

# Sustainable management of natural resources via enhanced knowledge bases: Experiences from four Latin American countries

Michiko Iizuka, Fernando Vargas, Jakob Baumann

UNU-MERIT<sup>1</sup>

## 1. Introduction

This article re-examines the role of natural resources (NRs) in economic development in resource-rich countries. For a long time, NRs and particularly non-renewable resources such as mining, have been considered a 'curse'. Nowadays, existing empirical and normative evidence suggests NRs can be an engine for development, given the presence of good institutional capacity and sound policy interventions that connect NRs to productivity upgrading (Andersen et al., 2015; Brunnschweiler, 2008; Collier, 2010; Ferranti, Perry, Lederman, & Maloney, 2002; Humphreys, Sachs, & Stiglitz, 2007; Iizuka & Soete, 2013; Marin, Navas-Alemán, & Perez, 2015; Perez, 2010; Sinnott, Nash, & Torre, 2010; The Natural Resource Charter, 2014; Ville & Wicken, 2013; Wright & Czelusta, 2004, Dietsche, 2014). The role of institutions in managing national wealth has been considered important for sustainable economic development from a distributional perspective (Acemoglu & Robinson, 2012). This paper pays particular attention to institutions linking the extractive industry to investments in knowledge development and diffusion aimed at enhancing national/aggregated productivity growth.

Since the 1990s, one financial institution that has become increasingly widespread among resource-rich countries is the natural resource fund (NRF). NRFs provide a mechanism for setting

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<sup>1</sup> UNU-MERIT, Boschstraat 24 6211 AX Maastricht, the Netherlands.

aside part of the income incurred from NRs in form of foundations, trust and funds (FTFs including sovereign wealth funds) and can also provide a means of ‘smoothing out’ volatilities typical of commodity prices, thereby preventing adverse effects on fiscal and macroeconomic conditions in the country as well as the effects of adverse exchange rates (Collier, 2010; Hamilton & Ley, 2011; Wall & Pelon, 2011; Zhang, Garcia-Quiles, & Thelen, 2015 etc.).

Despite the fact that some reports that NRFs helped to reduce the impacts on resource-rich countries after the commodity super cycle (The Economist, 2015), it has been widely accepted that NRFs alone are unable to place countries on a path to sustainable growth. Other efforts have also been strongly recognized, such as the importance of human resource development and knowledge creation institutions—for example, in Norway and Australia (Gelb, 2012; Gylfason, 2012; Ville & Wicken, 2013). Moreover, the institutional learning abilities of governments can be used to coordinate and link stakeholders to ensure productive development in a dynamic manner (Crespi, Fernández-Arias, & Stein, 2014). This suggests the need for more proactive policy measures to go beyond fixing market failures at the macro level. This claim resonates with other literature (Collier & Laroche, 2015; Collier, 2010), which calls for prior investments (so-called ‘investing in investing’) such as the provision of basic physical and institutional infrastructure before countries engage in more productive activities using NRs (Collier & Laroche, 2015).

In Latin America (LA), from around 2000 onwards, many countries started to move their economic policy in directions that went beyond macroeconomic stabilization policies. This approach is clearly embodied in the following characteristics: first, importance is placed on developing a knowledge-based economy to enhance the productivity of economic activities; second, there is a focus on systemic efforts to foster connections and coordination between stakeholders—industry, government and universities—to accelerate productivity growth by emphasizing the role of institutions (physical and legal) and human resource development (expertise) (Cimoli, Dosi, & Stiglitz, 2010; Crespi & Dutrénit, 2014; Crespi et al., 2014; Navarro, Benavente, & Crespi, 2016; Perez, 2010). Many LA countries are resource-rich and their reliance on NRs increased during the commodity super cycle (Sinnott et al., 2010). This created unique cases in which ‘industrial policy’ or productivity enhancing policies were formulated based around NRs. This development reflects broader discussions that are currently taking place on ‘industrial policy’, particularly with regard to decisions between ‘vertical’ or ‘horizontal’ policies (Crespi et al., 2014) as well as ‘market-defying’ or ‘market-conforming’ strategies (Lin & Chang, 2009) that allow governments to put the economy on more productive pathways.

This paper looks at cases of resource-rich LA countries that have introduced institutional mechanisms to finance structural transformation via enhancing knowledge creation and innovation using income incurred from NRs. The paper focuses on emerging institutional mechanisms that link NRs and science, technology and innovation (STI) policies and institutions in an effort to transform the economy. While recognizing the importance of NRFs, this paper focuses on emerging institutions that are integrating NRs and STI. The following section reviews recent discussions concerning natural resources, the role of institutions, particularly in designing mechanisms to manage NRs with more active policies to stimulate the development process.

## **2. Theoretical considerations on natural resources and productivity development**

### **2.1 Curse of natural resources revisited**

For a long time, NRs were considered a ‘curse’ for development. This was due to, first, the belief that the volatility and uncertainty of demand creates fiscal and macroeconomic problems (Gylfason, 2012); second, *Dutch disease* discouraged the growth of other export sectors due to exchange rate appreciation (Corden & Neary, 1982); third, the reliance on ‘commodities’, as inferior goods, caused negative terms of trade leading up to trade imbalances over the long term (Prebisch, 1950; Sachs & Warner, 2001; Singer, 1949); fourth, they are considered an ‘enclave’ activity—lacking forward and backward linkages—therefore generating relatively little employment and having minimal impact on other economic activities (Hirschman, 1958); fifth, they also lack linkages with technological and scientific knowledge through ‘supplier-dominated industrial activities’ (Pavitt, 1984); and sixth, they cause political conflicts and corruption over ‘access’ to resources (Auty, 1990, 1993).

The above ‘pessimistic’ views on NRs are now increasingly being questioned and re-considered from different perspectives. First, the negative terms of trade argument, suggested by Prebisch (1950) and Singer (1949) and in subsequent empirical analysis such as Sachs & Warner (1995, 1997) among others, is increasingly considered inconclusive (Brunnschweiler, 2008; Cuddington, 1992; Ellsworth, 1956; Tilton, 2013). Many of the discussions concentrate on methodological issues such as choice of indicators (Brunnschweiler, 2008; Cuddington, 1992; Ellsworth, 1956), time periods analyzed (Cuddington, 1992; Ellsworth, 1956) and analytical methods applied (Brunnschweiler, 2008). Critics have also expressed concern that earlier discussions excluded other important factors such as human capital, physical infrastructure and institutional capability in explaining the trade and growth link (Brunnschweiler, 2008). Others argue that more fundamental changes are taking place in NR activities regarding the use of

scientific knowledge and technology (Iizuka & Soete, 2013; Marin et al., 2015; Perez, 2010). Furthermore, several historical case studies have shown that NR-based activities can bring about the enhancement of productivity, diversification of activities and generation of employment with specialization and increased knowledge intensity (David & Wright, 1997; Upstill & Hall, 2006; Urzúa, 2011; Ville & Wicken, 2013).

This discussion demonstrates that NR activities can be more than just enclaves. The conditions to fully utilize the potential of NRs, can be summarized in three policy challenges: first, dealing with the volatility of financial flows; second escaping from dependence on a few commodities; and third, enhancing productivity and knowledge intensity of NR-based activities. Each challenge requires sound institutions and policy interventions.

## **2.2 Institutions to manage income generated from natural resources for sustainable development: What are the key institutional designs?**

Institutions such as NRFs, a subset of sovereign wealth funds (SWFs)<sup>2</sup> (Collier, 2010; Dantas, Marin, Figueredo, & Brazo-Ortega, 2013; Davis, Ossowski, & Fedelino, 2003; Hjort, 2006; Natural Resource Governance Institute & Colombia Institute on Sustainable Investment, 2014; Usui, 1997; Zhang et al., 2015) are being created by governments when they have budgetary surpluses from NR activities as a way to prevent having an excess of liquidity in their economies that may cause instability in macroeconomic balances. Apart from investing abroad to mitigate exchange rate appreciation resulting in *Dutch disease*, NRFs can also cover budget deficits when NR revenues decline, create savings for future generations, and earmark some proportion of income for national development projects. It is said that many NR-based countries are less vulnerable to price fluctuations compared to 20 years ago because of increased presence of NRFs<sup>3</sup> since the 2000s (The Economist, 2015).

Nevertheless, empirical studies on the relationship between resource funds (RFs),<sup>4</sup> governance and institutional quality in resource rich countries found that the likelihood of states to have stable macroeconomic management increases with high quality governance and institutions (Tsani, 2015), suggesting that RF is not the sole factor contributing to the sound management of the economy.

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<sup>2</sup> The income from SWFs is not exclusively from NRs. NRFs are government-owned investment funds “whose principal source of finance is revenue derived from oil, gas and mineral sales” that invest “at least in part in foreign financial assets” (Natural Resource Governance Institute, 2014, p. 6)

<sup>3</sup> NRFs are categorized into savings and stabilization funds (Hamilton and Ley, 2011). By providing a buffer from the volatility of natural resource revenues, stabilization funds are primarily aimed at securing public finances. Savings funds generally aim to invest some specified proportion of resource revenues for future generations. While both funds can obviously be important for the stability of public finances over the business cycle, there is no guarantee that government will not create deficits.

<sup>4</sup> Here, the “resource funds” discussed by Tsani (2013) are closer to SWFs in that they are based on NR income, but the main purpose is to stabilize the macroeconomic balance.

Furthermore, existing research reveals that NRF is not the only answer to the management challenge of NRs. In fact, there is no concrete evidence that demonstrates a strong association with growth (Humphreys & Sandbu, 2007; Stevens & Dietsche, 2008) and others claim that the impacts of NRF remain rather inconclusive (Davis et al. (2003) and Fasando, quoted in Humphreys & Sandbu (2007))

The experience of NR-rich developed countries such as Australia and Norway indicates the importance of establishing institutions surrounding natural resources to enhance technological capability and diversification of activities. For instance, both countries developed knowledge infrastructure such as universities (i.e. School of Mines in Norway), and public laboratories (Commonwealth Scientific and Industrial Research, or CSIR, and later the Commonwealth Scientific and Industrial Research Organisation, CSIRO, in Australia). Furthermore, sector-based associations were created as mechanisms to link creation and diffusion of knowledge to applications through strengthening ties with local firms (university-industry linkages, lobbying for investing in physical infrastructure). These cases demonstrate continuous technological efforts and learning over the years through collaboration among different stakeholders has enabled them to overcome local specific disadvantages by means of innovation. The technology to enable drilling for deep sea oil in Norway and technology to liquefy oil to allow long distance transportation in Australia are some examples of techniques for overcoming specific problems that later resulted into productivity gains (Upstill & Hall, 2006; Ville & Wicken, 2013).

The development of new technologies and knowledge described suggests the potential of diversification of economic activities in areas related to NRs, such as high value-added mining consulting services and sophisticated mining equipment for Australia (Urzúa, 2011). Even among emerging resource-rich countries such as Chile and South Africa, the importance of enhancing technology and innovation is well recognized (Ebert & La Menza, 2015; Garcia, Knights, & Tilton, 2001). The case of South African copper mines shows the importance of having local institutions that are able to strengthen local specific 'on site' competencies (Kaplan, 2012). These examples illustrate the importance of institutions in linking the productive sector with existing local knowledge. While the importance of such institutional mechanisms is well accepted, existing studies have fallen short in describing and analyzing the institutions that integrate STI and management of NRs to spur structural transformation.

Recent literature on NRs management points to the importance of stronger government involvement (Arezki, Gylfason, & Sy, 2012; Collier & Laroche, 2015). Collier & Laroche (2015) proposed a framework whereby they divide NRs extractive activities into a "natural resource policy chain" utilizing the following phases: discovering, exploiting, taxing, 'investing in investing', and

investing of resources. They suggest that different interventions are needed at each phase of the chain, especially for resource-rich and capital-poor sub-Saharan African countries. For instance, in the first phase (discovery), interventions are needed to overcome knowledge asymmetry on exploration risks and the availability of mineral resources; in the second phase (extraction), interventions need to deal with upfront large-scale and long-term investments for infrastructure; in the taxing phase, it is important to overcome knowledge asymmetries in order to negotiate with international agents (developers, trading houses, commodity markets) and to maintain transparent mechanisms for granting rights and levying charges for extraction. The fourth ('investing in investing') and fifth (investing of resources) phases of investment are concerned with establishing the capacity to foresee the future needs of the country and build systemic capability by prioritizing necessary investments.

The earlier discussion (Collier, 2010) also emphasized the importance of government interventions, particularly in regard to "investing in investing," which consists of first, building capacity for public investment, and second, improving the environment for private investments (Collier & Venables, 2011). In fact, for low-income countries, several authors (Collier, 2010; Stiglitz, 2007) agree on use of NR revenues for investments with public assets/goods characteristics; therefore there are higher social rates of return (i.e. human capital and physical infrastructure). This is because the fundamental solution ultimately depends on the government's capacity for making sound management decisions regarding the following matters: 1) how much income from NRs is to be integrated into government revenues (setting an appropriate threshold), 2) how future uncertainties and risks should be assessed, and 3) how funds can be spent effectively (prioritizing usage). In other words, the initiatives above are based on a more careful approach of governments that extends beyond simply fixing macroeconomic stability but proactively engaging in building more resilient mechanisms.

Institutional design criteria have been developed for NRFs (Hamilton & Ley, 2012; Humphreys & Sandbu, 2007). These state that such institutions should incorporate: 1) rule-based design on quantitative limitations for the use of finances (basically, removing discretionary decisions on use of funds); 2) "multiple stakeholder governance," to avoid concentration of powers over resources via the introduction of third parties (i.e. technical bodies or committees) in deciding on the spending or sharing decision-making powers and risks (i.e. Norway's State Petro funds, where disbursement of funds from the Central Bank requires approval from parliament); and 3) ensuring transparency on the uses of funds via promoting dissemination of information of activities by funds as well as involving third parties such as local communities, NGOs and international

organizations (i.e. EITI, Natural Resource Charter) to monitor and evaluate the activities of funds or any finances used for public investment (Hamilton & Ley, 2012; Humphreys & Sandbu, 2007). These design considerations require strong commitments from the government, plus the institutional capacity to mobilize agencies. Hence this would require a clear policy statement by the government on use of resources.

