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# Exploiting comparative advantage in agriculture and resources: the way forward for Small Island States

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Using Papua New Guinea as a case study, this paper investigates the macroeconomic and sectoral impacts of various developments in its agricultural and resource sector. It was found that commodity booms from 2004 to 2009 and the proposed large liquefied natural gas project increase output growth substantially but with Dutch disease consequences. The output expansion of the agricultural and fishery sectors on the other hand has limited positive impacts and the challenge lies in raising the productivity growth in these sectors and the better use of foreign aid. Lastly, the optimal policy strategy for sustainable development in the agricultural, fishery and resource sectors lies in the packaging of appropriate complementary policies (both institutional and economic) that support one another and the coherent implementation of these policies in a timely manner.

**Key words:** agriculture, commodity prices, computable general equilibrium model, Papua New Guinea.

## 1. Introduction

While Asian economies such as Thailand and Malaysia have managed to progress from an agricultural and resource-based economy to one with an increasing share of the manufacturing sector, some less developing economies have yet to exploit their comparative advantage in agriculture and resources sufficiently to move forward with industrialisation. This paper draws lessons for other developing countries using Papua New Guinea (PNG) as a case study to better understand the potential path towards sustainable economic development and growth, and the challenges it faces in this path.

More specifically, the paper addresses the following questions. First, in an agricultural-based economy, which sectors gain and lose in terms of the impacts on GDP, employment and other macroeconomic aggregates from the experience of the recent commodity boom? Second, what are the potential impacts from the US$15 billion investment in PNG's liquefied natural gas (LNG) project that is expected to commence production in 2014? Third, what impacts on the economy can be expected from the recent commitment to improve the agriculture and fishery sectors? These scenarios are simulated

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using appropriate shocks in a dynamic computable general equilibrium (CGE) model.

The choice of PNG as a case study is based on the following reasons. First, this fills an important gap in the literature given the dearth of studies investigating such issues in small island developing economies,[1] although there are 52 such states according to the United Nations Department of Economic and Social Affairs. Second, previous studies on these economies have often focused on partial equilibrium models or qualitatively based discussion with little robust empirical investigation.[2] The drawback of such models lies in the fact that they only measure first-round effects and ignore forward and backward linkages and their effects on macroeconomic variables, and the relative mix of the different factors of production in the different sectors. This study uses a general equilibrium model to overcome these limitations to provide the first-best option for impact studies.

Third, some studies have focused on regional analyses on the small island states mainly in the area of trade. These include Perez (2006) and Anderson and Martin (2005) who have used a CGE model such as the Global Trade Analysis Project (GTAP) model for analysis in the African Caribbean and Pacific regions with one possible shortcoming. That is, the multi-regional nature of the GTAP model does not account for the high level of heterogeneity within the region and this masks the varying impacts for the developing and developed countries in the region. Also, there exists a high level of aggregation in the impact variables owing to restrictive databases of the economies when formulating the GTAP model. This does not allow for an in-depth analysis on a wide range of macroeconomic variables or the effect on key sectors of the economy.

Fourth, the dynamic nature of the adopted model in this paper is able to trace the impacts of the simulated shocks over time. This provides a better insight into policy-making to help the economy adjust to the shocks. The rest of the paper is organised as follows. The next section briefly reviews the PNG economy to set the context of the study. Section three describes the theoretical framework and features underlying the CGE model used in the analysis while section four details the simulations and the possible reforms undertaken for the three scenarios of the commodity boom, LNG project, and the fisheries and agricultural sectors. Section five analyses the quantitative impacts of the scenarios considered on the economy, and section six discusses policy options and challenges for PNG to better manage adverse impacts. The last section concludes.

[1] These economies are low-lying coastal countries that tend to share similar sustainable development challenges, including small but growing populations, limited resources, remoteness, susceptibility to natural disasters, vulnerability to external shocks, excessive dependence on international trade and fragile environments.

[2] See Freitag (2011), Jayaraman and Chee-Keong (2010), Parry and McElroy (2009), Gani (2009), Read (2008), Rao *et al.* (2008), Monge-Roffarello *et al.* (2005), and Atkins (2000).

## 2. The Papua New Guinea Economy

Of all the Pacific island countries, PNG is the largest, accounting for 83 per cent of the region's land area and 80 per cent of the total Pacific population. Despite the relatively large land mass and rich natural endowments, living standards of the broader population have languished, particularly in the rural areas. According to UNDP (2010), the Human Development Index for PNG was just 137 of 169 countries. To help PNG, Australia has been providing aid to PNG for 35 years, and initially, this aid exceeded PNG's own revenue and equalled PNG–Australia trade. Since its independence in 1975, Australia has provided more than A$14 billion in real terms (A$8.1 billion in nominal terms) as aid to PNG (AusAID 2003).[3] Over time, Australia's aid to PNG as a percentage of PNG's GDP has declined from 22 per cent in 1975 to less than 5 per cent since 2005 (Batten 2009). Nevertheless, PNG remains the largest of Australia's bilateral aid programs. The long-term decline in aid volumes has been a deliberate policy endorsed by both governments, in an effort to wean PNG off Australian aid, and towards self-reliance (AusAid 2006).

The economic development of PNG since its independence from Australia in 1976 has been disappointing right up to 2005. Prior to that, the real per capita annual average growth rate of about 3 per cent was barely matching population growth, but between 2005 and 2009, real average growth was about 4.7 per cent (Gouy *et al*. 2010). The anomaly of the recent growth can be explained by the price surge for PNG's mineral commodities.

In the early 1990s, although PNG experienced an extractive resources boom, principally in crude oil, timber harvesting and gold, the revenues accruing from the boom were generally not reinvested into other appropriate and diversified forms of economic capital. Instead, it was used to finance current consumption including items such as increased public service salaries and benefits. The decade of the 1990s was often known as the lost decade and political unrest, but since 2000, PNG has come a long way towards getting herself out of the brink.

There has generally been increased macroeconomic stability, together with the flow-on effects of structural reforms in 2000 and 2002, has facilitated broader-based economic growth (AusAid 2009). By 2008, public debt had been reduced to 30 per cent of GDP from a high of 70 per cent in the early 2000s. Although mineral exports have remained the principal driver of economic growth (see Table 1), the PNG government is now attempting to focus on developing non-mineral sectors such as agriculture, construction, tourism and other service industries. In fact, in the last 5 years, the mining sector has grown at an average annual rate of about 1 per cent, whereas the non-mining sector has grown at an average annual rate of about 5 per cent. Total non-mining GDP is projected to grow on average by about 7.3 per cent in 2011 and 2012 (Ministry of Treasury and Finance 2011).

