Articles

Revenue from the Extractive Industries and Copper Mining in Peru

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Abstract

In the framework of a weak approach to sustainability, this paper evaluates whether the revenues earned on copper mining have translated into better educational, health, and roadway infrastructure in Peru's extractive zones, both at the district- and department-wide level, between 2004 and 2013. The results reveal that the infrastructure in places that are home to the extractive industries has indeed improved to a greater degree than in other locations, but only on a small order of magnitude. This weak effect is tied to the State's shaky vision of sustainability and the fact that the regionalization process in Peru is still under way.

Keywords: Infrastructure, non-renewable natural resources, copper mining, inter-governmental transfers, provision of public assets.

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1. INTRODUCTION

In Peru, as in other Latin American economies, natural resources abound. The commodities price boom in the aughts boosted fiscal revenue in these countries. Nevertheless, has this revenue served to extend the conditions for economic growth into the future?

In Peru, copper generates the most foreign currency, amounting to approximately 23% of the value of total exports over the past 10 years. With that said, this paper aims to determine if the revenue resulting from this ore has translated into significant increases in capital expenditures in education, healthcare, and roadway infrastructure in the mining areas, beginning with the idea that in so doing, these towns would be able to supplant what was formerly an endowment of natural capital with productive capital (Hartwick, 1977).

This assessment is conducted at two levels: first, at the district level, and second, at the department (an administrative region) level. Concerning the former, the evaluation covers 23 copper-mining districts in the departments of Ancash, Arequipa, Moquegua, and Tacna, from 2008 to 2013, as they enjoy the highest copper production levels. Concerning the latter, this paper examines the 11 departments that were home to continuous copper mining operations from 2004 to 2013. The data gathered is the foundation for estimates made using dynamic panel data and the Generalized Method of Moments (GMM).

This paper is organized as follows: Section 2 summarizes the theoretical and empirical tenets governing the relationship between non-renewable resources and sustainable growth, and the principles underpinning revenue sharing with mining towns; Section 3 describes data on mining, revenue, and fiscal spending, at the district and department levels alike; Section 4 introduces the results of the empirical evaluation; and, finally, Section 5 presents the conclusions.

2. THE INCOME GENERATED BY NATURAL RESOURCES AND TAX REVENUE SHARING WITH LOCAL GOVERNMENTS

Theoretical Considerations

Determining the role of natural resources in the sustainable growth of a society is as of yet an unresolved task in economic analysis. The largest controversy revolves around the degree to which manufactured capital is capable of substituting the natural ecosystem or part of it. At the moment, the various functions played by ecosystems—ranging from their role in the provision of raw materials and a destination for waste to the furnishing of water, air, and soil as a critical means of support for all forms of life—are widely recognized (Daly and Farley, 2004; Pearce and Turner, 1995; Ekins *et al.*, 2003).

Against that backdrop, the concept of *weak sustainability* refers to an approach by which sustainable growth over time is possible thanks to technological developments that little by little replace exhaustible resources, such that the total stock of capital, natural or non-natural, remains constant, and with it, the assets that determine the wealth of a nation. By contrast, the concept of *strong sustainability* supposes that nature plays a vital role that cannot be substituted in any way by manufactured capital and, accordingly, for economic growth to be sustainable, the role of nature must be preserved (Dietz and Neumayer, 2007).

In practice, the two sustainability approaches are complementary to one another, although weak sustainability is easier to instrumentalize, as it concentrates on the role of exhaustible resources, and not on nature. A formal point of departure for this instrumentalization is known as Hartwick's rule, whereby the constant and infinite per capita consumption of a society can be achieved by investing all income derived from extracting a non-renewable resource in different forms of manufactured capital (Hartwick, 1977)—for example, productive infrastructure—assuming moreover that renewable resources are exploited in accordance with their own rate of biological renewal. Expanding upon this concept, and including investment in education and environmental degradation, the World Bank (WB) uses genuine net savings as a measure of the maintenance of wealth in a country (The World Bank, 2011). Nevertheless, in both cases, the assumption is that it has been possible to convert income from natural resources into investment in fixed capital, a process composed of a chain of actions in which various agents participate, including the State, by charging taxes and providing public goods.

In Peru, pursuant to the Constitution, natural resources are owned by the State. Under that premise, various studies have evaluated the effect of extractive activities on fiscal revenue and spending, investment, and employment, underscoring the positive effects, especially from an aggregate standpoint (Macroconsult, 2012; IPE, 2012; 2011). However, it is the populations living around the extraction zones which directly absorb the costs and benefits of said activities, including the environmental risk. At the level of local analysis, diverse papers (Ticci, 2011; Aragón and Rud, 2013; Camacho *et al.*, 2015; Loaysa and Rigolini, 2015) have found both positive and negative effects of extractive activities, depending on the zone and year of study in question, but they have not drawn on the weak or strong sustainability approaches.

Internationally, the WB's estimates of the magnitude of each country's natural resource revenue[2] (The World Bank, 2016) has helped measure how this income is transformed into different forms of fixed capital around the world (Banco Mundial, 2009). These magnitudes can then be compared with the infrastructure gap in each country, suggesting that the State could close this gap if it were to capture a higher percentage of the revenue (Fuss *et al.,* 2016). In Latin America, Gómez *et al.* (2015) described the fiscal instruments used to capture the income on non-renewable resources and explored the distribution of income across local governments, including the tools used to deal with the negative externalities arising from extraction.

