WPS8183

Policy Research Working Paper 8183

Investigating the Transmission Channels behind Dutch Disease Effects

Lessons from Mongolia Using a CGE Model

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WORLD BANK GROUP
Macroeconomics and Fiscal Management Global Practice Group
September 2017

Abstract

This paper uses a computable general equilibrium model —Maquette for Millennium Development Goal Simulations (MAMS)—calibrated to Mongolia to investigate how the development of major mining projects leads to Dutch disease. The simulations suggest that the process is complex, with the relative strength of the different spending and resource movement channels determined by structural features of the economy, such as factor input needs of the mining sector and substitution elasticities, and how mineral windfalls are eventually spent. In Mongolia, mining sector demand for domestic factor inputs explains two-thirds of the appreciation of the real exchange rate, with demand for labor, a "quasi-fixed" factor, the most potent channel for transmitting Dutch disease.

The simulations also suggest that public policies may only play a limited role in limiting Dutch disease, even if growing fiscal revenues are channeled toward productivity-enhancing public investment rather than public consumption or lower taxes. This finding suggests that policy makers face real trade-offs, namely that, as an equilibrium response, Dutch disease is unavoidable and at odds with an export-led, manufacturing-oriented development strategy unless resources are left in the ground (or mining earnings are saved abroad). If the objective is to limit Dutch disease, then the simulations point to policies that minimize the usage of domestic inputs by the mining sector, or that accommodate the growing demand for key inputs such as labor e.g. through immigration. Regarding spending, policy makers should channel mining revenues toward public investment, to expand the economy's long-run supply potential. Where large direct income flows from the mining sector to households are important, monetary policy may be more useful than fiscal policy in constraining private spending.

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Investigating the Transmission Channels behind Dutch Disease Effects: Lessons from Mongolia Using a CGE Model

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JEL: D57, D58, E60, O53, Q33

Keywords: CGE, MAMS, Dutch disease, Mongolia, Natural Resources

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I. Introduction

Dutch disease, a term originally used by The Economist in 1977 to describe the appreciation of the Dutch guilder after oil was after the start of North Sea oil exports, refers to the macroeconomic effects of natural resource windfalls. Following seminal papers by Corden and Neary (1982), Corden (1984), and Van Wijnbergen (1984), economists have recognized a factor of production *movement* effect and a *spending* effect as key elements of the disease.[2] With government spending of resource revenues also playing an important role in transmitting Dutch disease to the economy, a large literature focused on appropriate fiscal policies in resource rich countries has also emerged (Van der Ploeg and Venables, 2012; Barnett and Ossowski, 2002; Davis et al. 2002).

Dutch disease is potentially relevant to Mongolia, where natural resource dependence has grown fast over the past decade-and-a-half. Mineral wealth is estimated at $1 trillion to $3 trillion for a population of just 3 million (IMF, 2015). As major mining projects – notably, the giant copper-gold Oyu Tolgoi (OT) mine[3] – have come onstream, growth has surged, making the country one of the fastest growing in the world in recent years. Mining exports account for more than 90 percent of total exports and nearly a fifth of government revenues, leaving the economy highly vulnerable to commodity price volatility. Despite the adoption of a fiscal rule in 2010, fiscal policy has remained pro-cyclical and the public sector has become a conduit for Dutch disease to the economy in recent years. Public spending has expanded strongly, and Mongolia is perhaps the only country in the world which has employed a direct resources-to-cash scheme – operating a universal cash transfer scheme between 2010 and 2012 (Ying and Howes, 2015). Arguably, these policies came up against to domestic absorption constraints – regarded as a key factor in why developing countries experience problems with resource windfalls (Van der Ploeg, 2012; Van der Ploeg and Venables, 2010) – that are visible in the form of structurally high inflation and large (non-mining) trade deficits.

Looking beyond fiscal policy, private spending of income from the mineral sector has emerged as another channel of transmission for Dutch disease. In 2012, the government allotted a notional 20 percent of the equity of the state-owned mining company, Erdenes Tavan Tolgoi (TT),[4] to the population. Prior to elections in mid-2012, it monetized the value of these shares by offering the public a choice of selling their stake back to the government if they did not wish to wait for the public listing of Erdenes TT. Approximately half the population – about 1.2 million people – elected to receive cash for their shares, with the remainder opting to retain shares.[5] It is estimated that 1.5 million Mongolians still own shares in Erdenes TT, and in June 2016, the Mongolian PM announced plans to buy another 30 percent of the shares from the public.[6]

This study analyzes the transmission mechanism behind Dutch disease effects within a computable general equilibrium (CGE) framework. Specifically, the study examines what are most important channels by which Dutch disease is transmitted to the Mongolian economy when the mining sector scales up in size and the

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[2] The literature has also expanded to include similar effects from other shocks such as capital inflows, aid, and remittances and tourism. See Auty, 2001; Adams and Bevan, 2003; and Acosta et al, 2009. Magud and Sosa (2010) also provide a comprehensive overview of the analytical literature and associated empirical evidence.

[3] The OT mine is one of the largest copper-gold mine complexes in the world. It is expected to produce 0.5 million tons of copper, 0.65 million ounces of gold, and 3 million ounces of silver a year, on average, during its first 10 years. Escondida, the world's largest copper mine located in Chile, in comparison, produced 0.81 million tons of copper in 2011 and 1.09 million tons in 2010.

[4] Erdenes Tavan Tolgoi (Erdenes TT) is the subsidiary of Erdenes MGL a government-owned company that owns Tavan Tolgoi (TT). TT is one of the world's largest untapped coking and thermal coal deposits, and is divided into six sections the largest two of which are referred to as the Tsankhi coalfields. Erdenes TT manages the development of the East Tsankhi block.

[5] IMF (2011) and Van den Brink et al. (2012).

[6] http://theubpost.mn/2016/06/13/cabinet-to-buy-back-erdenes-tavan-tolgoi-shares-from-the-public/.

associated policy implications. It uses model-based analysis to gain conceptual clarity on these issues. The drawback is that such an analysis is necessarily highly stylized and therefore model results provide only a limited degree of realism. That is, the simulation results presented here for Mongolia should be seen as sketching out the underlying processes, with individual numerical results providing qualitative insights but not quantitative precision.

Regarding our modeling strategy, a CGE framework is preferred as it allows us to take into account complex interactions across time, across different factor inputs and a multitude of sectors in the economy. In contrast, DSGE models that are frequently used to model Dutch disease in existing literature are more limited with respect to the number of variables that can be considered and the degree to which economies/sectors can be disaggregated. The paper is accompanied by a background paper that benchmarks a CGE model for Mongolia against actual developments in the economy during the 2006-09 commodity boom-bust period (Khan and Gottschalk, 2017). That paper shows that a CGE framework is able to approximate macroeconomic impacts associated with commodity price fluctuations, but that it underestimates macroeconomic demand pressures, in part due to the inherent complexity of commodity boom-and-bust cycles and the long-term focus of MAMS simulations in which economic adjustment to shocks takes time.

The paper proceeds as follows. It calibrates the World Bank's CGE model MAMS ("Maquette for Millennium Development Goal Simulations") to Mongolia. The model provides an economy-wide multi-sectoral framework for medium-to-long-run analysis.[7] Baseline simulations are set up to benchmark the impact of a doubling of mining sector output between 2013 and 2016, with simulation results reported until 2026. In these simulations, all transmission channels for Dutch Disease are allowed to operate, i.e., the mining sector is fully integrated into the economy, drawing upon available factor inputs and generating income for households and the public sector. The simulations show that a doubling in mining production results in an appreciation of the real exchange rate of 15 percent and in a contraction of tradable sector output by approximately 20 percent.[8] These two variables are considered to be key indicators of Dutch disease effects.

A key issue that needs to be clarified at the outset relates to the role of foreign direct investment (FDI) for Dutch disease effects. Arguably, none of the Dutch disease effects described above would have happened if it had not been for large FDI projects that build the major mining projects in the first place. This study attempts to dig deeper and show that what really matters for Dutch disease effects is (i) to what extent these projects utilize domestic inputs, and (ii) to what extent natural resource revenues generated by them are spent domestically. To illustrate this, the study constructs a reference scenario where FDI projects bring about a major expansion in mining but the rest of the Mongolian economy remains completely insulated as long as the mining sector is a perfect enclave that utilizes no domestic inputs (i.e., all production factors and inputs are imported) and all income generated by the project accrues to foreigners and never enters the Mongolian economy. Our simulations show that Dutch disease effects arise only as the enclave character of the mining sector is loosened and spillovers to the domestic economy occur.

Finally, alternative scenarios are set up to gauge the relative importance of individual transmission channels, including the use of domestic factor inputs (intermediate, labor and capital); government spending of income from the mining sector on public consumption, investment and tax cuts; and household spending of dividend income from the mining sector.

[7] See Lofgren et al. (2013) for a description of the basic features of MAMS.
[8] Again, these results should be seen qualitatively.

To our knowledge, this is the first study to unpack the channels through which Dutch disease is transmitted in such extensive detail. The simulations provide the following insights:

- The use of domestic inputs (versus spending of revenues by the government and households) by the mining sector seems to explain about two-thirds of the total simulated real appreciation, and 80 percent of the shrinkage of the tradable sector that occurs in the baseline.
- Unpacking the relative importance of domestic input, the use of labor by the mining sector is the most potent channel for transmission of Dutch disease. This is reflected in a larger shrinkage of the traded sector and larger real appreciation, accounting for just over a third of the total appreciation that occurs in the baseline (capital inputs account for less than 10 percent). This reflects the fact that labor is a "quasi-fixed" factor that grows only in line with population growth. In contrast, domestic capital inputs can be "endogenously" increased over time through higher savings and investment. This points to a role for active labor force policies (immigration, or increases in labor force participation rates) in reducing Dutch disease pressures.
- Rising household incomes due to rising wages can have positive or negative effects. Higher household incomes are partly spent on goods and services (reinforcing Dutch disease), but are also partly saved, thus helping to finance investment and helping to increase the economy's capital stock. On aggregate, though it seems they are positive in our simulations.
- The impact of government spending on Dutch disease effects depends critically on the additional revenues the government receives and how they are spent. Simulations suggest a sizable (or one-for-one) fiscal impact from spending higher mining revenues on public consumption or tax cuts. In the case of rising public consumption, simulations also point to some crowding out of private consumption. When revenues are spent on public investment, the real appreciation is minimal in the short run (due to the higher import content of public investment). In the long run, the real exchange rate depreciates because higher public investment raises productive capacity of the economy. However, when all channels are operational, government spending on public investment alone is insufficient to reverse Dutch disease impacts from the other channels.
- The impact of spending of dividend income by households on the tradable sector is similar in magnitude to those individual scenarios where rising government revenues are spent on public consumption and tax reductions. This suggests that rising spending on goods and services has approximately the same impact on tradable sector production, irrespective of the source of spending.

The results imply a number of policy lessons. First, Dutch disease is complex even in a highly stylized model setting: myriad prices change in the economy, and multiple channels are at work when mining output is scaled up. Which channel of transmission dominates depends critically on the structural features of the economy including factor elasticities, the intensity by which mining uses certain inputs and their import shares, and the size of revenues flowing to the government.

The results also suggest that Dutch disease is unavoidable and inherently at odds with an export-led development strategy. On the production side, limiting Dutch disease impacts would require minimizing domestic inputs into the mining sector as it scales up production, or encouraging faster accumulation of the needed inputs. As discussed above, "labor" is arguably the most potent channel in the simulation: unlike other factor inputs that can be endogenously increased over time (for instance capital inputs through greater savings), labor can only expand in line with population growth. Accordingly, it remains a bottleneck over the long term, driving appreciation of the real exchange rate and causing the non-resource traded sector to shrink as the latter donates labor to the other sectors. This suggests a role for labor force policies that encourage greater labor force participation or immigration.

On the spending side, limiting Dutch disease impacts will require focusing on activities that have a high import content and that boost the overall supply potential of the economy, especially that of the tradable sector. This likely means focusing spending on public investment. If household spending of mining income is also an important channel of transmission, then there may be a role for tighter monetary policy to reduce the potency of this channel.

The rest of the paper is organized as follows. Section II summarizes the key features of MAMS and the calibration strategy for Mongolia with the underlying structure of the economy. Section III analyzes the results for a set of simulations designed to explore the relative importance of the spending and resource movement channels through which Dutch disease occurs in Mongolia. Section IV discusses the main policy conclusions.

II. Model framework

MAMS is a recursive dynamic CGE model developed at the World Bank to analyze strategies for achieving MDGs, and for undertaking country-level, medium-to-long-run policy analysis (Lofgren et al., 2013). The model is dynamic recursive in that the solution in any time period depends on current and past periods, not the future. Only relative prices matter and these help to clear the markets for factors, goods, and services. As part of the micro foundations of the model, producers maximize profits and consumers maximize utility.

The calibration strategy for Mongolia is detailed in the companion paper (Khan et al., 2017) and this section only describes the broad framework. The underlying Social Accounting Matrix (SAM) that sets out the basic relationships and income flows in the economy was calibrated using publicly available 2005 data from the National Statistical Office (NSO), notably input-output tables for that year. These data were supplemented with other NSO data on employment, balance of payments, and public finances.

In the Mongolia CGE model, there are seven sectors (i.e. activities, each of which produces a specific good or service), five of which are in the private sector (Table 1). In addition, there ae three institutions: a single representative household, the government and the "rest of the world" (ROW). None owns a sector or industry, but rather earns income from a share of the relevant production factors (labor, capital and mining capital). For the household, the income sources also include transfers from the government and remittances from overseas, while the government also earns revenues from indirect and direct taxes. The SAM is set out in Appendix A.

Production technologies are nested. At the top level, output for each sector is generated by aggregates of value added and intermediates. At the lower level, these aggregates are produced by a CES aggregation of production factors and a Leontief aggregation of intermediate inputs, respectively. The mining sector is a special case in that factor use also is determined by a Leontief formulation. Factor inputs other than the mining factor are paid market wages; the mining factor ("mining capital") is paid the residual. Overall labor supply is determined by exogenous population growth, so that labor is a relatively scarce factor. Finally, the selection of production, trade, input and demand elasticities is set to match actual economic developments as closely as possible (see Khan et al. 2017).

The choice of mechanisms for maintaining internal and external balances are as follows. With respect to the budget, spending adjusts in response to revenues, with additional revenues spent on government consumption (unless specified otherwise as is the case with some individual simulations that explored later). Private investment is kept constant as a share of total absorption while private saving adjusts to provide needed financing. A flexible real exchange rate clears the balance of payments. The numéraire is the CPI so that nominal values like wages, household income, household expenditures are CPI-indexed.