[3] Total funding for 2011–2012 is projected to be A$482.3 million.

**Table 1** Value of exports by sector (Kina millions, nominal prices)

| Sector | 1990 | 1995 | 2000 | 2005 | 2009 |
|---|---|---|---|---|---|
| Minerals | 757.5 | 2435.4 | 4443.7 | 7651.9 | 9057.0 |
| Gold | 393.2 | 840.1 | 1950.8 | 2834.1 | 5366.7 |
| Copper | 349.2 | 754.5 | 595.4 | 2497.7 | 2025.9 |
| Oil | — | 827.7 | 1870.8 | 2283.1 | 1610.4 |
| Others | 15.1 | 13.1 | 26.7 | 37.0 | 54.0 |
| Agriculture | 194.6 | 470.9 | 838.5 | 1707.1 | 2035.1 |
| Forestry | 79.6 | 449.7 | 308.8 | 476.3 | 409.9 |
| Fishing | 8.2 | 12.3 | 33.7 | 193.0 | 207.3 |
| Others | 10.0 | 31.5 | 117.0 | 242.8 | 190.6 |
| Total | 1049.9 | 3399.8 | 5741.7 | 10271.1 | 11899.9 |

Source: *Quarterly Economic Bulletin* (various issues), Bank of Papua New Guinea.

With regard to trade, PNG has maintained a healthy balance of trade in goods since 2002, and this is because of the export activities in minerals such as gold, copper and oil, which make up 80 per cent of total exports. Agricultural production and forestry activities targeted at export have also been rising over time. For example, agricultural exports grew by an average of 19 per cent per annum between 1998 and 2008, while fisheries exports grew by an average of 6 per cent per annum during the same period (Table 1).

As stated in the 2011 Budget, the PNG government is, however, committed to increasing the value of manufactured goods as this sector has the potential to increase formal employment growth and broaden the tax base. However, despite the potential investment opportunities in downstream activities, PNG has had difficulty in addressing the dearth of private investment in this sector. The share of foreign direct investment (FDI) has also not been high, averaging about 5 per cent of GDP and mainly concentrated in the mining and petroleum industries. In fact, PNG lags behind other similar developing countries in terms of ease of doing business. According to the World Bank's *Doing Business 2011 Report* that investigates the regulations affecting business activity, PNG is ranked 103rd among the 183 economies assessed (World Bank 2011). A major obstacle to encouraging business is the poor infrastructure, in particular, transport and electricity.

## 3. The PNG Computable General Equilibrium Model

The CGE model of PNG used in the analysis, PNGGEM, comes from the Australian Bureau of Agricultural and Resource Economics (Levantis 2004). This model has 43 industries producing 37 commodities (see Appendix 1). The agricultural sector is highly disaggregated with 13 agricultural industries divided into smallholder and plantation sectors for the export crops (cocoa, coffee, palm oil and other tree crops). Most of the commodities in PNGGEM have competing imports, but as is the case in most CGE models, the Armington assumption is adopted whereby we consider imports to be imperfect substitutes

for the domestic commodities. This section presents a brief overview of the theoretical structure of the model, as well as brief descriptions of how the labour market and capital utilisation are modelled.

### 3.1. Theoretical overview

The theoretical structure of PNGGEM is based on Walras' Law which envisages the economy as a circular flow of funds where the supply of goods equals the demand for goods. The supply side is given by the sum of production and imports, while the demand side is given by the sum of intermediate inputs, consumption, private investment, government consumption, government investment and exports. The circular flow of funds implied by the above Walrasian condition is first disaggregated into five core equations representing the following key sectors of the economy: production sector, household sector, government sector, external sector and finance sector.

The production sector equation describes the flow of funds in each of the 43 industries in the model. The funds earned from selling the output are shown on the left-hand side, while on the right-hand side we have the allocation of these funds. The funds are applied to intermediate input costs, labour costs, payments to capital owners (net of tax), payment of government production and import taxes, and involuntary payments because of the external consequences of crime. In the household sector, the sources of funds are factor income receipts from labour and capital supplied to the production sector, net investment income from overseas, net private unrequited transfers from overseas and net government transfers. The funds are then applied to consumption, private savings, income taxes and the external costs of crime. Private savings are determined by the product of marginal propensity to consume out of disposable income and aggregate disposable income.

The government sector sources its funds from tax revenues, net foreign aid, payments to government-owned capital by the production sector and public unrequited transfers from abroad.[4] These funds are applied to consumption, investment, transfers to households, and to the external costs of crime,[5] while the balance (change in government savings) goes to the budget surplus (or deficit), which is determined as the residual of revenues less expenditures. The external sector equation corresponds to the balance of payments and can be interpreted as the source and use of the local currency (kina) to pay for imports or to transfer investment income overseas. The funds are applied to purchase exports, capital inflows investment income inflows, and net unrequited public and private transfers. The external sector also includes an expression for the external cost of crime which is interpreted as a transfer

[4] Public unrequited transfers are assumed to be exogenous.

[5] The external costs of crime are borne involuntarily and are assumed to be a fixed share of the economy-wide external costs of crime.

of local funds to the rest of the world for PNG does not receive a return (i.e. it is a loss the economy).

The final core equation depicts the finance sector. Here, the source of funds is from private savings, net government savings and net capital inflows. These funds are then applied to private investment. Private and government savings are determined within the household and government sector equations, while private investment is determined at the industry level and aggregated across industries. Dealing with investment and capital consumption in CGE modelling presents a difficult challenge because CGE models are effectively one-period models, whereas current investment generally tends to be realised over future periods as well as the current period. The approach taken to modelling capital and investment is explained below.

In addition to the five core equations described above, there are two additional types of equations: (i) equations designed to determine variables in the core equations (e.g., prices, different types of demand, output supply, etc.), and (ii) equations designed to determine variables independent of the core equations (e.g., real GDP, exports, imports and aggregate employment).

