GWS SPECIALISTS IN EMPIRICAL ECONOMIC RESEARCH

ECOMOD 2018 – CONFERENCE PAPER

The fragility of the copper demand for the Chilean economy.

Is the increasing demand of China and India of Peruvian copper a threat for Chile?

Loreto Bieritz

Anke Mönnig

Impressum

AUTHORS

Loreto Bieritz, Anke Mönnig

Tel: +49 (541) 40933-190, Email: bieritz@gws-os.com

TITLE

The fragility of the copper demand for the Chilean economy.

Is the increasing demand of China and India of Peruvian copper a threat for Chile?

PUBLICATION DATE

DISCLAIMER

FUNDING

The results at hand have been prepared in the course of a research project for the German Federal Ministry of Education and Research (BMBF).

PUBLISHER OF THE GWS RESEARCH REPORT SERIES

Gesellschaft für Wirtschaftliche Strukturforschung (GWS) mbH

Heinrichstr. 30

49080 Osnabrück (Germany)

ISSN 2196-4262

Table of Contents

1 INTRODUCTION

As one of the world leading copper producers, Chile`s economy is strongly focused on copper: 10 % of its GDP bases on the mining sector, 30 % of all investments in the country and nearly 50 % of the Chilean exports originate on copper. Hence the dependency of Chile on that metal is high. The fact, that governmental spending is directly linked to the projected copper price, emphasizes the importance of the price for economic development. Due to a current strong worldwide demand the copper price is rising at the moment. The increasing market for electromobility and renewable energy will nourish the demand for copper even stronger: while a conventional car needs around 25 kg of copper, an electric car demands 80 kg of this metal (Toyama (2017), Warren Centre (2016), McHugh (2017)). Even though a weakening in the copper demand is not expected, China has started to enlarge its copper demand in Peru. The imported Peruvian copper misses the purity of the Chilean one but Chinas refinery capacities gives them the possibility to import the ore and refine it by themselves (Rumbo Minero (2016)). The reflexion if the northern neighbour could become a serious competitor is the topic of the presented scenario analysis.

2 COFORCE - THE CHILEAN FORECASTING MODEL

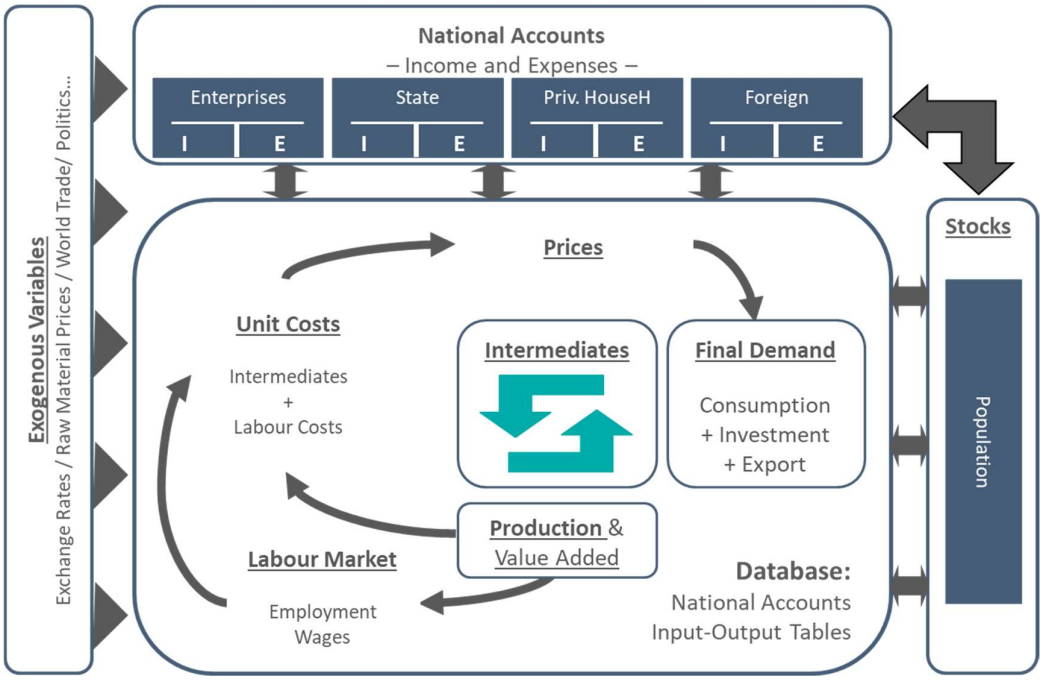
In train of the research project “Development of sustainable strategies in the Chilean mining sector through a regionalized national model” the national forecasting and simulation model COFORCE (copper forecasting Chile) was developed from scratch. The project is funded by the BMBF [1] and supports the cooperation and exchange in knowledge between a Chilean team of the University Adolfo Ibañez in Viña del Mar and the Institute of Economic Structures Research - GWS - in Osnabrück, Germany. In the first phase of the project the national model was built. Subsequent the model will be regionalized to be able to analyse regional disparities.

2.1 MODEL CHARACTERISTICS

COFORCE is based on the modelling philosophy of the INFORUM group and is characterized as a macro-econometric input-output-model, where all parameters besides the exogenous variables and the stock-data are estimated. The model equations are solved iteratively over time and no equilibrium condition has to be met. That means for instance, that the labour market does not necessarily balance also in the long run. It is distinguished by its empirical specification and is constructed around the interrelationships between individual industrial sectors.