### **2.3 Towards an integrated analytical framework for sustainable management of NR-based activities in structural transformation**

The design principles for NRFs described above is static to prevent rent-seeking behavior and to maintain macroeconomic stability. While these principles are important, these fall short in meeting challenges for sustainable implementation of policy. The design characteristics for policy implementation should deal with the dynamically changing conditions in order to create new institutions. This is due to the fact that followings can only be ‘discovered’ through interaction: 1) knowing solutions *ex-ante*, 2) identifying the “appropriate” knowledge and technical skills needed for the purpose, 3) evaluating a sufficient time lag to evaluate and monitor the outcomes of intervention, 4) finding out appropriate distance with private sector when collaborating to avoid regulatory capture, and 5) coordinating functionally the multiple stakeholders with different intentions (Crespi, Fernandez Ariez & Stein, 2014). As the contexts in which the policy takes place vary, there can be no single prescription for institutional design; however, general guidelines drawn from the literature can provide a basis for comparing the existing institutions that manage NRs to enhance productivity.

Table 1 below shows the combined design principle of the institutions based on the above two strands of literature on extractive industry management and productive development.

**Table 1: Design criteria for institutions to manage NR for productive development**

	<b>Conceptual Institutional Design Guideline</b>	<b>Operationalization of concept/what to look for</b>
<b>Static design criteria</b>	<b>1) Clear purpose of establishment: NR income to finance STI activities</b> Policy statement declaring how NR income is used to finance investment in STI following knowledge economy model	Policy statement/ legal/ government document which indicates intentions
	<b>2) Rule-based design (less scope for discretion):</b> The clear rule principle exists and leaves limited scope for discretion and corruption by the government in power for collecting, using and allocating the tax income on NRs	Clear legislation, setting clear rules on how tax is levied, how it is allocated and to whom it is allocated
	<b>3) Multiple stakeholder governance</b> Responsibility and authority is shared between multiple organizations with regard to critical decision making on use of income from NR tax for the STI policy	Clearly outlining who is involved in decision making and managing; ensuring separate institutional bodies to decide on use of funds; division of power and responsibility clearly stipulated in legal documents
	<b>4) System to ensure transparency</b> Disclosure of information on inflow and outflow of funds	Ensuring channels of information such as a publication of annual reports or providing facilities to access information on a website
<b>Dynamic criteria</b>	<b>5) Develop mechanisms to monitor and evaluate activities</b> Enables identification of problems of ongoing projects as well as completed ones. This should provide opportunities for policy learning through feedback loops in reaction to any changes in policy needs to accommodate policy goals	Presence of monitoring entity and external evaluation entity; feedback system to improve policy-making
	<b>6) Provision of institutional/managerial capacity</b> Existing institutions and human resources are able to carry out intended activities	Systems to ensure that institutions and human resources are able to negotiate to obtain the best possible options; whether allocated resources are being used for intended purposes effectively
	<b>7) NRs are integrated in STI institutions: policy mix</b> Inter-ministerial coordination is achieved to decide on use of resources incurred from NRs for STI purposes with policy alignments; no major conflicting issues exist among ministries involved/mechanisms to involve the private sector in policy process	Presence of inter-ministerial coordination body/mechanism; Presence of institutional mechanisms to involve private sector in the process of policy-making

Source: Authors compilation based on Collier & Laroche (2015); Collier & Venables (2011); Collier (2010); Crespi et al. (2014); Hamilton & Ley (2011); Humphreys & Sandbu (2007); and Stiglitz (2007).



## 2.4 Methodology applied to country case studies

As stated in the introduction, this paper aims to explore institutional designs that allow developing countries to enhance productivity using wealth from NRs. Many of the existing discussions in regard to institutions have concerned SWFs and/or NRFs, which provide institutional mechanisms to isolate volatility prevalent in the NR-based activities. This paper instead focuses on emerging institutional setups of NRs to finance STI at the national level.

In order to understand the institutional design principles of NRs, which have particular characteristics, the existing literature on NRFs was reviewed to identify the key features that should be taken into account when designing institutions. These institutional characteristics focus on preventing corruption and capture prevalent in NR management. These constitute static design criteria that do not change as a result of interactions during implementation. On the other hand, when institutions are given the task of implementation, dynamic interactions are likely to occur. This means that institutions are expected to dynamically transform their functions in order to effectively meet project goals. In other words, such criteria function as an adjustment valve to help sustain the continuity of institutions. These are the dynamic criteria of institutions that have been collected from reviewing literature on innovation policy implementation. Table 1 indicates how each type of criteria functions with institutions involved in management of NR for productive development.

Using these institutional design principle criteria, NR-rich Latin American countries—Chile, Colombia, Peru and Bolivia—with national institutions related to NRs and STI can be examined using information obtained from secondary sources and key informant interviews (a list of interviews has been provided in the Appendix). Interviews were conducted in late 2015 and early 2016 with experts working in the specific area of policy on innovation and mining.

In the 2000s, Latin American countries—especially those endowed with NRs—grew economically owing to a boom in commodity prices. While growth took place in many resource rich countries, it was reported that during the boom, the structure of the economies became progressively more reliant on natural resources (CEPAL, 2010). Each of the countries examined in this paper have tried in distinctive ways to shift from a market-led economic approach to a more policy-oriented approach, with greater attention given to the role of knowledge (STI) (Crespi & Dutrénit, 2014). The stimulus for such transitions lay in the concern over growth without productivity gains. The next section examines institutional set ups concerning NRs and STI. After an examination of the institutional features of each country, a comparative analysis will be made to

identify some common features and future challenges referring to the design criteria for institutions.

### 3 Existing systems in each country

In this section, institutional setups regarding the use of NRs for productivity enhancement via strengthening STI capability are examined. Each country case is analyzed using the criteria mentioned in Section 2. Each country case will have the following sections: 1) description of the institutional design of financing STI from the extractive sector; 2) descriptive background for such institutions with links to STI; and 3) evaluation of existing institutions in light of the above design principles with some reference to challenges.

#### 3.1 Chile

##### Financing STI from copper royalties<sup>5</sup>

Chile has had a NRF, Copper Stabilization Fund, in operation since 1987 (OECD 2014c). This fund has successfully insulated fiscal revenues from the cyclical fluctuations of copper prices. While this fund has been successfully contributing to maintaining the macroeconomic stability, this was insufficient for the country to escape from resource dependence. In fact, during the *commodity super cycle*, dependency on natural resources increased in both real economic terms and as a proportion of total exports (CEPAL, 2010).

Since the 2000s, Chile has gradually shifted away from a market-oriented approach towards a more policy-oriented approach concerning STI (Aninat et al., 2010; Eyzaguirre, Marcel, Rodríguez, & Tokman, 2005; Olivari, 2016). This approach justifies selective policy interventions to enhance knowledge and innovation to stimulate structural transformation. In such a process, finance from the mining sector is considered to play a critical role. Parallel to the discussion on STI, taxes on mining—especially involving Multinational companies (MNCs)—was a publicly debated issue with negative sentiments expressed towards MNCs for not paying enough for resource rent. As the result, a system was proposed to Congress to levy progressive taxes from copper mining companies above certain level of sales (at a level equal to or greater than the equivalent value of 12,000 metric tons of fine copper: MFT). The funds raised, along with additional resources, were to be transferred to a fund for promoting innovation. In mid-2004, the Innovation for Competitiveness Fund (*Fondo*

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<sup>5</sup> For more details of prior institutions for STI policy, please refer to the OECD Innovation Policy Review, Chapter 4, (OECD, 2007).

*de Innovacion para la Competitividad*: FIC) was established to receive the mining royalties.<sup>6</sup> One year later, a new mining law (*Impuesto especifico a la actividad minera*, Law No. 20097, which came into force on 1 January, 2006) was established, as the foreign direct investment law needed to be modified to include royalty-related articles (Olivari, 2016). The FIC finances projects related to scientific investigations, business innovation, and technology transfer via specialized public agencies in a range of sectoral areas as outlined in the National Innovation Strategy (National Innovation Council, 2007).

The FIC is managed by an executive secretariat situated in the Division of Innovation in the Ministry of Economy<sup>7</sup>. For any entity to access FIC, a project proposal needs to be submitted with the relevant implementing agency (such as CORFO, the Chilean Economic Development Agency, or CONICYT, the National Commission for Scientific Research and Technology). Once the project is approved, the executive secretariat signs agreements with the respective implementing agency.<sup>8</sup> This agreement includes a list of indicators and objectives for use in monitoring and evaluation by the Office of the General Comptroller of the Republic (*Contraloría General de la República*). The Ministry of Economy monitors the resource transfer to guarantee successful completion of the objectives of project (Ministerio de Economía, n.d.).

At the time of its creation, FIC was managed by the central government (in the capital, Santiago) but since 2008 (OECD, Territorial Reviews Chile, 2009 and OECD, 2014c), the government has transferred more authority to the regions by allocating 25% of the fund's resources to the regions (60% of which goes to regions where mines are located, 40% goes to regions without mines). The remaining 75% is managed by public agencies in Santiago (Cuervo & López Fonseca, 2013). Later, FIC was incorporated into the regional budget, the National Fund for Regional Development (Fondo Nacional Para Desarrollo Regional: FNDR), managed by the Subsecretariat for Regional Development (OECD, 2009). The decentralization of FIC aims to enhance regional development and is well in line with the National Innovation Strategy (2007) (OECD, 2009).

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<sup>6</sup> In the same year, NRF in Chile, Copper Stabilization fund was transformed into a broader sovereign wealth fund called Economic and Social Stabilization Fund with Fiscal Responsibility Law (FRL). This change strengthened its fiscal framework (de Melo, 2008) with clearer set of rules to maintain macroeconomic stability.

<sup>7</sup> <http://www.economia.gob.cl/subsecretarias/economia/innovacion-2/el-fondo-de-innovacion-para-la-competitividad-fic>

<sup>8</sup> The major implementation agencies of FIC are: Chilean Economic Development Agency (Corporacion de Fomento de la Produccion: CORFO), Science and Technology Research Council (Comision Nacional de Investigacion Cientifica y Technologica: CONICYT), Innova Chile Committee, Subsecretariat of Agriculture, Subsecretariat of Economy and National Institute of Statistics (Instituto Nacional de Estadisticas: INE).

## Backgrounds and STI institutions

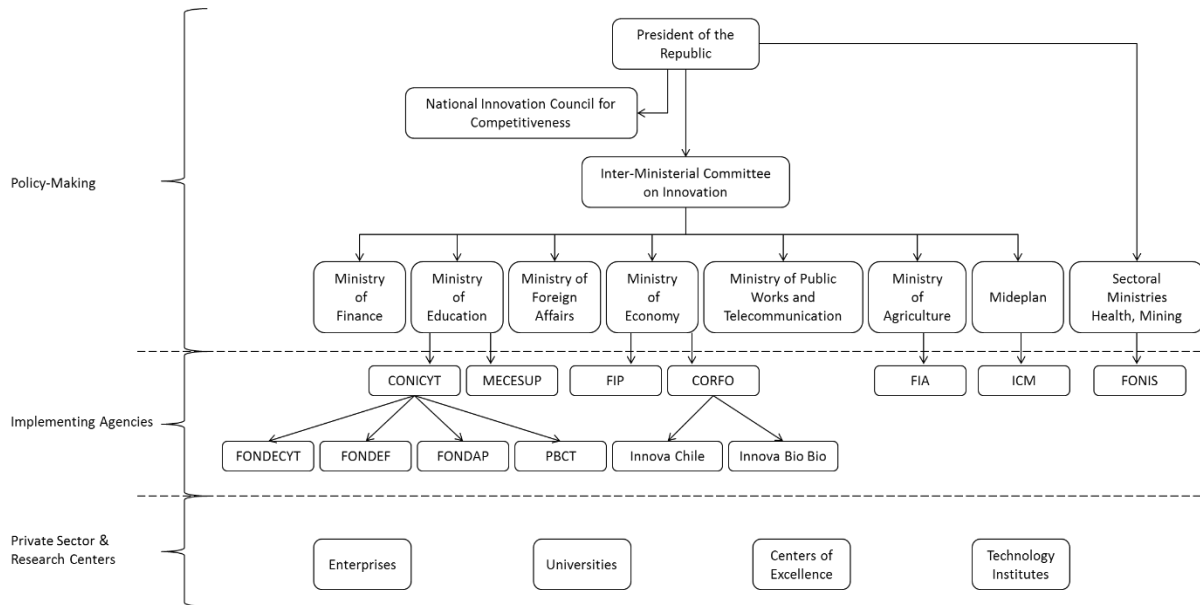
Two organizations were working closely on issues concerning STI even before the 2000s. One is CORFO (Chilean Economic Development Agency) and the other is CONICYT (Science and Technology Research Council). CORFO is a part of Ministry of Economy, which supports productive development of industries. CONICYT is a part of Ministry of Education, which is responsible for coordinating, promoting and supporting scientific research. In 2004 two new institutions were established to promote innovation in science, technology and innovation. One is FIC and the other is the National Innovation Council (Consejo Nacional de Innovación para el Desarrollo: CNID<sup>9</sup>). The CNID was established by Presidential Decree to serve at the center of a series of initiatives that were implemented from 2005 onward to strengthen the innovative capacity of Chile's economic system (Benavente & Price, 2014; also see Chapter 4 of OECD Review, 2007). CONICYT and CORFO both act mainly in the implementation side of innovation policies.

In 2007, following recommendations by the OECD and World Bank concerning the separation of the advisory and monitoring role from the design and implementation role, the Inter-Ministerial Committee on Innovation (CMI) was established to take charge of design and execution (decisions on usage of funds) of the innovation policy via coordination across agencies and sectors. This CMI, chaired by Ministry of Economy, includes several ministries related to STI activities (these are Ministry of Finance, Ministry of Education, Ministry of Foreign Affairs, Ministry of Public Works, Ministry of Transport and Telecommunications, Ministry of Agriculture and Ministry of Social Development). The CNID hence focused on a long-term strategy of STI (National Innovation Strategy) monitoring progress towards the national goals and acting as an independent advisory committee to the President (Olivari, 2016).

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<sup>9</sup> At the time of establishment, this organization was called National Innovation Council for Competitiveness (CNIC); however, in 2015 the name of this organization was change to National Innovation Council for Development (CNID). In this paper, we will refer to this as CNID.

**Figure 1: Chile: National Innovation System**



Source: Based on Zahler, Bravo, Goya, & Benavente (2014)

In 2010, a right-wing government came to power and substantial changes were made in STI institutions. For instance, an early attempt to introduce a vertical policy, cluster project was abandoned and the strategy was shifted to a more horizontal approach of strengthening the innovation culture through programs such as the ‘Start-Up Chile’ program (Olivari, 2016). In 2014 the center-left coalition returned to power and the selective approach to innovation policy was clearly resumed with a plan—the Agenda of Productivity, Innovation and Growth (2014-2018)—elaborated by the Ministry of Economics. The above demonstrates the difficulties of maintaining a continuity of policy over the political cycle.