### 3.2. Modelling the labour market

The PNG labour market is split into four sectors: village, plantation, urban and urban 'murky' (or informal) sectors. For the first three sectors, there are three categories of labour defined – skilled, semi-skilled and unskilled labour, while the village and murky sectors are assumed to utilise only unskilled labour. Equations are specified to determine the level of demand for each labour type for a given level of labour requirement by each industry. A modified version of the Harris–Todaro mechanism (Harris and Todaro 1970) based on Fields (1975) is employed. The labour market is split into rural and urban sectors where the urban sector is characterised by a distorting urban sector wage which draws labour from the rural to the urban areas. However, because the wage is sticky downwards, employment does not respond to the increased labour supply and therefore the rural-urban migration results in a labour surplus. Rural-urban migration continues until the expected return (given that urban employment is not guaranteed because of surplus labour) for an urban worker equals the opportunity costs of leaving the rural environment. The surplus labour feeds into the 'murky' sector (Fields 1975), which is made up of legitimate informal employment and crime.

### 3.3. Modelling capital utilisation

In this model, the representation of capital consumption differs from the ORANI/MONASH style models where it is restricted to being fixed or completely mobile. An inherent assumption of these models is that capital is utilised at full capacity (or at a constant ratio of full capacity). However, this assumption is unrealistic as firms constantly adjust their degree of capital

utilisation according to the changes in market conditions. In this model, capital utilisation is allowed to vary according to profitability with the following assumptions:

- Industries adjust their capital stock levels through investment to target an optimal level of capacity utilisation.
- Within a given period, industries adjust their capacity utilisation according to the changes in market conditions. For example, if there is an increase in demand leading to increased profit opportunities and increased rates of return, then the industry will respond by increasing its factor usage (including its capital usage).

Let the optimal level of capital consumption in industry $j$ be given by $F_{kj}^{\text{opt}}$ for a given stock level, $K_j$.[6] The percentage deviation of capital consumption ($U_j$) from its optimum level can then be written as

$$U_j = \frac{F_{kj} - F_{kj}^{\text{opt}}}{F_{kj}^{\text{opt}}} \tag{1}$$

When the optimal level of capital consumption is being used, then $U_j = 0$. Next, it is assumed that there is a relationship between the real price of capital (i.e. the real gross return on a unit of capital before depreciation) and the percentage change in the deviation of capital consumption from the optimum whereby increases in the real price of capital lead to increases in the employment of capital. Let the relative price of capital in industry $j$ in percentage terms be $w_{kj}^{\text{rel}}$ (net after tax). The percentage change in net relative returns is then defined as the change in nominal returns less inflation and less the cost of capital (the real interest rate). That is,

$$w_{kj}^{\text{rel}} = w_{kj}^{\text{net}} - \rho - r \tag{2}$$

where $w_{kj}^{\text{net}}$ is net nominal returns, $\rho$ is the GDP deflator, and $r$ is the real interest rate. If relative returns in industry $j$ improve, then capital utilisation (and consumption) in that industry will increase. This relationship is captured as follows.

$$\mathrm{d}U_j = \sigma_j^k . w_{kj}^{\text{rel}} + h_{kj}^f \tag{3}$$

where $\mathrm{d}U_j$ is the change in capital consumption and $h^f{}_{kj}$ is an exogenous shock term.

The next step is to determine the optimal or target level of capital utilisation ($F^{\text{opt}}{}_{kj}$). This is expressed as a fixed proportion of capital stock ($\zeta_j$) and the current capital stock level ($K^{t0}{}_j$) as follows:

[6] It is assumed that capital utilisation is the same as capital consumption.

$$F_{kj}^{\text{opt}} = \zeta_j . K_j^{t0} \tag{4}$$

The fixed proportion is the variable (so that $\zeta_j$ is not the same across industries). The model also defines the capital stock level for the next period, ${F^{\text{opt1}}}_{kj}$ (which is determined according to the investment and depreciation in the current period) and the optimal level of capital utilisation in the next period (${K^{t1}}_j$). The relationship between the two is expressed as:

$$F_{kj}^{\text{opt1}} = \zeta_j . K_j^{t1} \tag{5}$$

The next step is to model investment. It is assumed that future expectations are based on current circumstances. In this case, net investment (i.e. investment less depreciation) will respond in the same direction as $\mathrm{d}U_j$ if capital consumption is initially at the optimal level. In other words, if capital consumption increases beyond the optimal level so that $\mathrm{d}U_j > 0$, then the industry will respond so that net investment will be greater than zero. That is, if $dU_j > 0$, then there will be net additions to the capital stock in response. These net additions to the capital stock will then increase the optimal level of capital consumption in the next period. A gradual process of adjustment is assumed so that if percentage capital consumption ($f_{kj}$) is initially at the optimal level, then ${f^{\text{opt1}}}_{kj} = \gamma_j . f_{kj}$, where $\gamma$ (the speed of adjustment) lies between 0 and 1, and $f^{\text{opt1}}$ is the optimal level of capital consumption for the next period. Based on the assumption of gradual adjustment, the change in the optimal level of capital consumption in the next period will be a partial correction of the disequilibrium at the end of the current period. That is,

$$\mathrm{d}F_{kj}^{\text{opt1}} = \gamma_j [(F_{kj} - F_{kj}^{\text{opt}}) + (F_{kj} . f_{kj} - F_{kj}^{\text{opt}} . f_{kj}^{\text{opt}})] \tag{6}$$

Finally, investment is determined in the following relationship:

$$\mathrm{d}K_j^{t1} = F_j^i - D_j \tag{7}$$

where $dK_j^{t1}$ is the change in the capital stock level in the next period, ${F^i}_j$ is investment, and $D_j$ is depreciation.

The model is essentially recursive dynamic in the sense that each period is solved as a static equilibrium problem given the stock of capital and investment.[7] The results for a particular period are used to update the database to form the basis for the next simulation and so on.[8] In the simulations, we compute the changes in the endogenous variables from their values in the initial solution caused by changes in the exogenous variables.

[7] This approach can be contrasted with other dynamic models in which there is inter-temporal optimisation.

[8] Thus, the model is solved in a multi-step fashion rather than in one-shot percentage changes. We thank the associate editor for making this point.

Two types of simulations are carried out in these multi-step simulations. The first is the base case simulation that represents the projection path the PNG economy will follow under *business as usual* conditions. This is in effect a forecasting simulation where forecasts are made about the growth rates of key socioeconomic variables such as population, real output, real government consumption and investment expenditure, domestic and world inflation, and export and import prices, which are all set exogenously. The forecasts are taken from expert agencies such as the World Bank, the IMF and official government forecasts (see Appendix 2). The second simulation is a policy scenario that measures the path the economy would take following the introduction of a policy (e.g. a tariff reduction). The difference between the policy scenario and the base case scenario measures the impact of the policy.

