Identifying the keys of growth in natural resource-driven countries in the knowledge economy

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Abstract

The effect of natural resources (NR) has been an economic topic widely discussed by scholars and international organizations to provide solid arguments for a successful management of them. Traditional findings show a negative impact of NR on growth due to social, economic and environmental factors. This adverse result can be neutralized if countries promote a better institutional quality, increase human capital and adopt an industrial structure more knowledge intensive. In this paper which seek to know the keys for growth in natural resource-driven countries under the lens of the knowledge economy perspective. We show new evidence that corroborate how a development path based on NR is plausible if it is integrated intangible factors into growth strategies.

Cluster and data panel analyses allow us to identify the determinants of growth in specialized economies, along with a case study focused on Chile as a representative NR-driven country. This provides new clues extensible to other developing countries with an economic structure dominated by NR. The results confirm that there is a group of countries describing a successful growth trajectory based on primary industries while this path is grounded on innovation capabilities and institutional quality. The empirical study also reveals the essential role of openness and FDI as a channel to access foreign technologies and knowledge in these economies. The findings justify the design of a comprehensive framework for understanding the economic evolution of NR nations based on the strengths of intangibles without leaving their natural resource-intensive industries aside. The case of Chile also confirms the importance of intangibles for countries' growth and demonstrates that a weak innovation capability can block progress, despite the successful advance of openness, FDI, investments and NR exploitation. Thus, the key aspect would be the transformation of activities related to NR exploitation in an endogenous process, by strengthening the knowledge-based assets of endogenous nature, into the NR industry.

Key words:

Innovation, Chile, Knowledge economi, Knowledge, intangibles, natural resources.

1. Introduction

The recent economic crisis has brought back old questions among economists and accentuating the interest on how to reach a sustainable progress. Although being successful in the past, the most traditional economic approaches seem to be failing to support growth in the long term, even affecting cultural and social arrangements. As Rodrick (2008) pointed out, there are many ways to achieve development, a lot of factors are involved in the process and there are various possible manners to combine them. Some elements are always critics for any trajectory, while others have different performance depending on a set of complementary variables and applied strategies. In this regard, natural resources (NR) traditionally have been considered an important factor for countries' progress; however, these have been also seen as responsible of social, environment and economic collapses, in spite of their importance as productive resource (Frankel, 2010).

Seminal work on NR and growth by Sachs and Wagner (1995, 1999 and 2001) indicated that resource-abundant economies tend to grow slower than economies without important resource endowments. The causes of this fact would be in the presence of weak institutions, lack of capabilities, and wrong strategies applied to avoid the consequences of perverse incentives of windfalls and regular profits of NR exploitation, which may result in social conflicts, deindustrialization, civil wars, inequality, excessive public sector indebtedness, and environmental damage (Manzano and Rigobon, 2007; Wright and Czelusta, 2007; Van der Ploeg, 2011).

This negative picture that can be observed in countries such as Angola, Nigeria, Zambia, Sierra Leone, Venezuela, among others, contrasts with some successful cases of economies based on NR industries. Norway, Canada, Australia are examples among them, where NR have served as basis for their development, and even today primary resources remain relevant for the economic performance (Smith, 2007; Saether et al., 2011; Ville and Wicken, 2012). Then, several questions emerge from these contrasting facts: Why natural resources generate such different effects ? What factors are most influencial in the NR performance? What trajectory is described by successful NR-driven countries? What are the key elements for policy making? These questions are discussed in this paper in order to assist policy makers and entrepreneurs to deal with the challenges of NR production. Thus, the main purpose is to identify the determinants of growth in NR-driven countries, since the literature does not offer clear clues on how these natural endowments may serve as a lever for progress. To achieve this aim, the research is conducted using the knowledge-based economy framework, which provides new tools to understand economic development in the knowledge era. This perspective assumes intangible assets as core elements of national economies and as source of sustainable development (Edvinsson and Kivikas, 2004; Corrado et al., 2009). These intangibles assets have a cumulative and complex nature, and they are the basis of innovative capability and absorptive capacity, as evolutionary growth theory argued (Nelson, 2008).

The analytical strategy to address this research has three steps. First, to seek to detect countries that describe a positive growth path driven by NR through cluster analysis methodology. Secondly, an empirical growth model to identify the pillars of growth in NR-based economies. This model includes both traditional production factors (capital, labor and NR) and those proposed by the Knowledge Economy framework

(human capital, openness, foreign direct investment –FDI, technology capacity, and institution quality). Finally, a dynamic growth analysis is applied to the Chilean case, following Fagerberg et al. (2007) model, along with a convergence evaluation. Chile is selected as a representative emerging NR-based country to analyze growth dynamics and to suggest future policies that could be implemented in other nations with a similar industrial structure.

The results show that there exists a relevant set of countries that share a successful growth path characterized by a strong dependence on NR-based industries. Model estimation findings confirm that NR can positively affect growth of specialized economies (NR-driven), while in developed economies (OECD) their impact is not significant. The analysis also reveals the importance of the international dimension as a channel for accessing embedded technologies via FDI and trade. In addition, a positive effect of local innovative capabilities has also been detected. This would indicate that not only absorptive capacities, but also innovative capabilities, are required in these economies. Furthermore, institutions were also identified as an important factor for growth, since they facilitate the control of the pressures resulting from the exploitation of NR and provide a stable environment for investors and producers. Thus, this path assumes primary resources as a pillar of the economy, and investment in intangibles within the NR sector as a key driver to get higher added value activities, product diversification and to encourage exports.

The study of the Chilean growth dynamics clearly shows a loss of vitality, and the convergence study explains this fall in term of the weak technology capability, the insufficient institutional quality and the short productive investments. Thus, from empirical analysis and under a Knowledge Economy perspective, it was possible to identify a growth path based on NR and intellectual capital while for a successful development path, these economies necessary combine NR with intangible assets, throuth openness, FDI, higher innovation capabilities and good institutions.