Table 1: Model Disaggregation

Sectors (Activities and Commodities	Non-government (5)	Agriculture Construction Private Traded Sector Private Non-traded Mineral
	Government (2)	Public Infrastructure services Other government services
Factor Inputs	Primary Factors (3)	Labor Private Capital Mining Capital
	Wholly Imported factors (2)	Fuel Intermediate Mining Capital
Institutions	Institutions (3)	Household Government Rest of the World (ROW)

Calibration strategy

To analyze the channels by which a scaling up of the mineral sector causes Dutch disease, three key scenarios are developed.

- **"BASE" (business-as-usual**). This simulation assumes that, in the absence of a structural expansion in the mining sector, the economy grows at an annual rate of 5 percent. Selected results for key macroeconomic indicators are shown in Appendix B and show a continuation of long run trends. The GDP shares of key macroeconomic variables remain broadly constant over time. The long run growth rate for government consumption is the same as government investment. The real exchange rate is broadly stable. As the economy grows, factor payments received by each of the factor inputs increase over time, but wages increase sharply over the simulation period (2005-2026), reflecting the fact that it is a relatively scarce factor. Other details of the calibration strategy are outlined in Khan et al. (2017).
- **"Baseline scaling up" simulations:** In this scenario, the OT mine starts to produce in 2013 with mining output doubling by 2016. In this scenario, the mining sector is fully integrated into the economy, using labor, capital and intermediate inputs, and generating income for the government and households.
- **"Reference" scenario:** In this scenario, mining becomes ***a perfect enclave sector***, so that even as mining output doubles, there is ***no impact on the economy*** at all**.** With this scenario in hand, the different channels through which Dutch disease occurs are switched on, one-by-one, in order to examine their effects in isolation.

Since the main scenarios of interest are the scaling up of the mining sector, and the individual reference scenarios, the following sub-section sets out how these are calibrated, and their impacts.

Baseline scaling-up scenario: Mining output doubles and the mining sector is fully integrated into the economy

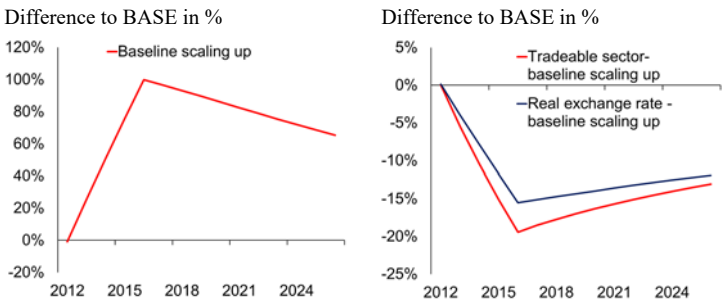
The scenario assumes that OT production starts in 2013, with the mine reaching full capacity by 2016. Production increases are gradual between 2013 and 2016. By 2016, production doubles relative to

underlying BASE projections (Figure 1).[9] Post-2016, production plateaus with annual mining output growth projected at 3 percent in line with projected production plans. This implies that the relative size of OT output diminishes over time, with total output slowly converging to BASE in relative and absolute terms as the OT project reaches the end of its life. The trajectory of the key macroeconomic variables is shown in Appendix C.

The scenario assumes that additional government receipts are used for increasing government consumption. Mining products are reclassified to be perfectly substitutable between exports and domestic production, unlike all other commodities in the model that are imperfectly substitutable between export and domestic sales. This captures the fact that the startup of the OT mine produces for exports only.[10]

Figure 1: The baseline scenario

A. Mining output **B. Dutch disease effects**



Notes: BASE is the business-as-usual scenario in which there is no resource windfall and the economy grows at a 5% pace over the long term. The baseline scenario assumes mining output doubles by 2016, and that the mining sector is fully integrated into the economy, with all Dutch disease transmission channels fully switched on.

Under this scenario, a doubling in mining production leads to 15 percent real appreciation and a shrinkage in tradable sector production of approximately 20 percent (Figure 1B). These two variables are considered as key indicators of Dutch disease effects in this study. As neither a real appreciation nor a shrinkage in the tradable sector is inherently 'bad' for the economy, for these effects to become a "disease" it is necessary to assume that the tradable sector is of special significance for economic development or an engine of innovation (e.g. see van Wijnbergen, 1984). If so, a shrinkage of the tradable sector could then undermine overall growth prospects, if the resulting reduction in growth outweighs the benefits of increased mining production. One way to mechanically implement this is to make the rate of TFP growth a function of the size of the tradable sector. However, this is beyond the scope of the paper and the study therefore focuses on the transmission mechanism that leads to the decline in the tradable sector in the first place.

Reference scenario: Mining output doubles but mining sector is not integrated into the economy, i.e., is an enclave sector

To understand how Dutch disease effects come about when mining production is scaled up, a **reference** scenario where mining has no impact on the economy is needed. With this in hand, it is possible to examine the individual transmission channels in isolation. Doing so is the objective of the remainder of this paper. A priori, there are two main transmission channels:

[9] This is much smaller than the impact of the OT project, which is expected to raise output by about 250 percent. However, a doubling of production creates a more intuitive scaling up scenario.

[10] A few technical issues merit discussion. First, the scaling up of mining production is going to lead to a large increase in nominal GDP. This affects variables programmed in terms of GDP shares, especially private transfers from the rest of the world and FDI. As this is not realistic, the foreign currency unit (FCU) value for these variables is kept the same as in the BASE scenario. Accordingly, private transfers are set to grow at a fixed rate of 5 percent in FCU terms (the economy-wide growth rate). For FDI, the FCU growth rate is set at 6.5 percent, somewhat higher than the economy-wide growth rate, to reflect the increasing role of FDI as Mongolia's economy matures, and these assumptions are the same as in the BASE simulations. Growth in mining production is set to 4 percent per annum during 2008-12 in order to align this period reasonably closely with BASE simulations.

- *Use of domestic production factors*: scaling up mining production will require domestic production inputs such as domestically-produced intermediate inputs, domestic labor, or domestic capital, which lead to Dutch-disease effects.
- *Domestic spending of mining receipts*: scaled-up mining production will lead to higher incomes for the government and domestic households, and part of this additional income will be spent; the resulting increase in domestic demand could be another source of Dutch-disease effects.

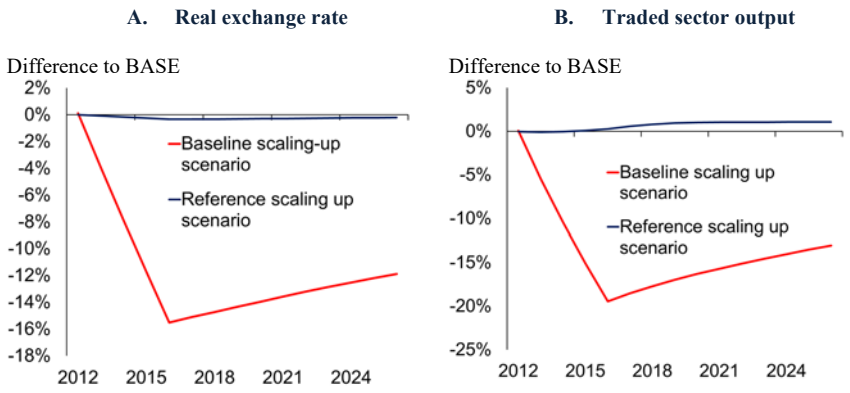
Isolating these two effects requires a modification of the SAM such that: (i) no domestic factor inputs are used when mining production is scaled up; and (ii) neither households nor the government receive any additional income when mining output increases. This means that mining production would: (i) only use imported inputs; (ii) the mining sector would be fully foreign-owned; and (iii) it would pay no taxes or import duties. Beginning with the production side, the following changes are made to the SAM. First, usage of domestic intermediate inputs, labor and capital used in the mining sector is set to zero. Second, domestic production factors are replaced with imported intermediate, mining-specific production factors. Apart from imported intermediate inputs, the only remaining production factor is mining-specific capital, which is assumed to be fully foreign owned.

On the income side, the production-side modifications rule out any increase in income for households: neither labor nor domestic capital (from which households earn income) are employed in the mining sector. This leaves only the government via higher tax collection as a potential beneficiary from scaled-up mining production. To switch this channel off, import duty, export taxes, production or sales taxes, and dividends from this sector accruing to the government are set to zero.[11] However, these modifications reduce household income in the steady state while at the same time creating a current account imbalance due to higher demand for imported intermediate inputs. To rebalance the SAM, transfers from ROW to households are increased, which also compensates for the rising current account deficit. On the fiscal side, lost revenue from the mining sector is replaced via higher budget support from abroad.

As Figure 2 shows, even though mining output is doubled in both the reference and baseline scenarios, the effects on the real exchange rate and tradable sector output are negligible in the former. Higher mining production yields higher income for the mining sector and higher foreign exchange earnings for the economy at large in both scenarios. However, in the **reference** scenario, the extra FX earnings flow immediately out of the domestic economy as payment for imported intermediate inputs and increased dividend payments for foreign owners of the mining-specific production factor. Accordingly, there is no need for relative price changes, a real appreciation or changes in the structure of the domestic economy; rather, the domestic economy is fully insulated from the mining sector. This corresponds with the mining sector being a perfect enclave sector.

[11] There was no need to set income taxes to zero as well because income taxes related to the mining sector accrue to the government only through the involvement of domestic households with this sector. Foreign ownership is proxied via their ownership of the mining sector specific production factor, which is not subject to income taxes. In the simulations, the role of income taxes paid by foreign companies operating in the mining sector is instead simulated via (i) dividend income to the government (reflecting that the foreign investors in the OT project offered the government an ownership share in the project) and the imposition of a mining-specific production tax.

Figure 2: Baseline and reference scenarios



Notes: BASE is the business-as-usual scenario in which there is no resource windfall and the economy grows at a 5% pace over the long term. The baseline scenario assumes mining output doubles by 2016, and that the mining sector is fully integrated into the economy. The reference scenario switches off all Dutch disease transmission channels while scaling up mineral output. In this scenario, the mining sector is a perfect enclave using no domestic inputs, and with all mining revenues repatriated overseas.

III. Transmission Mechanisms Leading to Dutch-Disease Effects

The remainder of this paper is going to investigate the two main transmission channels that lead to Dutch disease. It does so by **undoing the modifications implemented in the reference scenario.** Recall that in the **reference** scenario, mining production is scaled up without any domestic impacts as it is a complete enclave sector. Alternative scenarios are set up where the mining sector starts to draw upon domestic inputs and where mining income is spent domestically. These scenarios are then compared to the reference scenario in order to judge their importance in contributing to Dutch disease.

An example is a simulation where the mining sector requires domestic intermediate inputs; by evaluating the simulations results against the reference scenario it should be possible to discern the economic effects of higher intermediate demand by the mining sector in isolation. However, the results in the following sections should be considered as approximate only. This is because it is not possible to switch on/off the transmission channels of scaled-up mining production without affecting the underlying structure of the economy and the SAM as described below.

The role of domestic production factors in the scaling-up of mining production

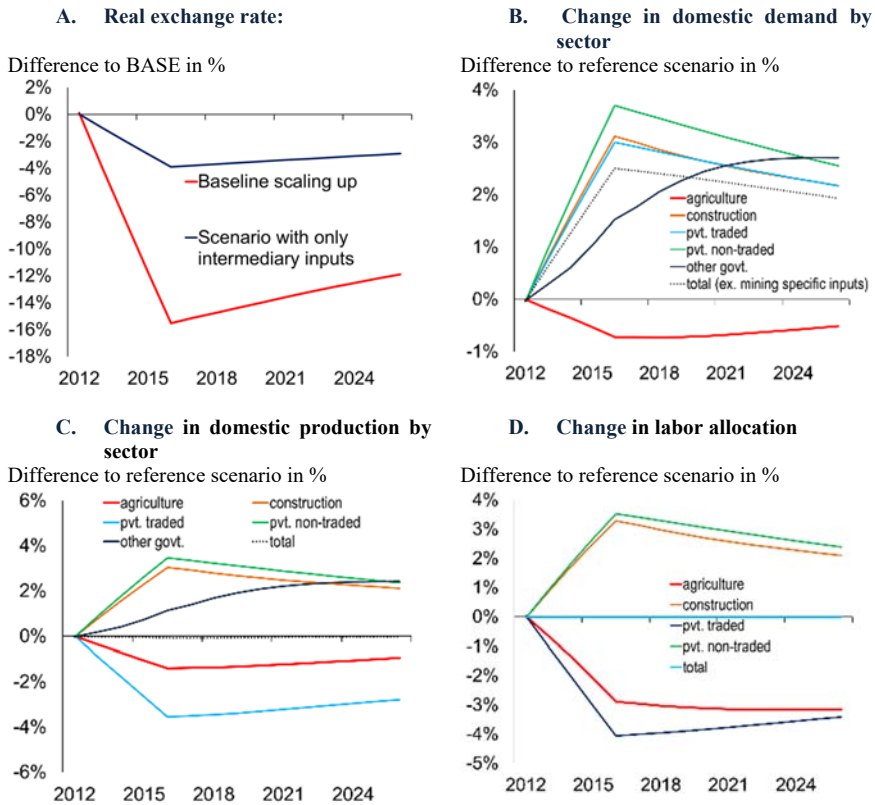
a) Using domestic intermediate inputs

In this scenario, the mining sector requires only domestic intermediate inputs. These account for about 15 percent of total inputs in the mining sector, and are mostly tradable and non-tradable goods with the first accounting for about half of total domestic intermediate demand, and the last for about a third. The re-introduction of domestic intermediate inputs into the mining sector is offset by a corresponding reduction in imported intermediate inputs. The other major change in the SAM is a reduction in foreign transfers to

households, needed to offset the impact of lower import demand in steady state on the current account and to balance the SAM.

Size of Dutch disease effects: The increased demand for domestic intermediate inputs as mining output increases leads to a moderate real appreciation (Figure 3) and a decline in tradable sector output (not shown). In isolation, the demand effect for domestic intermediate inputs accounts for about 25 percent of Dutch disease effects observed in the **baseline** scenario.[12]

Figure 3: Scenario where mining uses only intermediate inputs



Notes: BASE is the business-as-usual scenario in which there is no resource windfall and the economy grows at a 5% pace over the long term. The baseline scenario assumes mining output doubles by 2016, and that the mining sector is fully integrated into the economy. The reference scenario switches off all Dutch disease transmission channels while scaling up mineral output, so that the mining sector is a perfect enclave, using no domestic inputs, and with all mining revenues repatriated overseas. Other govt. refers to government consumption. The simulations in Figures 3B, C and D show scenarios in which mining remains an enclave for all intents and purposes, with the exception of domestic intermediate inputs which it utilizes in production.