Typical exogenous variables in the policy scenario include tax rates, import and export prices, tariffs, various exogenous shock terms, and the consumer price index (CPI) which is the *numeraire*. Although the base year for the model is 2002, it was not thought necessary to update it because the base case simulations used actual percentage changes in the key variables to update the model by applying them as shocks. The model was solved using Version 9 of *GEMPACK* (Harrison and Pearson 1996).

## 4. Simulation scenarios

In seeking to address the questions raised earlier, we undertake three policy experiments. These are the following: impacts of the commodity boom; impacts of the LNG project; and output expansion of agriculture and fisheries. Each of these scenarios is briefly discussed below.

### 4.1. Modelling the 2004–2009 commodity boom

In recent years, PNG has benefited from rises in the world prices of commodities such as coffee, cocoa, palm oil, timber, copper, gold and crude oil. However, being a commodity dependent economy, it is also highly susceptible to downswings in commodity prices. For example, the global financial crisis which began in September 2008 reduced the prices of commodities such as copra, tea, palm oil, crude oil and copper. Table 2 shows that palm oil and copper prices, for example, declined in 2009 by 42 per cent and 28 per cent, respectively, of their 2008 values. Since then, commodity prices have rebounded, but prices of some commodities such as copra and palm oil remain below their 2008 value. To simulate these events, we used changes in the values of commodity prices between 2004 and 2009 as seen in Table 2.

### 4.2. Modelling the impacts of the LNG Project in 2014–2015

Oil production in PNG has been showing a downward trend since 2005 owing to a natural decline in the current oil fields. However, gas has the potential to

**Table 2** World Prices of Selected Commodities (US$ per tonne)

| Year | Cocoa | Coffee | Copra | Palm oil | Copper (US¢/lb) | Gold (US$/oz) |
|---|---|---|---|---|---|---|
| 2000 | 2657 | 5319 | 849 | 864 | 82 | 278 |
| 2001 | 3628 | 4616 | 703 | 953 | 72 | 269 |
| 2002 | 6901 | 5153 | 1003 | 1513 | 71 | 310 |
| 2003 | 6280 | 5021 | 1025 | 1578 | 80 | 364 |
| 2004 | 5098 | 5631 | 1379 | 1526 | 128 | 410 |
| 2005 | 4795 | 7870 | 1210 | 1309 | 167 | 443 |
| 2006 | 4857 | 7658 | 1148 | 1454 | 303 | 603 |
| 2007 | 5763 | 8093 | 1693 | 2285 | 323 | 696 |
| 2008 | 6925 | 8269 | 2103 | 2589 | 315 | 855 |
| 2009 | 7914 | 8561 | 1245 | 1857 | 234 | 970 |
| 2010 | 8406 | 11,572 | 1889 | 2462 | 340 | 1202 |

Source: *Quarterly Economic Bulletin* (various issues), Bank of Papua New Guinea.

become PNG's most important natural resource, and since 2006, the commercialisation of gas has remained an important agenda for the PNG government. This has resulted in the government's partnership in an LNG project with ExxonMobil which was signed on 22 May 2008. The project is estimated to increase PNG's national output by K11.4 billion per annum on average (ACIL Tasman 2008). By comparison, the contribution of oil and gas production to GDP in 2006 was K305 million, which was equivalent to 3.5 per cent of GDP, and crude oil and gas exports constitute 22 per cent of total exports in 2006. Another sense of the scale of the project can be obtained from the following comparison. In 2006, PNG's real GDP was K8.65 billion and this is expected to increase by over 100 per cent per year at the height of LNG production. The key direct benefits of the project are expected to be derived from revenues (e.g. taxes, royalties and dividends) accruing to the PNG government and landowners, estimated to be about K115 billion[9] over the 30-year project life, and in the form of significant increased employment for Papua New Guineans during the construction (between 3600 and 4500 jobs) and operating phases (more than 600 full time positions) of the project (ibid).

Based on the above estimates, this scenario is simulated by imposing a shock of 400 per cent on oil and gas exports in 2014 and 2015. The shock value of 400 per cent is given by the percentage increase of K11.4 billion over K2.6 billion in 2006. It is assumed that all of the LNG will be exported because at present there is sufficient energy generated for domestic use and PNG has no current plans to process the natural gas for domestic use.

### 4.3. Modelling the expansion in agriculture and fisheries output over 2012–2015

Concern has been raised that mining-oriented growth has come at the expense of government attention to the non-mining sectors, and this has inhibited

[9] An exchange rate of 1 kina = US$0.278 was used.

broad-based growth for poverty alleviation (Datt and Walker 2006). In particular, agricultural production still remains a comparative advantage for PNG where most of the rural people depend on agricultural activities such as food crops apart from tree crops such as coffee, cocoa, palm oil and tea. The PNG government in its first comprehensive *National Agriculture Development Plan 2007–2016* has committed to improve infrastructure such as road access and other transport facilities, as well as providing support for best farming practices via extension services to diversify crops or use of high yielding varieties.

The fishery sector is also important when it comes to the recently ratified economic partnership agreement (EPA) with the European Union (EU) in June 2011. This has resulted in the relaxation of the rules of origin by the EU as processed fish from PNG can be sourced anywhere outside territorial waters. This aspect can be taken advantage of by the establishment of the Pacific Zone Marine Industrial Park in PNG to attract downstream processing; then, fishing would see far greater growth. In addition, in September 2011, the New Zealand government announced that it will invest A$7.5 million over 5 years in a fisheries training program to ensure a coordinated approach for private sector led sustainable fisheries development in the Pacific islands region.[10] Thus, it can be expected that the agricultural and fishery sectors will see an expansion, and we consider a scenario of 3 per cent growth in both these sector's GDP output over 2012–2015 based on the *National Agricultural Development Plan 2007–2016*.

## 5. Simulation results

The simulation results using PNGGEM are discussed under each of the three scenarios above.

### 5.1. Impacts of the commodity boom

The PNG kina is often referred to as a 'commodity currency' (Cashin *et al.* 2002) as the exchange rate is driven by commodity prices and so is the economy's performance given that it is highly dependent on the movement of commodity prices. Figure 1 shows that until 2011, the nominal exchange rate has been appreciating, and after a slight depreciation it trends downwards albeit at a slower rate.

It can be seen that at the highest GDP growth rate of about 10 per cent in 2007, the commodity price slump which followed the 2007–08 financial crisis caused the growth rate of the economy to decline to 3.5 per cent in 2010 (Figure 2). Abstracting from megaprojects such as the LNG project that are expected to come on stream in the near future, subdued commodity prices in the near term are expected to have a sluggish growth-inducing effect. Figure 1

[10] See http://www.pacifictradeinvest.com/wp/?p=1558.

