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OIL WEALTH AND POTENTIAL DUTCH DISEASE EFFECTS IN UGANDA

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ABSTRACT

Based on the hypothesis that different spending options from oil inflows are likely to generate different Dutch disease effects, this study employs a dynamic Computable General Equilibrium Model to investigate how different spending option targeted at particular sectors affect the competitiveness of traded goods sector in Uganda. The results suggest that there would indeed be winners and losers under these various scenarios depending on what the additional resources of oil are used for. As expected, increased oil resources would lead to significant appreciation of the currency in all scenarios. Also, as the theory predicts, we find that the demand for non-tradables (mainly the services sector) increases. However, for simulations where oil resources are used for productive activities, we find that the losses in competitiveness would be compensated for by growth in other sectors. For instance, directly investing in agriculture where the bulk of the population is employed, would lead to significant productivity gains in the sector resulting into significant poverty reduction for the rural poor. Likewise, using oil revenues to boost spending on education and health, would increase labour productivity of both the urban and rural population leading to both short and long-term growth. While investment in infrastructure could reinforce the Dutch disease effects given its strong effects on the appreciation of the exchange rate and the implications for higher demand for non-tradables, this is compensated for by the positive externalities generated for other sectors by having better public goods.

Key words

Oil wealth; Dutch disease effects; tradable goods; poverty; Computable General Equilibrium Model (CGE); policy making; spending and absorbing increased foreign exchange earnings; non-productive sectors; productive sectors; agriculture; industry; services; competitiveness.

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1. INTRODUCTION

The recent discoveries of oil and gas deposits in Uganda present new opportunities through access to energy and increased oil revenues that can be used to chart a sustainable growth path that does not only create economic growth but also results in economic development whereby growth is fairly well distributed to facilitate poverty reduction. However, these discoveries come in the midst of serious concerns and controversies that have characterized the empirical relationship between oil rents and development, particularly in the oil exporting African countries. The disappointing development performance of many resource-rich economies has been a topical issue among policy makers, NGOs, civil society and academicians. Many countries have failed to leverage their natural resource wealth into strong states. For some of these countries, oil, gas, and mineral wealth have become associated with high poverty rates, weak state institutions, corruption, and conflict (Warner 1995; Sala-i-Martin and Subramanian 2003; Bannon and Collier 2003; Collier and O'Connell 2004). Thus, natural resource discoveries in Africa have been associated with the `resource curse syndrome'.

One concern that has triggered a substantial amount of theoretical and empirical debate is the Dutch disease effect of natural resource abundance. This phenomenon describes the situation whereby the additional revenues from the natural resources put pressure on demand for domestic goods and services in a way that consequently raises the value of the local currency (real exchange rate appreciation) and makes tradable goods uncompetitive. Even though quite an extensive literature already exists on the Dutch disease effects of different financial foreign inflows, the empirical evidence has not been conclusive. While Sachs and Warner (1999, 2001) find that countries with high resource-exports-to-GDP ratios experience lower growth rates, other research shows that resource abundance has a neutral or even positive effect on growth (Davis 1995; Lederman and Maloney 2003). An IMF (2005) study reported on the absence of Dutch disease effects in five countries (Ghana, Ethiopia, Mozambique, Tanzania and Uganda) although they 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. This corroborates a similar work by Li and Rowe (2006) which confirms a strong negative and significant relationship between aid inflows into Tanzania and real effective exchange rate (REER). Other studies like Ogun (1995),Nyoni (1998), Sackey (2001) and Ouattara and Strobl (2004) also found similar results whereby aid inflows were associated with real exchange rate depreciation, all of which contradict the predictions of the Dutch disease model.

On the contrary, a number of other studies have shown that additional foreign inflows have been associated with real exchange rate appreciations. For instance, a panel study of 62 developing countries by Elbadawi (1999) and in-country analysis by Oomes and Kalcheva (2007) for Russia, Lartey (2008) for Philippines all found Dutch disease effects. Dutch disease effects on competitiveness have also been documented. It is clear from the ambiguity of the empirical results that the seriousness of the existence of any such Dutch disease depends on the particular circumstances in the country. Uganda faces similar economic management challenge following the discovery of oil and gas in commercial quantities. One of the challenges is finding ways of spending and absorbing increased foreign exchange earnings while mitigating the likely adverse effect on the economy. Within the context of the Uganda, about 30 percent of the budget is financed by aid (Uganda Budget, 2008/2009). A number of people have studied the Dutch Disease effects in Uganda (see for example, Adam and Bevan 2003; Nkusu 2004;Atingi-Ego 2005; World Bank 2007) but none of them have looked in detail at the effect of increased oil resources on the economy. The question is whether there is any evidence that the additional oil revenues will have an impact on the competitiveness of exports in Uganda, on the backdrop of the different spending options especially for infrastructure as stipulated in the national development plans.

The specific objective of this study is to use the dynamic computable general equilibrium modelling framework to investigate how different spending options targeted at particular sectors affect the competitiveness of traded goods sector in Uganda. The model is based on the recent Social Accounting Matrix (SAM) for Uganda and the simulations are guided by the financing required to meet the aspirations stipulated within their National Development Plans. The key elements of the simulations and the extent to which the appreciation would hurt both economies would depend on the use of the oil resources, on which the different scenarios are developed. We specifically concentrate on the productive sectors that we consider to be tradable and are more likely to be harmed by increased oil resources- manufacturing and the agriculture, and social services sectors like education and health that may indirectly enhance productivity of the labour force. We also consider the effect of using oil resources for various public expenditure programs on the performance of these sectors and on the welfare of the population. The overarching motivation is to inform policy making in Uganda on ways to minimize any potential negative effect on the management of the economy, and on public spending in particular.

The rest of the paper is organized as follows: section two and three provide some stylized information on Ghana and Uganda. Section 2 compares and contrasts stylized facts in terms of growth performance, structural and political constraints while section 3 discuses the oil and gas industry in Uganda. The theoretical and empirical overview of the Dutch Disease literature is provided in section 4.

2. STYLIZED FACTS ON UGANDA

Uganda has a total area of 945,987 square kilometres and a population of 31.7 million. In 2010 Uganda's population growth rate was estimated at 3.3 percent per annum. About half of the population in Uganda is below the age of 15 years and the population structure is projected to remain youthful in the medium to long term. This poses a development challenge especially with respect to the usage of the existing resources for purposes of improving the welfare of the population. Uganda's life expectancy as of 2010 was estimated at 53 years. The country is endowed with a rich and varied natural resource base and is landlocked, located astride the equator and about 800 kilometres off the west coast of the Indian Ocean.

Uganda's market-friendly reforms started from 1987. The economy, though, small has sizeable foreign influence or domination with large overseas communities. Ugandans living in the Diasporas have proved willing and able to contribute through investments, remittances and other means to the economic transformation underway in the country. These factors have all facilitated the economic growth in Uganda beyond the possibilities open to many other developing countries, especially in sub-Saharan Africa.

Uganda's GDP growth has generally been high in recent years. On average, the economy grew at about 8 percent per annum during the period 2001/2-2008/9. Uganda's GDP growth declined from 11 percent in 2005/6 to about 7 percent in 2008/9 on account of adverse effects of the global financial crisis. A glance at inflation trends is more encouraging for Uganda since a low annual inflation in single digits from 1991 is maintained and the policy stance is to maintain a low and stable inflation in the long term. However, due to increased food prices during the second half of 2007/8 (mainly on account of higher demand for food within the region) and also due to the depreciation of the shilling during the same period, annual inflation increased from 7.4 percent in 2007/8 to 14.1 percent in 2008/9, which was far above the inflation target of 5 percent.

Although Uganda has, in recent years, recorded an impressive export diversification and significant increase in export earnings, about 70 percent of her exports are primary commodities. The traditional export in Uganda is mainly coffee whose share in total exports is declining. The economy remains vulnerable to external shocks generated from prices of primary commodities on the international market. Even though agriculture has remained the mainstay of Uganda's economy the services sector has, in recent years, recorded the largest share of national output at 51.5 percent. It also remains the fastest growing sector.

Like many other SSA countries, Uganda is facing many problems and constraints related to the economic reforms and increasing poverty. Since 1986, there have been considerable changes in the circumstances under economic management. In 1998, Uganda benefited from the Highly Indebted Poor Country (HIPC) debt relief, being among the 44 developing countries that benefited from the debt relief initiative. To qualify for entry into the international league table of HIPC, Uganda needed to demonstrate that her GDP per capita was below US$675 and that the country was experiencing difficulties in servicing the external debt. As of 1998, Uganda's GDP per capita fell below US$300 and the country could service the external debt only at the expense of social services.

Uganda's development agenda is currently being guided by a five-year National Development Plan (NDP) launched in April 2010. This plan marked the beginning of the rethinking the role of the state in Uganda's economic development process. Nonetheless, the private sector remains the key driver of Uganda's growth. Uganda still has a fragile democracy with competitive party politics reintroduced only in 2006. The country suffers from deep-rooted official corruption (according to Transparency International which names the judiciary and Police as some of the most corrupt institutions). The leadership of Uganda has consistently declared its commitment to fight official corruption.

A key message from the above overview indicates that Uganda has witnessed significant and steady growth in recent years, yet the growth is still too modest to enable the attainment of many of the other development goals. The diversification of exports that Uganda has witnessed dates only a few years back to about 2004. Thus, Uganda's export base is still fragile. Thus, the key issue is, whether the oil discovery in Uganda will adversely affect Uganda's export diversification drive through the dreaded Dutch disease.

3. THE OIL AND GAS INDUSTRY

This section reviews the oil and gas industry in Uganda. To the extent possible it describes the processes of oil exploration and estimates of the oil volumes as well as the institutional framework for oil development.