In this tale, Zarsky and Stanley's (2013) paper, which applied both the weak and strong sustainability approaches, is worth mentioning. In the former, they measured the impact of the Marlín mine in Guatemala on productive infrastructure and local jobs. In the latter, they evaluated the risk of compliance in environmental impact studies, which would serve to upkeep an ecosystem's vital functions. Pursuant to both criteria, they calculated what they refer to as the net benefits of extractive activities, with rather unfavorable results in each case.

The State's main tools to secure its share of non-renewable resource income consist of direct taxes and royalties. According to Peruvian regulations, the *canon* refers to the portion of direct taxes that mining companies pay to the central government, to be transferred to the local governments where the resources are extracted. For mining, the canon amounts to 50%. Likewise, the 2004 royalties law ordered that 100% of what the central government collects be transferred to its original destination. To determine these percentages, the government has adhered to practical rather than theoretical criteria, because the literature specialized in public finance does not recognize any objective tool to calculate how much of the revenue collected ought to be transferred (Gómez *et al.*, 2015).

Thus, beyond the canon and the royalties, budget allocations to local governments are essentially justified on the rationale of the regulatory principles of distribution, efficiency, and compensation, with much left up to the discretion of the various decision-making levels (Carranza *et al.*, 2006).

As McLure and Martínez (2000) and Brosio (2006) pointed out, the *principle of redistribution* in the allocation of the budget is one of the basic duties of the State, especially in cases where zones wealthy and poor in natural resources live alongside each other, with the aim of easing social pressure. Accordingly, in 1993, Peru enacted the Municipal Compensation Fund, which is used to distribute a portion of the indirect taxes collected in the country across municipalities, with amounts determined based on the number of inhabitants, mortality rates, levels of unmet basic needs, and rural rates. At the same time, the canon law allocates a percentage of the amounts designated for the region to municipalities that are not home to any mining activities. However, these mechanisms have failed to close the income disparity that emerged from rising commodities prices in the aughts (Del Valle, 2013).

When it comes to the *principle of efficiency*, the idea is to strike a balance between central government spending on national public works and complementary spending by the local governments. The former brings with it the advantage of efficiencies due to the scale of spending, while the latter takes into account local preferences for public assets needed at the local level (Fretes and Ter-Minassian, 2015). In response to this principle, in 2007, the Fund for the Promotion of Regional and Local Public Investment (FONIPREL) was launched in Peru, created to foster the joint financing of public investment projects spearheaded by local governments, and designed to reduce gaps in the provision of basic services and infrastructure. Obviously, this spending coordinated across different levels of government is of interest to the companies generating the income in the first place, because at the end of the day, these services help cut their own extraction costs.

Where the *principle of compensation* is concerned, various authors consulted (Brosio, 2006; Canavire-Bacarreza *et al.*, 2012; McLure and Martínez-Vásquez, 2000) have noted that budget transfers serve as redress for the extraction of a non-renewable natural resource and remediation of the environmental problems resulting from these activities.

Because the regionalization process in Peru is not yet complete, it is moreover important to bear in mind recommendations related to fortifying both the local government's tax collection powers and their spending capacity. In this sense, the danger of the local government depending primarily on transfers is that it turns local authorities into passive subjects with respect to the quantity and quality of public assets they can provide.

In Peru specifically, Vega (2008) found that tax collection problems are exacerbated when the percentage of the rural population is higher, due to low levels of property registration and low income per capita, while Del Valle (2013) warned of the risks of municipal governments becoming overly dependent on natural resource revenue, due to the volatility of international prices.

When it comes to spending capacity, the abundant revenue derived from high commodities prices allows for the possibility of spending without considering criteria related to profitability, and even overvaluation. The problem is sharpened when the population is clustered into smaller municipalities, as is the case of the Andean regions in Peru. Added to that, it can push up spending on bureaucratic affairs and/or the number of public works. In these situations, the transfers from the central government ought to be accompanied by defined spending rules and a mechanism to provide support and oversight when projects are being executed. Such is the intention of the norms regulating the use of the canon, as Article 6 of the law expressly stipulates that these funds are to finance exclusively infrastructure works or research at public universities. Likewise, FONIPREL and the National Public Investment System (SNIP), opened in 2000, are both central government bodies that certify the quality of local government investment projects, relying on cost-benefit criteria to approve these projects. Unfortunately, the system has turned into a bottleneck for local governments.

It appears, then, even if this analysis is limited to a weak sustainability approach, the transformation of the income generated by non-renewable resources into manufactured capital entails the participation of a series of bodies with procedures that as of yet are not fully formed. Likewise, adopting a strong sustainability approach to evaluate to what degree extractive activities are performed while maintaining the vital functions of the environment would require a multidisciplinary team. This is precisely what local governments need, as all sorts of extractive activities, both renewable and non-renewable, take place. On this will depend their success in terms of regulatory capacity.

Empirical Evaluations

The fiscal decentralization process in a context of unequal endowments of natural resources has sparked interest in evaluating the effects of the income generated, both on the fiscal spending of local governments, as well as on the direct welfare of the population in production zones.

Along these lines, Alvarado *et al.* (2003) conducted a study examining the tax revenue shared with municipal governments in Peru between 1993 and 2000, constructing income and spending functions through ordinary least squares econometric models. The explanatory variables used were own income and transfers received, including the different types of canon transfers. They found that transfers have weakened local governments' efforts to collect their own resources.