Transmission mechanism: Why does a real appreciation and shrinkage in the tradable sector arise in this scenario? The driving force is the rise in domestic demand, especially for non-tradables. Meeting this demand requires a supply response that involves a reallocation of production factors between sectors in the economy, including a transfer of production factors from the tradable to the non-tradable sector. The real appreciation plays a key role in this reallocation of factors.

The starting point of the transmission mechanism is an increase in domestic demand in all major sectors (except agriculture) that produce the intermediate products that are in especially high demand in the mining sector (Figure 3B). Demand for public sector consumption and construction services also increases, reflecting higher government revenues that are spent and higher private sector investment which requires construction services.

Expenditure-switching effects also play a role. The real appreciation observed makes goods and services that can be imported such as tradable goods relatively cheaper than non-tradables. This helps re-direct demand for non-tradables to tradables; given that the demand for tradables can be met through imports whereas demand for non-tradables has to be met through a domestic supply response, large expenditure-

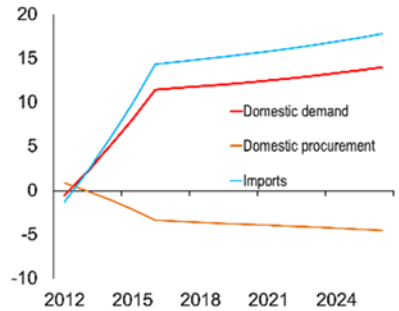
[12] In practice, different transmission channels are likely to cancel each other out or reinforce each other, in which case it is unlikely that the individual effects are going to sum up to 100 percent.

switching effects lessen the need for the economy to generate domestic supply responses. Quantifying the effects of expenditure-switching, however, is difficult and has not been attempted here.

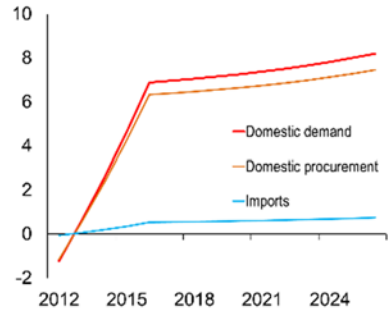
The domestic production response mostly follows demand (Figure 3C), but not always, with tradable production falling sharply even though demand has risen strongly. There are three avenues for meeting higher domestic demand: i) raising domestic production; ii) increasing imports; and iii) freeing up production capacity for domestic demand by reducing exports. Here, all three channels are in operation, reinforcing each other. Rising domestic production is constrained by the availability of factor inputs, particularly labor which only grows in line with the population (labor is in essence quasi-fixed). In contrast, the capital stock can be increased in the simulation through savings and investment, although this takes time.

Figure 4: Scenario where mining uses only intermediate inputs

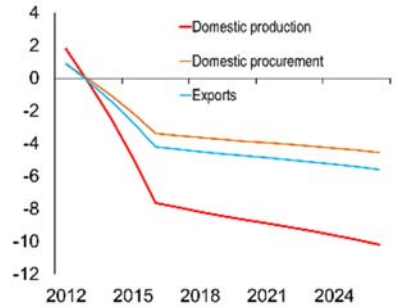
A. Change in domestic demand, procurement and import volumes for tradable goods
Difference to reference scenario, absolute terms



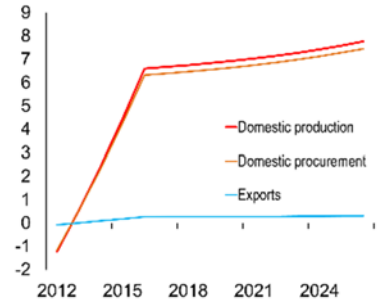
B. Change in domestic demand, procurement and import volumes for non-tradable goods
Difference to reference scenario, absolute change



C. Change in domestic production, procurement and export volumes for tradable goods
Difference to reference scenario, absolute change



D. Change in domestic production, procurement and export volumes for non-tradable goods
Difference to reference scenario, absolute change



Notes: The reference scenario switches off all Dutch disease transmission channels while scaling up mineral output, so that the mining sector is a perfect enclave. The simulations here show scenarios in which mining remains an enclave using no inputs (and repatriating all profits), with the exception of domestic intermediate inputs which it utilizes in production.

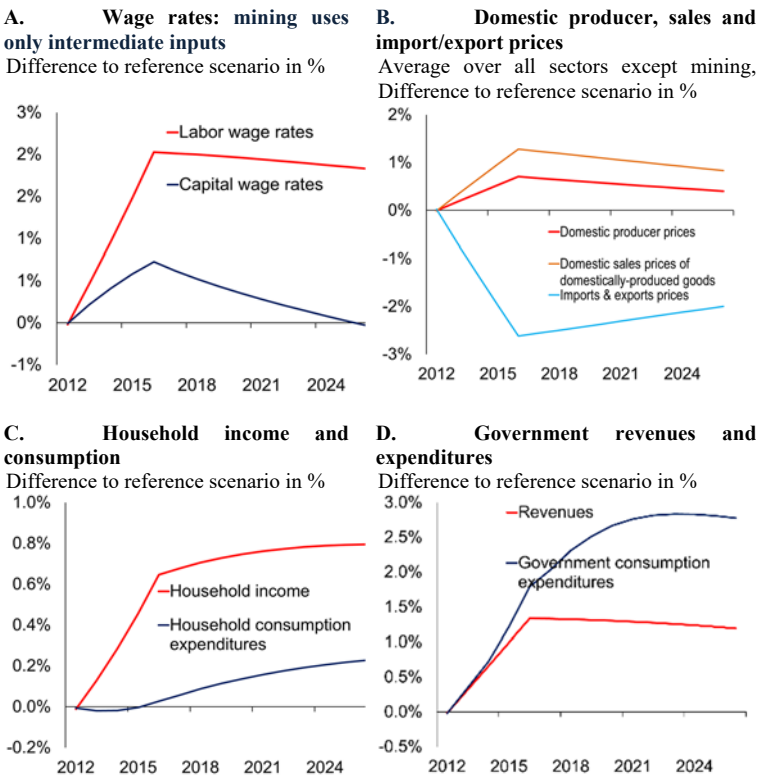
With both labor and capital being relatively fixed in the short run, the expanding sectors draw in labor and capital from the other sectors – mainly agriculture and tradable sector that shrink correspondingly (Figure 3D). The increased demand for tradables is met through: (i) a large increase in imports of tradables notably agriculture[13] (Figure 4A and B) and; (ii) a reduction in exports by the traded sectors, which helps free up a considerable part of domestic production for domestic use (Figures 4C and 4D).

Driving these changes are movements in relative price changes. First, wage rates for the production factors increase. For labor, the wage increase is quasi permanent; for capital it is eventually reversed as the supply of capital increases over time (Figure 5A). Second, output prices for export-oriented goods or close import substitutes fall due to the appreciation of the currency (Figure 5B), making export production less attractive and imports more price competitive. The combination of higher input costs and lower output prices reduces profitability in export-oriented and import-competing sectors; this causes them to shrink, releasing the production factors in demand in other sectors, especially non-tradables. In contrast, the output price for

[13] Elasticities for these sectors were delineated precisely to capture this characteristic.

domestically-oriented sectors, including non-tradables, increases on account of the rise in demand, which makes it possible for these sectors to pay higher input prices without suffering reduced profitability.[14]

Figure 5: Scenario where mining uses only intermediate inputs



Notes: The reference scenario switches off all Dutch disease transmission channels while scaling up mineral output, so that the mining sector is a perfect enclave. The simulations here show the impact of an alternative scenario in which mining remains an enclave for all intents and purposes, using no domestic input and repatriating all income overseas, except domestic intermediate inputs which it uses in production.

Key results

Dutch disease effects such as the real appreciation and the shrinkage in the tradable sector are equilibrium outcomes of scaled-up mining production that utilizes domestic intermediate production inputs. Without this, it would be impossible for the economy to meet the demand for non-tradable intermediate inputs by the mining sector.

The real exchange rate appreciation is needed to achieve both external and internal equilibrium. Higher mining production and exports lead to rising FX earnings; in the reference scenario where the mining sector does not rely on domestic production factors, these earnings are used to pay for imported intermediate inputs and for higher usage of the foreign-owned mining-specific production factor, with the result that all of the additional FX earnings leave the domestic economy immediately.[15] However, in the current scenario part of these earnings are used to pay for these domestic inputs, thereby increasing the supply of FX that is domestically available, leading to a balance of payment surplus. It is this surplus, and the ensuing attempt by domestic agents to sell surplus foreign exchange, that leads to the initial appreciation.

Finally, households play a secondary role in the adjustment process, relative to government spending. Higher wages increase household incomes, which are spent in part on goods and services, which requires a corresponding supply response. But a substantial portion is saved, thus financing investment that builds up the economy's capital stock and facilitating an endogenous response to the demand for additional production factors. The increase in income, and more importantly the rise in imports, also leads to an increase in government revenue which is used mainly for additional government consumption; the remainder is used for public investment in order to facilitate higher public consumption, e.g., additional school or administrative buildings. Again, the economy will have to meet the resulting demand as well (Figures 5C and 5D).

[14] The output price for domestically-oriented sectors is represented by the domestic sales prices for domestically-produced goods.

[15] In a more conventional setup where the mining sector is essentially foreign owned, the payments for the foreign-owned mining specific sector would be equivalent to profit remittances.

b) Using only labor as domestic production factor

Domestic labor accounts for about 8 percent of total inputs in the mining sector in the base-year for the SAM, i.e., about half the value intermediate inputs did in the preceding scenario. As before, relative to the reference scenario the amount of imported intermediate inputs is adjusted downwards as domestic labor takes its place. Again, balancing the SAM requires also lowering the amount of foreign transfers households receive.

Figure 6: Real exchange rate appreciation in response to scaled up mining production

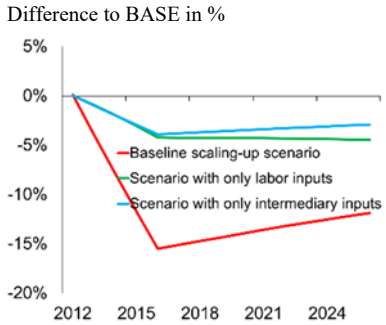
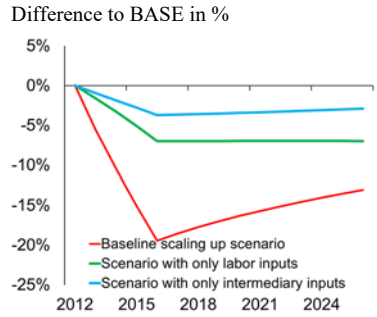


Figure 7: Tradable sector production in response to scaled up mining production



Notes: BASE is the business-as-usual scenario in which there is no resource windfall and the economy grows at a 5% pace over the long term. The baseline scenario assumes mining output doubles by 2016, and that the mining sector is fully integrated into the economy. The additional simulations here show scenarios in which mining remains an enclave for all intents and purposes, using no domestic input and repatriating all income overseas, except domestic labor inputs (green line) or intermediate inputs (blue line).

Size of Dutch disease effects: The impact on the real exchange rate is slightly larger than that of domestic intermediate inputs (Figure 6). Despite its relatively smaller role in the mining sector compared to domestic intermediate inputs, domestic labor causes a larger shrinkage of the tradable sector (Figure 7).

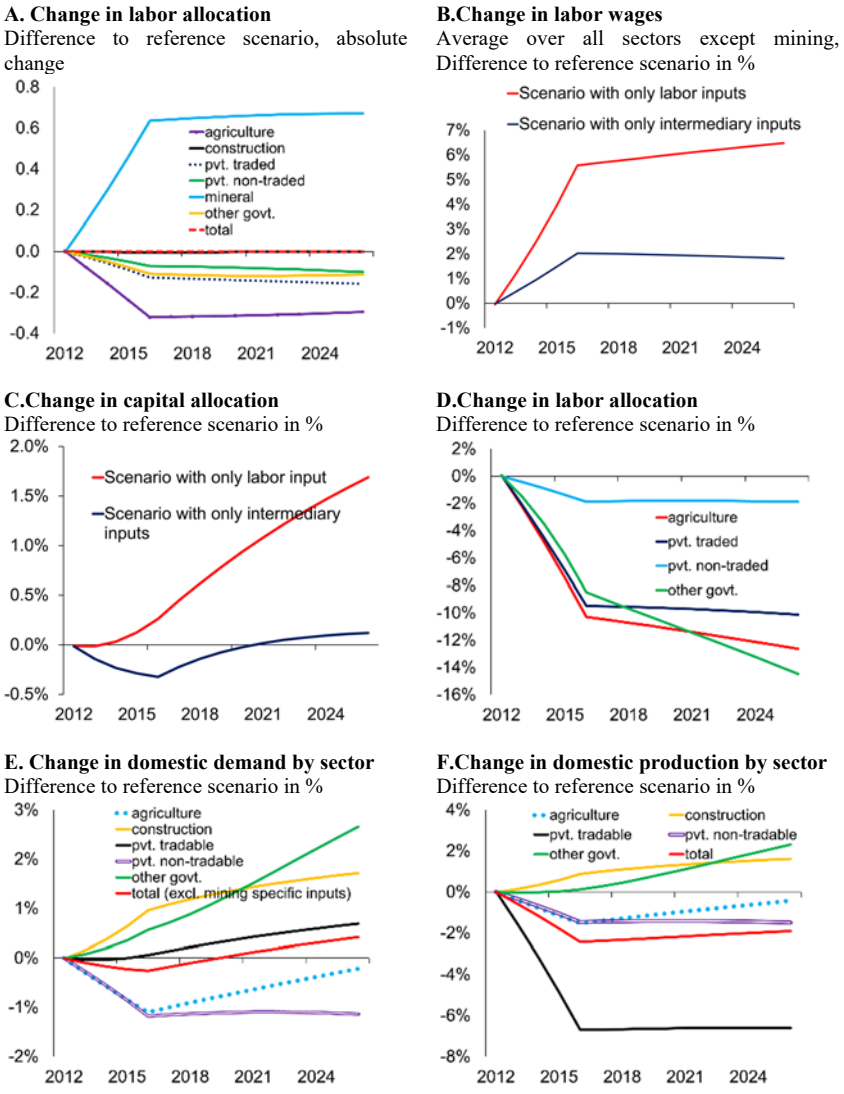
Transmission mechanism.

Labor: Increased labor demand by the mining sector needs to be met by reducing labor inputs elsewhere. In the simulation, labor that migrates to the mining sector comes from (i) agriculture, (ii) the tradable sector, (iii) government services and (iv) the non-tradable sector, in this order measured in absolute terms (Figure 8A). Note that high labor demand raises wage rates for labor, much more so than in the previous scenario (Figure 8B). As a result, household income in this scenario also rises more than previously, enabling a larger increase in savings and buildup of capital in this scenario (Figure 8C). Agriculture is the chief source of labor for the mining sector both in absolute terms as well as in percentage terms (Figures 8A, 8D). In contrast, the fall in demand for, and production of, agricultural goods is modest (Figures 8E,8F). In fact, the last two are broadly comparable to the simulation results in the previous scenario.