3.1 Exploration for Oil

Although oil exploration in Uganda dates back to the early 1920s with several shallow wells drilled by the Africa-European Investment Company between 1936 and 1956 in present day Buliisa district, serious oil exploration could not take off due to several constraints. The drilling that was carried out at that time revealed numerous shows and recovered free oil on test (Uganda Government) but with no confirmation about the existence of oil. After the drilling in Buliisa failed to produce confirmatory results about the existence of oil, the colonial government discontinued oil exploration in Uganda at that time mainly on account of i) a policy that prioritized agriculture over oil exploration for Uganda; and ii) the second World war, which turned the attention of the colonial government to more urgent security concerns. Oil exploration in Uganda was not taken very seriously until 1983/84 when a survey of minerals conducted at that time indicated that there was a possibility of the existence of hydrocarbons in some parts of Uganda. In preparation for further exploration for oil, Uganda enacted the Petroleum Exploration and Production Act of 1985, which was subsequently revised in 2000 to cater for emerging realities in the oil and gas sector.

With increased indications that oil was most likely to be found in the Albertine valley in 1989, Uganda licensed the entire valley covering about 20,000 square kilometres to Petrofina Oil and Gas Exploration Company. However, Petrofina's oil and gas exploration license expired in 1993 without any work done. The departure of Petrofina is partly attributed to the insecurity in Uganda at that time as well as the expiry of the exploration agreement, which contained a work plan that the company failed to follow. In 1993 Uganda put in place the Petroleum Regulations (Exploration and Production) on the conduct of oil exploration operations by foreign companies. This defined how oil exploration companies and Government would relate in the advancement of oil exploration in Uganda. The departure of Petrofina also provided an opportunity to Uganda to lease out smaller areas and also increase the competition by attracting more foreign companies to explore for oil and gas.

By 2009 the Albertine valley was divided into nine exploration areas whose size ranged between 1,000 and about 6,000 square kilometres. Out of the nine exploration areas five were licensed out to foreign companies for exploration of oil and gas by 2009; four exploration areas were yet to be licensed out. The foreign companies have, over time, conducted more seismic surveys and drilling. The existence of oil was confirmed in 2006 when Heritage oil sunk

Kingfisher 1 well in block 3A and discovered oil. Since then, more wells have been suck and by April 2010 the companies had drilled 36 wells in search of oil and gas. Out of the 36 wells drilled, 33 were successful cases, and it was by this time established that Uganda's oil reserves existed in commercial quantities.

The initial phase of oil development in Uganda focused on establishing the existence of the resource. According to the Petroleum Exploration Department of the Ministry of Energy, 30 to 40 percent of the Albertine valley had been explored by April 2010. The quantity of oil reserves underground discovered by then was estimated at 2 billion barrels of oil, translating to 100,000 to 300,000 barrels of oil per day (Uganda Government, YY) and could rise with more discoveries being expected, following the ongoing exploration for oil and gas.

3.2 Institutional Framework for Oil Development in Uganda and Ghana

The confirmation of the existence of oil in Uganda in 2006 called for development of a supportive legal framework for the oil and gas industry that ensures the development of the oil and gas industry and good utilization of oil revenues. Accordingly, Uganda enacted The Petroleum Exploration Act 1985 (revised in 2000). Under this law, Government grants exclusive rights for exploring and producing petroleum in any licensed area. The size and location of the acreage to be included in a Petroleum Sharing Agreement (PSA) is settled through negotiation. Petroleum exploration and production activities in Uganda are carried out in accordance with the laws of Uganda as reported by the Commissioner of Petroleum Exploration.

Following the confirmation of the existence of oil, Uganda finalized the National Oil and Gas Policy in 2008. However, the law under which the policy would be operationalized is, by 2010, yet to be passed. In this respect there are on-going debates and consultations within Government.However, there are concerns that the law is taking too long to be enacted. Government had earlier mooted an Early Production Scheme (EPS) for oil which would have seen Uganda begin to produce oil by the end of 2009. While the EPS was suspended for some different reasons, there were public concerns that the scheme was being scheduled to become operational without an appropriate law to guide oil production and the utilization of oil revenues. These concerns are yet to be fully provided for within the institutional framework. However, the Government has pronounced itself on how oil revenues will be utilized – mainly on infrastructure development to increase the productive potential of the economy and turn the finite oil resource into an infinite resource that could generate sustainable economic growth. There is also a debate on how Uganda should utilize her oil revenues to avoid the Dutch disease effects which would otherwise see the country's export-base shrink perhaps to one commodity – oil. The Government has also pronounced itself on the manner in which it would manage the oil revenues first by creating an oil fund, and second by carefully drawing on the oil fund to finance the productive sectors of the economy. Uganda's central bank is expected to manage the oil fund in a manner similar to the way in which Uganda's foreign reserves are managed.

Nonetheless, the government pronouncements on oil that are not guided by a legal and institutional framework (law) for oil management are causing anxiety among some sections of the population, referring to the dangers that could arise from such oil as 'the oil curse'. Some commentators have pointed to Uganda's failure to sign on the Extractive Industry Transparency Initiative (EITI) as a sign that all is not well for Uganda with regard to the oil exploration, development and utilization of oil revenues. Furthermore, the Production Sharing Agreements (PSAs) which Uganda is reluctant to disclose even to the Members of Parliament are also a concern to a wide section of the Ugandan population. However, officials of the Oil Exploration Department of the Ministry of the Energy in Uganda say that apart from the institutional weaknesses with regard to information dissemination, which was not a priority during the exploration phase, there are no hidden motives and that everything, in the development of the oil industry, has been done technically well and in the interest of developing the oil and gas industry.

Uganda faces new economic management challenge following the discovery of oil and gas in commercial quantities. One of the challenges is finding ways of spending and absorbing the increased foreign exchange earnings while mitigating the likely adverse effect on the economy. The section below draws lessons from elsewhere to inform the study on how Uganda could mitigate the Dutch disease effects.

4. LITERATURE REVIEW

After discovering oil in Uganda it is expected that the resource will bring improvements in the people's welfare through increased economic growth. However, the literature on Dutch disease warns us that the expected changes in a country's structure of production after a favourable shock such as a large discovery of oil could deny benefits to the economic agents that are engaged in the tradable sector (Christine 2003).

The Dutch disease is primarily associated with a natural resource discovery, but it can result from any large increase in foreign currency, including foreign direct investment, foreign aid or a substantial increase in the natural resource prices. The term was coined to describe the adverse impact on the economy of the Netherlands in the 1960s following the discovery of natural gas in the North Sea. It so happened that the new found wealth caused the Dutch Guilder to rise, causing the exports of all non-oil products to become less competitive on the world market and eventually resulting in a decline in the manufacturing sector. In the 1970s, the same economic condition occurred in Great Britain, when the price of oil quadrupled and whereby it became economically viable to drill for North Sea Oil off the coast of Scotland. By the late 1970s, Britain had become a net exporter of oil; it had previously been a net importer. The Pound soared in value, but the country fell into recession when British workers demanded higher wages and exports became uncompetitive. Nigeria and other oil exporters also suffered catastrophically from Dutch Disease in the 1970s when the oil prices boomed (resulting in a severe contraction in Nigeria's agriculture, a highly tradable sector).

The theory of Dutch disease is that an increase in revenues from oil will adversely affect the tradables (manufacturing and agriculture) of a nation's economy by appreciating the local currency, which in turn makes manufacturing and agriculture less competitive. According to Corden and Neary (1982) in their analysis of the Dutch disease, the economy can be divided into three sectors: the natural resource sector (in this case oil), the non-resource tradable sector (in this case agriculture and manufacturing), and the non-tradables sector (which includes the non-tradable services and construction). The real exchange rate is defined as the price of non-tradables (set in the domestic economy) relative to the price of tradables (set in the world market). The Dutch disease broadly has two transmission channels: the spending effect on the one hand, and the resource movement effect on the other.

The spending effect: This comes into play when increased income from the booming natural resource sector stimulates demand and spending by the private and public sectors, leading to higher prices and output in the non-tradables sector (non-tradable services and construction). However, for the non-natural resource tradables sector (manufacturing and agriculture), prices are fixed at international levels and profits are squeezed by rising economy-wide wages, which in renderstradables less competitive in international markets. Increased demand is increasingly met out of rising imports as imports become cheaper.

The resource movement effect: This takes place when the boom in the natural resource sector (oil) and the non-tradable sector (non-tradable services and construction) attract capital and labour away from other parts of the economy. Output declines in the tradables sector, where prices are fixed at world market levels. Since the natural resources sector (oil) can only absorb a small proportion of the labour force, the biggest proportion of the labour force seeks employment in the non-tradables sector.

Both the spending and resource movement effects result in a fall in the output share of non-natural resource tradables (agriculture and manufacturing) relative to non-tradables. Consequently, countries that suffer from Dutch disease are expected to experience some or the entire following phenomenon:

i. A decrease in the price of imports and subsequent increase in demand for imported goods and services;
ii. A rise in the prices of non-tradables (services and construction) due to increased demand and subsequent resource movement into those sectors (labour and capital); and consequently more production of non-tradables at the expense of tradables;
iii. Disincentive to invest in tradables (agriculture and manufacturing);
iv. Export concentration - production of tradables (agriculture and manufacturing) suffer and could get wiped out due to absence of competitiveness; Jobs in manufacturing sector move to lower-cost countries;
v. Mixed welfare outcomes especially for people that were originally engaged in production of tradables; and
vi. Mixed growth outcomes.

Typically, the start of the Dutch Disease Effect is characterized by a surge in foreign exchange sales due to a substantial increase in capital inflows, which by definition also implies a rise in the TOT. The additional foreign currency is converted into domestic income, which results in an increase in the exchange rate (the exchange rate effect). The extra income drives demand for domestic and imported products (the spending effect) and the increase in the exchange rate reduce the price received from all internationally traded commodities. This becomes a disadvantage to the export and import competing sectors which contract while capital and labour are drawn to the booming non-tradable and domestic sectors (the resource movement effect).

