out new research efforts to analyze what is the potential role of natural resources in development under the lens of a knowledge-based approach that highlights the elements of the national systems of innovation.

Economic growth is a changing process in which a diversity of factors interacts and this interplay makes possible to interpret them following a systemic approach (Castellacci, 2007a; Fagerberg and Verspagen, 2002). The idea is that knowledge is not only an issue related to scientific and technology advance but it is closely related to the possibilities that the production system and the institutional framework offer for integrating innovation as a main driver for the advance of countries. Overall, the countries can take advantages of the opportunities derived from knowledge economy if they are able to manage appropriately an industrialization process oriented to the creation of more knowledge-intense activities, the generation and consolidation of their intangible assets in favor of competitiveness, and the reorientation of production towards higher value added goods and services that can be based on their original specialization. This would imply that although structural changes in traditional sectors, such as those resource-based, are a key aspect, it should not necessarily be so radical if the development strategy will adopt a systemic view.

A large part of the available evidence agrees on the existence of a negative relationship between natural resources and economic growth, or on the fact that resources almost do not harm it. These results are consequence of a variety of recurrent causes among which we find: the Dutch disease, the presence of social conflicts, the inadequate human capital distribution among industries, the generation of environmental damage, the excess of debt, the natural resources depletion, and even the generation of negative impacts on innovation systems (Bravo-Ortega and De Gregorio, 2005; Fagerberg and Srholec, 2008; Gylfason and Zoega, 2006; Lederman and Maloney, 2007; Manzano and Rigobon, 2007; Sachs and Warner, 1999; Smulders, 2005; Stavins, 2011). However, some recent works support the idea that those economies based on natural resources can reach development through the adoption of a more systemic strategy that considering the existence of potential complementarities would place knowledge at the core of the process (Gylfason and Zoega, 2006; Iizuka and Soete, 2011).

According to Pavitt´s taxonomy (Pavitt, 1984), natural resources industries are mainly supplier-dominated in relation to their access to technology, reason why their technological opportunities are low because core technologies are provided by other sectors and mostly by foreigners. However, many authors also argue that human capital may contribute to positive results from the exploitation of natural resources, and this can become a key aspect for the definition of a successful catching up process. Thus, many countries based on natural resources have been obliged to make serious efforts to develop the necessary absorptive capacities that allow them to benefit from foreign knowledge and technologies. Nonetheless, as it has been suggested in the literature, it is plausible to integrate technology and human capital along with physical endowments in a sustained path of development. This conception would imply an alternative systemic view that could not necessarily defend the unique strategy of a radical shift in the national industrial structure in favor of others more knowledge-intensive that would give way to the reduction and even the elimination of natural resources industries. A possible combination for the definition of development strategies is to take advantage of the productive diversification of countries analyzed under an integrative approach based on knowledge and the strengths of the national productive and innovation system; this would allow us to detect what is the combination of internal factors and external influences that will promote a sustained development process.

There is a gap in the national systems of innovation literature concerning the factors supporting development in countries with large natural resource endowments; the contribution of this paper goes precisely in this direction, trying to provide an integrative explicative framework for understanding the possibilities of development in economies based on natural resources. The assumption is that development trajectories are country-specific and they can be supported in the original productive system. This research focuses on the analysis of the combination of factors supporting development in economies that being based on natural resources show a high economic performance. The theoretical roots of this proposal are found in the knowledge-based economy approach that defends the role of intangible assets as one of the most influential factors for the advance of countries (Bontis, 2004; Edvinsson, 2003; Lin and Edvinsson, 2008).

For the empirical analysis, information has been obtained from international sources, such as the WDI, UNCTAD, and CANA (Castellacci and Natera, 2011) databases, for the period 1996 to 2008. The complete sample of countries includes OECD and non-OECD economies. Using Cluster analysis, a group of countries composed by a set of high and medium-high income economies according to the World Bank (WB) criteria has been identified; these countries share some key common features such as a high participation of natural resources in their respective GDP and also rates of growth higher than the average of the complete sample; we nominate this group as SELECTED countries. The applied growth model is defined by the inclusion of a set of traditional regressors (capital, labor and natural resources) together with factors more related to national innovative and absorptive capabilities, the institutional framework and some indicators of internationalization. The estimation is done for both static and dynamic panel data.

The results of this analysis show first, the existence of a positive impact of natural resources on growth in the case of the SELECTED countries group, while it is not significant in the case of OECD economies neither for the total sample of countries. Secondly, the relationship between natural resources and growth depends on the type of resources, being similar the impact of forestry and oil in both SELECTED and OECD countries, while differences arise in agriculture and mining: the negative impact of agriculture does not stand in the former group, and it is positive the effect of mining in their economic performance. Finally, our findings confirm that a knowledge-based approach combining physical and intangible factors is a suitable framework, based on the national system of innovation, to explain growth not only in advanced economies but also in those successful economies dominated by natural resources. The adoption of this perspective and this new fresh empirical evidence would derive into interesting implications for the definition of national policy strategies.

The rest of the paper is organized as follows: Section 2 presents a short revision of the main arguments found in the literature, focused on the relationship between natural resources and economic development. Section 3 describes the objectives and the working hypothesis of this study. Section 4 presents the methodology and the data description. Section 5 includes the most relevant results from the model estimations along with a discussion thereof. Finally, Section 6 presents the main conclusions, some policy implications, future research lines, and limitations.

2. Literature background

The generation of sustainable economic growth is one of the most important challenges for countries, along with the achievement of a more equal income distribution and the search for the appropriate mechanisms to overcome poverty; in such a context, innovation is adopting more and more a crucial role in the definition of development strategies (Erika and Watu, 2010; Gimenez and Sanau, 2007; Álvarez and Botella, 2012). Although the diffusion of technologies across countries is one of the main supportive pillars in many traditional growth models (Solow, 1956), most of the pioneering proposals did not explain how innovation and international transfer of knowledge took place. We had to wait a long path for the changes in the main economists' conception, that was motivated by the own evolution of the economic activity and also by the sequential transit from the classical prevalence of natural resources and labor in the explanation of the accumulation process, to the establishment of the new paradigm in which physical capital assets gained the protagonist role, being only more recently when the predominance of intangibles entered into the scene (Romer, 1990; David and Foray, 2002; Corrado et al., 2009).

The most updated models include technical change as an endogenous driver of growth and development (Romer, 1990; Aghion and Howitt, 1992, 1997; Fagerberg and Srholec, 2008; Gancia and Zilibotti, 2005; Silva and Teixeira, 2011), being the creative ability of agents to introduce novelties in the system (Schumpeter, 1947) and the endogenous knowledge accumulation process some key arguments for explaining how innovation results are *path dependent* (Fagerberg et al., 2010). However, as it is claimed by evolutionist economists, the main limitations in the present consolidated growth framework are due to the existence of dynamic dependences including aspects such as interaction, learning and the cyclical components of growth (Castellacci, 2007a). Despite the prediction of many models that underline knowledge generation as a main engine of growth, the process of development can be understood by the interaction of innovation and imitation as two different and complementary forces that can encourage the possibilities of countries for catching-up. In the international context, the former can increase divergence among countries, while the later can contribute to reduce the gap across countries regarding the technological competences that may favor catching-up (Fagerberg and Verspagen, 2002). Hence, the development of absorptive capacities would become a crucial aspect (Fagerberg and Srholec, 2008).