Note at their peak, total demand and domestic output do not decline by much more than 1 percent, which is hard to reconcile with a reduction in labor input by the non-mining sectors (Figures 8E,8F). In agriculture, this is because the sector is able to release substantial amounts of labor without having to scale down production drastically since it can substitute labor with capital.[16] This is the case for government services as well.[17]

Government services and construction sectors meanwhile also increase their capital inputs in line with rising output. Again, relative prices play a key role for this substitution of factors: wage rates for labor rise substantially while those for capital actually decrease, reflecting the impact of increased saving on the supply of capital. Hence, labor becomes relatively more expensive while capital becomes cheaper. This relative price change drives the substitution of factors taking place in agriculture and government services.

Figure 8: Scenario where mining uses only labor inputs



Notes: The reference scenario switches off all Dutch disease transmission channels while scaling up mineral output, so that the mining sector is a perfect enclave. The simulations here show the impact of an alternative scenario in which mining remains an enclave for all intents and purposes, using no domestic input and repatriating all income overseas, with one exception --- i.e. the usage of domestic labor inputs. In figure 8A due to the fact that in this simulation the labor input in the mining sector is increased in the steady state, the percentage comparison to the reference scenario does not show the increase in labor input as mining production is scaled up; hence, the absolute change is used here

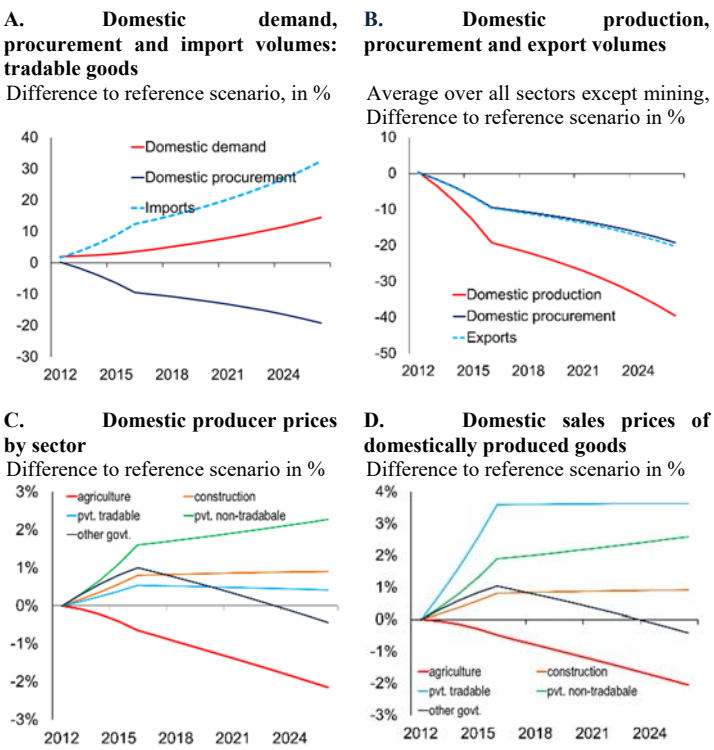
[16] At first glance, it may not be obvious how a 2 percent increase in the capital stock can compensate for a decline by more than 10 percent in the labor force, given that output declines by only about 1 percent. The answer is that capital plays a much larger role in the production function than labor, i.e., the corresponding CES parameters for capital are higher than those for labor.

[17] This is no coincidence: in the calibration of the elasticity of substitution between factors in the production function, both elasticities were set to relatively high values (of 1.5 and 2.5 respectively). This reflects the situation during the 2005-08 boom phase in Mongolia when agriculture's share in labor shrank sharply while public employment did not increase by much despite the fiscal expansion over this time. [

Tradables: For tradables, reconciling a sharp drop with labor inputs (and a somewhat more moderate reduction in capital inputs) with above-average demand is straightforward: higher imports (Figure 9A) can meet domestic demand directly and lower exports (Figure 9B) free up production capacity indirectly that can be used to meet demand for domestically-produced tradables, similar to the scenario with domestic intermediate inputs. On the production side, domestic production falls by considerably more than domestic procurement of domestically-produced goods, with the reduction in production for export markets making up the difference.

As before, the real exchange appreciation is the key driver for these changes, but the increase in labor wage rates is higher than in the case where the mining sector used only intermediate inputs. Hence tradable sector profitability falls by more, which accounts for the fact that shrinkage of tradable sector production is more pronounced in this scenario even though the extent of the real exchange rate appreciation is broadly similar in both scenarios.

Figure 9: Scenario where mining uses only labor inputs



Notes: The reference scenario switches off all Dutch disease transmission channels while scaling up mineral output, so that the mining sector is a perfect enclave, using no domestic inputs and repatriating all profits. The simulations here show the impact of an alternative scenario in which mining remains an enclave for all intents and purposes, with the exception of domestic labor inputs, which it uses in production.

Non-tradables: In this sector, the reductions in labor input, domestic production, and domestic demand are all approximately in the range of 1-2 percent; only capital accumulation is less, declining at its peak by less than 0.5%. This relative proportionality in the adjustment reflects two factors at work. First, by definition, higher domestic demand for non-tradables cannot be met through imports or curtailment of exports. As a result, when domestic production declines, domestic demand has to decline by approximately the same amount, leading to the observed proportionality in the decline of domestic production and demand.

Second, unlike agricultural and government services, substituting between labor and capital in the non-tradable sector is difficult. This is a feature of the calibration that reflects that during the 2005-08 boom phase when employment surged in this sector. Some substitution between production factors does take place in the simulation—the reduction in the non-tradable sector labor force is larger than the retrenchment of capital—but only on a modest scale (see Khan et al. 2017).

Taken together, these characteristics imply that if the non-tradable sector sheds labor, domestic production and demand have to decline as well. This is achieved as follows: first, when labor costs increase due to rising demand from the mining sector, the non-tradable sector passes through some of the increase to prices in contrast to the tradable sector. As a result, domestic producer prices increase, and so do domestic sales prices in the non-tradable sector, which outpaces that of all other sectors (Figure 9C, D). This implies that the relative price of non-tradables increases, which affects demand accordingly. With less demand, production in the non-tradable sector contracts, releasing labor that migrates to the mining sector. Hence,

the observed reduction in demand, production, and labor input are all equilibrium responses to the scaling up of mining production and the ensuing higher demand for labor.

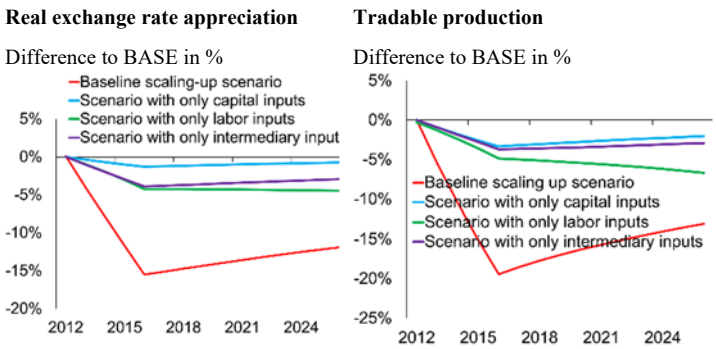
Key results

Domestic labor demand appears to be a more potent transmission mechanism of Dutch disease than demand for domestic intermediate inputs. This is reflected in the larger shrinkage of the traded sector when the mining sector uses labor inputs vs when it uses intermediate inputs, even as the size of the real exchange rate appreciation remains broadly the same in both simulations. The substantial increase in labor costs underpins these larger impacts. Namely, the shift in domestic demand for traded goods away from domestic production towards imports, declining profitability in the traded sector, the substitution of capital for labor, and declining production in the non-traded sector that all are necessary to release labor to mining.

c) Using only capital as domestic input

The scenario introduces capital input into mining sector production while domestic intermediate and labor inputs are set to zero. Capital accounts for about 6 percent of total inputs in the mining sector, about a quarter less than labor input. Compared to domestic intermediate inputs, capital inputs are only about a third as large. The other adjustments to balance out the SAM proceed as before.

Figure 10: Scenario where mining uses only domestic capital inputs



Notes: BASE is the business-as-usual scenario in which there is no resource windfall and the economy grows at a 5% pace over the long term. The baseline scenario assumes mining output doubles by 2016, and that the mining sector is fully integrated into the economy. The additional simulations here show scenarios in which mining remains an enclave for all intents and purposes, using no domestic inputs and repatriating all income overseas, except domestic labor inputs (green line) or intermediate inputs (black line) or capital inputs (green line).

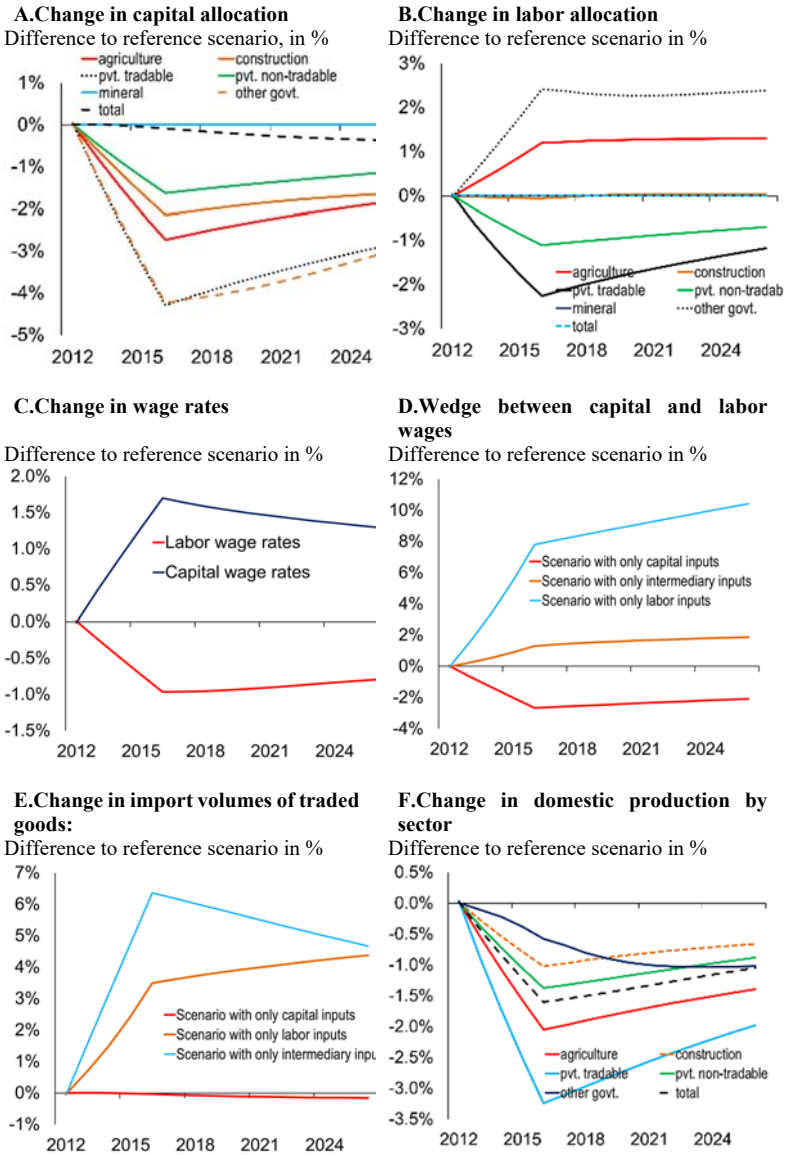
Size of Dutch disease effects: The introduction of capital as a production factor in the mining sector has the smallest impact on the real exchange rate compared to domestic intermediate and labor inputs, accounting for less than 10 percent of the total real appreciation under the baseline scaling-up scenario (Figure 10A). On part this reflects lesser usage of capital by the mining sector relative to the other two factors. However, the result holds even after adjusting for different input shares. The impact on tradable sector output is comparable to the role domestic intermediate inputs play for tradable sector production, even though they have a much larger input share in mining sector production (Figure 10B).

Transmission mechanism and key results. The primary task for the transmission mechanism is to channel domestic capital into the mining sector. In principal, the economy can generate capital endogenously—unlike labor—through domestic savings and investments, but this takes time.

Hence, at least in the beginning, capital has to be diverted from other sectors into the mining sector. In absolute terms, it turns out that agriculture and the tradable sector are the most important 'donors'; in percentage terms, the sector providing government services also sheds capital (Figure 11A). Key results and differences from the transmission channels observed in earlier simulations are as follows.

The substitution between capital and labor continues to play an important role in the transmission mechanism. Agriculture and government services replace some of their capital through additions to their labor stock (Figure 11B) as the cost of capital increases relative to wages (Figure 11C, 11D). However, the resulting wedge between capital and labor incomes, however, is relatively modest compared to that in previous scenarios. The higher capital needs of the mining sector do not trigger any reallocation in domestic demand away from domestically produced goods towards imports as in previous scenarios (Figure 11E). This is to be expected given the relatively modest real appreciation in this scenario.

Figure 11: Scenario where mining uses only domestic capital inputs



Notes: The reference scenario switches off all Dutch disease transmission channels while scaling up mineral output, so that the mining sector is a perfect enclave. The simulations here show the impact of an alternative scenario in which mining remains an enclave for all intents and purposes, with the exception of domestic capital inputs, which it uses in production.

There is also a uniform decline in output across all sectors (outside mining) that is instrumental in releasing capital towards mining in contrast to earlier scenarios (Figure 11F). This reflects a fall in household income (Figure 12A, 12B) led by falling labor wages that compresses overall demand rather than increasing it as in the labor and intermediate input scenarios. With this additional factor present, relative prices like wage rates and the real exchange rate have to work less, which explains why both of them change less compared to the domestic labor scenario.

