RISK ASSESSMENT OF "DUTCH DISEASE" IN MONGOLIA DUE TO A MAJOR RESOURCE AND EXPECTED MASSIVE CAPITAL INFLOW [1]

Batsukh Tserendorj[2], Avralt-Od Purevjav[3]

The First Draft was submitted on 2 February 2012
The Last Draft was submitted on 27 July 2012

[1] This research was sponsored by the Economic Research Institute (ERI), National University of Mongolia and the IRIS Center at the University of Maryland.
[2] Department of Economics and Econometrics, Institute of Finance and Economics, Mongolia
[3] University of Arizona

Executive Summary

Mongolia is a country with abundant natural resources and mineral deposits such as Oyu Tolgoi mine counted as third biggest copper and gold mine in the world, Tavan Tolgoi mine one of the biggest coal mines in the world and other big mines of copper, coal, iron and zinc.

Looking at the overview of Mongolia current outlook, mining sector is started growing rapidly, the growth peaked to 9.5 percent in 2011. Mining sector contributes constantly about 20% of the GDP while agriculture sector contribution is decreasing over time. The fact that more than 90 percent of the total export consists of mineral commodity export, it shows country is heavily dependent on resource based export. Moreover, almost half of the fiscal revenue is collected from commodity revenue, proving economy as a whole is vulnerable to the external shocks in mineral sector. The real exchange rate appreciated about 37% during the period of 2006-2011.

The country has been dependent on mostly agriculture and mining sector and Mongolian economy is expected to grow rapidly in coming years based on large mining projects. So we face the problem that whether the big capital inflows and investments due to mining projects and boom in mining sector could lead economy to its long run sustainable growth path.

There are a number of studies that have examined the “Dutch Disease” effects on economies that have abundant natural resources. However, hardly any research has been carried out for Mongolian economy. An exception is Fisher et al. (2011) paper that evaluates the impact of the Oyu Tolgoi project on the Mongolian economy using a dynamic CGE model. Also there are some studies associated with the impact of the global financial and economic crisis on the Mongolian economy such as Narantuya et al. (2009a, 2009b, 2009c, 2010) and Tuvshintugs (2009a, 2009b, 2010). To our knowledge, a DSGE model has not been applied to assessing the risks of “Dutch disease” in Mongolia.

This paper aims to investigate the impact of the massive capital inflow in a Mongolian economy using a New Keynesian Dynamic Stochastic General Equilibrium Model with a natural resource sector. We use calibrated model for different fiscal, monetary and reserves policy responses and examined the effects of FDI inflow shock and commodity price shock on natural resource sector to verify whether these shocks cause Dutch disease impacts in the economy.

The simulation results suggests that a boom in natural resource causes an increase in wages and marginal product in the non-manufacturing sector thus leads to an increase in labor demand. Through the resource movement effect, the production of non-tradable good rises and manufacturing production declines. Through the spending effect, the appreciation of the domestic currency leads to the decline of tradable sector. Second, the impact of the increase in commodity price shock has similar effect in the economy as the first shock. Shock leads to a decline in the output of the manufacturing sector go along with a boom in natural resource and non-tradable sectors and the impact on other sectors is quite large. The labor demand increases much greater than other sector due to wage decline in manufacturing industry through resource movement effect. And the real appreciation of domestic currency contributes to decline in manufacturing industry through the spending effect.

Examining the role of fiscal policy, the capital inflow affects the economy mainly through the fiscal spending policy on non-tradable goods. By implementing fiscal policy with high import share of new spending leads real appreciation and decline in tradable sector is minimized. Moreover, the paper suggests that the government should save a portion of income from mineral revenue and spend it on sustainable fiscal missions; the short-term fiscal demand pressure will be reduced considerably.

If the government decides to save part of the mineral revenue domestically, central bank faces some issues with the management of the foreign currency inflow. Because supply management of foreign currency associated with the mineral revenue has important role in stabilizing aggregate demand and containing inflationary pressures, reserve policy must be consistent with fiscal policy. As for the central bank, a discretionary tightening of monetary policy to reduce inflation from current high levels to a new, lower steady state can work but it requires a strong commitment to price stability and it induces a massive crowding out of investment in the private sector.

Хураангуй

Монгол улс нь байгалийн баялаг, түүхий эдийн арвин их нөөцтэй орон юм. Тухайлбал, зэс, алтны агууламжаараа дэлхийд 3-т тооцогдох Оюу толгойн, дэлхийн хамгийн том нүүрсний ордуудын нэг болох Таван толгойн болон стратегийн ач холбогдол бүхий нүүрс, зэс, төмрийн хүдэр, цайрын томоохон орд газруудтай.

Монголын эдийн засгийн өнөөгийн нөхцөл байдлыг товч дурьдвал уул уурхайн салбарын өсөлт 2011 онд эрчимжиж 9.5%-д хүрсэн бөгөөд уул уурхайн салбар ДНБ-ий 20%-ийг эзлэх болсон ба хөдөө аж ахуйн салбарын эзлэх хувь жилээс жилд буурсаар байна. Экспортын орлогын 90 гаруй хувийг 10 гол нэр төрлийн уул уурхайн бүтээгдэхүүний эскпорт эзэлж байгаа нь манай орон нөөцийн эскпортод тулгуурласан болохыг харуулж байна. Мөн төсвийн орлогын 49% нь уул уурхайн түүхий эдийн орлогоос бүрдэж байгаа бөгөөд эдийн засаг бүхэлдээ гадаад шоконд өртөмтгий, эмзэг байгааг харуулж байна. Бодит ханш 2006-2011 оны хооронд 37%-иар чангарсан байна.

Манай орны эдийн засаг хөдөө аж ахуй, уул уурхайн салбарт түшиглэж ирсэн бөгөөд цаашид ч уул уурхайн салбарт түшиглэн хөгжих төлөвтэй байна. Энэхүү уул уурхайн салбарт чиглэсэн их хэмжээний хөрөнгө оруулалт, салбарын өндөр өсөлт нь Монгол улсын хөгжилд урт хугацааны тогтвортой эдийн засгийн өсөлтийг бий болгож, чадах уу? гэсэн асуулт хүн бүрийн сонирхлыг татаж байна.

Байгалийн баялаг ихтэй орнуудын эдийн засагт “Голланд өвчин”-ий шинж тэмдгийг шинжилсэн судалгааны ажлууд олон байдаг боловч Монголын эдийн засгийн хувьд Фишер (2011) нарын Оюу толгой төслийн Монголын эдийн засагт үзүүлэх нөлөөллийг “Динамик Ерөнхий Тооцооллын загвар”-аар судалсан ажлаас өөр хийгдсэн ажил хараахан байхгүй байна. Харин дэлхийн санхүү, эдийн засгийн хямралын Монголын эдийн засагт үзүүлэх нөлөөг Нарантуяа (2009a, 2009b, 2009c, 2010) болон Түвшинтөгс (2009a, 2009b, 2010) нар судалжээ.

Энэхүү судалгааны ажлаар Монголын эдийн засагт орж ирж буй их хэмжээний хөрөнгийн урсгалын нөлөөг байгалийн баялгийн сектор бүхий Шинэ Кейнсийн Динамик Стохастик Ерөнхий Тэнцвэрийн загвараар шинжлэхийг зорилоо. Шинжилгээнд төсөв, мөнгө, нөөцийн өөр, өөр бодлогыг харгалзан үзсэн калибрацийн загварыг ашигласан бөгөөд гадаадын шууд хөрөнгө оруулалтын шок болон дэлхийн зах зээл дээрх бүтээгдэхүүний үнийн шокын нөлөөгөөр эдийн засагт “Голланд өвчин”-ий шинж тэмдэг илэрч байгаа эсэхийг шалгасан.

Симуляцийн шинжилгээгээр ГШХО-ыг нэмэгдүүлэх шокын үр дүнд байгалийн баялгийн секторын үйлдвэрлэлд гэнэтийн өөрчлөлт гарч, худалдаалагддаггүй секторын цалин болон ахиу бүтээгдэхүүн нэмэгдэн, хөдөлмөрийн эрэлт нэмэгдэж байна. Хөдөлмөрийн эрэлт нэмэгдснээр нөөц шилжилтийн сувгаар худалдаалагддаггүй бүтээгдэхүүний үйлдвэрлэлийг нэмэгдүүлж, аж үйлдвэрийн бүтээгдэхүүний үйлдвэрлэл багасч, харин зардлын сувгаар бодит ханш чангарснаар худалдаалагддаг салбарын үйлдвэрлэл буурч байна. Дэлхийн зах зээл дээрх бүтээгдэхүүний үнийн шок нь дээрхтэй мөн төстэй хариу үйлдэл үзүүлж байна. Шок үр дүнд байгалийн баялаг бүхий салбар болон худалдаалагддаггүй салбаруудад гэнэтийн тэлэлт болох бол аж үйлдвэрийн салбарт уналт

болох төлөв харагдаж байна. Энэхүү шокын бусад секторт үзүүлэх нөлөө нь харьцангуй их байна. Нөөц шилжилтийн сувгаар цалингийн бууралтаас шалтгаалан тус салбарын хөдөлмөрийн эрэлт их хэмжээгээр нэмэгдэх бол зардлын сувгаар бодит ханш чангарснаар аж үйлдвэрийн салбарын үйлдвэрлэл буурч байна.

Төсвийн бодлогын эдийн засагт үзүүлэх нөлөөллийг шинжлэхэд, худалдаалагддаггүй салбарт төсвийн зарцуулалтыг нэмэгдүүлснээр эдийн засагт илүү их үр ашгийг бий болгохоор байна. Төсвийн зарцуулалтыг импортыг дэмжих байдлаар хийснээр ханшийн чангаралт болон худалдаалагддаг салбарын үйлдвэрлэлийн бууралтыг багасгаж чадна.

Засгийн газар уул уурхайгаас орж ирэх орлогын тодорхой хэсгийг дотоодод хуримтлуулбал Төв банк гадаад валютын урсгалыг зохистой удирдах хүндхэн асуудалтай тулгарна. Хэрвээ төв банк гадаад валютын нөөцийг хуримтлуулж, засгийн газар зарцуулалтаа дотоод валютаар хийсэн тохиолдолд ханшийн чангаралт сулрах боловч инфляцийг ихээр хөөрөгдөх сөрөг нөлөөтэй. Гадаад валютын нийлүүлэлт нь нийтэрэлтийг тогтворжуулах болон инфляцийн дарамтыг нэмэгдүүлэхэд аль алинд нь хүчтэй нөлөөлөх тул валютын нөөцийн бодлогыг төсвийн бодлоготой уялдуулах нь зүйтэй. Төв банкнаас өнөөгийн хэрэгжүүлж буй мөнгөний хатуу бодлого нь инфляцийг бууруулж, нам тогтвортой түвшинд авчрах боловч нөгөө талаас хувийн секторын хөрөнгө оруулалтыг шахан гаргах сөрөг нөлөөтэй юм.

1. Introduction

Mongolia is blessed with abundant mineral resources. The country possesses major reserves of 80 different minerals including copper, gold, coking coal, iron ore, fluorspar, molybdenum. The largest income comes from copper, coal and gold. It also has a great potential for more discoveries as many parts are still not explored.

In October 2009, the Government of Mongolia signed an agreement on development and operation of the Oyu Tolgoi deposit with an international mining company, owning 34% of the mine. Oyu Tolgoi deposit is estimated to become the 3rd largest copper mine in the world including 24 million tons of copper, 874 tons of gold and 5589 tons of silver reserve discovered during the mine life of 59 years.[4] The mine is expected to start functioning in 2013 and contribute almost one third of the economic growth in coming years, increasing GDP per person by 60% from now to 2020.

Besides Oyu Tolgoi, there are other plans for developing mines of mineral resources which are already discovered. Tavan Tolgoi coal mine is the second largest mining investment in Mongolia with reserve of 6.5 billion tons of high quality coking coal which is equivalent to 8 months of world consumption of coking coal. Initial estimates have indicated Tavan Tolgoi will produce 30 million tons of coal annually for the next 30 years, most of which is coking coal. Its development is projected to have significant and long-term impacts in the South Gobi region and on the Mongolian economy.[5]

As expected, the Mongolian economy has relied on the mining sector and the high prices of mineral products in the international market for economic growth. Real GDP growth is expected to be an average over 15% a year for the following 3 years. It is also expected that there will be significant growth in economy as the mining boom triggers agriculture, construction and service sector development.[6] In terms of expenditure, GDP will grow dramatically because of the investments in mining sector, as increasing flow of mining related imports such as plant, equipment, and fuel. Even though big mining projects such as Oyu Tolgoi will not come on stream until 2013, other small mining projects are likely to increase production and exports of mineral products.

Looking forward, Mongolia faces critical policy challenges. Indeed, the country is one of the richest countries in the world in terms of mineral endowments, and international prices of minerals have been at high levels in recent years. Mongolian medium and long-term growth outlook seems favorable, because its large mineral reserves give it the potential to grow rapidly and raise living standards significantly. However, international experience shows that mineral reserves do not guarantee prosperity and that rents from their exploitation need to be invested wisely to ensure sustainable growth in the long run. Once forecasts for the development of mining sector are realized, the strong medium-term outlook for GDP growth will encourage fiscal revenues as taxable activity expands in all sectors of the economy, leading to growth in expenditures particularly on social welfare.

---

[4] SES NUM and BAEconomics, Development of the OyuTolgoi copper mine, an assessment of the macroeconomic consequences for Mongolia, February, 2011

[5] USGS Minerals Yearbook Mongolia 2010, Mongolian ministry of mineral resources and energy estimates of TavanTolgoi, 2010

6 National Development and Innovation Committee projection of GDP growth, February 2012

The government is determined to use these revenues from large mineral resources for imposing a credible fiscal discipline. This needs more attention as there is a tendency towards pro-cyclical spending. In the past, the large propensity to consume of mineral revenues led to pro-cyclical “boom–bust” policy which economy becomes more dependent from the world mineral prices[7]. To ensure medium-term fiscal responsibility, Mongolia approved a Fiscal Responsibility Law and Medium-term Fiscal Framework in 2010. The Law anticipates a deficit reduction, impose ceilings on structural deficits, public expenditure and overall debt and redirect the excess revenues into the Human Development Fund. Moreover, it is obvious that resource-rich countries have faced problems ranging from corruption to internal conflict. Therefore, it is recommended that the Government of Mongolia should learn from other countries such as Chile that have managed mineral wealth successfully.

One of the major concerns during the mining sector boom is that the Bank of Mongolia is likely to raise interest rates as inflation increases over the period. The demand impulse from spending natural resource revenues may raise inflation. This is a particularly important issue in Mongolia, because of its already high rate of inflation reaching 14.3% in 2010 and 11.1% in 2011[8]. Strong economic growth and the government’s cash disbursements program as well as big pay rises for public sector workers have all contributed to high inflation. Maintaining inflation at an average level of 15 to 20% in coming years is crucial; otherwise huge increases in inflation may lead to a wage-price spiral as workers demand higher wages to compensate for the increase in inflation. If the Bank of Mongolia were to increase its policy rate in order to prevent high inflation, this may attract more capital inflows into the Mongolian banking sector, which would lead to inflationary credit expansions. Again, the increase in inflation may also prompt the Bank of Mongolia to tighten monetary policy even further. The risk of this would be a reduction in investment spending and the associated long run implications for the economy.

Moreover, there are concerns about the economy’s capacity to cope with the requirements of these ambitious mining projects. It is highlighted that there is a risk of “Dutch Disease” problem occurring due to the continued expansion of the mining sector. "Dutch Disease" refers to an economic condition where a booming mining sector prompts structural change within the economy to progress at a faster rate than what policy makers can manage. Corden and Neary (1982) examined the effects of a mining boom in two ways: the resource movement effect and the spending effect. The first describes the movement of mobile factors into the mining sector, bidding up their wages, causing other sectors to contract. In case of Mongolia, this effect is maybe small because the mining sector’s capital and labor are primarily foreign. The second effect refers to the use of the increased revenues since the spending effect alone is sufficient to produce Dutch disease effect.

A third effect may occur when the inflow of capital and the increase in exports associated with the growth in the mining sector also put upward pressure on the exchange rate. The combination of these two impacts makes traditional export sectors like agriculture and manufacturing less competitive in global markets. The end result is sectors like agriculture and manufacturing contract while the mining sector continues to grow and thus, the economy becomes much more dependent on the mining sector for employment, government revenue and earning foreign

[7] IMF, Staff Report for the 2011 Article IV Consultation and Post-Program Monitoring, March 2011
[8] The Bank of Mongolia, Statistical bulletin, December 2011

exchange. Given the long-term cycles that commodity prices exhibit, this situation can prove disastrous.

It must be stressed that “Dutch Disease” is a manageable condition. For example policies that improve the productivity of traditional sectors can help to offset the reduction in their competitiveness caused by rising input costs and an appreciating exchange rate. Furthermore policies that enforce the saving of some government revenue from the mining sector can help to mitigate the upward pressure on the exchange rate and provide a source of funds for when commodity prices fall.

The purpose of this study is to analyze the impact of mining boom on the Mongolian economy by employing an adjusted multi-sector Dynamic Stochastic General Equilibrium Model under different fiscal, monetary and reserves policy responses. The model is ideally suited to analyze macroeconomic issues in low income countries. In particular, it features varying degrees of international capital mobility (an important role for public capital in production) and imperfect labor mobility across sectors and other features characterizing such countries. Given the features of the model, we are able to distinguish between the short-term impact of the mineral revenue on inflation, output and the real exchange rate, and the medium-to-long term impact on competitiveness and growth. In addition, based on recent projections of mineral production in Mongolia, policy choices were investigated in order to analyze the impact of the mining sector on inflation and the exchange rate in short run and the role of different public policies in minimizing the "Dutch Disease" effects on competitiveness of the economy in the medium to long run.

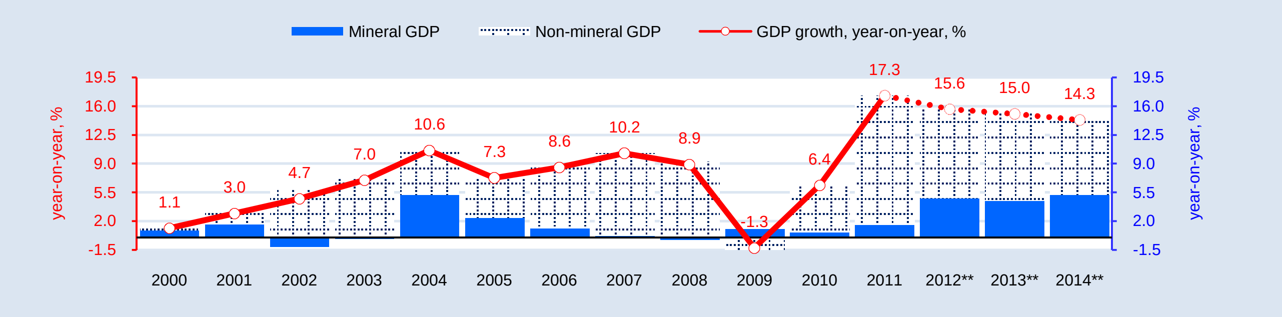
The rest of this paper is organized as follows. Chapter II provides to an overview and outlook of the Mongolian economy. The next chapter describes a review of literature on the impact of the Dutch disease on the Mongolian economy as well as some of the empirical papers that have applied empirical approaches to evaluate policy effectiveness. Chapter IV summarizes the DSGE model for a small open economy with mining sector. Chapter V presents the parameter calibration. The next section covers the simulations for the baseline case as well as the some sensitivity analysis. Finally, Chapter VII concludes the results from the empirical analyses of the study.

2. Overview and Outlook of the Mongolian Economy

2.1. Real Sector

The Mongolian economy has been growing rapidly, about 8.5% year on year, for the last 8 years. Even though the economy was relatively small with GDP of US$ 1.3 billion in 2000, it has increased quickly during the decade and reached US$ 14.4 billion by the end of 2011. The country has relatively low living standards with per capita income of US$ 2,988 in 2011, which is classified into a lower-middle-income country according to the World Bank classification by country income level.

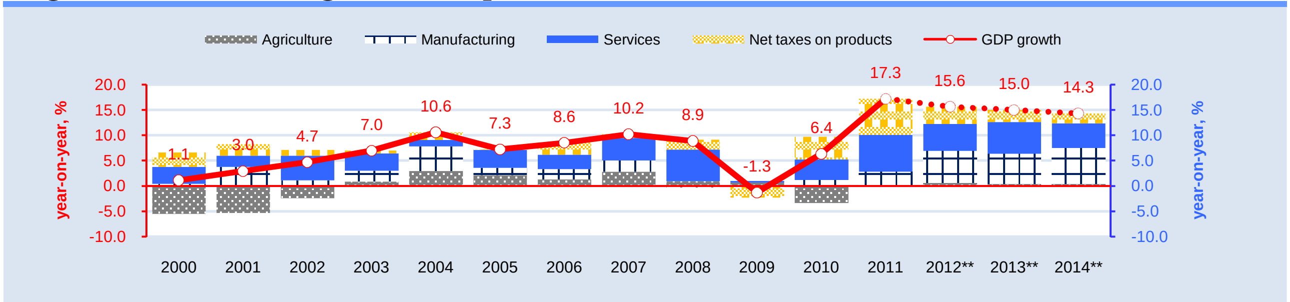
Figure 2-1. Mineral and Non-mineral GDP



Source: National Statistical Office, NDIC projection

Economic growth which was 8.9% in 2008, slowed to -1.3% in 2009 due to the global economic downturn. The most suffered sector during the crisis was mineral sector as a result of the copper price decline starting from 2007 where the scope of the downturn in mineral GDP growth was very low and its contribution to GDP has become almost invisible 2007 to 2008 (Figure 2.1). Growth reached 6.4% in 2010 and 17.3% in 2011, which is the highest annual growth ever accounted for the last 20 years. Mining sector growth was 3.6% and 8.7% respectively in the years mentioned above. Increases in the wholesale & retailing, construction, transportation sectors and net tax on products from import of mineral equipment had a significant impact on the growth.

Figure 2-2. Real GDP growth components



Source: National Statistical Office, NDIC projection

The agriculture sector showed signs of stability during the crisis where the growth of the sector was 2% in 2009. However, it has decreased by 16.6% in 2010 because of the natural disaster "Zhud" and it has recovered by 0.3% in 2011 (Figure 2.2). The agricultural sector's contribution to the growth is becoming comparably less year by year.

The manufacturing sector increased by 6.1% in 2010, 16.0% in 2011, with growth in the metal ore sector having a positive impact. The construction sector experienced a boom from 2005 to 2008, fuelled by the increased demand for houses with the improved availability of mortgage financing for citizens. The construction sector was then hit hardly by the economic downturn in 2009 (-34%) and started to grow again rapidly with 16% growth in 2010 and 14% in 2011.