The relevance of foreign technology in development is a plausible argument for explaining the catching-up process, being openness, trade and FDI important channels for knowledge acquisition. According to Catalán (2008), Castellacci (2007b), and Madsen et al. (2010), openness can encourage growth and also promote the domestic generation of patents (Romer, 1990) as well as the education improvement (Cavallaro and Mulino, 2009; Fagerberg, 1994). Furthermore, it is well known the importance of FDI and international trade in technological change since those allow the flow of technology and know-how between countries (Dunning, 2009; Roy and Van den Berg, 2006; Narula and Dunning, 2010), which impacts directly on production activities. More recently, literature has pointed out that knowledge flows go not only from developed to developing countries but also in the reverse direction, with potential benefits for the richest countries as well (Cuervo-Cazurra and Genc, 2008; Gammeltoft et al., 2010; Goldstein and Wells, 2007; Singh, 2008).

On the other hand, institutions may also play an important role because they provide an adequate environment for local and foreign investments, making possible the reduction of potential social conflicts, and the promotion of new activities related to higher value added businesses. It is plausible to think that good institutions and long-term policies may avoid the negative effects of the natural resources exploitation, such as civil wars, perverse economic incentives, rent seeking, and corruption (Rosser, 2006; Van der Ploeg, 2011). Hence, a good part of the empirical evidence agrees on the key role played by aspects such as human capital, physical capital investments, technology and institutions in the generation of national product (Gimenez and Sanau, 2007). These assumptions have also some direct implications for the improvement of countries' competitiveness because technological change adopts a complementary character with respect to the most traditional explicative aspects of prices, costs and salaries (Argüelles and Benavides, 2008; Castellacci, 2008; Fagerberg et al., 2007).

The concept of national innovative capacity developed by Furman et al. (2002) -that is defined as the ability of a country to produce and commercialize innovative technology flows along time-, provides a framework supported in three well established lines of research: The endogenous growth theory (Romer, 1990); the conceptual approach of national competitive advantages based on the existence of clusters (Porter, 1990); and the research results from the national systems of innovation conceptual approach (Lundvall, 2007; Nelson and Winter, 1982). The national innovative capacity assumes that this is referred to the output of innovations and to a set of determinant factors that are crucial to consolidate the process of innovation at the national level. This capacity permits to select and to assimilate foreign technologies, to develop new ones (Argüelles and Benavides, 2008), and to absorb external knowledge (Fagerberg et al., 2010). Then, differences in national capacities can be observed due to differences in the economic geography (and this can condition the level of inter-firm spillover effects) or to differences in national innovation policies (mainly those oriented to the support of Basic research, the legal protection of Intellectual property rights, or the education system). The key idea would be that the national innovative capacity can be related, but it is different from the scientific and technological advance, and this could imply to go beyond those elements that are crucial for the development and commercialization of new technologies.

Even though the literature broadly confirms that countries with high economic standard have transformed their productive structures towards a higher predominance of high-tech sectors (Catalan, 2008), some economies based on natural resources (NR) with predominance of low tech-industries, have showed high economic performance using the opportunities that these sectors may also offer (Von Tunzelmann and Acha, 2005). In the literature of NR two main points of view are developed: Some contributions focus on the growth effects of NR endowments while others refer to the aspect of intensity or specialization in the related industries. Nonetheless, most of the studies under these two perspectives show an inverse relationship between NR and economic development, more intense when the level of human capital in countries is low (Bravo-Ortega and De Gregorio, 2005; Gylfason and Zoega, 2006; Sachs and Warner, 1999; Sachs and Warner, 2001).

In this line of research, recent contributions point out that institutions are one of the most important factors to reach positive results from the exploitation of NR; although, they deal with a common methodological problem associated with the high correlation existing between several indicators of institutions (Frankel, 2010; Ville and Wicken, 2012). The empirical evidence shows that countries with a high institutional quality show no curse and reduce the risk of falling down in these economies (Van der Ploeg, 2011; Rosser, 2006). By contrast, other studies show that abundant NR hamper the growth when weak institutions are present (WTO, 2010) and then, in presence of a high concentration of NR industries combined with weak institutions, negative effects in the macroeconomic stability can be expected. The strong relationship between NR and institutions is also explained by the fact that NR can worsen institutions and support social conflicts as part of the perverse economic incentives linked to resource exploitation (Barbier, 1999; Lindkvist and Sánchez, 2008; Ross, 1999; Van der Ploeg, 2011). Overall, an extensive body of literature deals with the complexity of the effects that NR have in the advance of countries and societies in different fields beyond economics[1]. The reason is that we deal with an endogenous process that face reverse causality and interconnected relationships; the causes and the effects are closely related, being difficult to separate one from each other.

Some scholars have also pointed out a relation of causality driving these negative effects, and these are some common reasons for them (in Table 1):

The easy generation of high incomes that discourages investments in other more knowledge-intensive industries; the low growth potential of a fixed production factor; the negative effect of currency appreciation over manufacturing exports or what is known as the Dutch disease; the generation of a wrong feeling of economic security that discourages investments in other assets (Gylfason and Zoega,

1. For economics, see: Barbier (2003), Bravo-Ortega and De Gregorio (2005), Frankel (2010), Gylfason and Zoega (2006), Manzano (2006), Manzano (2012), Ross (1999). In the institutional field, see: Fagerberg and Srholec (2008), Ferranti et al. (2002), Frankel (2010), Manzano (2006), Manzano (2012), Ross (1999), Sachs and Warner (1999), Van der Ploeg (2011), WTO (2010). For social impacts, see: Barbier (1999), Castellacci (2006b), Ferranti et al. (2002), Frankel (2010), Lindkvist and Sanchez (2008), Ross (1999), Rosser (2006), Stijns (2005), Van der Ploeg (2011), WTO (2010). And in the environmental field, see: Smulders (2005), Stavins (2011), Van der Ploeg (2011), Wright (1990), WTO (2010).

2006); the presence of high levels of corruption and the reduction of the institutional quality (Sachs and Warner, 1999); an inadequate distribution of human capital among industries (Bravo-Ortega and De Gregorio, 2005); the negative effects in innovation systems (Fagerberg and Srholec, 2008); and the environmental damage (Smulders, 2005; Stavins, 2011).