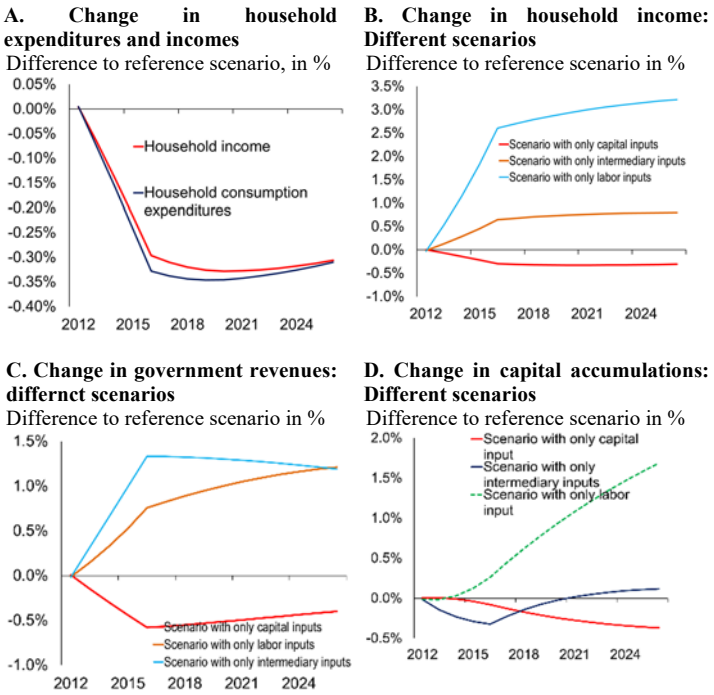
The reduction in government demand is another transmission channel that lowers overall demand that was not present in the other two scenarios (Figure 12C). It follows from: (i) the lower level of imports which reduces indirect tax collection, especially import tariffs, and; (ii) lower household incomes reducing direct

tax collection and thereby government expenditures. An increase in the relative sales price of non-tradables remains a key transmission mechanism that helps non-tradable production decline. Focusing on

agriculture and tradables, the two sectors that release most of the capital migrating to the mining sector in the scenario considered here, their sales prices for domestically-produced products rise more than that of any other goods, implying that their relative price increases. This tends to reduce demand, leading to lower production and the release of capital used in their production.

Finally, building up capital through savings is a transmission mechanism that is active in the other two scenarios but it is not at work in the scenario considered here (Figure 12D). This is a result of declining overall absorption (i.e., private and public consumption and investment expenditures), because private investment is programmed in the simulations to remain constant as a share of overall absorption, and with absorption declining, so does private investment and thereby capital accumulation.

Figure 12: Scenario where mining uses only domestic capital inputs



Notes: The reference scenario switches off all Dutch disease transmission channels while scaling up mineral output, so that the mining sector is a perfect enclave. The simulation in figure 12A shows a scenario in which mining remains an enclave for all intents and purposes, using no domestic inputs and repatriating all income overseas, except domestic capital inputs. In figures 12B, C and D, this last scenario is compared with scenarios in which mining only uses labor inputs (blue line) or intermediate inputs (orange line).

d) Combined effect of domestic inputs

This scenario switches on all domestic inputs simultaneously. These account for approximately a third of total inputs into the mining sector, with the rest accounted for by imported intermediate inputs and the foreign-owned mining-specific production factors.

Note that the size of Dutch disease effects accounted for by all domestic inputs used by the mining sector can only be an approximate estimate: as noted in the previous simulations, the use of different inputs can reinforce or cancel each other. However, the latter is easily determined by comparing the simulation results for Dutch disease effects for the scenario where all domestic inputs are switched on, to the sum of the individual effects generated in the previous simulations.

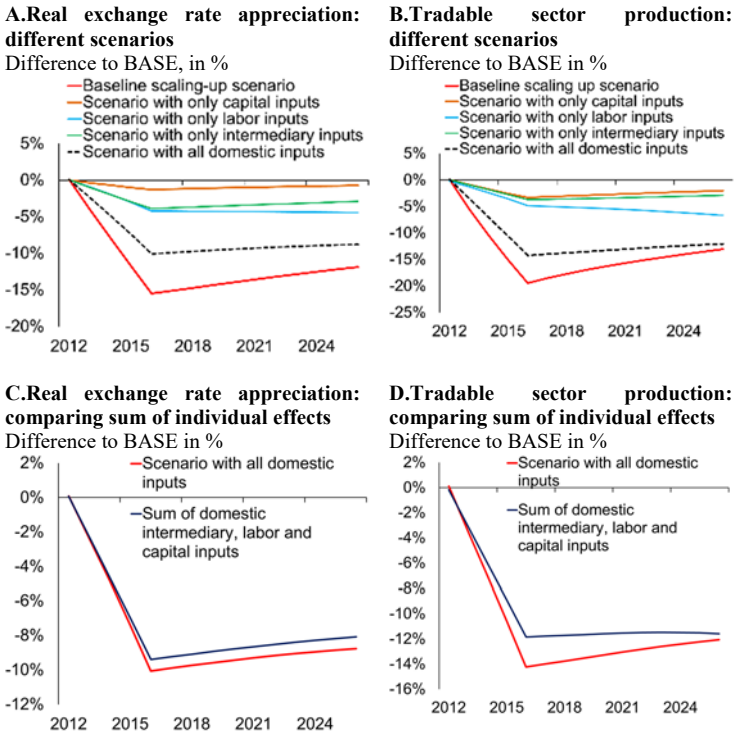
Size of Dutch disease effects. The use of domestic inputs by the mining sector seems to explain about two-thirds of the total real appreciation, and 80 percent of the shrinkage of the tradable sector that occurs in the baseline scenario. Does the total effect of domestic inputs correspond approximately to the sum of the effects of the individual inputs? Approximately it would seem the answer is yes (Figure 13). This would

suggest that interaction effects between the different inputs are either relatively weak or they cancel each other out.

Key lessons. A number of lessons also emerge from the simulations so far. First, the overall transmission mechanism is complex, and Dutch disease is an equilibrium response to the scaling up of mining production. There are multiple channels at work that differ in their relative importance for the different domestic inputs, and their interaction effects when several domestic inputs are introduced simultaneously are unknown. The usage of labor by the mining sector appears to have the largest impact on the real exchange rate and the traded sector.

Second, real exchange rate appreciation fulfills at a minimum two functions: on the demand side it leads to expenditure switching effects that redirect demand from non-tradables to tradables. On the supply side, it helps to meet tradables demand through import, reducing domestic tradables production in the process, which helps free up production factors in demand in other sectors. The tradable sector is a major 'donor' of these production factors.

Figure 13: Comparing scenarios using domestic inputs



Notes: BASE is the business-as-usual scenario in which there is no resource windfall and the economy grows at a 5% pace over the long term. The baseline scenario assumes mining output doubles by 2016, and that the mining sector is fully integrated into the economy. The additional simulations here show scenarios in which mining remains an enclave for all intents and purposes, using no domestic inputs and repatriating all income overseas, except domestic labor inputs (blue line) or intermediate inputs (green line) or capital inputs (orange line) or all domestic inputs simultaneously (dotted black line).

In Mongolia, agriculture is typically the other major 'donor' of production factors. The transmission mechanism is somewhat different, though, from that in the tradable sector: the fall in output in agriculture tends to be less severe than that in the tradable sector, because, at least in the Mongolia calibration, substitution between labor and capital in this sector is more feasible. This means if agriculture sheds labor, part of the impact on overall production can be compensated by accumulating more capital instead. Nevertheless, domestic agricultural production declines in all scenarios considered above.

Besides real exchange rates, changes in wage rates and domestic producer/sales prices are the other relative price changes that are driving the transmission mechanism. Changes in the relative price of labor and capital, for example, drive the factor substitution taking place in agriculture. Increasing wages for scarce production factors also reinforce the effect of the real appreciation on profitability in the tradable sector, contributing to its shrinkage. Relative prices play a role in changing demand patterns in product markets. This is not only important for agriculture and tradables but plays also a key role in the response of the non-tradable sector to the scaling up of the mining sector. Given the multitude of relative price changes, all sectors are affected, both on the demand and production sides.

Finally, household income effects can be positive or negative. Higher household incomes are partly spent on goods and services (reinforcing Dutch disease), but are partly saved, thus helping to finance investment and helping to increase the economy's capital stock. On aggregate, though, it seems they are positive. Ditto for the effect on government revenues.

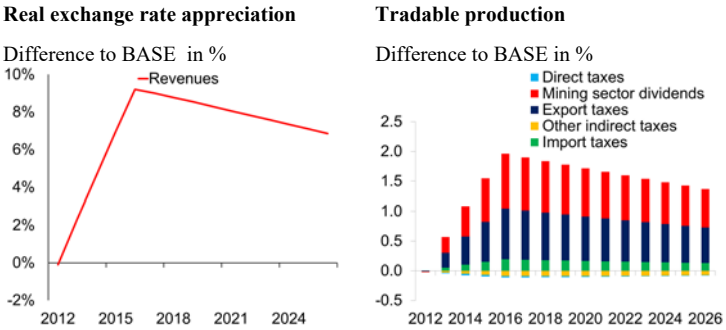
The role of domestic spending of mining receipts in the scaling-up of mining production

This section focuses on income effects of scaled up mining production. Of course, income effects such as increases in household income and government revenues did already play a role in preceding simulations, but these were indirect effects. In this section, (i) higher government revenue collection and (ii) a rise in household incomes due to dividends from the mining sector will be the driving forces of the transmission mechanism. **Note that in contrast to the previous simulations, no domestic production factors are employed in the mining sector in this set of simulations**.

a) Government spending of mining receipts

Beginning with a scenario where government revenue increases on account of scaled up mining production, this scenario reintroduces (i) import taxes, (ii) export taxes, (iii) other indirect taxes, and (iv) dividend collection from the mining sector that was removed from the reference scenario in order to switch off this transmission channel.[18] In total, in the baseline, these mining revenues account for a bit more than 10 percent of all government revenue collection.

Figure 14: Impact of rising government revenues as mining sector doubles in size



Notes: BASE is the business-as-usual scenario in which there is no resource windfall and the economy grows at a 5% pace over the long term. The scenario assumes mining output doubles by 2016, and that the mining sector does not utilize any domestic inputs but that mining revenues flow into the domestic economy and to the government via taxes and dividends.

Scaling up of mining production raises government revenue collection by just under 10 percent at its peak relative to the business as usual scenario; over time, the revenue increase in percentage term decreases slightly, reflecting the falling relative share of the mining sector once production plateaus (Figure 14). In percent of GDP, the increase in revenue is more modest at about 2 percent, mostly driven by the increase in export taxes, i.e., royalties, and payment of dividends by the mining sector.[19]

[18] Technically, dividend collection from the mining sector is modeled as factor payments from the mining-specific production factor to the government. Under the reference scenario, all of these factor payments are sent to foreign owners, whereas in this scenario approximately 10% of these factor payments accrue to the government, reflecting partial public ownership of the mining sector. The absolute amount of dividends paid to the government in the baseline is calibrated on the basis of actual revenue collection, mostly reflecting dividend payments from Erdenet, a partially-state owned copper mine.

[19] Higher revenue collection from the mining sector necessitates other changes relative to the reference scenario in order to balance the SAM. First, higher domestic revenue collection is offset by lower budget support from the rest of the world to keep overall revenues constant. Second, higher tax payments of the mining sector (but not dividend payments, which are made by the mining-specific production factor employed in this sector) lower the income of this sector; to compensate, household purchases are increased by the same amount. Third, higher household purchases of mining goods in the baseline create a deficit in the

A key issue in the transmission mechanism is how the government uses the additional revenues it receives as mining sector production scales up: the simulations below will consider three alternatives, namely:

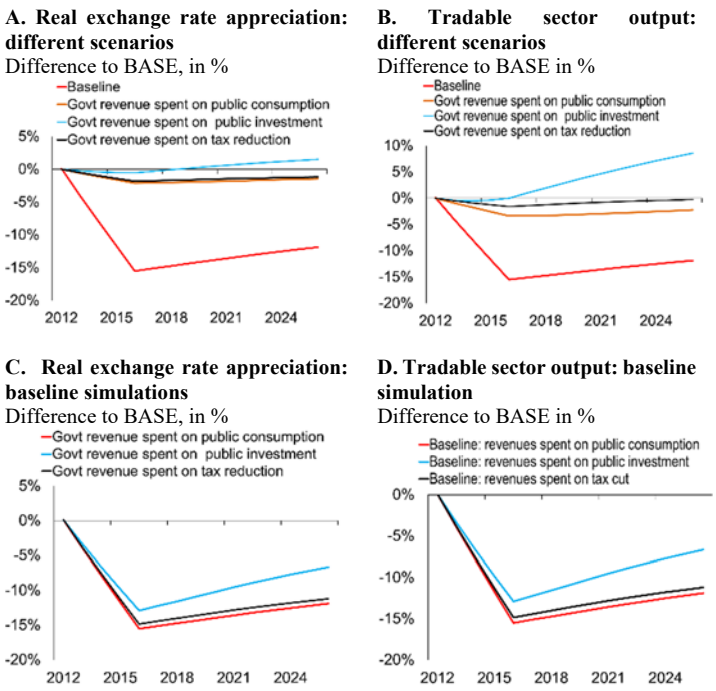
(i) spending on consumption goods;
(ii) spending on public investment;
(iii) a reduction in direct taxes for households. Before turning to a detailed discussion of the individual scenarios, the following section reviews the aggregate Dutch disease effects for all three scenarios.

Size of Dutch disease effects. Beginning with the real exchange rate, at first glance the impact of domestic spending by the government appears small compared to the baseline (Figure 15A). This however, is misleading. The impact of government spending on Dutch disease effects depends critically on the amount of government spending, which in turn is a function of the additional revenues the government receives as the mining sector scales up production. [20]

This is also borne out in the simulations. The peak increase in revenues is about 2 percent of GDP. When spent on public consumption or tax cuts, they lead to a roughly 2 percent appreciation of the real exchange rate, suggesting a sizable (or one-for-one) fiscal impact. When used for public investment, the real appreciation is minimal in the short run (due to the higher import content of public investment). In the long run, the real exchange rate depreciates because higher public investment raises productive capacity of the economy. [21] This illustrates that the type of fiscal spending matters significantly for Dutch disease effects.

Regarding the tradable sector, the results are broadly similar to those for the real exchange rate (Figure 15B). In the scenario with public investment no Dutch disease effects are visible because tradable sector production increases. In the public consumption and tax cut scenarios, there is

Figure 15: Government spending of mineral receipts



Notes: BASE is the business-as-usual scenario in which there is no resource windfall and the economy grows at a 5% pace over the long term. The baseline scenario assumes mining output doubles by 2016, and that the mining sector is fully integrated into the economy.

household sector which is 'filled' by higher transfers from the rest of the world. In addition, higher transfers from the rest of the world also compensate for the foreign exchange deficit that arises when budget support grants were pared back in the first step.

[20] These can vary substantially between countries (due to different tax regimes) and even between projects in the same country because of different cost structures and project-specific fiscal terms. For Mongolia, the revenue effects of scaled-up mining production assume that existing fiscal terms for the mining sector—at least as embedded in the SAM— are applied to a new mining project. In the real world, fiscal terms for a new project are subject to negotiation and may well be much larger than those simulated here. For the sake of simplicity, we avoid changing these terms.