With recovery in the agricultural sector, coupled with services sector activity and strong growth in construction associated with the rapidly expanding mining industry, the economy is likely to face a boom in 2012-14. Real GDP growth is expected to be around 15% year-on-year for the next 3 years.

In terms of expenditure, it is also expected that GDP will grow dramatically as a result of the investments made in the mining sector such as mining related equipment, plant, and fuel in the next few years. Even though big mining projects such as Oyu Tolgoi will not come on stream until 2013, other small mining projects are likely to increase the country's production and export. Furthermore, this positive trend in the mining sector will provide further growth in demand as tax income from the sector supports government expenditures, particularly on social welfare, so as the consumption.

2.2. Mineral Sector

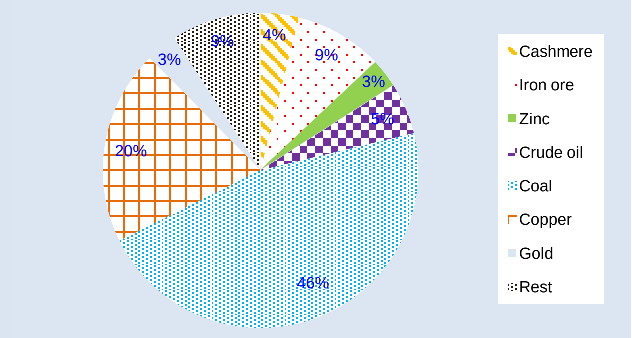
Mongolia is a country with vast natural resources and is heavily dependent on their extraction. According to the USGS[9] (2009), the most important minerals in Mongolia are the following: nonferrous metals: copper, gold, lead, zinc; ferrous metals: iron; energy minerals: uranium and coal; and other minerals: metallurgical coke and fluorspar.

As of 2011, total mineral exports were equivalent to about 40% of GDP. The total export revenue grew on average by 30% per year for the last four years. The top seven mineral commodity exports constitute 91% of total export revenues in 2011; therefore it clearly shows Mongolia's dependence on the extraction of natural resources. The two main export commodities, copper and coal currently compose 66% of total export earnings (Figure 2.5). The prices of these minerals were at high levels during this period. Also, Mongolian mineral exports increased as the demand of China due to strong economic growth.

Like other countries dependent on the mining sector, the Mongolian current account balance is vulnerable to the price change of mining products. A dramatic decline in commodity prices and a sharp drop in external demand due to the global downturn of 2008 and 2009 were significant external shocks to Mongolian economy. In 2010 and 2011, Mongolian economy benefited from high global prices for some mineral commodities such as copper coal and gold, external demand for coal and iron ore.

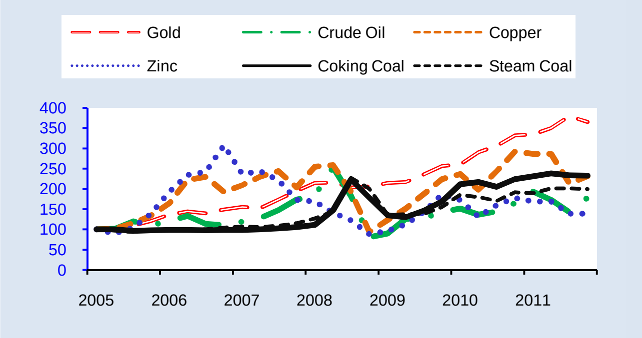
[9] United States Geological Survey

Figure 2-3. Share of Commodities to Export (2011)



Source: Bank of Mongolia

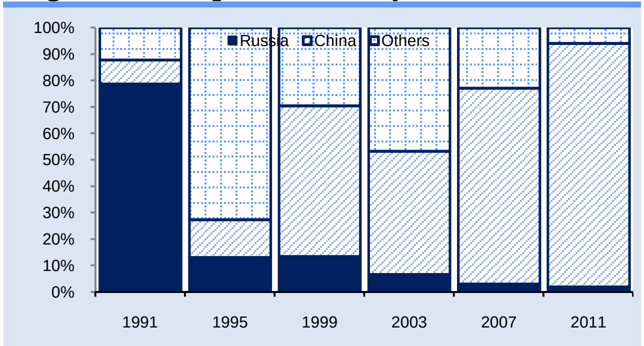
Figure 2-4. Commodity Price Indices (2005=100%)



Source: Bloomberg

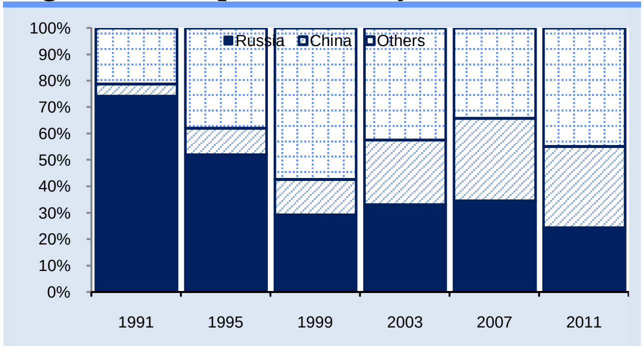
The mining industry in Mongolia is expected to grow and develop in the near future, not only because of reserves but also because of its proximity to, and trade with China, which is expected to sustain its growing demand for mineral commodities. In 2011, some metal projects were in the pre-feasibility or feasibility stage for production of copper, gold, molybdenum, silver, and uranium. Several of these projects were expected to be commissioned by sometime in 2013, including Oyu Tolgoi. Although mining investment in Mongolia have been directed primarily towards coal, copper, and gold, the country also has significant industrial mineral deposits that could be developed more quickly as means for relatively near-term economic stimulus, provided that there is sufficient transportation infrastructure.

Figure 2-5. Export shares by countries



Source: National Statistical Office

Figure 2-6. Import shares by countries



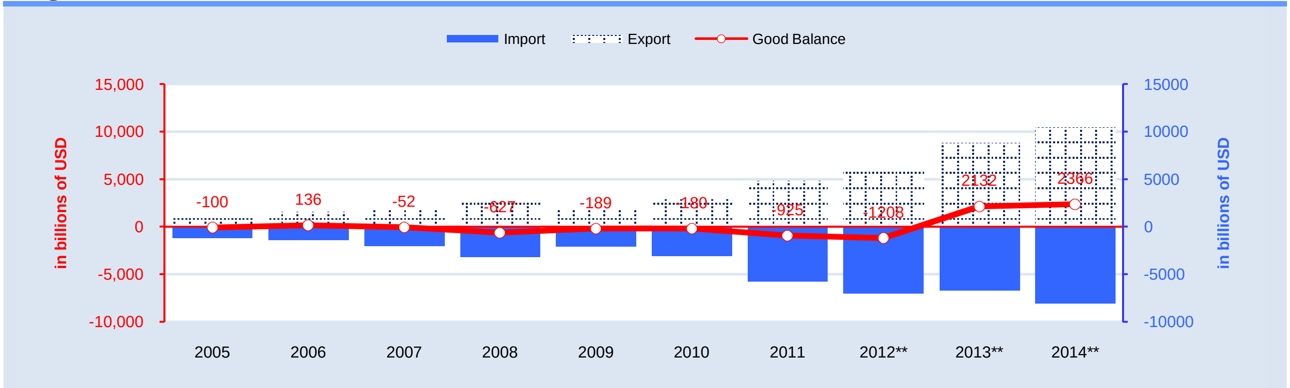
Source: National Statistical Office

Mongolia faces challenges to develop the mining sector responsibility, not only in terms of the environment and industry practices, but also economically in order to avoid a widening trade deficit and high inflation which could result from rapid economic growth. Also it will be important to consider Chinese mineral policy and mineral needs. Since 92% of total exports are currently going to China, its policies will greatly influence Mongolian ability to process minerals efficiently.

2.3. External Sector

Mongolia is a land-locked country, bordering Russia and China, where distances are huge and transport costs are high. These two factors make Mongolian produced goods expensive and uncompetitive in the international market. China has become its biggest trading partner, accounting for 92% of exports and 31% of imports while Russia accounted for only 24% of imports in 2011. China imports raw primary goods and exports manufactured goods to Mongolia, causing Mongolian producers to operate in direct competition with Chinese manufacturers.

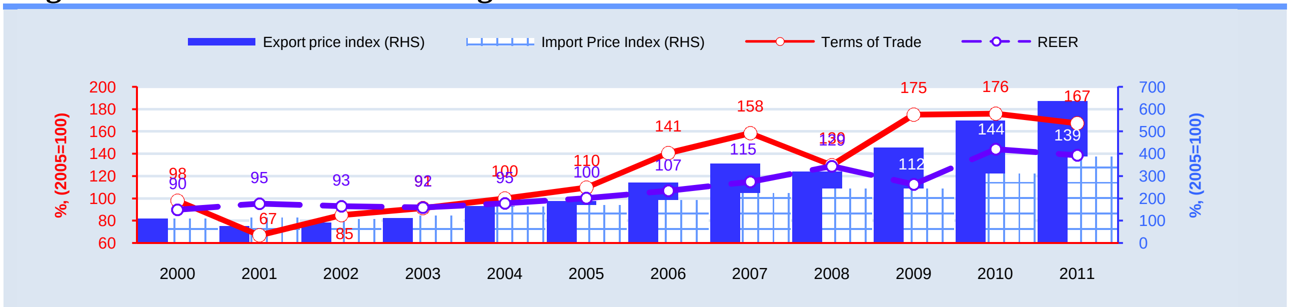
Figure 2-7. Goods trade balance



Source: Bank of Mongolia, BoP projection

Exports are expected to remain strong in 2012-14, in line with robust external demand, notably from China, and high global prices for metals and coal. However, there is a high risk for Mongolian economy suffering from any sharp downturn in Chinese economic growth. Import demand is growing strongly and will continue to be strong in the next two years as domestic demand picks up. Moreover, investments linked to the Oyu Tolgoi, as well as other mining operations create a large demand for imports, thus trade deficit is likely increase and it will be financed by foreign investment into the mining sector.

Figure 2-8. Real Effective Exchange Rate and Terms of Trade

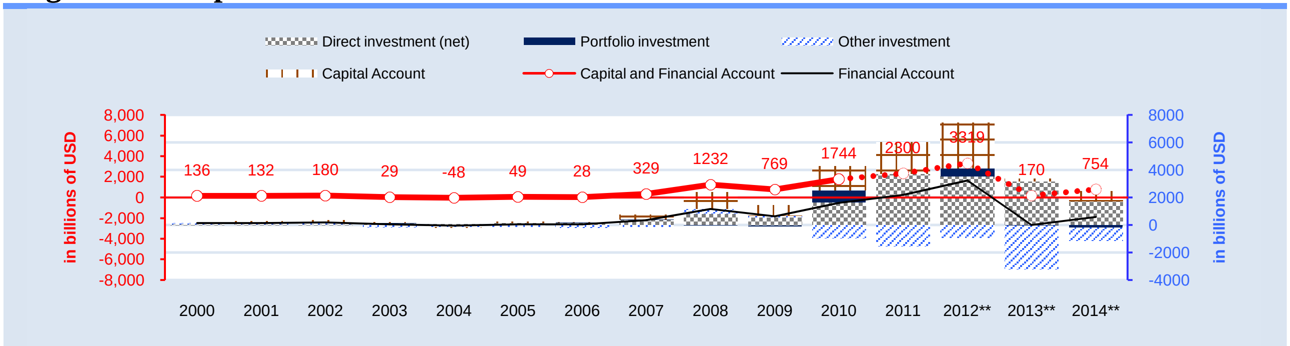


Source: Bank of Mongolia

The real effective exchange rate has been appreciating since 2003, except the period of economic downturn. Export price index increase due to the high prices of world mineral products while import price index growth is relatively slow. As a result terms of trade is increasing.

Mongolia’s improving terms of trade which induced foreign investors to invest in Mongolia, attracted foreign direct investment (FDI) and FDI increased rapidly for the past few years. Between 2004 and 2011, net direct investment rose from US$ 131.5 million, which is equivalent to 6.2% of GDP, to US$ 3,202 million (17% of GDP).

Figure 2-9. Capital and Financial account



Source: Bank of Mongolia, BoP projection

However, the flow of FDI is mostly related to exploration and start-up costs in big strategic mineral deposits of copper, gold and coal with small-scale inflows to the service sector. Therefore, the FDI inflow into the country has been highly concentrated towards the mining sector, particularly 80% of FDI in 2011. In order to decrease the country's reliance on commodities, more FDI is required in other sectors of the economy.

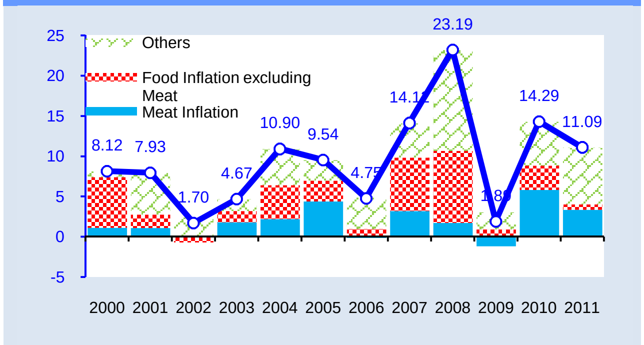
2.4. Monetary and Exchange Rate Policy

Monetary policy executed by the Bank of Mongolia (BoM) aims to maintain the stability of the Mongolian national currency, the togrog. In recent years, the BoM has also gradually started to target price stability. The BoM announces the tolerance band of CPI inflation for every year in State monetary policy guidelines with a target of single digit inflation. The nominal exchange rate should be kept flexible and reflect a market force. This all indicates the starting preparations for shifting from monetary aggregate targeting to an inflation targeting regime. The BoM is operationally independent from the government.

Monetary policy taken by the BoM in 2009 has limited policy space in mitigating adverse effects of the current economic crisis. Timely decisions and measures prevented the crisis from deeply affecting the economy. In order to protect the domestic currency against destabilization and to restore confidence in the togrog, the BoM raised its policy rate to 14% from 9.75% at the beginning of 2009.

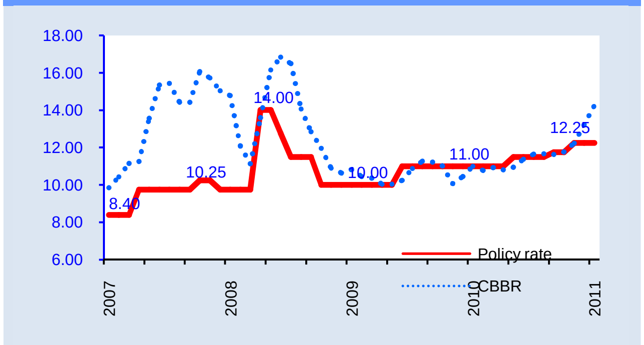
Starting from 2011, strong signs of overheating began. The BoM moved to tighten monetary policy numerous times, including three separate increases of its interest rate from 11% to 12.5%. It also increased the required reserve ratio by 2 percent points to reach 11% in 2011. These measures have been welcome but are not considered enough to prevent the increasing inflationary pressures expected in coming years.

Figure 2-10. Annual Inflation rate



Source: Bank of Mongolia

Figure 2-11. Policy rate and CBBR



Source: Bank of Mongolia

Mongolia has a bright economic future as it continues to develop its vast mineral resources. In the near term, however, there are substantial risks to the economic outlook with the economy overheating. Inflation is already high and rising further, which is likely to have a heavy burden on the poor and erode the ability of Mongolian private sector to operate effectively. These heightened domestic risks of macroeconomic instability come at a time when the global economic outlook is worsening. In order to prevent both high and/or rising inflation and to lessen the known vulnerabilities, tight monetary policy is not sufficient. Fiscal policy should also be considered.

2.5. Fiscal Policy

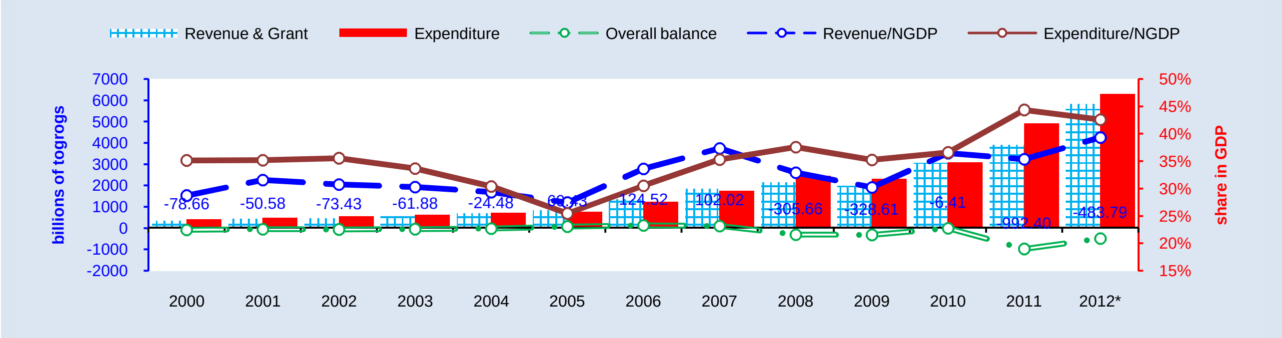
In October 2009, the Government of Mongolia (GoM) signed an Investment Agreement with Ivanhoe Mines, OT LLC and Rio Tinto PLC defining the fiscal and regulatory environment of the Oyu Tolgoi project. The GoM owns 34% of total equity of OT LLC with the option to increase their shareholding by a further 16% after 30 years.

The GoM has a history of weak fiscal discipline and changes in mineral prices have severe impacts on fiscal account. For the past few years, the current fiscal account was running surpluses because of high commodity prices in world markets where one third of the government revenue was collected in the form of the windfall tax on copper and gold mining. The large propensity to consume the mineral sector revenues lead to destabilizing pro-cyclical “boom–bust” policies that were dependent on the world mineral prices. To ensure a medium-term fiscal responsibility, Mongolia approved a Fiscal Responsibility Law and medium-term Fiscal Framework in 2010. These steps were meant to anticipate a deficit reduction, impose ceilings on structural deficits, public expenditure and overall debt and redirect the excess revenues into the Human Development Fund.

The key policy challenge for the GoM is to use the large mineral resources for imposing a credible fiscal discipline and improving the social safety net in order to shift the country toward more stable growth path.

Mongolian politics and social patterns in the period of resource booms have significant influence on the development of Mongolia.With the current mining boom, as the potential for rents is rising dramatically, corruption is also becoming a more crucial issue. Mongolia has consistently ranked highly in worldwide surveys of corruption and its effects can be observed at all levels of society and government (Rossabi).

Figure 2-12. Fiscal Revenue and Expenditure



Source: Ministry of Finance

The governance of Mongolia has been deteriorating over the last decade (Altantsetseg)and it has become evident that the country's economic and financial policies are ineffective and are not being implemented coherently. According to the world governance indicatorby the World Bank[10], the level of government effectiveness of Mongolia is closer to the countries recognized as struggling with the 'curse' of resource wealth, than to countries that have succeeded in developing strong economic growth with good economic structure reforms. Moreover, the government of Mongolia is running a pro-cyclical fiscal policy in recent years, distributing revenue from mining sector as cash to all citizens which was to fulfill populist election pledges that were promised by major parties. And this direct cash distribution system highlights economic development in Mongolia is strongly interrelated with political and institutional factors.The level of political stability and absence of violence in Mongolia is relatively high compared to that of the other 'cursed' model countries. However, in recent years, this stability has been declining sharply due to boom in mining sector and primary commodity export.

[10]World Bank (2011) World Governance Indicator 1996-2010, Mongolia http://info.worldbank.org/governance/wgi/sc_chart.asp

3. Review of the Literature

There have been numerous studies associated with the “Dutch Disease” and “Natural Recourse Curse”. In this research proposal, we highlight some key findings of the literature by focusing on the effects of “Dutch disease” on the economy. Furthermore, we briefly have reviewed the possible explanations of the general theory or hypothesis, as well as some of the empirical papers that have examined these hypotheses. Finally, a gap in the previous literature is discussed.

The “natural resource curse” hypothesis is based on the observation that resource-rich economies grow slower, on average, than resource-poor economies. For example, Sachs and Warner (1995) report a robust negative relationship between real GDP growth per capita and the ratio of resource exports to GDP in a sample of 97 developing countries during the period 1970–1989.

One possible explanation for the natural resource curse is that resource wealth tends to raise a fight over existing resources, which in turn leads to poor institutional quality and lower economic growth. Hausmann and Rigobon (2003) argue that the presence of common-pool problems or uncertainty related to property rights over the resource income leads to inefficiencies in the use of existing resources, which can generate lower growth. Sala-i-Martin and Subramanian (2003) call this the “institutional impact of natural resources,” and find empirical evidence that some natural resources (in particular, oil and minerals) exert a robust negative and nonlinear impact on growth via their harmful impact on institutional quality. In a similar study, Isham et al. (2005) find that countries that export fuels, minerals, plantation crops, and coffee or cocoa do worse across an array of governance indicators, even when controlling for other potential determinants of governance.

A second explanation for the natural resource curse is that resource rents tend to be volatile. This volatility arises in part from the fact that natural resources typically have a low price elasticity of supply. Volatility, in turn, has been shown to be negatively correlated with growth (Ramey and Ramey(1995)) and investment (Aizenman and Marion(1999)), including investment in education (Flug, Spilimbergo, and Wachtenheim(1998)). Hausmann and Rigobon (2003) argue that the main reason for this negative effect is the existence of financial market imperfections, as a result of which, volatility leads to a higher cost of capital, lower investment, and lower welfare.

A third explanation of the resource curse, which is the hypothesis commonly known as “Dutch Disease”. Going back to Corden (1982) and Corden and Neary(1984), the Dutch Disease hypothesis is briefly summarized as the notion that an exogenous increase in resource prices or in resource output results in real exchange rate appreciation and a decline in the manufacturing sector. Under certain conditions, which we will describe below, this can lead to lower growth in the long-run.

The predictions of the “Dutch Disease” model following Corden and Neary (1984), distinguishes between a *resource movement effect* and a *spending effect*. Corden and Neary (1984) refer to this fall in manufacturing output as “direct de-industrialization.” While the price of manufacturing goods does not change, because it is determined abroad, the decline in services output leads to excess demand for services and therefore to an increase in the price of services. The result is an increase in the price of non-tradable relative to tradable, inducing an appreciation of the real exchange rate.