Nonetheless, some recent pieces of literature recognize the potential of NR-based activities for growth when an adequate combination with human capital (HC) is present (Iizuka and Soete, 2011; Bravo-Ortega and De Gregorio, 2005) or when there is an intensive use of high technologies because these are able to create some sort of opportunity windows for diversification and development (Iizuka and Soete, 2011; Lundquist et al., 2008). Moreover, Hauser et al. (2011) point out that the integration of social factors is also required to achieve positive results in terms of sustainable development. According to Catalan (2008), successful growth results in countries based on NR are explained by the HC endowment together with the strength of public institutions, the promotion of S&T public policies and the establishment on technological clusters. Finally, those authors who have tried to analyze the differences between renewable and non-renewable resources and to explain this disparity of effects, pointed out the existence of a positive impact when renewable resources are associated with human capital investments and how this is a key issue to generate sustainable development (Pender, 1998), while Stijns (2005) identifies important differences when the two types of natural resources are considered.

3. Objectives and hypotheses

The main objective of this paper is to develop an integrative approach that combines those traditional factors generally present in the explanation of growth with those more closely related to the national systems of innovation perspective. The proposal is to test how plausible would be to conceive the idea that resource-based economies can reach higher level of development following a strategy that combine their predominant specialization based on an intense use of natural resources along with the reinforcement of intangible assets[2].

A specific working objective is also to check the effects of different types of natural resources in different groups of countries -developed economies and resource-based countries-, trying to evaluate the aspects that make possible to clearly identify different trajectories and the key drivers of the successful ones. The findings of our empirical work could derive into implications for the discussions of policies oriented to improve sustained growth and for the definition of integrated strategies.

The main contribution of this study is to provide such a framework to understand different patterns of development, including those based on natural resources. A vast part of the literature confirms the relevance of the industrial structural transformations in the richest coun-

Table 1. Causes, effects, and impacts of NR explanation

Causes	Effects	Impacts
• Volatility of prices • Weak institutions • Social conflicts • Finite nature of NR	• Increase of public spending • Empowerment of the state or social groups • Weakening of institutions (corruption, lack of rule of law, governments' instability, etc.) • Deindustrialization; Dutch Disease • Macroeconomic volatility • Pollution and depletion • Windfall	**Negative** • Industrial concentration • Wars and other social conflicts • High public debt • Lower grouth • Environment degradation **Positive** • Diversification based on NR • Development

Source: Authors' elaboration

2. There is enough support for this argument in previous findings of available empirical evidence (Pender, 1998; Bravo-Ortega and De Gregorio, 2005; Gylfason and Zoega, 2006; Catalan, 2008; Lederman and Maloney, 2007; Wright and Czelusta, 2007; Perez, 2008; Sæther et al., 2011; Ville and Wicken, 2012).

tries to reach development, but our proposal is to try to identify an alternative conception that being integrated by relevant elements for sustainable development does not necessarily means to leave completely aside the traditional sectors. Our findings will also provide new information for policy makers' decisions related to the improvement of development in laggard countries with high natural resource endowments. The general assumption is that positive growth effects derived from knowledge and innovation are possible not only thanks to high tech and science-based industries, but there are extensive to all types of sectors and fields of activity. In such a case, the definition of development strategies based on knowledge should integrate not only R&D related activities but the whole production system, together with institutional and organizational aspects of societies and the influences from the international context.

The development of our working hypothesis is supported in the existing literature previously revised, raising an analytical framework that built on the national system of innovation approach could be simultaneously applied in economies based on natural resources. Among the discussions of scholars about the differences between renewable and nonrenewable natural resources and their importance for sustainable development, some contributions claim the positive contribution of renewable resources when these are combined with human capital (Pender, 1998). Others, such as Stavins (2011), indicate the potential role of technology to reduce the problem of scarcity in the case of nonrenewable resources and to increase their productivity, although it could generate a possible over-exploitation of renewable resources that would reduce economic growth at the end, obliging countries to implement different public policies to mitigate those negative effects (Smulders and Gradus, 1996). Therefore, our first hypothesis is that *under a knowledge-based economy approach, natural resources may affect positively growth but differentiated impacts of renewable and nonrenewable resources can be expected (H1).*

The new growth theory and the evolutionary approach postulate that intangibles are at the core of economic development explanations, and also in the intellectual capital literature, human capital and technology are seen as important aspects in wealth creation (Bontis, 2004; Corrado et al., 2009; Dunning, 2009; Edvinsson, 2003; Edvinsson and Kivikas, 2004). However, their potential role across countries may differ when considering the relative level of development achieved by nations. In developed countries, the main source of technology is the local production and this impacts positively on growth through different forms of innovation, while in developing countries the acquisition of foreign knowledge and technology is still one of the main alternatives for catching up (Castellacci, 2006b; Gimenez and Sanau, 2007; León-Ledesma, 2002; Silva and Teixeira, 2011). According to this, our second hypothesis is that *intangibles exert a positive influence in growth in those economies based on natural resources, as it happens in the case of developed countries (H2).*

4. Data and methodology

Our empirical analysis is conducted following an applied growth model rooted on the knowledge economy framework and the evolutionary theory, integrating a combination of both physical and intangibles explicative factors. The sample is composed by 133 countries for which there is available statistical information for the period comprised from 1996 to 2008. For the estimation of the model, three subgroups of countries have been taken into account: The first corresponds to OECD economies that integrate the developed nations group. The second group is formed by a set of NR-specialized countries (called NR SPECIALIZED), and this includes economies whose NR exports represent more than 50% of total exports. And finally, the third group is made up for some countries with a high participation of NR in their GDP; these are high or medium-high income economies according to the WB classification, and shows rates of growth higher than the average of the group. This later group of countries (called SELECTED) was identified through Cluster analysis techniques using data from the World Development Indicators (WDI) database elaborated by the World Bank. The solution of the Cluster analysis shows a group of countries integrated by Argentina, Australia, Canada, Chile, Colombia, Kazakhstan, Mexico, Peru, Russia, and South Africa. Other studies have also identified some of these countries as successful nations that exploiting their natural resources have achieved a positive path of development, a result that is coincident with ours (Castellacci, 2006b; Gimenez and Sanau, 2007; León-Ledesma, 2002; Silva and Teixeira, 2011).

Regarding the variables included in the empirical model, these have been selected according to the literature review and taking into account the restrictions of the analytical method. We follow the conventional approach used in other applied models of growth conceived through the creative destruction process (Aghion and Howitt, 1992), taking labor and capital (investment) as the main traditional factors. Investment was used as indicator of capital in a similar way as Stijins (2005) and Castellacci (2008). For the analysis of the effect that natural resources have in countries performance, two indicators were constructed. The first is an index of Specialization calculated as the ratio between natural resources exports and total exports. The second indicator is Intensity, defined as the ratio between export of natural resource and GDP, according to Sachs and Warner (1999; 2001). Additionally, other variables related to the different natural resources (mining, oil, agriculture, and forest) and intangible assets were incorporated in the analysis. Patents are taken as the indicator of technology while schooling is adopted as a proxy for human capital. Moreover, the openness rate and an indicator of foreign direct investment (inward FDI stock) were selected to proxy the international influences. Finally, an indicator of institutions has also been introduced; the institutions index elaborated according to WB methodology has been chosen (Kaufmann et al., 2003). Table 2 shows the definition and sources of all the variables used in our empirical analysis and the descriptive statistics are presented in Table 3. These have been calculated for the whole sample, and separately for OECD, for countries specialized in NR and for the group of SELECTED countries previously defined. Additionally, we have also included OPEC countries as a control group because although these countries also exploit intensively their natural resources, they show notable differences in the level of development with respect to the SELECTED economies as it is shown by the lower average values in some of the indicators used –i.e. institutions, patents, schooling or FDI.