[21] Another way to see this is that meeting fiscally-induced demand means mobilizing domestic resources, just as was the case for the scenarios with the mining industry using domestic inputs directly. Indeed, In the baseline, revenue collected from the mining sector is about equal in absolute terms to the domestic inputs of labor, capital, and intermediate inputs after these have been rescaled to account for the same input share into the mining sector.

a modest contraction in output, comparable to the scenario where the mining sector uses only intermediate inputs.

It is also worth looking at impacts of different fiscal spending strategies in the original baseline simulations. These had assumed that higher revenues were entirely spent on government consumption and led to large real exchange rate appreciations and shrinkage of the tradable sector. As Figures 15C and 15D show, even

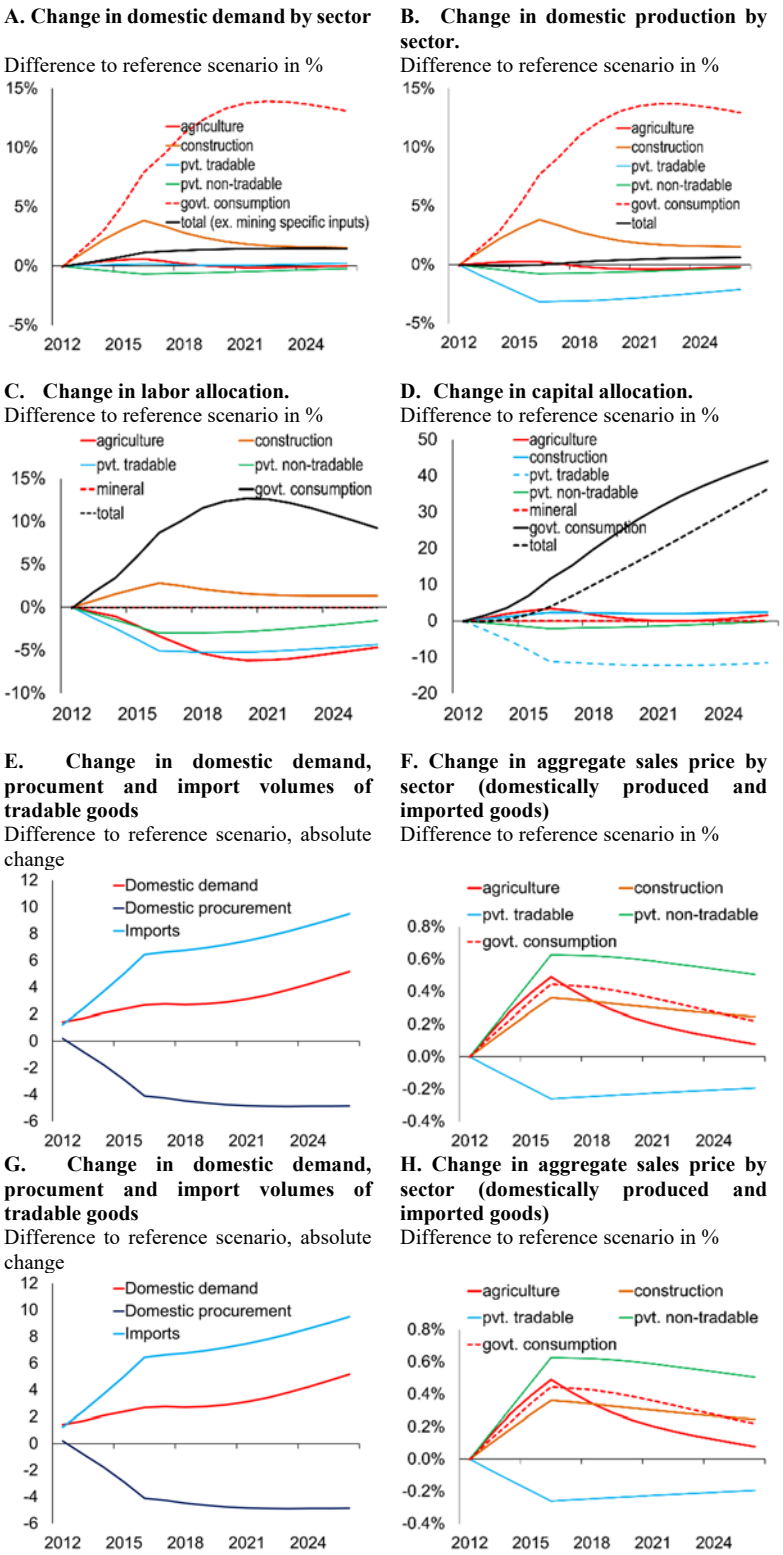
if they had been spent on public investment, the decline in the tradable sector remains substantial, i.e., government spending on public investment alone is insufficient to reverse Dutch disease.

Spending additional government revenues on public consumption

The starting point for the transmission mechanism in this scenario is the increase in demand for public consumption goods, met through higher output in the sector, and in construction. The higher levels of labor and capital needed to produce public consumption goods are "donated", as in previous simulations, by mainly agriculture, and the tradable sectors (Figure 16, A-D).

Domestic demand for tradables is met through imports and exports decline that helps free up more domestic production capacity. Relatively buoyant demand conditions raise domestic sales prices with the exception of tradables prices that are dominated by the real appreciation (Figure 16E,F)

Figure 16: Government spending of mineral receipts on public consumption



Notes: The reference scenario switches off all Dutch disease transmission channels while scaling up mineral output, so that the mining sector is a perfect enclave.

This price differential leads to expenditure switching effects that allow a greater proportion of domestic demand to be met by imports. This makes it possible to devote more domestic production capacity to the demand for domestically-produced goods such as public consumption goods.

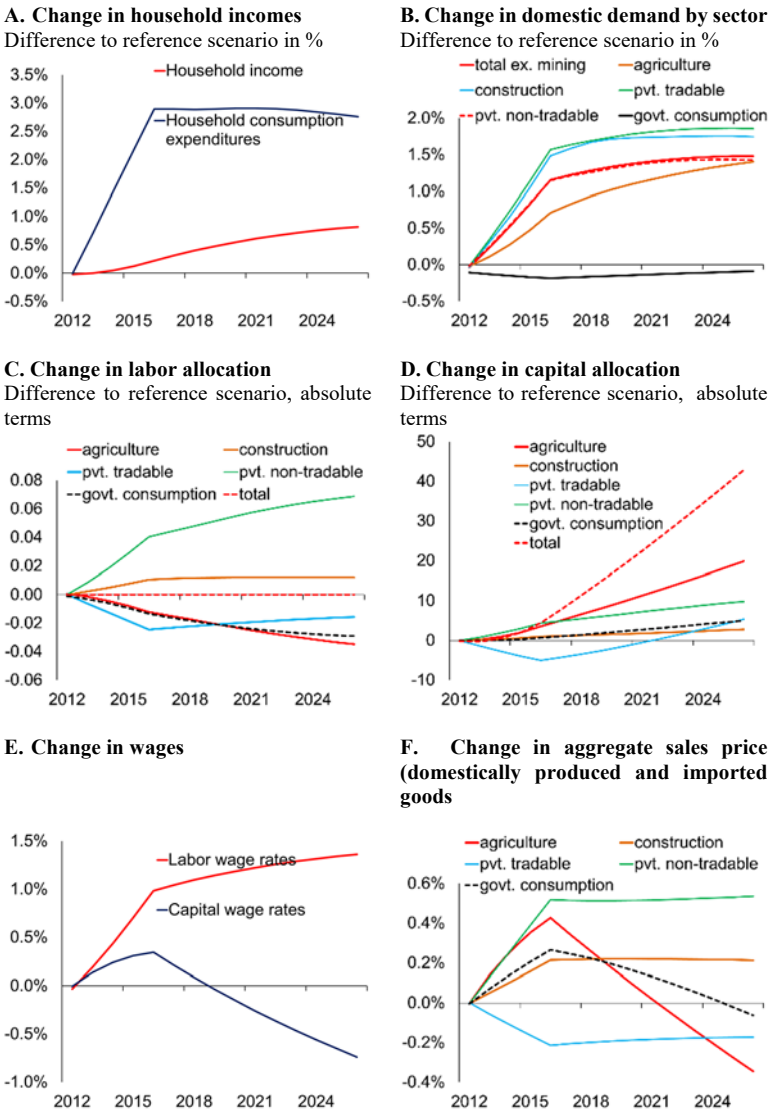
However, the changes in wages for labor and capital also lead to income effects that support the transmission mechanism by raising savings and investment. Nevertheless, with investment needs outpacing income gains, household expenditures decline in order to generate the required savings, a result that could be characterized as a crowding out of private consumption by public consumption (Figure 18A, 18B).

Spending additional government revenues on tax reductions

In this scenario, all of the increase in government revenues from the mining sector is transferred to households via a cut in direct taxes. This is akin to a universal cash transfer program funded by resource revenues. It is a particularly appropriate scenario to consider in Mongolia, given use of such programs in the past: in 2006, Mongolia introduced resource-financed payments for all children, and in 2010 the scheme was expanded, with larger payments to be provided to all citizens (Ying and Howes, 2015). In 2012, the scheme was narrowed to cover only children as a result of severe fiscal pressures due to a sharp drop in global commodity prices following the global economic crisis of 2009 and a sharp slowdown in growth.

In the simulations, the resulting increase in disposable income due to the tax cut boosts both household consumption expenditures and savings. Higher consumption expenditures raise demand across the board (Figure 17A,B), and the remainder of the transmission channel is very similar to the one observed in other scenarios: essentially production of tradables falls to free up production factors in other sectors (Figure 17C,D).

Figure 17: Government spending of mineral receipts on direct tax cuts for households



Notes: The reference scenario switches off all Dutch disease transmission channels while scaling up mineral output, so that the mining sector is a perfect enclave.

Underpinning it is the impact of appreciation of the real exchange rate on the tradable sector, the effects of which are reinforced by rising wage rates, especially for labor. In the longer term, the increase in savings and investment builds up the capital stock and the resulting larger supply of capital leads to a decline in relative cost of capital that underpins the substitution of labor with capital in the agricultural sector. Strong demand leads to general price increases with the exception of tradables and government investment goods for which prices are determined by the real appreciation. This price divergence leads once again to expenditure switching effects. With capital becoming more plentiful in the long run and thereby cheaper, prices for agricultural products decline, reflecting that agriculture is relatively capital intensive in the Mongolia calibration, especially after the substation of labor with capital in this sector.

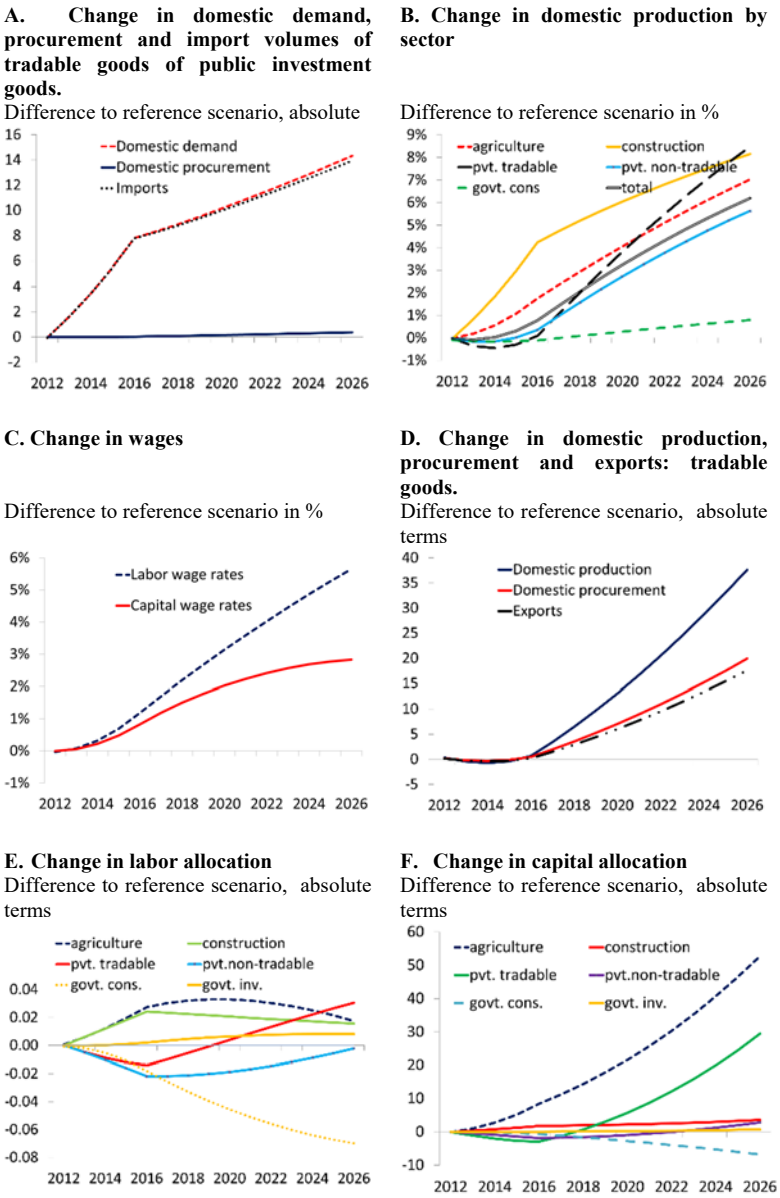
Spending additional government revenues on public investment

This scenario has been designed to investigate whether it is possible to counter Dutch disease effects through fiscal policy. In short, the answer is yes. However, note that this scenario isolates the impact of public investment spending: when other channels are also switched on, the positive impacts associated with higher govt. spending are considerably diluted (refer back to Figures 16C,D).

The simulations have two key features; firstly that demand for public investment goods is met easily through imports (Figure 18A). As a result, the demand created by higher fiscal spending does not create domestic demand per se and thereby avoids the real appreciation that otherwise would reallocate domestic demand and production factors to generate the necessary domestic supply response.

The second is that public capital accumulation increases total factor productivity, thereby boosting overall production capacity directly as well as indirectly, including in the tradable sector (Figure 18B). The indirect effect stems from the increase in profitability as TFP rises, which

Figure 18: Government spending of mineral receipts on public investment



Notes: The reference scenario switches off all Dutch disease transmission channels while scaling up mineral output, so that the mining sector is a perfect enclave.

leads to increased demand for labor and capital. The latter in turn bids up wage rates for labor and capital (Figure 18C) – with investment rising over time, the supply of capital increases in the long run, which dampens the increase in the wage rate for capital. The increase in private investment itself is a result of the surge in public investment, because the last increases economy-wide absorption and private investment is programmed in the simulations to grow in line with absorption. With wage rates increasing, household income rises, which leads to both higher savings and household consumption expenditures. The increase in household income and the resulting rise in household consumption expenditures boosts overall demand, broadly aligning demand with the rise in the production potential stemming from higher total factor productivity.