While the resource movement effect is unlikely to be important in developing countries, the spending effect is likely to be important. The resource movement effect only occurs if factors are sufficiently mobile between the mining and non-mining sectors, which is unlikely in Mongolia given that the mining sector employs relatively few workers and labor mobility is low in general. However, the spending effect happens regardless of whether the mining sector employs any labor at all. The spending effect occurs simply because higher oil prices generate higher wages and/or profits in the mining sector, thus raising aggregate demand in the economy.

One reason why de-industrialization may lead to lower growth is that it implies increased volatility. As Hausmann and Rigobon (2003) point out, the smaller the manufacturing sector, the more difficult it is for the economy to absorb shocks. If the manufacturing sector disappears forever, the service sector will be the only significant employer, and all shocks will have to be absorbed by expenditure switching and increased unemployment, implying increased volatility. As argued above, this implies lower growth as long as financial markets are imperfect. However, it does not explain why growth would be permanently lower. That is, why could the manufacturing sector not is rebuilt during times of low commodity prices?

The empirical evidence to support the interaction between additional foreign inflows and Dutch disease effects has not been definitive. There are studies like IMF (2005) that have reported on the absence of Dutch disease effects for five countries (Ghana, Ethiopia, Mozambique, Tanzania and Uganda) that experienced foreign exchange inflows through aid surges. Years in which aid inflows surged were associated with depreciations (not appreciations) of the real effective exchange rate. A similar result in Li and Rowe (2007) confirms a strong negative and significant relationship between aid inflows into Tanzania and real effective exchange rate (REER). An earlier study by Nyoni (1998) during 1967-93 also found the same results whereby aid inflows were associated with real exchange rate depreciation, all of which contrast the predictions of the Dutch disease model.

There are also a number of country case studies (e.g. Malawi and Sri Lanka) where aid inflows have been associated with real exchange rate appreciations. The study by Rajan and Subramanian (2008) provide evidence of a systematic adverse effect of foreign aid on competitiveness of exports for 33 sampled countries over the 1980s and 15 countries for the 1990s. A one percentage point increase in the ratio of aid to GDP is roughly associated with a four percentage point overvaluation of the exchange rate. Regression estimates from a sample of 73 aid-receiving countries for the period 1981-2000 in a study by Arellano et al (2009), indicate a strong negative relationship between the level of manufactured exports and the scale of aid, which is consistent with the theoretical Dutch disease model. The study by Prati et al. (2003) shows that a doubling of aid might lead to an appreciation of the real exchange rate of four percent in the short term and up to 30 percent over a decade. Other economists like Adam (2005) and Gupta et al. (2006) find no strong relationship between the amount of aid a country receives and its real exchange rate.

The above literature review indicates that a number of studies have examined the “Dutch Disease” effects on economies that have abundant natural resources. However, hardly any research has been carried out for Mongolian economy. An exception is Fisher et al. (2011) study that evaluates the impact of the Oyu Tolgoi project on the Mongolian economy using a dynamic CGE model. The results suggest that the development of the mine will have significant and long-term positive effects on the Mongolian economy, while non-mining tradable sectors will experience reduced competitiveness from an appreciating real exchange rate and higher labor cost. The paper also examined two alternative scenarios regarding the use of fiscal revenues from Oyu Tolgoi. In the wealth accumulation scenario, the authors found that accruing fiscal revenues in a sovereign wealth fund would mitigate the impact of Oyu Tolgoi on the real exchange rate and the international competiveness of the non-mining tradable sector. Conversely, a policy of distributing the fiscal revenues from Oyu Tolgoi directly to private households would exacerbate the appreciation in the real exchange rate and the associated structural adjustment pressures. These results clearly show that responsible fiscal policy can help to reduce the risk of Dutch disease in the Mongolian economy.

There have been some studies associated with the impact of the global financial and economic crisis on the Mongolian economy. Narantuya et al. (2009a, 2009b, 2009c, 2010) evaluated the impact of the global financial and economic crisis on the Mongolian economy for the four consequent quarters of 2009 and assessed the state of the economy for every quarter in order to see how the impacts were progressing. They concluded that the impact of the global financial and economic crisis was significant, especially in the mining sector that is dependent on the dynamics of world commodity markets. Tuvshintugs (2009a, 2009b, 2010) reveals that the global financial crises did not have a deep and direct impact on the Mongolian financial system as the Mongolian economy is not deeply interconnected to the world financial system. According to their findings, Mongolia’s major trading partners were hit by the crisis and as a result, the demand for Mongolian export goods decreased and amount of remittance from foreign countries fell dramatically. The author highlighted Mongolia’s increasing dependence on primary goods exports made the country vulnerable to external shocks at the onset of the crisis.

Yoshimi (2011) examined the recent conditions of Mongolian economy with this theoretical insight and compared it with the case of other resource rich economies. She demonstrated the institutional and political implications of the mining boom in Mongolia in accordance with new variants of the ‘resource curse’ theory and that both governance and political stability are displaying clear negative effects. The paper concluded that Mongolia’s newly exploited mineral wealth is in the process being transformed from a blessing for development into a curse.

To our best knowledge, a DSGE model has not been applied to assessing the risks of “Dutch disease” in Mongolia due to a mining boom and expected massive capital inflow. Given the shortcomings in the existing literature, this study uses this approach to analyze the possible impacts of “Dutch disease” on the Mongolian economy. Versions of the model employed in this research have already been used to assess country-specific aid scaling up scenarios, under the project “Gleneagles aid scale-up scenarios” in many country cases. The IMF (2008a, 2008b, 2009 and 2010) conducted research to provide macroeconomic assessments of these scenarios for several African countries.

4. A Small Open Economy Model

In this section we briefly present a small-open dynamic stochastic microfounded New Keynesian model with a natural resource sector developed in Berg et al. (2009, 2010, 2011). The model will be employed in order to construct scenarios that can help policy makers to understand the short and medium-term issues associated with massive capital inflow. The model considers a small open economy with three goods: a natural resource good, a tradable good and a non-tradable good. The economy consists of the following agents: two types of households, some participating in asset markets and others not; natural resource producing firms, tradable and non-tradable goods producers; a central bank; and a government.

4.1. Households

The model considers two types of households as in Campbell and Mankiw (1989) and in Mankiw (2000) (*savers* with a fraction $\mathfrak{s}$ of all households and *hand-to-mouth households* [11], denoted with (d) and (s) superscripts respectively) and each has the same form of utility function and a different budget constraint. A representative household derives utility from consumption basket (C_t^j) and the real money balance (M_t^j/P_t), and disutility from working hours (h_t^j):

$$\sum_{t=0}^{\infty}(\beta^j)^t\left[\frac{1}{1-\sigma}\left\{\left[\mathfrak{a}\left(C_t^j\right)^{\frac{\mathfrak{b}-1}{\mathfrak{b}}}+(1-\mathfrak{a})\left(M_t^j/P_t\right)^{\frac{\mathfrak{b}-1}{\mathfrak{b}}}\right]^{\frac{\mathfrak{b}}{\mathfrak{b}-1}}\right\}^{1-\sigma}-\frac{\hbar^j\left(h_t^j\right)^{1+\psi^j}}{1+\psi^j}\right] \tag{1}$$

Where $\beta^j \in (0,1)$ is the subjective discount factor, $\psi^j > 0$ is inverse of the Frisch elasticity of labor supply, σ is the inverses of the elasticity of intertemporal substitution for consumption, $\hbar^j$ is the preference weight on leisure for household $j = [d, s]$. $\mathfrak{a} \in (0,1)$ is the share of consumption in the utility, $\mathfrak{b} > 0$ is the elasticity of intratemporal substitution between consumption and real money balance.

Both real and nominal variables in the model are growing around an exogenous deterministic growth $(\mathfrak{g})$ induced by economy-wide productivity [12], which is the same across the sectors. To solve the model, we need to make variables stationary by having all domestic nominal variables deflated by the domestic comsumer price index (P_t), foreign nominal variables deflated by the foreign CPI (P_t^*), and having all trend stationary variables divided by their deterministic trend $(\mathfrak{g})$. The utility function with normalized variables (in stationary tems), denoted by lower case letters, is the following.

$$\sum_{t=0}^{\infty}(\beta^j)^t\left[\frac{1}{1-\sigma}\left\{\left[\mathfrak{a}\left(C_t^j/H_t\right)^{\frac{\mathfrak{b}-1}{\mathfrak{b}}}+(1-\mathfrak{a})\left(M_t^d/P_tH_t\right)^{\frac{\mathfrak{b}-1}{\mathfrak{b}}}\right]^{\frac{\mathfrak{b}}{\mathfrak{b}-1}}H_t\right\}^{1-\sigma}-\frac{\hbar^j\left(h_t^j\right)^{1+\psi^j}}{1+\psi^j}\right]=$$

[11] Hand-to-mouth households are sometimes called non-savers, liquidity-constrained, rule-of-thumb consumers, or static optimizers while savers are called dynamic optimizers.

[12] The labor productivity level H_t grows at the constant factor $\mathfrak{g}$ so that $H_t = \mathfrak{g}H_{t-1}$. The productive of labor that are used in the production of the traded and non-traded goods correspond to $H_th_t^T$ and $H_th_t^N$, respectively.

$$= \sum_{t=0}^{\infty} (\boldsymbol{\beta}^j)^t \left[\frac{\mathbf{1}}{\mathbf{1}-\boldsymbol{\sigma}} \left\{ \left[\mathfrak{a} \left(\boldsymbol{c}_t^j \right)^{\frac{\mathfrak{b}-1}{\mathfrak{b}}} + (\mathbf{1}-\mathfrak{a}) \left(\boldsymbol{m}_t^j \right)^{\frac{\mathfrak{b}-1}{\mathfrak{b}}} \right]^{\frac{\mathfrak{b}}{\mathfrak{b}-1}} \boldsymbol{H}_t \right\}^{\mathbf{1}-\boldsymbol{\sigma}} - \frac{\hbar^j \left(\boldsymbol{h}_t^j \right)^{\mathbf{1}+\boldsymbol{\psi}^j}}{\mathbf{1}+\boldsymbol{\psi}^j} \right] \equiv$$

$$\equiv \sum_{t=0}^{\infty} (\beta^j)^t \left[\frac{1}{1-\sigma} \cdot \left\{ \left[\mathfrak{a} \left(c_t^j \right)^{\frac{\mathfrak{b}-1}{\mathfrak{b}}} + (1-\mathfrak{a}) \left(m_t^j \right)^{\frac{\mathfrak{b}-1}{\mathfrak{b}}} \right]^{\frac{\mathfrak{b}}{\mathfrak{b}-1}} \right\}^{1-\sigma} - \frac{\hbar^j \left(h_t^j \right)^{1+\psi^j}}{1+\psi^j} \right] \tag{2}$$

where $c_t^j \equiv C_t^j / H_t$ is that households' consumption in stationary terms,$m_t^j \equiv M_t^j / P_t H_t$ is real money balance in stationary terms.[13]

A representative household must efficiently allocate consumption expenditure among different goods as composite consumption (c_t^j) consists of the non-tradable good $\left(c_t^{jN}\right)$ and the tradable good $\left(c_t^{jT}\right)$ combined into a CES basket:

$$c_t^j = \left[\vartheta^{\frac{1}{\gamma}} \left(c_t^{jN} \right)^{\frac{\gamma-1}{\gamma}} + (1-\vartheta)^{\frac{1}{\gamma}} \left(c_t^{jT} \right)^{\frac{\gamma-1}{\gamma}} \right]^{\frac{\gamma}{\gamma-1}} \tag{3}$$

where $j = [d, s]$ and $\gamma \in (0,1)$ denotes the intratemporal elasticity of substitution, ϑ indicates the degree of preferences of non-tradables in consumption. The non-tradable goods are produced by a continuum of monopolistically competitive firms, indexed by $i \in [0,1]$. Aggregating all consumption of non-tradable goods yields:

$$c_t^{jN} = \left[\int_0^1 \left(c_{it}^{jN} \right)^{\frac{\theta-1}{\theta}} di \right]^{\frac{\theta}{\theta-1}} \tag{4}$$

where θ is the elasticity of substitution between different pairs of non-tradable goods. The CES consumption basket implies that the consumption price index for a unit of composite consumption is:

$$P_t = [\vartheta (P_t^N)^{1-\gamma} + (1-\vartheta)(P_t^T)^{1-\gamma}]^{\frac{1}{1-\gamma}} \tag{5}$$

where P_t^N and P_t^T are the nominal prices for non-tradable and tradable goods. The relative price of non-tradable goods to the CPI is:

$$p_t^N = P_t^N / P_t \tag{6}$$

The law of one price holds for the tradable goods sector, so

$$P_t^T = \mathcal{E}_t P_t^* \quad and \quad \epsilon_t = \mathcal{E}_t P_t^* / P_t \tag{7}$$

[13] The term $(\beta^j)^t \frac{H_t^{1-\sigma}}{1-\sigma}$ was omitted from the utility function since H_t is exogenous and does not represent a control variable.

where $\mathcal{E}_t$ is the nominal exchange rate in units of domestic currency per dollar, P_t^* is the foreign CPI in dollars, and ϵ_t is the CPI based real exchange rate.

Each household supplies differentiated labor services to the two production sectors, namely tradable $\left(h_t^{jT}\right)$ and non-tradable sectors $\left(h_t^{jN}\right)$. The total labor, $0 < h_t^j < 1$, supplied by households is:

$$h_t^j = \left[\delta^{-\frac{1}{\eta}}\left(h_t^{jN}\right)^{\frac{1+\eta}{\eta}} + (1-\delta)^{-\frac{1}{\eta}}\left(h_t^{jT}\right)^{\frac{1+\eta}{\eta}}\right]^{\frac{\eta}{1+\eta}} \tag{8}$$

where $\delta \in (0,1)$ is the steady-state share of labor in the non-tradable goods sector $\left(h_t^{jN}\right)$in total employment (h_t^j). The elasticity of substitution between sectors is $\eta > 0$, which affects the labor mobility between the two sectors and allows intersectoral wage differentials.

The real and stationary wage index $(w_t = W_t/P_tH_t)$ is

$$w_t = [\,\delta(w_t^N)^{1+\eta} + (1-\delta)(w_t^T)^{1+\eta}]^{\frac{1}{1+\eta}} \tag{9}$$

where $w_t^T = W_t^T/P_tH_t$ and $w_t^N = W_t^N/P_tH_t$ are the aggregate wage index, or the unit cost of sales to the tradable and non-tradable sectors.

It is assumed that *savers or dynamic optimizers* are the sole owners of firms, and they receive the after-tax nominal profits from the non-tradable goods sector (Θ_t^N) and from the tradable good sector (Θ_t^T) and total nominal labor earnings $(W_t h_t^d = W_t^N h_t^{dN} + W_t^T h_t^{dT})$. In addition, only savers have access to financial and capital markets, so they can allocate their disposable income to various forms of assets including nominal money holdings (M_t^d), domestic government nominal bonds (B_t^d), which pay a "gross" nominal interest rate $(i_t \equiv 1 + r_t)$, and foreign assets (B_t^{d*}) that pays a "gross" nominal international interest rate (i_t^*) and subject to portfolio adjustment costs $(\mathcal{P}_t^n)$. Thus, their budget constraint can be written in nominal terms as:

$$\begin{aligned} &(1+\tau_c)P_tC_t^d + M_t^d + B_t^d + \mathcal{E}_tB_t^{d*} + P_t^N = \\ &= (1-\tau_h)W_th_t^d + M_{t-1}^d + i_{t-1}B_{t-1}^d + \mathcal{E}_t i_{t-1}^* B_{t-1}^{d*} + \Theta_t^T + \Theta_t^N + \mathcal{E}_t RM_t^{d*} + TR_t^d \end{aligned} \tag{10}$$

Dividing both sides by H_tP_t and manipulating, we obtain the budget constraint in normalized (in real and stationary) terms:

$$\begin{aligned} &(1+\tau_c)c_t^d + m_t^d + b_t^d + \epsilon_t b_t^{d*} + \mathcal{P}_t^r = \\ &= (1-\tau_h)w_th_t^d + \frac{m_{t-1}^d}{\mathrm{g}\pi_t} + \frac{i_{t-1}b_{t-1}^d}{\mathrm{g}\pi_t} + \epsilon_t i^* \frac{b_{t-1}^{d*}}{\mathrm{g}\pi^*} + \Pi_t^T + \Pi_t^N + \epsilon_t rm^{d*} + tr_t^d \end{aligned} \tag{11}$$

where $\Pi_t^N = \frac{\Theta_t^N}{H_t P_t}$, $\Pi_t^T = \frac{\Theta_t^T}{H_t P_t}$, $rm^{d*} \equiv \frac{RM_t^{d*}}{H_t P_t}$, $c_t^d \equiv \frac{C_t^d}{H_t}$, $m_t^d \equiv \frac{M_t^d}{P_t H_t}$, $b_t^d \equiv \frac{B_t^d}{P_t H_t}$, $b_t^{d*} \equiv \frac{B_t^{d*}}{P_t^* H_t}$, $tr_t^d \equiv \frac{TR_t^d}{H_t P_t}$, $\mathcal{P}_t^r = \mathcal{P}_t^n / H_t P_t = \frac{\upsilon}{2}\epsilon_t\left(b_t^{d*} - b^{d*}\right)^2$ and all are de-trended and in real terms.[14] π^* and π_t are foreign and domestic inflation respectively. τ_c and τ_h are the consumption and labor tax rate. tr_t^d is government transfers and rm^{d*} is remittance received from abroad (in normalized terms).

Dynamic optimizers' problem is to maximize the utility function (2) subject to the budget constraint (11) and the first order conditions are presented in the Appendix.

The *hand-to-mouth households* have the same utility functional form as savers in (1) and (2) and both c_t^s and h_t^s are take the form as in (3) and (8) respectively. To capture the short planning horizon in their economic decisions, the hand-to-mouth households solve an intratemporal optimization problem, subject to the budget constraint (in normalized tems):

$$(1+\tau_c)c_t^s + m_t^s = (1-\tau_h)w_t h_t^s + \frac{m_{t-1}^s}{\mathrm{g}\pi_t} + \epsilon_t rm^{s*} + tr_t^s \tag{12}$$

Since the only assets that the hand-to-mouth households can hold is money, their subjective discount factor set to zero ($\beta^s = 0$) to avoid that these consumers could smooth consumption by changing their money holdings. A relatively large share of hand-to-mouth households in the sum of all households is an important feature for low-income countries because most people do not participate in the financial and asset markets. The first order conditions of this static problem are shown in the Appendix.

4.2. Production Sectors

The economy is divided into three sectors: natural resource, tradable, and non-tradable sectors. Modeling these sectors and assuming the factor mobility between them, is essential to analyzing the impacts of "Dutch disease".

***Natural Resource Sector*:** A single natural resource exporting firm operates in a perfectly competive market and only uses capital (K_t^M) to produce natural resource output (Q_t^M) under the assumed constant total factor productivity (A^M), so this sector uses the following technology:

$$Q_t^M = A_t^M (K_{t-1}^M)^{\alpha_M} \tag{13}$$

can be also transformed into stationary terms by dividing by both sides by H_t. Then,

$$q_t^M = \frac{Q_t^M}{H_t} = A^M \left(\frac{K_{t-1}^M}{H_{t-1}}\frac{H_{t-1}}{H_t}\right)^{\alpha_M} = A^M (k_{t-1}^M)^{\alpha_M}(\mathbf{g})^{-\alpha_M} \equiv a^M (k_{t-1}^M)^{\alpha_M} \tag{14}$$

[14] Following Schmitt-Grohe and Uribe (2003), acquiring foreign assets is subject to a portfolio adjustment cost, $\mathcal{P}_t^r = \frac{\upsilon}{2}\epsilon_t(b_t^{d*} - b^{d*})^2$, where b^{d*} denotes its steady-state value. The parameter υ governs the degree of capital account openness. When υ is very large, the capital account for the private sector is almost closed as in low-income countries.

where $q_t^M = Q_t^M/H_t$, $k_{t-1}^M = K_{t-1}^M/H_{t-1}$ and $a^M \equiv A^M(\mathrm{g})^{-\alpha_M}$ is a constant productivity parameter for the resource sector.The coefficients α_M indicates the production shares of capital.Also, as resource production is capital intensive, labor is excluded from natural resource production for simplicity.

The capital in the resource sector evolves according to the law of motion,

$$K_t^M = (1-\delta_M)K_{t-1}^M + I_t^M; \tag{15}$$

which can be written as

$$\left(\frac{H_{t+1}}{H_t}\right)\left(\frac{K_t^M}{H_{t+1}}\right) = (1-\delta_M)\frac{K_{t-1}^M}{H_t} + \left(\frac{I_t^M}{H_t}\right); \tag{16}$$

which is equivalent to the following normalized term:

$$\mathrm{g}k_t^M = (1-\delta_M)k_{t-1}^M + i_t^M; \tag{17}$$

where this sector's capital (k_t^M) is accumulated through investments (i_t^M) and subject to a depreciation rate (δ_M). The investment ($i_t^M = \epsilon_t \hat{\imath}_t^*$) in this sector is assumed to be exogenous, which is approximated by foreign direct investment (FDI). $\hat{\imath}_t^*$ is percent deviation of $\boldsymbol{i}$ from its steady state and denominated in foreign currency evolving according to the stochastic process.

$$\hat{\imath}_t^* = \rho_{fdi}\hat{\imath}_{t-1}^* + u_t^{fdi} \tag{18}$$

where $\rho_{fdi} \in (0,1)$ is the autocorrelation coefficient, and $u_t^{fdi}$are uncorrelated and normally distributed innovations with zero mean and a standard deviation of σ_{fdi}^2.

The the resource sector's after-tax net real profit[15] in dollars is

$$\Pi_t^{M*} = (1-\tau_M)p_t^{M*}q_t^M = (1-\tau_M)(P_t^{M*}/P^*)q_t^M \tag{19}$$

where $p_t^{M*}q_t^M$ denotes total sales revenue in terms of foreign currency relative to the foreign price (P^*) and royalties (τ_M) imposed by the government based on production quantity.The world commodity price in dollars (P_t^{M*}) is treated as exogenous as it is assumed that the country's natural resource output is relatively small, and the resource firm is a price taker in the relevant world commodity market.

The evolution of the foreign commodity price in percentage deviations from its steady state ($\hat{p}_t^{M*}$) is given by the following stochastic process.

$$\hat{p}_t^{M*} = \rho_{pM}\hat{p}_{t-1}^{M*} + u_t^{pM} \tag{20}$$

[15]Since there is no profit maximization in the natural resource sector, equation 19 simply defines the after-tax profit of the sector. This profit equals the output value minus royalty payments to the government. In contrast to the other sector, the natural resource sector does not employ any labor, so there are no wage payments to subtract. In addition, investment decisions are exogenous, so there is no need to subtract investment either.

where $\rho_{pM} \in (0,1)$is the autocorrelation coefficient, and u_t^{pM} are uncorrelated and normally distributed innovations with zero mean and a standard deviation of σ_{pM}^2.