2. Literature background

Numerous studies have been conducted to know the causes of failure of largely resource-rich countries and specialized in primary industries. Seminal work by Sachs and Warner (1995, 1997 and 2001) opened an important discussion about the impact of NR on growth, and the explicative factors behind it. First contributions argued that NR negatively affected economic performance as consequence of a mix of economic and social causes. Findings showed that NR-based economies grew more slowly than their potential, or fall definitely into recession (Mehlum et al., 2006), results that would be explained by economic imbalances as a consequence of an excessive public spending, macroeconomic instability and a high concentration of exports. In addition, Dutch disease (Corden and Neary, 1982) is another consequence of NR exploitation due to the currency appreciation problem as well as the industrial concentration in resource sectors, ultimately impacting the competitiveness of manufacturing exports that drives towards a deindustrialization process (Manzano, 2012).

These economic effects of NR activities, and its causes, were also related to the social scope in a reverse way. Scholars observed a strong relationship between commodity production and social conflicts. NR-rent seeking was considered as the origin of the fights, since conflicting groups try to preserve the property of those profitable endowments as tool to finance illegal acts (Rosser, 2006). As Ross (2004) indicated, this situation appears more frequently when there are social inequalities and weak institutions, especially insufficient rule of law, high corruption levels and the presence of terrorist activities. In these cases, governments are unable or unwilling to change this path, and hence crisis and instability are maintained for decades deteriorating even more institutions quality. This leads to a vicious circle, where NR exploitation damages institutions, while weakened institutions adversely affect the economic performance of NR. Thus, institutional quality seems to be both the responsible and the result of NR exploitation. Acemoglu and Robinson (2012) defended that institutions are key for growth. They argued that extractive ones cause failure, while inclusive institutions support sustainable progress.

A third dimension has also been considered as a determinant of NR impact. NR could cause negative effects on environment and development if some cautions are not taken into account. Given the finite nature of non-renewable resources, their exploitation reduces the reserves, in turn affecting growth in the long term (WTO, 2010). Moreover, in renewable resources, such as forestry and fishery, the extraction rates can be higher than those of self-regeneration, causing scarcity and environmental degradation. Although this scarcity can be compensated by technical progress in exploration, extraction, and substitution (Van der Ploeg, 2011), these innovations also improve productivity increasing profits and exploitation activities (Smulder, 2005; Stavins, 2011), and a vicious circle could begin. Thus, both degradation and depletion end up being a constraint to development, requiring strong regulatory measures to reduce or mitigate their effects, for which good institutions are essentials.

Recent pieces of literature are recognizing the potential role of NR- for growth, when there is an adequate combination with human capital (HC) (Iizuka and Soete, 2011; Bravo-Ortega and De Gregorio, 2005; Manzano, 2012), good institutions (Mehlum et al., 2006; Frankel, 2010) and an intensive use of high technologies and knowledge that can create windows of opportunity for diversification and development (Lindkvist and Sanchez, 2008). Moreover, Hauser et al. (2011) indicate that the integration of social factors is also required to achieve positive results in terms of sustainable development.

These new perspective is part of the Knowledge Economy (KE) framework, which postulates that intangibles assets are the core of the development process. In the KE, intangibles are as important as physical assets, and the exploitation of technologies becomes more significant than raw materials production or low-cost labor for nations' competitiveness (Dunning, 2000; Edvinsson and Kivikas, 2004; Corrado et al., 2009). In such an economy, sustainable competitive advantages are driven by the creative, innovative and sophisticated use of knowledge and intellectual assets (Passerini, 2007; Mokyr, 2010). Innovation increases competitiveness of firms, industries and nations, and brings disruptive change into the production process and markets (Schumpeter, 1947), breaking the economic determinism of Neoclassic approach (Castellacci, 2006; Dosi and Nelson, 2010) and the potential resource curse described by the literature. Thus, knowledge can be created and incorporated into traditional activities, resulting in

new opportunities for low-tech and resource-based industries, diversifying, adding value, and reinventing these sectors.

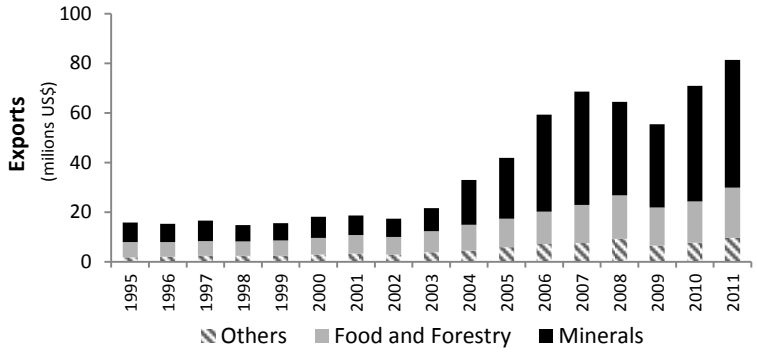
As a result of the dynamics and relevance of knowledge for the economy, scholars built a theoretical framework in the context of the KE, called Evolutionary Theory, in which innovation is at the core of growth and knowledge is understood as a complex entity that cannot be analyzed in purely economic terms, since it is often tacit, interactive, systemic, breaks the stability, continually upsets equilibrium, and is embodied in people and organizations (Nelson and Winter, 1982; Morcillo, 2006). According to this theory, there is no theoretical optimum and the economy is in permanent disequilibrium, since the possibilities for economic action are always changing through a complex process of co-evolution and transformation in which the dynamic relationships between technological, economic and institutional changes play a determinant role (Dosi and Nelson, 2010; Castellacci and Natera, 2013).

Under this perspective, unlike neoclassical postulates, traditional industries (such as those based on NR) could takeoff - or advance - creating and incorporating innovations in the system of production and management, which may result in new products and services. This wealth creation would be supported on the intangible assets of NR based sectors, as well as those provided by transverse and supplier industries, as part of spillover effects. Thus, new opportunities may emerge in primary sectors by investing in intangibles within sector, avoiding abandon them as indicated traditional recommendations (Sachs and Vial, 2002; Rosser, 2006; Malone, 2007; Manzano, 2012; Ville and Wicken, 2012).