[1] German Federal Ministry of Education and Research

Figure 1: Scheme of the model



In Figure 1 the general operation of COFORCE is illustrated in the central block, showing the intermediates, the value added and the final demand together with the labour market as the core of the model, from which the unit costs and the prices derive. The data in this inner block are estimated from the last year of historic data on. At present this is the year 2013.

The main features of the model are bottom-up modelling on 73 industry levels, total integration of input-output tables and national accounts that considers not only inter-industry relations but also income distribution and use (see Figure 1). Further characteristics are bounded rationality of economic actors, imperfect markets as well as price rigidities. Demand and supply are both treated equally. The projection horizon of the model is 2035.

2.2 DATA

To guarantee the quality of the data used, only official data sources, in particular National Accounts and Input-Output tables are used in COFORCE. They are delivered in particular by the National Statistical Institute (INE) and the Chilean Central Bank. The Input-Output-Data and the National Accounts are delivered for 73 industries and products. The employment-data is available for 32 industries. The historic database contains data for the period from 1996 until 2013. The projection starts in the year 2014 and goes until 2035.

Detailed trade data in COFORCE derives from the global trade model TINFORGE, which date from International public organizations as the OECD and the IMF. The specifications for export demand thus take into account not just the economic power of Chile's

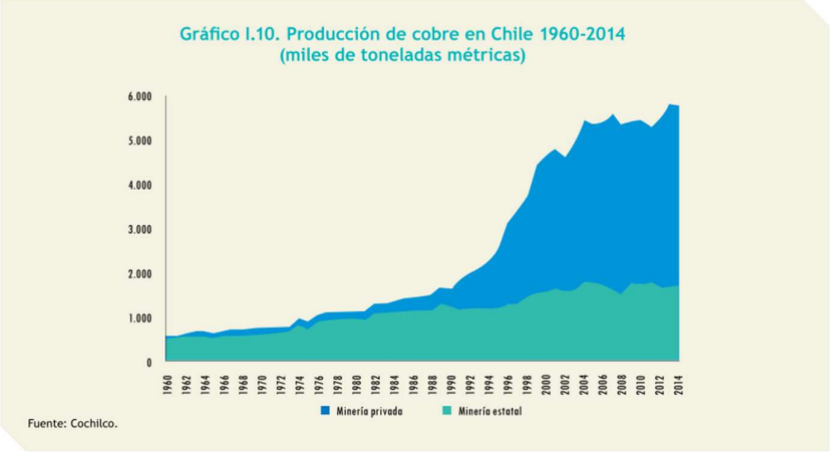
trading partners and their proportion of trade, but also distinguish between tradable goods categories. The model incorporates data for a total of 154 countries and the rest of world and 33 goods categories. This detailed treatment of Chilean export demand enables in-depth analysis of the Chilean economy and especially the copper mining industry against the backdrop of globalisation.

Next to the world trade data, the exchange rate and raw material prices are integrated as exogenous variables in COFORCE as well as the stock-data for population. These variables also date from national and international official sites as the Central Bank in Chile or the IMF.

3 THE CHILEAN COPPER MARKET

The production of the copper industry is characterized by a dynamic development. Its development is strongly linked to the investment conditions. In the years 1960 to 1980 conditions for private investment were limited and therefore the production stemmed mainly from state owned-companies. From 1990 on, the investment-conditions were liberalized in Chile with the effect, that production rose dynamically through private activity (see Figure 2) (Rodríguez Cabello et. al. (2015)). In Figure 2 the green area shows the production by state-owned companies and the blue area the one of private mining companies.

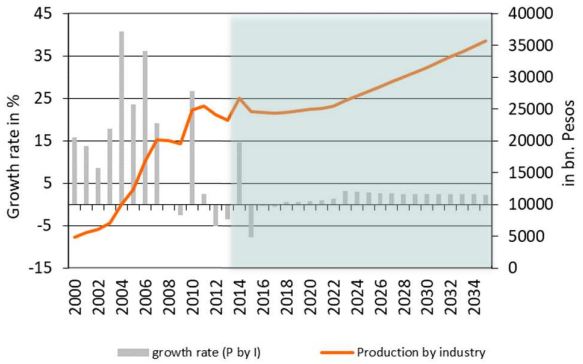
Figure 2: Copper production of private and state-owned companies in Chile 1960 – 2014 (in tons)



Source: Rodríguez Cabello et. al. (2015), p. 15

Whereas the production in tons in Figure 2 doesn`t show a strong decline through the global financial crash in 2008/2009, the production in current prices declined (see Figure 3). Afterwards the industry didn`t return to the former growth path. In the forecast (light green area in Figure 3), the production is assumed to grow constantly on a modest level.

Figure 3: Production of copper industry in current prices (2000-2035)

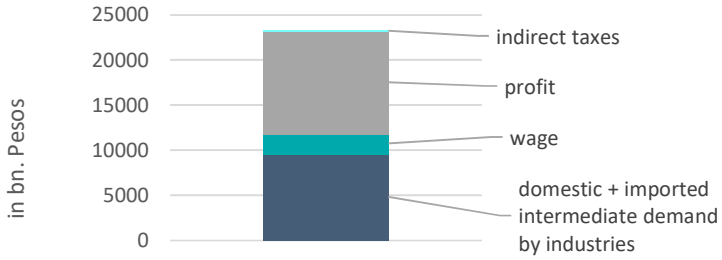


Source: COFORCE, own calculation

The copper production is strongly linked to the world market. Only 0,4 % of the final demand of copper correspond to the domestic demand at purchaser prices. The other 99,6 % are exports. The main trading partners for copper of Chile are China, Japan, India and Korea. Together, these four Asian countries demand nearly 80 % of Chilean copper. Especially China is a strong importer with a demand of more than 35 % of Chilean copper. India imports nearly an eights part of Chilean copper exports but its importance is growing constantly. The copper export itself has a share of around 45 % of the total Chilean exports. Therefore, they have a crucial role in the economic system.