***Tradable Goods Sector*:** In this sector, the tradable good is a manufactured good. Again, tradable goods producers operate in a perfectly competitive market. A representative firm produces its tradable goods using private capital (K_{it}^T), labor (h_{it}^T), and public capital (k_t^G). The production function is given by:

$$Q_{it}^T = A_t^T (K_{it-1}^T)^{1-\alpha_T} (H_t h_{it}^T)^{\alpha_T} (k_{t-1}^G)^{\alpha_G} \tag{21}$$

which can be also transformed into stationary terms by dividing by both sides by H_t. Then

$$q_{it}^T = A_t^T (k_{it-1}^T)^{1-\alpha_T} (h_{it}^T)^{\alpha_T} (k_{t-1}^G)^{\alpha_G} \tag{22}$$

The coefficients α_T and α_G indicate the production shares of labor and public capital.[16] $H_t$is the level of Hicks-neutral labor productivity, which grows at the constant rate of g and the productivity (A_t^T) is subject to learning-by-doing externalities, depending on the history of the previous sectoral outputs:

$$log\, A_t^T = \rho_{AT}\, log\, A_{t-1}^T + d\, log\, q_{it-1}^T \tag{23}$$

where $\rho_{AT} \in (0,1)$is the autocorrelation coefficientand$d > 0$is persistent productivity effect caused by deviations of traded sector output from trend in order to capture the fact that a decline in the traded sector will impose an economic cost through lost total-factor productivity in this sector.[17]

Private capital (K_{it}^T) is accumulated through investments (I_{it}^T) and subject to a depreciation rate (δ_T) and investment adjustment costs ($\Psi_{it}^T = \frac{\kappa_T}{2}\left(\frac{I_{it}^T}{\mathrm{g}\cdot I_{it-1}^T} - 1\right)^2$) as in Christiano et al. (2005). Thus, the law of motion for capital is:

$$K_{it}^T = (1-\delta_T)K_{it-1}^T + [1-\Psi_{it}^T]I_{it}^T = (1-\delta_T)K_{it-1}^T + \left[1 - \frac{\kappa_T}{2}\left(\frac{I_{it}^T}{\mathrm{g}\cdot I_{it-1}^T} - 1\right)^2\right] I_{it}^T \tag{24}$$

which can be written as in (16) and (17)

$$\mathrm{g}k_{it}^T = (1-\delta_T)k_{it-1}^T + \left[1 - \frac{\kappa_T}{2}\left(\frac{i_{it}^T}{i_{it-1}^T} - 1\right)^2\right] i_{it}^T \tag{25}$$

where $k_{it-1}^T = K_{it-1}^T/H_t$, $i_{it}^T = I_{it}^T/H_t$ and κ_T is the investment adjustment cost parameter.

The representative firm chooses labor, investment and capital to maximize the followingnet present-value profit weighted by savers' utility subject to equations (22) and (25):

---

[16] See Baxter and King (1993) and Kamps (2004) for more information.

[17] See Matsuyama (1992) ,Krugman (1987), Rodrik (2008), Adam and Bevan (2006) and Torvik (2001) for more explanations.

$$\max_{l_{it}^T, i_{it}^T, k_{it}^T} E_t \sum_{t=0}^{\infty} \beta^t \lambda_t^d (1-\tau_k) \widetilde{\Pi}_{it}^T \tag{26}$$

where $\widetilde{\Pi}_{it}^T = \epsilon_t q_{it}^T - w_t^T h_{it}^T - i_{it}^T - \iota \cdot \epsilon_t (q_{it}^T - q_t^T)$ is the profit of the representative firm. $\beta^t \lambda_t^d$ is the discount factor of the profits[18]and τ_k is the effective tax rate on corporate profits. ι captures the distorting factors in low-income countries that discourage firms from investing and hiring to achieve a higher level of production. This distortion is offset in the aggregate, as the amount $\iota \cdot \epsilon_t q_t^T$is restricted to each firm.$q_{it}^T$is multiplied by the real exchange rate ϵ_t in the profit due to the law of one price. Berg et al. (2010) argues that it was meant to capture a broad set of institutional features that keep poor countries from investing at the high rates that migh otherwise be justified by the low stocks of private capital. In this way, we match the observed low investment shares in many low-income countries. In addition, this simplifies the steady state analysis by ensuring that distortions are zero at steady state. The first-order conditions are presented in the Appendix.

The after-tax profit for the tradable goods sector is:

$$\Pi_t^T = (1-\tau_k) \int_0^1 \widetilde{\Pi}_{it}^T di \tag{27}$$

***Non-tradable Goods Sector*:** In this sector, non-tradable goods producers operate under monopolistic competition. There is a continuim of firms indexed by $i \in [0, 1]$ and each firm produces an intermediate good that is different from that of other firms. The final goods (Q_t^N) production technology is:

$$Q_t^N = \left[\int_0^1 Q_{it}^{N\frac{\theta-1}{\theta}} di \right]^{\frac{\theta}{\theta-1}} \tag{28}$$

A final goods firm maximizes the following profit function:

$$profits = P_t^N Q_t^N - \int_0^1 P_{it}^N Q_{it}^N di \tag{29}$$

subject to the production technology in (28) and this result in the first order condition of

$$P_t^N \left[\int_0^1 Q_{it}^{N\frac{\theta-1}{\theta}} di \right]^{\frac{1}{\theta-1}} Q_{it}^{N-\frac{1}{\theta}} = P_{it}^N \tag{30}$$

which simplifies to a demand function for good produced by firm$i$:

[18] it is stochastic and related to the savers' marginal utility of consumption since they own the firms

$$Q_{it}^{N} = Q_{t}^{N}(P_{it}^{N}/P_{t}^{N})^{-\theta} \tag{31}$$

which can be written in the following normalized term:

$$q_{it}^{N} = q_{t}^{N}(p_{it}^{N}/p_{t}^{N})^{-\theta} \tag{32}$$

where q_{it}^{N} is demand for good produced by firm i, $p_{it}^{N} = P_{it}^{N}/P_{t}$, $p_{t}^{N} = P_{t}^{N}/P_{t}$ are relative prices.Putting this demand for good i into the bundler function gives:

$$Q_{t}^{N} = \left[\int_{0}^{1} \left(Q_{t}^{N}(P_{t}^{N}/P_{it}^{N})^{-\theta}\right)^{\frac{\theta-1}{\theta}} \ di\right]^{\frac{\theta}{\theta-1}} = Q_{t}^{N}\left[\int_{0}^{1} (P_{it}^{N}/P_{t}^{N})^{\theta-1} \quad di\right]^{\frac{\theta}{\theta-1}} \tag{33}$$

which can be written as

$$P_{t}^{N} = \left[\int_{0}^{1} (P_{it}^{N})^{1-\theta} \quad di\right]^{\frac{1}{1-\theta}} \tag{34}$$

Each firm (i) produces non-tradable goods using the following production function:

$$Q_{it}^{N} = A^{N}(K_{it-1}^{N})^{1-\alpha_{N}}(H_{t}h_{it}^{N})^{\alpha_{N}}(k_{t-1}^{G})^{\alpha_{G}} \tag{35}$$

which can be also transformed into stationary terms as in (21) and (22):

$$q_{it}^{N} = A^{N}(k_{it-1}^{N})^{1-\alpha_{N}}(h_{it}^{N})^{\alpha_{N}}(k_{t-1}^{G})^{\alpha_{G}} \tag{36}$$

The coefficients α_{N} indicates the production shares of labor , while α_{G} denotes the share of public capital used in production.A^{N} is a constant productivity parameter. Private capital (k_{it}^{N}) evolves by the law of motion like in the tradable goods sector.

$$\mathrm{g}k_{it}^{N} = (1-\delta_{N})k_{it-1}^{N} + \left[1 - \frac{\kappa_{N}}{2}\left(\frac{i_{it}^{N}}{i_{it-1}^{N}} - 1\right)^{2}\right] i_{it}^{N} \tag{37}$$

The maximization problem of the monopolist corresponds to choosing the price level (p_{it}^{N}), the amount of labor (h_{it}^{N}), capital (k_{it}^{N}), and investment (i_{it}^{N}) in order to maximize the following discounted profit subject to the production function (36), demand constraint (32), and the law motion for capital (37):

$$\max_{l_{it}^{N}, i_{it}^{N}, k_{it}^{N}, p_{it}^{N}} E_{t} \sum_{t=0}^{\infty} \beta^{t} \lambda_{t}^{d} (1-\tau_{k}) \widetilde{\Pi}_{it}^{N} \tag{38}$$

where $\widetilde{\Pi}_{it}^{N} = [p_{it}^{N} q_{it}^{N} - \Upsilon_{it}^{N}] - w_t^N h_{it}^{N} - i_{it}^{N} - \iota[p_{it}^{N} q_{it}^{N} - \Upsilon_{it}^{N} - (p_t^N q_t^N - \Upsilon_t^N)]$ is the profit of the representative firm. Each firm faces price adjustment costs $\Upsilon_{it}^{N} = \frac{\varsigma}{2}\left(\frac{\pi_{it}^{N}}{\pi_{it-1}^{N}} - 1\right)^2 p_t^N q_t^N$ and Υ_t^N corresponds to Υ_{it}^{N} with $p_{it}^{N} = p_t^N$. Also, $\pi_t^N \equiv \frac{P_t^N}{P_{t-1}^N} = \frac{p_t^N}{p_{t-1}^N}\pi_t$ is the inflation rate for non-tradables with the steady-state value represented by π_t. These costs are a variant of those proposed by Rotemberg (1982), as they allow for indexation to past values of inflation. The first-order conditions are presented in the Appendix.

The after-tax profit of the non-tradable goods sector is:

$$\Pi_t^N = (1 - \tau_k)\int_0^1 \widetilde{\Pi}_{it}^{N} di \tag{39}$$

4.3. The Public Sector

The government’s budget constraint in real terms is given by:

$$\begin{aligned} tax_t + \left(b_t - \frac{b_{t-1}}{g\pi_t}\right) - \left(d_t^G - \frac{d_{t-1}^G}{g\pi_t}\right) + \epsilon_t Aid^* = \\ = p_t^g g_t + tr_t + (i_{t-1} - 1)\frac{b_t^c}{g\pi_t} + \epsilon_t\left(wf_t^* - \frac{wf_{t-1}^*}{g\pi^*}\right) \end{aligned} \tag{40}$$

where the left-hand side represents the government’s revenue that includes total government receipts (tax_t), the change in total government debt ($b_t = b_t^c + b_t^{cb}$), which is held by household (b_t^c) and by the central bank (b_t^{cb}), the change in government deposits at the central bank (d_t^G), and foreign aid (Aid^*) in local currency. The right-hand side represents government spending and includes government purchases (g_t), transfers to both households (tr_t), interest payments on government debt ($(i_{t-1} - 1)\frac{b_t^c}{g\pi_t}$) held by consumers and the change in the sovereign wealth fund (wf_t^*).

Total government receipts (tax_t) include taxes on labor income (τ_h), corporate profits (τ_k), consumption (τ_c), royalties ($\tau_M p_t^{M*} q_t^M$), dividends from resource production ($div^m \Pi_t^{m*}$), and the interest earned from the sovereign wealth fund ($\frac{(i^*-1)wf_{t-1}^*}{g\pi^*}$):

$$tax_t = \tau_M p_t^{M*} q_t^M + \tau_h w_t h_t + \tau_k(\Pi_t^N + \Pi_t^T) + tax_t^M \tag{41}$$

where $tax_t^M = \epsilon_t\left[\tau_M p_t^{M*} q_t^M + div^M \Pi_t^{M*} + \frac{(i^*-1)wf_{t-1}^*}{g\pi^*}\right]$ is the total resource revenues collected by the government.

Total government purchases is a CES basket that includes tradable and non-tradable goods,

$$g_t = \left[\nu^{\frac{1}{\gamma}}(g_t^N)^{\frac{\gamma-1}{\gamma}} + (1-\nu)^{\frac{1}{\gamma}}(g_t^T)^{\frac{\gamma-1}{\gamma}}\right]^{\frac{\gamma}{\gamma-1}} \tag{42}$$

where ν denotes the degree of home-bias in government purchases. The relative price of government purchases to the CPI is

$$p_t^G = \left[\nu \quad (p_t^N)^{(1-\gamma)} + (1-\nu) \quad (\epsilon_t)^{1-\gamma}\right]^{\frac{1}{1-\gamma}} \tag{43}$$

Finally, total government purchases (g_t) consist of expenditures on government consumption (g_t^C) and government investment (g_t^I). Therefore, public capital (k_t^G) is accumulated through effective government investment ($\tilde{g}_t^I$) with the historical government investment efficiency (ε) and subject to a depreciation rate (δ_G).

$$k_t^G = (1-\delta_G)k_{t-1}^G + \varepsilon\tilde{g}_t^I \tag{44}$$

where $log\frac{\tilde{g}_t^I}{\tilde{g}^I} = \xi \cdot log\frac{g_{t-1}^I}{g^I}$ and ξ governs the severity of absorptive capacity constraints.[19]When $log\frac{\tilde{g}_t^I}{\tilde{g}^I} > 0$, meaning the expenditure on government investment is above steady state (g^I), $0 < \xi < 1$. If $log\frac{\tilde{g}_t^I}{\tilde{g}^I} < 0$, then $\xi = 0$.

***Fiscal Policy*:** The government follows simple rules in terms of constant shares in allocating a resource windfall. First, the share (μ^M) of a windfall ($tax_t^M - tax^M$) to save in a sovereign wealth fund (wf_t^*)will be decided. A windfall , $tax_t^M - tax^M$, is defined as the additional resource revenue received beyond the steady-state level of tax^M. The law of motion of the sovereign wealth fund (wf_t^*) is

$$wf_t^* = \left(1 - \frac{1}{\mathrm{g}\pi^*}\right)wf^* + \frac{1}{\mathrm{g}\pi^*}wf_{t-1}^* + \frac{1}{\epsilon_t}[\mu^M(tax_t^M - tax^M)] \tag{45}$$

where wf^* is steady state value of sovereign wealth fund denominated by foreign currency and $\mu^M(tax_t^M - tax^M)$ ensures that wf_t^* is stationary process around wf^*.

Second, policy rules of government how to spend the unsaved windfall among government consumption (g_t^C), and government investment (g_t^I) can be expressed as

$$g_t^j = g^j + \frac{1}{p_t^g}(1-\mu^M)[\phi^{g_j}(tax_t^M - tax^M)] \tag{46}$$

where $j = [C, I]$and $g^j$is the steady-state value and $\sum\phi^{g_j} = 1$.

[19]Buffie, Berg, Pattillo, Portillo, and Zanna (2011) study the debt sustainability issue for government investment scaling-up and model absorptive capacity constraints as an increasing expenditure for implementing government investment projects. The emphasis here is on allocating a given inflow of resource revenues; hence, there are the constraints as fewer projects (or less effective government investment) can be accomplished for a given expenditure. In this specification, a 1-percent increase in government investment above the steady-state level leads to ξ (< 1) percent increase in effective government investment.

Reserve and Monetary Policy: In a typical natural resource-dependent country, the capital inflow-related monetary policy problem can be described as follows: when the government spends the local-currency counterpart to capital inflows, how should the resulting monetary emission be handled? In particular, how much should be sterilized? And should the sterilization be done through the sale of local-currency open-market operations or through the sale of foreign exchange? To analyze this problem, the central bank balance sheet is introduced in the model as follows:

$$m_t - \frac{m_{t-1}}{g\pi_t} + d_t^G - \frac{d_{t-1}^G}{g\pi_t} = b_t^{cb} - \frac{b_{t-1}^{cb}}{g\pi_t} + \epsilon_t\left(fr_t^* - \frac{fr_{t-1}^*}{g\pi^*}\right) \quad (47)$$

where $b_t^{cb}$are the government bonds held bythe central bank and fr_t^*denotes the foreign currency value of reserves. The balance sheet implies that changes in money supply $(m_t - \frac{m_{t-1}}{n\pi_t})$ depend on open market operations $(b_t^{cb} - \frac{b_{t-1}^{cb}}{g\pi_t})$, changes in deposits $(d_t^G - \frac{d_{t-1}^G}{g\pi_t})$ and changes in net foreign assets, which by assumption are fully driven by changes in international reserves $(\epsilon_t\left(fr_t^* - \frac{fr_{t-1}^*}{g\pi^*}\right))$.

Since accumulating part of a resource windfall as international reserves can be a solution to mitigate Dutch disease, the reserve policy follows the process:

$$fr_t^* = (1-\rho_R)fr^* + \rho_R fr_{t-1}^* + \frac{1}{\epsilon_t}[\omega(tax_t^M - tax^M)] + \omega_\epsilon[\pi_t^\epsilon - \pi^\epsilon] \quad (48)$$

where ω indicates the share of a resource windfall accumulated as international reserves. $\pi_t^\epsilon > 0$ is the nominal depreciation of the local currency, and fr^* and π^ϵ are the steady-state levels of reserves and nominal depreciation. The persistence parameter (ρ_R) satisfies $\rho_R \in (0;\ 1)$, while $\omega_\epsilon > 0$ measures the degree of commitment to a nominal depreciation target.Also, $\omega(tax_t^M - tax^M)$ and $\omega_\epsilon[\pi_t^\epsilon - \pi^\epsilon]$ ensure the stationarity of fr_t^*.While μ^M governs how much of windfall to be saved in the sovereign wealth fund, ω controls how much of windfall should be sterilized.

To conduct monetary policy, the central bank adjusts the money aggregate to target CPI inflation (π) according to a simple rule:

$$m_t = \frac{m_{(t-1)}}{g\pi_t}\left[(1+\pi^m)\left(\frac{\pi_t}{\pi}\right)^{-\phi_\pi} - 1\right] \quad (49)$$

where $(1 + \pi^m)$ is the steady-state nominal money growth rate and $\phi_\pi > 0$. Regarding the monetary policy rule, we assume that open-market operations adjust so that money supply always grows at $(1+\pi^m)\left(\frac{\pi_t}{\pi}\right)^{-\phi_\pi}$in order to capture the fact that low-income countries still target money, at least *de jure*.At the steady state, reserve money grows at the rate $1 + \pi^m$and otherwise its growth adjusted in response to inflation by the parameter$\phi_\pi > 0$.

4.4. Aggregation and Equilibrium

Let $\mathcal{X}_t$ denote the aggregation quantity of a variable. Then, for all consumer-related variables we aggregate across the two types of consumers:

$$\mathcal{X}_t = \mathfrak{s}x_t^d + (1-\mathfrak{s})x_t^s, \qquad x \in \{c, c^N, c^T, m, h, rm^*, b^*, b^c\} \tag{50}$$

The market clearing condition for the non-tradable good is

$$q_t^N = (p_t^N)^{-\gamma} D_t^N \tag{51}$$

where D_t^N is the total demand for non-tradable goods:

$$D_t^N = \vartheta\left[c_t^N + i_t^N + i_t^T + \frac{\varsigma}{2}\left(\frac{\pi_{it}^N}{\pi_{it-1}^N} - 1\right)^2 p_t^N q_t^N\right] + \nu(p_t^G)^\gamma g_t \tag{52}$$

Current account deficits (CAD_t) of the model economy are

$$\begin{aligned} CAD_t &= \left[c_t + i_t + p_t^G g_t + \Upsilon_t^N\right] - \\ &- p_t^N q_t^N - \epsilon_t q_t^T - \epsilon_t p^{M*} q_t^M - \epsilon_t (i^* - 1)\frac{b_{t-1}^* + wf_{t-1}^*}{\mathrm{g}\pi^*} - \epsilon_t rm^* \end{aligned} \tag{53}$$

where $i_t = i_t^N + i_t^T + i_t^M$. The balance of payment condition is

$$\begin{aligned} CAD_t &= \epsilon_t[Aid^* - \mathcal{P}_t^r] + \\ &+ \epsilon_t\left\{[i_t^* - (1 - div^M)\Pi_t^{M*}] + \left(\frac{wf_{t-1}^* + b_{t-1}^* + fr_{t-1}^*}{\mathrm{g}\pi^*} - wf_t^* - b_t^* - fr_t^*\right)\right\} \end{aligned} \tag{54}$$

The net foreign asset position (NFA_t) for the economy is defined as

$$NFA_t = \epsilon_t(wf_t^* + b_t^* + fr_t^*) \tag{55}$$

Lastly, the nominal GDP in the price of domestic composite consumption is

$$Q_t = p_t^N q_t^N - \epsilon_t q_t^T - \epsilon_t p_t^{M*} q_t^M \tag{56}$$

To calculate real GDP, each sector's output is evaluated at its steady-state prices relative to the CPI.Model solution-simulation method is first order approximation around its deterministic steady state.

$$Q_t = p^N q_t^N - \epsilon\, q_t^T - \epsilon\, p^{M*} q_t^M \tag{57}$$

5. Calibrations

The parameters of the model are calibrated to the Mongolian economy based on the existing empirical studies since there are a large number of microfounded parameters. Some parameters depend on steady state ratios that are determined from national income accounts, public and private sector balance sheets and input-output matrices, and some of them are informed by some structural macroeconometric estimates. Moreover, some parameters describe the policy response to mineral revenue or the policy regime in place and therefore treated as free parameters that are modified according to the policy experiments. All of these parameters are listed in Table 5-1.