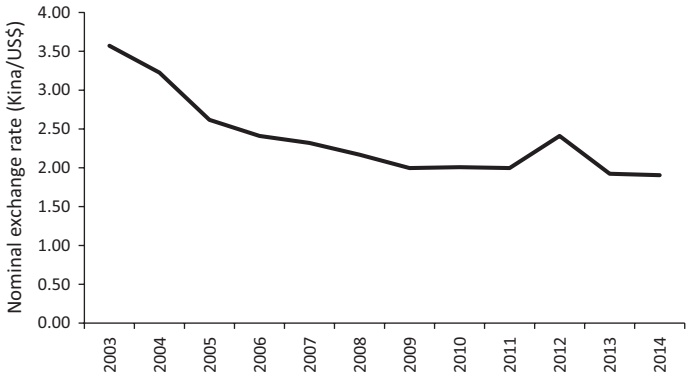


**Figure 1** Impact of commodity prices on the nominal exchange rate. Note: A fall indicates an appreciation given the definition of the exchange rate as Kina/US$. Source: PNGGEM simulation results.

shows that over the period 2003–2015, real GDP growth fluctuates in line with commodity prices. However, the average annual GDP growth over that period is about 5 per cent per annum.

The commodity price shocks are seen to have positive spillover effects on all the sectors of the economy apart from forestry (which did not experience a boom in the price of its products) as seen in Figure 3. The tradable agricultural sector which consists of cash crops such as coffee, cocoa, copra and palm oil expands by 11 per cent. As expected, the other agricultural sector that includes import-competing goods such as beef, eggs, rice and sugar grows by only 3.5 per cent. The commercial and financial service sectors expand by 10 per cent and 8 per cent, respectively, as a result of the flow-on effects from the commodity boom.

The foregoing results confirm the fact that the PNG economy is vulnerable to commodity price volatility. From a policy perspective, the response of the


**Figure 2** Impact of commodity prices on real GDP growth, 2003–2015. Source: PNGGEM simulation results.

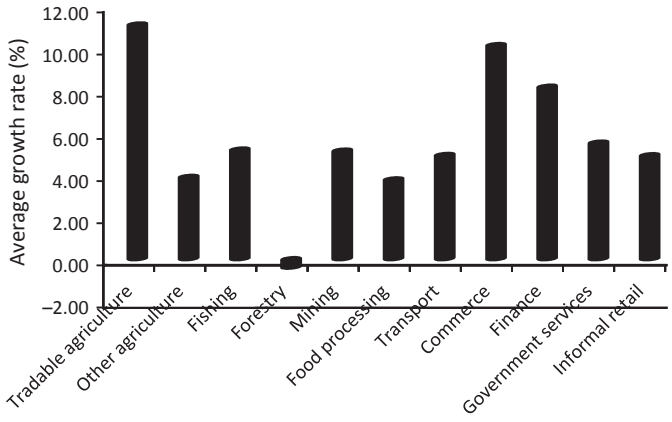


**Figure 3** Impact of commodity prices on sectoral GDP, 2003–2015. Source: PNGGEM simulation results.

PNG government should be to diversify the economy away from a reliance on primary exports. This can be seen in the attempt being made at expanding the agricultural and fishery sectors as stated in the 2011 budget. But the export competitiveness of these sectors needs to be improved before significant gains can be made. There is also a need to invest in agro-processing industries and light manufacturing. Although at the present time, these issues do not appear to be on the government's agenda, they should be given serious thought for two reasons. First, these activities can absorb the large number of unskilled workers in PNG and thus reduce unemployment. Second, these activities have the potential to forge forward and backward links with the agricultural sector, and this is a much needed progression in a developing agricultural economy. Incentives for private investment in these sectors should be considered, failing which foreign investors should be wooed to take on these ventures.

To the extent that government expenditures depend crucially on its receipts from commodity exports, there is a need for appropriate strategies to manage such receipts. In particular, there is a need for the establishment of a stabilisation fund for commodities which the government could use to smooth its expenditures over time. In 1974, PNG established such a fund named the Mineral Resource Stabilisation Fund, but this was not properly managed and was used more as a source of government revenue rather than for undertaking worthwhile investment.

However, at the end of 2000, the legislation surrounding this fund was repealed and the fund has now been replaced by a raft of *de facto* stabilisation funds in the form of trust funds. The PNG Department of Finance holds more than 20 such trust accounts for various commodities and purposes. While in principle these funds are intended to have beneficial effects such as helping to smooth government expenditures and moderate inflationary pressures from the commodity boom, the sheer number of these accounts raises governance concerns such as lack of accountability and transparency

regarding how these funds are utilised. There are also concerns that the way the trusts are currently regulated may not generate maximum rates of returns for the country (Gouy *et al.* 2010).

### 5.2. Impacts of the LNG Project

The simulation results in Table 3 show that the LNG project increases aggregate exports by 94 per cent per annum. This is less than the increase in oil and gas exports because there are declines in the exports of some commodities as seen below.

Aggregate imports also increase but at a slower rate of 57 per cent per annum, resulting in a positive trade balance. Real household consumption increases by 83 per cent, driven by an increase in household disposable incomes, which is in turn because of a 42 per cent increase in aggregate employment. Given the increase in both private and public consumption, as well as in the positive trade balance, we observe that real GDP increases by 95 per cent.

The large increase in oil and gas exports coupled with the huge inflow of revenues drives up the real exchange rate (kina/US$), causing it to appreciate by 9 per cent.[11] The currency appreciation reduces the external competitiveness of the tradable sectors such as agriculture and forestry, causing them to contract. In this case, the tradable agricultural (cash crop) sector declines by 13 per cent while forestry declines by 10 per cent as seen in Figure 3. The fishery sector on the other hand is not adversely affected because the level of exports in this sector is very small, and a lot of fishing is undertaken by foreign companies in PNG's waters for processing and export elsewhere.

The mining sector sees virtually no change in GDP growth because the LNG project attracts resources from the non-mining sectors such as agriculture where the rates of return are lower. Manufacturing and service sectors, on the other hand, expand as a result of providing services to the booming LNG sector. The highest growth is observed for government services which expand by 83 per cent, followed by transportation (43 per cent), financial services (42 per cent), food processing (16 per cent) and

**Table 3** Macroeconomic impacts of the LNG Project, 2014–2018

| Variable | Average growth (%) |
|---|---|
| Real GDP | 95.46 |
| Real household consumption | 83.03 |
| Aggregate exports | 94.22 |
| Aggregate imports | 56.98 |
| Aggregate employment | 41.57 |
| Real exchange rate (kina/US$) | −9.0 |

Source: PNGGEM simulation results.

