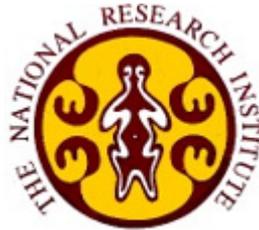**The National Research Institute**

Discussion Paper No. 108

Land reform in Papua New Guinea: Quantifying the Economic Impacts

by

Lindsay Fairhead, Gae Kauzi and Charles Yala

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The analysis in this paper was undertaken independently of the authors' institutions and of the National Research Institute, and the views expressed in this paper are those of the authors alone.

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INTRODUCTION

Land is the single most important material asset of the people of Papua New Guinea (PNG). From fertile soils, abundant marine life and rich mineral resources to some of the world's most biodiverse ecosystems and unique landscapes, land provides PNG with the potential for great prosperity. Yet this has not been PNG's experience.

Despite PNG's rich supply of land resources, there has been next to no progress in developing land-based industries such as agriculture and tourism. Past efforts to 'reform' land systems have largely failed. Barely five percent of land is currently contributing to economic development. Meanwhile, 79 percent of the country's population remain dependent on subsistence for their livelihood, earning less than K200 a year. Further, half of the rural population have little to no access to basic services.

In urban areas, there is an abundance of land, but a paucity of secure title. This is the case for both State alienated land and for customary land. The three percent of land that is under State ownership has not been well used because land administration has been poorly resourced. As a result, urban real estate prices are extremely high. Excessive rents undermine the living standards of public servants and private sector employees alike, forcing many to reside in disorganised squatter settlements without adequate services.

Recognising the vital importance of land for PNG's future prosperity, Prime Minister Sir Michael Somare launched PNG's own solution, the National Land Development Program in 2007. PNG's land program has four aspects:

- improving land administration;
- addressing land dispute settlement;
- developing a framework for mobilising customary land; and
- establishing a viable land properties market.

It is clear from the economic literature that the land reform program will benefit PNG. However, it was not clear by how much PNG would benefit, or whether some may benefit more than others. Therefore, the National Research Institute commissioned this research to estimate and quantify the economic impacts of PNG's land reform program using a computable general equilibrium model of the PNG economy.

The model analysis indicates significant gains to the PNG economy from implementing the land reform program, including in rural PNG, because land is so important for agriculture.

Modelling results also indicate that the timing of implementing the program is crucial. Delays in implementing the program will exacerbate high land prices currently experienced in urban areas where high population growth is outstripping the supply of secure land.

The remainder of this paper elaborates on these issues. PNG's land development program is explained in detail in Section 1. This is followed in Section 2 with a discussion of how PNG's land program fits in with the economic literature regarding the role of secure land title for development. In Section 3, the authors outline the PNG model, before describing the base case scenario in Section 4 and the assumptions behind the land development modelling in Section 5. The economic impacts of the land development program are reported in Section 6. Section 7 concludes with key policy implications.

SECTION 1: LAND IN PNG AND PNG'S LAND DEVELOPMENT PROGRAM

The National Land Development Program, PNG's land reform initiative, was launched in February, 2007 by Prime Minister Sir Michael Somare. It was originally conceived in August 2005 at the National Land Summit in Lae, Morobe Province, and then developed by the National Land Development Taskforce (National Land Development Taskforce, 2007).

The National Land Development Program is aimed at improving access to land for development. The land program is a significant initiative towards achieving the growth target of five percent per annum as set in the Government's own National Medium Term Development Strategy 2005–2010 (Government of Papua New Guinea, 2004). The land reform program focuses on four major themes:

- improving the system of land administration;
- improving the system of land dispute settlement;
- designing a framework for mobilising land held under customary title for development; and
- developing a viable real estate market.

These themes resulted from the recommendations of the National Land Summit in Lae. The National Land Development Taskforce comprised three expert committees that worked on these themes.