Although a broad number of studies in growth

Table 2. Definition of variables and indicators included in the model

Variable	Definition	Source
GDP	GDP per Capita, PPP, at 2005 constant prices (US $)	CANA from Penn World Table
Labor	Labor force, total	WDI
Capital	Investment. Share of GDP Per Capita at constant prices 2005 PPP Converted (%)	Penn World Table
Mining	Mineral rents (% of GDP)	WDI
Oil	Oil rents (% of GDP)	WDI
Agriculture	Agriculture, value added (% of GDP)	WDI
Forest	Forest rents (% of GDP)	WDI
Patents	US Patents granted per Country of Origin. Number of utility patents granted by the USPTO by year and Inventor's Country of Residence per inhabitant	CANA from USPTO
Schooling	Mean years of schooling. Average number of years if school completed in population over 14.	CANA from Barro & Lee and WB
Inward FDI	FDI Inward Stock (%GDP)	UNCTAD
Openness	Openness Indicator: (Import+ Export)/GDP. PPP	CANA from UNCTAD
Institutions	Index made up Rule of law, Corruption control, Voice and Accountability, Political stability and Absence of violence/terrorism, Government effectiveness, and Regulatory quality.	World Bank
NR specialization	NR exports as share of total exports	UNCTAD (exports)
NR intensity	NR exports as share of GDP	UNCTAD, CANA, and WDI

Table 3. Descriptive Statistics: Average values for the period 1996-2008. The list of countries and the composition of the groups can be found in Annex 1

Variable		All countries		NR SPECIALIZED		SELECTED		OECD		OPEC	
		Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
GDP per capita	(US$ 2005)	10,176	10,471	7,280	9,522	13,236	8,820	23,336	8,024	13,649	15,394
Investment	(%)	22.6	6.9	21.5	6.3	21.7	2.9	23.7	4.2	23.0	7.5
Forest rents	(% GDP)	1.28	2.17	1.59	2.11	0.43	0.38	0.27	0.39	0.41	0.60
Mining rents	(% GDP)	0.63	2.01	1.08	2.74	2.05	3.11	0.44	1.88	0.09	0.18
Oil rents	(% GDP)	4.77	10.83	8.45	13.86	5.55	7.38	0.72	2.20	31.44	13.03
Agriculture, VA	(% GDP)	15.84	13.92	20.16	13.96	5.90	2.61	3.52	2.28	10.60	11.38
Specialization, NR	(% export)	52.6	30.3	78.5	13.1	62.9	21.4	27.9	22.8	92.1	4.8
Intensity, NR	(% GDP)	15.1	13.0	21.0	13.8	15.1	10.4	8.31	6.82	38.5	16.0
Institutions	(index)	2.49	0.89	2.16	0.75	2.72	0.92	3.69	0.54	1.88	0.59
Inward FDI	(% GDP)	34.9	64.8	28.1	22.1	29.3	12.8	35.2	25.2	24.3	23.5
Patents	(Pat/MM hab.-year)	19.3	45.7	6.1	12.1	15.2	33.0	62.5	71.4	2.2	4.4
Openness	(index)	0.68	0.39	0.59	0.26	0.47	0.15	0.67	0.34	0.64	0.20
Schooling	(N° years)	7.44	2.59	6.66	2.51	8.88	1.51	10.14	1.46	6.56	0.56

Source: see Table 2

literature adopts OLS as a valid method to estimate growth models, it is well known that one of the most outstanding inconveniences of this estimation method in cross-country analis is the existence of countries specific-effects, reason why OLS is inconsistent and upward biased (Castellacci, 2008). The use of Panel Data methodology has become very popular in the last decades because it permits to face this problem among other strengths, taking into account fixed effects in cross-countries analysis. Nonetheless, this data treatment has also some limitations when endogeneity problems are present and they are not considered explicitly. From an evolutionary perspective, those factors that contribute to the country development follow a path dependent trajectory that describes a cumulative process (Dosi, 1988), and this may justify a possible endogenous structure of the model that allows the incorporation of past effects into present results through the inclusion of instrumental variables and the lagged dependent variable as regressors. The dynamic panel techniques –such as the GMM or differences GMM - solve the problem mentioned above, treating the explanatory variables as endogenous (Arellano and Bond, 1991; Castellacci, 2008). An extension of the GMM, named difference and system GMM, was elaborated by Arellano and Bover (1995), takes the regressors in levels and differences as instrumental variables, making possible the use of all the available moment conditions, providing a superior performance to the estimation. However, this last method can generate overidentification problems due to the instruments proliferation and imperfect estimations can be obtained (Roodman, 2006; Roodman, 2009). Roodman's analysis considered that the overidentification could be frequent when there is a large number of periods (T) in the sample[3].

In our analysis we run three estimations with different specifications of the model, using GDP per capita as the dependent variable. Following a traditional growth approach, the first estimation includes capital, labor and natural resources (specialization) as independent variables. Accordingly, the general specification would adopt the following form:

(1)

$$\mathbf{GDP_{it} = \beta 0 + \beta 1\, K_{it} + \beta 2\, L_{it} + \beta 3\, NR_{it} + \eta_i + \gamma_t + \varepsilon_{it}}$$

Where:

GDP: ln Gross Domestic Product (GDP) per capita

K: InCapital, investment

L: In Labor

NR: In Natural resources specialization

The subscript *it* refers to the country *i* in period *t*, η_i and γ_t represent individual and time effects, respectively; ε_{it}: random error term.

In the second specification of the model, the

3. The application of GMM - System and Differences - can be driven by the use of one-step or two-step estimations. According to the econometrics literature, the first one uses the weighting matrix homoscedasticity, but the heteroscedasticity problem persists, so two-step should be occupied. Finally, for testing the serial correlation of the errors, we used the Arellano & Bond test.

diverse types of natural resources are incorporated, namely forestry, agriculture, oil, and mining. The objective is to know whether each one of them has a differentiated impact on growth. The equation would adopt the next form:

(2)

$$\mathbf{GDP_{it} = \beta 0 + \beta 1K_{it} + \beta 2L_{it} + \beta 3Oil_{it} + \beta 4Ag_{it} + \beta 5F_{it} + \beta 6M_{it} + + \eta_i + \gamma_t + \varepsilon_{it}}$$

Where:

GDP: ln Gross Domestic Product (GDP) per capita

K: In Capital, investment

L: In Labor

Oil: Oil, rents

Ag: Agriculture, value added

F: Forest, rents

M: Mining, rents

The subscript *it* refers to the country *i* in period *t*, η_i and γ_t represent individual and time effects, respectively; $\varepsilon_{it:}$ random error term.