Alternative views about the Dutch disease phenomenon point to assumptions which may not hold and therefore negate the likelihood of the possible adverse effects of increased capital inflows. The Dutch disease phenomenon assumes that the beneficiary countries have no idle productive capacity or are operating on their production frontiers yet most developing countries do have excess capacity, which would increase the spending and absorptive capacity of more resources without Dutch disease (McKinley 2005). The phenomenon also presumes that all foreign currency inflows are not entirely used to purchase imports instead of domestic goods and there is also a perfectly elastic demand for tradable goods. Clearly, the Dutch disease effects may be muted or lessened with a variation or relaxation of any of these underlying assumptions. For example, the impact of the Dutch disease could be non-existent if the foreign exchange inflows are used to induce a rapid supply-side response in the economy that more than offsets the demand response (Li and Rowe, 2006). The Government could directly use its new stock of foreign currency to purchase imports instead of domestic goods and as such minimize the potential for inflation or better still, enhance this option by importing capital goods, which would raise domestic productivity (McKinley, 2005).

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 (2006) 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 out 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 1 percentage point increase in the ratio of aid to GDP is roughly associated with a 4 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 Prahtiet al. (2003) shows that a doubling of aid might lead to an appreciation of the real exchange rate of 4 percent in the short term and up to 30 percent over a decade. Other economists like Adam (2005), Gupta et al. (2006) find no strong relationship between the amount of aid a country receives and its real exchange rate.

Adam and Bevan (2006) analysed possible short and medium term responses to alternative aid-financed public expenditure programs in Uganda. The simulations conducted showed that public infrastructure augments the productivity of private factors and that there are potentially large medium-term gains from aid funded increases in public investment, despite the presence of some short-run Dutch disease effects. A similar result was obtained in the work by Lofgren and Diaz-Bonilla (2005) on Ethiopia which particularly focused on aid-financed investments in human capital, specifically through public expenditure on health and education. This paper is fundamentally similar in spirit and conception to these Computable General Equilibrium (CGE)-based simulation models described above but applied to reflect a number of important features of today's Ugandan economy.

Another strand of the literature argues that whether or not the Dutch disease phenomenon poses a threat depends on what the inflows are used for. If it finances infrastructure construction, and if this is the right kind of infrastructure, then these inflows will have a supply-expanding effect. This could be of sufficient scale to offset any Dutch Disease effect (or the latter might be evident for a while until the infrastructure is built and then productivity effect begins to manifest (Adam and Bevan 2006). Hence, the Dutch disease effects may be overturned if there are productivity spillovers in both tradable and non-tradable sectors. Thus, Adam and Bevan (2006) in the process of analyzing the possible short and medium term responses to alternative aid-financed public expenditure programs in Uganda, found out that public infrastructure augments the productivity of private factors and that there are potentially large medium-term gains from aid funded public investment, despite the presence of some short-run Dutch disease effects. A similar result was obtained in the work by Lofgren and Diaz-Bonilla (2005) on Ethiopia which particularly focused on aid-financed investments in human capital, specifically through public expenditure on health and education.

Chatterjee et al. (2000) analyze the impact of aid tied to public investment in infrastructure on private capital formation and growth and show that the effects of such transfers on growth depend on the initial stock of public capital. Agenoret al. (2006) analyse the link between foreign aid, the level and composition of public investment, growth and poverty reduction for Ethiopia and provide results that are consistent with Nkusu (2004) which emphasises that in assessing the scope for Dutch disease effects associated with foreign aid, the possibility of a rapid supply response should not be discarded on a dogmatic basis. Under a flexible exchange rate regime, substitution effects between aid and debt-creating capital flows may have a large impact on the behaviour of the nominal exchange rate and thus on the magnitude of the real appreciation associated with increases in foreign assistance. Clemens and Redelet (2003) found out that particular types of aid, termed 'short-impact aid' (which includes budget support, investments in infrastructure and aid to productive sectors), have a much stronger impact on growth than aid taken as a whole.

In a related study, Levy (2007) looks at the impact of using Chad's annual revenue for public investment, particularly in the development of road and irrigation infrastructure and conclude that each of these investment improve productivity and capital stock and present particular advantages in terms of growth and household welfare. Similarly, Bourguinon and Sundberg (2007) based on a MAMS model calibrated using data from Ethiopian concluded, among other things, that the impact of large aid inflows or the Dutch disease effects can be serious but that strategic investments to boost productivity and to address trade constraints are important in addressing the adverse effects.

On the one hand, Younger (1992), in his work on aid and the Dutch disease, draws attention to the macroeconomic problems confronting the Ghanaian authorities as a result of massive aid inflows. On the other hand, Jebuni et al. (1991) observed that in Ghana, liberalization with a real depreciation of the exchange rate was more prone to resulting into an improved export performance. Asea and Reinhart (1996) found that the failure to deal appropriately with the heavy capital inflows could derail the significant structural reform programme that had been undertaken. In a related study, Sackey (2004) estimated an empirical model on Ghana's real exchange rate with special focus on foreign aid. The results showed that although aid dependence is quite high, aid inflows lead to depreciations in the real exchange rate. Aid inflows were also found to have had a positive impact on export performance. Simulations run over the period 2009-2029 with a CGE model by the World Bank (2009) also show that Ghana's long-term growth trajectory would shift down in comparison to a non-oil scenario. The long term per capita income growth rate would decelerate to 2.4 percent and by 2029 real per capita incomes would be 14 percent lower.

The paper by Bohme et al. (2010) investigates the effects of oil-financed public investment on poverty using a dynamic multi-sectoral general equilibrium model featuring inter-temporal productivity spillovers. The results bear out the expectation that a surge of oil revenues leads to a real appreciation, distorting incentives which favour non-tradable activities over export agriculture and manufacturing, thereby increasing rural and national poverty.

As argued above, policymakers can use fiscal policy to mitigate the adverse effects of the Dutch disease depending on whether the foreign exchange inflows are perceived to be temporary or permanent (Christine 2003). In case foreign exchange inflows are expected to be depleted fairly rapidly (e.g. aid flows to be temporary), it would be appropriate for policy makers to protect the vulnerable sectors - possibly through foreign exchange intervention. The sale of domestic currency in exchange for foreign currency—that is, the buildup of official foreign exchange reserves - tends to keep the foreign exchange value of the domestic currency lower than it would otherwise be, helping to insulate the economy from the short-run disturbances of Dutch disease that will soon be reversed (Christine 2003). However, there will still remain the challenge of ensuring that that the buildup of reserves does not lead to inflation and that the country's additional wealth is spent wisely and managed transparently; a central bank account or a trust fund is one of the usually recommended option (Christine 2003).

In situations whereby the newfound wealth is likely to be permanent or lasting a long period of time (oil discoveries fall in this category), policymakers need to manage the inevitable structural changes in the economy so as to ensure economic stability. They may want to take steps to boost productivity in the non-traded goods sector (possibly through privatization and restructuring) and invest in worker retraining. They may also want to continue to diversify exports to reduce dependency on the booming sector and make them less vulnerable to external shocks, such as a sudden drop in commodity prices.

5. METHODOLOGY

It has been argued that discoveries of significant oil resources could lead to an appreciation of the currency and reduction in other exports. With a reduction in exports, this could lead to lower growth both in the short- and long-term and probably hurt producers involved in the tradable sectors. The question is whether there is any evidence that the additional oil revenues will have an impact on the competitiveness of exports in Uganda, on the backdrop of the required financing especially for infrastructure as stipulated in the recently concluded NDP.

In order to assess the implications of oil discoveries on other sectors through changes in the appreciation of the currency, we use a dynamic Computable General Equilibrium Modal based on the Social Accounting Matrix (SAM) for Uganda. The simulations are guided by the financing required to meet the aspirations stipulated within the National Development Plan. The key elements of the simulations and the extent to which the appreciation would hurt the Ugandan economy would depend on the use of the oil resources, on which the different scenarios are developed.

5.1 Description of the Uganda Social Accounting Matrix (SAM) for 2007

A Social Accounting Matrix (SAM) is a table which summarizes the economic activities of all agents in the economy. These agents typically include households, enterprises, government, and the rest of the world (ROW). The relationships included in the SAM include purchase of inputs (goods and services, imports, labour, land, capital etc.); production of commodities; payment of wages, interest rent and taxes; and savings and investment. Like other conventional SAMs, the Uganda SAM is based on a block of production activities, involving factors of production, households, government, stocks and the rest of the world.

The Uganda SAM is a 120 by 120 matrix. The various commodities (domestic production) supplied are purchased and used by households for final consumption (42 per cent of the total), but also a considerable proportion (34 per cent) is demanded and used by producers as intermediate inputs. Only 7 percent of the domestic production is exported, while 11 per cent is used for investment and stocks and the remaining 7 percent is used by government for final consumption. Households derive 64 per cent of their income from factor income payments, while the rest accrues from government, inter-household transfers, corporations and the rest of the world. The government earns 32 percent of its income from import tariffs – a relatively high proportion, but a characteristic typical of developing countries. It derives 42 percent of its income from the ROW, which includes international aid and interest. The remainder of government’s income is derived from taxes on products (14 percent), income taxes paid by households (6 percent) and corporate taxes (5 percent).

Investment finance is sourced more or less equally from government (26 per cent), domestic producers (27 per cent) and households (26 per cent), with enterprises providing only 21 per cent. Imports of goods and services account for 87 percent of the total expenditure to the Rest of the World (ROW). The rest is paid to ROW by domestic household sectors in form of remittances; wage labour from domestic production activity; domestic corporations payments of dividends; income transfers paid by government; and net lending and external debt related payments.

The extent of household disaggregation is very important for policy analysis, and involves representative household groups as opposed to individual households. Pyatt and Thorbecke (1976) argue persuasively in favour of a household disaggregation that minimizes within-group heterogeneity. This is achieved in the Uganda SAM through the disaggregating of households by rural and urban, and whether households are involved in farming or non farming activities. The Uganda SAM identifies three labour categories disaggregated by skilled, unskilled and self employed. Land and capital are distributed accordingly to the various household groups.

5.2 Salient Features of the CGE Model

The CGE model used in the present study is based on a standard CGE model developed by Lofgren et al. (2002). This is a real model without the financial or banking system (See Table A1). It cannot be used to forecast inflation. The CGE model is calibrated to the 2007 SAM. GAMS software is used to calibrate the model and perform the simulations.