Empirical studies are seeking to identify clues for NR-driven countries in the knowledge era. Successful evidence in cases such as Australia, Sweden, Norway and Canada would indicate that technical change is a key element (Howitt and Mayer-Foulkes, 2002; Lederman and Maloney, 2007; Crawford et al., 2010; Ville and Wicken, 2012). However, the progress would be possible if a mix of good institutions, suitable policies and innovation capabilities are present into the system (Castellacci and Natera, 2013), but as Rodrick (2008) indicates, there is not only a successful combination of key variables, but rather the evidence offers a number of examples from which several lessons can be learned. In this regard, Chile is an interesting case of a developing an NR-based country, leader in its region and with a recommendable growth path for similar economies (Rosser, 2006; Frankel, 2010). According to the World Bank (2013) countries' classification, Chile is a high-income economy, reaching a per capita GDP in 2012 of US$15,848, equivalent to 1.8 times higher than in 1980. Chile is the most competitive economy in Latin America, and its successes are result of strong institutional setup, efficient government, macroeconomic stability, and great openness to foreign trade (WEF, 2013).

In addition, NR have also been part of this economic success. According to UNCTAD (2013), NR exports represent more than 80% of total country exports, with mining (mainly cooper) responsible for more than 60%, and renewable resources - food and forestry - around 25% (Graph 1).

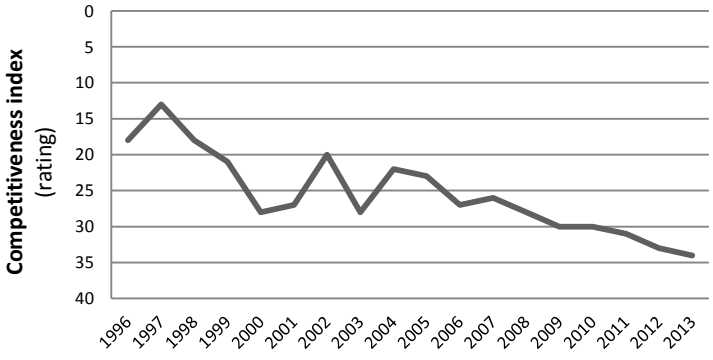
Graph 1. Exports of Chile between 1995 and 2011



Source: data from UNCTAD

However, income is far behind developed economies, and some signs of middle income trap (MIT) have been identified in the last decade (Pérez, 2012; Traub, 2013). This complex situation is also reflected in the fall in competitiveness index (Graph 2) as result of structural failures and a strategy closer to an absorptive or "open innovation system" (Lee et al., 2012), instead of an endogenous innovation strategy.

Graph 2. Competitiveness index of Chile by WEF



Source: data from WEF´s reports

3. Research objectives and methodology

The contrasting evidence suggests that there are certain elements that determine the outcomes. These factors would be built on the basis of elements that evolve and change along time. Therefore, our main purpose is to know the keys of growth in natural resource-driven countries in the knowledge economy.

Past lessons do not necessarily provide enough suitable clues for country development, as the base of economy has moved to intangible assets and permanently are emerging new interconnections between them. For this reason, our first specific objective is to identify the pillars of prosperous economies based on NR industries. Unlike most studies on growth and NR that define target sample using rankings built with NR indicators, we apply a cluster analysis to identify a set of countries that meet

two main conditions: outstanding economic performance measure by per capita GDP and its growth, and high relevance of NR production in GDP, assessed through mineral rents and the added value of agriculture over GDP. Oil rents, an important source of wealth for many countries, have not been included to avoid bias of oligopolistic behavior.

According to the literature, current sources of progress are immaterial factors, as the KE argued (David and Foray, 2002; Foray, 2004). Furthermore, traditional production variables – capital and labor – remain important for NR sectors, as they are capital intensive (e.g. mining) or labor demanding (e.g. agriculture). Therefore, to know the determinants of GDP in countries specialized in NR, we estimate an applied growth model integrating a combination of physical and intangible explanatory variables. Following to evolutionary authors, we use patent as an indicator of innovation capability, while schooling is taken as reflection of human capacity. FDI (stock of inward FDI) and openness (the weight of imports and exports in GDP) were introducing into model as indicators of the international influence because of the importance of them as a way to capture knowledge and technology from advanced countries (Keller, 2004; Bas and Kunc, 2009). An Institutions index, developed according to WB methodology (Kaufmann et al., 2003), is added to introduce the effect of local context. This index is composed of five indicators (Rule of law; Corruption control; Voice and Accountability; Political stability and Absence of violence/ terrorism; Government effectiveness; and Regulatory quality), capturing a wide range of institutional elements. Finally, to identify NR impact on GDP, a Specialization index was calculated as the ratio between natural resource exports and total exports. Unlike Intensity index, defined as the ratio between natural resource exports and GDP (Sachs and Warner 1995 and 2001), the Specialization index offers a better understanding of primary economies and their international trade, common in developing countries and target of this work. A complete description and source of variables is provided in Table 1.

Table 1. Definition of variables and indicators included in the model

Variable	Definition	Source
GDP	Per capita GDP, PPP, at 2005 constant prices (US$)	CANA from Penn World Table
Labor	Labor force, total	WDI
Capital	Investment. Share of per capita GDP (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
Forestry	Forest rents (% of GDP)	WDI
Patents	US Patents granted per country of origin. Number of utility patents granted by USPTO per year and the inventor's country of residence per inhabitant	CANA from USPTO
Schooling	Mean years of schooling. Average number of years of school completed in population over 14	CANA from Barro & Lee and WB
Inward FDI	FDI Inward Stock (%GDP)	UNCTAD
Openness	Openness indicator: (import + export)/per capital GDP ppp	CANA from UNCTAD
Institutions	Index composed of: 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 (exports), CANA and WDI

Source: Authors' elaboration

We use panel data method in the model estimations because it permits to deal with country fixed effects. The estimation is carried out using both static and dynamic Panel data in order to assume a possible endogenous structure, as a consequence of the

path-dependent trajectory and the cumulative process of capabilities (Dosi, 1988). Difference and System GMM specification, developed by Arellano and Bover (1995), is performed, which takes the regressors in levels and differences as instrumental variables, making it possible to use all the available moment conditions and thus providing a better estimation. The general specification would adopt the following form:

$$GDP_{it} = \beta 0 + \beta 1 K_{it} + \beta 2 L_{it} + \beta 3 NR_{it} + \beta 4 Pat_{it} + \beta 5 FDIIS_{it} + \beta 6 Op_{it} + \beta 7 Sch_{it} + \beta 8 Insi_{t} + \eta_i + \gamma_t + \varepsilon_{it} \quad \text{(Equation 1)}$$

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

Where:
GDP: ln per capita Gross Domestic Product (GDP)
$\beta 1 GDP_{it-1}$: lag of dependent variable (ln per capita GDP in t-1)
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}: random error term.