The remarkable increase of private investment in copper mining in Chile can be deduced to the high possibility to gain profits. Focussing on the composition of the production of the Chilean copper industry, the share of profit of 50 % is outstanding (see Figure 4). In total, value added makes nearly 60 % of production. The intermediate demand makes a little bit more than 40 %, whereas the domestic one is predominant to the imported one.

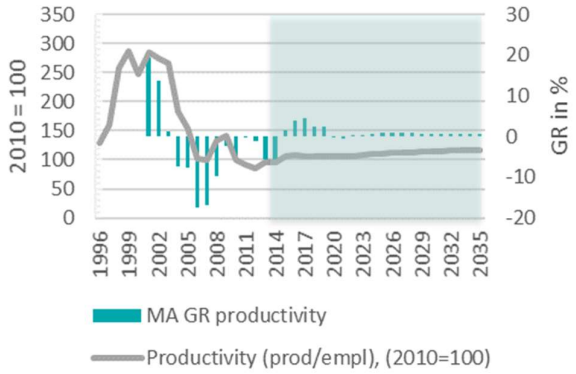
Figure 4: Production of the copper industry (2013)



Source: COFORCE, own calculation

With a quota of around 70 % the intermediate demand for copper products comes out of the copper industry itself. The basic industries of non-ferrous metals, business services, construction and commerce are the following most important purchasers of copper products.

Figure 5: Productivity of the copper industry (1996-2035)



Source: COFORCE, own calculation

A tenth part of production is wage. It goes to the more than 220.000 employed in the copper and mining extraction sector. While employment shows a constant development, the production in constant prices declined especially in the period of 2002–2006 with the effect of a loss in productivity until the year 2014 (see green bars in Figure 5). As employment-growth develops weaker in the forecast than the one of the production in constant prices, the ongoing productivity of the copper industry will rise in a modest level (light green area in Figure 5).

3.1 A RISING COPPER DEMAND IN GROWING COUNTRIES - THE COPPER DEMAND IN CHINA AND INDIA

The development of industrialized countries has been strongly influenced by copper as it was needed for electricity, plumbing and communication. Even though, new materials replaced partly the use of copper, its conducting characteristics and power storage capacities are still vital for the actual challenges of growing and densely urbanized cities. Mobility solutions with low exhaust emissions are getting essential in urban areas, where air pollution, climate concerns and congestions are achieving critical levels. Furthermore, communication keeps crucial, especially with the requirements of the industry 4.0 and a higher demand of labour mobility. The latter rises the need for housing and its technical appliances as well as improving in a cleaner power generation to achieve international decarbonization aims (Warren Centre (2016)).

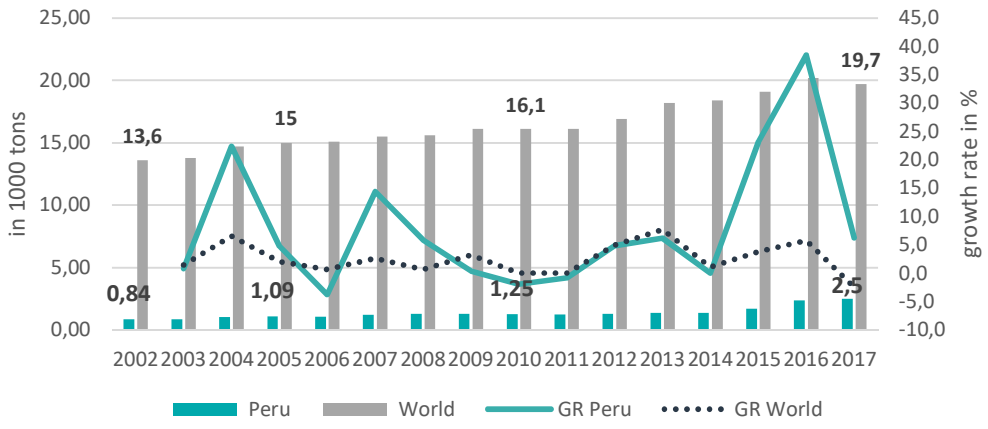
A recent study from the Warren Centre of the University of Sydney (Australia) about the impact on copper demand by 2030 in Asia concludes, that the growing sustainability awareness in Asian countries will favour copper intensity (Warren Centre (2016)). Based on the fast growing and aging population in China and India combined with its highly centralized economic development, the copper demand from these countries will be outstanding. A main factor will be the electricity demand in Asia that is predicted to represent half of the world`s demand by 2030 – out of which China will consume two-third. For pollution reasons China is shifting away from fossil fuels to renewable energy production and India pursues an ambitious renewable policy. In contrast to a fossil fuel power generation the use of copper in renewables are four to twelve times higher (Warren Centre

(2016), McHugh (2017), Spiegel Online (2014), Uken (2011)). The electrification of transport will also rise the copper demand: Light vehicles, that use electromobility instead of primary energy sources need 80 kg of copper instead of 25 kg (Toyama (2017), Warren Centre (2016), McHugh (2017)). Until 2030 the Warren Centre predicts 75 million electric and plug-in hybrid cars out of which 55 % will circulate in China and nearly 20 % in India. In sum more than 55 million vehicles would be in these two countries, which would represent a positive impact in copper demand. The expansion to an efficient public transport systems like high speed or urban rails and electric buses will also have a significant additional copper demand. The cited study assumes a high implementation of these transport systems for China. The building necessity in China and India is another decisive factor to increase the copper demand. As a consequence of the population development in these countries, construction needs will rise. For the year 2024 the UN expects India`s population to surpass China`s one. Each of them will have around 1,44 billion people. Until 2030 the population in India is projected to surpass the level of 1,5 billion persons while China is expected to remain stable (United Nations (2017)). In consequence of a lower urbanisation in India, the additional copper demand will be equivalent to 55 % of Chinas demand with an urbanisation degree of 65 %. Additional appliance-demand is forecasted at 790 kt in China and 430 kt for India until the year 2030 (Warren Centre (2016)).