Table 5-1: Baseline calibration of structural parameters

Descriptions	Parameters	Values
Preferences Parameters		
Discount factor of dynamic optimizer household	β^d	0.9965
Discount factor of static optimizer household	β^s	0.0
Elasticity of substitution between the two types of labor	η	1
Inverse of the Frisch elasticity of labor supply for savers	ψ^d	2
Inverse of the Frisch elasticity of labor supply for hand to mouth	ψ^s	2
Inverse of the inter-temporal elasticity of consumption	σ	2
Fraction of savers with all households and hand-to-mouth households	$\mathfrak{s}$	0.5
Elasticity of intra-temporal substitution between consumption and real money balance	$\mathfrak{b}$	8.5
Technology Parameters		
The depreciation rate in non-tradable sector	δ_N	0.015
The depreciation rate in tradable sector	δ_T	0.015
The depreciation rate in mining sector	δ_M	0.02
Elasticity of substitution between varieties-related to markup power	θ	12
Investment adjustment costs in non-tradable sector	κ_N	25
Investment adjustment costs in tradable sector	κ_T	25
Share of labor income in non-tradable sector	α_N	0.7
Share of labor income in tradable sector	α_T	0.7
Share of capital income in mining sector	α_M	0.9
Elasticity of substitution between tradable and non-tradable goods	γ	0.89
Productivity in the tradable sector (normalization)	A^T	1
Productivity in the non-tradable sector (normalization)	A^N	1
Learning in the traded sector	d	0.1
Persistence in learning-by-doing disturbance	ρ_{AT}	0.1
Persistence of the commodity price shock	ρ_{pM}	0.95
Persistence of the FDI shock	ρ_{fdi}	0.95

Policy Parameters		
Labor tax rate	τ_h	0.1
Consumption tax rate	τ_c	0.2
Profit tax rate	τ_k	0.3
Output tax on mining	τ_m	0.05
The depreciation rate of public capital	δ_G	0.02
Adjustment cost parameter for holding foreign assets	υ	$0 \ll \upsilon \ll +\infty$
Elasticity of output in public capital	α_G	0.1
Degree of home-bias in government purchases	ν	0.7
Government investment efficiency	ε	0.5
Inflation targeting coefficient from implicit interest rate rule	ϕ_π	2.5
Interest rate response to money growth rate	ϕ_μ	0.5
Interest rate response to output gap	ϕ_q	0.0
Weight of exchange rate target on reserves	$\omega_\in$	0.0
Share of mining revenues accumulated as reserve	μ^M	0.0
Persistence of reserve accumulation	ρ_R	0.99

The subjective discount factor (β^d) for dynamic optimizer households is set at 0.9965 which implies an annual steady state real interest rate of 8% whereas that for static optimizer households is zero by definition. Following Berg et al. (2010) among others, the inverse of the Frisch elasticity of labor supply for savers (ψ^d)and hand-to-mouth households (ψ^s) are set at 2. As in Dib (2008) and Lartey (2008) the inverse of the elasticity of the intertemporal substitution of consumption (σ)is set at 2. In line with the econometric estimates provided by Horvath (2000), elasticity of substitution between the two types of labor(η) is set to 1. As in Dib (2008), the parameter that represent the degree of monopoly power in the non-tradable good market(θ)is equals to 12, which implies the steady state price markup are equal to roughly 10%. Also, the elasticity of substitution between tradable and non-tradable goods (γ) is set at 0.89 as in Tokarick (2009). Investment adjustment cost of 2 sectors are set to 25, ensuring smooth impulse response for investment.

Table 5-2: Steady State Values

Variables	Value
National Income accounts (as a share of GDP)	
Consumption	63.1
Tradable sector	42.2
Non-Tradable sector	20.9
Private investment	23.9
Government Spending (excl. interest & transfers)	21.6
Government consumption	17.1
Government investment	4.5
Government spending on tradable goods	8.9
Government spending on non-tradable goods	12.7
Trade Balance	-8.6
Exports	56.2
Mineral exports	14.0

Imports	64.8
Value added share in the non-tradable sector	36.6
Value-added share in the mining sector	23.3
Intermediate inputs in mining sector:	6.8
Value added share in the domestic tradable sector	40.2
Government accounts (as a share of GDP)	
Total (accounted) government tax revenues	24.6
Aid (grants & loans)	2.4
Government debt	44.1
Held by the central bank	0.1
Government deposits at the central bank	4.7
Central Bank Accounts	
Government debt held by the Central Bank	0.1
Government deposits at the Central Bank	4.7
Net Foreign Assets (Reserves)	16.8
Assets (as a share of GDP)	
Real money Balances (Base money/Broad money)	12.2
Foreign assets held by the private sector	7.0
Government bonds held by the private sector (includes foreign debt)	44.0
Steady State Growth & Inflation	
Annual inflation rate	7.6
Real GDP growth (in percent)	6.6

The capital depreciation rates in the tradable and non-tradable sectors(δ) are set at 0.015 as in Bu (2004), while those in public sector and natural resource sector are set to 0.02 consistent with Arslanalp et al. (2010). The parameters ($\alpha_T, \alpha_N, \alpha_M$), which are associated with the shares of labor income in the tradable, non-tradable, and mineral sectors, are calibrated to match the average ratios observed in the Mongolian Input-Output table for 2005 and those are to 0.7, 0.7 and 0.9 respectively. The elasticity of output with respect to public capital (α_G) is assigned to value of 0.1 in line with Arslanalp et al. (2010). Labor, consumption and profit tax rates are set same as in the Mongolian Law of Taxes. The parameters not listed in the table was calculated in their steady state.

Steady state values shown in Table 5-2 are calculated as annual average of the data of Mongolian economy for the period 2000-2007, assuming these years represent stable periods without cyclical up and downs. The share of home and foreign goods consumption are set to 20.9% and 42.2%, respectively. This implies that consumption is more intensive in foreign goods than domestic. The government share of spending is set to 21.6% which is the sum of average government consumption and investment to GDP in sample period. Government share of spending on non-tradable good is defined as share of government spending multiplied by total spending on non-tradable goods from Mongolian IO Table. The net export to GDP ratio in steady state is set to -8.6% but this ratio is very volatile for Mongolia.

Value added of non-tradable sector is calculated as share of gross value added non-tradable GDP plus net tax on production of non-tradable sector to GDP. Value added share of mining sector and tradable sector are calculated as non-tradable’. Intermediate inputs in mining sector 6.8 is the difference between mining export and value added of mining sector.Government debt and government deposit by central bank is the ratio of government claims and deposits in central bank to GDP from Central bank balance. Net foreign asset is calculated as in same manner. Government aid is calculated as sum of grants and foreign financing of government to GDP ratio.Steady state value of Annual inflation rate and Real GDP growth are 7.6% and 6.6%, respectively which are average values of sample period.Other parameters are calibrated to match the annual observed averages in the data of the Mongolian economy for the period 2000-2007.

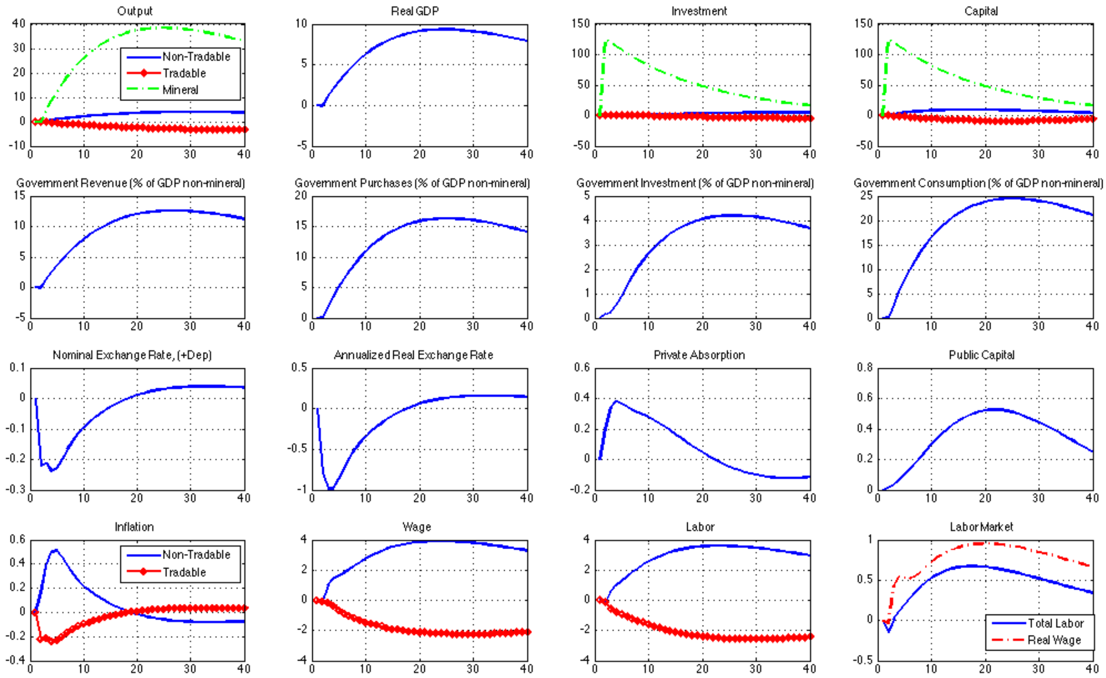
6. Simulation Analysis

In this section, the calibrated model is used to analyse the effects of an increase in commodity prices (windfall) and an FDI inflow (boom) to the natural resource sector of the economy. In particular, the model will be used to verify whether these shocks generate a “Dutch disease” effect in both resource movement and spending, and in which case structural adjustment pressures are greatest.

6.1. The Baseline Scenarios

Using the calibrated parameters in Table 5-1 and Table 5-2, two simulations with different shocks (windfall and boom) are conducted under the assumptions that the exchange rate regime is flexible; the government revenues are spent in full, and the reserve rule implies full absorption of mineral revenue. With respect to monetary policy operations, we assume that the central bank adjusts money growth if inflation deviates from its target but the tightening is relatively modest.

Figure 6-1. Baseline Scenario: FDI Shock



Impulse responses are shown as percentage deviations from steady state, unless otherwise noted. Parameter specifications for the baseline simulations are spending all incremental mining revenue ($\mu^M = 0$), non-tradable share is high ($\nu = 0.7$) and exchange rate regime is flexible ($\omega_\epsilon = 0$).

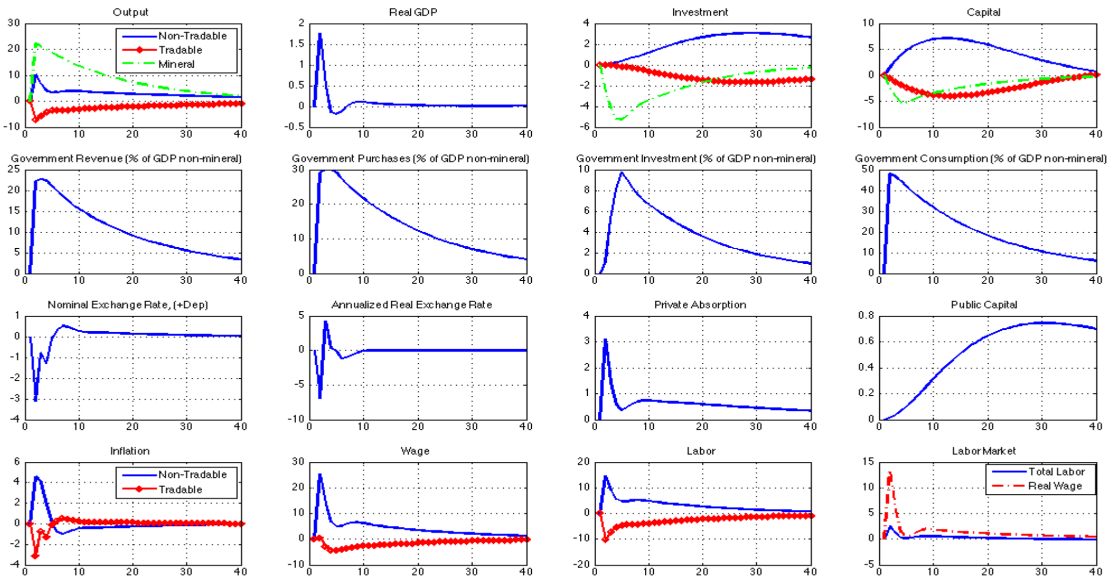
First, we analyze the effect of the increase in FDI (FDI shock or boom) that leads to a boom in the natural resource sector and an increase in government revenue by about 10% of non-mineral GDP. The responses of the selected variables namely, output, capital, investment, wage, labor, inflation, the exchange rate and government revenue, are shown in Figure 6.1, where the annual responses of the selected macroeconomic variables are measured as percentage deviations from their steady state.

After the boom (increase in natural resource sector), Figure 6.1. depicts an increase in wages, and marginal product in the non-manufacturing sector which leads to an increase in labor demand and therefore a rise in the production of non-tradable goods and a decline in manufacturing production. This second effect is defined as the *resource movement effect*. On the other hand, Figure 6.1. shows an increase in the real exchange rate due to the rise of natural resource exports compared to a decline in tradable goods exports. Through the spending effect, this appreciation of the exchange rate has contributed to the de-industrialization of the tradable goods sector.

Second, we consider the impact of the increase in commodity price (commodity price shock or windfall) that leads to increase in the government revenue by about 20% of non-mineral GDP (Figure 6.2).

The simulation results show that an increase in the international price of the natural resource commodity leads to a decline in the output of the manufacturing sector. Indeed, Figure 6.2 shows a decline in all selected variables (production, capital, investment, wage, and labor) in the tradable goods sector. This decrease is accompanied by a boom in natural resource and non-tradable sectors. Indeed, the impact on other sectors is quite large.

Figure 6-2. Baseline Scenario: Commodity Price Shock



Impulse responses are shown as percentage deviations from steady state, unless otherwise noted. Parameter specifications for the baseline simulations are spending all incremental mining revenue ($\mu^M = 0$), non-tradable share is high ($\nu = 0.7$) and exchange rate regime is flexible ($\omega_\epsilon = 0$).

As Figure 6.2 shows, variables for the non-tradable good sector, including capital, investment and wages, respond positively to commodity price shocks. This expansion in the natural resource sector is the result of the decline of manufacturing industry whose wages and capital decline. Hence, labor demand is much greater in the other sector (*resource movement effect*).

Figure 6.2 also shows an appreciation of the real exchange rate after the windfall. This is due to currency inflows, which is resulted from the increase in the export of natural resources. The appreciation of the exchange rate contributes to the decline of manufacturing industry through a decline in price competitiveness of the sector and therefore, the decline of its exports. This is similar to the *spending effect*.

Through these results, we can see that in both cases, windfall and boom, the economy and the tradable sector in particular face significant structural adjustment pressures in the short term, which dissipate as time progresses. The typical effects associated with “Dutch disease” including the spending and resource effect can both be seen in each scenario but in the long term, real GDP is nearly eight percent higher than its steady state value after the boom and level with its steady state value after the windfall.

6.2. Role of the Fiscal Policy

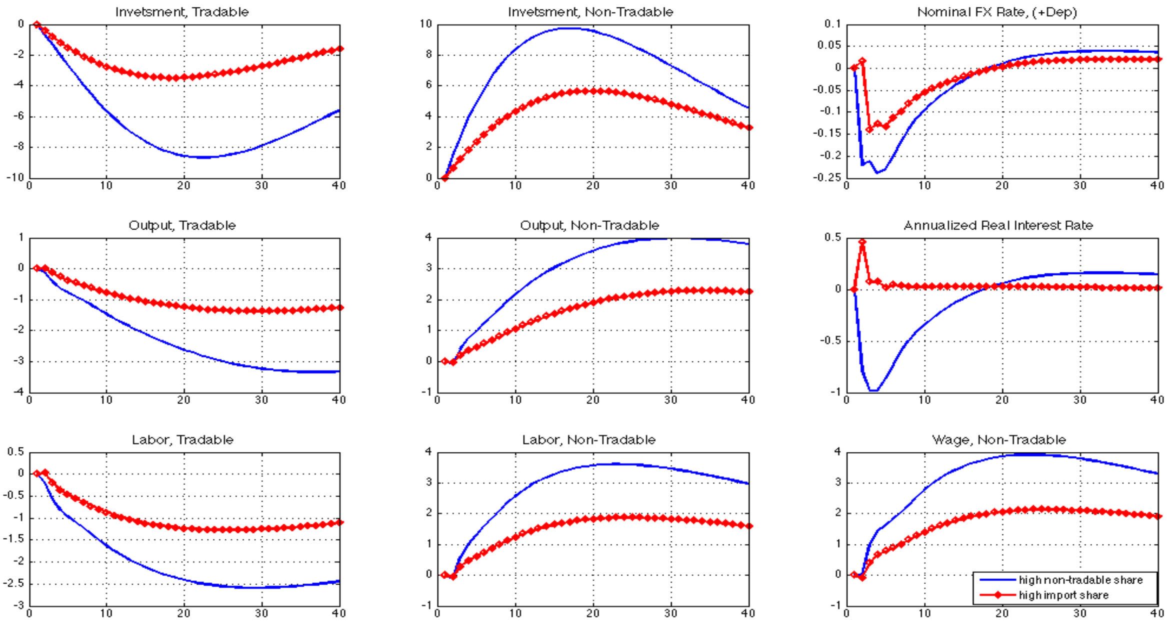
Fiscal spending ruled by fiscal policy, especially on non-tradable goods, can influence the macroeconomic effects of resource booms or capital inflows. That is, government demand for non-tradable goods, can influence the reallocation of resources in the economy. In order to illustrate this, we conduct a simulationwhere the share of government spending of mineral revenue on non-tradable goods is reduced from 70 percent in the baseline to 30 percent. The simulation results are shown in comparison with the baseline shock of the FDI shock (Figure 6.3).

The results show that in the short-term, labor has to migrate from tradable goods to non-tradable goods sector as investment is not feasible in the short term. However, in the medium-term, if demand for non-tradable goods is scaled up gradually, the build-up of the capital stock can take place in parallel to the reallocation of labor. The reallocation of labor and capital from the tradable goods to the non-tradable goods sector implies a relative decline in the former. This is the Dutch disease effect, which is potentially harmful to overall economic prospects if productivity growth in the tradable goods sector is higher than in the non-tradable goods sector.

Prices of non-tradable goods rise relative to that of tradables and the degree of absolute price changes depends on the exchange rate regime. This relative price change is equivalent to a real appreciation and the degree of the real appreciation does not depend much on the exchange rate regime or monetary policy, but depends on fiscal policy. Therefore, if government expenditure is scaled up rapidly as mineral revenue accrues, real wages tend to rise in order to facilitate the reallocation of labor as the capital stock can adjust only gradually.

Available policy options to mitigate the impact on the structure of the economy include a fiscal policy with a high import share of new spending. By focusing spending on goods and services that can be imported or infrastructure spending that has a high import content, the demand for non-tradable goods rises by less, thereby avoiding the need to reallocate production factors to the non-tradable goods sector. As a result the real appreciation and decline in the tradable goods sector is minimized.

Figure 6-3. High non-tradable vs. High import share (FDI shock)

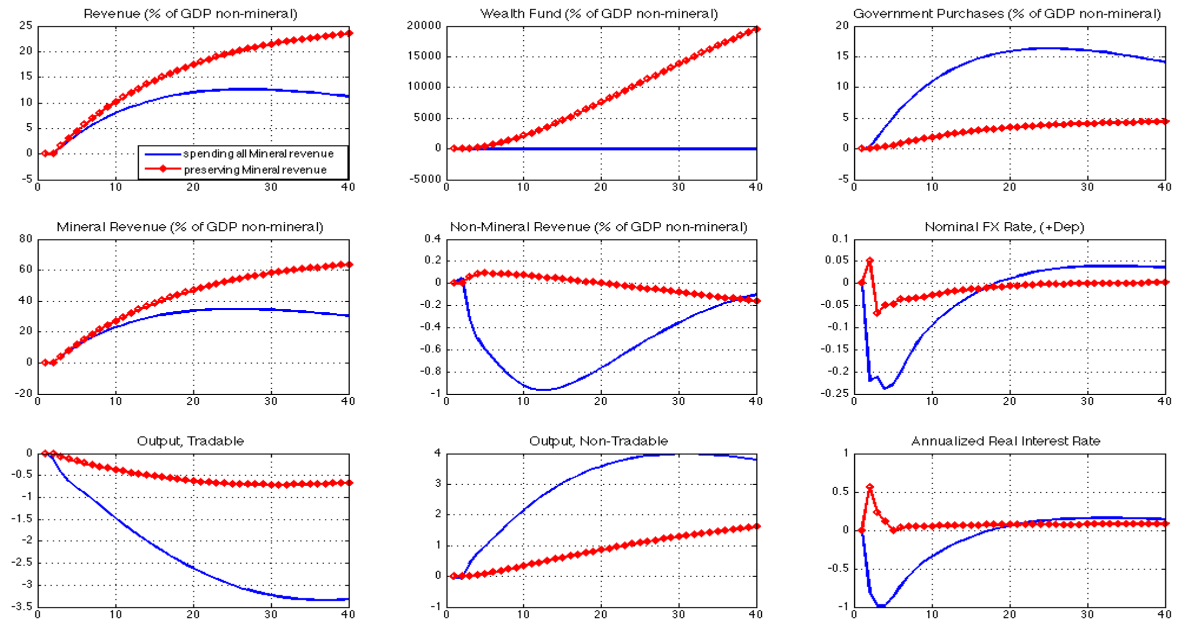


Impulse responses are shown as percentage deviations from steady state, unless otherwise noted. ***Blue lines*** *are spending all incremental mining revenue ($\mu^M = 0$), exchange rate regime is flexible ($\omega_\epsilon = 0$) and non-tradable share is high ($\boldsymbol{\nu} = \mathbf{0.7}$).* ***Red lines*** *are spending all incremental mining revenue ($\mu^M = 0$), exchange rate regime is flexible ($\omega_\epsilon = 0$) and non-tradable share is high ($\boldsymbol{\nu} = \mathbf{0.3}$).*

Another option is to transform a temporary spending increase into a much smaller but permanent fiscal expansion—the key here is to save the bulk of the inflows and spend only the portion that can be spent on a *sustainable basis*. In the baseline we assumed the mineral revenue is spent in full, but the permanent component of the mineral revenue should be spent in order to have sustainable fiscal policy over time. Figure 6.4 presents a spending scenario where 30 per cent of the mineral revenue is spent and the remained is preserver through government investment. This fiscal policy could avoid the higher real appreciation or deeper decline in the tradable goods sector that occurs under the temporary fiscal expansion.

The macroeconomic impact of this simulations is small and avoids the large demand-driven boom that occurs in the short-term in the baseline scenario. In this case, the benefits of the mineral revenue are spread over time, which is consistent with the consumption decision of optimizing, forward-looking consumers. This scenario shows that responsible fiscal policy can avoid the higher real appreciation and deeper decline in the tradable goods sector that occurs under the temporary fiscal expansion and thus, reduce the risk of “Dutch disease” in the Mongolian economy. These results are consistent with those found in Fisher *et al.* (2010). In summary, saving some of the revenue from a mining boom means the macroecononic volatilities can be smoothed and possibly be avoided.