Similarly, Aguilar and Morales (2005) evaluated the effect of revenue sharing on local gross domestic product (GDP) between 1998 and 2002. Although they offer a descriptive evaluation of the different types of canons, they are not considered as an explanatory variable in the model. Using dynamic panel data, they found that revenue sharing has positive, albeit limited, effects on economic activity.

Likewise, Herrera (2008) performed a study on the tax revenue specifically shared with mining municipalities, using accounting tools, between 2003 and 2007. The study concluded that local governments receive, thanks to the mining canon, amounts that exceed their fiscal capacity and spending needs by approximately 67.5% in the period studied.

On the other hand, Caselli and Michaels (2013) did not directly evaluate the case of Peru, but did use a methodology that makes their study a useful source. They assessed oil production in 3,659 areas tied to oil activities in Brazil and its effects on the welfare of the people through fiscal spending. They performed a cross-section analysis comparing just two moments in time, finding that oil-related fiscal revenue has grown to a far greater degree than spending on a series of public assets and social transfers, supposing that the discrepancy has ended up in the pockets of public servants and led to political clientelism.

In a similar vein, Del Pozo *et al.* (2013) evaluated the impact of the mining canon on household welfare in Peru. Although they did not look at fiscal spending as such, they did measure the impact of the changes in the mining canon on access to drinking water, sanitation, electricity, and roads. They used the National Household Survey (ENAHO) between 2001 and 2010 and applied the difference-in-difference (DID) technique. They found positive impacts on urban and less poor households and negative impacts on rural and poorer households.

The research in this paper is focused on evaluating the effect of copper mining. The aim with the data gathered is to find quantifiable evidence that natural capital (copper ore) is being substituted by productive capital (education, healthcare, and roadway infrastructure) through public spending in the framework of a weak sustainability approach.

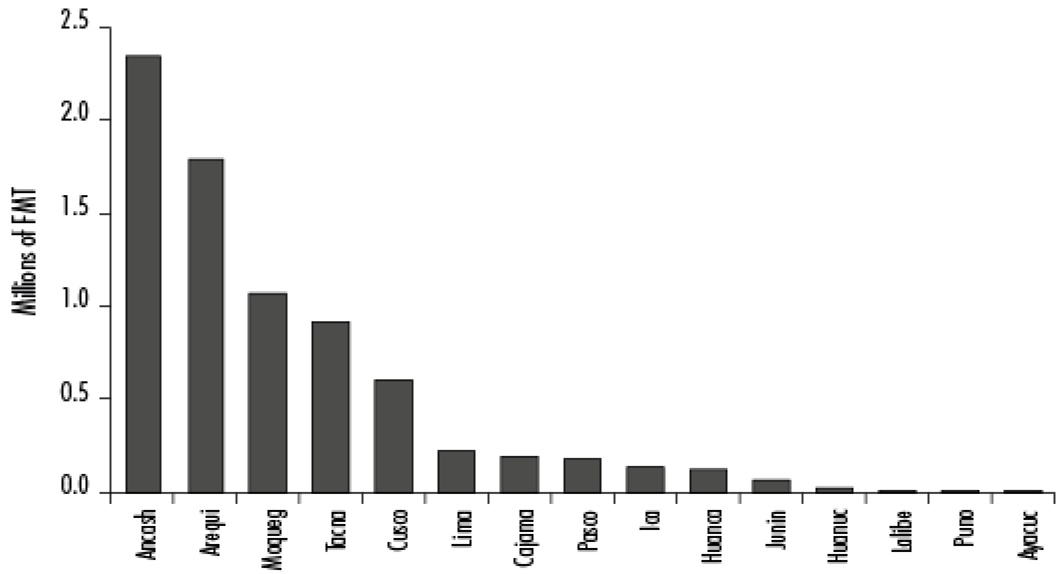
In addition, in the research cited, especially in more recent studies, surveys tend to be the principal source of data and as such, the primary evaluation methods used have been the difference-in-difference (DID) technique, propensity score matching (PSM), and instrumental variables for cross-section data. The older studies have tended to draw on ordinary least squares and panel data time series, but the data generally ends around 2002.

In this research, because time series and information were available for the country's 24 departments, dynamic panel data were used with a generalized method of moments (GMM) technique, in order to correct for the potential endogeneity of the explanatory variables by incorporating instrumental variables, as well as the heteroscedasticity of errors (Arellano and Bover, 1995; Blundell and Bond, 1998).

3. COPPER MINING, THE CANON, AND FISCAL SPENDING

Peru is divided into 24 departments, of which 15 are home to copper mining. Ancash, Arequipa Moquegua, and Tacna produce the largest volumes of copper, as seen in Figure 1. These four departments are composed of 333 districts, of which 23 are copper-mining areas.

Figure 1. Cumulative Copper Mined (FMT) by Department, 2008-2013



Source: Created by the author.

Table 1 adds some geographical data to the mix. In Ancash and Arequipa, panel (a) shows that the mining districts are located 3,000 meters above sea level (m.a.s.l.), but their respective surface areas and populations are smaller than in districts located below 2,000 m.a.s.l., which are given in panel (b). This reflects the fact that there are many other economic activities besides copper mining in lower-altitude geographic zones in these departments. In Moquegua, panels (a) and (b) reveal that mining districts are located above 2,000 m.a.s.l., but their surface areas and populations are actually higher above those altitudes. In Tacna, mining only occurs below 2,000 m.a.s.l.

