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Impacts of Royalties on Copper Miners in Chile

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Abstract. We evaluate the effects of a recent proposal to raise an additional royalty payment for copper miners operating in Chile. We use a computable general equilibrium (CGE) model calibrated for the Chilean economy. Results show that GDP would decrease if we considered only the effects of the additional royalty payments. However, recycling the revenue into the economy through government expenditures and allowing real factor income to affect household consumption would make GDP to increase. This difference is mainly due to the very inelastic nature of both the demand and the supply curves for copper.

Keywords: Taxation; CGE models; Chile; Copper; Impact analysis

JEL Classification Number: C68; H20; Q38

1. Introduction

The extraction of non-renewable natural resources has the potential to generate income to finance government activities. Rent capturing through taxation may enhance the public sector ability to harness the potential of natural resources to sustain a broad-based development. Chile, the largest copper producer and exporter in the world, is one of the few nations that have succeeded in this endeavour (Collier and Venables, 2011). The country's strategy is grounded on stabilization funds, fiscal discipline and complementary policies, such as trade openness, to avoid Dutch disease (Fuentes, 2011).

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To cope with the country's commodity dependence, the Chilean government has envisaged over the years fiscal regimes that draw on two main sources of copper revenue: (i) profits obtained from CODELCO, the state-owned corporation that is responsible for around one third of total copper output; and (ii) specific and general taxes to mining activities, including the royalty on large-scale copper mines. In spite of the good management of the windfall gains during the recent copper boom, when a considerable part of the increased fiscal revenues was directed to offshore sovereign wealth funds (SWF) (Ebert and LaMenza, 2015), there is still political pressure to raise additional revenue to increase government expenditures in the producing regions. Whether there is a fair regional distribution of the rents from copper remains a disputable debate in the country.

There are different fiscal tools available to raise mining-based government revenue. Because royalties are generally payable irrespective of a project's profitability (Otto, et. al., 2006), they tend to be used as a preferable fiscal tool to secure income from natural resources operations (Lilford, 2017). Royalties reflect payments made in reference to the amount and value of the mineral produced (sales revenue). The most common form of royalties, called *ad valorem*, collects revenues based on percentage of the value of the resource extracted. This percentage is usually applied to the gross value of production, without accounting for production costs.

In this context, a recent proposal to raise an additional royalty payment for copper miners operating in the country to bolster the development of the regions around their deposits is under study in the Chilean Congress. The initiative, which was put forward by opposition legislators from mining areas and does not have government support, proposes a three percent tax on the nominal value of extracted metals (Reuters, 2018). The proposed use of the additional revenue to funding current government activities differs in essence from the prevailing fiscal regimes for the mining sector in Chile, that focus on the promotion of mechanisms that favour intergenerational transfers.

Imposing royalties to mining operations may bring important costs to the economy (Ergas, Harrison and Pincus, 2010; Dobra and Dobra, 2013; Postali, 2015). There are potential losses for the industry which has to face additional costs to its operations. Nonetheless, if recycled into the economy to finance public expenditures, royalties' revenues may provide upfront benefits to the government. The goal of this article is to calculate the general equilibrium effects of the additional royalty on the copper industry in Chile, disentangling these effects. For this appraisal, we rely on a computable general equilibrium (CGE) model calibrated with the most recent data (2014) for the Chilean economy.

2. The model

Our model's structure represents a variant of the well-documented ORANI-G model (Horridge, Parmenter and Pearson, 2000; Dixon, et. al., 1982). We use an absorption matrix published by the Chilean Central Bank as the basis to calibrate the CGE model, together with a set of elasticities borrowed from the econometric literature applied for Chile. This database allows capturing economy-wide effects through an intricate plot of input-output relations.

The Chilean version of the ORANI-G model identifies 111 sectors and 179goods and services, one service used as margin (trade services), indirect, value added and production taxes, and five user groups (producers, investors, household, foreign sector and government).

The copper sector is fully integrated in the model. In 2014, it was responsible for 10.8% of national GDP and 46.0% of total exports. Copper was its primary output (93.6% of total sectoral output), but the sector also produced molybdenum oxide (1.7%), molybdenum (1.2%), and other products (3.5%). Most of the sector's output was exported to other countries (92.7%), while the remaining part went to intra-industry consumption (5.9%) and a smaller share to the non-ferrous industry (1.4%).

From a cost perspective, intermediate consumption was responsible for 39.7% of total costs of copper production, with the remaining 60.3% allocated to payments to primary factors and production taxes. The sector paid 82.6% of total intermediate inputs costs to domestic suppliers, with the main items being housing services (17.6% of total materials cost – 93.0% from domestic sources); copper (17.4% of total – 86.0% domestic); and energy (17.2% of total – only produced domestically). Value added generated by the copper sector was very capital-intensive, with 84.9% of payments to primary factors accruing to capital, and only 15.1% to labor.