Finally, the inclusion of intangible variables as repressors in accordance with the evolutionary approach would lead to equation 3a; for the estimation of different development path the estimations include the sample of NR-SPECIALIZED. On the other hand, for taking into account possible endogenous structure of the model, equation 3b was estimated for the target sample (SELECTED); xtabond2 (Roodman, 2006) estimator was used to introduce dynamics and to take into account the endogenous relationship of the model and the reverse causality of technological factors in the GDP advance.

(3a)

$$\mathbf{GDP_{it} = \beta 0 + \beta 1K_{it} + \beta 2L_{it} + \beta 3NR_{it} + \beta 4Pat_{it} + \beta 5FDIIS_{it} + \beta 6Op_{it} + \beta 7Sch_{it} + \beta 8Ins_{it} + \eta_i + \gamma_t + + \varepsilon_{it}}$$

(3b)

$$\mathbf{GDP_{it} = \beta 0 + \beta 1GDP_{it-1} + \beta 2K_{it} + \beta 3L_{it} + \beta 4NR_{it} + \beta 5Pat_{it} + \beta 6FDIIS_{it} + \beta 7Op_{it} + \beta 8Sch_{it} + \beta 9Ins_{it} + + \eta_i + \gamma_t + \varepsilon_{it}}$$

Where:

GDP: ln Gross Domestic Product (GDP) per capita

K: ln Capital, investment

L: ln Labor

NR: ln natural resources, specialization

Pat: ln Patents

FDIIS: ln FDI, inwards

Op: ln Openness

Sch: ln Schooling

Ins: Institution index

The subscript *it* refers to the country *i* in period *t*, η_i and γ_t represent individual and time effects, respectively; ε_{it} is a random error term.

5. Empirical analysis

The study of the natural resources impact on national income and economic growth has been generally built making use of diverse proxies for natural resources. The indicators of intensity and specialization are closer to resources' exploitation than abundance or other endowment indicators (Sachs and Warner, 1999; Sachs and Warner, 2001; Stijns, 2005), and furthermore, intensity – expressed as the composition of country's trade, can also be considered as an expression of its endowments (Wright, 1990). However, there is not consensus about the most adequate indicators for NR in growth analysis. Some researchers consider that specialization is more a measure of productive structure while others point out that specialization is an adequate indicator to reflect the economic contribution of NR. Figure 1 shows the natural resources (specialization) by country groups. There is an important difference between OECD and the rest of countries, despite the wide data dispersion. It can also be observed that SELECTED and OPEC countries are more specialized in NR than OECD because as already said most of these developed countries have carried out structural transformations that derived into a higher predominance of knowledge-intensive activities (Catalan, 2008; Ferranti et al., 2002).

Those countries more specialized in NR are the OPEC members, although these economies show in general lower levels of GDP per capita than SELECTED (Figure 2). It is noted that income differences between OPEC and OECD are larger than those between SELECTED and the OECD group, an aspect that can be justified according to the empirical findings showing the negative effect of natural resources on development. This is mostly explained by the insufficient capacity to exploit the international diffusion of technologies - called absorptive capacity- (Castellacci, 2007a; Castellacci, 2007b), the low level of investments in human capital of these economies (Behbudi et al., 2010; Bravo-Ortega and De Gregorio, 2005), and also by the presence of weaker institutions (Frankel, 2010).

The importance that natural resources may adopt into the development process of countries as growth supporter (Barbier, 1999, Iizuka and Soete, 2011) is more plausible through the adoption of a more systemic perspective that takes into account other complementary factors. To justify this statement, a first step of our analysis is the estimation of the effect of NR specialization in national product taking only the traditional factors as exogenous variables, and the results confirm that both capital (investment) and abor are positively related to GDP in all the cases. Natural resources have no effect on GDP in the majority of the subsamples, a result that is consistent with many previous studies on the topic. The exception is found in the case of the SELECTED countries being positive and significant the effect on growth, a result that allows us to confirm our first hypothesis. The positive development path followed by this group of countries has been based on natural resources, while for developed countries the "natural factors" are not considered as a determinant of their economic progress. For the complete sample (ALL), NR have not impact on GDP growth; the different results found across the subsamples are probably due to the diversity of countries included in the group. Meanwhile, when the sample is more homogeneous (e.g. SELECTED) this relation tends to be clarified. Capital and NR impact positively growth in countries specialized in natural resources, a result that is consistent with others such as Wright (1990) and Lederman and Maloney (2007) who explained that capital is complementary to NR, and therefore both factors show similar effects.

Moreover, the main reason for this result can be found in the positive interaction of natural resources with intangible assets as we will show later in this paper. Similar results can be found in the related literature, such as Blomström and Kobbo, (2007), Bravo-Ortega and De Gregorio (2005), Bretschger (2005), Catalan

Figure 1. Natural resource specialization by country groups: OPEC, NR SPECIALIZED, SELECTED, and OECD. Period 1996-2008