5.3.1 Productions and commodities

For all activities, the producers maximize profits given their technology and the prices of inputs and output. The production technology is a two-step nested structure. At the bottom level, primary inputs are combined to produce value-added using a CES (Constant Elasticity of Substitution) function. At the top level, aggregated value added is then combined with intermediate input within a fixed coefficient (Leontief) function to give the output. The profit maximization gives the demand for intermediate goods, labour and capital. The detailed disaggregation of the production activities captures the changing structure of growth.

The allocation of domestic output between exports and domestic sales is determined using the assumption that domestic producers maximize profits subject to imperfect transformability between these two alternatives. The production possibility frontier of the economy is defined by a Constant Elasticity of Transformation (CET) function between domestic supply and export.

On the demand side, a composite commodity is made up of domestic demand and final imports and is consumed by households, enterprises, and government. The Armington assumption is used here to distinguish between domestically produced goods and imports. For each good, the model assumes imperfect substitutability (CES function) between imports and the corresponding composite domestic goods. The parameter for CET and CES elasticity used to calibrate the functions used in the CGE model are exogenously determined.

5.2.2 Factor of production

There are 6 primary inputs: 3 labour types, capital, cattle and land. Wages and returns to capital are assumed to adjust so as to clear all the factor markets. Unskilled and self-employed labour is mobile across sectors while capital is assumed to be sector-specific.

5.2.3 Institutions

There are three institutions in the model: households, enterprises and government. Households receive their income from primary factor payments. They also receive transfers from government and the rest of the world. Households pay income taxes and these are proportional to their incomes. Savings and total consumption are assumed to be a fixed proportion of household's disposable income (income after income taxes). Consumption demand is determined by a Linear Expenditure System (LES) function. Firms receive their income from remuneration of capital; transfers from government and the rest of the world; and net capital transfers from households. Firms pay corporate tax to government and these are proportional to their incomes.

Government revenue is composed of direct taxes collected from households and firms, indirect taxes on domestic activities, domestic value added tax, tariff revenue on imports, factor income to the government, and transfers from the rest of the world. The government also saves and consumes.

5.2.4 Macro closure

Equilibrium in a CGE model is captured by a set of macro closures in a model. Apart from the supply-demand balances in product and factor markets, three macroeconomic balances are specified in the model: (i) fiscal balance, (ii) the external trade balance, and (iii) savings-investment balance. In terms of fiscal balance, government savings are assumed to adjust to equate the difference between government revenue and spending. In terms of external balance, foreign savings are fixed with exchange rate adjustment to clear foreign exchange markets. In relation to the savings-investment balance, the model assumes that savings are investment driven and adjust through flexible saving rate for firms. Thealternative closures, described later, are used in a subset of the model simulations.

5.2.5 Recursive Dynamics

To appropriately capture the dynamic aspects of oil resources on the economy, this model is extended by building some recursive dynamics by adopting the methodology used in previous studies on Botswana and South Africa (Thurlow 2007). The dynamics is captured by assuming that investments in the current period are used to build on the new capital stock for the next period. The new capital is allocated across sectors according to the profitability of the various sectors. The labour supply path under different policy scenarios is exogenously provided from a demographic model. The model is initially solved to replicate the SAM of 2007.

6. RESULTS

6.1 Baseline Scenario

The use of the baseline scenario is to provide a benchmark for the comparison of our simulations. This scenario assumes that business continues as usual with no oil discoveries. Under this scenario we assume that oil revenues will not be in existence. The treatment of oil revenues in our analysis assumes that this is an enclave sector and that the additional revenues generated are treated like grants donated from abroad. We assume that growth in Total Factor Productivity (TFP) for all sectors is about 1 percent and this generates about 6 percent for real GDP growth under the baseline. The simulation period is 2010-20, with the production targeted to start in 2013. The main results of the BASE scenario are summarized in Tables 2.

Table 1 provides the expected revenues from oil. We assume that the international price of the oil barrel would be about US 60-80 dollars. This would generate about US 50 billion dollars over the extraction period as projected by the oil companies involved in the exploration of oil. The total capacity of the basin is estimated at between 200,000-350,000 bpd which would make Uganda one of the top 50 producers. We assume that the oil production will start in 2013 and reach its peak in 2020. Thereafter, there would be no increase in revenues as a result of oil and rather it would be a gradual reduction as the available reserves will start declining. At the moment, the oil production agreements are not yet public and we ,therefore, assume that the government would share 40 percent of total production while the producers would take the other 60 percent. The revenues below do not take into account the corporate taxes that would be generated as a result of the production activities of the companies producing the oil. Also, the current capital gains taxes which are under dispute between Uganda Revenue Authority and the exploring companies are not considered. As shown below, the oil revenues projected to accrue to government are expected to be about one third of total revenues.

Table 1: Projections of Oil Production and Revenues

	2015	2020	2025	2030	2035	2040
Barrels per day (1000)	200	250	300	350	300	280
Barrels per year (365 days)	73,000	91,250	109,500	127,750	109,500	102,200
Oil Value (per day ,1000)						
US 80 dollars per barrel	16,000	20,000	24,000	28,000	24,000	22,400
US 60 dollars per barrel	12,000	15,000	18,000	21,000	18,000	16,800
Oil Value (per year, 1000)						
US 80 dollars per barrel	5,840,000	7,300,000	8,760,000	10,220,000	8,760,000	8,176,000
US 60 dollars per barrel	4,380,000	5,475,000	6,570,000	7,665,000	6,570,000	6,132,000
Government Revenue (per day,1000)						
US 80 dollars per barrel	6,400	8,000	9,600	11,200	9,600	8,960

US 60 dollars per barrel	4,800	6,000	7,200	8,400	7,200	6,720
Government Revenue (per year,1000)						
US 80 dollars per barrel	2,336,000	2,920,000	3,504,000	4,088,000	3,504,000	3,270,400
US 60 dollars per barrel	1,752,000	2,190,000	2,628,000	3,066,000	2,628,000	2,452,800

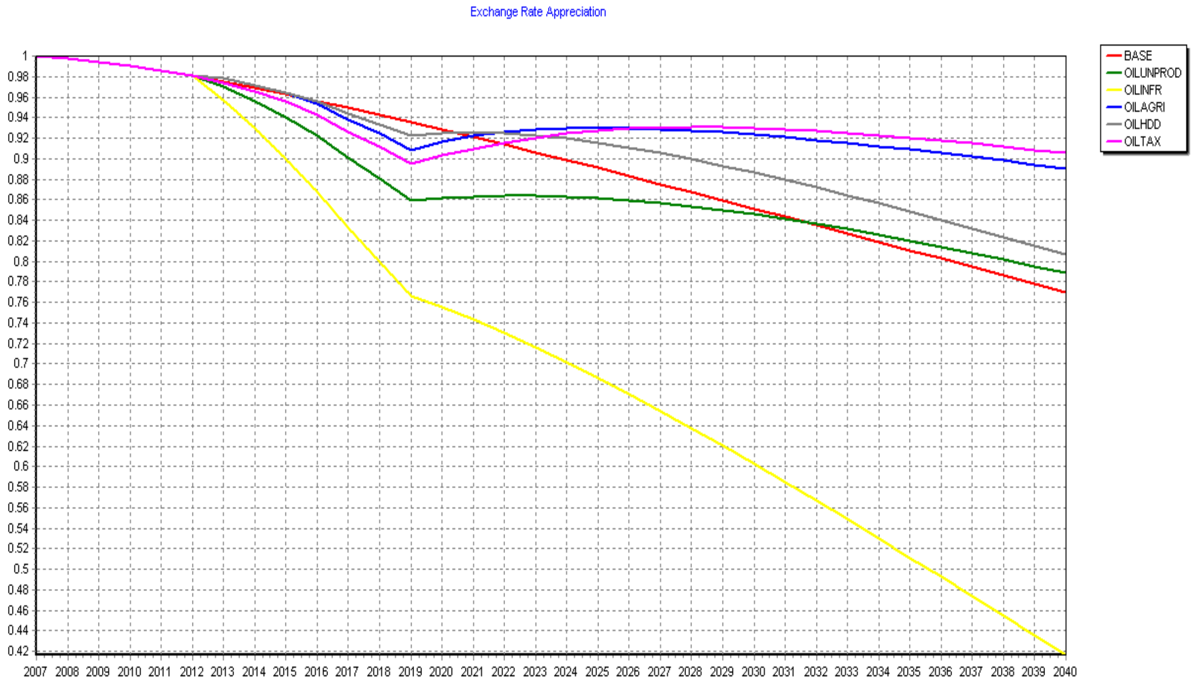
Notes: Government revenues are based on the assumption that the production sharing agreement is based on 40 percent for government and 60 percent for the companies extracting oil. Total value of the industry for the extraction period is estimated at US 50 billion dollars.

6.2 Increased oil revenues not used for any productive activity (OILUNPROD)

We first run a simulation whereby the increase in oil revenues is not being used for any productive activity. In this case, these revenues could be largely used, for example, to increase the size of government. The argument has always been that increased oil revenues would lead to increased demand and prices for non-tradables especially services. What this could imply is that jobs in the tradables sector would become less attractive and thereby lead to a reduction in the growth of these sectors.

From the results, we notice a considerable appreciation of the shilling when we assume that the additional oil revenues are going to be used on unproductive activities for the period 2010 to 2040. The effects of this surge in oil revenue flows are consistent with the Dutch-disease theory. Indeed what we find is increased growth in the services sector. Of particular concern is that the growth is mainly in the government services, particularly administration. Bevan (2005) notes that the public sector has a higher propensity to consume domestically produced goods and services than the private sector. On the contrary, private services contract over the years. In relation to agriculture, we note a significant reduction in production especially for the exportable commodities.

Fig. 1: Exchange Rate Appreciation (2007-2040)



All the traditional exports including cotton, coffee and tea reduce considerably. We also notice a resource shift towards production of non-exportable crops. This is consistent with what has happened in other resource rich countries where discoveries of oil have resulted into abandoning the agriculture sector.