These conditions reflect to a certain degree the effort that regional governments would have to make in the provision of public assets, such as education, healthcare, and roads, because at higher altitudes, it is harder and more costly to bring these services to the people.

Considering that in reality, Peru mines much more than just copper, it is not possible to separate out the canon data for only copper. As such, the figures below consider the mining canon in general received at the district level.

Table 2 shows that the mining canon granted to copper mining districts is four times higher than what non-mining districts receive. Nevertheless, greater funding does not necessarily translate into higher fiscal spending. Likewise, the same table shows that copper-mining districts use the revenue received to a lesser degree than non-mining districts. On the other hand, when it comes to the portion of the budget spent on education, healthcare, and roadway infrastructure, it emerges that in all three cases, spending is higher in mining districts than in non-mining districts. The discrepancy is greatest in roadway infrastructure.

Table 1. Altitude, Surface Area, and Population of Copper-Mining Districts in Ancash, Arequipa, Moquegua, and Tacna. Average Values per District, 2008-2013

Variable	*Ancash*	*Arequipa*	*Moquegua*	*Tacna*
(a) Above 2,000 meters above sea level (m.a.s.l.)				
Altitude (m.a.s.l.)	3 298.8	3 251.7	2 195.0	0.0
Average copper mined (FMT)	45 823.8	89 663.4	172 968.1	0.0
Surface (km^2)	379.8	958.6	1 793.4	0.0
Population (inhabitants)	4 653.7	3 215.2	6 415.8	0.0
(b) Below 2,000 meters above sea level (m.a.s.l.)				
Altitude (m.a.s.l.)	1 166.0	712.7	1 933.0	1 384.0
Average copper mined (FMT)	3.8	225.6	5 594.3	152 396.4
Surface (km^2)	549.8	1 355.5	776.0	1 111.4
Population (inhabitants)	5 025.7	4 683.9	1 971.2	3 974.5

Source: Created by the author.

Table 2. Mining Canon and Government Spending on Education, Healthcare, and Roadway Infrastructure in Copper-Mining and Non-Copper-Mining Districts, Soles per Capita, 2008-2013

	Non-mining	*Mining*
Number of districts	310	23
Mining canon per capita (S/)	836.7	3 203.4
Canon/fiscal revenue (%)	31.9	34.8
Spending/fiscal revenue (%)	68.7	61.4
Government spending per capita on infrastructure (S/)		
Education	216.9	455.1
Healthcare	226.8	604.5
Roadway	266.9	728.7

Source: Created by the author.

When it comes to the department level, Table 3 shows that the share of the mining canon in budgetary revenue in Ancash, Arequipa, Moquegua, and Tacna is rather significant as compared to the rest of the departments. However, budget spending is low.

Likewise, investment in education and healthcare infrastructure is remarkably higher in the four mining departments, but there are no differences in roadway infrastructure.

Table 3. Mining Canon and Public Spending on Education, Healthcare, and Roadway Infrastructure at the Department Level, Soles per Capita, 2008-2013

	Ancash, Arequipa, Moquegua, and Tacna	*All other departments (20)*
Canon per capita (S/)	726.6	74.6
Canon/fiscal revenue (%)	24.0	4.0
Spending/fiscal revenue (%)	74.0	85.0
Government spending per capita on infrastructure (S/)		
Education	153.9	83.9
Healthcare	134.1	92.6
Roadway	253.6	253.3

Source: Created by the author.

4. RESULTS OF THE EMPIRICAL EVALUATION

An Evaluation of the Effect of Copper Mining on Government Spending in Education, Healthcare, and Roadway Infrastructure at the District Level

This section presents the results of the econometric evaluation of the effects of copper mining on budgetary revenue and public spending on education, healthcare, and roadway infrastructure at the district level, between 2008 and 2013. It examines 23 districts where mining occurs in the departments of Ancash, Arequipa, Moquegua, and Tacna, which are home to the highest production levels nationwide.

The original figures in soles have been deflated using the price index from each department to express real values, in per capita terms. To perform econometric estimates of the variables, they were all transformed into logs, so that the coefficients could be interpreted in percentage units.

The estimates were made using the GMM method developed by Arellano and Bover (1995) and Blundell and Bond (1998), in order to capture the inertial component that characterizes the budget and/or public spending through the incorporation of the lag as an explanatory variable. To eliminate the endogeneity that comes with this lag and the endogeneity of the rest of the explanatory variables, the method uses differences and the previous lags of all of the variables as its instruments. Likewise, it permits the introduction of specific variables as instruments, insofar as certainty exists that they are truly correlated with the explanatory variables. In the estimates made, inflation was chosen as the instrument in the electricity and water sector at the department level, as well as oil prices, because these variables affect the value of production in general.

The models uses an unvarying fixed effects constant, which makes it possible to capture the particularities of each of the districts defined as a cross section. The algorithm makes the estimate in two stages, and to subsequently determine if the instrument or instruments chosen are adequate, the Sargan test is applied, which should validate the null hypothesis of the over-identifying instruments. The non-autocorrelation of the error is proven with the Arellano-Bond test, which should also validate the null hypothesis of non-autocorrelation on the orders 0, 1, 2, etc.