### Static design criteria

There is a clear goal shared among some policy makers in related organizations to support productivity enhancements via increasing knowledge intensity in activities, using the NRs to finance innovation with the establishment of FIC and redesigning the STI institutionality.

The mechanism is equipped with a clear set rule and policy goal for FIC. CMI (comprising representatives from seven ministries), chaired by the Ministry of Economy, coordinates policy design and decisions on the use of FIC. Projects are executed by one of the implementing agencies such as CORFO (and Comité Innova Chile) and CONICYT. Disbursements of finances were made in accordance with the National Strategy for Innovation elaborated by the CNID, which creates long-term strategies through discussion with the private sector as part of its platform. The above

illustrates the involvement of multiple organizations to provide checks and balances on individual organizations exercising excessive governance power.

The budgetary information is open to the public, ensuring transparency. The allocation of resources from the FIC to specialized public agencies is published on the webpage of the Office of the Budget (*Dirección de Presupuestos*)<sup>10</sup> as stipulated in the annual law of the budget (*Ley de Presupuesto*). In 2008, the FIC was transferred to regional governments and incorporated into the regional budget, FNDR, which made it more difficult to follow the use of FIC budgets specifically from the regions.

### Dynamic design criteria

In the 2000s Chile created institutions on STI (CNIC, FIC) to strengthen policies to enhance productivity linking the financing coming from the mining tax (FIC). While this was a great step forward in establishing institutions that can provide a foundation for implementing proactive policies, some challenges remain. For instance, there is no clear information on how projects executed with FIC finances are monitored and evaluated (interview, Araya Pacheco, 2015). This suggests that evaluation is not being practiced on a regular basis to systematically improve the performance and allow continuous learning and improvement of the policy instruments. Under the existing system, the private sector, the principal actor of innovation, is not permitted to take part in the decision-making process on the use of FIC (OECD, 2014a) but some have suggested the possibility of greater involvement by the private sector in the decision-making process.

Moreover, although the regional initiative is considered important in enhancing productivity in the regions and a quarter of the budget has already been allocated to regional governments, structurally the regions are still under the strong influence of the central government, and possess limited capability (such as lack of experts and expertise). Often the needs of regional governments are not well articulated due to lack of capacity, resulting in a weaker negotiating position with the central government (Cuervo & López Fonseca, 2013; OECD, 2007, 2009, OECD, 2014a). Although consideration has been given to the need to decentralize the decision making process, the existing capacity gap may hamper the effectiveness of projects financed by FIC.

Regional government also has difficulties in financing long-term projects with the FIC regions due to the fluctuating financial flows linked to production of copper. This can potentially be a serious problem because long-term projects would be greatly preferable if the country is to structurally transform.

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<sup>10</sup> <http://www.dipres.gob.cl/595/w3-propertyvalue-15145.html>. See Ministerio de Economía, Fomento y Turismo”, then “Subsecretaría de Economía y Empresas de Menor Tamaño” and “Programa Fondo de Innovación para Competitividad.”

As for coordination, Olivari (2016) comments that despite the fact that CNIC and CMI were created to steer innovation policies between related actors in public and private sectors, “experts deemed that there was an insufficient cohesion and coordination of the programs and instruments through which the innovation policy was implemented” (Olivari, 2016, p. 28). This view coincides with the external panel review of experts on The National Innovation Strategy for Competitiveness conducted in 2010. This indicated that, although CNID provided space for discussion to generate consensus, the speed of implementation is too slow, with weaknesses partly due to the lack of CMI coordination to create consensus on policy design and use of funds (Olivari, 2016). Furthermore, because Chilean institutions for STI policy (CNID) in 2005 were created and renewed by presidential decree and never became law, its functions became the subject of change due to the political cycle.

## 3.2 Colombia

### Financing STI from NR royalties<sup>11</sup>

Since 2010, Colombia clearly identified the potential of exploiting non-renewable NRs to enhance productivity and transform economic activities. This idea was well reflected in The National Development Plan (Plan Nacional de Desarrollo (PND) 2010-2014) (Cuervo & López Fonseca, 2013; DNP, 2011). From this basis, Colombia reformed laws associated with mining royalties, particularly on how they were levied and distributed. Colombia’s mining royalty law was established as early as 1919 and thereafter the law underwent several reforms.

Prior to the most recent reform in 2011, the General System of Participation of 1994 (Sistema General de Participaciones: SGP) was in place to manage mining royalties. This allocated 80% of NR royalty revenue to the NR producing regions (65% royalties to the oil/mineral producing department and 15% to the producing municipalities) and the remaining 20% to the National Royalty Fund. As the NR-producing regions in Colombia represented only 17% of total population, this law significantly favored the NR-producing regions in financial terms (OECD, 2015). The use of funds allocated to regions (80%) was earmarked to finance improvements in education, healthcare, clean water and sewage within the general guidelines, while the royalties distributed to the National Royalty Fund (20%) mainly financed development of infrastructure for the mining sector.

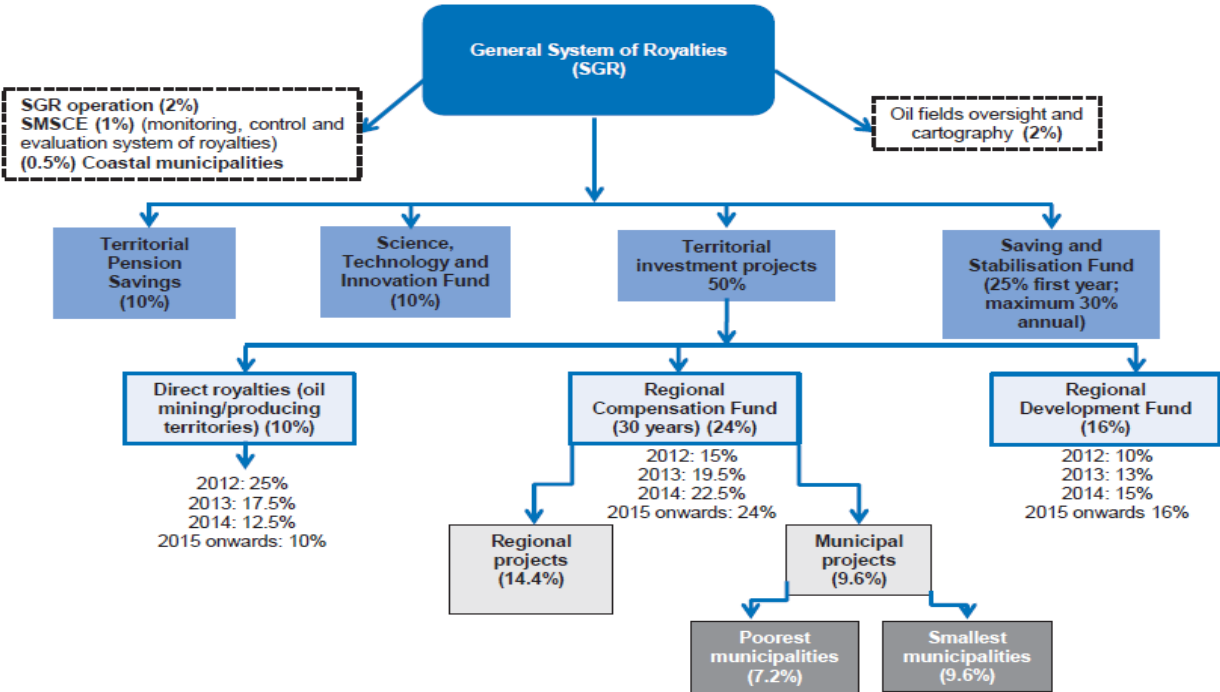
In 2011, a new allocation system, General Royalty System (Sistema General de Regalias: SGR) was established via enactment of Legislative Act no. 5 which went into force in 2012 (Law No.

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<sup>11</sup> Development of STI policy in Colombia is well documented in OECD (2014, Chapter 4, Section 2).

05, 2011). The SGR manages the royalties generated by the exploitation of the country’s mineral resources. Its main objectives remain the same: to support social, economic, environmental, and regional development (Cuervo & López Fonseca, 2013)(see Figure 2 for allocation).

SGR differs markedly from SGP in following ways: first, 10 percent of royalty revenue is earmarked for Science Technology and Innovation Funds (Fondo de Ciencia Tecnología e Innovación: FCTel) to enhance capacity building (OECD, 2014a); second, the method of allocation was changed making it accessible to all regional departments, regardless of location in NR-producing regions (OECD, 2014a); third, it allowed each department to invest the funds on the basis of their needs, strategic priorities and programming documents.<sup>12</sup> As the finances belonging to SGR are not part of the general budget, (Article 2 (Paragraph 1) (Law No. 05, 2011)), the transition from SGP to SGR has provided extra financial resources for regions that do not produce NRs.



**Figure 2: Funds within the General System of Royalties**

Source: OECD (2014b)

<sup>12</sup> The fund, however, was prohibited to cover operation costs beyond a designated period.



SGR also created a fund similar to NRF, called the Saving and Stabilization Fund (FAE) that took 25% of the total royalty revenues in 2012 (although the actual target is 30%). This fund is managed by the Central bank and aims to share the benefits from natural resources across generations via smoothing out the boom and bust of commodity prices, following explicit rules.<sup>13</sup> The FAE will also accumulate revenue windfalls to finance counter-cyclical fiscal policies during economic downturns.

While the FAE focuses more on the stabilization of fiscal policy, FCTel, is intended to cover four categories of scientific and technological activities to stimulate productive development. These are research and development, innovation, scientific and technological capacity building and scientific technological services (OECD, 2014a). Currently, FCTel is allocated to (regional) departments (of which there are 32 plus the federal district of Bogota) based on a formula created by Ministry of Finance that takes population, unemployment and unmet basic needs (*Indicador de Necesidades Basicas Insatisfechas*: NBI) into consideration. Moreover, by law,<sup>14</sup> usage of resources belonging to FCTel shall be in accordance with the national and regional development plans.

Projects applying for FCTel funding are screened, selected and managed at the national level by the Governing Bodies of Administration and Decision (Organo Colegiado de Administration y Decision: OCAD).<sup>15</sup> OCAD consists of three groups of representatives: Universities (4 public, and 2 private), the public sector (6 representatives of government: Colciencias, DNP, MinTIC, MEN, MADR) and departamental governments<sup>16</sup> (6 departamental governments: Quindío, Santander, Caquetá, Bolivar, Nariño Vichada)(see Figure 3). Each group has the right to one vote and decisions can be approved when there are two favorable votes out of three. Colciencias (Administrative Department of Science, Technology and Innovation/Departamento Administrativo de Ciencia, Tecnologia y Innovacion), the main agency of STI policy, is the technical secretariat of the OCAD for FCTel (Decree No. 1949, 2012).

Project proposals are first reviewed and screened by the corresponding territorial entity to check for suitability against the listed requirements on points of sustainability, viability and coherence in accordance with the national development plan for STI. Thereafter, those proposals

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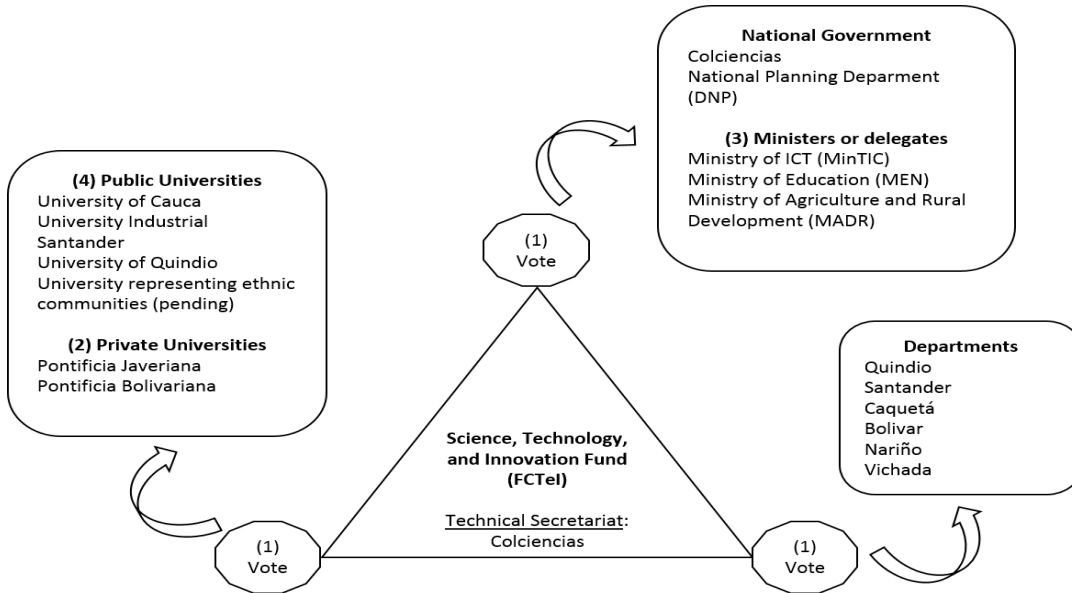
<sup>13</sup> For instance, the law clearly states that up to 10% of the budget allocated to the FAE in the previous year is allowed to be used for counter-cyclical policy interventions in times of difficulty.

<sup>14</sup> Article 2 of Law No. 05 (2011).

<sup>15</sup> OCAD for other funds also exists at regional levels. According to the legislation, OCAD is in charge of 1) defining, evaluating, approving and prioritizing the usefulness and suitability of funding projects under STI funds, 2) making decisions on the departments' and country's needs, 3) making decisions based on scientific and technical quality and relevance, 4) orienting the resources of the STI fund towards projects with regional impact that stimulate regional capabilities, 5) putting together the Comite Consultativas (advisory committee) and designating a project executor for public projects (OECD, 2014b). OCAD for STI is different from those that are used for regional development.

<sup>16</sup> Colombia has a federal government. Below the national level, there are regions, departments and municipalities. Departamento is common subnational unit. A region is a group of departamentos.

are submitted to Colciencias for screening on compliance with the rules set out in the call. Once proposals are screened, these are sent to OCAD for final decision for approval or rejection.