There is still considerable uncertainty on the relationship between oil revenues and growth. For some countries, discoveries of oil have led to considerable growth while for others the oil sector has tended to replace other productive sectors hence leading to a reduction in growth. The overall impact of this scenario on growth is shown in Figure 1. On average, due to the loss in competitiveness of the exportable sector, the growth path as a result of oil revenues not being spent productively would be lower than the baseline where the country did not have any oil. Bleaney and Greenway (2001) suggest that an appreciation would hurt investment even though it lowers the price of imported capital goods because it reduces the returns to investment in the tradables sector.

Fig 2: Overall GDP Growth 2008-2040

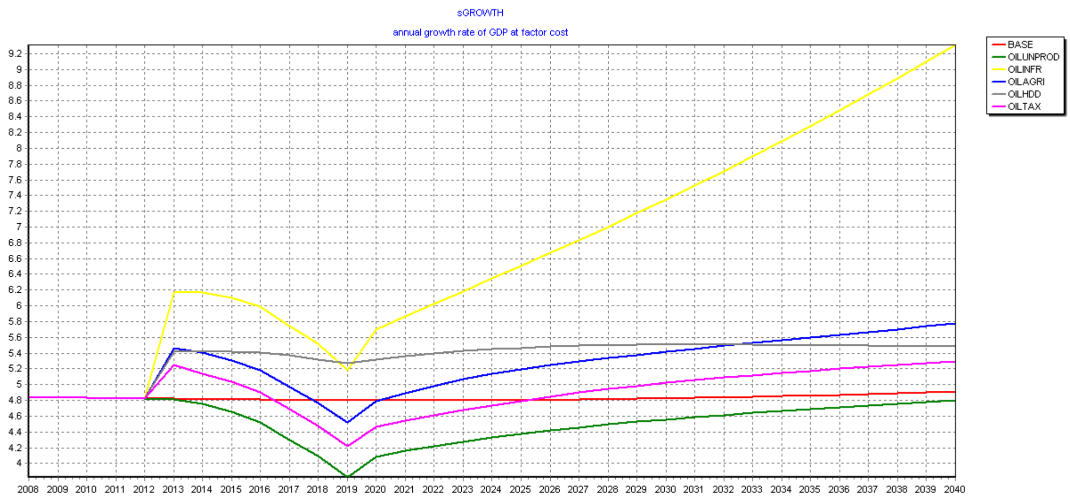


Fig 3: Agriculture Growth 2008-2040

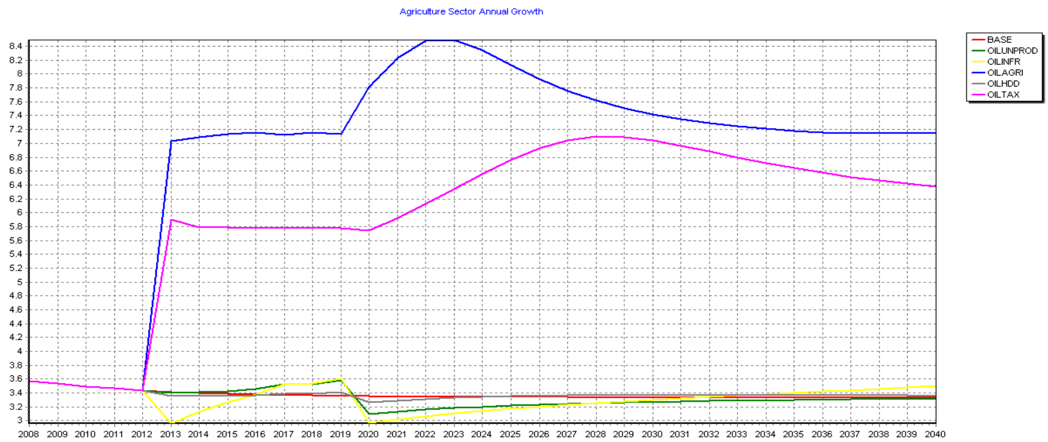


Fig 4: Manufacturing Growth 2008-2040

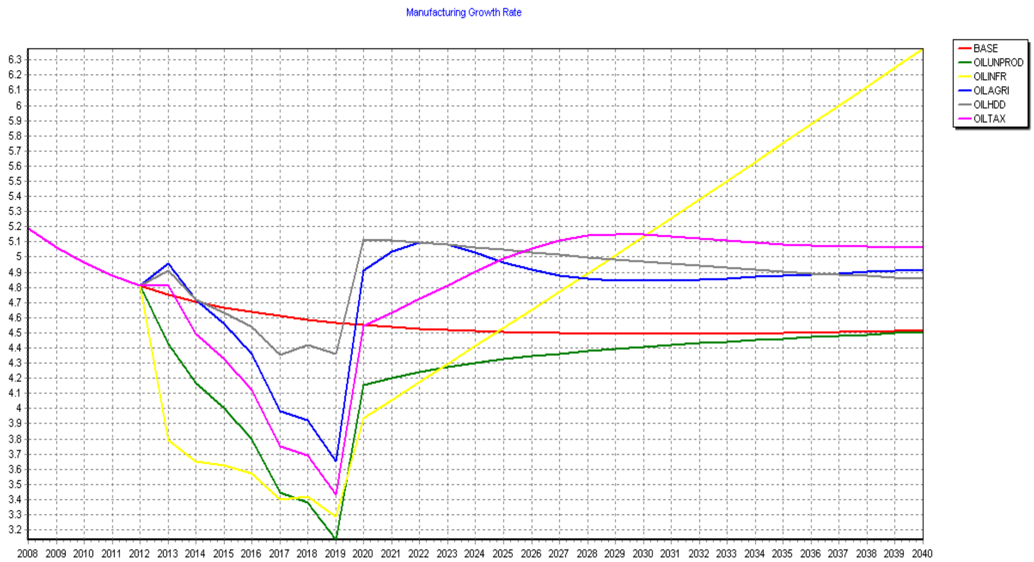
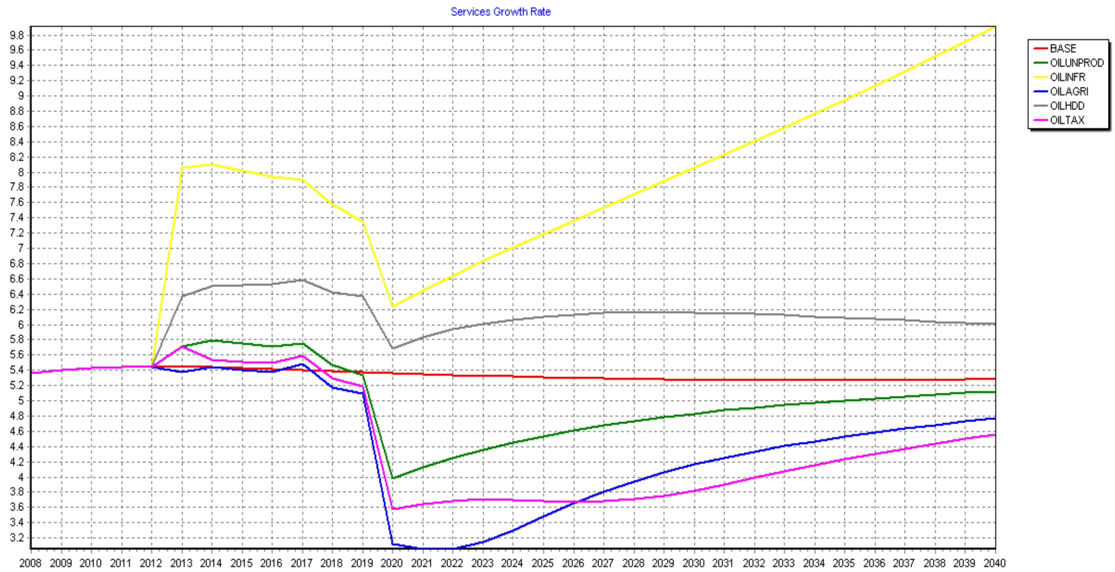


Fig 5: Services Sector Growth 2008-2040



The growth for the manufacturing sector is also reduced compared to the baseline where there are no oil revenues (Figure 3). Overall, the local manufacturing sector becomes less competitive as imports become a lot cheaper. The price rise in non-tradables especially the government sector attracts more resources into the production of non-tradables rather than tradables. Since the losses in the tradable sectors are compensated by the increase in the services sector, an argument could be made to the effect that increased oil resources may not be necessarily a bad thing. However, we note from the results that the net impact of oil resources on growth would be negative if they are used entirely on unproductive activities. In general, the government generally employs highly skilled labour for the oil sector. The increased demand for skilled labour which is not abundantly available results into a reduction in production in the manufacturing sector.

The growth of the services sector as shown in Figure 4 will be largely dominant during the period when the oil revenues will be expected in 2013 until when the oil production will reach its peak in 2020. The services sector would largely be growing at the expense of the industrial and agriculture sectors.

6.3 Oil resources and Increase in Infrastructure Spending (OILINF)

The effects of the oil resources depend on whether it is used to improve the productivity of the economy and to remove supply constraints. In this case we focus on a simulation where increased oil resources are spent on improving infrastructure, particularly roads and energy. The argument is that producers of tradables would then have access to markets and thereby mitigate the losses as a result of the appreciation due to the increased flows.

From the results we note that with higher spending on infrastructure, the losses due to the appreciation of the currency are reduced. As shown in figure 1, the appreciation effects of spending in terms of all the additional revenues on infrastructure are way much stronger than all the other simulations. However, the positive externalities that come with good public infrastructure would far outweigh the costs of appreciation of the currency especially in the long run. Under the current National Development Plan, the poor infrastructure has been identified as one of the binding constraints for growth in Uganda. If all the additional revenues are spent on infrastructure, the growth path generated would be far much higher than the baseline and all the other simulations for the period 2010-50. The growth path of agriculture and most manufacturing activities does not necessarily improve in the short-run for a simple reason that increased spending on infrastructure would attract even more resources away from the tradable sectors to the non-tradables.[1] However, the growth path of services also remains high the reason being that the large infrastructure projects are provided by the government. Hence, the overall increase in demand for non-tradables outweighs the losses incurred due to the un-competitiveness of the export sector. The earlier results by Adams and Bevan (2005) suggests that there may be a case for prioritizing scaled-up infrastructure investment sooner because it would yield a better supply response and offset some of the adverse macroeconomic consequences of increased resources. This is portrayed in the manufacturing sector whose growth rate would be higher than the baseline after 2020 when the infrastructure needs would be addressed. Indeed the focus of the NDP is to increase more spending on infrastructure if oil resources become available.