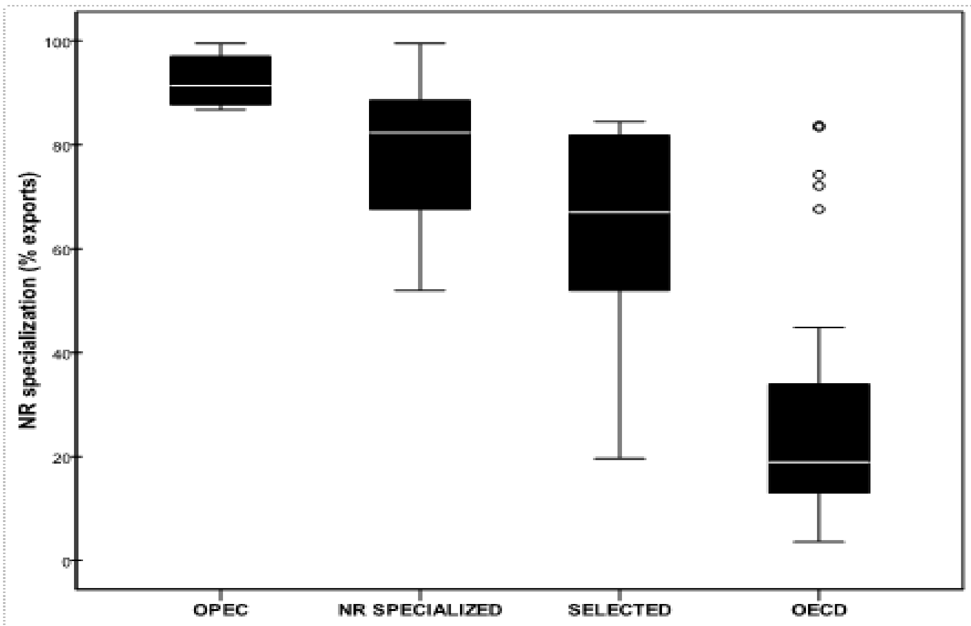
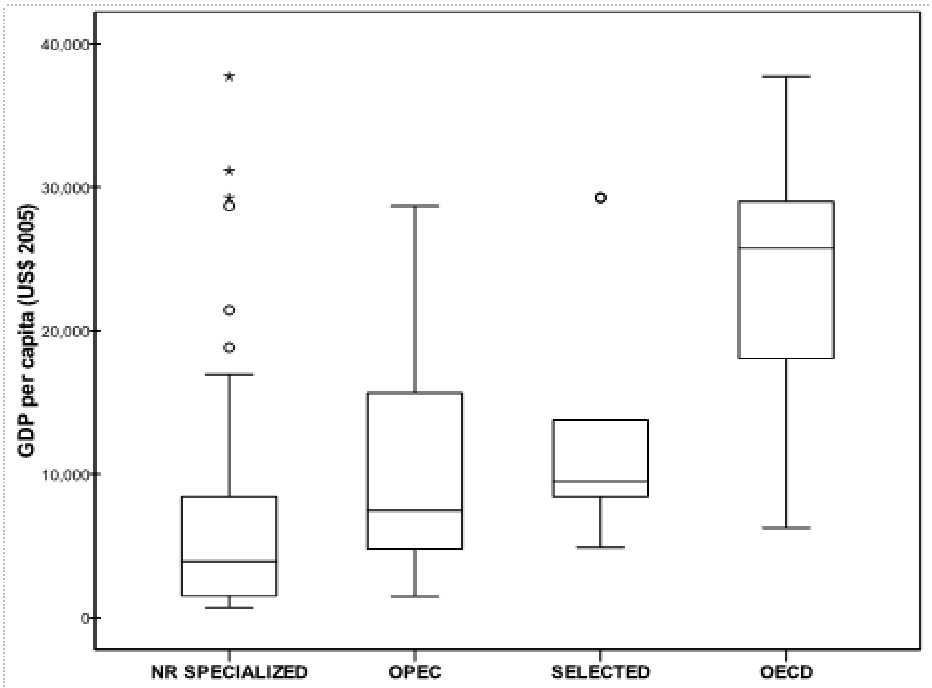


Figure 2. Gross Domestic Product per capita (US$ 2005) of NR SPECIALIZED, OPEC, SELECTED, and OECD countries. Period 1996-2008



(2008), Gylfason and Zoega, (2006), Perez, (2008), Sæther et al. (2011), and Wright and Czelusta, (2007).

On the other hand, when considering explicitly the different types of natural resources as regressors (Table 5), capital and labor are still directly and positively related to growth. Moreover, oil is also an important factor that supports economic development and it is positive and significant the effect on GDP in SELECTED, OECD and ALL groups. Similar results are also found in Wright (1990), Stijns (2005), and Behbudi et al. (2010); their findings confirm a positive relationship with the economic performance. By contrast, forestry negatively affects the economic progress, being plausible to think that these results are conditioned by environmental factors, as it is described in the related literature about scarcity and overexploitation of natural resources, because technological progress can generate degradation and pollution and this would affect development in long run (Stavins, 2011). In addition, the restrictions derived from environmental

Table 4. Effects of physical factors (investments, labor, and natural resources) in GDP per capita

	ALL		SELECTED		OECD		OPEC		OPEC (rand)	
	coef	se	coef	Se	coef	Se	coef	se	coef	se
Capital (invest)	0.163***	0.05	0.547***	0.15	0.558***	0.20	0.068*	0.04	0.228**	0.11
Labor	1.332***	0.10	1.446***	0.19	2.486***	0.25	1.321***	0.21	0.337*	0.18
NR (specialization)	0.026	0.05	0.505**	0.26	-0.064	0.12	0.259	0.60	1.901*	1.00
cons	-12.43***	1.48	-16.12***	3.00	-31.07***	3.58	-11.89***	3.17	3.15	3.01
Hausman test Chi-Sq	607.2		13.5		473.5		-327.9		-327.9	
Num. of obser.	1,860		140		462		126		126	
R-sq: within	0.447		0.695		0.644		0.695		0.457	
R-sq: between	0.000		0.048		0.001		0.681		0.666	
R-sq: overall	0.000		0.015		0.000		0.556		0.456	

* Significant at 10%; **Significant at 5%; ***Significant at 1%, Robust standard errors. Fixed effects, except OPEC (random and fixed, effects).

policies may reduce the productive performance and even increase production costs (Blomström and Kobbo, 2007). However, as Ferranti et al. (2002) point out, forest endowments can be economically productive when a network is created and high technology is incorporated into the process, while Blomström and Kokko (2007) argue that a successful forestry industry can be possible when openness, technology, knowledge and appropriate policies are articulated.

The results from estimations show that agriculture and mining have not the same impact on GDP. Agriculture has a negative effect on GDP for the complete sample (ALL) and the OECD countries, coincidently with Stijns (2005) and Manzano and Rigobon (2007), who found Duth disease symptoms in economic performance caused by this sector. Likewise, Hauser et al. (2011) explain how agriculture is more a form of life than a production system in several countries. However, it can be though that the group of SELECTED countries has been successful in the strategies to introduce technology and human capital into agriculture activities, contributing to eliminate the negative effect, according also with the analysis conducted by Esposti and Pierani (2000), Perez (2008), and Piesse and Thirtle (2010).

There are not effects of mining in GDP in the case of OECD countries, nor for the complete sample of countries, while it is positive the impact in the SELECTED countries. Again, it is plausible to think that this positive effect can be related to the incorporation of complementary and intangible factors in this sector, such as human, structural and relational capital, and this would permit the achievement of a sustainable development in this industry (Ville and Wicken, 2012) as we will explore further in this paper.

Thus, resource-based countries show the capacity to neutralize the negative effect of agriculture observed in the complete sample and to get a positive impact of mining in their economies. This transformation of traditional sectors towards more efficient industries may be related to the incorporation of technological change, although its relative effect is modulated by other factors. Even though the technological capacity may improve the relation between NR and economic development, renewable and non-renewable resources maintain differences in the impact on GDP, which is also consistent with our first hypothesis.