**Figure 3: Colombia: voting in the OCAD of the FCTel**

Source: Based on Colciencias (2014)

Table 3: Colombia: Allocations to departments by FCTel, US\$ (2015 – 2016)

Department	Available Resources certified by the MHCP (*)2015-2016	Total amount approved by the FCTel-SGR(2015-2016)	% being used(2015-2016)	% being used(2012, 2013-14)
AMAZONAS	9,641,176.05	8,856,946.09	91.9	59.8
ANTIOQUIA	69,874,878.54	65,233,728.57	93.4	6.3
ARAUCA	17,175,160.15	14,847,720.01	86.4	2.4
ATLÁNTICO	32,215,088.54	23,207,185.92	72.0	0.0
BOGOTÁ	24,831,305.01	22,613,507.46	91.1	19.9
BOLIVAR	58,539,042.40	18,881,418.56	32.3	52.5
BOYACÁ	40,190,356.69	16,870,657.97	42.0	6.0
CALDAS	18,934,863.52	14,670,282.81	77.5	0.0
CAQUETÁ	24,777,699.49	23,750,658.95	95.9	64.9
CASANARE	19,197,587.68	13,705,173.89	71.4	4.1
CAUCA	49,866,648.34	41,173,778.55	82.6	6.5
CESAR	38,600,703.81	26,705,210.51	69.2	65.1
CHOCÓ	35,153,749.37	28,784,853.32	81.9	0.0
CÓRDOBA	67,453,879.01	54,021,521.13	80.1	34.0
CUNDINAMARCA	38,647,817.11	33,140,790.36	85.8	21.9
GUAINÍA	8,084,932.59	7,010,650.76	86.7	54.6
GUAJIRA	46,727,722.47	34,352,116.21	73.5	5.0
GUAVIARE	11,642,623.29	6,871,800.22	59.0	7.0
HUILA	37,669,058.75	21,526,826.22	57.1	41.3
MAGDALENA	45,366,249.39	35,291,363.03	77.8	6.1
META	20,406,993.56	12,458,690.01	61.1	0.0
NARIÑO	56,606,036.86	29,691,629.79	52.5	23.8
NORTE DE SANTANDER	37,022,977.54	22,089,239.87	59.7	0.0
PUTUMAYO	20,518,005.01	8,086,324.49	39.4	4.2
QUINDÍO	8,506,908.53	6,367,467.65	74.9	0.0
RISARALDA	16,106,673.56	16,830,270.86	104.5	0.0
SAN ANDRÉS	9,549,272.67	-	0.0	39.3
SANTANDER	31,241,499.03	26,976,434.20	86.3	37.4
SUCRE	42,251,543.61	22,111,271.14	52.3	14.2
TOLIMA	30,644,608.31	26,630,921.11	86.9	30.5
VALLE DEL CAUCA	41,905,070.31	23,165,175.86	55.3	1.9
VAUPÉS	8,145,822.66	2,508,776.86	30.8	14.9
VICHADA	11,442,397.45	10,018,312.08	87.6	56.6
<b>TOTAL</b>	<b>1,028,938,351.31</b>	<b>718,450,704.45</b>	<b>69.8</b>	<b>22.3</b>

(\*) Ministry of Finance and Public Credit (Ministerio de Hacienda y Crédito Público)

Source: Based on Colciencias (2015a). COP has been converted into the US\$ rate from Oct 6, 2015 (oanda.com)

Table 3 shows the allocation of FCTel funds received by each department, as assigned by the Ministry of Finances and Public Credit. From 2013 onwards, FCTel has been allocated biannually. The total amount of FCTel for the 2015-2016 period is USD 1,028 million but approved projects accounted for only 70 percent of the budget (Colciencias, 2015a).<sup>17</sup> Table 3 shows the 2015-2016 allocation of FCTel and disbursements. Diversity in the range of percentages demonstrates, to some extent, the regional gap in capacity to implement STI-related activities. Although not comparable, a similar pattern was present in the 2012, 2013-2014 periods (Cuervo & López Fonseca, 2013) (see

<sup>17</sup> Colombian Pesos converted into US\$ taking the exchange rate from the 6th of October, 2015, from oanda.com

Table 3). Such a disparity in capacity can be observed in other innovation indicators. For instance, the bibliometric output suggests that six universities (out of 81) accounted for over 60% of Colombia's scientific publications over 2000-2011 (OECD, 2014a, p. 109). Based on this, decentralized administration of funds may be unable to meet the original goal without capacity building in the region's administrative and scientific capacity.

### **Background and STI institutions**

Several important changes took place in STI institutions, prior to the establishment of SGR in 2011. One was the creation of Colciencias<sup>18</sup> (Law No. 1286, 2009), in 2009. Several policy documents provide a basis for its establishment, such as COMPES document 3582<sup>19</sup>(CONPES, 2009; Cuervo & López Fonseca, 2013) and National Development Plan 2010-2014 (DNP, 2011 quoted in Cuervo & López Fonseca, 2013), which states the importance of the knowledge economy and underlines the need to integrate knowledge-based activities in the Colombian economy, and highlights the potential of exploiting non-renewable NRs for this goal.

Colciencias is the central actor among STI institutions in Colombia. It is involved simultaneously in the design and implementation of STI policies and undertakes the role of a science ministry and innovation agency, coordinating ministries related to STI activities(OECD, 2014a). It has its own budget to allocate for STI programs and provides technical assistance on managing the evaluation process. Colciencias supports the allocation of FCTel as the technical secretarial of the OCAD (Cuervo & López Fonseca, 2013) but does not have any decision-making power over the selection process (Decree No. 1075, 2012).

### **Static design principle**

Colombia established a system for using NR royalty revenues to finance STI activities on the understanding that knowledge-based activities are needed in order to enhance productivity, thereby highlighting the potential of NRs to play a critical role in enabling this process (Cuervo & López Fonseca, 2013; DNP, 2011; CONPES, 2011).

Colciencias plays central role in design and implementation of STI policy as well as coordinating agency for other ministries on the issue of STI policy The institutional design of the process of selecting projects for FCTel financing is very much a bottom-up process involving multiple stakeholders in OCAD with Colciencias as the chair. This multiple layered structural design

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<sup>18</sup>Before 2009, Colciencias was one department under the DNP (National Planning Department: Departamento Nacional de Planeacion: DNP).

<sup>19</sup> CONPES is a committee formed by the head of ministries, vice presidents and heads of the Planning Bureau (DNP) and Colciencias. CONPES approves policy documents approved by the government usually presented by DNP.

should ensure transparency and shared responsibility. Furthermore, Colciencias provides information on its webpage about investment and projects that allows FCTel<sup>20</sup> to increase transparency.

### **Dynamic implementation principle**

For monitoring and evaluation, SGR allocates 1% of the overall royalty payments to support the supervision, monitoring and evaluation of the system. Half of this 1% is allocated to the Comptroller General's office (Contraloría General de la República), which carries out fiscal surveillance of the system. Separate from the above, Colombia created SMSCE (System of Monitoring, Oversight, Control and Evaluation of the Royalties: Sistema de Monitoreo, Seguimiento, Control y Evaluación de las Regalías), a monitoring and evaluating agency, with the enactment of Article 2 (Paragraph 3) of Law No. 05 (2011). SMSCE watches over the adequate and transparent use of the resources of the SGR<sup>21</sup> according to Decree No. 414 (2012). The management of NRs also involves DNP, which collects analyses and verifies accounts and the performance of project investments, and exercises sanctions for improper, inefficient or illegal use of funds. DNP conducts evaluations of projects on a selective basis to assess the management and its capacity to deliver, compared with the goals set out in the initial proposal (OECD, 2014b, p. 108). This suggests that monitoring and evaluation is well institutionalized in this area in Colombia.

While the basic institutional design is well established, institutions have experienced some challenges. One of the challenges referring to the operation of the SGR system is the disparity in capabilities among departments in managing projects related to STI and research (Cuervo & López Fonseca, 2013; Korinek, 2015; OECD 2014b). There are capacity gaps amongst departments in terms of the number of researchers and quality of research contents, which is reflected partially in the uneven usage of FCTel. In Colombia, capacity building in the regions can be a critical factor in successful use of FCTel.

In order to solve this problem and to facilitate the application of appropriate projects from the regions, Colciencias drafted and defined the requirements and guidelines of FCTel (FCTel y la *Guía no. 2 de proyectos de ciencia, tecnología e innovación*, Colciencias, 2012) following the international manuals of STI (such as Frascati and Oslo). Another action taken by Colciencias was to create Regional Committees for Science, Technology and Innovation (*Consejos Departamentales de Ciencia, Tecnología e innovación: CODECTI*) and draft the Regional Strategic Plan for Science, Technology and Innovation (*Planes estratégicos Departamentales de Ciencia, Tecnología e*

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<sup>20</sup> <http://www.colciencias.gov.co/blog/regal-para-la-cienciatecnolog-e-innovaci-n>.

<sup>21</sup> <https://www.sgr.gov.co/SMSCE/MonitoreoSGR.aspx>.

*innovacion*: PEDCTI). Both CODECTI and PEDCTI were strengthened by Law No. 1286 (2009), which provides a basis for establishing priorities to invest in STI in the regions. In fact, all 33 departments now have CODECTI and prioritize their investment plans in accordance with PEDCTI. With CODECTI in place, actors at the department level are more aligned and projects can be reviewed against the criteria according to regional priorities before going to OCAD at the national level. While these adjustments have been made, the regional capacity gap still persists and further measures are needed to resolve the gap in capacity among the departments.

### 3.3 Peru

#### Financing STI from NRs

Peru has established several tax regimes related to the exploitation of NRs following previous decades of growth in the mining sector.<sup>22</sup> These are: a special levy on mining (Law No. 29790, 2011), a royalty on mining (Law No. 29788, 2011), a special tax on mining (Law No. 29789, 2011), and a canon law (Law No. 28077, 2003). However, only the mining royalty and the canon law directly finance STI activities, namely research at public universities in the regions.

The “canon” is the share of the total income and rent obtained by the state for the exploitation of natural resources that goes to the regional and local governments (Article 1, Law No. 27506 (2001)). The canon is distributed to subnational governments at various levels: 10% to municipalities, 25% to district municipalities and provinces, 40% to local governments and departments of the regions and 25% to regional governments. In 2004, there was a modification of the law, and the revised law (Law No. 28077, 2003) now obliges regional governments to transfer 20 % of their received “canons” to public universities in the region. This fund is to be used for scientific investigations and development of technology to support regional development by public universities. This regional focus has been strong in Peru: in discussions on the allocation of NR funds for STI activities, it was natural to choose a decentralized way to transfer funds, as most of the NRs are located in the regions and regional universities need to enhance their capabilities (Interview, Kuramoto Huamán, 2015).

Mining royalties are the economic remunerations paid to the state for the exploitation of metallic and non-metallic mineral resources. The mining royalty law of 2011 (Law No. 29788, 2011) allocates mining royalties to all NR-producing regions as follows: 5% of the total to public universities, 20% to municipal governments, 20% to provincial governments, 40% to district and

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<sup>22</sup> Peru’s mining sector has grown significantly in recent decades after attracting a vast amount of FDI (close to US\$4 billion in 2009). It is also a leading export industry, almost doubling its contribution to GDP from 2.9% to 5.2% between 1980 – 2000 (World Bank, 2016).

provincial municipal governments, and 15% to regional governments. The amount that goes to the universities should be spent on scientific investigations and investment in technology (EITI, 2014, p. 54) while the rest is to be used for sustainable development in the regions.

## **Background and STI Institutions**

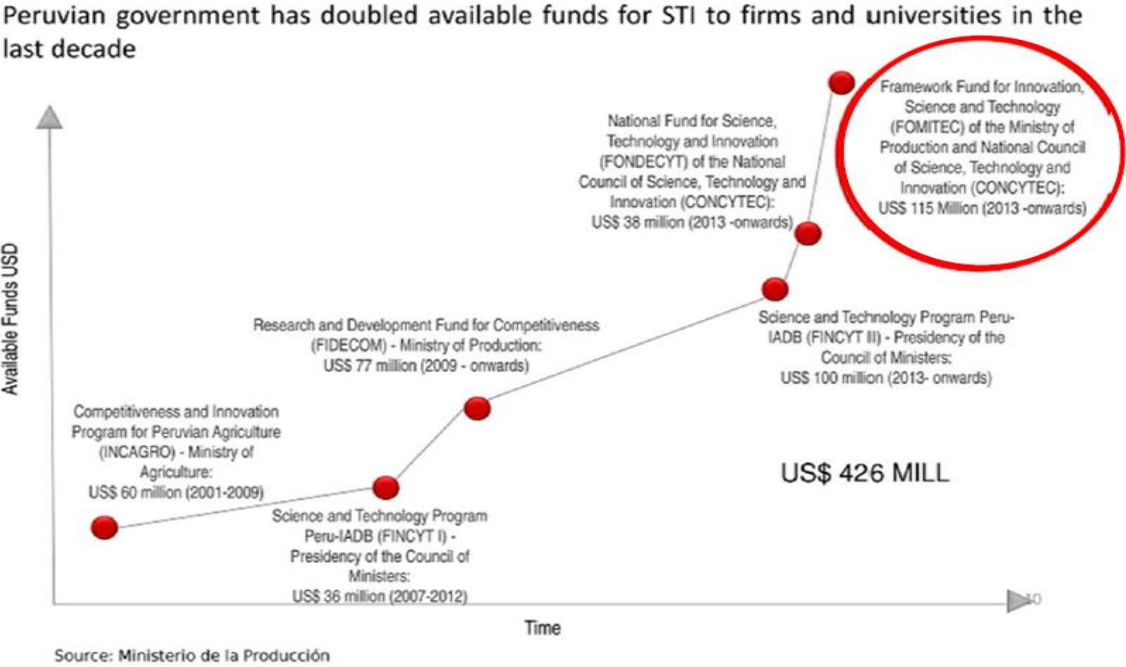
Since the 2000s, enhancing productivity became one of the critical goals for the Peruvian economy. This stems from a realization that the high economic growth and improvement in socio-economic conditions that Peru enjoyed in 2004-2013 did not increase productivity, or promote diversity of economic activities, nor did it reduce income disparity or the rate of informal employment (Ministerio de la Produccion, 2014, 2016).