In addition, we incorporate different combined variables with NR; in particular, NR and institutions, patents, FDI and schooling (NR x Ins; NR x Pat; NR x FDI; NR x Sch, respectively) to identify the compound effect of intangibles factors and NR that allows us to capture the interaction between the conventional approach on NR and the KE principles.

The following step of this research was to study the dynamics of growth process in a specialized and developing country such as Chile, where NR have not only been an income generator engine but have also played the role of lever for development. This country is rather a good case of successful economy growth based on NR than an example of succeeding economy according to the KE model while now it is facing a complicated crossroads. Until now, Chile has been successful applying technological innovations from developed countries to its NR industries. Thus, Chile has followed an absorptive or "open innovation system" (Lee et al., 2012), through a "Developmental Network State" approach (Negoita and Block, 2012), instead of an endogenous innovation strategy. Therefore, the second specific objective here is to know the dynamics of Chilean growth and the convergence process of the key determinant factors, a proposal that seeks not only to look into the past but also detect some future clues for a sustainable strategy in the long term that would be also suitable for other NR countries. We used the methodology presented by Fagerberg et al. (2007) to characterize country performance which grouped economies into four categories: Catching up, Losing momentum, Moving ahead, and Falling behind. Unlike these authors, we take several periods of a same individual – Chile – in order to try to understand the evolution of growth. This analysis allows us to see the growth path of a country and its comparative performance. To complement this analysis, a convergence study (β convergence) is performed in order to asses in depth the gap reduction of each key component of the Chilean economy and the evolution. For this evaluation, distance between countries was calculated according to Li and Liu (2005):

$$GAP_{it} = (A_{max} - A_{it}) / A_{it} \quad \text{(Equation 3)}$$

Where:
GAP: is the GAP between the leader and the economy analyzed i in the time t
A_{max}: data from leader economy
A_{it}: data from economy analyzed (i) in the time t

Meanwhile, the convergence (Sala-i-Marti, 2000) is estimated as follow:

$$A_{it} = \alpha + \beta\, t \quad \text{(Equation 4)}$$

Where:
A: is the GAP between country i and the leader, in the time t.
β: Convergence coefficient
t: time
α: Intersect of the model

β coefficient indicates if a country reduce the gap with the frontier economy. We used Canada and Australia as NR leaders, and additionally the Chilean data are also compared with the US because this is one of the most developed nations and its historic trajectory also shows a NR specialized path.

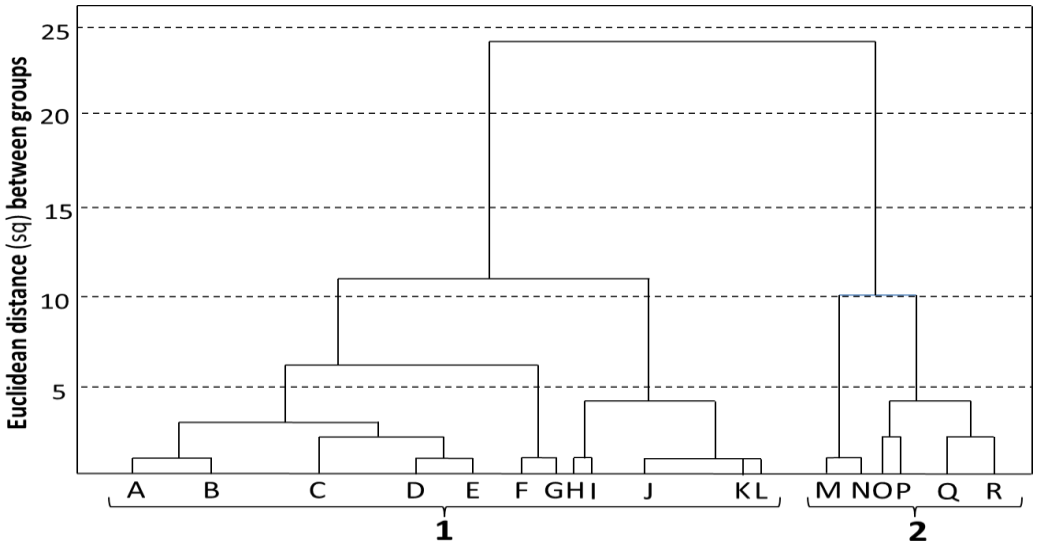
Statistical information has been obtained from different international sources such as WDI, UNCTAD, and CANA (Castellacci and Natera, 2011) databases, for the period 1980 to 2011. The sample is composed by a set of 145 countries.

4. Results and discussion

The cluster analysis used to identify countries that describe a growth trajectory based on NR, resulted in a group of countries formed by nations with an outstanding economy and a productive structure highly dominated by primary industries. This group (named NR-driven) is made up of Argentina, Australia, Canada, Chile, Colombia, Kazakhstan, Mexico, Peru, Russia, Malaysia, and South Africa. Unlike previous studies, this statistical tool has clustered in one group apparently very different countries, located in distinct regions and continents, with distinct cultures and ethnic origins, and contrasting political and governance regimes. This situation agrees with Mehlum et al. (2006) who argue that origin or geographical location is not a determinant of growth, unlike institutional quality, openness and NR. Furthermore, in the NR-driven cluster there are developed and developing countries, which would indicate that NR may have a dual role: driving (big push effect) and supporting growth.