3.2 PERU – A SERIOUS COMPETITOR?

Peru has the third biggest copper reserves in the world and accounts as the second biggest producer after Chile (ICSG (2017), Chong et. al. (2016), Marchesi et. al. 2013)). The copper mining industry expanded its production from the year 2002 on and intensified it especially from 2010 on, when production was doubled and achieves an amount of 2,5 million tons or the equivalent of an eights of worlds production (see Figure 6). This production-increase strengthened the dominant role of mining products for the Peruvian economy as it has a share of over 60 % of all Peruvian exports (Chong et. al. (2016)).

Figure 6: Copper production in Peru and the world (2002-2017), in tons and growths rates



Source: USGS (2017), own calculation

The latest increase is the result of an intensification of production in the southern copper belt of Peru. Especially the exploration of Las Bambas, a mine owned by the Chinese company MMG Ltd. contributes to the strong increase in recent years. The mine`s output started with 300 thousand tons in 2016 and in its first complete year of activity (2017) the output was of more than 450 thousand tons. That is an equivalent of 18 % of the national production in that year (Las Bambas (2018), SEMANA económica (2017), Taj (2018), Trading Economics (2018). The Peruvian mining policy sets value on promoting mining investments. Although investments declined from 2013 on, the recent rise of metal prices favors further activities (Chong et. al. (2016), La República (2017)).

4 SCENARIO – A DEMAND SHIFT TOWARDS PERU

The capacity of the Las Bambas-mine is of over 50 million tons and therewith one of the world`s largest copper mines. Once in full production, Peru will rise to one of the main copper producers worldwide. In order to respond the rising protests against the exploration and its social and environmental consequences for the region, infrastructural projects like a 600 km long railway stretch to the coast are being evaluated to lower the dust and noise of the trucks carrying the concentrates (Taj (2018)). Once this project is realized an acceleration of production is possible.

The aim of the described scenario is to quantify the impact of a demand shift on the Chilean economy, especially on the GDP, the governmental income and on selected sectoral productivity. Therefor the demand from China and India of Chilean copper will be reduced from 2018 on for a period of five years. Assuming that Peru is constantly developing its mining capacity and its infrastructure to transport the copper concentrates to the coast, the reduction of copper demand from Chile will rise constantly in this scenario.

In sum, the amount of demanded copper from Chile will be reduced for 5 years until the year 2022. From the year 2023 on, the reduced export will finish. This allows the analysis of the rebound-effect after the intervention. The scenario will be compared to the baseline-scenario, that represents the COFORCE model-results without an intervention, i. e. without changing the copper exports.

4.1 SCENARIO ASSUMPTIONS AND SETTING

The Chinese and India’s demand shift takes into account the production rise by the Las Bambas-mine, which corresponds to an equivalent of 8,2 % of Chilean production in the year 2017. The output of over 450 thousand tons in the year 2017 is absorbed by the Asian market and represses the Chilean copper because of lower production prices and direct access through Chinese ownership (Las Bambas (2018), SEMANA económica (2017), Taj (2018)). But in consequence of the remarkable purity of the Chilean product, the output of the new Peruvian mine doesn`t replace in total the copper demand from Chile. In the scenario we assume that China and India reduce their copper demand from Chile by 5 % p. a. each for a period of five years (2018 – 2022). Further, it is taken into

account, that the international copper demand will still rise constantly. That means, that the Chilean copper exports won`t fall by 5 % p. a. directly but the former growth path will weaken (see Table 1).

In the year before the intervention, the Chinese shares are of 33,8 % of the Chilean copper exports and the Indian shares amounts 12,9 %. Reducing the copper imports of China and India, Chinese shares at the end of the scenario-period are of 31,7 % and Indian shares are of 12,7 % (see Table 1).

Table 1 Scenario setting

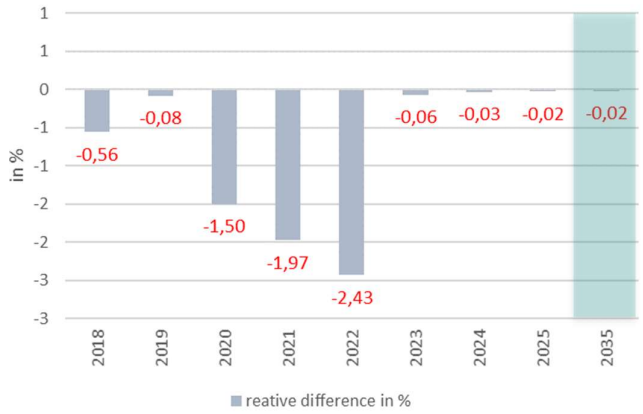
	2017	2018	2019	2020	2021	2022
BASIS copper export, 2017=100	100	103,0	106,1	109,3	112,7	116,2
SCENARIO copper export, 2017=100	100	100,5	101,0	101,6	102,2	102,9
China, in %	33,8	33,7	33,0	32,7	32,3	31,7
India, in%	12,9	12,9	13,1	12,9	12,8	12,7