As the result, since the 2000s, there have been several initiatives to make the economy more productive through the introduction of STI institutions. Measures have included the launch of INGARO (Innovacion y Competitividad para el Agro Peruano, 2001) and the Innovation and Competitiveness of Peru's Agro Sector (Funds from World bank) (2004); the establishment of S&T and Technological Innovation Framework Law (Law No. 28303, 2004); reform of the National Council for Science, Technology and Technological Innovation (CONCYTEC) with STI policy implementation function (2004); and the creation of Technological Innovation Centers (Consortio de Investigacion Economica y Social: CITEs) by Ministry of Production to provide technological services to small and medium-sized enterprises (2004). In 2006, the R&D Fund for Competitiveness (Fondo de Investigacion y Desarrollo para la Competitividad: FIDECOM) was created to promote productive innovation by Ministry of Economy and Finance. This was followed by the establishment of the Financing of Innovation Science and Technology (Financiamiento para la Innovacion, Ciencia y la Tecnologia: FINCYT) in 2007, to promote a wide range of programs, the most important of which were aimed at strengthening the research and innovation capacity of enterprises, universities, public research centers and encourage collaboration between them. The financial mechanism, FONDECYT, was administratively subsumed in CONCYTEC and it was designed to coordinate the other organizations that were executing S&T activities, yet no effective measures have actually been taken (Kuramoto, 2014). Kuramoto (2014) describes Peru's innovation system as weak and extremely underfunded. Furthermore, the policy design was still rather incipient, with various duplications of tasks. This view is well in line with the OECD review on STI, which urged clear division of labor between CONCYTEC, Ministry of Economics and Finance and Ministry of Production (PRODUCE).

In the past few years, institutions involved in STI in Peru have shown some signs of consolidation. The National Program of Innovation for Competitiveness and Productivity (Innovate

Peru) was created by supreme Decree in July 2014 (Supreme Decree No. 003-2014-PRODUCE) to provide an executive arm of the National Plan for Productivity Diversification of PRODUCE. This program has focused on helping firms and supporting entities to increase productivity and competitiveness. There are four financing instruments within the program: two existing ones— FINECYT and FIDECOM—and two new ones—FOMITEC and Fondo MIPYME. Both FINECYT, which formerly belonged to CONCYTEC, and FIDECOM, under Ministry of Economy and Finance, are now under PRODUCE. FINECYT and FIDECOM focus on projects that look at knowledge generation and STI enhancement for firms as well as system-making. The new fund, FOMITEC (Framework Fund for Science, Technology and Innovation), created in 2014, has four areas to finance: dynamic start-ups, centers for excellence developed by CONCYTECH, and two lines of finances for investigations. Fondo MIYPME, created in 2015, aims to increase the productivity of micro-, small- and medium-scale industries. The new funds entail much greater collaboration between CONCYEC and PRODUCE. The diagram below shows how institutions evolved as finances increased.

**Figure 4 Evolution of STI institutions and amount of finances allocated for STI**



In March 2016, a Supreme Decree approved the National Policy for the Development of Science, Technology and Technological Innovation (Supreme Decree No. 015-2016-PCM, 2016). The policy confirms the importance of STI and clearly assigns CONCYTEC the role of coordination body



between ministries (Consejo de Ministerios). The law also assigns the role of monitoring and evaluating national policy to CONCYTEC.

### Static design criteria

There is a clear and well-established purpose to the canon and mining royalties in respect to STI. Indeed, the law clarifies the methods of allocating the finances collected from NRs. Both mining taxes are transferred (directly or indirectly) to regional public universities in accordance with the law, allowing some space for discretion by the central government. Public universities are obliged to use those funds exclusively for scientific investigations and technology in support of regional development.

Once the funds are received by universities, their internal systems are utilized in deciding how to spend the funds, under the limits of the law. To the best of our knowledge, there is no formal space in which the regional public universities can involve the local community or other stakeholders in the allocation decisions of the budget. The *Portal de Transparencia Económica* of the Ministry of Economy and Finances (MEF) discloses information on financial transfers.<sup>23</sup> While information on transfers of resources to the national, regional, and local governments as well as to public universities of the canons and mining royalties is accessible, detailed information on use of the funds is not available.

### Dynamic design criteria

Peru has system of monitoring and evaluation by international NGOs as well as civil society to maintain the transparency of extractive industrial activities and transfers of finances to public universities. Peru is the first Latin American country that is compliant with the Extractive Industries Transparency Initiative (EITI<sup>24</sup>), which is a global standard to promote open and accountable management of NRs (EITI, 2015). In Peru, the National Multi-sectoral Commission (*Comisión Nacional Multisectorial*)<sup>25</sup> is responsible for the implementation of the EITI standard. This commission comprises representatives from the government, extractive industries, and civil society. The work of EITI-Perú is documented on a webpage<sup>26</sup> and their latest publication is the *Cuarto estudio de conciliación nacional* (EITI-Perú, 2013).

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<sup>23</sup> [http://www.mef.gob.pe/index.php?option=com\\_content&view=section&id=37&Itemid=100143&lang=es](http://www.mef.gob.pe/index.php?option=com_content&view=section&id=37&Itemid=100143&lang=es).

<sup>24</sup> Currently Colombia is in negotiation to adapt EITI standards.

<sup>25</sup> See this link for a list of members: [http://eitiperu.minem.gob.pe/quienes\\_somos/index.html](http://eitiperu.minem.gob.pe/quienes_somos/index.html)

<sup>26</sup> <http://eitiperu.minem.gob.pe/index.html>. See “quiénes somos” and “estudios.”

Furthermore, there is *Grupo Propuesta Ciudadana* (GPC),<sup>27</sup> a group that monitors the use of canon resources and *Consortia de Investigación Económica y Social* (CIES),<sup>28</sup> which also supports research on the use of the canon resources by public universities (Garfias Dávila, 2011)(Interview, Kuramoto Huamán, 2015). The above seems to indicate that in Peru, numerous non-governmental organizations are conducting monitoring, evaluation and transparency, thereby complementing the role of government.

As described in the research of Garfias Dávila (2011), Peru suffers from a shortfall in the capacity of universities to administer research (Interviews, Kuramoto Huamán, 2015; Suaznábar, 2015) and there are some difficulties for existing research institutions and human resources in carrying out the kind of research activities intended by the government (Interviews, Kuramoto Huamán 2015 and Suaznábar, 2015).

The use of canons and mining royalties received by the universities is restricted solely to investigations and related activities relevant for the regions in which they are located. However, investment in the development of the capacities needed to conduct high-quality research is restricted to equipment and infrastructure, neglecting the relevance of human capital. This strict rule may be a result of the lack of proper monitoring systems: without such systems in place, the central government has little incentive to extend the eligible expenditures beyond “tangible” investments, to avoid the possibility that funds will be diverted. There were some attempts by the government to give some flexibility by introducing the annual law of the budget (*Ley de Presupuesto*<sup>29</sup>). However, so far, this problem has not been adequately addressed.

While direct allocations from central government to regional public universities may decrease financial costs, it also reduces the capacity to implement targeted policies. Indeed, while CONCYTEC and PRODUCE can design their programs by focusing on specific technologies, sectors (or applied focus), they cannot directly influence the decision-making process within the beneficiaries of the royalties and canon.

Until recently, no clear inter-ministerial coordination role was present at the national level, which created conflicts between public institutions with overlapping responsibilities such as CONCYTEC and PRODUCE. Coordination with the private sector, in the STI general case, and on the spending of income generated by the mining royalty and canons in particular, was also lacking.

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<sup>27</sup> <http://www.propuestaciudadana.org.pe/quienes-somos>: This group is a consortium of NGOs, working jointly to consolidate the Peruvian democratic system, contributing to the elaboration of policy proposals aimed at the reform of the inclusive state and at an adequate management of public resources.

<sup>28</sup> <http://cies.org.pe/>: The CIES is an association of Peruvian institutions, aimed at teaching economic and social sciences. They fund related research and have their own publications, e.g., the “Concurso Anual de Investigación.”

<sup>29</sup> [http://mef.gob.pe/index.php?option=com\\_content&view=article&id=2327&Itemid=101158&lang=es](http://mef.gob.pe/index.php?option=com_content&view=article&id=2327&Itemid=101158&lang=es).

These are now changing as a result of the Supreme Decree on National Policy for Development of the Science, Technology and Technological Innovation (CTI) (Supreme Decree No. 015-2016-PCM, 2016), approved in March 2016. This decree clearly states that the CONCYTEC plays the role of coordinating body as well as the role of monitoring and evaluation. Furthermore, CONCYTEC has started an initiative to promote relationships between universities and the private sector (e.g. alliance for innovation). While the improvement of coordination problem within STI institution is positive news, the institutions fell short in channelling the NR institutions such as canon and mining royalties onto a path of productivity development.

### 3.4 Bolivia

#### Financing STI from NR royalties

In Bolivia, several taxes on proceeds from the exploitation of natural resources have been established over the last 20 years. These are: a mining royalty (Law No. 535, 2014), a hydrocarbons royalty (Law No. 3058, 2005), a special tax on hydrocarbons and its derivate (IEHD) (Law No. 1606, 1994), and a direct tax on hydrocarbons (IDH) (Law No. 3058, 2005).<sup>30</sup> Amongst the above, IDH<sup>31</sup> is only one that transfers financial resources to public universities.

Since 2006, many changes have taken place concerning institutions to manage NRs and STI.<sup>32</sup> First, the hydrocarbon sector was nationalized under Supreme Decree No. 28701. In the same year, a National Development Plan was elaborated (PND, 2006), which referred to the issue of innovation as an important element for development for the first time. This was followed by the establishment of a Vice-Ministry for Science and Technology (*Viceministerio de Ciencia y Tecnología (VCyT)*) to oversee STI policy. A new constitution was adopted by referendum in 2009. This allows the government to exert more influence over the management of the country's natural resources (e.g., *Articles 351, 367, 368*) for use in attaining development goals. This law also provides greater autonomy at the subnational level in use of finances (IMF, 2010) and, in the field of STI policy, stronger emphasis was placed on the importance of science and technology (Constitución, 2009). In addition, the Agenda Patriótica de Bicentenario 2025 (2013), a development proposal by the government, listed science and technology and sovereignty over natural resources as two of the 13 pillars of development. This emphasis on science and technology was reiterated in the national

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<sup>30</sup> Article 2 of Supreme Decree No. 29322 (2007) altered the distribution of the IDH, modifying Article 2 of Supreme Decree No. 28421 (2005).

<sup>31</sup> The tax rate of the IDH is 32 % and is paid on the total production of hydrocarbons measured at the point of audit (fiscalización) (Law No. 3058, 2005, Article 55).

<sup>32</sup> Article 2 states that the entire production of all hydrocarbons has to be given to the state-owned oil and gas company, YPFB.

innovation plan in 2013 (Ministerio de Educación, 2013). While these are mentioned in various policy documents, the integration of these two themes has remained weak. In fact, IDH is the only source of finances from NRs to public universities and the research sector.

In 2007, Article 2 of Supreme Decree No. 29322 (2007) modified the existing law to reallocate the IDH proceeds to the following three destinations: first, the municipalities of the department distribute funds based on the number of inhabitants, 66,9%; second, public universities of the department (if there are two or more public universities in the department, distribution is agreed upon between Ministry of Finance, Ministry of Education and CEUB (Executive Committee of the Bolivian Universities, Comité Ejecutivo De La Universidad Boliviana, and the benefiting universities), 8.62%; and third, the prefecture of the department receives the remaining amount (Supreme Decree no. 29322, 2007). The reason for the high proportion of IDH going to the regions reflects the government's commitment to use NRs to address regional development disparities and finance social programs (IMF, 2010).

The amount distributed to public universities enables them to obtain additional funding for research (Céspedes Quiroga, 2015). Table 1 shows the amount of IDH allocated to each public university and the type of expenditures that public universities have made. This table captures several noteworthy trends. First, most universities have spent more than half of the received amount on infrastructure. Second, all the universities apart from two did not use a large proportion of funds allocated. Third, out of the entire budget, very little (less than 1%) was actually spent on research on STI. It needs to be mentioned that since 2007 to 2013, the amount of IDH increased by 3 times. In another words, it is possible that the development of the capacity necessary to use funds for research purposes was unable to keep up with the rapid increase in funds going into public universities.

**Table 3: Bolivia: spending of IDH income by public universities (2013) (in millions of bolivianos)**

Entity	Transfer TGN*	Infrastructure & Academic Equipment	Processes of Evaluation & Accreditation	Programs for the Improvement of Quality & Academic Performance	Research on STI in the Framework of Development Programs	Programs of Social Interaction for the Poor	Total Amount spent	Spending of resources in %
UMSFX	83,53	26,15	0,02	5,71	0,00	8,33	<b>40,22</b>	48,15%
UMSA	130,53	2,50	0,00	38,96	0,76	0,41	<b>42,63</b>	32,66%
UPEA	54,89	26,85	0,00	0,03	0,06	0,00	<b>26,94</b>	49,07%
UMSS	136,03	12,07	1,01	4,96	1,77	0,52	<b>20,32</b>	14,94%

UTO	83,53	55,02	0,03	11,03	0,30	0,10	<b>66,48</b>	79,59%
UATF	30,90	14,93	1,77	5,28	0,02	0,44	<b>22,43</b>	72,59%
UNSXX	52,62	29,41	0,00	0,00	0,00	0,00	<b>29,41</b>	55,90%
UAJMS	110,59	98,31	1,26	19,34	0,05	0,00	<b>118,96</b>	107,57%
UAGRM	189,84	186,43	0,69	37,52	0,90	0,19	<b>225,73</b>	118,90%
UTB	83,53	58,69	0,21	0,00	2,37	0,00	<b>61,26</b>	73,35%
UAP	83,53	6,39	33,02	27,45	0,10	0,01	<b>66,97</b>	80,18%
<b>TOTAL</b>	<b>1.039,52</b>	<b>516,75</b>	<b>38,01</b>	<b>150,29</b>	<b>6,31</b>	<b>10,01</b>	<b>721,36</b>	<b>69,39%</b>

Source: Ministerio de Economía y Finanzas Públicas (n.d.). Note: \*TGN, National General Treasury

Note: UMSFX: Universidad San Francisco Xavier, UMSA: Universidad Mayor de San Andrés, UPEA: Universidad Pública de El Alto, UMSS: Universidad Mayor de San Simón; UTO: Universidad Técnica de Oruro; UATF: Universidad Autónoma Tomas Frías; UNSXX: Universidad Nacional Siglo XX; UAJMS: Universidad Autónoma Juan Misael Saracho; UAGRM: Universidad Autónoma Gabriel René Moreno; UTB: Universidad Tecnológica Boliviana; UAP: Universidad Amazónica de Pando.