The argument could be made to the effect that when resources are shifted from tradable commodities to services, it may not particularly be a bad policy. However, a reduction in output for the tradables sectors also creates other economic problems. In the manufacturing sector whereby labour becomes too expensive due to its excessive demand in the services sector, the declines in production could cause people to lose their jobs and hence cause an increase in poverty.

Overall, albeit the appreciation of the currency, there are long-term benefit of investments financed by oil revenues – such as in infrastructure in the roads and energy sectors —which may improve productivity and growth in both the tradable and non-tradable sector. The overall effect on economic growth of a sustained increase in oil revenues and the corresponding possible contraction in tradables depends on the relative sizes of these two effects and what the oil is used for.

6.4 Oil resources Targeted to the Agriculture Sector (OILAGR)

The previous experiment clearly showed that if oil resources are utilized to improve the

[1] This is not to make an argument that increased spending on infrastructure is not good for other sectors. Improving the infrastructure has other social benefits beyond the macro-economic implications on other sectors.

infrastructure, it would lead to some gains and cause the mitigation of some of the negative effects associated with the Dutch-disease, especially in the long run. Since the bulk of the population is employed in the agricultural sector, one would want to know what would happen if most of the oil resources were used to unleash the binding constraints to agricultural productivity. We, therefore, run a simulation whereby the oil revenues are used to improve the productivity of the agricultural sector. In this case, oil resources would be used to provide, for example, fertilizers, extension services or better technologies that would result into higher yields in the sector.

This simulation shows that appropriateuse of oil resources to increase productivity in the agricultural sectorwould mitigate the adverse Dutch disease effects associated with the oil resources. The overall growth rate would be higher than the baseline. In relation to the exports, we note that they would be a lot higher than in the case whereby the oil resources were not spent productively. Given that a large part of the manufacturing sector is agro-processing, we also note that manufacturing would hardly be affected given its intermediary link with the more productive agricultural sector. The agro-processing sector would also grow in line with other agricultural activities.

Interestingly, the argument that resources would be shifted to the non-tradables like services would not hold in this case. Indeed, the growth rate of the services would be much more subdued during the period 2013-20. Given than the majority of the population which is poor is involved in agricultural activities, targeting the oil resources at the sector would also result into considerable reduction in poverty. The welfare of citizens increased through higher levels of consumption – and this is determined not only by what they produce themselves, but also by the additional consumption and investment that the oil revenue finances.

6.5 Oil resources and investment in human capital (OILHDD)

The alternative use of oil revenues is to invest it in human capital development. In this case the government would invest the bulk of the resources in health and education thereby enhancing the skills and productivity of workers. In this context we assume that the increased spending on human capital development would be reflected in the improved service delivery in the health and education sectors. In addition, we link the productivity of workers with the spending on health and education. Using oil resources to finance these activities could support the argument that oil revenues enhance the production of non-tradables and could therefore impact negatively on the growth of the country. However, increased social spending in health and education has other indirect benefits particularly the increased productivity of workers. Increased productivity compensates for all the related negative effects of increasing oil resources. As shown in the Figure 2, we note that the growth path generated would still be higher than the baseline or spending the additional revenues unproductively.

6.6 Oil resources and Reduction in direct taxes (OILTAX)

It can be argued that if there were substantial oil revenues flowing into the country, it could reduce the domestic revenue effort. To an extent, a reduction in the domestic taxes could lead to less distortion and could help spur economic growth. Furthermore, this could also lead the country to be so dependent on volatile oil revenues. In addition, a government that is not getting much revenue from its citizens is not accountable and this could also breed corruption (Bevan 2005).

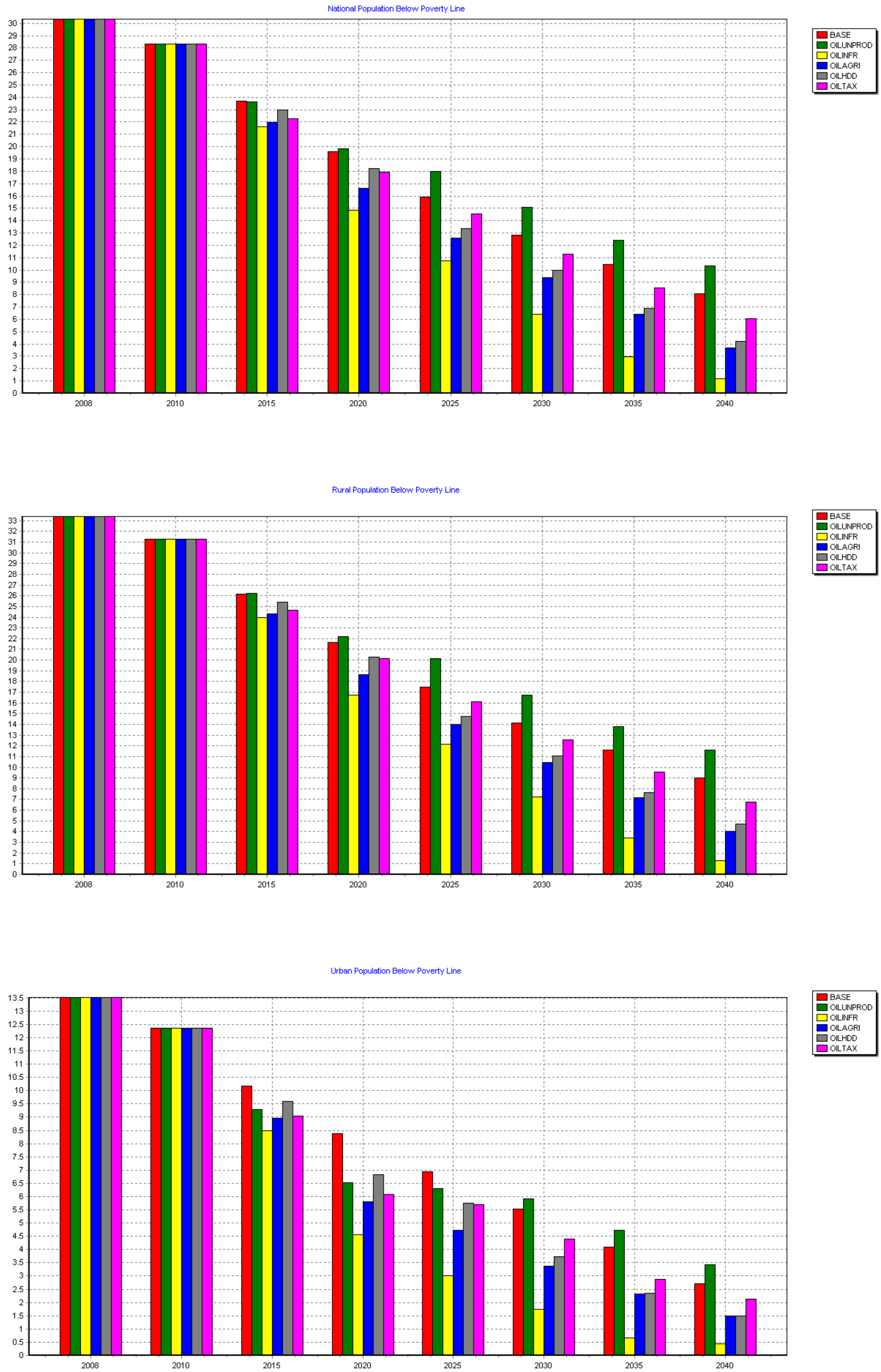
It can also be argued that if the increased oil resources were permanent, rather than improving on social services, the government could reward its citizens by reducing direct taxes. In this case, the oil revenues would be directly financing the consumption of the households. This could be an interesting preposition. However, it is difficult to argue in favour of this preposition given the very low tax effort for a country like Uganda. The current tax revenue effort has stagnated at 13 percent of GDP which is very low compared to over 18 percent for other countries in the region like Kenya and Tanzania. Notwithstanding, the reduction in direct taxes frees up resources available for households, resulting into increased savings and investments for the subsequent periods. The scenario generates the least growth next to the unproductive spending and it would be least preferred (Figure 1).

6.7 Who are the Winners and Losers?

The winners and losers depend so much on the activity a household is involved in. As argued above, it also depends on how the oil revenues are going to be utilized. In a scenario whereby oil resources are not productively utilized, the major winners are households involved in the services sector especially the public sector. This is demonstrated in the results where we have a surge in services provided by the public sector. The losers in this case are individuals who are involved in the exportable agricultural or manufactured commodities. Appreciation of the real exchange rate would have a negative impact on the rural households producing cash crops for export.

As shown in Figure 6, at the national level, poverty would reduce most when the resources are mainly spent on infrastructure. In the extreme case where resources are spent on unproductive activities, poverty at the national level would even be higher than if the country did not discover oil. This similar pattern is also portrayed for both the rural and urban households.

Fig 6: Poverty Indices under Various Scenarios



7. CONCLUSIONS AND POLICY IMPLICATIONS

Increased oil revenues could indeed hurt the economy if not managed well. The Dutch disease effects if oil revenues are spent on unproductive activities are also found to be real. In particular, we find a real exchange rate appreciation that, in turn, leads to a significant reduction in exports especially in the traditional exports. However, if oil resources are used on productive activities, we note that it could be reversed.

Increased spending on infrastructure leads to higher growth compared to a situation whereby the oil resources are not spent productively. However, this would still be accompanied by a significant reduction in the production of the tradables sectors. To mitigate this problem, the government could intervene directly by addressing some of the binding constraints to production of the tradables (agriculture and industry). While spending on infrastructure development is a good thing, if done in isolation without adequate spending on the tradables sector, this could adversely affect the employment and welfare of the people engaged in the tradables sector.