Land in PNG can be broadly classified into two major types — land held under formal tenure, and land held under customary tenure. Approximately three percent of the total land in PNG is under formal tenure administered by the *Land Act* 1996. The rest, 97 percent in total, is held under customary tenure, administered by custom. Given over 800 distinct languages in PNG, customary land tenure varies widely across the country.

Developing Access to Formal Land

Of the three percent of land that is under formal tenure, the majority is owned by the State. This land was largely alienated from the traditional customary landowners by the colonial government. State owned land can be further divided into land reserved for use by public service delivery agencies, leasehold and freehold.

The rest of the formal land consists of pockets converted to freehold by customary landowners using the *Land Tenure Conversion Act* 1963, special business leases issued under provisions provided for by the *Land Act* 1996, and special leases for major development projects such as mining, gas, petroleum and forestry projects.

There are two features of state owned land that currently undermine its use and bankability. First, land under state ownership, especially land that was alienated prior to independence, is increasingly being reclaimed by a new generation of customary landowners. The National Land Development Taskforce highlighted this as a growing problem, capable of undermining the productive utilisation of all land owned by the State (National Land Development Taskforce 2007:23). This problem undermines incentives to invest, especially for the long term, and weakens the bankability of all state land.

Second, the entire system of land administration is inefficient and dysfunctional, including town and physical planning; surveying; land allocation and the filing and storage of land records including titles. Practical examples include reported cases of mismatches between physical land and allotments indicated on survey plans; duplicate titles being issued over one piece of land and titles and files being destroyed by fraud or by moisture and decay. The inefficiencies in land administration undermine security of tenure; increase opportunities for rent-seeking which raises transaction costs and undermines the bankability of individual land titles on state land.

The system of land administration is fundamental to the efficient and productive use of land and the collateral use of land titles. Therefore the National Land Development Taskforce recommended a major overhaul of the entire formal land system.

Developing Access to Customary Land

In broad terms, land under customary tenure is collectively held by a social unit, consisting of clans or tribes. Within this are bundles of rights accessible only to individual members, often associated by lineage defined by birth or marriage. The rules that define and enforce security of property rights are understood and accessible to the members of the landowning social unit. In the purest customary land tenure system, there are no systems facilitating transactions with non members.

Features of customary tenure undermine incentives for productive members of the landowning social unit; raise information and transaction costs for non members and thwart the bankability of land.

Under customary tenure, productive members of the landowning social unit may not have exclusive access to:

- the most productive portion;
- optimal amount of land required for investment; or
- the flow of income and benefits from any investment they make on the land.

Without this access, productive members of the landowning social unit are deterred from expending time and money to improve productivity.

With respect to non members, the absence of a property market generally prevents productive non members from paying landowners to use their land. Generally, only non members with the financial capacity to coordinate landowners and thereby overcome the absence of a market have succeeded in accessing customary land.

Further, the absence of a clearly defined and enforced property rights system that is widely understood, accepted and enforced undermines the bankability of all land held under customary tenure.

In this context, it becomes clear why development of enterprises on land held under customary title in PNG has been of two extremes — either large scale or small scale. Operators with large economies of scale are able to invest in coordination strategies that mitigate the incentive and asymmetry of information problems inherent in customary land tenure. Real examples include large scale enterprises within the mining, petroleum, gas and forestry industries and large scale agricultural operators such as in oil palm. Producers without large economies of scale remain small operations.

The aim of reforming customary land tenure, within the framework of the PNG land reform program is to establish institutions that help overcome the incentive, information and coordination problems described above. The focus is on creating an incentive based system where customary landowning social units deposit their collective property rights and those with the ability, either from within or without the landowning social unit, access and utilise the land productively. In return, members of the customary landowning social unit derive incomes from availing their land.

Figure 1 represents the conceptual framework envisioned by the National Land Development Taskforce and drafted into Bills for Parliament by the Constitutional and Law Reform Commission (2008). The two pieces of legislation, the *Incorporated Land Groups Act (Amendment)* 1999 and *Land Registration Act (Amendment)* 1999, were passed unanimously by the PNG National Parliament on 19 March, 2009.