Figure 6-4. Full Spending vs. Preserving Mineral Revenue (FDI shock)



Impulse responses are shown as percentage deviations from steady state, unless otherwise noted. ***Blue lines*** *are non-tradable share is high* $(\nu = 0.7)$*, exchange rate regime is flexible* $(\omega_\epsilon = 0)$ *and spending all incremental mining revenue* $(\boldsymbol{\mu^M = 0})$*.* ***Red lines****are non-tradable share is high* $(\nu = 0.7)$*, exchange rate regime is flexible* $(\omega_\epsilon = 0)$ *and preserving mining wealth through government investment* $(\boldsymbol{\mu^M = 0.3})$*.*

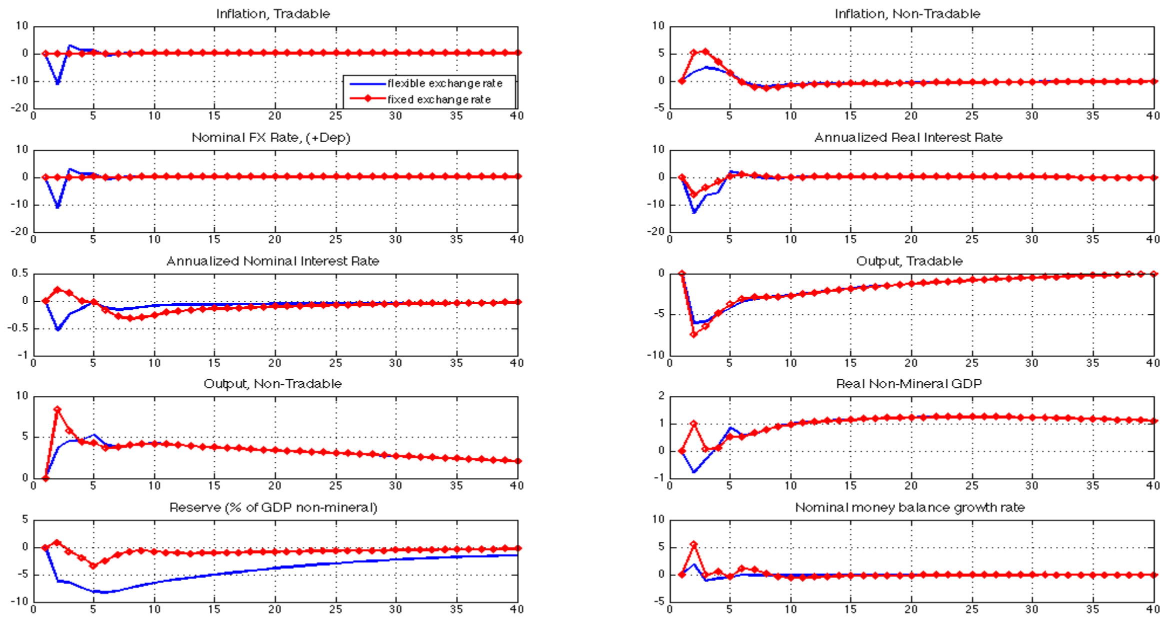
6.3. Role of the Monetary and Exchange Rate Policy

The exchange rate regime interacts with the monetary policy rule. To disentangle these, it is useful to consider first a scenario where monetary policy is passive in order to isolate the impact of the exchange rate regime. The easiest way to implement a passive monetary policy is through a monetary targeting regime where the central bank takes little action to influence the money growth path. Therefore, in the short term, monetary policy is passive, but in the long run, money growth rates will return to their steady state path. Following this, the simulations are going to consider the impact of sterilization within a monetary targeting regime and then return to the interest targeting rule used in the baseline specification.

A passive monetary policy with monetary targeting: The following scenario considers a commodity price shock that raises mining revenues and impacts government revenue by about 10% of non-mineral GDP and then gradually phases out. Commodity price shocks have a more immediate effect than increases in FDI because the ability of the exchange rate to adjust very quickly is one of the defining features of a flexible exchange rate regime. To model a passive monetary policy, a monetary targeting regime is chosen where (i) the central bank does not react to changes in inflation and it does not sterilize the build-up of foreign exchange reserves. The simulation compares a flexible exchange rate regime to a fixed exchange rate regime under the assumption that government reveunues are spent in full (Figure 6.5.).

Considering the impact of the commodity price shocks on the tradable and non-tradable goods sectors, the response is very similar under fixed and flexible exchange rate regimes. Hence, the key result here is that the choice of the exchange rate regime does not have a major impact on real variables in the economy when monetary policy remains passive.

Figure 6-5. Flexible vs. Fixed Exchange Rate Regime (Commodity Price Shock)



Impulse responses are shown as percentage deviations from steady state, unless otherwise noted. ***Blue lines*** *are spending all incremental mining revenue ($\mu^M = 0$), non-tradable share is high ($\nu = 0.7$) and exchange rate regime is flexible ($\boldsymbol{\omega_\epsilon = 0}$).* ***Red lines*** *are spending all incremental mining revenue ($\mu^M = 0$), non-tradable share is high ($\nu = 0.7$) and exchange rate regime is fixed ($\boldsymbol{\omega_\epsilon = 10000}$).*

Regarding the small differences in the real variables that result from the choice of the exchange rate regime, these are a larger increase in real wages under the fixed exchange rate regime, which in turn leads to a larger increase in labor supply in the short run and hence a larger short-term output response. Put another way, the short-term boom under the fixed exchange rate regime is larger, i.e., demand pressures are larger, which in turn lead to the aforementioned wages, labor supply, and output responses.

While the differences on the real side are small, effects of fixed and flexible exchange rate regimes are very large on the nominal side. Here, the much larger short-term boom under the fixed exchange rate regime is clearly visible. Under the flexible exchange rate regime, the sharp appreciation broadly offsets inflationary pressures emanating from the non-tradable goods sector, thereby keeping overall inflationary pressures at bay. This is not the case under the fixed exchange rate regime, where the non-tradable goods sector has no relief from a nominal appreciation diverting private sector demand to the tradable goods sector and faces the full brunt of the overall demand increase. Consequently, the need to scale up production in this sector is larger, which leads to more intense wage pressures. The end result is a much larger increase in non-tradable goods and overall inflation.

Monetary policy under the fixed exchange rate regime is passive, which means it does not counteract the changes in monetary balances that result mainly from changes in the domestic currency value of its foreign reserve holdings. Initially, foreign exchange holdings in foreign currency do not change much, but their real value in domestic currency falls because of the real appreciation, which reduces real money balances. Given the spike in GDP, real money balances as a percentage of GDP drop significantly; this drop in real money supply, given the simultaneous tendency for money demand to increase because of the output boom, drives up the nominal interest rate. However, the surge in inflation means that the real interest rate declines initially.

Given that agents are forward looking, this short-lived decline does not signal in itself a substantial easing; rather, one has to consider the real interest rate path over the following quarters as well. Following the initial boom period, the central bank begins to accumulate foreign exchange reserves under the fixed exchange rate regime, which leads to an increase in real money balances while in GDP terms money balances move back to their steady state values. Measured through the real interest rate, the initial easing is followed by a temporary tightening, reflecting that the annualized quarterly inflation rate falls faster in the wake of the receding boom than the nominal interest rate. Overall, the monetary policy stance measured through the real interest rate appears broadly neutral and not very different from that of under the flexible exchange rate regime even so inflationary pressures are much larger under the fixed exchange rate regime. This invariance of the policy stance with respect to economic conditions is the essence of the passive monetary policy regime.

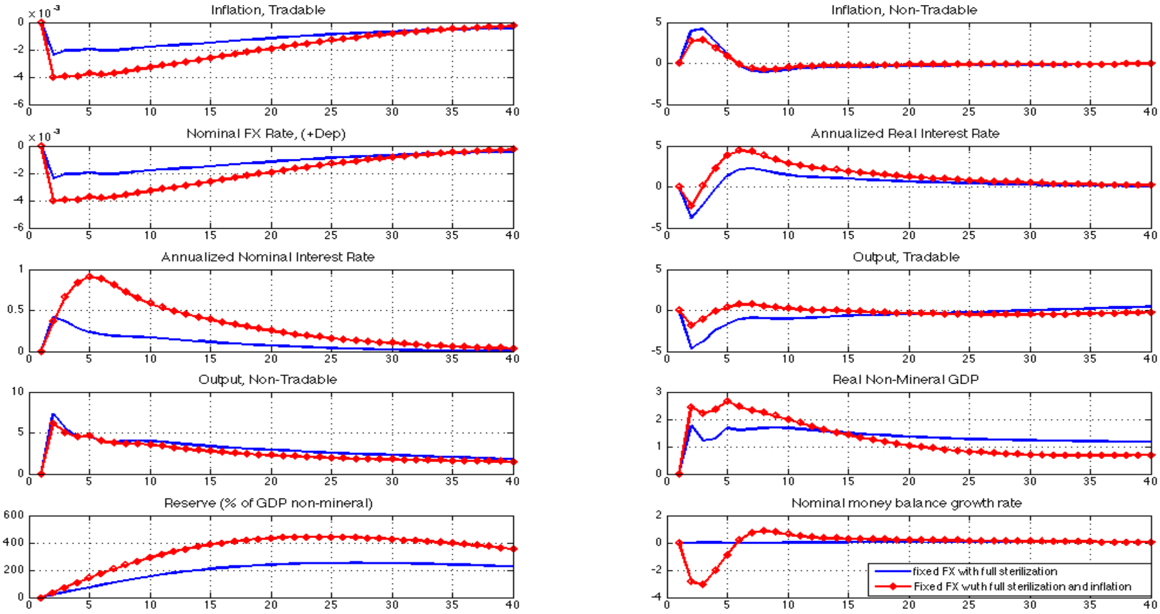
Monetary targeting with full sterilization: Next we consider the role of monetary policy within a fixed exchange rate regime in more detail. Specifically, the question arises as to what happens if monetary policy is more aggressive in stemming the increase in the real money balance from the build-up in foreign reserves and in responding to the rise in inflation?

In this simulation, the path for commodity price shocks is the same as before, and so is fiscal spending of the revenue inflows. When the nominal exchange rate is fixed, the monetary policy rule is modified in two ways: (i) there is full sterilization together with no inflation targeting, and (ii) in order for monetary policy to respond more aggressively to the increase in inflation, the inflation parameter is set at a moderately positive value of 0.5.

Considering again the impact of the oil price shocks on the tradable and non-tradable goods sectors (Figure 6.6.), the impact is now very different: a more aggressive monetary policy—the combination of sterilizing and tightening in response to inflationary pressures—is effective in curbing the rise in non-tradable goods prices as well as keeping the real appreciation and real wage increases in check. This prevents the decline in the size of the tradable goods sector and yields an overall stronger output response.

Considering the nominal variables, inflation rates are much more subdued because of the response of the nominal and real interest rates, which show a very substantial tightening. The tightening induces a massive crowding out of the private sector. In a sense, this tightening of monetary policy creates space in the economy for meeting the increased government demand by reducing the corresponding private sector demand, which means that the private sector is crowded out.

Figure 6-6. Low Inflation Response vs. Moderate Inflation Response under Fixed Exchange Rate Regime with Sterilization (Commodity Price Shock)

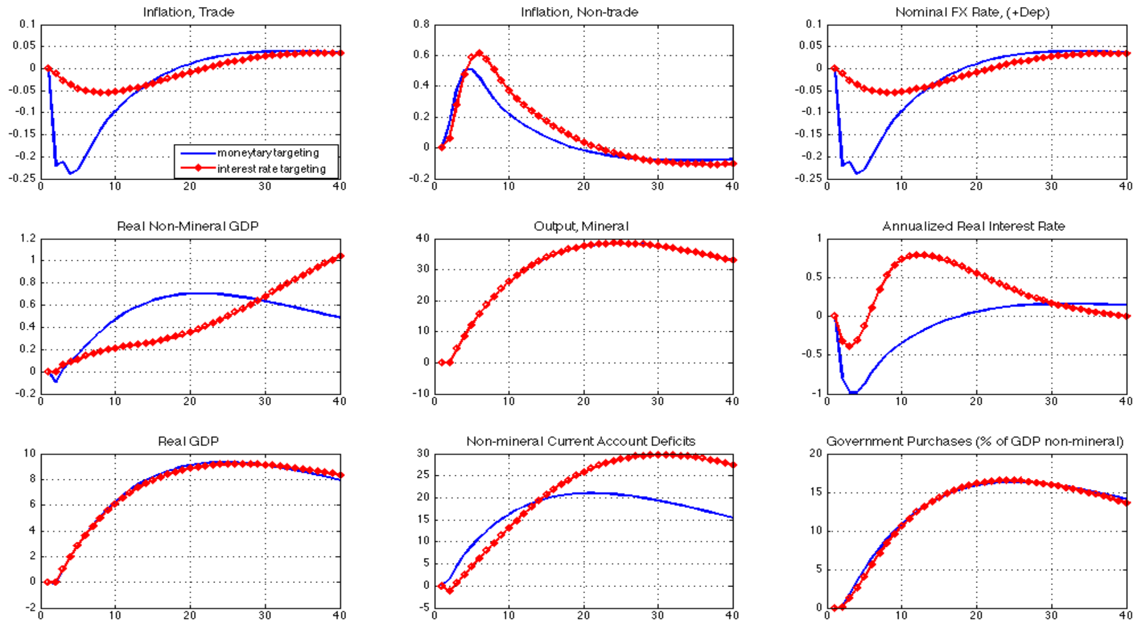


Impulse responses are shown as percentage deviations from steady state, unless otherwise noted. ***Blue lines*** *are spending all incremental mining revenue ($\mu^M = 0$), non-tradable share is high ($\nu = 0.7$), exchange rate regime is fixed ($\omega_\epsilon = 10000$) and the full sterilization ($\omega = 1$).* ***Red lines*** *are spending all incremental mining revenue ($\mu^M = 0$), non-tradable share is high ($\nu = 0.7$), exchange rate regime is fixed ($\omega_\epsilon = 10000$) and inflation targeting coefficient is high ($\boldsymbol{\phi_\pi = 0.5}$) with the full sterilization ($\omega = 1$).*

Other simulations will look at circumstances where this is the appropriate policy response. In general, though, a fiscal expansion that crowds out the private sector fails to make use of the foreign reserves inflow for financing an increase in the current account deficit. The last would prevent the crowding out of the private sector because it allows for the overall demand increase to be met by imports. Of course, this still requires shifting private sector demand to imports and reallocating resources from the tradable to the non-tradable goods sector, tasks for which the real appreciation is indispensable. But as noted before, if the real appreciation is seen as a problem, the first answer is to moderate the increase in fiscal spending.

Interest rate targeting vs. monetary targeting: Having looked at monetary targeting, the following simulations return to interest rate targeting and the scaling up of FDI–the base scenario). The monetary targeting simulations have shown that the choice of the exchange rate regime matters only if the central bank chooses to sterilize the build-up of foreign exchange reserves that occurs under a fixed exchange rate regime. Under interest rate targeting, there is no corresponding ‘sterilization’ parameter, because the extent of open-market operations is solely governed by the need to hit the interest rate target. This means some sterilization is inbuilt to the interest rate targeting regime under a fixed exchange rate regime. This leads to the question of how much? To answer this, the following simulations are going to calibrate a monetary targeting regime to broadly match the results for interest rate targeting under a quasi-fixed exchange rate.

Figure 6-7. Monetary and Interest Rate Targeting



Impulse responses are shown as percentage deviations from steady state, unless otherwise noted. ***Blue lines*** *are spending all incremental mining revenue ($\mu^M = 0$), non-tradable share is high ($\nu = 0.7$), exchange rate regime is fixed ($\omega_\epsilon = 100$), the full sterilization ($\omega = 1$), inflation targeting coefficient is high ($\phi_\pi = 2.5$), interest rate response to money growth rate is ($\phi_\mu = 0.5$) and* ***Red lines*** *are interest rate rule.*

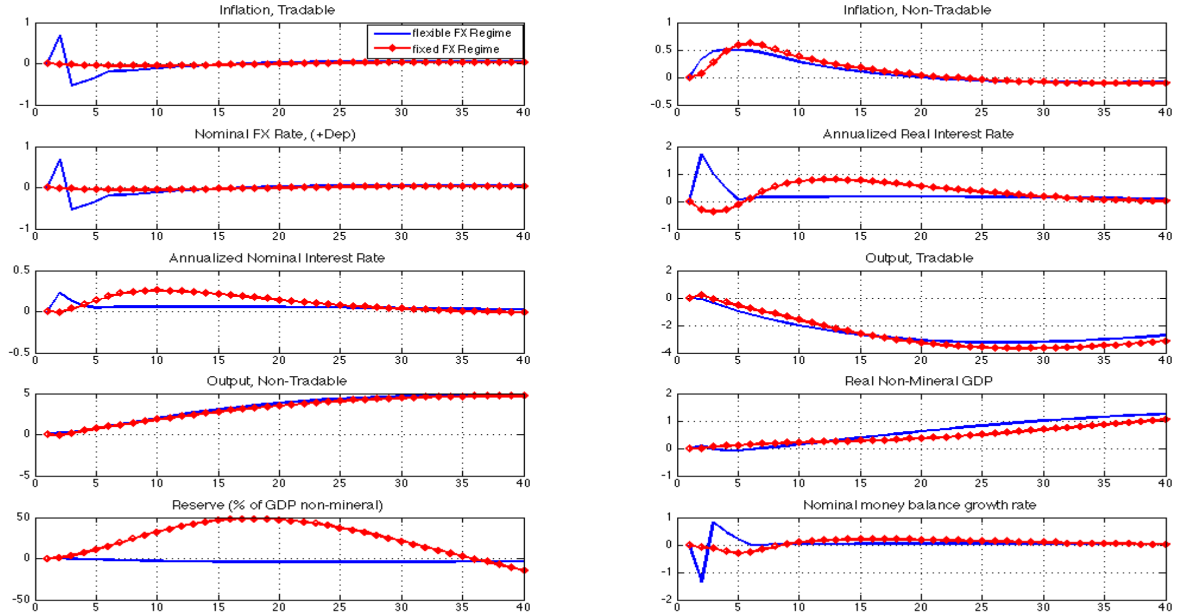
Figure 6.7 shows that a monetary targeting regime matches the medium-term fairly well for the interest rate regime (but shows more long-term persistence) for the following values: the same inflation aversion as in the interest rate rule, and a fairly large degree of sterilization under interest rate targeting.

This 'quasi-sterilization' of the foreign exchange build-up under the base interest rate rule is visible in the large amount of sales of government securities by the central bank and the resulting persistent increase in the nominal interest rate, which leads to an equally persistent increase in the real interest rate – a substantial tightening of monetary policy. This tightening policy crowds out private consumption and investment and in turn, the non-mineral current account deficit increases by less than the mineral revenue inflows. This means the private sector is being crowded out.

Flexible and fixed exchange rate regime under interest rate rule: This simulation uses the baseline specification for the interest rate rule and asks what the difference is between a flexible and quasi-fixed exchange rate regime.

Beginning with the impact on the tradable and non-tradable goods sectors (Figure 6.8.), the differences between the two exchange rate regimes are not large but visible. The real appreciation, the nominal appreciation and wage pressures are smaller under the fixed exchange rate regime. The initial output response is larger, but smaller over the medium term. It is clear from the previous simulations that it is not the fixed exchange rate regime perse that leads to the lower real appreciation, etc., rather, it is the fact that under a fixed exchange rate regime (nominal) inflationary pressures are larger, to which the central bank responds, via its interest rate rule, by a much more pronounced monetary tightening.

Figure 6-8. Flexible and Fixed FX Regime



Impulse responses are shown as percentage deviations from steady state, unless otherwise noted. ***Blue lines*** *are interest rate rule, non-tradable share is high ($\nu = 0.7$), the full sterilization ($\omega = 1$), inflation targeting coefficient is high ($\phi_\pi = 2.5$), interest rate response to money growth rate is ($\phi_\mu = 0.5$) and exchange rate regime is fixed ($\boldsymbol{\omega_\epsilon = 100}$).* ***Red lines*** *are interest rate rule, non-tradable share is high ($\nu = 0.7$), the full sterilization ($\omega = 1$), inflation targeting coefficient is high ($\phi_\pi = 2.5$), interest rate response to money growth rate is ($\phi_\mu = 0.5$) and exchange rate regime is flexible ($\boldsymbol{\omega_\epsilon = 0}$).*

This tightening effectively sterilizes a good part of the foreign exchange build-up that takes place under the quasi-fixed exchange rate regime. The monetary tightening crowds out the private sector, i.e., private consumption and investment fall relative to the baseline. Because of this crowding out, there is less need for a real appreciation to redirect demand from non-tradable goods to tradables goods or help reallocate production factors to the non-tradable goods sector in order to meet the higher government demand for non-tradable goods. The lower private investment accounts for the lower medium-term output response, because the capital stock in the economy is smaller.

7. Conclusion

Mongolia is a typical developing country, which depends heavily on resource-based exports. It has rich confirmed mineral resources and a great potential for more discoveries as many parts are still unexplored. The largest income comes from copper, coal and gold. Capital inflow is expected to increase massively due to these large mining projects, leading to financial investment in commercial banks and foreign direct investment in mining sector. Therefore, it is highlighted that the Mongolian economy will be expected to rapidly grow in forthcoming years. Even though FDI in mining sector create opportunities for high economic growth, it will also cause an appreciation of the domestic currency, which can reduce the international competiveness of other sectors such as agriculture and manufacturing (Dutch Disease effects).

Other issues with the mining boom are the inflow of a short term liability called "hot money" and economic overheating, which leads to inflationary pressures and rapid growth of monetary aggregates and credit and banking sector problems if the flows are not properly managed. In this state of the Mongolian economy, massive capital inflow driven by upcoming large-scale mining projects and expansionary fiscal policy mean policymakers have to choose between inflation and exchange rate oriented policies. Therefore rising inflation and unstable exchange rate are the main macroeconomic risks Mongolia faces today.

Given the existing literature outcomes and case studies of other countries like Mongolia with major resource and expected massive capital inflow, this study aims to empirically investigate the impact of the massive capital inflow driven by upcoming large-scale mining projects on the Mongolian economy. This is especially important for instituting economic policies to better manage similar economic shocks in the future. This paper uses a multi-sector, New Keynesian Dynamic Stochastic General Equilibrium Model with a natural resource sector calibrated for different fiscal, monetary and reserves policy responses. Using the calibrated model, the effects of an increase in commodity price shock and FDI inflow shock on natural resource sector of the economy were analyzed to verify whether these shocks generate Dutch disease impacts in both resource movement and spending effects and in which case structural adjustment pressures are the most important.

The simulation results have shown that a boom in natural resource causes an increase in wages, and marginal product in the non-manufacturing sector which leads to an increase in labor demand. Therefore, through the resource movement effect, there isa rise in the production of non-tradable good and a decline in manufacturing production while through the spending effect, the appreciation of the exchange rate has contributed to the decline of the tradable goods sector. The fiscal spending, especially on non-tradable goods, is the main driving force of the macroeconomic effects of capital inflows because the economy needs to restructure to meet government demand for non-tradable goods. The impact on the structure of the economy can be mitigated by a fiscal policy with high import share of new spending. As a result the real appreciation and decline in the tradable sector is minimized. In addition, if the government saves a portion of the inflows and spends on a sustainable fiscal response to the mineral revenue, the short-term demand pressures will be significantly reduced.