Regression (1) estimates the effect of copper-mining activity on budgetary revenue in the 23 districts where copper mining takes place. By way of comparison, regression (2) moreover estimated the effect of the canon, resulting from mining activity in general, on budgetary revenue in the same districts. In both cases, the control variables were a set of data to describe the mining district, which could have an effect on the budget, like territorial density, altitude of the capital above sea level, percentage of the population that are children, number of teachers in the school system, and a dummy variable as to whether there are paved roads to the capital of the district.

These variables are linked with the budget insofar as lower territorial density means it would be harder to supply the population with basic public assets; if the district is located at a higher altitude above sea level, the geography will make trade exchanges with other zones trickier; if there are more children, more education and healthcare services are necessary; if there are fewer teachers, more infrastructure is also required; and if there are fewer paved roads, more will have to be built. All of this places a burden on the budget and creates pressure to come up with more and better services.

$$PIM_{i,t} = \alpha_1 + \beta_1 \cdot PIM_{i,t-1} + \gamma_1 \cdot VBqcu_{i,t} + \theta_{1,j} \cdot \sum X_{j,i,t} + u_i + \varepsilon_{i,t} \qquad (1)$$

$$PIM_{i,t} = \alpha_2 + \beta_2 \cdot PIM_{i,t-1} + \gamma_2 \cdot Canon_{i,t} + \theta_{2,j} \cdot \sum X_{j,i,t} + u_i + \varepsilon_{i,t} \qquad (2)$$

Where:

PIM: Log of the budget per capita in each department.
VBqcu: Log of the gross monetary value per capita of copper mined in each district.
X_j: Log of the territorial density of the population, altitude of the capital, percentage of the population that is children, the number of teachers in the school system, and a dichotomous variable indicating whether there are paved roads or not, in each district.
i: District.
t: Years.
u: Fixed effects constant.
e: Error term.
α, β, γ, θ, ρ: Parameters to calculate.
Instrument: Inflation in the electricity and water sectors and oil prices.

Table 4. Budgetary Revenue as a Function of Copper Mined and the Mining Canon in the Districts of Ancash, Arequipa, Moquegua, and Tacna, 2008-2013

	Regression (1)	*Regression (2)*
Variables	*Budgetary revenue*	
Budgetary revenuet $_{t-1}$	0.417	0.448**
(S/ per capita)	(0.255)	(0.220)
Gross copper value	0.0409*	
(S/ per capita)	(0.0216)	
Mining canon		0.432**
(S/ per capita)		(0.170)
Territorial density	-0.582	-0.658
(Inhabitants per km^2)	(0.689)	(0.468)
Altitude of the capital	-0.109	-0.143
(m.a.s.l.)	(0.754)	(0.428)
Population of children	0.834	0.554
(% of total population)	(1.619)	(1.101)
Number of teachers in the school system	0.514	0.669
	(0.426)	(0.510)
Paved roads to the capital (dummy)	0.100	-0.0232
	(0.232)	(0.214)
Intercept	5.157	1.712
	(8.632)	(5.584)
Observations	92	92
AR(1) test[a]	z = -1.5055	z = -1.7078
	Pr > z= 0.1322	Pr > z= 0.0877
AR(2) test[a]	z = -.09361	z = 0.90032
	Pr > z= 0.9254	Pr > z= 0.3679
Sargan test[b]	Prob > chi2 = 0.0656	Prob > chi2 = 0.0574

Robust standard error in parentheses. Significance level: *<0.1, **<0.05; and ***<0.01. [a] Arrellano-Bond test for serial correlation. [b] Sargan test for indicators.

Source: Created by the author.

The results in Table 4 (column (1)) show that the value produced on copper in the districts evaluated does have a positive effect on revenue. However, the effect is slight, because the result indicates that for each additional percentage unit mined, the revenue rises by 0.04%, a sign that the ore extracted augments the district's resources, which can later be used in improving conditions for the population. Although the calculated coefficient is small, it only reflects one type of ore. The canon as a whole has a greater impact on revenue, with a coefficient of 0.43, as seen in column (2). The canon component is understandably higher because it is a direct element of revenue and is also tied to mining of all types of ore, not just copper.

Columns (1) and (2) also reveal that the budget has a strong inertial component. For each percentage unit of revenue from the year prior, the current budget rises by around 0.4%. The rest of the variables in the two regressions did not amount to a statistically significant impact on budgetary revenue.

Next, regression (3) represents a set of equations evaluating the effect of copper mining on fiscal revenue in capital assets in the sectors of education, healthcare, and roadway infrastructure at the district level.

$$Y_{m,i,t} = \alpha_{m,3} + \beta_{m,3} \cdot Y_{m,i,t-1} + \gamma_{m,3} \cdot VBqcu_{i,t} + \theta_{m3,j} \cdot \sum X_{m,j,i,t} + u_{m,i} + \varepsilon_{m,i,t} \qquad (3)$$

Where:

Y_m: Log of fiscal spending per capita on capital goods in the education, healthcare, and roadway infrastructure sectors in each district.
Instrument: Inflation in the water and electricity sector and oil prices.