We model the additional royalty as a new *ad valorem* production tax on the total cost of production of the copper sector. Output price (adjusted for production taxes) of sector j, PX_j, is given by the weighted average of value added prices and the cost of intermediate inputs:

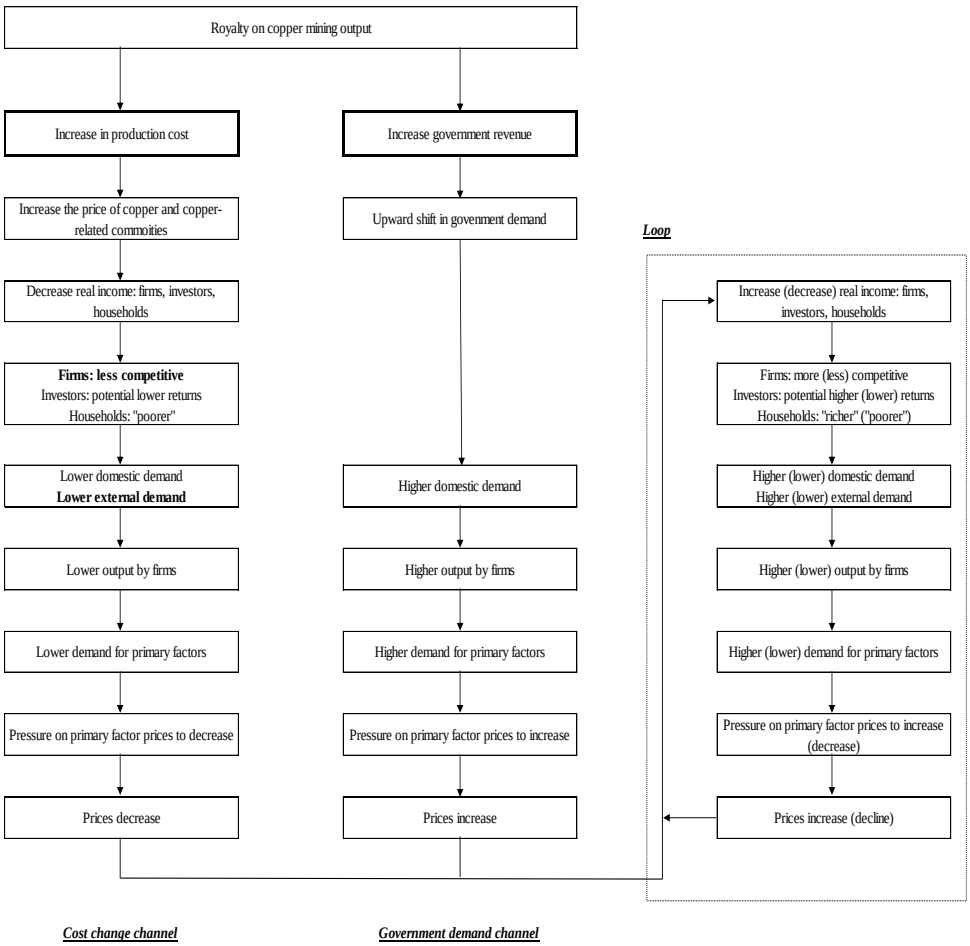
$$PX_j\left(1 - prodtax_j\right) = X_j^{-1}\left\{PV_j V_j + \sum_i a_{ij}\ PC_i X_j\right\}$$

where $prodtax_j$ is the rate of production tax.

Thus, increasing royalties in the copper sector will increase production costs, increasing the price of copper and copper-related products. This *cost change channel* is one of the two main channels through which we achieve the model's results. The second is the

government demand channel which operates when we allow royalties revenues to feed back into the system to finance government expenditures (Figure 1).

Figure 1: Causal relations underlying the system of equations of the CGE model



3. Summary of results

Despite the lack of government backing, the opposition's proposal for the additional royalty on the copper sector is under debate in Chile. To measure the impacts of the proposed three percent tax on the nominal value of copper output and disentangle the effects of different channels, we run the model under three variants of a short run macro adjustment closure.

Closure 1 focuses on the cost change channel and the potential economic losses as a consequence of the taxation and royalty impositions. This is the standard ORANI short run closure (Horridge, Parmenter and Pearson, 2000). On the supply-side, we make the capital stock, technology and the real wage exogenous. With the real wage given, the model can determine aggregate employment. With employment, technology and capital determined, the model can determine aggregate output (GDP). On the demand side, aggregate household consumption, investment, and other demands are fixed. With GDP determined from the supply side and domestic absorption given, the trade balance must act as an endogenous 'swing' variable to satisfy the GDP identity. That is, if as a result of our shock GDP increases/decreases relative to domestic absorption, the trade balance must move toward surplus/deficit. We then make closure 1 more flexible by allowing government consumption to move with tax revenue in closure 2, which focuses on the upfront benefits through taxes and royalties payable to the government. In closure 3we also allow household consumption to move with factor income.