## Background and STI Institutions

Until 2006, STI institutions in Bolivia developed along their own evolutionary pathways. The first Bolivian STI institutions with systemic sense were started in about 1991. The Law (DSNo 22908) established the following institutions: National System of Science and Technology (SINACyT), National Council of Science and Technology (CONACyT) and Regional Councils of Science and Technology (CODECyT). CONACyT aims to establish policy guidelines and strategies to advance in the areas of science, technology and innovation. CONACyT was headed by the Vice President of Bolivia and represented by ministries, academia and private enterprise. In 1994, initiatives were taken to improve the system of S&T with more concrete measures, such as a short term plan (1996-1997); however, this was not being implemented due to lack of resources (Bortagaray and Gras, 2013)

In the 2000s, a series of initiatives were taken to strengthen STI policy in the public sector. For instance, in 2000, the Ministry of Agriculture took the initiative to create the Bolivian Agricultural Technology System (SIBTA) to promote technology diffusion in the agricultural sector. In 2001, the Law to Promote Science, Technology and Innovation (Law No 2209) was enacted to ratify the functions of CONACyT and CODECyT. Following ratification, in 2004, the National Plan of Science Technology and Innovation (2004 – 2009) was published. In 2006, the National Plan for Development 2006 – 2011 clearly showed the government’s intention to integrate STI into the development process.<sup>33</sup> In the same year, Vice-Ministry of Science and Technology (VCyT) was

<sup>33</sup> For example, the National Plan of STI (2004-2009) points out that, “science and technology are fundamental instruments and tools for changing the primary export production pattern through the emergence of transformation processes of Bolivia’s natural resources and the introduction of new products into the market.” In (Supreme Decree NO. 29272, 2007)

created to take charge of STI and higher education under the Ministry of Planning and Development. The VCyT was later moved under the Ministry of Education but remained in charge of STI development.

Despite STI institutions existing for some time, institutional functions in terms of design, implementation, coordination and execution are still at incipient stages in Bolivia. While some plans were made after 2006; the function of existing STI institutions is still weak.<sup>34</sup> Although there is a clear intention to enhance productivity via enhancement of STI capability and use of NRs for the developmental process, the two are not sufficiently linked for implementation to take off. This is even more noticeable in the case of the innovation side of STI policies. The policy discussion has been oriented towards the role of science, rather than innovation. Indeed, there is no formal organization in charge of designing and implementing programs that support STI activities in the private sector. Despite the declared focus on science, IDH funds are the only financial mechanism that flows into the budget of public universities but not to the rest of STI institutions. While the basic policy intentions are present to support STI activities, due to the existing capacity gap both in government as well as in universities, funds are not effectively being used to strengthen STI capacity in the university system.

### **Static design criteria**

Legal frameworks specify the allocations clearly, and use of funds is restricted to research. In Bolivia, 8.62 percent of the tax income received from IDH is currently allocated to public universities. Furthermore, public universities in Bolivia are autonomous and therefore possess considerable discretion on how to spend this income. However, a small conflict has arisen with the Ministry of Economy and Finances, regarding the institutional design required to audit the use of finances (IMF, 2010). Due to this administrative conflict, a greater proportion of finances for research is currently being spent on physical infrastructure for research (see Table 3) rather than research itself (Interview, Céspedes Quiroga, 2015).

The Ministry of Hydrocarbons and Energy publishes data on total income based on hydrocarbons and on the distribution of IDH among the provinces while the Ministry of the Economy publishes data on the allocation of resources by public universities based on income derived from the IDH (see Figure 5). The availability of this data should facilitate transparency in the flow of finances.

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<sup>34</sup> However, there is currently a proposal for a new law creating an innovation agency (Interview, Céspedes Quiroga, 2015).

### **Dynamic implementation criteria**

It was reported that, although the IDH revenue allocation is clearly set and transparent, with the Ministry of the Economy and Finance publishing information in revenue sharing with subnational governments, subnational allocations are often underestimated and communicated late in the budget process (IMF, 2010). There are no clear institutions monitoring the use of allocated funds to universities from IDH revenue to create a feedback loop for policy learning. Moreover, universities are still engaged in a learning process – many have very little experience with competitive funds for research and there are too few researchers who can apply for funding (Céspedes Quiroga, 2015). The political power of VCyT, the STI coordination agency, is limited to coordination of public universities to create synergies. This is may be due to the lack of political legitimacy.

## **4. Discussion and conclusions**

The previous section examined the existing institutions in LA countries that have been created to link NRs to finance STI activities to enhance productivity. The institutions were reviewed with reference to design principles (Table 1) that consisted of four static criteria (clear statement of establishment, rule-based design, multiple stakeholder governance, and system to ensure transparency) and three dynamic criteria (monitoring and evaluation, institutional and managerial capacity, policy coordination/policy mix).

All of the institutions examined were established in and after the 2000s. In this period, overall policy discussion in LA has been focused on the relevance of the knowledge economy and the importance of the role of policy in ‘fixing market failures’, more at the micro-level than in the 80s and 90s. It is important to keep in mind that in the backdrop to all this, there was commodity boom taking place which increased revenues from the production and exports of NRs. The significant increase in inflow of income created easier ground for the reform of existing institutions.

All the countries reviewed in this paper have established the institutions necessary to utilize NRs for the support of STI activities. All of these institutions are equipped with static criteria. These are: 1) a clear policy statement linking NR to STI activities for sustainable development or enhancing productivity; 2) a rule-based design to limit the scope for discretion; 3) multiple stakeholder governance; and 4) disclosure of information on money flow to ensure transparency.

At the level of implementation, there are variations in the degree of clarity in policy statements linking NR to STI activities among the countries we examined. For Chile and Colombia, NRs financing STI activities are clearly stated in the policy documents because this provides the basis on which the innovation funds were established (FIC in Chile and FCTel in Colombia). The

situation, however, is different in Peru and Bolivia. In both countries, several political statements hint at the importance of STI and use of NRs for developmental purposes; however, the two views are insufficiently explicated to create integrated institutions. In fact, until recently, many of the STI institutions created in Peru in the 2000s lacked adequate coordination. For instance, efforts to reform the canon were made as early as 2004, with the impetus towards strengthening regional universities; however, universities were left rather isolated from other public institutions working on STI. The situation appears to be similar in Bolivia. Since 2006, numerous official statements and laws were published stating that NRs should be used for national development and STI has an important role to play in such a process. Nevertheless, the link between these two, from a policy implementation perspective, was rather weak, except for the financial allocation of IDH to public universities—yet even this was focused on regional development.

With regards to the allocation of NRs income to STI activities, all the countries have a clear institutional design supported by legal instruments to specifically define the operation, such as how much or what proportion of NR income is assigned to STI activities. In case these resources are being used to establish competitive innovation funds, the selection process of projects and those involved in selection process are well defined by law. For instance, in Chile and Colombia, multiple public entities (CMI in Chile and OCAD in Colombia) are involved in the selection of projects to be financed. On the other hand, in Peru and Bolivia, finances are transferred to public universities that have an autonomous right to decide how these funds should be used, with the caveat that the law obliges them to use the funds only for research purposes. In all of the above cases, details for design are documented and the flow of finances is kept transparent through disclosure of the information on financial flows on publicly accessible websites.

While the static design principle works to ensure transparency and avoid the possibility of corruption, excessive control by law sometimes hampers the efficient use of funds. One example is the restriction on use of funding solely for research in public universities in Peru and Bolivia. Due to the shortfall of capacities in administration and research by universities and the sudden increase in inflow of finances, universities are not capable of using these funds effectively. At the same time, there are no embedded monitoring and evaluation mechanisms. Hence, the bulk of funds are currently used for investment in research infrastructure (e.g. purchase of ICT equipment and improving research facilities) instead of increasing managerial and research capabilities, conducting research or creating future researchers.

In contrast to static design criteria, dynamic design criteria try to examine institutional abilities to implement policies and improve effectiveness in meeting policy goals. These are as



follows: whether 1) institutions have adequate mechanisms to monitor and evaluate the program to improve the existing institutions, 2) institutions have capacities to manage funds for the intended purposes, and 3) NRs are being effectively integrated as part of STI policy with a coordinating function to ensure that stakeholders from both public and private sectors can interact.

The examination of cases here shows that mechanisms for monitoring and evaluation are present in the design in all countries except for Bolivia. However, weaknesses in institutional arrangements and lack of institutional capacities can result in the absence of evaluation and feedback loops to improve the performance of institutions. For instance, in Chile, CNID were assigned to evaluate the program after four years, but following the changes in the political cycle, that role has been somehow neglected. In Colombia, it is said that DNP will conduct an evaluation on investment projects on a selective basis. DNP is a separate entity from Colciencias, the coordinating agency for STI policy at national level. It is not clear how experiences are being shared between these two agencies. Peru has the unique presence of third-party evaluation and monitoring entities, with non-governmental organizations, *Grupo propuesta ciudadana* (PGC), which monitors the use of canon resources, and the Socio-Economic Research Consortium (*Consortio de Investigacion Economica y Social*: CIES), which supports research on use of the canon. Although this would allow some form of surveillance on the use of resources, it is not clear whether these can provide an effective feedback loop to improve the capacity of institutions. The monitoring and evaluation system of Bolivia for resource transfers to public universities, apart from auditing by the Ministry of Economy, is not very clear. It is also noteworthy that all countries except for Bolivia had an OECD innovation policy evaluation, and as a result, had changed their institutions regarding STI.

In addition to the above, the country cases demonstrated great variations in the level of institutional capacity to manage and use the funds for their intended purposes. All the countries studied were in the process of decentralization and enhancement of regional capacities. Hence it was natural that some of these funds were designated to regional administrations. Amongst all the countries studied, Colombia is the most advanced in terms of the decentralization process, while Chile remained highly centralized. This is reflected in the governance on the use of funds. In Chile, it was reported that the central government through Ministry of Economy, which is in charge of disbursement, could still exert power over the choice of projects against regional governments, while at the same time, regional governments often suffer from a limited capacity to articulate regional needs and to negotiate effectively (OECD, 2013). Colombia also had some disparities in its capacity to manage and administer projects in the regions during the early phase of implementation

of OCAD, particularly in terms of the bottom up selection process of innovation projects. This led Colciencias to provide manuals and create the Regional Strategic Plan for Science, Technology and Innovation (PEDCTI) as well as the Committee for Science Technology and Innovation (CODECTI) to encourage more projects to be submitted to OCAD. While this improved the situation, the recent share of funds by region still shows regional variations, which may be due to the persistent presence of regional capacity differences. Both Peru and Bolivia allocated a high proportion of mining tax to the regions to compensate for mining activities in the regions. Strengthening regional public universities by using the mining tax is considered part of the solution to reduce regional gaps. When use of funds in regional universities is observed (see Table 3), it shows that universities are unable to administer the budgets due to lack of capacity and restrictions on investing.

A third point to examine is the degree of integration between the two: NRs and STI activities. Both Chile and Colombia have better integration of NRs and STI activities than Peru and Bolivia owing to the static institutional design mentioned previously. Both Chile and Colombia have clear policy statements followed by the creation of funds to finance innovation that links the two activities. Nevertheless, when the dynamic aspects of institutions are examined, the degree of successful integration is influenced by the governance power of the coordination function usually assigned to one of the organizations (i.e. CNID and CMI in Chile, Colciencias in Colombia, CONCYTEC in Peru and VCyT in Bolivia). This function may be influenced by the governance power of coordinating organizations and determined by its administrative and technical capacity, financial capacity and political status.

While strong leadership of a coordinating body may be considered ideal in putting forward the STI policy agenda in political arenas, the cases examined demonstrated otherwise. This may be due to the particular nature of NRs management institutionality which entail mechanism to avoid corruption and regulatory capture. None of the coordination bodies has leadership status that enables them to strongly negotiate with other stakeholders. For instance, coordination agencies on STI activities in Chile and Bolivia (CNID in Chile and VCyT in Bolivia) have been established by Presidential/Supreme decree and not by law. This means that their role are strongly influenced by the political cycle, something that can be quite harmful for continuity of policy initiatives.

## **5. Challenges and policy implications**

Several countries in Latin America have taken up the interesting challenge of actively using NRs to improve the productivity of the economy and break away from the 'resource curse'. Numerous types of institutions were built in the 2000s as we have examined. These experiences offer

interesting insights for other resource-rich countries around the world. This paper examined a range of such institutions using the institutional design principle as the criteria for comparison. The criteria were explained in Table 1 and a comparative discussion were made in the previous sections based on each country's case.

Based on above discussion, the following points provide some generic policy suggestions for designing institutions that can promote the transformation from an NR-based economy to a knowledge-based economy:

(1) The building of capacity in public institutions to administer, manage STI activities is necessary. This is particularly needed in the regions, where qualified human resources may be scarce. Capacity building is often the focus of fund recipients or project executors, including firms and researchers. Though these remain important, close examination of cases suggests that building the administrative and managerial capacity of public institutions is important in implementing policies effectively. While this is nothing new, provision for training of public staff is often not mentioned in main policy documents or in the objectives of the NR-based funds. Furthermore, strengthening the monitoring and evaluation process of projects/programs is important not only in ensuring project effectiveness but also in building effective feedback loops. It can also to provide important learning opportunities at the institutional level.

The above point is similar to what Collier (2010) mentioned in relation to 'investing in investing'. Collier discussed this term as applicable in contexts where the capacity for initial operations is low, referring to the provision of basic infrastructure and human resources. Here, we argue that 'investing in investing' in this way is critical, even at more advanced stages of institutional development, for more ambitious and effective management of NRs.

(2) The rigid rule-based design can be beneficial in preventing corruption; however, some scope for adjustment should be provided in the design, especially regarding the use of finances, for the initial phase of policy implementation. Getting the right balance on rigidity or flexibility of rule-based design is difficult. A cautious approach is understandable, especially regarding the use of finances. At the same time, the design of policies should be adjustable to the existing level of institutional and human capacity in order to meet the intended goals. If the capacity level of the executors is underdeveloped, alternative measures should be considered: for instance, measures such as the gradual introduction of certain rules can be provided in conjunction with the provision of training opportunities.

(3) Ensuring the capacity of the coordination agency: does it require some kind of leverage—either political or/and financial—to negotiate with other stakeholders to advance policy dialogue?

In the cases examined, the coordination agencies had limited power over financial and political resources due to their institutional design. This can make it difficult for coordination agencies to negotiate and align different stakeholders with distinctive interests. For instance, Chile's CNID and Bolivia's VCyT had limited political and financial power. Colciencias had better political status due to its position at the ministerial level but it still had no access or governance power over financial resources in FCTel. The limited power of a coordination agency may hamper the very existence of institutions that finance STI with NRs. Nevertheless, it is fully accepted that shared responsibility and governance is important in a long term policy-making process.

(4) Participation of multiple stakeholders in decision making is positive as long as it does not slow down the overall policy process. Establishing a consensus in a participatory manner is useful; however, if strict requirements requiring the presence of every appointed member are exercised for all the decisions that need to be taken, then the policy process may become very slow.