The next figure (Figure 1) shows the cluster dendrogram of country classification according to GDP per capita, growth and NR. Groups A and B include most of the developed and emerging countries with high or medium-high income. In addition, Cluster B is made up of NR-driven and prosperous countries (upper middle and high income countries according to the World Bank classification). A complete list of countries integrated in each cluster can be seen in annex 1.

Figure 1. Cluster dendrogram of countries according to economic and NR indicators. Average linkage, squared Euclidean distance.



Source: Authors' elaboration

These results would indicate that NR could lead toward economic development; however, they may also conduct to failure. In order to get a better understanding of the responsible factors behind these opposite results, we perform an applied model of growth, including both tangible and intangible variables that will allow us to provide some insights for managing NR-based countries.

4.1. Determinants of growth in NR-driven countries

According to results from Cluster analysis, it can be said that those countries grouped in different clusters would be conduct under distinct strategies, probably supported on a diverse combination of resources. The models were performed in order to know the growth determinants in NR-specialized and successful economies, that is the NR-Driven countries sample (in this group, Malaysia is not included due to its different current industrial structure) and in the OECD sample (mainly high income and developed nations). A third group, named NR-dominated, was also incorporated into the analysis to try to identify the possible differences existing within NR-based economies. This set of countries (NR-dominated) is integrated by economies where NR exports represent more than 50% of total exports (see Annex 2 for group composition).

The results show (Table 1) that conventional production factors – capital and labor - have a positive effect on the national product in all the samples, but natural resources show different behaviors. In NR-Driven and NR-dominated economies primary resources positively affect GDP; by contrast, its role in OECD countries is not significant, a result consistent with previous evidence. In fact, theoretical and empirical contributions predict that NR can have different impacts depending on a set of complementary factors and the strategies carried out to exploit and manage NR endowments, affecting institutions, environment and industrial structure (Mehlum et al., 2006; Lederman and Maloney, 2007). However, doubts persist about the determinants of this process. Regarding this, the literature indicates that institutional frame and economic context would be the main responsible of NR performance. In addition,

authors argue that the causes are interconnected and have multiple dimensions. Our empirical analysis (Model A) clearly indicates the positive effect of openness and the importance of international trade for any economy as a way to export their products and to take advantages from the access to foreign goods markets with competitive prices.

Model B also shows that internationalization is a mandatory way for development of NR-based countries. In addition to openness, FDI have a significant and positive impact on GDP in both,OECD countries and NR-Driven countries, because it not only provides capital to host country, but also it is a recognized source of foreign knowledge and technology (Kellller, 2004), that are essential resources in this type of economies.

In more complex and advanced countries, such as NR-Driven and OECD, intangibles become relevant assets to support a long-term development path, as demonstrated Wright (1990) for USA, Blomström and Kobbo (2007) for Sweden, Smith (2007) for Finland; Sæther et al., 2011; and Ville and Wicken (2012) for Norway, Negoita and Block (2012) for Chile. Our results confirm that, in NR-Driven countries, innovation capabilities is a key element for countries' growth, indicating that catching up strategies should be combined with local innovation, which would denote a dependence on foreign knowledge to increase local productivity (Mastromarco and Ghosh, 2009), and the need to develop own technologies and knowledge.

In advanced economies, education takes a more active role, as it is shown by the estimation of Model B for OECD. In the case of NR-Driven economies, it is not clear that education does not positively impact on development, but this result would rather reflect that these nations have not yet managed to overcome the threshold above which it becomes essential, as argued by Mehlum et al. (2006). Moreover, labor indicator would be absorbing part of its effect.

The analysis also demonstrates the crucial role of institutions for growth. In fact, when specialized economies progress to higher development stages, institutions become determinants of economic growth, because good institutions avoid corruption, favor social and economic stability, control public indebtedness, reduce risk of social conflicts, and maintain a rational and balanced industrial policy (Rosser, 2006; Van der Ploeg, 2011; Acemoglu and Robinson, 2012). In particular, corruption control, democracy and transparency are essential, because currently these industries require social acceptance and stability.

Special attention should be paid on NR profits. Evidence indicates that interest groups could push government to meet their particular wishes, instead of orienting NR revenues in productive investments or to develop capabilities for future wealth creation. NR profits should be aimed at improving innovation capabilities through a better education level, advanced scientific facilities and infrastructures, R&D investments, or be invested in transversal and promissory technologies for NR industries. In addition, developmental network should be strengthened as a tool to generate greater synergies between actors and spillover effects (Negoita and Block, 2012).

In the case of OECD, the indicator of institutions is not significant and this can be interpreted according to the short variation of the variable values across countries in this group as these nations have already achieved high and stable levels of institutional quality.

Table 1. Panel data analysis of physical and intangibles factors

Variable	MODEL A						MODEL B						MODEL C					
	NR dominated		NR-Driven		OECD		NR dominated		NR-Driven		OECD		NR dominated		NR-Driven		OECD	
	coef	se	coef	se	coef	se	coef	se	coef	se	coef	se	coef	se	coef	se	coef	se
Capital (invest.)	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 (specialization)	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
Education (schooling)	-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 (chi-sq)	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		0.0602		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***	
Number of observations	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 NR-Driven (random effects). Robust standard errors.
Source: Authors' elaboration.

These findings reveal that RN may have a positive impact on GDP and these may serve as a "big push", and it is also posible that they provide an ongoing support for growth in the long run. But in order to achieve that goal, national strategies have to combine traditional resources (capital and labor) with intangible assets, the latter including the ability to absorb knowledge and foreign capital, together with local innovation capability within an inclusive institutional framework.

In order to verify the combined effects of intangibles and NR on GDP, of countries driven by NR, we introduce variables that reflect the joint action of NR with institutions, patents, education and foreign direct investment. The results (Table 2) corroborate that the capability for innovation, absorptive capacity and FDI are pillars of growth in specialist-NR economies. In addition, institutions and NR positively affect GDP in NR-Driven economies, confirming the findings of authors such as Gylfason y Zoega (2006); Mehlum (2006); Giménez y Sanaú (2007) and Frankel (2010).