4.2 EFFECTS OF THE EXPORT DEMAND SHIFT

4.2.1 EFFECT ON THE CHILEAN GDP

The export reduction to China and India lowers directly the Chilean GDP. In the first year of the export shift, GDP falls by 0,6 %. After a weak recovery of the GDP-effect in the second year of the scenario, GDP falls constantly with the reduced copper-export and reaches its lowest level in the years 2022, when the GDP falls by 2,4 % (see relative difference Figure 7). In the year 2023, when the copper-import demand from China and India gets back to its former path, GDP still shows a decline of 0,1 % to baseline. But already in the second year after the end of the export reduction, GDP is nearly recovered. Though, the Chilean GDP doesn`t recover completely from the demand shift until the end of the projected period in 2035. A small difference of 0,02 % to baseline remains (see the year 2035 in the light green bar in Figure 7).

Figure 7: Relative difference of gross domestic product in constant prices to baseline

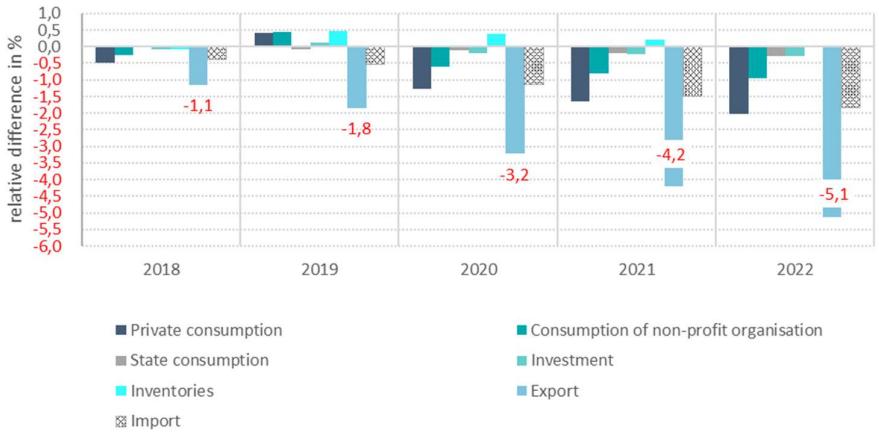


Source: COFORCE, own calculation

The improvement of the GDP-decline in the second year of the scenario is a consequence of private consumption (see dark blue bar in Figure 8). In COFORCE the consumption of private households are estimated as a function of the real disposable income and the relative producer prices to consumer prices. The real disposable income and the relative producer price by product are functions of consumer prices and of the producer prices. Both, consumer and producer prices are estimated with last year´s wage or last year`s unit costs. Wages fall by a reduced production. Unit costs are also functions of production or wages and change therefore through the changed export. In sum, these two time lagged variables lead to a short improvement of GDP in the second year of the export demand-shock.

In addition to the lowered wages, the reduced production implies also a fall in the Chilean import demand, which, in turn, damps the decrease in GDP. The development of a changed Chilean import-demand is shown as a patterned bar in Figure 8, which declines with each year of reduced copper exports.

Figure 8: Relative differences in the gross domestic product-components to the baseline scenario



Source: COFORCE, own calculation

Nevertheless, the strongest influence on the GDP has the export itself (pale blue bar in Figure 8). It reduces by 1,1 % in the first year of the scenario and falls by 5,1 % in comparison to baseline in the year 2022.

Besides of the state consumption, the other GDP-components don`t recover in total until the end of the projection period. The state consumption instead returns to the former growths path in 2027.

4.2.2 EXPORT-EFFECTS ON THE CHILEAN PRODUCTION

The effect, that the demand shift has on foreign trade as well as on private consumption (see 4.2.1) implies a decline in the production of nearly all industries. Comparing the national production in the baseline scenario with the copper-export-reduction-scenario a relative difference on the level of the GDP-deviation can be observed. The relative difference is calculated with the production in constant prices.

Focusing on the single industries the strongest effect of a lower copper export manifests in the copper mining industry itself, where the relative difference to the baseline scenario rises up to nearly -12 % at the end of the demand shift in 2022 (see Table 2). Hereafter production decreases in industries strongly linked to the copper production like the manufacturing of transportation equipment, the railway transportation or the manufacturing of machinery (with and without electrical equipment) as well as the supply of electricity and gas.

As we compare the production in constant prices we achieve also positive effects on a copper export reduction. Education, construction or iron mining for example show a production increase, because the production prices, fall comparatively stronger than the production itself. As a result, the production in constant prices rise.

Table 2 Top fifteen affected industries in production by a copper export-demand shift (constant prices; relative difference in %)

	2018	2019	2020	2021	2022	2035
Oil Extraction	-0,6	-0,4	-1,6	-2,1	-2,6	0,0
Iron Mining	0,1	1,4	0,4	0,5	0,6	0,0
Copper Mining	-2,5	-4,3	-7,2	-9,4	-11,6	0,0
Manufacture of machinery and non-electrical equipment	-1,0	-0,1	-2,6	-3,4	-4,2	0,0
Manufacture of machinery and electrical equipment	-0,8	-0,8	-2,3	-3,0	-3,7	0,0
Manufacture of transportation equipment	-1,8	0,2	-5,4	-7,1	-9,0	-0,1
Manufacture of rubber products	-0,7	0,4	-1,9	-2,5	-3,0	0,0
Electricity supply	-1,0	-1,3	-2,8	-3,8	-4,7	0,0
Gas supply	-0,8	-0,8	-2,2	-2,9	-3,6	0,0
Construction	0,2	0,6	0,7	0,9	1,1	0,0
Restaurants	-0,6	0,6	-1,6	-2,0	-2,4	0,0
Railway transport	-0,9	-0,8	-2,5	-3,2	-3,9	0,0
Insurance companies	-0,6	1,2	-1,7	-2,1	-2,5	-0,1
Public education	0,3	0,5	1,0	1,3	1,6	0,0
Recreational activites	-0,4	0,0	-1,1	-1,1	-1,2	0,0