In particular, the tradables sector that would be affected most due to the Dutch disease effects of oil resources are the exportable commodities including the traditional crops and the manufacturing sector. The government could intervene by providing extension services and new technologies to the agricultural sector to enhance productivity of the sector. Likewise, if the government spent a significant proportion of its oil revenues on infrastructure, the productivity of workers would be greatly enhanced and this would result in more growth both in the short and long-term.

The Government should prioritize agriculture to keep food prices low, and wages competitive, both of which support industrial development. Neglecting agriculture and focusing directly on industrial development has major disadvantages including the likelihood that: i) industrialization will not take off partly because of the high wages and uncompetitive exchange rate; ii) poverty will increase due to the limited participation of peasants in the economic growth process; iii) the tradables sector will suffer due to the appreciation of the local currency and iv) the fastest growing non-tradables sector would absorb limited quantity of labour, which would increase poverty especially in economies with a large agriculture base.

Under all the explored scenarios, the effect of increased oil revenues on poverty depends so much on how the government uses the oil resources. The households would benefit the most if the bulk of the oil resources were used for infrastructure and agricultural development. This is partly because of positive externalities infrastructure and agriculture have with other sectors. However, not addressing the Dutch disease effects and their associated effects on exportable commodities could exacerbate poverty especially in the rural areas.

At the macroeconomic management level, the monetary authorities would need to depreciate the exchange rate through build-up of foreign reserves (i.e. in a market determined foreign exchange environment like in the case of Uganda). While theory teaches that increased liquidity in the economy arising from purchase of foreign exchange in a country's foreign exchange market could lead to increases in inflation, the increase in inflation is likely to be small or not at all if (and only if) public expenditure targets the productivity gains in agriculture and industry. Depreciating the exchange rate would support a wide range of export commodities (agricultural and manufactured goods) and reduce dependence on export of oil; failure to do so is likely to result into the wiping out of other export commodities.

Therefore, as far as Uganda is concerned, it will be important to continue to prioritize the stabilization of the economy while at the same time ensuring rural biased development that ensures participation of all economic agents (particularly the rural poor) in the growth process. It will be necessary for Uganda to identify crops that could be supported from production to market access to ensure stable producer prices of the selected agricultural commodities, which would stabilize the incomes of the poor people that are not engaged in agriculture. This would entail creating supportive public sector institutions that would ensure limited fluctuation of producer prices of selected commodities through, for example, the creation of agricultural stabilization funds.

With regard to industry, it is important for Uganda to remain an open economy, to make sufficient public investment in order to reduce the cost of doing business with a view of attracting selective Foreign Direct Investment (FDI) into the economies. An appreciating shilling would not be supportive of FDI and would spell disaster for the manufacturing sector. To the possible extent, Uganda should address local currency appreciation through, for example, depreciating the exchange rate and spending on imported inputs to enhance productivity.

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9. ANNEX TABLES:

Table A1. CGE model sets, parameters, and variables

Symbol	Explanation	Symbol	Explanation
Sets			
$a \in A$	Activities	$c \in CMN(\subset C)$	Commodities not in *CM*
$a \in ALEO(\subset A)$	Activities with a Leontief function at the top of the technology nest	$c \in CT(\subset C)$	Transaction service commodities
$c \in C$	Commodities	$c \in CX(\subset C)$	Commodities with domestic production
$c \in CD(\subset C)$	Commodities with domestic sales of domestic output	$f \in F$	Factors
$c \in CDN(\subset C)$	Commodities not in *CD*	$i \in INS$	Institutions (domestic and rest of world)
$c \in CE(\subset C)$	Exported commodities	$i \in INSD(\subset INS)$	Domestic institutions
$c \in CEN(\subset C)$	Commodities not in *CE*	$i \in INSDNG(\subset INSD)$	Domestic non-government institutions
$c \in CM(\subset C)$	Aggregate imported commodities	$h \in H(\subset INSDNG)$	Households
Parameters			
$cwts_c$	Weight of commodity c in the CPI	$qdst_c$	Quantity of stock change
$dwts_c$	Weight of commodity c in the producer price index	$\overline{qg}_c$	Base-year quantity of government demand
ica_{ca}	Quantity of c as intermediate input per unit of activity a	$\overline{qinv}_c$	Base-year quantity of private investment demand
$icd_{cc'}$	Quantity of commodity c as trade input per unit of c' produced and sold domestically	$shif_{if}$	Share for domestic institution i in income of factor f
$ice_{cc'}$	Quantity of commodity c as trade input per exported unit of c'	$shii_{ii'}$	Share of net income of i' to i (i' ∈ INSDNG'; i ∈ INSDNG)
$icm_{cc'}$	Quantity of commodity c as trade input per imported unit of c'	ta_a	Tax rate for activity a
$inta_a$	Quantity of aggregate intermediate input per activity unit	$\overline{tins}_i$	Exogenous direct tax rate for domestic institution i
iva_a	Quantity of aggregate intermediate input per activity unit	$tins01_i$	0-1 parameter with 1 for institutions with potentially flexed direct tax rates
$\overline{mps}_i$	Base savings rate for domestic institution i	tm_c	Import tariff rate
$mps01_i$	0-1 parameter with 1 for institutions with potentially flexed direct tax rates	tq_c	Rate of sales tax
pwe_c	Export price (foreign currency)	$trnsfr_{if}$	Transfer from factor f to institution i
pwm_c	Import price (foreign currency)		

Table A1 continued. CGE model sets, parameters, and variables

Symbol	Explanation	Symbol	Explanation
Greek Symbols			
α_a^a	Efficiency parameter in the CES activity function	δ_{cr}^t	CET function share parameter
α_a^{va}	Efficiency parameter in the CES value-added function	δ_{fa}^{va}	CES value-added function share parameter for factor *f* in activity *a*
α_c^{ac}	Shift parameter for domestic commodity aggregation function	γ_{ch}^m	Subsistence consumption of marketed commodity c for household h
α_c^q	Armington function shift parameter	θ_{ac}	Yield of output c per unit of activity a
α_c^t	CET function shift parameter	ρ_a^a	CES production function exponent
β^a	Capital sectoral mobility factor	ρ_a^{va}	CES value-added function exponent
β_{ch}^m	Marginal share of consumption spending on marketed commodity c for household h	ρ_c^{ac}	Domestic commodity aggregation function exponent
δ_a^a	CES activity function share parameter	ρ_c^q	Armington function exponent
δ_{ac}^{ac}	Share parameter for domestic commodity aggregation function	ρ_c^t	CET function exponent
δ_{cr}^q	Armington function share parameter	η_{fat}^a	Sector share of new capital
υ_f	Capital depreciation rate		
Exogenous Variables			
$\overline{CPI}$	Consumer price index	$\overline{MPSADJ}$	Savings rate scaling factor (= 0 for base)
$\overline{DTINS}$	Change in domestic institution tax share (= 0 for base; exogenous variable)	$\overline{QFS}_f$	Quantity supplied of factor
$\overline{FSAV}$	Foreign savings (FCU)	$\overline{TINSADJ}$	Direct tax scaling factor (= 0 for base; exogenous variable)
$\overline{GADJ}$	Government consumption adjustment factor	$\overline{WFDIST}_{fa}$	Wage distortion factor for factor f in activity a
$\overline{IADJ}$	Investment adjustment factor		
Endogenous Variables			
AWF_{ft}^a	Average capital rental rate in time period t	QG_c	Government consumption demand for commodity
$DMPS$	Change in domestic institution savings rates (= 0 for base; exogenous variable)	QH_{ch}	Quantity consumed of commodity c by household h
DPI	Producer price index for domestically marketed output	QHA_{ach}	Quantity of household home consumption of commodity c from activity a for household h
EG	Government expenditures	$QINTA_a$	Quantity of aggregate intermediate input
EH_h	Consumption spending for household	$QINT_{ca}$	Quantity of commodity c as intermediate input to activity a
EXR	Exchange rate (LCU per unit of FCU)	$QINV_c$	Quantity of investment demand for commodity

$GSAV$	Government savings	QM_{cr}	Quantity of imports of commodity c
QF_{fa}	Quantity demanded of factor f from activity a		
MPS_i	Marginal propensity to save for domestic non-government institution (exogenous variable)	QQ_c	Quantity of goods supplied to domestic market (composite supply)
PA_a	Activity price (unit gross revenue)	QT_c	Quantity of commodity demanded as trade input
PDD_c	Demand price for commodity produced and sold domestically	QVA_a	Quantity of (aggregate) value-added
PDS_c	Supply price for commodity produced and sold domestically	QX_c	Aggregated quantity of domestic output of commodity
PE_{cr}	Export price (domestic currency)	$QXAC_{ac}$	Quantity of output of commodity c from activity a
$PINTA_a$	Aggregate intermediate input price for activity a	RWF_f	Real average factor price
PK_{ft}	Unit price of capital in time period t	$TABS$	Total nominal absorption
PM_{cr}	Import price (domestic currency)	$TINS_i$	Direct tax rate for institution i (i ∈ INSDNG)
PQ_c	Composite commodity price	$TRII_{ii'}$	Transfers from institution i' to i (both in the set INSDNG)
PVA_a	Value-added price (factor income per unit of activity)	WF_f	Average price of factor
PX_c	Aggregate producer price for commodity	YF_f	Income of factor f
$PXAC_{ac}$	Producer price of commodity c for activity a	YG	Government revenue
QA_a	Quantity (level) of activity	YI_i	Income of domestic non-government institution
QD_c	Quantity sold domestically of domestic output	YIF_{if}	Income to domestic institution i from factor f
QE_{cr}	Quantity of exports	ΔK^{a}_{fat}	Quantity of new capital by activity a for time period t