Table 2. Panel data analysis of physical and intangible factors for NR-Driven countries.

	Model C		Model C-1		Model C-2		Model C-3		Model C-4		MODEL C-5	
	coef	se	coef	se	coef	se	coef	se	coef	se	coef	se
GDP (L1)											0.496*	0.28
Capital (invest.)	0.649***	0.13	0.681***	0.11	0.724***	0.11	0.648***	0.13	0.693***	0.11	0.357**	0.14
Labor	0.409***	0.16	0.322***	0.10	0.343***	0.12	0.674**	0.29	0.424**	0.17	-0.076	0.42
NR (specialization)	0.383***	0.10									0.256*	0.14
Patent	0.077***	0.03	0.105***	0.03			0.057**	0.03	0.065**	0.03	0.094*	0.05
Education (schooling)	0.607	0.41	0.700*	0.40	0.747*	0.41			0.658	0.42	0.526	0.52
Openness	0.245**	0.10	0.240**	0.10	0.217*	0.11	0.195**	0.09	0.210**	0.10	0.188***	0.07
FDIIS	0.150***	0.05	0.153***	0.04	0.176***	0.04	0.136**	0.06			0.122***	0.05
Institutions	0.235**	0.11			0.143	0.09	0.136	0.16	0.163*	0.10	0.126	0.14
NR x Inst			0.360***	0.11								
NR x Pat					0.092***	0.03						
NR x Edu							0.398**	0.18				
NR x FDI									0.179***	0.04		
_cons	-0.469	2.15	1.329	1.26	0.300	1.78	-4.391	4.62	-1.152	2.42	4.592	5.00
Hausman test (chi-sq)	4.63		-180.51		10.43		26.8***		5.96			
R-sq (within)	0.805		0.7991		0.7886		0.8091		0.8001			
R-sq (between)	0.8238		0.8459		0.8515		0.3745		0.8058			
R-sq (overall)	0.8191		0.8351		0.8402		0.4365		0.7968			
Observations	128		128		128		128		128		60	
Specification	Random		Random		Random		Fixed		Random		Two steps	
Instruments											11	
Arellano-Bond test for Ar(1)											-2.28**	
test for Ar(2)											-0.81	
Sargan test (chi-sq)											0.88	

Note: *** p<0.01, ** p<0.05, * p<0.1. Robust standard errors.
Source: Authors' elaboration.

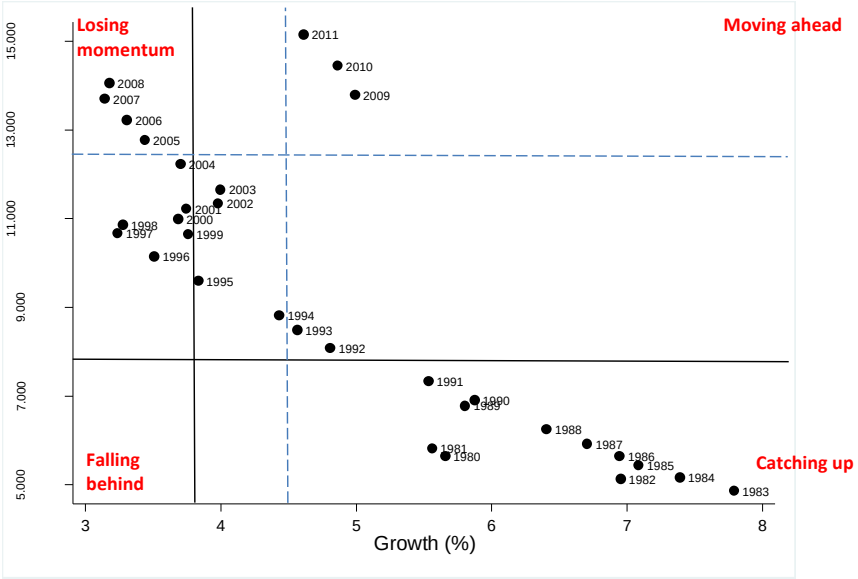
Finally, to test the potential endogenous process and as a test of robustness, we estimated the dynamic panel specification using the Difference and System GMM method for the sample NR-Driven (Table 2, Model C-5). The results show the same tendency as the static models do. However, the estimated coeficients of some variables, like labor and institutions, are not significant due to the strong effect of lagging GDP as the path dependency literature described (Dosi, 1988), which would indicate the importance of long-term policies to achieve sustainable development. The high concordance among the results is remarkable and reflects the strong explanatory power of the proposed model that integrates intangibles as a key determinant of GDP.

4.2. Growth determinants of Chile and its main constrains

Literature on NR and growth has provided abundant insights about failures, however the causes and strategies in positive cases are still insufficiently clear and some open questions remain. An exceptional case is Chile, whose economic trajectory shows a jump in per capita GDP and steady growth over the past thirty years. Its industrial structure is clearly dominated by NR industries, producing primarily commodity.

Despite of these remarkable results, a deeper analysis of the dynamics of growth shows an almost continuous fall during the period 1983-2011 (Graph 3), probably because Chile has followed a strategy more absorptive or based on an "open innovation system" view (Lee, et al, 2012) instead of an endogenous innovation strategy based on the KE principles. Therefore, the second motivation to study this country is to reveal hidden facts about its growth path that could serve to other specialized nations. Following the taxonomy presented by Fagerberg et al. (2007) on growth dynamics, we analyzed the case of Chile. This clearly indicates a declining trend in its growth path and this confirms the problems to sustain a high development standard. During the eighties the economy was in a catching up stage, while in the nineties it moved toward losing momentum during the 2000s. At the end of the reviewed period, new signs of dynamism are observed, probably because of high commodity prices (mainly cooper), rather than a real improvement of competitiveness, internal capabilities or structural changes. This is consistent with the competitiveness data reported by WEF (2013), indicating a constant and worrying drop in competitiveness and confirming the low innovation capability of Chile.

Graph 3. GDP growth dynamics of Chile (1989 –2011).