The objective of defining security of tenure over customary land is achieved by incorporating the social unit (clan, tribe or family) that claims customary land rights to the total land area. This is done by introducing major amendments to the *Incorporated Land Groups Act* 1974. A bundle of rights suitable for trading or leasing is placed into a central depository. The bundle of rights is created by incorporating a new chapter in the *Land Registration Act* 1974. Access to the property rights from the central depository by productive land users is administered by the *Land Act* 1996. Importantly, only the portion that the incorporated landowning social unit intends to deal on is registered. Furthermore, the stream of incomes defined by the *Land Act* 1996 accrues to the incorporated landowning social unit.

Figure 1: The Legal Framework of Customary Land Tenure Reform in PNG
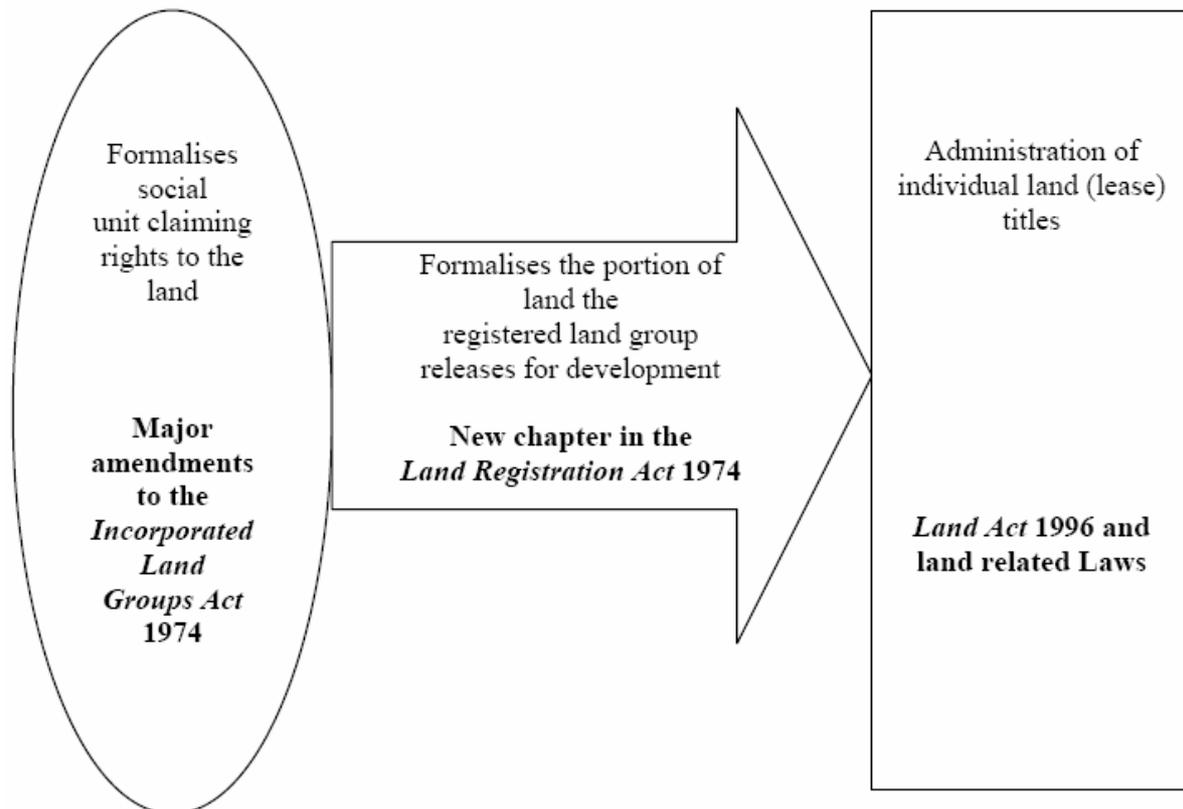
SECTION 2:THE ECONOMICS OF SECURE LAND TITLES AND ITS APPLICATION TO PNG'S LAND REFORM PROGRAM