In these estimates, the results in Table 5 show a favorable effect for the value of copper mined on public investment in education, healthcare, and roadway infrastructure, with 0.16%, 0.16%, and 0.15%, respectively, figures that are even higher than the effect on budgetary revenue. These results indicate that the ore extracted, seen as natural capital, is indeed slowly being transformed into physical capital, to a modest degree. The table also shows that public investment in education and healthcare does not have an inertial component, while investment in roadway infrastructure does, which would be tied to the fact that in general, roadway projects require more time to be executed. Along the same lines, altitude is inversely and significantly related to spending on roadways, a sign that more roadway infrastructure works are developed at lower altitudes.

Table 5. Spending on Capital Assets in Education, Healthcare, and Roadway Infrastructure as a Function of Copper Mined in the Districts of Ancash, Arequipa, Moquegua, and Tacna, 2008-2013.

	Regression (3a)	*Regression (3b)*	*Regression (3c)*
Variables	*Investment in education*	*Investment in healthcare*	*Investment in roadway infrastructure*
Investment in education $_{t-1}$	-0.143		
(S/ per capita)	(0.156)		
Investment in healthcare $_{t-1}$		-0.00992	
(S/ per capita)		(0.274)	
Investment in roadway infrastructure $_{t-1}$ (S/ per capita)			0.237**
			(0.117)
Gross copper value $_{t-1}$	0.165**	0.160*	0.149*
(S/ per capita)	(0.0740)	(0.0865)	(0.0771)
Population of children $_{t-1}$	5.804	-1.889	
(% of total population)	(27.53)	(4.611)	
Students per teacher $_{t-1}$	-0.891		
(Number of students)	(6.035)		
Altitude		-1.038	-0.771**
(m.a.s.l.)		(1.825)	(0.381)
Paved roads to the capital $_{t-1}$ (*dummy*)			-0.00993
			(1.288)
Intercept	14.05	8.983	8.264***
	(51.07)	(19.28)	(2.760)
Observations	72	59	82
AR(1) test[a]	z = -0.73173	z = -0.87409	z = -2.1564
	Pr > z= 0.4643	Pr > z= 0.3821	Pr > z= 0.0311
AR(2) test[a]	z = -1.8235	z = -1.4748	z = -.67596
	Pr > z= 0.0682	Pr > z= 0.1403	Pr > z= 0.4991
Sargan test[b]	Prob>chi2= 0.1536	Prob>chi2= 0.5077	Prob>chi2= 0.5032

Robust standard error in parentheses. Significance level: *<0.1, **<0.05; and ***<0.01. [a] A aArrellano-Bond test for serial correlation. [b] Sargan test for indicators.
Source: Created by the author.

Evaluation of the Effect of Copper Mining on Government Spending in Education, Healthcare, and Roadway Infrastructure at the Department Level

Having demonstrated the favorable effect of copper production on budgetary variables at the district level, this section deals with the results of the department-level estimates.

Departments are divided into three groups: group 1 consists of Ancash, Arequipa, Moquegua, and Tacna, which, as has been shown, enjoy the highest levels of copper production, attaining an annual average of over 100,000 fine metric tons (FMT). Group 2 includes the seven departments that have been home to continuous mining during the period of study, but with an annual average of 100,000 FMT or less. These are: Ayacucho, Cusco, Huancayo, Huánuco, Junín, La Libertad, and Pasco. Group 3 contains the six departments that do not mine copper, but do mine other minerals, and they are included to evaluate whether being a copper producer or not creates a significant difference in fiscal spending. Belonging in this group are: Amazonas, Apurímac, Lambayeque, Madre de Dios, Piura, and San Martín. Lima was removed from the mix due to the size of its economy and population, which could distort the results, and the other three departments have not had continuous copper production. The evaluation dates back to 2004, when the amount of canon transferred to the regions jumped suddenly from 20% to 50% of income tax, thanks to a legislative change.

The following regressions estimate the effect of copper mining (4) and the mining canon (5) on the budgetary revenue at the department level. The control variables used in both regressions were non-mining GDP, the illiteracy rate, the percentage of the population living in rural areas, and altitude of the capital above sea level. Likewise, because 2007 saw an increase in the amounts of mining canon generated due to peaking international commodities prices, a dummy variable was added in to capture the effect.

$$PIM_{i,t} = \alpha_4 + \beta_4 \cdot PIM_{i,t-1} + \gamma_4 \cdot VBqcu_{i,t} + \theta_{4,j} \cdot \sum X_{j,i,t} + \rho_1 \cdot d_{2007} + u_i + \varepsilon_{i,t} \quad (4)$$

$$PIM_{i,t} = \alpha_5 + \beta_5 \cdot PIM_{i,t-1} + \gamma_5 \cdot Canon_{i,t} + \theta_{5,j} \cdot \sum X_{j,i,t} + \rho_2 \cdot d_{2007} + u_i + \varepsilon_{i,t} \quad (5)$$

Where:

PIM: Log of the budget per capita in each department.
VBqcu: Log of the gross monetary value per capita of copper mined in each district.
Canon: Log of the mining canon per capita per department.
X_j: Log of non-mining GDP per capita, illiteracy rate, percentage of the population in rural

areas, altitude of the capital in each department.
d_{2007}: Dummy for the year 2007.
i: District.
t: Years.
u: Fixed effects constant.
e: Error term.
α, β, γ, θ, ρ: Parameters to calculate.
Instrument: Inflation in the electricity and water sectors.