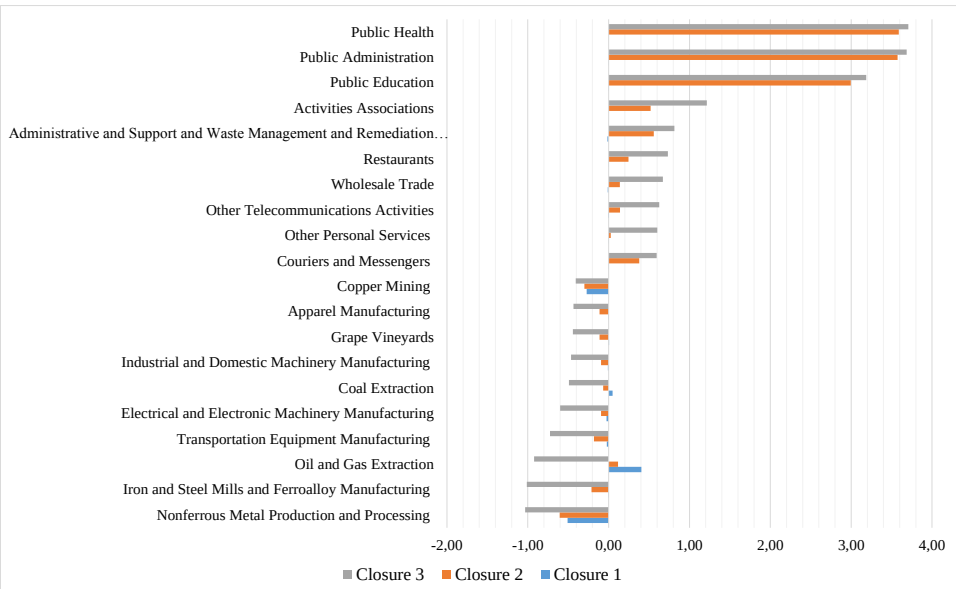
Table 1: Macroeconomic impacts of a three percent additional royalty payment by the copper sector (in percentage change)

	Short run		
	Closure 1	*Closure 2*	*Closure 3*
Aggregate primary factor payments	-0.274	0.696	2.594
Aggregate payments to capital	-0.406	0.281	2.232
Aggregate payments to labor	-0.098	1.246	3.075
Index of factor cost (excludes tech change)	-0.242	0.316	2.101
Average capital rental	-0.406	0.281	2.232
Average nominal wage	-0.024	0.363	1.929
Aggregate primary factor use (excludes tech change)	-0.032	0.378	0.482
Aggregate capital stock, rental weights	0.000	0.000	0.000
Aggregate employment, wage bill weights	-0.075	0.880	1.125
Real GDP from expenditure side	-0.030	0.357	0.512
Aggregate real investment expendiutre	0.000	0.000	0.000
Real houselhold consumption	0.000	0.000	0.653
Export volume index	-0.090	-0.151	-0.370
Aggregate real government demands	0.000	3.719	3.816
Import volume index, CIF weights	-0.001	0.217	0.843
Average real wage	0.000	0.000	0.000
Real devaluation	-0.266	-0.794	-2.454
Consumer price index	-0.024	0.363	1.929
Exports price index, local currency	0.870	1.134	2.073
Government price index	-0.025	1.035	2.551

Table 1 presents the simulation results comparing the three adjustment scenarios. Results for closure 1 show that, as a result of the additional royalty payments by the copper sector, GDP would decrease -0.030% relative to domestic absorption. Thus, the trade balance would move toward deficit. Compared to closure 2, recycling the revenue into the economy through government expenditures would make GDP to increase 0.357%. This difference is mainly due to the very inelastic nature of both the demand and the supply curves for copper. Copper exports face a downward-sloping constant-elasticity export demand curve, calibrated with a low-valued parameter (Fernandez, 2018). Moreover, with fixed capital stocks, the supply elasticity can be approximated by an expression that reflects its close connection with the elasticity of substitution between capital and labor, the shares of labor and capital in primary factor costs, and the share of primary factors in total costs. In other words, for given values of the substitution elasticity, supply is more elastic as either the labor/capital ratio is higher, or the share of materials in total cost is higher (Dixon, et. al., 1982). Finally, allowing real factor income to affect household consumption in closure 3 further improves GDP results (0.512%).

We have also calculated the impacts of the royalty payments on sectoral output. Figure 2 highlights those sectors that achieved the top and bottom performance in the three closures.

Figure 2: Impacts on sectoral activity of a three percent additional royalty payment by the copper sector (in percentage change)



4. Final comment

The more inelastic the demand or the supply of a taxed item, the lower the excess burden of the tax because of the smaller reduction in quantity sold as a result of the tax. Copper output in Chile is mainly exported and faces low export demand elasticity. Moreover, given its high K/L ratio, short run responses are restricted under fixed capital stock environments. Thus, taxing copper output may raise government revenue with a low excess burden, at least in the short term.

Good governance of natural resources indicates that governments should direct a substantial part of tax revenue raised from the mining sector into asset formation by means of domestic investment, focusing on long term intergenerational transfer of wealth (Collier and Venables, 2011). In the Chilean case, potential short run upfront growth effects, as shown in our simulations, may tempt governments to deviate from the long run focus of the current fiscal regime.

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