There is a general agreement amongst economists that secure property rights have an important role to play in stimulating sustained economic growth. This section provides a short overview of this large literature with a view to defining the channels through which the PNG Government's land reform program can be expected to impact on the country's economic development. The discussion begins with an overview of the theory underpinning the economics of land titling, followed by an analysis of the problems and the interventions defined within the PNG land reform program.

The Economics of Secure Land Titles

Explaining the Standard Economic Framework

The standard framework for analysing the economics of land titling is reproduced in Figure 2. This framework was first used in an analysis of the land titling program in Thailand by Feder, Onchan, Chalamwong and Hongladarom (1988).

The conceptual framework is based on the premise that credit transactions are inherently risky (Feder and Nisho 1999). Lenders advance a loan against a promise by the borrower to repay the principle with interest. Because the lender has less information than the borrower about the prospects of full and timely repayment, collateral arrangements become important. Collateral improves the information content about borrowers and guarantees loan repayments.

Land with title is a fixed asset and therefore important loan collateral — in fact, the most important collateral (Barro 1976, Benjamin 1978, Plout 1985, Coco 2000). Without a land title, lenders cannot be assured that the intended borrower is indeed the owner of the land to be mortgaged. For these reasons, presentation of a formal land title is often a mandatory precondition for loans from mainstream financial institutions.

Figure 2 depicts two complementary channels — investment and credit — impacting positively on productivity, land values and income. The investment channel depicts demand for investment by the titleholder. Because the ownership of a land title grants the titleholder direct claims to the stream of income and benefits, the titleholder has the incentive to engage in productive investment activities. The titleholder will demand credit to meet both capital (investment) and operational (variable input) expenses. In exchange for the land title as collateral, financial institutions willingly supply credit to meet these expenses.

Access to credit increases the titleholder's ability to plan and develop the land optimally. At the same time, the titleholder has a greater incentive to invest in optimal investment projects and exert sufficient efforts because the borrower (titleholder) stands to lose the land title in the event that the loan is not repaid (default on the loan). The investment activity should therefore be able to generate income which is sufficient to meet the operating costs, service the loan, and remain profitable. The increased level of investment and supply of credit leads to improvements in the productivity of land. This in turn translates to higher land prices and incomes.

Figure 2 therefore represents well the dynamic system behind the land titling system. This system functions to increase investment, supply of credit, productivity, land values and incomes, thereby laying the foundation for broad-based sustained economic growth.