The net effect is to boost tradable sector output – a key departure from previous scenarios. The challenge for the tradable sector is to find outlets for its higher production. One outlet is higher domestic sales, driven by the overall increase in demand; in contrast to the other scenarios, domestic tradables retain their competitiveness because there is no substantial real appreciation in this scenario, allowing domestic tradables to participate in the general increase in demand. The other outlet is an increase in exports; to facilitate this, the real depreciation is critical to increase price competitiveness and to create export markets for tradables (Figure 18D). Finally, just as in other scenarios imports for tradables increases as a result of the general increase in domestic demand, notwithstanding the real depreciation.

Another effect is that higher private investment leads to higher demand for agricultural products and construction services the two sectors with the strongest increase in both demand and production; consequently, agriculture does not fulfill its customary role observed in previous scenarios of releasing labor while stocking up on capital.

With the tradable sector for once unavailable to supply the rest of the economy with labor and capital, the burden falls mainly on the sectors supplying non-tradables and public consumption goods. *D*emand for these is relatively weak, so that TFP gains in these two sectors can be used for releasing production factors instead of boosting production levels (Figures 18E,F). In addition, labor is substituted with capital in the public consumption goods sector—the elasticity of substitution between factors is calibrated to be relatively high in this sector, based on historical experience[22]—which explains why the release of labor from the public consumption goods sector is relatively much larger than the release of capital. For non-tradables, demand is also relatively weak, which means that part of the total factor productivity gains in this sector can be used as well to release production factors.

b) Private sector spending of dividends from the mining sector

In this scenario, the only transmission channel that is switched on is a rise in private sector household income stemming from the receipt of dividends from the mining sector.[23] In the baseline calibration, domestic private ownership of the mining sector has been set to about 30 percent, compared to 10 percent for the government and 60 percent for foreigners. Household dividend collection exceeds total government revenue collection from the mining sector by approximately 50 percent, which implies that dividends are a very substantial income source for households.

A caveat is that typically households in natural resource rich economies are likely to own small scale mines whereas large-scale new mining projects are likely to be owned mainly by foreign companies. Hence, dividend payments to households from the new large-scale mining project simulated here are likely

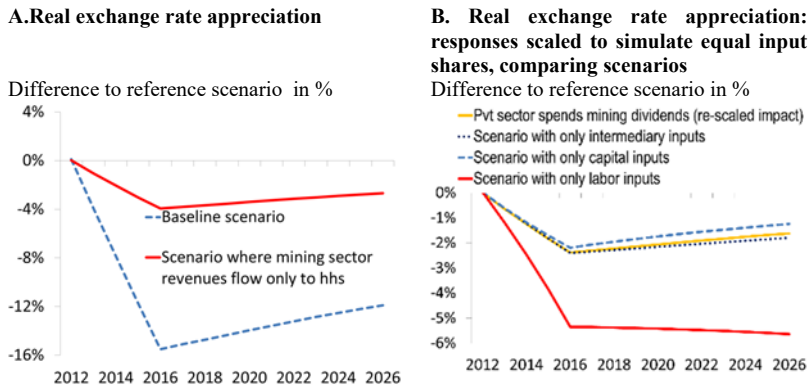
[22] See companion paper Khan et al (2017).

[23] As before, payments from the mining-specific production factor to households are interpreted as dividend payments.

overstated, whereas revenue collection in the previous scenario was probably understated. However, in Mongolia's case, the distribution of the shares of Erdenes TT means that ownership of large scale mines is (given share buybacks by the government during 2012), and will be, a substantial source of household income once the mine is developed and listed. Accordingly, scenarios where Dutch disease effects are transmitted to the economy through the household ownership of large scale mines are not unreasonable.

Dutch disease effects: At first glance, the contribution of private sector spending of mining dividends appears to make a noticeable contribution to the overall real appreciation under the baseline scenario (Figure 19A). However, as with government revenues, the real appreciation needs to be set in proportion to the mining revenues received by households. Rescaling dividend payments to households to the same value as domestic inputs into the mining sector on average shows that the impact on the real appreciation is similar to that of the scenarios where the mining sector uses domestic intermediate and capital inputs (Figure 19B), but much less than the scenario where mining uses labor as an input only. For government revenues, the results were similar to the two scenarios where the government spent its additional revenues on public consumption or used it for tax reductions (not shown). This suggests that if mining receipts increase the domestic demand for different goods and services (as well as capital) the impact on the real exchange rate is broadly similar.

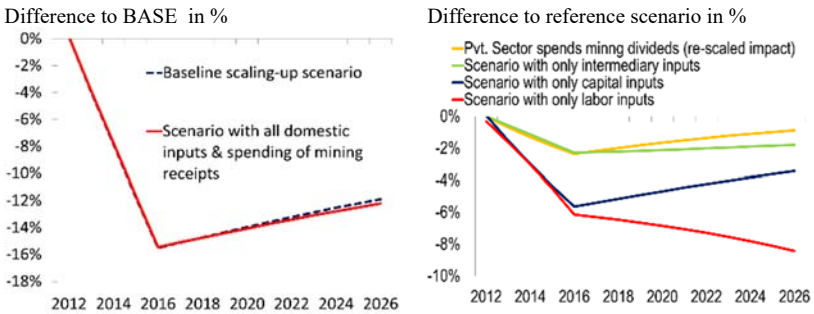
Figure 19: Scenarios where mining sector revenues flow to only households and are spent by them



Notes: The baseline scenario assumes mining output doubles by 2016, and that the mining sector is fully integrated into the economy. The reference scenario switches off all Dutch disease transmission channels while scaling up mineral output, so that the mining sector is a perfect enclave.

Furthermore, with results in hand for all individual channels behind the real appreciation—i.e., domestic inputs into the mining industry, government spending of mining revenues, and private sector spending of mining dividends—it is possible to check whether the individual channels reinforce each other or cancel out. Comparing the sum of the individual results to the baseline scaling-up simulation that encompasses all of these channels simultaneously shows only a small difference, which suggests there is little interaction

Figure 20: Scenarios where mining sector revenues flow to only households and are spent by them



Notes: BASE is the business-as-usual scenario in which there is no resource windfall and the economy grows at a 5% pace over the long term. The baseline scenario assumes mining output doubles. The baseline scenario assumes mining output doubles by 2016, and that the mining sector is fully integrated into the economy. The reference scenario switches off all Dutch disease transmission channels while scaling up mineral output, so that the mining sector is a perfect enclave.

between the different channels as far as the real exchange rate is concerned (Figure 20A).

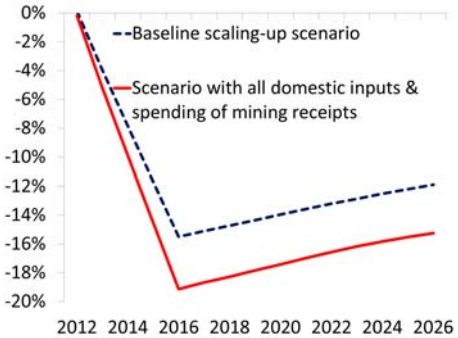
For the tradable sector, the impacts are similar to that on the real exchange rate. However, once mining dividends are rescaled to match the average domestic inputs into the mining sector the effect is similar to that of using domestic intermediate inputs in the mining sector (Figure 20B); a similar result was obtained for government spending on public consumption and tax reductions indicating that increasing spending on goods and services has approximately the same impact on tradable sector production, irrespective of the source of spending. If demand for capital inputs increases, however, the impact on tradables production is much larger compared to that of higher demand for goods and services; this result differs from Figure 19B where the impact on the real exchange rate of higher demand for capital inputs and goods and services was comparable.

For both the real exchange rate and tradable sector production, variations in the demand for labor have by far the biggest effect, especially in the long run (Figures 19B, 20B). The last result could reflect that labor supply in the model simulations is fixed whereas in the real world it is likely to respond to demand—for example, an increase in wages for skills in high demand would draw students into these professions, thereby raising the supply over time; this implies that the actual long-run effect of changes in the demand for labor could be smaller than that indicated by the simulations.

Turning to interaction effects, in contrast to the real exchange rate these are present for the tradable sector because the sum of the individual effects is by about a quarter larger than the effect in the baseline scaling-up simulation where all transmission channels are present simultaneously (Figure 21). This suggests that some of the individual effects cancel out in the aggregate transmission mechanism.

Figure 21: Tradable output: comparing factor input and private sector spending of mining dividends scenarios.

Difference to reference scenario in %



Notes: The reference scenario switches off all Dutch disease transmission channels while scaling up mineral output, so that the mining sector is a perfect enclave.

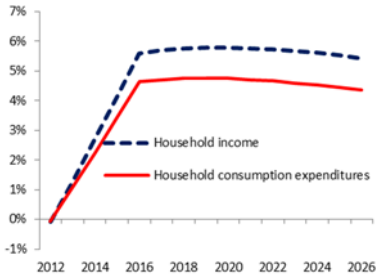
Transmission mechanism: The transmission mechanism is very similar to that of the tax reductions scenario. Central to both is the increase in household income and the resulting surge in household consumption expenditures (Figure 22A). The increase in household consumption expenditures increases demand across the board, including for public consumption goods (Figure 22B). In addition, rising household incomes lead to higher income taxes whereas higher consumption expenditures raise indirect tax collection (Figure 22C); in contrast to the tax reduction scenario, the gains in government revenue collection are not passed on to households via tax reductions but instead are used for increasing public consumption expenditures.

Rising demand is met by a reduction in tradables production which, helped by a real exchange rate appreciation, releases labor and capital inputs to other sectors. Other transmission mechanisms at work, as in previous scenarios, are the substitution of labor with capital in the agricultural sector, which increases the labor supply for other sectors, and expenditure switching effects that redirect demand towards tradables and hence imports. Besides the real appreciation, this transmission mechanism is supported by rising labor wage rates whereas capital wage rates remain broadly unchanged, reflecting the effect of increased investment on capital supply (Figure 22D,E,F).

Figure 22: Scenario where mining sector revenues flow to only households and are spent by them

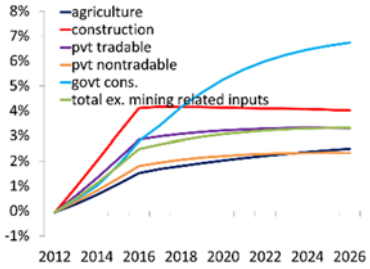
A. Change in household incomes and consumption

Difference to reference scenario, in %



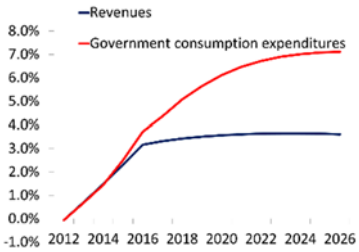
B. Change in domestic demand by sector

Difference to reference scenario in %



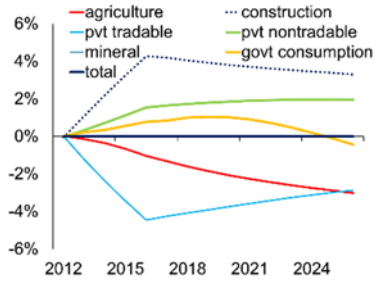
C. Change in governement expenditures and revenues

Difference to reference scenario, in %



D. Change in labor allocation

Difference to reference scenario, in %

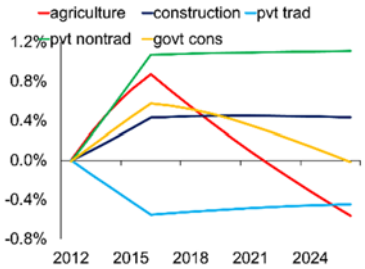


E. Change in wages

Difference to reference scenario, in %

F. Change in aggregate sales price

Difference to reference scenario, absolute terms



Notes: The reference scenario switches off all Dutch disease transmission channels while scaling up mineral output, so that the mining sector is a perfect enclave.

IV. Lessons

This section briefly summarizes the three main lessons that emerged from the simulations in this paper.

Complexity of the transmission channels

The economic effects of scaled-up mining production are complex. Dutch-disease effects, which typically focus on the real exchange rate and tradable sector response, capture only part of the transmission mechanism. Arguably, all sectors of the economy are affected by a scaling up of mining production—and not only the tradable sector—and many relative prices change, not only the real exchange rate.

Having said that, the focus on the tradable sector in the discussion of Dutch disease effects is not misplaced because in most of the scenarios considered here it does play a special role: the shrinkage in the tradable sector releases production factors that are in demand elsewhere in the economy. Unwrapping this a bit more leads to the core of the transmission mechanism: scaling up mining production raises the demand for domestic production factors, be it directly through the mining sector requiring additional domestic labor and capital inputs as it scales up production or indirectly through higher demand for domestically-produced goods and services by the mining, government, and household sectors as their incomes rise.

At least in the short term, the supply of domestic production factors can be considered as more-or-less fixed; the only sector where domestic production can easily be replaced through imports is the tradable sector, and doing so makes it possible to shrink the sector while still meeting the demand for tradables, which in turn releases the production factors that are in demand in other sectors. In this sense the shrinkage of the tradable sector plays a crucial role in facilitating the short-run supply response of the economy to meet the demand for non-tradable goods and services. In the absence of a central planner who decrees the shrinkage of the tradable sector, it is the real appreciation that makes this happen.

But there are also other processes at work. For example, the rise in labor wage rates that took place in many scenarios reinforces the effect of the real appreciation on profitability of the tradable sector, thereby contributing to its shrinkage. Changes in relative prices on product markets—especially price increases of non-tradables relative to tradables—lead to expenditure-switching effects that ultimately channel demand towards imports. Looking beyond the tradable sector, in many scenarios agriculture substituted labor with capital, thereby increasing the labor supply available for other sectors.

The strength of these different channels depends on structural characteristics of the economy such as factor input requirements of the mining sector, elasticities of substitution, revenue take of the government from scaled-up mining production, etc. As a result, this paper can sketch the main transmission channels at work but it cannot yield universally applicable rules of how scaling-up of mining production will affect individual sectors and relative prices; the process is too complex for this to be feasible.

Equilibrium outcomes

Dutch disease effects such as the real appreciation and shrinkage of the tradable sector are equilibrium outcomes. In a sense, this result was predetermined because all the simulations in this paper took place in a Computable General Equilibrium (CGE) model, which means any real appreciation and tradable sector

response generated in this model has to be an equilibrium outcome. Hence, the extent to which this captures Mongolia's reality depends on the deeper question to what extent a CGE model is relevant for Mongolia. To this end, the companion paper has shown that the CGE model used here can reproduce many of the salient features of the boom-and-bust cycle Mongolia experienced in the second half of the 2000 (Khan et al., 2017). With this background, the finding that the scaling-up simulations yield sizeable real appreciations and shrinkages of the tradable sector as equilibrium outcomes should be taken seriously.