Solid lines define the classification of country growth stage according to the criteria offered by Fagerberg and others, while the dashed limits are the average of NR-Driven countries.
Source: Own elaboration based on World Bank data.

The analysis of convergence indicates that the main weakness is the low innovation capability of Chile(Table 3). Patent indicator achieve a level 70-130 times

lower than NR leading countries. This is a reflection of the lack of capacity to create knowledge, which also affects the absorption capacity. In addition, education quality is still poor as show international reports (OECD, 2014), although education gap has decreased.

This findings would indicate that to cross the threshold toward a profile of higher income and development levels, Chile must urgently implement strong policies to foster innovation activities in all fields, but above all in NR sectors, promote collaboration networks, and make a greater effort to accumulate knowledge assets.

Table 3. Convergence coefficients (β) between Chile (CHL) and leaders: Australia (AUS), Canada (CAN) and United States of America (US).

	AUS/CHL				CAN/CHL				US/CHL			
	β	initial	final	DS	β	initial	final	DS	β	initial	final	SD
GDP (per capita)	-0.035***	1.9	1.32	0.27	-0.053***	2.23	1.08	0.37	-0.08***	2.87	1.21	0.51
Investment	0.010**	0.18	0.01	0.12	0	0.06	-0.21	0.1	0	-0.07	-0.34	0.11
Patent	0.919	44	76.9	17.7	-2.372	120.4	130.7	49.5	-9.645	338.6	328.5	151.6
Schooling	-0.014***	0.45	0.16	0.09	-0.008***	0.27	0.11	0.05	-0.013***	0.49	0.25	0.09
Openness	-0.006**	-0.48	-0.5	0.08	-0.008	-0.14	-0.23	0.25	-0.002	-0.69	-0.69	0.04
FDIIS	0	-27.7	-28.7	0.1	0.004*	-0.62	-0.5	0.06	0.008**	-0.81	-0.69	0.1
Institution	-0.002	0.12	0.14	0.03	-0.006***	0.15	0.14	0.04	-0.011***	0.09	0.04	0.05
Scientific articles	-0.209***	11.63	8.87	1.4	-0.360***	13.3	8.12	2.31	-0.346***	12.19	7.06	2.16
Royalties	-0.105***	0.97	0.76	1.01	-0.161***	1.89	0.88	1.49	-0.008	-0.67	-0.39	0.25
GINI	-0.019***	-0.22	-0.51	0.13	0.002**	-0.51	-0.44	0.03	0.003	-0.32	-0.28	0.06
R&D	-0.008	2.02	1.83	0.55	0.037***	1.94	2.02	0.38	-0.017	4.32	3.54	0.55
Infrastructure	-0.075***	1.93	0.53	0.45	-0.053***	1.63	0.67	0.34	-0.083***	3.4	1.72	0.52

*Significant at 10%; **Significant at 5%; ***Significant at 1%. Two steps. Robust standard errors. Negative coefficient means convergence. Source: Author's elaboration.

Institution quality is another aspect in which Chile has to pay more attention. Although this indicator present some limitaions because the complexity for measuring this concept, the WB institution index offers suitable information about rule of law, corruption, transparency, political and social stability, government effectiveness, and regulatory quality. The coefficient (negative β) of this variable indicates a reduction of the gap, but important weaknesses remain. According to WB data (World Bank, 2013), these shortcomings are related to lower government effectiveness and the loss of government ability to define and implement policies to promote private business. This would indicate the need to enhance the institutional framework to avoid potential social conflicts, to provide more stability for investments, and contribute to strengthen international and local networks. As Mehlum et al. (2006) argued, good institutions are more relevant when the NR countries are closer to frontier.

Investment in fixed (and productive) capital is also an strategic factor for these sectors, as they are capital-intensive and require important inflows of physical assets. Despite investment gap has increased during the entire period, Chile has narrowed it in

the nineties as a result of foreign capital through FDI and other foreign investments, and also due to the reinvestment of NR revenues (Álvarez and Fuentes, 2006; García, 2006; Pérez, 2012). Signs of broadening the gap are found at the end of the period, although the gap values are still around zero. Thus, it is interesting to pay attention to this variable in order to detect the causes of the reduction of Chilean attractiveness for business, and to try to correct them.

The convergence analysis confirms the success of opening policies implemented since the seventies, becoming a core stone of Chilean economy. Chile is leader in inward FDI among NR-Driven economies, which has permitted to finance important productive infrastructure, incorporate foreign technology and know-how, and open new markets for its exports (Negoita and Block, 2012).

This study has revealed the main barriers that Chile should face in order to return to the growth path, maintaining NR sectors as pillars of its economy. As the KE and evolutionary theory pointed out, intangibles are the key for wealth creation, even in NR sectors, and innovation the tool for growth, and it is precisely in this dimension where Chile has the greatest weaknesses, which result in a major concern for the future. This country could continue using foreign sources of knowledge, but the opportunities are reduced to the extent that the country is closing the gap. Therefore, main opportunities come from local innovation, which can be developed in international networks of scientific collaboration.

5. Conclusions

The cluster analysis has permitted to identify a group of countries made up by upper-middle and high income economies and with an industrial structure dominated by NR. Unlike previous studies, cluster technique allowed us to obtain a more robust group of NR-Driven countries to seek a potential new development path. This set of nations does not have a geographic, ethnic, or political pattern, and therefore other factors would be responsible for growth, as it is suggested in this paper.

The estimated model showed that natural resources may positively impact on growth if traditional production factors are appropriately combined with others of intangible nature. In fact, capital and labor remains key factors of growth in NR-Driven economies, as neoclassic literature argues, but intangibles assets are identified as essentials, too. The findings confirm that NR have a positive effect on GDP in some countries, while in others, such as OECD members, their impact is not significant.

In accordance with the Knowledge economy perspective, it is possible to identify a growth path based on RN and Intellectual capital. A positive effect of innovation capabilities on GDP was detected in countries that describe this development trajectory (NR-Driven). This would indicate that not only the presence of absorptive capacity for catching up strategies are important to specialized economies, but also the capability for creating technologies and knowledge, mainly in advanced stages of development.