[11] The real exchange rate is defined in the model as the nominal exchange rate divided by the CPI. Given that the CPI is fixed, a fall in the nominal exchange rate (kina/US$) as a result of the resource boom causes the real exchange rate to fall (appreciate) by the same amount.

commerce (10 per cent). The big increases in food manufacturing, commercial and financial services are driven by the huge increase in demand by foreigners working in PNG, as well as by increased demand from the local population as a result of increased income.

The sectoral impacts on agriculture and forestry demonstrate the classic symptoms of the 'Dutch disease' (Corden and Neary 1982). This is because of the expansion in the resource project taking place at the expense of other forms of activities which have now become less competitive owing to the appreciation in the currency. Apart from the appreciating exchange rate, the other causal factor in the Dutch disease phenomenon is that the high rate of return generated by the booming oil and gas sector tends to bid resources away from other competing exports, further depressing their output. Sectors that perform strongly in the resource boom include those that provide services to the oil and gas sector (e.g. finance, commerce and food processing). There is also a big increase in the growth of social services (health and education) and government administration because of the huge increase in government receipts from the LNG project.

In the past, the inflow of revenue from PNG's mining and oil sector was also supplemented by a large inflow of funds from the international donor community, notably Australia. This inflow of foreign exchange added to the Dutch disease problem by supporting the exchange rate at unsustainably high levels which inevitably led to the floating of the Kina (AusAID 1999).

The employment impacts at the sectoral level mirror the declines in sectoral output. The biggest fall in employment of 34 per cent is observed for the tradable agriculture sector seen in Figure 4. The oil and gas industry is essentially an urban-based industry, and therefore, it can be inferred that most of these job losses will be in the rural areas, where most of the agricultural activities occur.

### 5.3. Impacts of expansion in agricultural and fisheries output

Table 4 reports the macroeconomic impacts of the agricultural and fisheries expansion strategies. It can be seen that average real GDP growth is modest at about 1.5 per cent although these sectors contribute on average about 30 per cent of GDP. Real household consumption growth, however, is relatively higher as 85 per cent of the population live in rural areas and rely on these sectors. Hence, there is an increase in employment and export growth is highest at 4.32 per cent (Figure 5). There is a slight hike in inflation because of consumer spending, but inflationary pressure, however, could also be fuelled by increase in government consumption (not shown here) and by a possible shortage of skilled labour (a perennial problem in PNG as noted by Gouy *et al*. 2010).

With the employment impacts seen in Figure 6, the highest increase is recorded in unskilled labour in agriculture and fishery sectors followed by semi-skilled and skilled labour. The reverse trend is noted in food processing

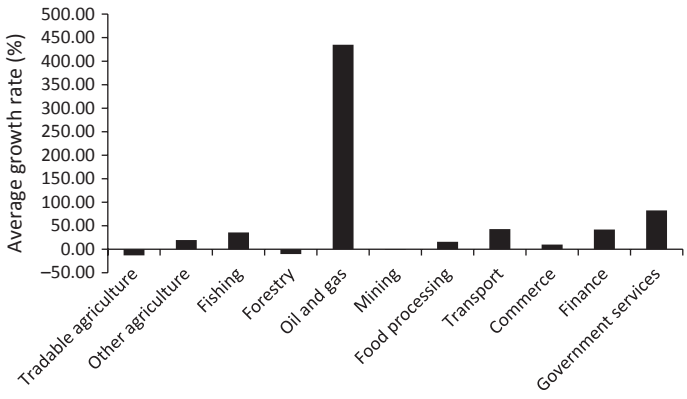


**Figure 4** Sectoral GDP impacts of the LNG Project, 2014–2018. Source: PNGGEM simulation results.

**Table 4** Macroeconomic impacts of agricultural and fisheries expansion, 2012–2015

| Variable | Average growth (%) |
|---|---|
| Real GDP | 1.48 |
| Real household consumption | 3.06 |
| Aggregate exports | 4.32 |
| Aggregate imports | 3.71 |
| Aggregate employment | 2.82 |
| Inflation rate | 1.99 |

Source: PNGGEM simulation results.

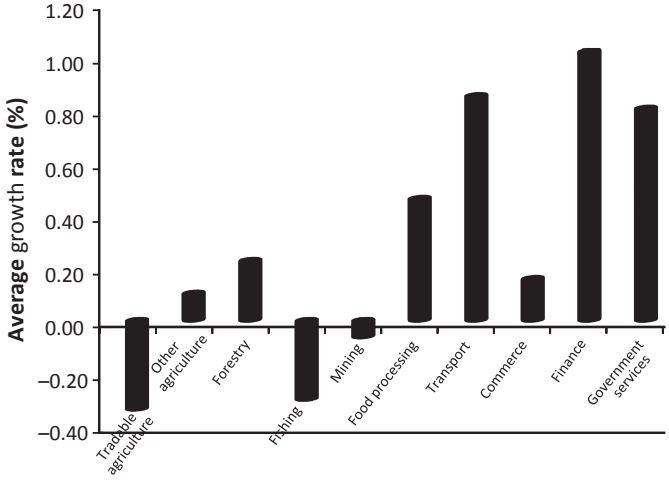


**Figure 5** Average Employment Impacts of the LNG Project, 2014–2018. Source: PNGGEM simulation results.

which requires a higher skill base given the factory-related operations involved. For sustainable growth, it is the increases in value added operations that matter most and a major constraint is the lack of skilled labour. Hence, upgrading

skills through education is vital, and this has been recognised by the 2010 PNG Australian Aid Review,[12] which recommends that education becomes the flagship sector for aid from Australia which is the largest single donor to PNG.