The results in Table 6 show that the budgetary revenue for each department is majorly affected by its own lag, which reflects its inertial nature. Nevertheless, it is also clear that the effect of copper mining on the district budgets disappears in this case, as the respective coefficients (column (4)) are statistically insignificant. However, column (5) shows that the mining canon has a favorable, although reduced (0.09), impact only in group 1, with no effect in group 2. Likewise, the non-mining GDP has significant effects on the department budget (0.41).

Broadly speaking, these results corroborate what other researchers have found (Carranza *et al.*, 2006) in regard to the highly discretional nature of budget allocations in the country, with criteria that weaken the relationship between the amounts allocated and local economic activity. In both regressions, the impact of peaking prices in 2007 was correctly captured by the dummy variable. The rest of the control variables do not display any statistically significant effects.

Table 6. Budgetary Revenue as a Function of Copper Mining and the Mining Canon, by Groups of Departments, 2004-2013

	Regression (1)	*Regression (2)*
Variables	*Budgetary revenue*	
Budgetary revenue$_{t-1}$	0.799***	0.826***
(S/ per capita)	(0.0471)	(0.100)
Gross copper value group 1	0.00935	
(S/ per capita)	(0.0390)	
Gross copper value group 2	-0.0338	
(S/ per capita)	(0.0494)	
Mining canon group 1		0.0901**
(S/ per capita)		(0.0419)
Mining canon group 2		0.0209
(S/ per capita)		(0.0361)
Non-mining GDP	0.353	0.411***
(% de GDP)	(0.245)	(0.155)
Illiteracy rate	-0.169	-0.158
(% of inhabitants	(0.162)	(0.188)
Rural population	-0.180	0.155
(% of inhabitants)	(0.407)	(0.624)
Altitude of the capital	0.238	0.0293
(m.a.s.l.)	(0.210)	(0.190)
D2007	0.292***	0.239***
	(0.0766)	(0.0816)
Intercept	0.421	1.765
	(1.624)	(1.306)
Observations	180	151
AR(1) test[a]	z = -2.0519	z = -1.985
	Pr > z= 0.0402	Pr > z= 0.0471
AR(2) test[a]	z = -1.8109	z = -1.523
	Pr > z= 0.0702	Pr > z= 0.1278
Sargan test[b]	Prob > chi2 = 0.4240	Prob > chi2 = 0.5022

Note: Group 1 consists of departments that produce over 100,000 FMT on average; Group 2, seven departments that produce 100,000 FMT or less on average.
Robust standard error in parentheses. Significance level: *<0.1, **<0.05; and ***<0.01. [a] Arrellano-Bond test for serial correlation. [b] Sargan test for indicators.
Source: Created by the author.

Finally, model (6) represents a set of equations that evaluate spending on capital goods in the education, healthcare, and roadway infrastructure sectors, respectively, in each department as a function of the mining canon transferred. Initially, copper mining was included as a regressor variable, but the results were insignificant. For that reason, for this new set of equations, the monetary value of copper was not used as a regressor, but rather as an instrument, similar to what Caselli and Michaels (2013) did in their assessment of the oil effect in Brazil. The idea is to indirectly measure, through the canon, how the revenue derived from copper mining translates into better long-term growth conditions at the department level.

$$Y_{m,\,i,\,t} = \alpha_{m,6} + \beta_{m,6} \cdot Y_{m,\,i,\,t-1} + \rho_{m,6} \cdot Canon_{m,i,t-1} + \theta_{m,6,j} \cdot \sum X_{m,j,\,i,\,t-1} + \rho_{m,3} \cdot d_{2007} + u_{m,i} + \varepsilon_{m,i,\,t-1} \qquad (6)$$

Where:

Y_m: Log of fiscal spending per capita on capital goods in the education, healthcare, and roadway infrastructure sectors in each department.
$X_{m,j}$: Control variables in the education sector include illiteracy rate, rural population, and population of children; for healthcare, access to the water and sewage grid and number of doctors per inhabitant; for the roadway infrastructure sector, territorial density, urban population, and non-mining GDP.
Instrument: Monetary value of the copper mined.

The results in Table 7 show that capital expenditures on education (column 6a), healthcare (column 6b), and roadway infrastructure (column 6c) have a strong inertial component, as the coefficients are relatively high and statistically significant. Where the role of the mining canon is concerned as a source of funding, there is an effect for investment in education in departments with higher copper mining production (0.13), but less of an effect in groups 2 and 3.

Moreover, the effects of the canon on healthcare investment are only found in group 2 (0.13), while the effects on roadway infrastructure are significant in groups 1 (0.36) and 2 (0.11), being three times higher in the former than in the latter.

Table 7. Spending on Capital Assets in Education, Healthcare, and Roadway Infrastructure in Groups of Departments as a Function of the Transferred Mining Canon, 2004-2013