Beyond the existence of different perspectives to understand the relationship between GDP and its determinants, the consensus is broad

Table 5. Effects of capital (investment), labor, and natural resources (agriculture, forestry, minerals, and oil) in GDP per capita

	ALL		**SELECTED**		**OECD**	
	coef	**se**	**coef**	**Se**	**coef**	**se**
Capital (invest)	0.099**	0.04	0.352***	0.12	0.376**	0.16
Labor	0.945***	0.12	0.961***	0.19	1.332***	0.40
Agriculture	-0.016***	0.00	-0.013	0.01	-0.087***	0.03
Forest	-0.019**	0.01	-0.183**	0.08	-0.193***	0.06
Mining	0.011	0.01	0.018***	0.00	0.003	0.00
Oil	0.008**	0.00	0.029***	0.01	0.029***	0.01
cons	-6.11***	1.83	-7.78**	3.20	-11.82*	6.23
Hausman test chi-Sq	209.4		16.3		68.3	
Num. of observ.	1,680		139		398	
R-sq: within	0.527		0.808		0.760	
R-sq: between	0.030		0.051		0.002	
R-sq: overall	0.039		0.007		0.005	

*Significant at 10%; **Significant at 5%; ***Significant at 1%. Fixed effects. Robust standard errors.

about the complexity of the problem. Then, we proceed now with another specification of the model that is supported by the predictions of the evolutionary theory and the knowledge-based economy framework, arguing that intangibles are important factors in the wealth creation process (Lin and Edvinsson, 2008). The analysis includes technology, human capital, institutions and internationalization indicators as proxies for the elements defining the national systems of innovation. Table 6 shows the results of the new estimations in which both tangibles and intangibles aspects are considered. The models were estimated for SELECTED and NR-SPECIALIZED samples trying to identify the existence of potential differences within NR-based economies. In addition, the estimation of the model for the OECD sample is also presented for making more complete international comparisons. It can be noted that natural resources definitively reflect a different behavior among country groups. While in SELECTED countries these resources affect positively GDP, in OECD its role is not significant. This finding is consistent with other empirical evidence as well as with some theoretical contributions that predict how NR may be a positive, negative or neutral factor, which depends on their management and the more general strategy applied (Lederman and Maloney, 2007; Blomström and Kokko, 2007). Authors such as Wright (1990), Pender (1998), Barbier (2003), Wright and Czelusta (2007), and Perez (2008) found positive impacts of natural resources on economic performance while others obtained negative or even the absence of a clear relationship between these two variables (Gylfason and Zoega, 2006; Lederman and Maloney, 2007; Sachs and Warner, 1999; Sachs and Warner, 1995; Stijns, 2005).

However, as long as countries evolve towards a more modern path, other factors gain importance as it is in the case of the most developed economies, grouped in the OECD, being more evident the contribution to growth of intangibles. Among these immaterial resources, education presents the highest coefficient revealing the importance of human capital in the advance of these countries. On the other hand, in the SELECTED countries, innovation capabilities are supporting their development trajectory. Thus, the estimations show that in these economies as well as in the OECD, GDP growth is also supported by intangibles, along with tangibles assets, and this allows us to confirm our second hypothesis.

An interesting result to mention is the one related to the indicators of openness and FDI, both of them referred to foreign transactions and capital flows. They have a significant positive impact in both OECD and those successful countries whose main industries are based on natural resources. In fact, the international flows of capitals, merchandises, and technologies have become a determinant factor for the takeoff of their economies, even denoting the dependence on foreign knowledge which is acquired through catching up (Ferranti et al., 2002), and the effect of raising local productivity with foreign technology (Mastromarco and Ghosh, 2009). In the case of NR SPECIALIZED economies, openness is also a significant aspect, reasonable if we think on the importance that for these countries the access to wider markets have for the commercialization of their production. In such economies there is still a traditional development path that does not necessarily takes full advantages of the opportunities offered by the knowledge economy, reason why the openness level becomes a strength aspect for expanding the demand abroad of their domestic product.

Meanwhile, these positive effects should not erode the role of the national system of innovation consolidation, not only for the importance of carrying out the adequate efforts to develop technologies locally and to improve the domestic absorptive capacities, but also because institutions are revealed as a significant positive factor for this group of economies, aspects that can enhance a more sustainable progress (Lederman and Maloney, 2007). The significant coefficient of both local invention (patents) and institutions in the case of SELECTED countries are indicators of the capabilities building process in these economies and it illustrates how positively this may affect their catching up processes.

Our findings confirm that NR-industries offer new possibilities, not only as a consequence of eventual commodity booms, but also taking into account the opportunities that are opened by technology and knowledge for the so-called low-tech industries. In fact, these new elements can reduce production costs, may promote the access to new markets, finding new deposits of natural resources and would enhance a sustainable exploitation of renewable NR, improving the quality of products as well as the development of new ones. Nowadays, it is possible to assert that in NR-based countries, structural transformations not necessarily obliged to change completely their industrial structure to reach a higher economic standing, but it is possible to conceive a sequential building process that encourage a new development path in which a combination of elements in the basis of the national system of innovation would take place adopting intangibles as the core of their development strategy.

Certainly, one right direction for the definition of actions addressed to enhance development in economies based on NR seem to be the promotion of investment in technologies and knowledge that allow them to achieve a more positive path of income generation along with the strengthening of their institutional framework. Additionally, although education is not statistically significant in the model estimation, this could not disregard its relevance in the definition of development strategies. It can be ascertained that the result of the estimation is likely due to the type of indicator used as a proxy for education that mostly reflect quantity and not quality of human resources and, moreover, the expected significant effect of human capital in growth is being partially captured by the labor indicator.

The results of our analysis also show that natural resources are supporting development along with intangibles factors in the case of the SELECTED countries, and the combined action of them works as engine of growth in the long run, confirming that NR-based countries can reach a high economic standard when natural endowments are joined with intangible assets. In accordance with the literature, our findings also confirm that foreign technology and capital have become crucial growth determinants in these economies.

Table 6. Panel data analysis of physical and intangibles factors

	NR SPECIALIZED		SELECTED		OECD		NR SPECIALIZED		SELECTED		OECD		NR SPECIALIZED		SELECTED		OECD	
	coef	se	coef	se	coef	se	coef	se	coef	se	coef	se	coef	se	coef	se	coef	se
Investment	0.135*	0.07	0.657***	0.11	0.455***	0.13	0.132*	0.07	0.690***	0.11	0.447***	0.14	0.131*	0.07	0.649***	0.13	0.447***	0.13
Labor	1.086***	0.25	1.004***	0.30	1.701***	0.24	1.085***	0.25	0.680**	0.31	1.529***	0.26	1.085***	0.25	0.409***	0.16	1.530***	0.25
NR (spec)	0.286***	0.10	0.398***	0.15	0.028	0.06	0.301***	0.10	0.305***	0.09	0.036	0.05	0.303***	0.10	0.383***	0.10	0.036	0.05
Patent	0.048	0.03	0.081**	0.04	0.075***	0.03	0.041	0.03	0.055**	0.03	0.045**	0.02	0.040	0.03	0.077***	0.03	0.045**	0.02
Educ (school)	-0.004	0.31	0.537	0.41	0.965***	0.36	-0.036	0.31	0.538	0.44	0.784**	0.34	-0.039	0.31	0.607	0.41	0.784**	0.34
Openness	0.148**	0.07	0.167**	0.08	0.365***	0.09	0.130*	0.08	0.152*	0.08	0.230**	0.09	0.129*	0.07	0.245**	0.10	0.230**	0.09
FDIIS							0.043	0.04	0.141**	0.05	0.100***	0.03	0.043	0.04	0.150***	0.05	0.100***	0.03
Institutions													0.010	0.11	0.235**	0.11	0.004	0.11
cons	-7.50**	3.51	-9.09**	4.25	-19.44***	3.49	-7.64**	3.53	-4.70	4.38	-17.01***	3.76	-7.66**	3.56	-0.47	2.15	-17.04***	3.75
Hausman test	84.87***		20.87***		204.82***		84.96***		16.90**		169.97***		131.36***		4.63		56.4***	
R-sq (within)	0.4999		0.7748		0.8028		0.5055		0.8087		0.823		0.5055		0.805		0.823	
R-sq (between)	0.0567		0.0419		0.0022		0.060		0.1676		0.0009		0.0586		0.8238		0.001	
R-sq (overall)	0.0006		0.0813		0.0037		0.001		0.2506		0.0025		0.0007		0.8191		0.0025	
F (chi2)	16.2***		34.55***		59.93***		15.04***		72.10***		62.15***		15.21***		528.07***		54.44***	
Numb of obs	479		128		426		479		128		426		479		128		426	