Figure 2: Land Ownership Security and Farm Productivity: A Conceptual Framework
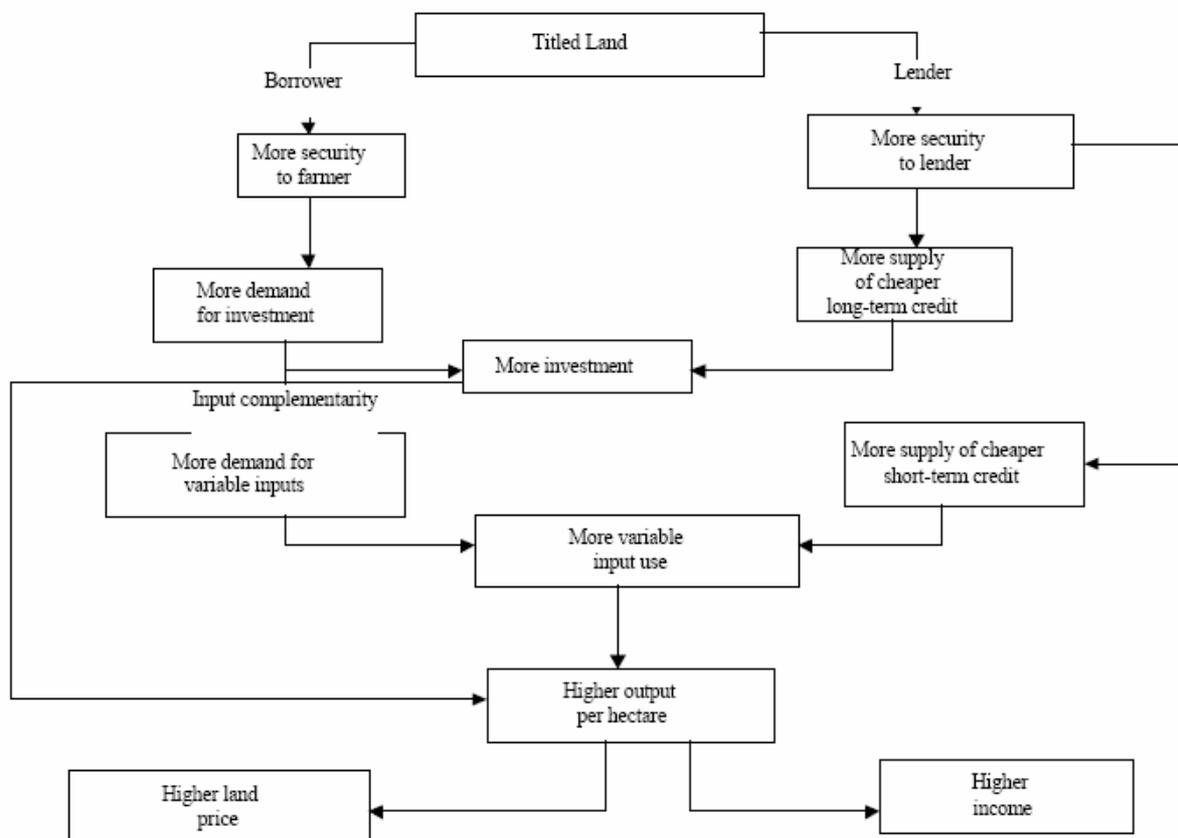
Source: Feder *et al.* (1988)

Review of the Empirical Literature

A review of a decade-long empirical literature on the economics of land titling (Feder and Nisho 1999) and an extensive review of the land policy and research (Deininger 2003) conclude that land reform efforts undertaken in South East Asia and to some extent, Latin America, support the linkages depicted in Figure 2. In contrast, results from reforms undertaken within the African continent are mixed. Payne, Durand-Lasserve and Rakodi (2008) reviewed the literature on land titling initiatives in the urban informal sector and failed to establish conclusive evidence of the expected positive social and economic impacts.

In addition to the seminal work of Feder *et al.* (1988) subsequent studies provide strong empirical support that securing title leads to higher levels of investments by providing the right incentives. Among these studies are Schweigert (2007), who used farm level data from Guatemala and Chand and Yala (2009), who used farm level data from PNG. Conversely, using farm level data from Ghana, Pande and Udry (2005) demonstrated that tenure insecurity led to lower levels of investment (represented by fallowing), ultimately reducing output by as much as one third.

There is a body of empirical evidence demonstrating the role that perception and belief play in raising land values and stimulating investments once security of tenure is established. Lanjouw and Levy (2002) examined data of self-assessed land values by households from slums in Ecuador. They found that belief in future gains from property registration raised the expected sale price of a plot by 23.5 percent after registration.

More recently, Jacoby and Minten (2007) provided evidence from farm level data collected in Madagascar that the issuance of land title raised the value of land by as much as six percent. Furthermore, Di Tella, Galiani and Schargrodsky (2007) provided empirical evidence from the analysis of attitudes and beliefs using household data from squatter settlers in Buenos Aires that, despite their socio-economic situation, households with land titles had attitudes that were more individualistic and materialistic.