In the cases examined here, the participation of the private sector was rather limited. This was particularly evident in the limited role it had in the selection, evaluation and monitoring process of projects. While it is important to prevent the public sector being captured by a certain private sector, it is also necessary to design mechanisms that will allow the private sector to participate in the decision-making process in a transparent and accountable way. The views of the private sector can be particularly useful for terminating potentially unsuccessful projects or public policy because the public sector is less inclined to stop programs that do not show promise, while the private sector is more conscious of cost.

(5) Creating mechanisms to maintain policy continuity and insulate them from political cycles.

Investing in knowledge requires time to bear fruit. Continuity of policy is, hence, important in creating long-term productive change. The policy process should not be disrupted unnecessarily by political cycles. However, best practice to provide protection against the time inconsistency of governments will depend on local conditions. This could go from hard mechanisms, such as those that provide a strong legal basis for institutions (by law), to soft ones, such as deeply involving the

private sector in policies that can advocate for maintaining good (perceived) STI policies through different political cycles.

#### Further considerations

This paper examined unique cases in LA where similar yet different institutional set ups appear to link NR finances in promoting structural transformation through enhancing productivity via STI activities. The cases are of relevance to other resource-rich countries; however, when applicability of generic findings are considered, the following issues need to be considered. First, a favorable political climate was present at the time of introduction of STI-NR institutionalization in all the cases in LA. Second, the commodity boom, by providing increasing inflows of money, made it easier to introduce changes in institutions that involved resource allocation in these countries. Third, having a successful model in neighboring countries (in LA this is Chile) may have created a demonstration effect. Finally, the presence of international financial facilities to support such initiatives (in this case, it was the IADB's finance) may have encouraged these countries to take initiatives.

#### References

- Acemoglu, D., & Robinson, J. A. (2012). *Why Nations Fail: The Origins of Power, Prosperity and Poverty*. 1st ed. New York: Crown.
- Acevedo Peña, C. G., Hernán Céspedes Quiroga, W. M., & Zambrana Montán, J. Eduardo. (2015). Bolivian Innovation Policies: Building an Inclusive Innovation System. *Journal of Entrepreneurship and Innovation Management*, 4(1), 63-82.
- Agenda Patriótica 2025. (2013). Agenda Patriótica 2025. Retrieved from <http://faolex.fao.org/docs/pdf/bol141864.pdf>
- Andersen, A. D., Johnson, B. H., Marín, A., Kaplan, D., Stubrin, L., Lundvall, B.-Å., & Kaplinsky, R. (2015). Natural Resources, Innovation, and Development. Aalborg Universitetsforlag. 10.5278/VBN/MISC/NRID.
- Aninat, C., Benavente, J. M., Briones, I., Eyzaguirre, N., Navia, P., & Olivari, J. (2010). The Political Economy of Productivity: The Case of Chile. IDB Working Paper Series No. 105. Retrieved from <http://ideas.repec.org/p/idb/wpaper/4662.html>
- Araya Pacheco, C. (2015). Interview on Chile. Interview conducted via skype on the 13th of March, 2015.
- Arezki, R., Gylfason, T., & Sy, A. (2012). *Beyond the Curse: Policies to Harness the Power of Natural Resources*. Washington DC: IMF.
- Auty, R. M. (1990). *Resource-based Industrialization: Sowing the Oil in Eight Developing Countries*. Oxford: Oxford University Press.
- Auty, R. M. (1993). *Sustaining Development in Mineral Economies: The Resource Curse Thesis*. London: Routledge.
- Bortagaray, I., & Gras, N. (2014). Science, Technology and Innovation Policies for Development. The

- Latin American Experience. In G. Crespi & G. Dutrénit (Eds.), *Science, Technology and Innovation Policies for Development. The Latin American Experience*, 255-285. Switzerland: Springer International Publishing. <http://doi.org/10.1007/978-3-319-04108-7>
- Brunnschweiler, C. N. (2008). Cursing the Blessings? Natural Resource Abundance, Institutions, and Economic Growth. *World Development*, 36(3), 399–419.
- CEPAL. (2010). *Panorama de la inserción internacional de América Latina y el Caribe (2009-2010)*. Publicación de las Naciones Unidas. Retrieved from [http://repositorio.cepal.org/bitstream/handle/11362/1174/S1000783\\_es.pdf](http://repositorio.cepal.org/bitstream/handle/11362/1174/S1000783_es.pdf)
- Céspedes Quiroga, M. (2015). Interview on Bolivia. Interview conducted via skype on the 12th of August, 2015.
- Cimoli, M., Dosi, G., & Stiglitz, J. (2010). *Industrial Policy and Development: The Political Economy of Capabilities Accumulation*. Oxford: Oxford University Press.
- Colciencias. (2014). Regalías para la Ciencia, Tecnología e Innovación. Bogotá, DC, Febrero de 2014. Retrieved from [http://www.colciencias.gov.co/sites/default/files/ckeditor\\_files/files/Generalidades FCTeI - SGR\\_Feb20'14 .pdf](http://www.colciencias.gov.co/sites/default/files/ckeditor_files/files/Generalidades_FCTeI_SGR_Feb20'14.pdf)
- Colciencias. (2015). Cociente de Giro del FCTeI-SGR para el Bienio 2015-2016. Retrieved from [http://www.colciencias.gov.co/sites/default/files/ckeditor\\_files/files/Cociente de Giro de FCTeI-SGR para el bienio 2015-2016 oct 6\\_2015.pdf](http://www.colciencias.gov.co/sites/default/files/ckeditor_files/files/Cociente de Giro de FCTeI-SGR para el bienio 2015-2016 oct 6_2015.pdf)
- Collier, P. (2010). *The Plundered Planet. Why We Must - and How We Can - Manage Nature for Global Prosperity*. Oxford: Oxford University Press.
- Collier, P., & Laroche, C. (2015). Harnessing Natural Resources for Inclusive Growth. International Growth Centre. IGC Growth Brief Series 001. London.
- Collier, P., & Venables, A. (2011). *Plundered Nations?: Successes and Failures in Natural Resource Extraction*. Houndmills, Basingstoke: Palgrave Macmillan.
- CONPES. Política nacional de ciencia, tecnología e innovación. CONPES 3582 (2009).
- Corden, M., & Neary, P. (1982). Booming Sector and De-Industrialisation in a Small Open Economy. *The Economic Journal*, 92(368), 825–848.
- Crespi, G., & Dutrénit, G. (2014). *Science, Technology and Innovation Policies for Development: The Latin American Experience*. Springer: Cham, Heidelberg, New York, Dordrecht and London.
- Crespi, G., Fernández-Arias, E., & Stein, E. (2014). *Rethinking Productive Development: Sound Policies and Institutions for Economic Transformation*. New York: Palgrave Macmillan.
- Cuddington, J. T. (1992). Long-Run Trends in 26 Primary Commodity Prices: A Disaggregated Look at the Prebisch-Singer Hypothesis. *Journal of Development Economics*, 39(2), 200–227.
- Cuervo, C. J., & López Fonseca, L. (2013). Regalías para la ciencia, la Tecnología y la Innovación; el Caso Colombiano. In *Observando el Sistema Colombiano de Ciencia, Tecnología e Innovación: sus Actores y sus Productos* (pp. 369–407). Bogotá, Colombia.
- Dantas, E., Marin, A., Figueredo, P. N., & Brazo-Ortega, C. (2013). The Emerging Opportunities for Innovation in Natural Resource-based Industries in Latin America: Only Potential or Being Realised? Technological Learning and Industrial Innovation Working Paper Series. Policy Brief January 2013. Retrieved from <http://bibliotecadigital.fgv.br/ojs/index.php/tlii-wps/article/view/7354>
- David, A. P., & Wright, G. (1997). Increasing Returns and the Genesis of American Resource

- Abundance. *Industrial and Corporate Change*, 6(2), 203–245.  
<http://doi.org/10.1093/icc/6.2.203>
- Davis, J. M., Ossowski, R., & Fedelino, A. (2003). *Fiscal Policy Formulation and Implementation in Oil-Producing Countries*. Washington, DC: International Monetary Fund.
- Decree No. 1075. (2012). Por el cual se Reglamenta la Organización y Funcionamiento de los Órganos Colegiados de Administración. May 22, 2016.
- Decree No. 1949. (2012). Po el cual se Reglamenta Parcialmente la Ley 1530 de 2012 en Materia Presupuestal y se Dictan otras Disposiciones. Departamento de Planeación. September 19, 2012.
- Decree No. 414. (2012). Por el cual se Reglamenta el Sistema de Monitoreo, Seguimiento, Control y Evaluación - SMSCE - del Sistema General de Regalías - SGR - y se dictan otras disposiciones. Departamento de Planeación. March 12, 2013. Retrieved from [http://wsp.presidencia.gov.co/Normativa/Decretos/2013/Documents/MARZO/12/DECRETO\\_414\\_DEL\\_12\\_DE\\_MARZO\\_DE\\_2013.pdf](http://wsp.presidencia.gov.co/Normativa/Decretos/2013/Documents/MARZO/12/DECRETO_414_DEL_12_DE_MARZO_DE_2013.pdf)
- DNP. (2011). *Plan Nacional de Desarrollo 2010--2014*.
- Ebert, L., & La Menza, T. (2015). Chile, Copper and Resource Revenue: A Holistic Approach to Assessing Commodity Dependence. *Resources Policy*, 43, 101–111.
- EITI. (2014). Estudio de Conciliación Nacional. Transparencia 2011-2012.
- EITI. (2015). *The EITI Standard*. (S. Bartlett & D. Rogan, Eds.). Oslo, Norway.
- EITI-Perú. (2013). Cuarto Estudio de Conciliación Nacional. Retrieved from <http://eitiperu.minem.gob.pe/documentos/4toEstudioEITIPeru2013.pdf>
- Ellsworth, P. T. (1956). The Terms of Trade between Primary Producing and Industrial Countries. *International Economic Affairs*, 10(1), 55–56.
- Eyzaguirre, N., Marcel, M., Rodríguez, J., & Tokman, M. (2005). Hacia la economía del conocimiento: el camino para crecer con equidad en el largo plazo. *Estudios Públicos*, 97. Retrieved from [http://bligoo.com/media/users/3/182374/files/18813/hacia\\_la\\_economia\\_de\\_conocimiento\\_eyzaguirre\\_cep\\_2005.pdf](http://bligoo.com/media/users/3/182374/files/18813/hacia_la_economia_de_conocimiento_eyzaguirre_cep_2005.pdf)
- Ferranti, D., Perry, G. E., Lederman, D., & Maloney, W. F. (2002). *From Natural Resources to the Knowledge Economy. Trade and Job Quality* (Vol. 10). Washington DC: World Bank.
- García, P., Knights, P. F., & Tilton, J. E. (2001). Labor Productivity and Comparative Advantage in Mining: *Resources Policy*, 27(2), 97–105.
- Garfías Dávila, M. (2011). La Investigación en la Universidad Pública Regional y los Fondos del Canon 2004 - 2008. IEP Instituto de Estudios Peruanos. Documento de trabajo, 165. Serie Educación, 3. Retrieved from <http://www.archivo.iep.pe/textos/DDT/ddt47.pdf>
- Gelb, A. (2012). Economic Diversification in Resource-Rich Countries. In R. Arezki, T. Gylfason, & A. Sy (Eds.), *Beyond the Curse: Policies to Harness the Power of Natural Resources*, 55-80. Washington DC: IMF.
- Government of Bolivia. (2009). *Constitución Política del Estado Plurinacional de Bolivia*.
- Gylfason, T. (2012). Natural Resource Endowment: A Mixed Blessing? In R. Arezki, T. Gylfason, & A. Sy (Eds.), *Beyond the Curse: Policies to Harness the Power of Natural Resources*, 7-34. Washington DC: IMF.
- Hamilton, K., & Ley, E. (2012). Sustainable Fiscal Policy for Mineral-Based Economies. In R. Arezki, T. Gylfason, & A. Sy (Eds.), *Beyond the Curse: Policies to Harness the Power of Natural Resources*,

- 131-148. Washington DC: IMF.
- Hirschman, A. O. (1958). *The Strategy of Economic Development*. New Haven CT: Yale University Press.
- Hjort, J. (2006). Citizen funds and Dutch Disease in developing countries. *Resources Policy*, 31(3), 183–191. <http://doi.org/10.1016/j.resourpol.2007.01.001>
- Humphreys, M., Sachs, J. D., & Stiglitz, J. E. (2007). *Escaping the Resource Curse*. Columbia University Press, New York.
- Humphreys, M., & Sandbu, M. (2007). The Political Economy of Natural Resource Funds. In M. Humphreys, J. D. Sachs, & J. E. Stiglitz (Eds.), *Escaping the Resource Curse*. Columbia University Press, New York 194-234.
- Iizuka, M., & Soete, L. (2013). Catching up in the 21st Century: Globalisation, Knowledge and Capabilities in Latin America, A case for Natural Resource Based Activities. In G. Dutrenit, K. Lee, R. Nelson, L. Soete, & A. Vera-Cruz (Eds.), *Learning, Capability Building and Innovation for Development*. Palgrave Macmillan.
- IMF (2010) Bolivia: Selected Issues, Washington DC: IMF.
- Kaplan, D. (2012). South African Mining Equipment and Specialist Services: Technological Capacity, Export Performance and Policy. *Resources Policy*, 37(4), 425–433. <http://doi.org/10.1016/j.resourpol.2012.06.001>
- Korinek, J. (2015). UNCTAD Global Commodities Forum April 13-14, 2015. Geneva: OECD.
- Kuramoto Huamán, J. (2015). Interview on Peru. Interview conducted via skype on the 5th of August, 2015.
- Kuramoto, J (2014) Inclusive Innovation Against All Odds: The Case of Peru. In G. Crespi and G. Dutrenit (Eds.) *Science, Technology and Innovation Policies for Development: The Latin American Experience*, 109-130. Springer: Cham, Heidelberg, New York, Dordrecht and London.
- Government of Colombia. (2011). Law No. 05. Acto Legislativo 05 de 2011. Por el cual se Constituye el Sistema General de Regalías, se Modifican los Artículos 360 y 361 de la Constitución Política y se Dictan otras Disposiciones Sobre el Régimen de Regalías y Compensaciones. Congreso de Colombia. July 18, 2011. Retrieved from <https://www.dnp.gov.co/LinkClick.aspx?fileticket=mXt-R20LpjA=&tabid=1238> \n <https://www.dnp.gov.co/LinkClick.aspx?fileticket=tYD8BLf-2-g=&tabid=1238>
- Law No. 1286. (2009). Por la cual se Modifica la Ley 29 de 1990, se Transforma a Colciencias en Departamento Administrativo, se Fortalece el Sistema Nacional de Ciencia, Tecnología e Innovación en Colombia y se dictan otras disposiciones. Congreso de Colombia. January 23, 2009.
- Law No. 141. (1994). Por la cual se crean el Fondo Nacional de Regalías, la Comisión Nacional de Regalías, se Regula el Derecho del Estado a Percibir Regalías por la Explotación de Recursos Naturales no Renovables, se Establecen las Reglas para su Liquidación y Distribución y. Congreso de Colombia. June 28, 1994. Retrieved from [https://www.sgr.gov.co/LinkClick.aspx?fileticket=Kjx2ci3ML\\_4=&tabid=103](https://www.sgr.gov.co/LinkClick.aspx?fileticket=Kjx2ci3ML_4=&tabid=103)
- Law No. 1606. (1994). LEY N° 1606. Congreso Nacional de Bolivia. December 22, 1994. Retrieved from [http://www.congi.org/docs/LEYES\\_NACIONALES/LEY\\_DE\\_IMPUESTO\\_AL\\_VALOR\\_AGREGADO \(IVA\).Nº1606.1994.pdf](http://www.congi.org/docs/LEYES_NACIONALES/LEY_DE_IMPUESTO_AL_VALOR_AGREGADO_IVA.Nº1606.1994.pdf)