Note: *** p<0.01, ** p<0.05, * p<0.1 Fixed effects, except the last estimation of SELECTED (random effects). Robust standard errors.

Finally, to test the potential endogenous process described by scholars and as a robustness check, we estimate the dynamic panel specification using the GMM method for the sample of SELECTED countries (in Table 7). It can be observed that the results do not diverge from previous estimations but on the contrary, they describe the same tendency than static models do. However, some variables –such as labor and institutions- are not significant, but this should be justified on the strong effect of the lagged GDP indicator that is capturing to some extent the cumulative impact of the other variables included in the model. The coefficient of the lagged dependent variable gets the highest value among independent variables, a result that denotes the path dependence and the cumulative process described by both innovation and economic progress, as it is highlighted by several researches in the evolutionary tradition. Nonetheless, it is remarkable the large similarity of the results and this reflect the strong explanatory power of the model proposed that integrates intangibles as a relevant determinant factor of growth. Thus, some potential implications for policy makers would be related with the improvement of the local capacities along with the application of policies that increase the openness level of their economies, fostering the flow of knowledge and technologies worldwide. In addition, long-term policies are required in order to achieve sustainable development because perverse incentives could appear, mainly in presence of weak institutions.

Table 7. Effects of physical, technological and intangibles factors in GDP per capita of SELECTED countries. Dynamic panel data estimation

	A		B	
	coef	**se**	**Coef**	**Se**
GDP (L1)	0.673***	0.136	0.496*	0.275
Investments	0.249**	0.124	0.357**	0.142
Labor	0.099***	0.024	-0.076	0.422
NR (specialization)	0.047	0.038	0.256*	0.138
Educ (school)	0.277	0.451	0.526	0.522
Patent	0.058***	0.018	0.094*	0.051
Openness	0.052	0.039	0.188***	0.073
FDIIS	0.136***	0.023	0.122***	0.045
Institutions			0.126	0.136
cons	0.504	0.967	4.592	5.004
Num. of observations	60		60	
Num. of instruments	10		11	
Arellano-Bond test for Ar(1)	-2.46**		-2.28**	
Arellano- Bond test for Ar(2)	-1.59		-0.81	
Sargan Test (chi2)	0.91		0.88	

*Significant at 10%; **Significant at 5%; ***Significant at 1%. Two steps. Robust satnadard errors.

6. Concluding remarks

There is notable empirical evidence in the related literature about the relationship between development and natural resources although this has not been much studied from the point of view of the national systems of innovation; this justifies new research efforts on the topic. The contribution of this paper focuses on the role of natural resources in development, following the possibilities offered by a knowledge-based approach that would suggest a combined role of intangibles in the advance of countries.

Our findings confirm that natural resources are relevant for growth in some countries while in others, such it is the case of the OECD economies, their impact is not significant or even tend to adversely affect it. In particular, for a group of countries with economic structures mainly dominated by the exploitation and commercialization of natural resources, a sustainable growth path has been identified (this is called SELECTED economies) although different impacts of renewable and nonrenewable resources are detected. Agriculture has not effects while oil a positively affects, and mining is only significant in this group and not in the other samples of NR specialized economies. These results come to justify the conception of an integrative framework for understanding the evolution of nations and the possibilities for defining a different development strategy based on the strengths of the national system of innovation without leaving completely aside their natural resource - intensive industries.

Meanwhile, our analysis shows the importance of openness as a channel to increase trade flows and also to accede to embodied technologies and foreign knowledge via FDI; this can be understood as a mechanism that facilitate the international diffusion of technologies and the potential positive impact on countries development. In fact, a favorable effect on local innovative capabilities and the generation of technologies has been detected in the development path of natural resources specialized countries. This indicates not only the capability for technology creation that benefit inventors in their territories, but also the presence of higher levels of the absorptive capacity that is required to benefit from foreign technologies, a key aspect to sustain development and to increase the natural resource industries productivity in the long run.

The findings come also to reveal that the group of SELECTED countries describes a path that being based on the exploitation of natural resources goes along with the integration of relational, structural, and human capital from an international perspective. The investment on physical assets is also crucial to maintain their economic performance and even to avoid negative booms or Dutch disease problems, and this has been done without a radical shift in their industrial structure. What it is clear from our results is that the choice adopted by successful resource-based countries is different from the one adopted by the OPEC or other NR SPECIALIZED economies; they have been able to overcome difficulties from market commodities fluctuations and internal social pressures, taking advantage from those strategies oriented by the knowledge economy and the globalization process.

In the light of this analysis, some policy implications can be mentioned in relation to the promotion of those national capabilities that would permit a better absorption and creation of local technology and know-how. These policies are necessarily conceived in a scenario of long-term that would consider not only internal factors due to the prevalence of a cumulative process, but also external ones. Openness is then crucial for these countries in order to integrate wider markets for their products, to reduce the risks associated to markets concentration, as well as to acquire foreign technologies. Therefore, policies oriented to enhance a successful internationalization process become critical along with those fostering the appropriate institutions and the creation of human and structural capital in order to sustain development in the long run.

In further research we will explore in larger detail aspects related to intangible assets supporting growth strategies along with natural resources, making possible the definition of a combined action to manage intellectual and physical capital in an integral perspective. Other important topic for future works is to understand deeper the role of intangibles in relation to renewable and nonrenewable natural resources, an aspect that would permit to adjust policies to each particular case. Moreover, the institutional set up of countries can affect the development strategies in these economies and this is a critical aspect still under analyzed. In addition, studies at the industrial level can help to clarify differences among the path defined by industries based on natural resources. Finally some limitations of this study is one common weakness in economic research that is due to the use of several proxies for the study of technological and intangibles factors, being always difficult to choose the most adequate indicators for broad samples of both developed and developing countries, as it also happens in the case of NR indicators for which both specialization and intensity could derive into different impacts when the sample of countries is very diverse.

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