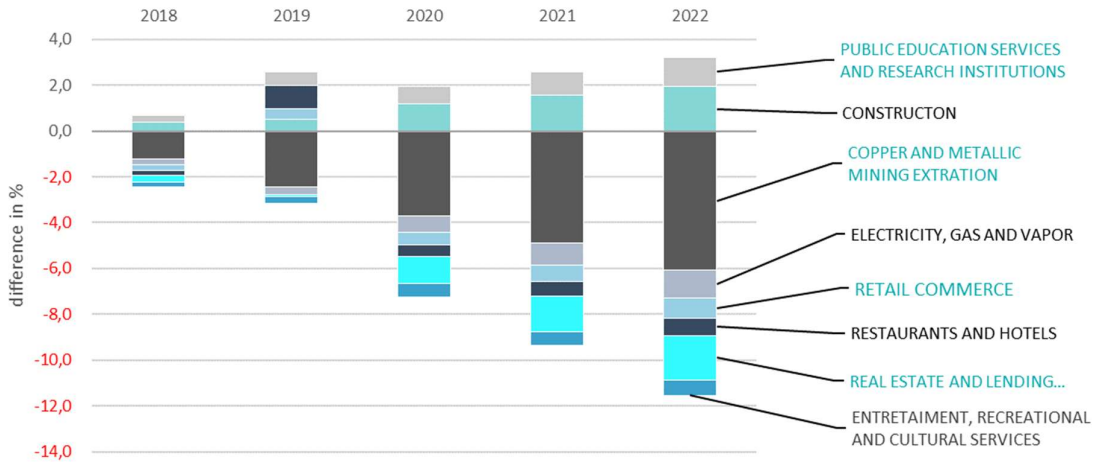
Source: COFORCE, own calculation

In the long run, the production-path of the baseline is nearly reached in the first year after the export-reduction finishes. The slightly different production level in between the scenario and the baseline maintains by 2035.

4.2.3 LABOUR MARKET REACTIONS

The production decline goes along with a soft employment-effect in a range of +0,1 % (2019) to -0,3 % (2022) in comparison to the baseline scenario. The single industries react diversely, whereas most show a declined employment after an export demand shift, while the employment in a few industries increase. A positive employment-effect can be seen in construction and in education and research institutions (see Figure 9). The reason for this effect is that in COFORCE employment is estimated with real production and real wage. Production in basic prices declines in all industries but as it was already shown in the production in constant prices (see 4.2.2), production in a few industries rise because of a price effect.

Figure 9: Main labour market reactions to an export-decline (in %)



Source: COFORCE, own calculation

The strongest employment effect is seen in the copper mining industry itself, where employment falls by 6,1 % (2022) in comparison to the baseline scenario, followed by real estate, electricity, retail commerce, restaurants and hotels and entertainment services (see Figure 9).

Similar to the real production, employment recuperates in the first year after the export-reduction ends. But the same level of employment can`t be achieved in no Chilean industry.

4.2.4 THE PRODUCTIVITY OF THE COPPER INDUSTRY

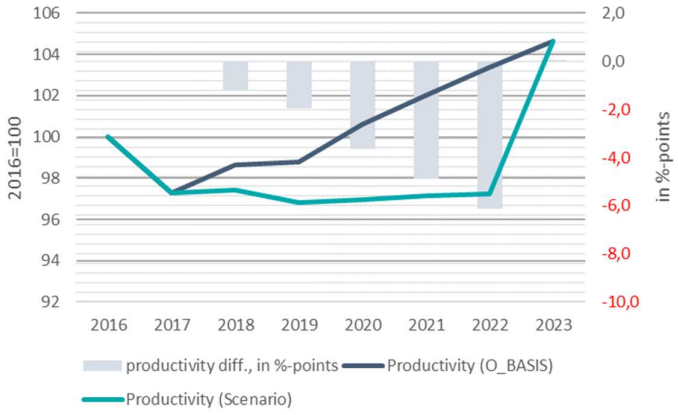
For the copper industry itself, the demand shift towards copper from other countries, has next to the production fall (see chapter 4.2.2) a direct effect on the productivity. Here the productivity is measured as the result of production in constant prices per employment .

In the baseline scenario (blue line in Figure 10) productivity declines in 2017 but manages to recover from 2020 on, when productivity reaches the index-level of 100 again. In the export-reduced scenario (green line in Figure 10), the recovery takes three years longer to achieve the productivity measured in the year 2016 (see Figure 10). As long the copper industry is restricted in its exports, its productivity doesn`t reach the level of 2016.

In the first year of a reduced copper-export, the productivity is 1,2 points below the productivity of the baseline scenario (see grey bars in Figure 10). This difference increases up to a difference of 6,1 points in the year 2022.

Other industries' productivity is less affected. The productivity of the Chilean economy as a sum declines in the calculated scenario and differs up to 2,2 percentage points from the baseline scenario in the year 2022. Equally to the copper industry, the productivity of the whole economy recovers its productivity after the last of intervention.