	Regression (6a)	*Regression (6b)*	*Regression (6c)*
Variables	*Investment in education*	*Investment in healthcare*	*Investment in roadway infrastructure*
Investment in education $_{t-1}$	0.739***		
(S/ per capita)	(0.0851)		
Investment in healthcare $_{t-1}$		0.593***	
(S/ per capita)		(0.134)	
Investment in roadway infrastructure $_{t-1}$			0.546***
(S/ per capita)			(0.124)
Mining canon group 1 $_{t-1}$	0.136***	0.0285	0.363**
(S/ per capita)	(0.0508)	(0.107)	(0.166)
Mining canon group 2 $_{t-1}$	0.0392	0.132***	0.112***
(S/ per capita)	(0.0355)	(0.0286)	(0.0426)
Mining canon group 3 $_{t-1}$	0.0447	-0.00427	0.00350
(S/ per capita)	(0.0388)	(0.0576)	(0.254)
D2007 $_{t-1}$	0.281***	0.119	-0.0374
	(0.107)	(0.111)	(0.149)
Illiteracy $_{t-1}$	-0.418		
(% of the population)	(0.470)		
Rural population $_{t-1}$	-0.701		
number of inhabitants)	(3.021)		
Population of children $_{t-1}$	-0.269		
(number of inhabitants)	(1.048)		
Access to sewage		0.748	
(percentage of households)		(2.112)	
Access to the water grid $_{t-1}$		-0.0878	
(percentage of households)		(0.455)	
Inhabitants per doctor $_{t-1}$		-0.319	
(number of people)		(1.291)	
Territorial density $_{t-1}$			-1.550**
(inhabitants per km^2)			(0.771)
Urban population $_{t-1}$			1.521
(number of inhabitants)			(1.169)
Non-mining GDP $_{t-1}$			-0.499
(% of total GDP)			(0.833)
Intercept	14.00	1.570	-13.19
	(24.68)	(15.89)	(12.33)
Observations	148	148	148
AR(1) test[a]	z = -2.7542	z = -1.4199	z = -2.294
	Pr>z= 0.0059	Pr>z= 0.1556	Pr>z= 0.0218
AR(2) test[a]	z = -.2628	z = 1.1047	z = -1.6957
	Pr>z= 0.7927	Pr>z= 0.2693	Pr>z= 0.0899
Sargan test[b]	Prob>chi2= 0.8704	Prob>chi2= 0.8795	Prob>chi2= 0.9978

Note: Group 1 consists of departments that produce over 100,000 FMT on average; Group 2, seven departments that produce 100,000 FMT or less on average.

Robust standard error in parentheses. Significance level: *<0.1, **<0.05; and ***<0.01. [a] Arellano-Bond test for serial correlation. [b] Sargan test for indicators.

Source: Created by the author.

It bears mention that because the role of the canon for the group 3 departments is not significant in any case, it could be said that having minerals, especially copper, plays a role in governmental capital expenditures in the areas evaluated.

Finally, the lagged dummy variable from 2007 was only significant in the education sector. For the control variables, lagged territorial density also indicates an inverse effect on investment in transportation, implying that the larger the territory, the greater the spending on roadways and highways to permit connectivity. The rest of the control variables seem to have no effect.

5. CONCLUSIONS

Pursuant to a weak sustainability approach, the transformation of the monetary value of a mineral into productive infrastructure is a process that goes through various stages and in which various actors are involved. It entails the formation of ore prices, their extraction, the calculation of all costs intervening in the business, an estimate of revenue, the capture of the revenue by the State and, finally, spending in different forms of capital at both the central and/or local level.

If at every link of the chain of events there were no market or state failures, it is likely that the transformation of one asset into another would contribute to the maintenance of a location's wealth. This paper has evaluated just a portion of that chain with the following results.

When it comes to spending on education, healthcare, and roadway infrastructure at the *district level*, copper mining has a direct, positive, and although small, econometrically consistent effect in the three sectors. This reveals that there is indeed a process by which natural capital is substituted by productive capital, fueling, albeit in a limited fashion, the maintenance of assets in the locations evaluated.

Where spending on education, healthcare, and roadway infrastructure at the *department level* is concerned, the effect of copper mining is only felt indirectly through the mining canon, and to a lesser extent in the education and healthcare sectors. In roadway infrastructure, the impact is positive in all mining departments, but larger in departments that mine more than 100,000 FMT of copper a year, which reflects the improved long-term production conditions in Ancash, Arequipa, Moquegua, and Tacna.

These results can be explained by two reasons: one, sustainability plays a very limited role in the state's vision of development and, on the other, regionalization is still under way. With regard to the former, in Peru, the state does not calculate revenue as a resource as such, a figure that ought to reflect the value of the resource and of which the state ought to have the full right to ownership. It captures only a portion of it through the same taxes that all companies in the country pay, whether or not they exploit natural resources, and only recently, starting in 2005, through royalties, with a progressive rate based on operating profit ranging from 1% to 12%. In an attempt to harness the price boom in the sector, in 2011, a Special Mining Tax was added with a fee scheme similar to the royalty model. Nevertheless, adding together all of the tax revenue (direct) and non-tax revenue paid in by the mining sector since 2013, the figure only amounts to 33% of mining income calculated by the WB that year.

The second reason is that although since 2002 certain functions have been shifted to the regions, and in various districts, the canon has become an important source of funding, the weak effect is tied mainly to the fact that certain institutional barriers restrict public spending at the local government level. On the side of the central government, the bevy of rules regulating spending through SNIP, enacted to prevent corruption and waste throughout the country, compels compliance with requirements that are fairly restrictive—although they have been eased since 2007—and continue to act as obstacles to project approval. On the side of the local government, the low wages paid to civil servants, the scarcity of finance professionals, and the amount of time required for new officials to catch up with the program every time there are regional and district-level elections, are all factors that interfere with the spending capacity of local governments, even when the financial resources are available.

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Nota

[2] The World Bank calculates resource revenue as the difference between the price and the unit cost of extraction, which includes the normal return on capital.