Figure 7 shows that the output expansion of agriculture and fisheries has limited relative impacts on other sectors such as other agriculture (which includes domestic production of beef, eggs, rice and sugar), food processing and service sectors (such as transport, finance, government services) as there are insufficient forward and backward linkages. This situation with regard to the impact on other agriculture and food processing reflects the structure of incentives, which is currently geared towards the tradable agricultural export sector. For instance, the government promotes essential services by providing assistance in marketing and transport for cash crops in the tradable

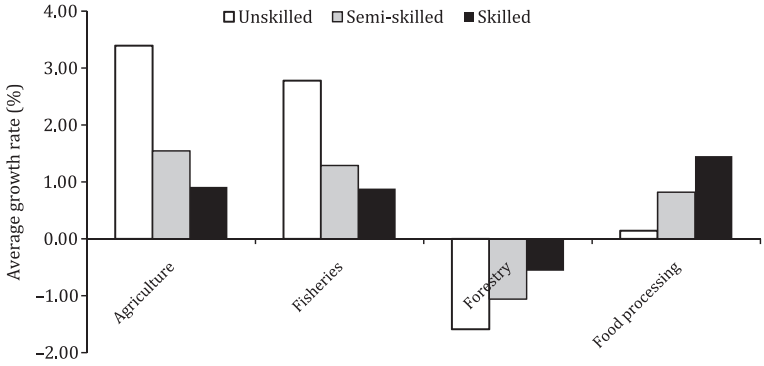


**Figure 6** Impacts on labour from agricultural and fisheries expansion, 2012–2015. Source: PNGGEM simulation results.

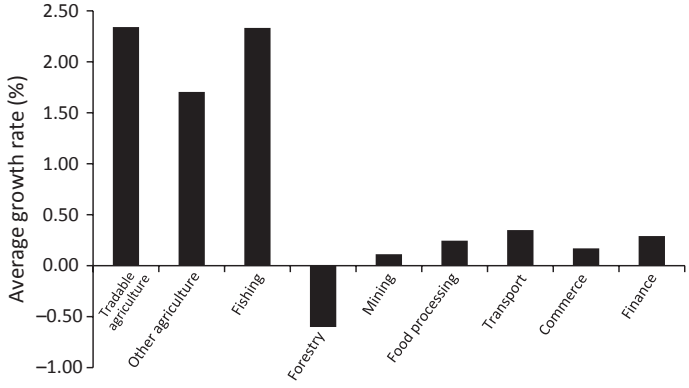


**Figure 7** Impacts on sectoral output resulting from agricultural and fisheries expansion, 2012–2015. Source: PNGGEM simulation results.

[12] See AusAID (2010).

agriculture sector. The forestry sector's output and employment is adversely affected because there is movement of labour away from forestry to the expanding agriculture and fishery sectors given the similarity in the skill composition in these sectors.

In general, it has been acknowledged that PNG's agricultural productivity growth is low by international standards (Department of National Planning and Monitoring 2010) and that it is important that productivity be improved (resulting in increased output at a lower cost) for sustainable growth rather than output expansion alone. But the latter is an easier strategy as a short-run solution and hence is more commonly used. This is greatly helped by the fact that only 4 per cent of the 30 per cent of the land suitable in PNG for agriculture is currently utilised for commercial production (Ministry of Treasury and Finance 2011).

As in most other developing countries, supply side constraints such as lack of microfinance for investment and infrastructure networks, poorly established marketing and procedures for buying and selling, are absent in PNG's agricultural sector. In the area of fishing, commercial fishing is mostly undertaken by foreign vessels for a small licence fee, and this has set back PNG's fishing industry where there are concerns of overfishing and the need to revamp licence fees, excise and other revenue raising arrangements from this sector (Havice and Campling 2010).

## 6. Which way forward?

In line with the *Papua New Guinea Development Strategic Plan* 2010–2030s (Department of National Planning and Monitoring 2010) overall aim of PNG becoming a middle-income country by 2030, two types of policy consideration are crucial. One is the proper management of natural resource revenue to avoid Dutch disease effects from potential commodity booms and the ongoing LNG project. In one sense, therefore, the Dutch disease problem can be seen as a result of how the government chooses to use the revenue from resource extraction, rather than a result of the resource extraction activity itself. The second policy consideration is the coherence and timing of policy implementation, and this is discussed later.

Coming back to the first policy consideration, several models have been put forth to manage resource revenue effectively. This is especially important given that a second LNG project (a US$6.0 billion venture) is being considered by the PNG government (Ministry of Treasury and Finance 2011). The use of independent trustees in the case of the OK Tedi Development Foundation in PNG is a good model for effective control over the revenues going into the trust fund, but effective expenditure is another thing altogether. Thus, institutional arrangements need to be in place for ensuring sound use of the revenue for sustaining the future. This requires strong political constituency to resist narrow vested interests.

Another model is to have a Permanent Fund where the collected funds are invested offshore and the investments are distributed quarterly on an equal basis to all citizens (Moss and Young 2009). This is carried out in Norway and Alaska and has been proposed for Ghana. Duncan (2010) argues that if this model is adopted in PNG, it is quite likely that the distribution of such funds to all Papua New Guineans would lead to increased agricultural and rural productivity growth which would have flow-on benefits to the whole economy. But implementing universal cash transfers under this system is easier said than done (especially in PNG where there are concerns about corruption), though, not beyond the realm of possibility.

The World Bank (2010b), on the other hand, suggests that additional spending from the PNG's natural resource revenue could grow sustainably in accordance with growth in non-mineral resources GDP. This would counteract the expected fall in other activities as a result of the Dutch disease. Here, the issue for the PNG government to consider is whether the collected funds should be an offshore or onshore entity. While some domestic stakeholders argue that development needs in PNG are such that all funds should be brought onshore, the problem is that, in this case, they will be held in the domestic currency, and this has ramifications for the exchange rate and the cost and difficulty of managing monetary policy given the high liquidity levels.

To minimise such macroeconomic risks and promote macroeconomic stability and prevent overheating of the domestic economy, the offshore option is an attractive one. Keeping the funds offshore is also a useful option because it can help to moderate the pressure on the real exchange rate to appreciate, thereby minimising the Dutch disease effects. In addition, the offshore funds can be invested abroad to maximise investment returns to finance domestic needs. Although high rates of return could be obtained by investing domestically in projects such as schools, hospitals and roads, there are doubts about the capacity of the economy to effectively absorb huge sums of money in a short period of time (Ministry of Treasury and Finance 2011). The decision on the exact nature and type of the resource fund, and the way the money will be spent is yet to be made as discussions on this matter are still ongoing.

The bottom line, however, is that institutional arrangements need to be devised to ensure that revenue from natural resources is collected properly and the money spent wisely. Effective implementation of these policies requires accountability, transparency and regulatory control. On these fronts, PNG's performance is far from satisfactory. On government effectiveness, PNG is in the bottom 25 per cent of the countries covered; on rule of law, it is in the bottom 20 per cent; and in relation to corruption control, it ranks in the bottom 10 per cent (World Bank 2010a). Furthermore, PNG is not yet a signatory to the Natural Resources Charter or the Extractive Industries Transparency Initiative, both of which are global standards for publishing revenues from the resources sector. Whether these conditions will change

for the better in the hands of the newly elected government remains to be seen.