Figure 10: Relative differences in productivity in the copper mining industry compared to the baseline scenario

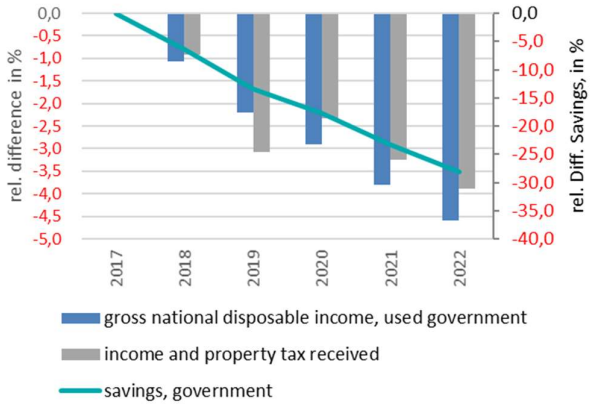


Source: COFORCE, own calculation

4.2.5 EFFECTS ON GOVERNMENTAL INCOME

As a consequence of the production-decline in nearly all industries, the Chilean governmental income decreases in moments of reduced copper exports. As seen in the GDP-effects (see 4.2.1), the decreasing effect on the gross national disposable income strengthens with each year of a reduced export (see blue bar in Figure 11). Starting with a relative difference of – 1,1 % (2018) the difference of the development of the gross national disposable income risens up to – 4,6% in the year 2022. Thereafter it recovers and reaches the former path (baseline) in the second year after the intervention has finished.

Figure 11: Relative differences in selected state accounts to the baseline scenario (in %)



Source: COFORCE, own calculation

The governmental income is not only reduced by the smaller profits of the copper mines but especially by the negative effects the reduced copper exports have on the labour

market: Employment lowers up to additional 28 thousand persons in the year 2022 and as a result, income and property taxes get less, too (grey bar in Figure 11). To balance the reduced national disposable income, the Chilean government is forced to reduce the savings strongly and risen its net lending during the period of the decreased copper-export. The savings lower from 6,3 % in the first year of the scenario and goes up to 28,1 % in the last year of the export intervention (see green line in Figure 11).

5 SUMMARY

The focus of the presented scenario was to analyse the vulnerability of the Chilean economy in relation to a demand shift of copper. A general rising world copper demand - especially by China and India - is assumed, but higher production capacities in Peru by the exploration of the Las Bambas-mine in the south of the country, manages to absorb a part of the rising copper demand and to deviate it from the world`s strongest copper producer Chile. The scenario stipulates a copper demand-reduction from Chilean copper by India and China of 5 % each p. a. for a period of five years. After this intervention, a return to the former export-demand is assumed. This gives the possibility to analyse the capacity of returning to the former development path.

In sum, a lower copper demand reduces the whole Chilean production in constant prices by 2,4 % after five years. Especially the production of the copper industry itself decreases by nearly 12 % in comparison to the baseline scenario (situation without a reduced export). Next to this direct production-loss, the production of the manufacturing of machinery and transport equipment is strongly negatively affected as well as the energy production and the railway transport. But as production prices don`t rise equally to the production decline, a few industries like iron mining, construction or education show an increase in real production. Employment, that in COFORCE is a function of production and real wages, show a comparable development to production. The Chilean production fall of 2,4 % (2022) goes along with a similar productivity-loss. On the level of the copper industry itself, the productivity-loss is of 6,1 % in the year 2022, when the export-reduction reaches its highest level. The governmental income is reduced, too by the assumed demand-shift to Peru and consequently its possibilities to enforce intended policy measures fall. In contrary, by increasing the net lending of the country, Chile even reduces its scope of action.

Hence the intermediate demand for copper is concentrated on a few industries, the scenario analysis shows, that an export reduction of copper affects the development of all industries in Chile. By a shifted export demand, Chile loses part of its GDP in a long run. And the GDP-effects get stronger as the export-reduction lasts. In the long run instead, the Chilean economy recovers fast. Even if the baseline development path is not reached in total, a recovery of the economic development is nearly achieved in the second year after the export-intervention finishes.

The strong rebound-effect show that the Chilean economy has capacities to recover fast from a demand-shift and therefore it shows a stable shape towards a stronger getting competitor in the region. But the exploration and development in the northern

neighbourhood should be observed and taken as an incentive to improve its own production and productivity against the backdrop of rising environmental and sustainable requirements. The most affected industries concerning production and employment should thereby work on a stronger diversification of their clients to be better prepared for a possible demand-shift and on a higher degree of flexibility in the labour market. Latter is either not capable to dismiss the employed persons in the same degree the demand falls or to find alternative occupational activities for the employed in the export-reduced-affected industries.

BIBLIOGRAPHY

Burger, Schalk (2018): Copper production declined in first ten months of 2017 – ICSG. Creamer Media's Mining Weekly, January 23, 2018, http://www.mining-weekly.com/article/copper-production-declined-in-first-ten-months-of-2017-icsg-2018-01-23, accessed May 4, 2018.

Chong, Esteban, Marchesi, Orlando, Aparicio, Hernán, Salicetti, Humberto & Remy, Alfredo (2016): 2016 Doing Business in Peru – Mining Chapter. PriceWaterhouseCoopers, https://www.pwc.de/de/internationale-maerkte/assets/doing-business-in-mining-peru-2016.pdf, accessed May 4, 2018.

Economía y Negocios (2017): Presupuesto 2018 aumenta gasto público en 3,9%. El Mercurio, October 2, 2017, http://www.elmercurio.com/Inversiones/Noticias/Fondos-Mutuos/2017/10/02/Presupuesto-2018-aumenta-gasto-publico-en-39.aspx, accessed May 4, 2018.