Another stream of literature that is very relevant for PNG demonstrates that the credit channel may remain ineffective for those operating on a small scale. Carter and Olinto (2003) directly tested the credit channel with farm level data from Paraguay and established that the credit channel did not work for farms with less than 20 hectares. Yala (2008) analysed the data from smallholder oil palm growers in PNG and found that the credit channel remained ineffective, even for farmers with formal land titles on state land. Galiani and Schargrodsky (2006) found that investments by squatter settlers in Buenos Aires, including to improving the quality of their housing, were funded out of pocket expenses. This implies that they were unable to access credit despite secure title.

The literature also demonstrates the value of an efficient property market. When a market operates well and with minimal transaction costs, property will be transferred to the most efficient users, as they can afford to pay the highest prices. This is demonstrated, for example, in the work of Deininger and Jin (2008). They analysed a large and nationally representative panel data set from Vietnam and found that both the land rental and the sales markets led to more productive land use because land is transferred to the most able producers.

Again, of importance to PNG is a growing body of evidence that titles are only valuable to the extent that they can be enforced. Inefficiencies in institutional design and lack of enforcement undermine security of land tenure and negate the usefulness of land titles. Broegaard (2005) examined farm level data collected in Nicaragua. This data revealed a lack of enforcement of titles arising from deep rooted social, economic and political arrangements that maintained inequality, poverty and the exercise of violence.

This situation undermined land tenure security for farmers with formal land titles. Atwood (1990) provided evidence based on data from Kenya that the absence of state institutions in defining and enforcing property rights results in the emergence of an informal system that competes with the modern system of land administration. Yala (2008) reported that an inefficient system of land administration in PNG contributed to poorly defined and poorly enforced property rights on land owned by the state. This undermined the security of tenure for smallholder oil palm growers with formal land titles.

Consistent with this thread from the literature, the policy emphasising land reform has shifted from initiatives focusing purely on 'individual land titling' (World Bank, 1975) to 'security of land tenure' (World Bank, 2003). Under the new theme of security of tenure, the emphasis is on the design of institutions that efficiently define and enforce property rights. Security of tenure in this case is the byproduct of institutional design, implementation and enforcement of these rights. Fitzpatrick (2005) empirically tested a dozen property rights systems from different parts of the developing world, including PNG. He concluded that there were no best fit models and each country should design institutions that take into account their own country's social, economic, and political context. The PNG land reform initiative is motivated by these very considerations.

Linking the PNG Land Reform Initiative to the Conceptual Framework

The land reform initiative in PNG has four major components:

- designing a framework to mobilise land held under customary tenure;
- creating a land court system to adjudicate disputes on customary land and to enforce the security of property rights over customary land;

- improving systems of land administration; and
- developing institutions required for a properly functioning land and properties market.

It is useful to consider these interventions within the context of the conceptual framework presented in Figure 2. This shows the theoretical basis for the PNG land reform program and ties into the economic modeling of this initiative. To aid in this consideration, a modified version of Figure 2 is presented as Figure 3. In Figure 3, the box at the top end with the inscription "underlying land" captures the first two aspects of customary land tenure reform. They are defining security of customary land tenure and creating a central depository of property rights. This box also covers the creation of a land court system to adjudicate land disputes and the development of a framework to resolve the problem of land reclaims by new generations of customary landowners over state owned land.

The second box with the inscription "individual land title", includes the third stage of customary land tenure reform, this being the administration of leases accessed through the central depository under the *Land Act* 1996. It also covers reforming the entire system of land administration. Introducing market enhancing institutions would be an important component of improving the administration of land. Successful implementation of the land program is expected to improve security of tenure over all land with formal titles. This is expected to positively impact on productivity, on income and on the value of newly titled land, through the various linkages discussed earlier. Further, while the value of newly titled land will increase, the increased supply of land to the rest of the economy will reduce the economy-wide cost of land. Quantifying these impacts is the focus of the remainder of this paper.