The second type of policy consideration lies in ensuring policy coherence, and this is related to the effective implementation of policies. While the formulation of the right policies is necessary, it is not sufficient for success. Policy coherence is fundamental and requires a framework that designs and links the policies in such a way that the timing of policies and the working of supporting policies go hand-in-hand. This is not only relevant to fight the resource curse but also for sustainable development of the agricultural and fishery sectors.

The expansion in output of the agricultural and fishery sectors show modest benefits when implemented in isolation and are unlikely to be effective unless implemented in tandem with other supporting policies to overcome supply-side constraints in infrastructure, marketing and quality control for improvements in total factor productivity growth. A one-stop shop for fisheries and agriculture needs to be in place so as to reduce costs and raise competitiveness to boost exports. This requires investment, and given the dearth of local investment, FDI is crucial to kick start this development, but the investment climate must be improved, and political stability with a ranking of bottom 20 per cent in 2010 (World Bank 2010a) does not look promising.

## 7. Conclusion

This paper has investigated the potential macroeconomic and sectoral impacts of commodity booms and large resource projects on agricultural-based small island economies using PNG as a case study. Specifically, we examined the impacts of changes in the world prices of commodities (e.g. coffee, cocoa, copper, and gold), the impacts of the proposed LNG project, as well as the effects of strengthening the agricultural and fishery sectors through investment in infrastructure and capacity building.

Our simulation results indicated that PNG's reliance on primary commodity exports has exposed the economy to volatile economic growth. In boom times, commodities have had a positive effect on growth, although at the same time that has led to appreciation of the real exchange rate which has to some extent reduced the external competitiveness of the tradable agricultural sector. The LNG project, on the other hand, is shown to have a massive impact on GDP growth. However, there are typical Dutch disease effects in the form of appreciation of the real exchange rate and contraction of the tradable agriculture (cash crop) sector. This leads to a reduction in employment particularly in the rural areas. The clear winners are the service sectors which are mostly urban based. The output expansion of the agricultural and fishery sectors, on the other hand, has limited positive impacts.

The study's results pose a number of pertinent policy implications for PNG and similar small-island economies. First, proper macroeconomic management practices are required to mitigate the potential adverse effects of commodity booms and large resource projects such as the LNG project. In this paper, we advocate the establishment of a stabilisation fund to address commodity price volatility by smoothening government budget expenditures, and an off-shore investment fund to sterilise the effects of the Dutch disease. Second, the results show that investing in agriculture without supporting policies to restructure the economy and address supply side constraints is likely to have limited positive impacts.

There is a need to develop value-added industries such as agro-processing and light manufacturing potentially via FDI to establish forward and backward linkages that will see more benefit in the economy. Here, the European Aid for Trade development initiatives underlying the recently ratified Economic Partnership Agreement that PNG has with the European Union can play an important role in helping these sectors. Finally, policy coherence must be a top priority for the PNG government where the optimal strategy lies in the packaging and implementing of appropriate support policies. Ultimately, the key drivers for the much needed reforms (institutional and economic) have to come from within PNG to build up a strong commitment to chart a sustainable development growth path.

To conclude, it is noteworthy to consider the limitations of the model and possible future extensions. The current model, which has a single representative household, has limitations when it comes to conducting income distribution and poverty analysis as there are no intra-group income distribution changes. The model could be modified to include multiple households. Alternatively, it could be converted into a 'micro-macro' CGE model where the macro-(CGE) part computes the macroeconomic variables (e.g. price level and growth rates) as inputs for the micromodel. Future work could consider alternative strategies of investing funds from the booming sector to raise productivity in other resource sectors to mitigate the Dutch disease problem.

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## Appendix 1. List of commodities and industries in PNGGEM

| List of commodities | List of industries |
|---|---|
| Fruit, vegetables and betel nut | Traditional agriculture |
| Livestock | Smallholder coffee |
| Coffee | Smallholder cocoa |
| Cocoa | Smallholder palm oil |
| Palm oil | Smallholder copra |
| Copra | Smallholder other tree crops |
| Other tree crops | Plantation coffee |
| Other agriculture | Plantation cocoa |
| Fishing | Plantation copra |
| Forestry | Plantation palm oil |
| Copper | Plantation other tree crops |
| Gold | Plantation fruit and vegetables |
| Other minerals | Other agriculture |
| Petroleum | Machinery, repairs |
| Quarrying | Chemicals and oils |
| Timber processing | Other manufacturing |
| Food processing | Road transport |
| Beverages and tobacco | Water transport |
| Metals and engineering | Air transport |
| Machinery, repairs | Education |
| Chemicals and oils | Health |
| Other manufacturing | Electricity and garbage |
| Road transport | Building and construction |
| Water transport | Commerce |
| Air transport | Finance and investment |
| Education | Hotels, accommodation |
| Health | Restaurants, fast food |
| Electricity and garbage | Govt admin and defence |
| Building and construction | Other private services |
| Commerce | Informal services |

**Appendix 1.** (Continued)

| List of commodities | List of industries |
|---|---|
| Hotels, accommodation | Security services |
| Restaurants, fast food | |
| Finance and investment | |
| Govt admin and defence | |
| Other private services | |
| Security services | |
| Informal retail | |

Source: Levantis (2004).

## Appendix 2. Growth forecasts (%) in key macroeconomic variables

| Variable | 2011 | 2012 | 2013 | 2014 | 2015–2018 |
|---|---|---|---|---|---|
| GDP† | 6.2 | 2.8 | 2.1 | 8.5 | 9.3 |
| Domestic inflation† | 6.5 | 4.5 | 4.0 | 4.0 | 4.2 |
| World inflation‡ | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 |
| Population growth rate§ | 2.3 | 2.4 | 2.4 | 2.4 | 2.4 |
| Import prices¶ | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 |
| Government consumption expenditure†† | 7.3 | 6.8 | 2.1 | 5.0 | 5.6 |
| Government investment expenditure†† | 2.1 | 0.0 | 0.0 | 4.0 | 3.8 |

†Sources: Government Budget Statements for 2011. ‡IMF, *World Economic Outlook 2011*. §Based on 5-year average growth rates from the *World Economic Indicators* database of the World Bank. ¶Based on world inflation rates. ††Government projections based on 2011 Budget Statements.