Elmer, Christina & Farahani, Donya (2015): Uno-Prognose zur Weltbevölkerung – die Menschheit in 85 Jahren. SPIEGEL ONLINE, August 3, 2015, http://www.spiegel.de/wissenschaft/mensch/uno-prognose-so-entwickelt-sich-die-bevoelkerung-bis-2100-a-1046128.html, accessed May 4, 2018.

Flanagan, Daniel M. (2018): Copper. In: U.S. Department of the Interior, U.S. Geological Survey (USGS): Mineral Commodity Summaries 2018, pp. 52–53, January 31, 2018, https://minerals.usgs.gov/minerals/pubs/mcs/2018/mcs2018.pdf, accessed May 4, 2018.

González, Alfonso (2016): Gobierno recorta en US$540 millones el gasto público para este año. EMOL, August 3, 2015, http://www.emol.com/noticias/Economia/2016/02/29/790594/Gobierno-recorta-en-US540-millones-el-gasto-publico-para-este-no.html, accessed May 4, 2018.

International Copper Study Group (ICSG) (2017): The World Copper Factbook 2017. Lisbon, http://www.icsg.org/index.php/component/jdownloads/finish/170/2462, accessed May 4, 2018.

La República (2017): Perú desplaza a China como segundo productor de cobre. March 6, 2017, https://larepublica.pe/economia/1020921-peru-desplaza-a-china-como-segundo-productor-de-cobre, accessed May 4, 2018.

Las Bambas (2018): La producción de Las Bambas impulsa año récord en cobre para MMG. January 24, 2018, http://www.lasbambas.com/notas-de-prensa/la-produccion-de-las-bambas-impulsa-ao-record-en-cobre-para-mmg, accessed May 4, 2018.

Marchesi, Orlando, Gaveglio, Fernando & Salicetti, Humberto (2013): 2013 Mining Industry – Doing Business in Peru. PriceWaterhouseCoopers, https://www.pwc.de/de/internationale-maerkte/assets/doing-business-in-mining-peru.pdf, accessed May 4, 2018.

McHugh, Babs (2017): Electric vehicles, renewable energy driving demand, and price, for copper. http://www.abc.net.au/news/rural/2017-08-15/copper-demand-and-

price-up-on-electric-vehicle-demand/8799106, accessed May 3, 2018.

Peru Reports (2018): Mining Statistics. https://perureports.com/mining-statistics/, accessed May 4, 2018.

Rodríguez Cabello, Jorge, Vega Carvallo, Alejandra, Chamorro Montes, Jessica & Acevedo Olavarría, Maximiliano (2015): Evolución, administración e impacto fiscal de los ingresos del cobre en Chile. Estudios de Finanzas Públicas, no. 23, DIPRES.

Rumbo Minero (2016): Minería Peruana 2017 – Proyecciones de los Top. December 2016, http://www.rumbominero.com/ED99/RM99.pdf, accessed May 4, 2018.

SEMANAeconómica (2017): Las Bambas impulsó el crecimiento de MMG en el 2016. March 10, 2017, http://semanaeconomica.com/article/sectores-y-empresas/mineria/218430-las-bambas-impulso-el-crecimiento-de-mmg-en-el-2016/, accessed May 4, 2018.

SPIEGEL ONLINE (2014): Erneuerbare Energien – Materialaufwand macht sich bezahlt. October 7, 2014, http://www.spiegel.de/wissenschaft/natur/erneuerbare-energien-trotz-materialaufwand-den-fossilen-ueberlegen-a-995864.html, accessed May 4, 2018.

Taj, Mitra (2018): Peru eyes $2.4 billion minerals railway as copper output rises. Reuters, January 11, 2018, https://www.reuters.com/article/us-peru-mining-railways/peru-eyes-2-4-billion-minerals-railway-as-copper-output-rises-idUSKBN1F003C, accessed May 4, 2018.

The Warren Centre (2016): Copper Technology Roadmap 2030 – Asia's Growing Appetite for Copper. July 2018, https://thewarrencentre.org.au/wp-content/uploads/2016/08/wc3488-1-The-Copper-Technology-Roadmap-2030.pdf, accessed May 4, 2018.

Toyama, Naoyuki (2017): Copper solid on China, India demand, electric cars: Antofagasta CEO. Nikkei Asian Review, September 9, 2017, https://asia.nikkei.com/Business/Copper-solid-on-China-India-demand-electric-cars-Antofagasta-CEO, accessed May 9, 2018.

Trade Promotion Council of India (TPCI) (2017): India's trading opportunity with Peru. http://www.tpci.in/wp-content/uploads/2017/06/Trading-Opportunity-with-PERU.pdf, accessed May 4, 2018.

Trading Economics (2018): Peru Copper Production 1988-2018. https://tradingeconomics.com/peru/copper-production, accessed May 4, 2018.

Uken, Marlies (2011): Ohne Kupfer keine Energiewende. ZEIT ONLINE, September 1, 2011, https://www.zeit.de/wirtschaft/unternehmen/2011-08/rohstoff-kupfer, accessed May 4, 2018.

United Nations (2015): World Population Prospects – Key findings & advance tables. 2015 Revision, Department of Economic and Social Affairs, Population Division, New York. https://esa.un.org/unpd/wpp/publications/Files/WPP2017_KeyFindings.pdf, accessed May 4, 2018.

ZEIT ONLINE (2015): Weltbevölkerung wächst schneller als angenommen. July 29, 2015, https://www.zeit.de/gesellschaft/2015-07/bevoelkerungsentwicklung-vereinte-nationen-weltbevoelkerung, accessed May 4, 2018.