The impact on medium term competitiveness resulting from Dutch Disease effects could be negative if there are sizeable learning externalities in the tradable goods sector. However, this negative effect could be reverted if the fiscal expansion translates into higher public capital. Under certain assumptions, the combination of higher public capital and learning externalities could actually lead to even higher competitiveness in the tradable sector.

If the government decides to save part of the mineral revenue domestically, there are some non-trivial issues with the central bank's management of the foreign currency inflow. Reserve policy must be consistent with fiscal policy. If the central bank simultaneously accumulates the foreign currency proceeds from mineral revenue, while the government spends the local currency proceeds on domestic goods, the real exchange rate appreciation will be smaller but inflation will be higher. This will be the case, even if the accumulation of reserves is sterilized. This highlights the role of the supply of foreign currency associated with the mineral revenue in stabilizing aggregate demand and containing inflationary pressures.

As for the central bank, a discretionary tightening of monetary policy to reduce inflation from current high levels to a new, lower steady state can also work but requires a strong commitment to price stability. However, the tightening induces a massive crowding out of the private sector. The higher demand for goods and services by the government is addressed under the quasi-fixed exchange rate regime through a partial crowding out of the private sector, which reduces the need for the real appreciation but also adversely impacts private sector capital accumulation. Under the flexible exchange rate regime, no crowding out of the private sector occurs as long as all of the foreign exchange inflows are sold.

Finally, the structural features of the Mongolian economy will also play an important role in the adjustment process. In particular, frictions in the labor market and the financial market, features that are accounted for in the model, amplify the impact on inflation. Hence, any progress in decreasing these frictions in the coming years would have a beneficial effect for the economy overall, and in its response to the large mineral revenue shock.

8. References

Adam, C and D Bevan. "Aid and the Supply Side: Public Investment, Export Performence, and Dutch Disease in Low-Income Countries." The World Bank Economic Review 2.20 (2006): 261-290.

Adam, C, S O'Connell and E Buffie. "Monetary Policy Rules for Managing Aid Surges in Africa." 2009.

Agenor, P and D Yilmaz. "Aid Allocation, Growth and Welfare with Productive Public Goods." Centre for Growth and Business Cycle Research Discussion Paper Series 95, (2008).

Agenor, P, N Bayraktar and K El Aynaoui. "Roads Out of Poverty? Assessing the Links Between Aid, Public Investment, Growth and Poverty Reduction." 2008.

Aizenman, Joshua and Marion Nancy. "Volatility and Investment: Interpreting Evidence from Developing Countries." 66 (1999): 157-179.

Altantsetseg, B. "From Vulnerability to Sustainability: Environment and Human Development." Background paper for Human Development Report (2010).

Andrew M, Warner, D Jeffrey and Sachs. "Natural resource abundance and economic growth." (1995National Bureau of Economic Research Working Paper No.5398).

Antonio, et al. "Investment in Education: Do Economic Volatility and Credit Constraints Matter?" 55 (1998): 465-484.

Arellano, C, Bai Yan and Jing Zhang. "Firm Dynamica and Financial Development." (2009).

Arslanalp, S, et al. "Public Investment and Growth Revisited." (2009).

Arvind, Subramanian, Sala-i-Martin and Xavier. "Addressing the natural resource curse: an illustration from Nigeria." (2003).

Benes, J, R Portillo and D Varva. "Modeling Sterilized Interventions and Balance Sheet Effects of Monetary Policy." (2009).

Berg, A, et al. "A small-open DSGE model with a natural resource sector." (2011).

—. "The Macroeconomics of Medium-Term Aid Scaling-Up Scenarios." (2010).

—. "The Macroeconomics of Scaling Up Aid: Lessons from Recent Experience." (2007).

—. "The Short-Run Macroeconomics of Aid Inflows." (2009).

Bhavnani, R, M Clemens and S Radelet. "Counting Chickens When They Hatch: The Short-term Effect of Aid on Growth." (2004).

Bu, J. "Fixed Capital Shock Depreciation in Developing Countries." (2004).

Corden, W, Max and J Peter Neary. "Booming Sector and De-Industrialisation in a Small Open Economy." 92 (1982): 825-848.

Dagher, J, J Gottschalk and R Portillo. "Oil Windfalls in a DSGE Model: The Case of Ghana." (2009).

Dib, A. "Welfare Effects of Commodity Price and Exchange Rate Volatilities in a Multi-Sector Small Open Economy." (2008).

Eichenbaum, Evans and Christiano. "Nominal Rigidities and the Dynamic Effects of a Shock to Monetary Policy." 1 (2005): 1-45.

Farah, A, E Sacerdoti and G Salinas. "The Macroeconomic Impact of Scaled-up Aid: The Case of Niger." (2009).

Fisher, Brain , et al. The Development of the Oyu Tolgoi Copper Mine: An Assessment of the Macroeconomics Consequences for Mongolia. Ulaanbaatar, 2010.

Gali, J and T Monaceli. "Monetary Policy and Exchange Rate Volatility in a Small Open Economy Model." 72 (2005): 707-734.

Gali, J, D Lopez-Salido and J Valles. "Understanding the Effects of Government Spending on Consumption." Journal of the European Economic Association (2007): 227-270.

Garey, Ramey and Ramey Valerie A. "Cross-Country Evidence on the Link Between Volatility and Growth." 85 (1995): 1138-1151.

Gottschalk, J, et al. "Analizing Fiscal Space Using MAMS: An Application to Burkina Faso." (2009).

Hausmann, Ricardo and Rigobon Roberto. "An alternative interpretation for the resource curse: theory and policy implications." (2003).

Horvath, M. "Sectoral Shocks and Aggregate Fluctuations." 45.1 (2000): 69-106.

International Monetary Fund and UNDP. "The Gleneagles Scenarios: Scaling Up to Achieve the Millennium Development Goals." (2010).

International Monetary Fund. "The Macroeconomics of Scaling-up Aid Scenarios: The Cases of Central African Republic, Rwanda, and Sierra Leone." (2008b).

—. "The Macroeconomics of Scaling-up Aid: The Cases of Benin, Niger, and Togo." (2008a).

Isham, et al. "The Varieties of Rentier Experience: How Natural Resource Endowments Affect the Political Economy of Economic Growth." 19 (2005): 141-174.

Krugman, P. "The Narrow Moving Band, the Dutch Disease, and the Competitive Consequences of Mrs. Thatcher : Notes on Trade in the Presence of Dynamic Scale Economies." (1987): 41-55.

Lartey. "Capital Inflows, Dutch Disease Effects and Monetary Policy in Small Open Economy." 16.5 (2008): 671-689.

Max and W Corden. "Booming Sector and Dutch Disease Economics: Survey and Consolidation." 36 (1984): 359-380.

Prati, A and T Tressel. "Aid Volatility and Dutch Disease: Is There a Role for Macroeconomic Policies." (2006).

Prati, A, R Sahay and T Tressel. "Is there a case for Sterilizating Foreign Aid Inflows?" (2003).

Rossabi, Morris. "Modern Mongolia, From Khans to Commissars to Capitalists." Columbia University Press (2005).

Rotemberg, J. "Sticky Price in the United States." 90 (1982): 1187-1211.

Schmit, S and M Uribe. "Closing Small Open Economy Models." 61 (2003): 163-185.

Tokarick, S. "A Method For Calculating Export Supply and Import Demand Elasticities." (2009).

Torvik, R. "Learning by Doing and the Dutch Disease." 45.2 (2001): 285-306.

World Bank. World Governance Indicator. Mongolia, 1996-2010.

9. Appendix A

9.1. The equations of the Model and Definition of Equilibrium

The First Order Conditions of the Households' Problem

The problem of the *savers* reduces to maximizing (2) with respect to consumption, realmoney balances, labor supply in both sectors, and domestic and foreign assets, subject to the constraint (11) with the lagrangian function associated with it is:

$$\mathbb{E}_t \sum_{t=0}^{\infty} (\beta^d)^t \left[\begin{array}{c} \left\{ \frac{1}{1-\sigma} \cdot \left\{ \left[\mathfrak{a}\left(c_t^d\right)^{\frac{\mathfrak{b}-1}{\mathfrak{b}}} + (1-\mathfrak{a})\left(m_t^d\right)^{\frac{\mathfrak{b}-1}{\mathfrak{b}}} \right]^{\frac{\mathfrak{b}}{\mathfrak{b}-1}} \right\}^{1-\sigma} - \frac{\hbar^d \left(h_t^d\right)^{1+\psi^d}}{1+\psi^d} \right\} - \\ -\lambda_t \left\{ \begin{array}{c} (1+\tau_c)c_t^d + m_t^d + b_t^d + \epsilon_t b_t^{d*} + \frac{\upsilon}{2}\epsilon_t\left(b_t^{d*} - b^{d*}\right)^2 - \\ -(1-\tau_h)w_t h_t^d - \frac{m_{t-1}^d}{\mathfrak{g}\pi_t} - \frac{i_{t-1} b_{t-1}^d}{\mathfrak{g}\pi_t} - \epsilon_t i^* \frac{b_{t-1}^{d*}}{\mathfrak{g}\pi^*} - \Pi_t^T - \Pi_t^N - \epsilon_t r m^* - tr_t \end{array} \right\} \end{array} \right]$$

The first order conditions with respect to $c_t^d, m_t^d, b_t^d, b_t^{d*}andh_t^d$are:

$$c_t^d: \quad \left[\mathfrak{a}\left(c_t^d\right)^{\frac{\mathfrak{b}-1}{\mathfrak{b}}} + (1-\mathfrak{a})\left(m_t^d\right)^{\frac{\mathfrak{b}-1}{\mathfrak{b}}} \right]^{\frac{1-\sigma\mathfrak{b}}{\mathfrak{b}-1}} \cdot \mathfrak{a}\left(c_t^d\right)^{-\frac{1}{\mathfrak{b}}} = \lambda_t(1+\tau_c) \equiv u_{c_t}^d(1+\tau_c)$$

$$m_t^d: \quad \left[\mathfrak{a}\left(c_t^d\right)^{\frac{\mathfrak{b}-1}{\mathfrak{b}}} + (1-\mathfrak{a})\left(m_t^d\right)^{\frac{\mathfrak{b}-1}{\mathfrak{b}}} \right]^{\frac{1-\sigma\mathfrak{b}}{\mathfrak{b}-1}} \cdot (1-\mathfrak{a})\left(m_t^d\right)^{-\frac{1}{\mathfrak{b}}} = \lambda_t \cdot \left(\frac{i_t - 1}{i_t}\right)$$

$$b_t^d: \quad \lambda_{t+1} = \lambda_t \cdot \left(\frac{\mathfrak{g}\pi_{t+1}}{i_t}\right)$$

$$b_t^{d*}: \quad \epsilon_t u_{c_t}^d \left[1 + \upsilon\left(b_t^{d*} - b^{d*}\right) \right] = \beta^d \left(u_{c_{t+1}}^d \cdot \frac{i_t^* \cdot \epsilon_{t+1}}{\mathfrak{g}\pi^*} \right)$$

$$h_t^d: \quad \hbar^d \left(h_t^d\right)^{\psi^d} = u_{c_t}^d (1-\tau_h) w_t$$

When $\beta^s = 0$, the first order conditions of the *hand-to-mouth consumers* optimization problemin (2) subject to the budget constraint (12) andthe lagrangian function associated with it is:

$$\mathbb{E}_0 \sum_{t=0}^{\infty} (\beta^s)^t \left[\begin{array}{c} \left\{ \frac{1}{1-\sigma} \cdot \left\{ \left[\mathfrak{a}(c_t^s)^{\frac{\mathfrak{b}-1}{\mathfrak{b}}} + (1-\mathfrak{a})(m_t^s)^{\frac{\mathfrak{b}-1}{\mathfrak{b}}} \right]^{\frac{\mathfrak{b}}{\mathfrak{b}-1}} \right\}^{1-\sigma} - \frac{\hbar^s (h_t^s)^{1+\psi^s}}{1+\psi^s} \right\} - \\ -\lambda_t \left\{ (1+\tau_c)c_t^s + m_t^s - (1-\tau_h) w_t h_t^s - \frac{m_{t-1}^s}{\mathfrak{g}\pi_t} - \epsilon_t r m^* - tr_t \right\} \end{array} \right]$$

The first order conditions with respect c_t^s, m_t^s,and$h_t^s$are:

$$c_t^s: \quad \left[\mathfrak{a}(c_t^s)^{\frac{\mathfrak{b}-1}{\mathfrak{b}}} + (1-\mathfrak{a})(m_t^s)^{\frac{\mathfrak{b}-1}{\mathfrak{b}}}\right]^{\frac{1-\sigma\mathfrak{b}}{\mathfrak{b}-1}} \cdot \mathfrak{a}(c_t^s)^{-\frac{1}{\mathfrak{b}}} = \lambda_t(1+\tau_c) \equiv u_{c_t}^s(1+\tau_c)$$

$$m_t^s: \quad \left[\mathfrak{a}(c_t^s)^{\frac{\mathfrak{b}-1}{\mathfrak{b}}} + (1-\mathfrak{a})(m_t^s)^{\frac{\mathfrak{b}-1}{\mathfrak{b}}}\right]^{\frac{1-\sigma\mathfrak{b}}{\mathfrak{b}-1}} \cdot (1-\mathfrak{a})(m_t^s)^{-\frac{1}{\mathfrak{b}}} = \lambda_t \equiv u_{c_t}^s$$

$$h_t^s: \quad \hbar^s(h_t^s)^{\psi^s} = u_{c_t}^d(1-\tau_h)w_t$$

The First Order Conditions of the Firms' Problem

In a symmetric equilibrium (dropping the sub-indices), the optimizing conditions for the firm in the *traded sector* correspond to (22), (25) and (26), also a lagrangian function associated with it is:

$$\mathbb{E}_0\sum_{t=0}^{\infty}(\beta^d)^t\left[\begin{array}{c}\lambda_t^d(1-\tau_k)\left\{\begin{array}{c}(1-\iota)\epsilon_t A_t^T(k_{it-1}^T)^{1-\alpha_T}(h_{it}^T)^{\alpha_T}(K_{t-1}^G)^{\alpha_G} - \\ -w_t^T h_{it}^T - i_{it}^T + \iota\epsilon_t q_t^T\end{array}\right\} - \\ -\lambda_t\left\{\mathrm{g}k_{it}^T - (1-\delta_T)k_{it-1}^T - \left[1-\frac{\kappa_T}{2}\left(\frac{i_{it}^T}{i_{it-1}^T}-1\right)^2\right]i_{it}^T\right\}\end{array}\right]$$

The first order conditions are:

$$k_{it}^T: \quad \beta^d\left(\frac{u_{c_{t+1}}^d}{u_{c_t}^d}\right)\left\{\lambda_{t+1}\cdot(1-\delta_T) + (1-\alpha_T)(1-\tau_k)(1-\iota)\frac{\epsilon_{t+1}q_{it+1}^T}{k_{it}^T}\right\} = [\lambda_t\cdot\mathrm{g}]$$

$$i_{it}^T: \quad \frac{(1-\tau_k)}{\lambda_t} = 1-\frac{\kappa_T}{2}\left(\frac{i_{it}^T}{i_{it-1}^T}-1\right)^2 - \kappa_T\cdot\frac{i_{it}^T}{i_{it-1}^T}\left(\frac{i_{it}^T}{i_{it-1}^T}-1\right) +$$

$$+\beta^d\kappa_T\frac{u_{c_{t+1}}^d}{u_{c_t}^d}\left\{[\frac{\lambda_{t+1}}{\lambda_t}\left(\frac{i_{it+1}^T}{i_{it}^T}-1\right)\frac{{i_{it+1}^T}^2}{{i_{it}^T}^2}\right\}$$

$$h_{it}^T: \quad h_{it}^T = \left(\frac{(1-\iota)\alpha^T\epsilon_t A_t^T(k_{it-1}^T)^{1-\alpha_T}(K_{t-1}^G)^{\alpha_T}}{w_t^T}\right)^{\frac{1}{1-\alpha_T}}$$

On the other hand, in a symmetric equilibrium (dropping the sub-indices), the first order conditions of the representative monopolist in the *non-traded sector* are equations (36)-(38) andthe lagrangian function associated with it is:

$$\mathbb{E}_0 \sum_{t=0}^{\infty} (\beta^d)^t \left[\begin{array}{c} \lambda_t^d (1-\tau_k) \left\{ \begin{array}{c} (1-\iota)\left[p_{it}^N q_{it}^N - \frac{\varsigma}{2}\left(\frac{\pi_{it}^N}{\pi_{it-1}^N} - 1\right)^2 p_t^N q_t^N \right] - \\ -\omega_t^N h_{it}^N - i_{it}^N + \iota p_t^N q_t^N \left[1 - \frac{\varsigma}{2}\left(\frac{\pi_t^N}{\pi_{t-1}^N} - 1\right)^2 \right] \end{array} \right\} - \\ -\lambda_t \left\{ \mathrm{g} k_{it}^N - (1-\delta_N) k_{it-1}^N - \left[1 - \frac{k_N}{2}\left(\frac{i_{it}^N}{i_{it-1}^N} - 1\right)^2 \right] i_{it}^N \right\} \end{array} \right]$$

The first order conditions are:

$$k_{it}^N: \qquad \beta^d \frac{\left(u_{c_{t+1}}^d\right)}{u_{c_t}^d} \left\{ \lambda_{t+1} \cdot (1-\delta_N) + (1-\tau_k) \frac{1-\alpha_N}{\alpha_N} \frac{w_{t+1}^N h_{it+1}^N}{k_{it}^N} \right\} = \lambda_t \cdot \mathrm{g}$$

$$p_{it}^N: \qquad \Phi_t^N = \beta^d \frac{u_{c_{t+1}}^d}{u_{c_t}^d} \left[\frac{(1-\tau_k)}{(1-\tau_k)} \frac{p_{t+1}^N q_{t+1}^N}{p_t^N q_t^N} \Phi_{t+1}^N \right] + \frac{(\theta-1)}{\varsigma} \left[\frac{\omega_t^N h_{it}^N}{p_t^N q_t^N} \left(\frac{\theta}{(1-\iota)\alpha^N(\theta-1)} \right) - 1 \right]$$

$$i_{it}^N: \qquad \frac{(1-\tau_k)}{\lambda_t} = 1 - \frac{k_N}{2}\left(\frac{i_{it}^N}{i_{it-1}^N} - 1\right)^2 - k_N \frac{i_{it}^N}{i_{it-1}^N}\left(\frac{i_{it}^N}{i_{it-1}^N} - 1\right) \quad +$$

$$+\beta^d k_N \frac{u_{c_{t+1}}^d}{u_{c_t}^d} \left\{ [\frac{\lambda_{t+1}}{\lambda_t}\left(\frac{i_{it+1}^N}{i_{it}^N} - 1\right) \frac{{i_{it+1}^N}^2}{{i_{it}^N}^2} \right\}$$

where $\pi_t = \frac{p_t}{p_{t-1}}$ and $\Phi_t^N \equiv \frac{\pi_t^N}{\pi_{t-1}^N}\left(\frac{\pi_t^N}{\pi_{t-1}^N} - 1\right)$.