- Law No. 20097. (2006). Introduce Modificaciones al Artículo 2 de la Ley N° 20026. Congreso Nacional de Chile. April 8, 2006.
- Law No. 27506. (2001). Ley de Canon. Congreso de la República Perú. July 10, 2001. Retrieved from <http://epdoc2.elperuano.com.pe/epdoc.nl8/SGPDownloadFile.aspx?FileName=0971041101020900880860810551100990560490571220770860811011100690471180730751080751211201061210481210510901000571160890660490551060541171120991000841121011030650650860990840790801051010>
- Law No. 28077. (2003). Ley que Modifica Diversos Artículos de la Ley N° 27506, Ley de Canon. Congreso de la República Perú. September 26, 2003. Retrieved from <http://www4.congreso.gob.pe/historico/cip/temas/descentralizacion/pdf/09A05.pdf>
- Law No. 28303. (2004). Ley Marco de Ciencia, Tecnología e Innovación. Congreso de Colombia. July 27, 2004. Retrieved from <http://epdoc2.elperuano.com.pe/epdoc.nl8/SGPDownloadFile.aspx?FileName=0971041101020900880860810551100990560490571220770860811011100690561051221171140560551080771071040481080690821130650561100720540981220721220571201071011100660480670780850521201080810781>
- Law No. 29788. (2011). Ley de Regalía Minera. Congreso de la República Perú. September 28, 2011. Retrieved from <http://www.elperuano.com.pe/PublicacionNLB/normaslegales/wfrmNormasLista.aspx>
- Law No. 29789. (2011). Ley que crea el Impuesto Especial a la Minería. Congreso de la República Perú. September 28, 2011. Retrieved from [http://insc.s3.amazonaws.com/mineria/LEY\\_29789\\_-\\_IEM.pdf](http://insc.s3.amazonaws.com/mineria/LEY_29789_-_IEM.pdf)
- Law No. 29790. (2011). Ley que Establece el Marco legal del Gravamen Especial a la Minería. Congreso de la República Perú. September 28, 2011. Retrieved from <http://www4.congreso.gob.pe/ntley/Imagenes/Leyes/29790.pdf>
- Law No. 3058. (2005). Ley de Hidrocarburos. Congreso Nacional de Bolivia. May 17, 2005. Retrieved from [http://www.ine.gob.bo/indicadoresddhh/archivos/alimentacion/nal/Ley N° 3058.pdf](http://www.ine.gob.bo/indicadoresddhh/archivos/alimentacion/nal/Ley%20N%203058.pdf)
- Law No. 535. (2014). Ley de Minería y Metalurgia. Congreso Nacional de Bolivia. June 2, 2014. Retrieved from [http://www.senarecom.gob.bo/normativas/ley\\_minera\\_2014.pdf](http://www.senarecom.gob.bo/normativas/ley_minera_2014.pdf)
- Law No. 756. (2002). Por la cual se modifica la Ley 141 de 1994, se establecen criterios de distribución y se dictan otras disposiciones. Congreso de Colombia. Juli 25, 2002. Retrieved from <https://www.sgr.gov.co/LinkClick.aspx?fileticket=68y2-RNV46g=&tabid=103>
- Lin, J-Y, Chang H-J (2009) Should industrial policy in developing countries conform to comparative advantage or defy it? A debate Between Justin Lin and Ha-Joon Chang. *Development Policy Review* 27(5): 483-502.
- Marin, A., Navas-Alemán, L., & Perez, C. (2015). Natural Resource Industries as a Platform for the Development of Knowledge Intensive Industries. *Tijdschrift Voor Economische En Sociale Geografie*, 106(2), 154–168.
- Ministerio de Economía. (n.d.). El Fondo de Innovación para la Competitividad (FIC). Retrieved July 9, 2015, from <http://www.economia.gob.cl/subsecretarias/economia/innovacion-2/el-fondo-de-innovacion-para-la-competitividad-fic/>
- Ministerio de Economía y Finanzas Públicas. (n.d.). Finanzas Territoriales. Matriz de Gasto IDH -

- Universidades Públicas. Retrieved from [http://www.economiayfinanzas.gob.bo/index.php?opcion=com\\_contenido&ver=contenido&id=3455&seccion=266&categoria=606](http://www.economiayfinanzas.gob.bo/index.php?opcion=com_contenido&ver=contenido&id=3455&seccion=266&categoria=606)
- Ministerio de Educación. (2013). Plan Nacional de Ciencia, Tecnología e Innovación. Bolivia, La Paz. Retrieved from [http://www.cienciaytecnologia.gob.bo/uploads/plan\\_nacional\\_de\\_ciencia\\_y\\_tecnologia.pdf](http://www.cienciaytecnologia.gob.bo/uploads/plan_nacional_de_ciencia_y_tecnologia.pdf)
- Natural Resource Governance Institute, & Colombia Institute on Sustainable Investment. (2014). Natural Resource Fund Governance: The Essentials. Natural Resource Governance Institute. Retrieved from [http://www.resourcegovernance.org/sites/default/files/NRF\\_Overview\\_EN.pdf](http://www.resourcegovernance.org/sites/default/files/NRF_Overview_EN.pdf)
- Navarro, J. C., Benavente, J. M., & Crespi, G. (2016). The New Imperative of Innovation: Policy Perspectives for Latin America and the Caribbean. Washington DC: IDB.
- OECD. (2007). OECD Reviews of Innovation Policy: Chile. Paris: OECD.
- OECD. (2009). OECD Territorial Reviews: Chile. Paris: OECD.
- OECD. (2013) Territorial REviews: Antofagasta, Chile, 2013. Paris: OECD.
- OECD. (2014a). OECD Reviews of Innovation Policy: Colombia 2014. Paris: OECD. <http://doi.org/http://dx.doi.org/10.1787/9789264204638-en>
- OECD. (2014b). OECD Territorial Reviews: Colombia. Paris: OECD. Retrieved from <http://dx.doi.org/10.1787/9789264224551-en>
- OECD (2014c) OECD Reviews of Rural Policy: Chile 2014. Paris: OECD.
- OECD. (2015). OECD Economic Surveys Colombia January 2015 *Overview*. Paris: OECD.
- Olivari, N. (2016). Entrepreneurial traits and innovation: Evidence from Chile. PHD Thesis UNU MERIT, Maastricht.
- Pavitt, K. (1984). Sectoral Patterns of Innovation: Towards a Taxonomy and a Theory. *Research Policy*, 13, 343–373.
- Perez, C. (2010). Technological Dynamism and Social Inclusion in Latin America: A Resource-based Production Development Strategy. *Cepal Review*, No. 100, April, pp. 121–141.
- PND. (2006). Plan Nacional de Desarrollo. Lineamientos Estratégicos 2006 - 2011. Ministerio de Planificación del Desarrollo. La Paz, Bolivia. Retrieved from <http://www.planificacion.gob.bo/sites/folders/documentos/plan.pdf>
- Prebisch, R. (1950). The Economic Development of Latin America and its Principal Problem. UN E/CN.12/89/Rev.1. Lake Success, N.Y.: United Nations.
- Sachs, J. D., & Warner, A. M. (1995). Natural Resource Abundance and Economic Growth. NBER Working Paper 5398, Boston, Massachusetts.
- Sachs, J. D., & Warner, A. M. (1997). Natural Resource Abundance and Economic Growth. Cambridge, Massachusetts: Harvard University,.
- Sachs, J. D., & Warner, A. M. (2001). The Curse of Natural Resources. *European Economic Review*, 45(4-6), 827–838.
- Singer, H. (1949). Economic Progress in Underdeveloped Countries. *Social Research: An International Quarterly of Political and Social Science*, 16(1), 1–11.
- Sinnott, E., Nash, J., & de la Torre, A. (2010). *Natural Resources in Latin America and the Caribbean - Beyond Booms and Busts?* Washington DC: World Bank.
- Stevens, P., & Dietsche, E. (2008). Resource Curse: An Analysis of Causes, Experiences and Possible

- Ways Forward. *Energy Policy*, 36(1), 56–65.
- Stiglitz, J. E. (2007). What is the Role for the State? In M. Humphreys, J. D. Sachs, & J. E. Stiglitz (Eds.), *Escaping the Resource Curse*, 23-52. Columbia University Press, New York.
- Suaznábar, C. (2015). Interviews on Peru. Interviews conducted via skype on the 7th and 10th of September, 2015.
- Presidencia del consejo de ministros, Republica de Peru (2016). Supreme Decree No. 015-2016-PCM. Decreto Supremo que Aprueba la Política Nacional para el Desarrollo de la Ciencia, Tecnología e Innovación Tecnológica - CTI. President de la República. March 9, 2016.
- Supreme Decree No. 28421. (2005). October 21, 2005. Retrieved from <http://www.lexivox.org/norms/BO-DS-28421.pdf>
- Supreme Decree No. 28701. (2006). Decreto Supremo de Nacionalización de Hidrocarburos. May 1, 2006. Retrieved from <http://www.lexivox.org/norms/BO-DS-28701.pdf>
- Supreme Decree No. 29322. (2007). Disposiciones Transitorias Disposiciones Abrogatorias y Derogatorias. October 25, 2007. Retrieved from <http://www.lexivox.org/norms/BO-DS-29322.pdf>
- The Economist. (2015). The Twilight of the Resource Curse? Africa's Growth is Being Powered by Things other than Commodities. Retrieved May 28, 2016, from <http://www.economist.com/news/middle-east-and-africa/21638141-africas-growth-being-powered-things-other-commodities-twilight>
- The Natural Resource Charter. (2014). *Natural Resource Charter* (2nd ed.). The Natural Resource Governance Institute. Retrieved from <http://naturalresourcecharter.org/sites/default/files/Natural Resource Charter second edition 2014.pdf>
- Tilton, J. E. (2013). The Terms of Trade Debate and the Policy Implications for Primary Product Producers. *Resources Policy*, 38(2), 196–203. <http://doi.org/10.1016/j.resourpol.2012.12.001>
- Tsani, S. (2015). On the Relationship Between Resource Funds, Governance and Institutions: Evidence from Quantile Regression Analysis. *Resources Policy*, 44, 94–111. Retrieved from <http://dx.doi.org/10.1016/j.resourpol.2015.01.003>
- Upstill, G., & Hall, P. (2006). Innovation in the Minerals Industry: Australia in a Global Context. *Resources Policy*, 31(3), 137–145. <http://doi.org/10.1016/j.resourpol.2006.12.002>
- Urzúa, O. (2011). The Emergence and Development of Knowledge Intensive Mining Service Suppliers in the late 20th century. Doctoral thesis, University of Sussex. Retrieved from <http://sro.sussex.ac.uk/45344/>
- Usui, N. (1997). Dutch Disease and Policy Adjustments to the Oil Boom: A Comparative Study of Indonesia and Mexico. *Resources Policy*, 23(4), 151–162.
- Ville, S., & Wicken, O. (2013). The Dynamics of Resource-based Economic Development: Evidence from Australia and Norway. *Industrial and Corporate Change*, 22(5), 1341–1371.
- Wall, E., & Pelon, R. (2011). Key Attributes of Foundations, Trusts, and Funds. In *Sharing Mining Benefits in Developing Countries*. Extractive Industries for Development Series. World Bank Oil, Gas and Mining Unit Working paper, Washington DC: 19-32.
- Wright, G., & Czelusta, J. (2004). The Myth of the Resource Curse. *Challenge*, 47(2), 6–38.
- World Bank. (2016). Worldbank data. <http://data.worldbank.org/> accessed May 20, 2016
- Zahler, A., Bravo, C., Goya, D., & Benavente, J. M. (2014). Public-Private Collaboration on Productive

Development Policies in Chile. IDB Working Paper Series No. IDB-WP-502.

Zhang, Y., Garcia-Quiles, V., & Thelen, N. (2015). Riding the Commodity Rollercoaster: Natural Resource Management in the Context of Increasing Commodity Price Volatility (advance online publication, 8 January 2015). *Comparative Economic Studies*, 57(2), 1–21. <http://doi.org/10.1057/ces.2014.41>

**Appendix 1. List of interviews conducted (please add more if there are any)**

Name: Ms. Juana Kuramoto Huaman, Director of Politics/Policies and programs related to STI at CONCYTECH (National Science and Technology)

Date: 5<sup>th</sup> August, 2015

Interviewer: Jakob Baumann via Skype

Name: Ms. Claudia Suaznabar, Senior Specialist, Division for Competitiveness and Innovation in IADB

Date: 7<sup>th</sup> and 10<sup>th</sup> of September, 2015

Interviewer: Jakob Baumann via Skype

Name: Mr. Mauricio Cespedes Quiroga, Coordinator of Bolivia's Science and Technology System, Vice Ministry of Science and Technology, Ministry of Education

Date: 12<sup>th</sup> August, 2015

Interviewer: Jakob Baumann via Skype

Name: Mr. Juan Carlos Navarro, Division for Competitiveness and Innovation in IADB

Date: 28<sup>th</sup> January, 2016

Interviewer: Michiko Iizuka in person in Panama City, Panama