The empirical study also reveals the essential role of openness and FDI as a channel to access foreign technologies and knowledge. This can be understood as a mechanism that may facilitate the international diffusion of technologies, with a potentially positive impact on development in resource-specialized economies. In addition, international networks, along with advanced human capital, are key elements to build absorptive capacities, which are critical for these economies.

Good institutional quality positively affects GDP of NR-Driven economies, because better institutions allow countries to overcome potential negative pressures, and achieve a political, social and economic stability that promote investments. In addition, good institutions provide a favorable long-term framework to carry out innovation activities with a long-term vision.

These results justify the design of a comprehensive framework for understanding the economic evolution of nations and the possibilities for defining a different development strategy based on the strengths of intangibles without leaving their natural resource-intensive industries completely aside, but this strategy would require high investment in knowledge assets. Thus, these resources could provide a “big push” and also support a sustainable growth.

The case of Chile clearly represents an example of NR-Driven country that has progressed exploiting its NR endowments and implementing suitable policies of openness and institutional and economic reforms. However, these measures have been insufficient to support a long-term economic development, as was evidenced by the growth dynamics analysis. The causes of this slowdown would be in immaterial factors, confirming the relevance of intangibles resources for NR-Driven economies.

International openness, FDI and capital investment have been the main factors involved in the gap reduction of Chile (GDP per capita) with leading economies. The results of the convergence analyses also indicate that the current main weaknesses of Chile are an inadequate institutional quality, social inequality and a lack of technological capability. This latter aspect is a matter of great concern because the distance is not only very large with the leaders, but also it is increasing. Therefore, the government must pay special attention to the factors that enhance innovation capability, such as education, I+D investments, entrepreneurship, public-private and firm-science networks, science-based employment, and advanced scientific infrastructure. Strategies such as the promotion of smart specialization and the potential for spillover, the increased participation in international innovation networks, and building long-run public-private partnerships, could be implemented.

The study of this case confirms the relevance of intellectual capital in growth strategies in NR-specialized countries. The key aspect would be the transformation of activities related to NR exploitation in an endogenous process, by integrating and strengthening the knowledge-based assets of endogenous nature, into the NR industry. If NR-economies do not assume the task to invest in these elements, their economic development will be blocked and could fall into the NR curse.

Further research will be devoted to analysis at both firm and sector levels, in order to provide more key aspects to policy makers and entrepreneurs. An analysis with micro-data would allow us to include directly innovation variables from surveys and to

deeply analyse spillover effects. In addition, a deeper study of education and institutions would be reasonable in order to detect more clues of the accumulative process of innovation capability building. Finally, some limitations of this study that are common in economic research respond to the use of several proxies for the study of technological and intangible factors, NR, and also development, although all the indicators are justified and the results are robust.

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7. Annexes

Annex 1. Cluster analysis. List of countries of each group.

1												2						
A		**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**	**K**	**L**	**M**	**N**	**O**	**P**	**Q**	**R**
BEL	JAM	CHL	MOZ	EGY	GIN	NOR	ARE	CAF	LBR	GHA	ETH	ZAR	NGA	TCD	COG	GNC	BRN	AZE
DEU	ISL	KAZ	UGA	IDN	MRT	VEN		GNB		MLI	SLE				IRQ		GAB	
CHE	NZL	AUS	KEN	CMR	MNG	ECU				SDN	LAO				AGO		LBY	
JPN	HRV	CAN	TMP		SYR	IRN				AFG	MMR						KWT	
AUT	MUS	MEX	KIR		GUY	YEM				KHM							OMN	
SWE	VCT	ZAF	CIV							NPL							BWA	
IRL	GRD	COL	ALB							RWA							SAU	
LUX	LCA	ARG	BTN							BEN							DZA	
CYP	HUN	PER	ARM							BFA								
FIN	DJI	MYS	PAK							KGZ								
MLT	HND	RUS	ZMB							GMB								
ESP	PHL		TON							NER								
BRB	DMA		VUT							TGO								
PLW	GTM		NIC							BDI								
ITA	BLZ		PRY							SLB								
PRT	LKA		MDA															
BHS	SRB		STP															
DNK	MAR		BGD															
NLD	TUR		IND															
GBR	URY		GEO															
USA	SLV		ERI															
ATG	SWZ																	
HKG	BIH																	
SGP	CPV																	
CZE	BGR																	
KOR	ROM																	
EST	THA																	
LUT	MDV																	
POL	CHN																	
JOR	LSO																	
BRA																		

Annex 2. List of countries of each group analyzed

OECD		**NR dominated**				**NR-Driven**
Australia	Japan	Algeria	Egypt	Madagascar	Saudi Arabia	Argentina
Austria	Mexico	Angola	Ethiopia	Malawi	Senegal	Australia
Belgium	Netherlands	Argentina	Fiji	Mali	Sierra Leone	Canada
Canada	New Zealand	Armenia	Gabon	Mauritania	South Africa	Chile
Chile	Norway	Australia	Gambia	Moldova	Sudan	Colombia
Czech Republic	Poland	Azerbaijan	Georgia	Mongolia	Tanzania	Kazakhstan
Denmark	Portugal	Bahrain	Ghana	Namibia	Togo	Mexico
Estonia	Slovakia	Benin	Guatemala	New Zealand	Trinidad and Tobago	Peru
Finland	Slovenia	Bolivia	Guyana	Nicaragua	Uganda	Russia
France	South Korea	Botswana	Iceland	Niger	Uruguay	South Africa
Germany	Spain	Burundi	Iran	Norway	Uzbekistan	
Greece	Sweden	Cameroon	Jamaica	Oman	Venezuela	
Hungary	Switzerland	Chad	Kazakhstan	Paraguay	Yemen	
Iceland	Turkey	Chile	Kenya	Peru	Zambia	
Ireland	United Kingdom	Colombia	Kuwait	Qatar	Zimbabwe	
Israel	United States	Coted'Ivoire	Kyrgyzstan	Russia		
Italy		Ecuador	LaoPDR	Rwanda		