9.2. Demand Functions, Aggregation, Market Clearing Conditions, and Other Equations

The composite consumption c_t^j consists of non-traded good (c_t^{jN}) and traded good $\left(c_t^{jT}\right)$, combined into a CES basket:

$$c_t^j = \left[\vartheta^{\frac{1}{\gamma}} \left(c_t^{jN}\right)^{\frac{\gamma-1}{\gamma}} + (1-\vartheta)^{\frac{1}{\gamma}} \left(c_t^{jT}\right)^{\frac{\gamma-1}{\gamma}} \right]^{\frac{\gamma}{\gamma-1}}$$

The consumption minimizes profits subject to the CES basket, taking as given all differentiated sector prices p^Nandp^T**.** Consequently, its minimization problem is:

$$min \rightarrow c_t^{jN} \cdot P_t^N + c_t^{jT} \cdot P_t^T$$

The lagrangian function given by:

$$\left[\left\{c_t^{jN}\cdot P_t^N + c_t^{jT}\cdot P_t^T\right\} - \lambda_t\left\{\left[\vartheta^{\frac{1}{\gamma}}\left(c_t^{jN}\right)^{\frac{\gamma-1}{\gamma}} + (1-\vartheta)^{\frac{1}{\gamma}}\left(c_t^{jT}\right)^{\frac{\gamma-1}{\gamma}}\right]^{\frac{\gamma}{\gamma-1}} - c_t^j\right\}\right]$$

The first order conditions with respect to $c_t^{jN}$and$c_t^{jT}$are:

$$c_t^{jN}: \quad (p_t^N)^{-\gamma}\cdot\left(c_t^j\right)\cdot\vartheta \quad = \left(c_t^{jN}\right)$$

$$c_t^{jT}: \quad (\epsilon_t)^{-\gamma}\cdot\left(c_t^j\right)\cdot(1-\vartheta) \quad = c_t^{jT}$$

While the demand of investment of traded goods in the traded and non-traded sectors correspond to the lagrangian function given by:

$$\left[\left\{i_t^{TT}\cdot P_t^N + i_t^{NT}\cdot P_t^T\right\} - \lambda_t\left\{\left[\vartheta^{\frac{1}{\gamma}}(i_t^{TT})^{\frac{\gamma-1}{\gamma}} + (1-\vartheta)^{\frac{1}{\gamma}}(i_t^{NT})^{\frac{\gamma-1}{\gamma}}\right]^{\frac{\gamma}{\gamma-1}} - i_t^T\right\}\right]$$

The first order conditions with respect to $i_t^{NN}$and$i_t^{NT}$are:

$$i_t^{TT}: \quad (p_t^N)^{-\gamma}\cdot(i_t^T)\cdot\vartheta \quad = (i_t^{TT})$$

$$i_t^{NT}: \quad (\epsilon_t)^{-\gamma}\cdot(i_t^T)\cdot(1-\vartheta) \quad = (i_t^{NT})$$

While the demand of investment of non-traded goods in the traded and non-traded sectors correspond to the lagrangian function given by:

$$\left[\left\{i_t^{NN}\cdot P_t^N + i_t^{TN}\cdot P_t^T\right\} - \lambda_t\left\{\left[\vartheta^{\frac{1}{\gamma}}(i_t^{NN})^{\frac{\gamma-1}{\gamma}} + (1-\vartheta)^{\frac{1}{\gamma}}(i_t^{TN})^{\frac{\gamma-1}{\gamma}}\right]^{\frac{\gamma}{\gamma-1}} - i_t^N\right\}\right]$$

The first order conditions with respect to$i_t^{NN}$and$i_t^{NT}$are:

$$i_t^{NN}: \quad (p_t^N)^{-\gamma}\cdot(i_t^N)\cdot\vartheta \quad = (i_t^{NN})$$

$$i_t^{TN}: \quad (\epsilon_t)^{-\gamma}\cdot(i_t^N)\cdot(1-\vartheta) \quad = (i_t^{TN})$$

Each household supplies differentiated labor services to the two production sectors, namely tradable $\left(h_t^{jT}\right)$and non-tradable sectors $\left(h_t^{jN}\right)$. The total labor, h_t^j, supplied by households is:

$$h_t^j = \left[\delta^{-\frac{1}{\eta}}\left(h_t^{jN}\right)^{\frac{1+\eta}{\eta}} + (1-\delta)^{-\frac{1}{\eta}}\left(h_t^{jT}\right)^{\frac{1+\eta}{\eta}}\right]^{\frac{\eta}{1+\eta}}$$

The lagrangian function associated with it is:

$$\left[\left\{h_t^{jN} \cdot w_t^N + h_t^{jT} \cdot w_t^T\right\} - \lambda_t \left\{\left[\delta^{-\frac{1}{\eta}}\left(h_t^{jN}\right)^{\frac{1+\eta}{\eta}} + (1-\delta)^{-\frac{1}{\eta}}\left(h_t^{jT}\right)^{\frac{1+\eta}{\eta}}\right]^{\frac{\eta}{1+\eta}} - h_t^j\right\}\right]$$

The first order conditions with respect to h_t^{jN} and h_t^{jT} are:

$$h_t^{jN}: \qquad \left(\frac{w_t^N}{w_t}\right)^{\eta} \cdot \left(h_t^j\right) \cdot \delta \quad = h_t^{jN}$$

$$h_t^{jT}: \qquad \left(\frac{w_t^T}{w_t}\right)^{\eta} \cdot \left(h_t^j\right) \cdot (1-\delta) \quad = h_t^{jT}$$

Total government purchases is a CES basket that includes tradable and non-tradable goods,

$$g_t = \left[\nu^{\frac{1}{\gamma}}(g_t^N)^{\frac{\gamma-1}{\gamma}} + (1-\nu)^{\frac{1}{\gamma}}(g_t^T)^{\frac{\gamma-1}{\gamma}}\right]^{\frac{\gamma}{\gamma-1}}$$

The lagrangian function given by:

$$\left[\{g_t^N \cdot P_t^N + g_t^T \cdot P_t^T\} - \lambda_t \left\{\left[\nu^{\frac{1}{\gamma}}(g_t^N)^{\frac{\gamma-1}{\gamma}} + (1-\nu)^{\frac{1}{\gamma}}(g_t^T)^{\frac{\gamma-1}{\gamma}}\right]^{\frac{\gamma}{\gamma-1}} - g_t\right\}\right]$$

The first order conditions with respect to g_t^N and g_t^T are:

$$g_t^N: \qquad (p_t^N)^{-\gamma} \cdot (g_t) \cdot v \quad = (g_t^N)$$

$$g_t^T: \qquad (\epsilon_t)^{-\gamma} \cdot (g_t) \cdot (1-v) \qquad = (g_t^T)$$

10. Appendix B

Figure 10.1 Baseline Scenario: FDI shock vs. Commodity Price Shock

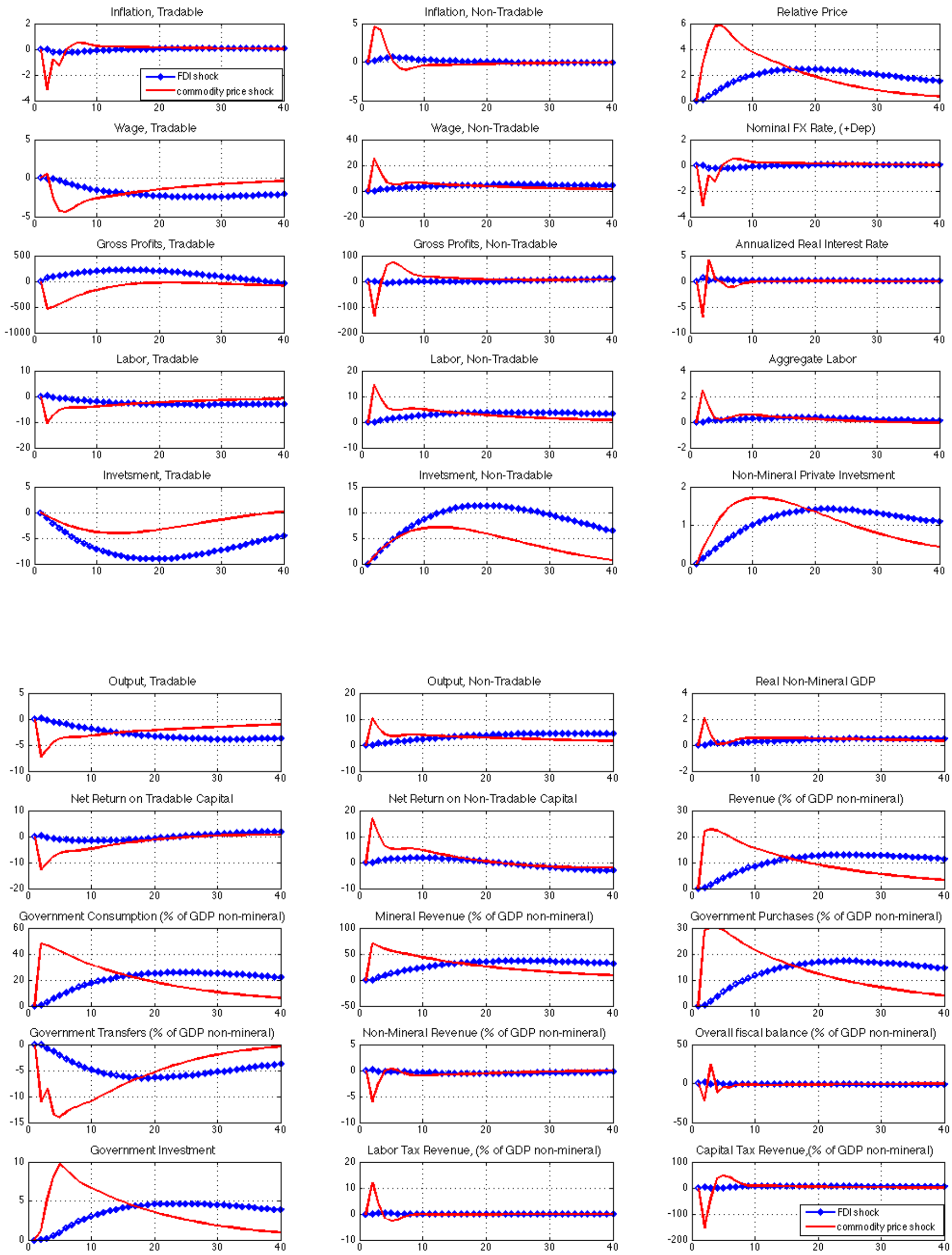


Figure 10.2 Full Spending vs. Preserving Mineral Revenue (FDI shock)

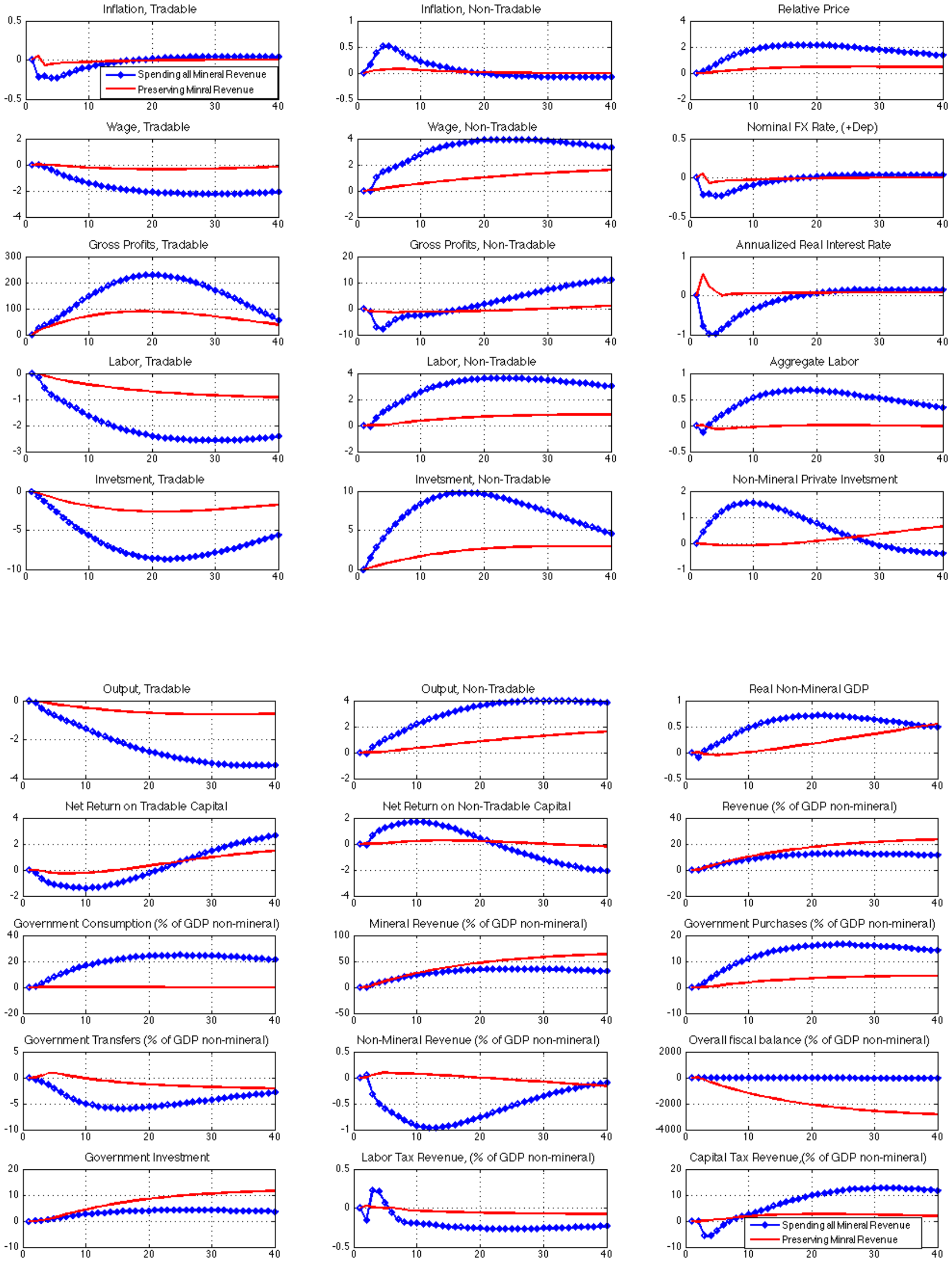


Figure 10.3 High non-tradable share vs. High import share

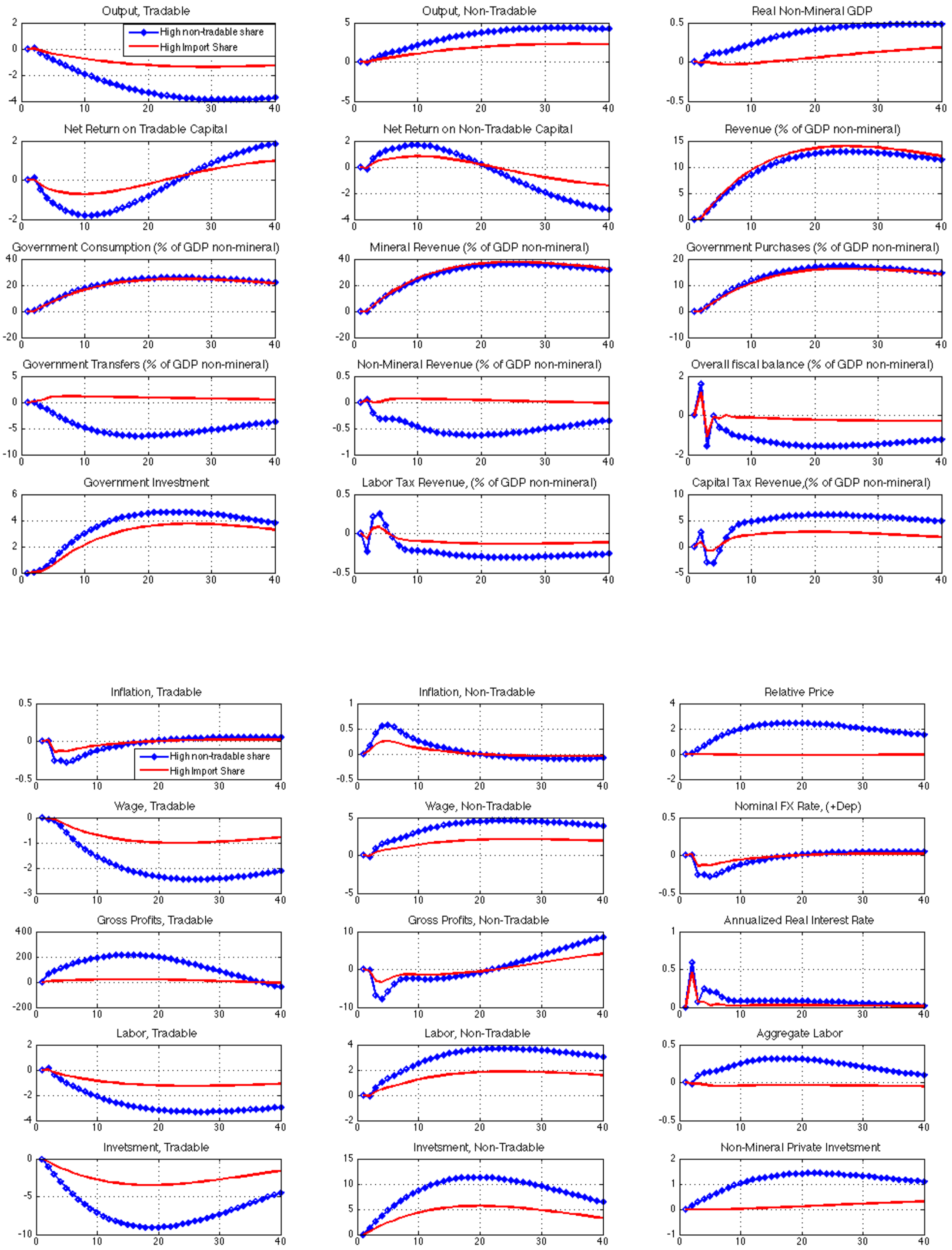


Figure 10.4 Flexible vs. Fixed Exchange Rate Regime

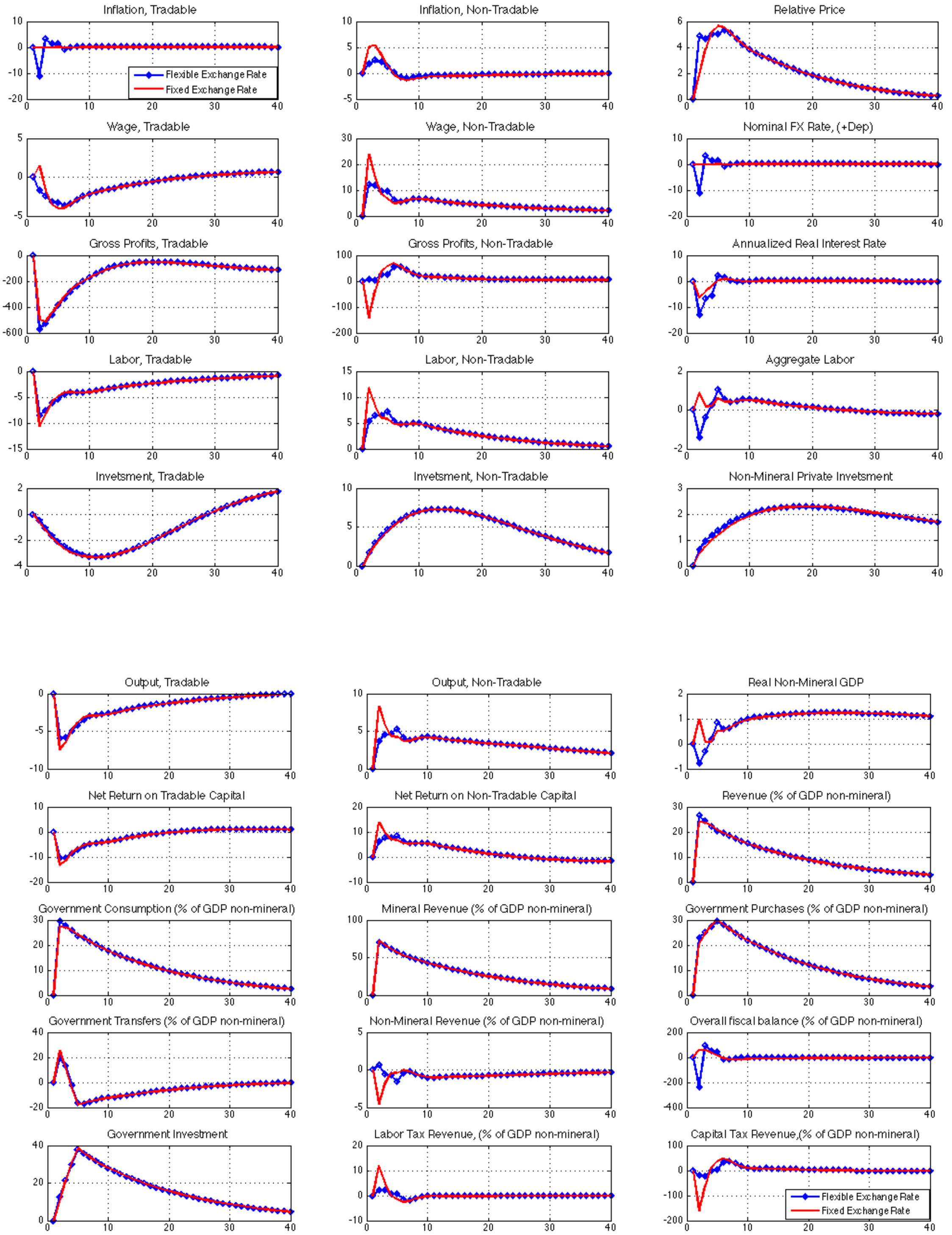


Figure 10.5 Monetary and Interest Rate Targeting

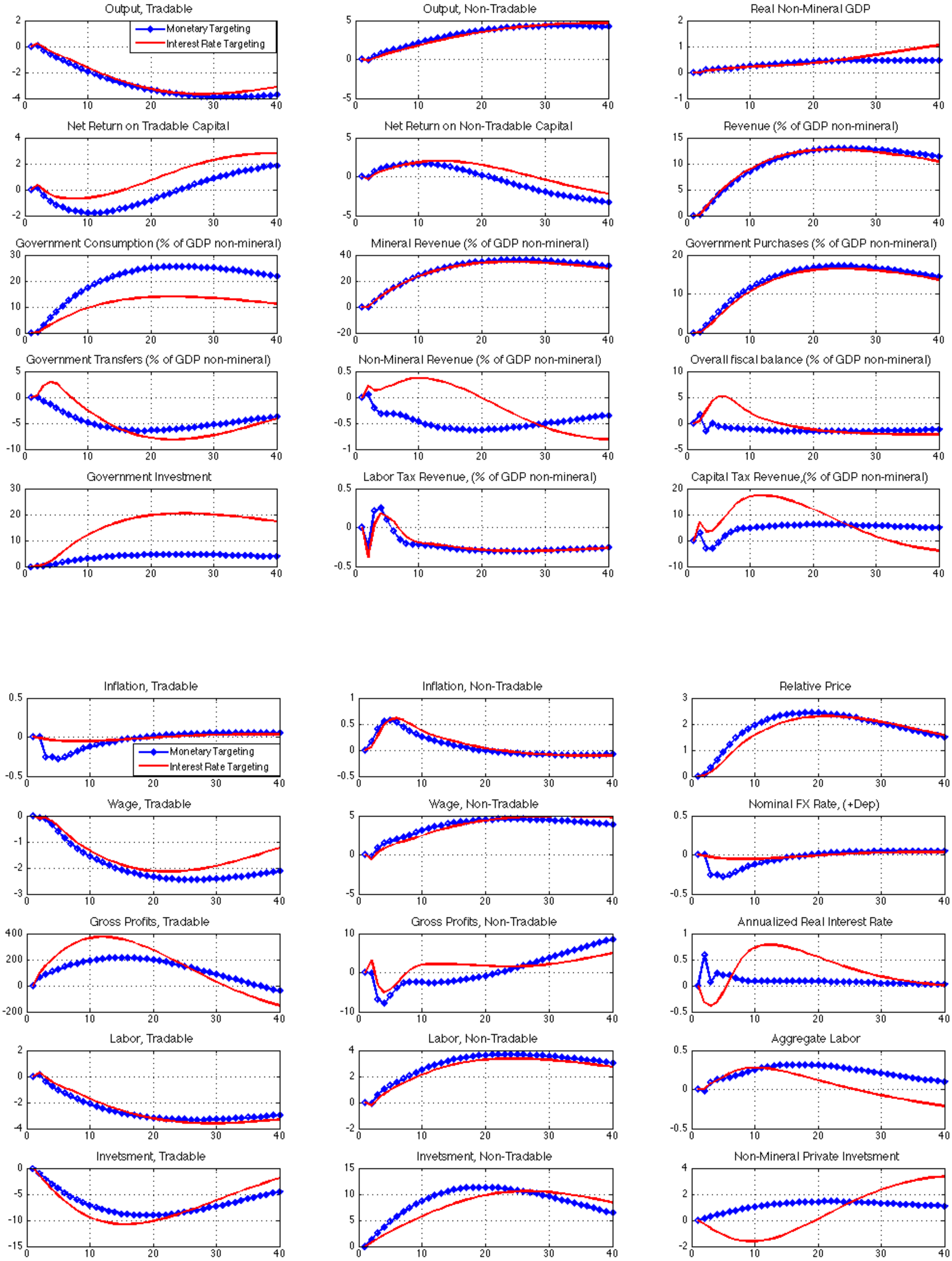


Figure 10.6 Flexible and Fixed FX Regime