If the real appreciation and shrinkage of tradable sector production are equilibrium outcomes, the question arises why they should be considered as a disease. Arguably, simulation results showed substantial reallocations of demand, factor allocations, and production across different sectors, but none of these seemed to make the economy at large worse off. In fact, scenarios such as tax reductions and household spending of mining dividends included large income gains of households and increases in household consumption, features that usually would be considered as positive. As noted at the outset of this paper, to introduce disease it is necessary to add additional features that give the tradable sector a special role for economic development; for example, it might be the source of TFP growth, which implies that shrinkage of the sector would have a permanent negative effect on the growth outlook of the economy that outweighs any short-term income gains from the mining sector. This is a separate question that has not been addressed in this paper. The answer to this question, which should be considered on a country-by-country basis, determines whether the real appreciation and shrinkage of the tradable sector is indeed a problem.

A related issue is the development strategy for a country: if this strategy is predicated on building up an export-oriented manufacturing industry following the example of many Asian countries, then the real appreciation and shrinkage of the tradable sector are clearly harmful to that strategy, regardless whether these are equilibrium outcomes or not. This leads to the final question of how to avoid Dutch disease effects. This issue is taken up in the final lesson.

Policy implications

If avoidance of Dutch disease effects is a policy objective, for example because the country is committed to an export-led, manufacturing-oriented development strategy, this can only be achieved through trade-offs that relinquish aspects of scaling-up mining production that typically would be considered as beneficial:

First, if avoiding Dutch disease effects is the overriding policy objective, an assumption that will be made for the remainder of the discussion in this section, the most certain way of accomplishing this is to leave the minerals in the ground. While radical, this proposition captures the notion that an export-led, manufacturing-oriented development strategy is fundamentally at odds with scaling up of mining production because the last is bound to lead to some Dutch disease effects that will undermine the first. After all, as argued above, Dutch disease effects are equilibrium outcomes that are embedded into the very structure of the economy and cannot be simply switched off through policy choices or clever management of the scaling-up process. The last two can have some impact, at a cost to other policy objectives, but are unlikely to avoid Dutch disease effects entirely.

Second, limiting Dutch disease effects from the production side means minimizing domestic inputs into the mining sector as it scales up production. If the goal is to build an export-oriented manufacturing industry, production factors have to be steered into this direction and not into mining. The trade-off here is that policy makers view jobs that are directly generated by the scaling up of the mining sector as a benefit—this job creation can take place either directly through increased employment in the mining industry (which leads to particularly strong Dutch disease effects) or indirectly through the demand for goods and services by this sector. But heralding jobs created by the scaling up of mining industry while simultaneously professing

adherence to an export-led, manufacturing oriented development strategy is internally inconsistent. Something has to give: either the scaling up of the mining sector has to be structured as much as possible as an enclave sector with minimal linkages to the rest of the economy, or the development strategy has to move away from the focus on exports and manufacturing, which in any event is not suitable for all countries.

Policy makers may also consider increasing domestic labor force participation rates – one possibility for Mongolia where female labor force participation, although not low, is concentrated in the informal/unremunerated part of the economy and is particularly limited in the mining sector (Khan, 2013 et al., 2013, a,b). Immigration may also be an option for relaxing supply constraints. Such policies have been employed in GCC countries, with evidence indicating that large inflows of foreign migrants and the associated extremely large remittance outflows have helped to dampen real exchange rate pressures associated with commodity booms (Espinoza et al. 2013). However there too tensions/trade-offs may exist, in the form of social (e.g., migrants substantially outnumbering locals as in Qatar) or long term economic consequences (low skill base of migrants that affects productivity and diversification efforts) and it is not clear to what degree these can be sustained.

Limiting Dutch disease effects from the spending of mining receipts means saving these receipts or focusing spending on areas that minimize Dutch disease effects. The use of mining receipts and the associated policy options differ for the public and private sectors, as we explain below.

Beginning with the public sector, the simulations above suggest that using additional government revenues for boosting government consumption or lowering taxes should be minimized if avoiding Dutch disease effects is the overriding policy objective. Again, achieving this objective entails a real trade-off because it means that worthwhile alternative policy objectives such as raising the level of public service delivery or sharing the mineral wealth with the (current) population cannot be achieved. In fact, experience in countries like Mongolia and Timor-Leste makes it doubtful that a strategy of full saving/deferred benefits of the mining boom is politically sustainable. Yet another alternative is to focus spending on activities that (i) have a high import content and (ii) that boost the overall supply potential of the economy, especially that of the tradable sector. This likely means focusing spending on public investment. The simulations above have shown that this can avoid Dutch disease effects, even though this spending strategy was not sufficient to offset Dutch disease effects from other transmission channels. In practice, it will also be necessary to consider the sustainability of ramped up public investment spending, given that this will entail permanently higher maintenance costs that can become fiscally challenging once the new mining projects have been exhausted and mining production recedes.

Turning to the private sector, to the extent that there are large income effects, and it is not possible to direct these resources through structural policies to areas that benefit the export-led, manufacturing-oriented development strategy, a tight monetary stance could constrain private consumption and investment and thereby counteract the increase in household expenditures that is at the heart of this Dutch disease transmission channel. The drawback is that this policy has distributive implications: not all households will benefit equally from mining sector dividends, but a tight monetary stance will affect all households, including those that do not benefit from the mining sector boom.

The bottom line is that the transmission channels behind the real appreciation and the decline in tradable sector production are complex and represent equilibrium outcomes; as such, they are not necessarily a disease. However, these effects do pose a challenge for the development strategy of a country, especially if this strategy aims for export-led, manufacturing-oriented growth. In this case, it will either be necessary to forfeit (or postpone) many of the benefits that are normally associated with a booming mining sector in order to avoid Dutch disease effects, or the growth strategy will have to be changed to allow for a real appreciation and shrinkage of the tradable sector to take place.

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Appendix A: Mongolia Social Accounting Matrix

	a-agr	a-const	a-prv_trd	a-prv_nontrd	a-min	a-ogov	a-oinf	c-agr	c-const	c-prv_trd	c-prv_nontrd	c-min	c-ogov	c-oinf	c-ncimp	c-intmimp	f-lab	f-capprv	f-min	hhd	gov	row	tax-hdf	tax-dir	tax-imp	tax-exp	tax-oind	int-dom	int-row	cap-hhd	cap-gov	cap-row	inv-ogov	inv-oinf	inv-prv	dstk	total
a-agr								680		80		1																									761
a-const									330	0	1																										332
a-prv_trd								1	25	1364	23	2	8																								1424
a-prv_nontrd								0	1	4	1291	1	8																								1303
a-min									2	0	3	949																									954
a-ogov										0	0		719																								719
a-oinf														5																							5
c-agr	80	3	196	18	1	4	0													164		36											14	10	257		782
c-const	0	5	30	15	10	7	0													4		1											15	11	265		363
c-prv_trd	45	181	415	238	78	96	1													1032		649											20	15	352		3123
c-prv_nontrd	36	47	252	292	56	55	1													465		75											6	4	95		1382
c-min	1	6	10	38	3	1	0													53		819											4	3	61		999
c-ogov	5	0	3	17	2	328	4														416	7															782
c-oinf																					5																5
c-ncimp																																		64			64
c-intmimp					185																																185
f-lab	149	55	251	316	73	177	2																														1022
f-capprv	445	35	266	370	54	43	1																														1214
f-min					489																																489
hhd																	1022	1154	153		174	258						2									2763
gov																			43			11	0	270	169	31	157										681
row								78	4	1429	37	4	51	6	59	175		61	293										24								2220
tax-hdf																				0																	
tax-dir																				270																	270
tax-imp								8	0	138	4	0	5	1	5	9																					169
tax-exp												31																									31
tax-oind								10	1	109	22	12	3	0																							157
int-dom																					2																2
int-row																				6	18																24
cap-hhd																				769												5					774
cap-gov																					65									1		99					165
cap-row																						365															365
inv-ogov																															58						58
inv-oinf																															106						106
inv-prv																														769		261					1030
dstk																																					0
total	761	332	1424	1303	950	712	9	777	363	3123	1382	999	794	12	64	185	1022	1214	489	2761	681	2220		270	169	31	157	2	24	770	165	365	58	106	1030	0

Appendix B: Macro Indicators in the BASE (Business-As-Usual) case.

Macro indicators for selected years (% of nominal GDP)

	2005	2009	2013	2017	2021	2025	2026
Absorption	108.3	105.4	104.2	103.3	102.8	102.6	102.6
Consumption - private	55.6	54.7	54.7	54.8	55.0	55.4	55.6
Consumption - government	13.9	13.0	12.2	11.5	10.9	10.4	10.3
Investment - private	33.4	32.5	32.1	31.8	31.7	31.6	31.6
Investment - government	5.4	5.2	5.2	5.2	5.1	5.1	5.1
Stock change							
Exports	51.4	53.8	54.7	55.5	56.0	56.2	56.2
Imports	-59.6	-59.2	-59.0	-58.8	-58.8	-58.8	-58.8
GDP at market prices	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Net indirect taxes	11.7	11.6	11.6	11.6	11.6	11.7	11.7
GDP at factor cost	88.3	88.4	88.4	88.4	88.4	88.3	88.3
Foreign savings	11.8	12.2	12.5	12.8	13.0	13.3	13.4
Gross national savings	26.9	25.5	24.8	24.3	23.8	23.5	23.4
Gross domestic savings	30.5	32.3	33.1	33.7	34.0	34.2	34.1
Foreign government debt	40.0	45.4	47.6	47.1	45.1	42.1	41.3
Foreign private debt	13.0	11.7	10.4	9.0	7.7	6.6	6.3
Domestic government debt	3.2	2.7	2.3	2.0	1.7	1.4	1.3

Real macro indicators by simulation and year (% growth)

	2005*	2006	2009	2013	2017	2021	2025	2026	Average annual growth rate
Absorption	333.9	3.8	4.3	4.6	4.8	4.9	5.0	5.0	4.7
Consumption - private	171.5	4.2	4.6	4.9	5.0	5.1	5.1	5.1	4.9
Consumption - govt	42.9	2.4	2.6	2.8	3.2	3.6	3.8	3.9	3.2
Fixed investment - private	102.9	3.8	4.4	4.8	4.9	5.1	5.1	5.2	4.8
Fixed investment - govt	16.6	3.2	4.1	4.8	4.9	4.9	5.1	5.2	4.7
Stock change									
Exports	158.4	5.2	5.5	5.2	5.3	5.2	5.2	5.2	5.1
Imports	183.9	3.3	4.2	4.6	4.9	5.1	5.2	5.2	4.6
GDP at market prices	308.4	4.9	4.9	4.9	5.0	5.0	5.0	5.0	5.0
GDP at factor cost	272.3	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Total factor employment (index)		5.8	4.6	4.0	3.8	3.7	3.6	3.6	4.0
Total factor productivity (index)		-0.8	0.4	1.0	1.2	1.3	1.4	1.4	1.0
Real exchange rate (index)		1.9	0.7	0.3	0.0	-0.2	-0.3	-0.4	0.3
Wages- labor		2.9	4.7	4.7	4.8	4.9	5.0	5.0	4.7
Wages- private capital		-7.6	-4.8	-3.0	-2.7	-1.9	-1.8	-1.8	-3.1

Note: *Base-year column (2005) shows data in LCU.

Appendix C: Macro indicators in the baseline (mining sector doubles in size)

Macro indicators for selected years (% of nominal GDP)

	2005	2009	2013	2017	2021	2025	2026
Absorption	108.3	105.8	101.8	96.6	97.5	98.7	99.0
Consumption - private	55.6	55.0	53.0	49.7	50.9	52.1	52.5
Consumption - government	13.9	13.1	12.0	11.7	11.9	11.5	11.4
Investment - private	33.4	32.6	31.4	29.8	30.1	30.4	30.5
Investment - government	5.4	5.1	5.4	5.3	4.7	4.6	4.6
Stock change							
Exports	51.4	53.4	56.6	60.5	59.7	59.0	58.7
Imports	-59.6	-59.2	-58.4	-57.1	-57.3	-57.6	-57.7
GDP at market prices	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Net indirect taxes	11.7	11.7	11.6	11.4	11.4	11.5	11.5
GDP at factor cost	88.3	88.3	88.4	88.6	88.6	88.5	88.5
Foreign savings	11.8	12.3	11.7	9.7	10.1	10.6	10.8
Gross national savings	26.9	25.4	25.1	25.4	24.6	24.4	24.4
Gross domestic savings	30.5	31.9	35.0	38.5	37.2	36.4	36.2
Foreign government debt	40.0	45.9	44.3	36.0	35.1	33.6	33.1
Foreign private debt	13.0	11.8	9.6	6.8	6.0	5.2	5.1
Domestic government debt	3.2	2.8	2.2	1.7	1.4	1.2	1.2

Real macro indicators by simulation and year (% growth)

	2005*	2006	2009	2013	2017	2021	2025	2026	Average annual growth rate
Absorption	171.5	4.2	4.5	6.4	5.4	5.2	5.1	5.1	5.3
Consumption - private	42.9	2.4	2.4	5.7	5.6	4.6	3.9	3.9	4.3
Consumption - government	102.9	3.8	4.2	7.2	5.4	5.1	5.1	5.1	5.4
Fixed investment - private	16.6	3.2	2.9	16.5	1.0	2.8	4.9	5.0	5.1
Fixed investment - government									
Stock change	158.4	5.2	4.5	17.5	4.3	4.1	4.1	4.1	6.5
Exports	183.9	3.3	3.7	11.6	4.6	4.6	4.7	4.7	5.7
Imports	308.4	4.9	4.5	9.9	4.9	4.7	4.6	4.6	5.7
GDP at market prices	272.3	5.0	4.6	9.5	5.0	4.7	4.6	4.6	5.7
GDP at factor cost		5.8	4.2	9.1	3.9	3.6	3.4	3.4	4.7
Total factor employment (index)		-0.8	0.4	0.5	1.0	1.1	1.2	1.2	1.0
Total factor productivity (index)		1.9	1.0	-3.8	0.5	0.3	0.0	0.0	-0.3
Real exchange rate (index)		3.8	4.1	7.1	5.9	5.6	5.6	5.6	5.6
Wages- labor		2.9	4.4	7.8	5.2	4.9	4.9	4.9	5.5
Wages-private capital		-7.4	-4.9	-2.2	-2.9	-2.5	-2.4	-2.4	-3.2

Note: *Base-year column (2005) shows data in LCU.