Table A2. CGE model equations

Production and Price Equations

$$QINT_{c\,a} = ica_{ca} \cdot QINTA_a \tag{1}$$

$$PINTA_a = \sum_{c \in C} PQ_c \cdot ica_{ca} \tag{2}$$

$$QVA_a = \alpha_a^{va} \cdot \left(\sum_{f \in F} \delta_{f\,a}^{va} \cdot \left(\alpha_{f\,a}^{vaf} \cdot QF_{f\,a} \right)^{-\rho_a^{va}} \right)^{-\frac{1}{\rho_a^{va}}} \tag{3}$$

$$W_f \cdot \overline{WFDIST}_{fa} = PVA_a \cdot QVA_a \cdot \left(\sum_{f \in F'} \delta_{f\,a}^{va} \cdot \left(\alpha_{f\,a}^{vaf} \cdot QF_{f\,a} \right)^{-\rho_a^{va}} \right)^{-1} \cdot \delta_{f\,a}^{va} \cdot \left(\alpha_{f\,a}^{vaf} \cdot QF_{f\,a} \right)^{-\rho_a^{va}-1} \tag{4}$$

$$QF_{f\,a} = \alpha_{f\,a}^{van} \cdot \left(\sum_{f' \in F} \delta_{f\,f'\,a}^{van} \cdot QF_{f'\,a}^{\;-\rho_{f\,a}^{van}} \right)^{-\frac{1}{\rho_{f\,a}^{van}}} \tag{5}$$

$$W_{f'} \cdot WFDIST_{f'\,a} = W_f \cdot WFDIST_{f\,a} \cdot QF_{f\,a} \cdot \left(\sum_{f'' \in F} \delta_{f\,f''\,a}^{van} \cdot QF_{f''\,a}^{\;-\rho_{f\,a}^{van}} \right)^{-1} \cdot \delta_{f\,f'\,a}^{van} \cdot QF_{f'\,a}^{\;-\rho_{f\,a}^{van}-1} \tag{6}$$

$$QVA_a = iva_a \cdot QA_a \tag{7}$$

$$QINTA_a = inta_a \cdot QA_a \tag{8}$$

$$PA_a \cdot (1 - ta_a) \cdot QA_a = PVA_a \cdot QVA_a + PINTA_a \cdot QINTA_a \tag{9}$$

$$QXAC_{a\,c} = \theta_{a\,c} \cdot QA_a \tag{10}$$

$$PA_a = \sum_{c \in C} PXAC_{ac} \cdot \theta_{ac} \tag{11}$$

$$QX_c = \alpha_c^{ac} \cdot \left(\sum_{a \in A} \delta_{a\,c}^{ac} \cdot QXAC_{a\,c}^{\;-\rho_c^{ac}} \right)^{-\frac{1}{\rho_c^{ac}-1}} \tag{12}$$

$$PXAC_{a\,c} = PX_c \cdot QX_c \left(\sum_{a \in A'} \delta_{a\,c}^{ac} \cdot QXAC_{a\,c}^{-\rho_c^{ac}} \right)^{-1} \cdot \delta_{a\,c}^{ac} \cdot QXAC_{a\,c}^{-\rho_c^{ac}-1} \tag{13}$$

$$PE_{cr} = pwe_{cr} \cdot EXR - \sum_{c' \in CT} PQ_c \cdot ice_{c'c} \tag{14}$$

$$QX_c = \alpha_c^t \cdot \left(\sum_r \delta_{cr}^t \cdot QE_{cr}^{\rho_c^t} + (1 - \sum_r \delta_{cr}^t) \cdot QD_c^{\rho_c^t} \right)^{\frac{1}{\rho_c^t}} \tag{15}$$

$$\frac{QE_{cr}}{QD_c} = \left(\frac{PE_{cr}}{PDS_c} \cdot \frac{1 - \sum_r \delta_{cr}^t}{\delta_c^t} \right)^{\frac{1}{\rho_c^t - 1}} \tag{16}$$

Table A3. CGE model equations (continued)

$QX_c = QD_c + \sum_r QE_{cr}$	(17)
$PX_c \cdot QX_c = PDS_c \cdot QD_c + \sum_r PE_{cr} \cdot QE_{cr}$	(18)
$PDD_c = PDS_c + \sum_{c' \in CT} PQ_{c'} \cdot icd_{c'c}$	(19)
$PM_{cr} = pwm_{cr} \cdot (1 + tm_{cr}) \cdot EXR + \sum_{c' \in CT} PQ_{c'} \cdot icm_{c'c}$	(20)
$QQ_c = \alpha_c^q \cdot \left(\sum_r \delta_{cr}^q \cdot QM_{cr}^{-\rho_c^q} + (1 - \sum_r \delta_{cr}^q) \cdot QD_c^{-\rho_c^q} \right)^{-\frac{1}{\rho_c^q}}$	(21)
$\frac{QM_{cr}}{QD_c} = \left(\frac{PDD_c}{PM_c} \cdot \frac{\delta_c^q}{1 - \sum_r \delta_{cr}^q} \right)^{\frac{1}{1+\rho_c^q}}$	(22)
$QQ_c = QD_c + \sum_r QM_{cr}$	(23)
$PQ_c \cdot (1 - tq_c) \cdot QQ_c = PDD_c \cdot QD_c + \sum_r PM_{cr} \cdot QM_{cr}$	(24)
$QT_c = \sum_{c' \in C'} \left(icm_{cc'} \cdot QM_{c'} + ice_{cc'} \cdot QE_{c'} + icd_{cc'} \cdot QD_{c'} \right)$	(25)
$\overline{CPI} = \sum_{c \in C} PQ_c \cdot cwts_c$	(26)
$DPI = \sum_{c \in C} PDS_c \cdot dwts_c$	(27)
Institutional Incomes and Domestic Demand Equations	
$YF_f = \sum_{a \in A} WF_f \cdot \overline{WFDIST}_{fa} \cdot QF_{fa}$	(28)
$YIF_{if} = shif_{if} \cdot \left[YF_f - trnsfr_{row\,f} \cdot EXR \right]$	(29)
$YI_i = \sum_{f \in F} YIF_{if} + \sum_{i' \in INSDNG'} TRII_{ii'} + trnsfr_{i\,gov} \cdot \overline{CPI} + trnsfr_{i\,row} \cdot EXR$	(30)
$TRII_{ii'} = shii_{ii'} \cdot (1 - MPS_{i'}) \cdot (1 - \overline{tins}_{i'}) \cdot YI_{i'}$	(31)
$EH_h = \left(1 - \sum_{i \in INSDNG} shii_{ih} \right) \cdot (1 - MPS_h) \cdot (1 - \overline{tins}_h) \cdot YI_h$	(32)
$PQ_c \cdot QH_{ch} = PQ_c \cdot \gamma_{ch}^m + \beta_{ch}^m \cdot \left(EH_h - \sum_{c' \in C} PQ_{c'} \cdot \gamma_{c'h}^m \right)$	(33)
$QINV_c = IADJ \cdot \overline{qinv}_c$	(34)

$$QG_c = \overline{GADJ} \cdot \overline{qg}_c \quad (35)$$

Table A3. CGE Model Equations (continued)

$$EG = \sum_{c \in C} PQ_c \cdot QG_c + \sum_{i \in INSDNG} trnsfr_{i\,gov} \cdot \overline{CPI} \quad (36)$$

System Constraints and Macroeconomic Closures

$$YG = \sum_{i \in INSDNG} \overline{tins}_i \cdot YI_i + \sum_{c \in CMNR} tm_c \cdot pwm_c \cdot QM_c \cdot EXR + \sum_{c \in C} tq_c \cdot PQ_c \cdot QQ_c + \sum_{f \in F} YF_{gov\,f} + trnsfr_{gov\,row} \cdot EXR \quad (37)$$

$$QQ_c = \sum_{a \in A} QINT_{c\,a} + \sum_{h \in H} QH_{c\,h} + QG_c + QINV_c + qdst_c + QT_c \quad (38)$$

$$\sum_{a \in A} QF_{f\,a} = QFS_f \quad (39)$$

$$YG = EG + GSAV \quad (40)$$

$$\sum_{r\ c \in CMNR} pwm_{cr} \cdot QM_{cr} + \sum_{f \in F} trnsfr_{row\,f} = \sum_{r\ c \in CENR} pwe_{cr} \cdot QE_{cr} + \sum_{i \in INSD} trnsfr_{i\,row} + FSAV \quad (41)$$

$$\sum_{i \in INSDNG} MPS_i \cdot \left(1 - \overline{tins}_i\right) \cdot YI_i + GSAV + EXR \cdot FSAV = \sum_{c \in C} PQ_c \cdot QINV_c + \sum_{c \in C} PQ_c \cdot qdst_c \quad (42)$$

$$MPS_i = \overline{mps}_i \cdot \left(1 + MPSADJ\right) \quad (43)$$

Capital Accumulation and Allocation Equations

$$AWF^a_{f\,t} = \sum_a \left[\left(\frac{QF_{f\,a\,t}}{\sum_{a'} QF_{f\,a'\,t}} \right) \cdot WF_{f\,t} \cdot WFDIST_{f\,a\,t} \right] \quad (44)$$

$$\eta^a_{f\,a\,t} = \left(\frac{QF_{f\,a\,t}}{\sum_{a'} QF_{f\,a'\,t}} \right) \cdot \left(\beta^a \cdot \left(\frac{WF_{f,t} \cdot WFDIST_{f\,a\,t}}{AWF^a_{f\,t}} - 1 \right) + 1 \right) \quad (45)$$

$$\Delta K^a_{f\,a\,t} = \eta^a_{f\,a\,t} \cdot \left(\frac{\sum_c PQ_{c\,t} \cdot QINV_{c\,t}}{PK_{f\,t}} \right) \quad (46)$$

$$PK_{f\,t} = \sum_c PQ_{c\,t} \cdot \frac{QINV_{c\,t}}{\sum_{c'} QINV_{c'\,t}} \quad (47)$$

$$QF_{f\,a\,t+1} = QF_{f\,a\,t} \cdot \left(1 + \frac{\Delta K^a_{f\,a\,t}}{QF_{f\,a\,t}} - \upsilon_f \right) \quad (48)$$

$$QFS_{f\,t+1} = QFS_{f\,t} \cdot \left(1 + \frac{\sum_a \Delta K_{f\,a\,t}}{QFS_{f\,t}} - \upsilon_f \right) \quad (4$$

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