Figure 3: Expected Economic Impacts of the PNG Land Reform Initiative
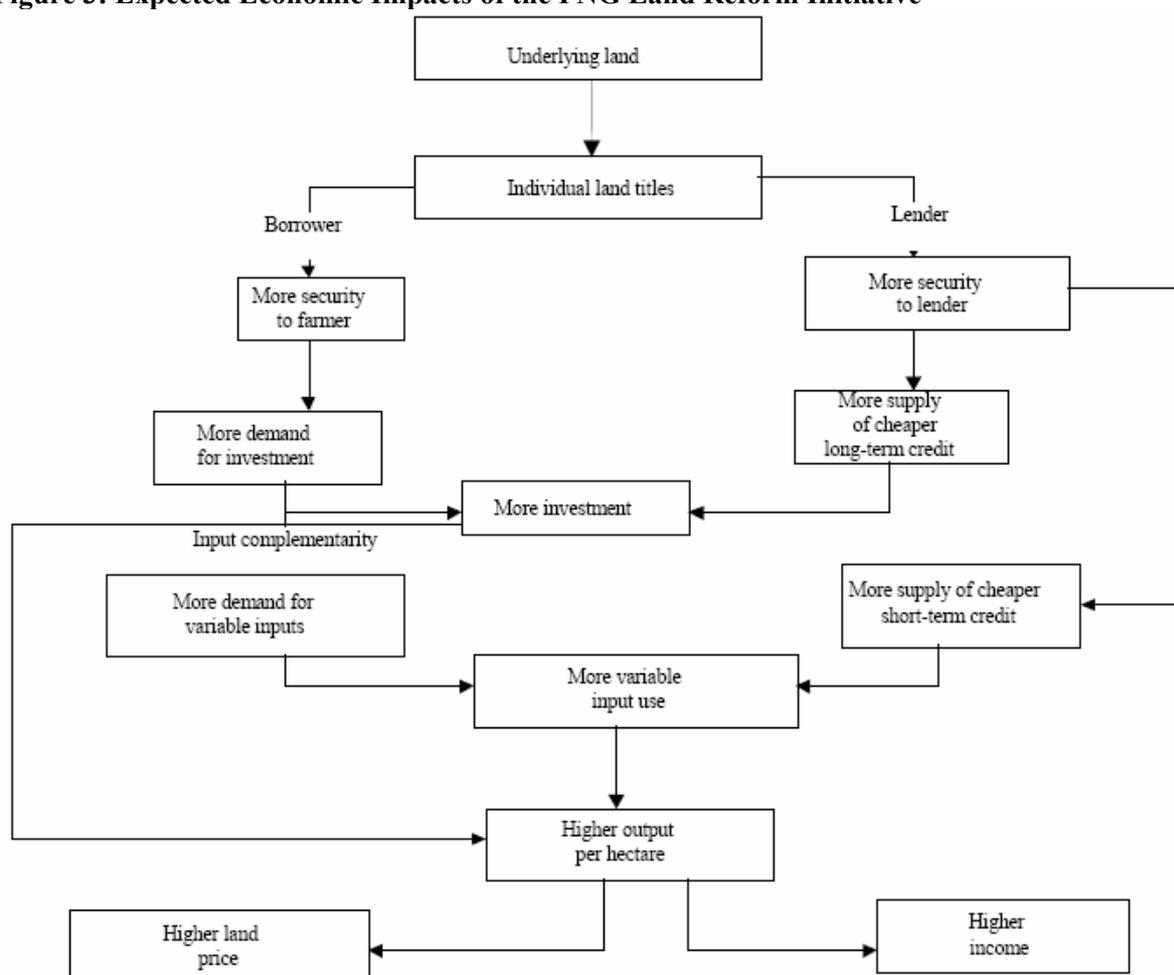
SECTION 3: THE PNG CGE MODEL

The PNG CGE model is a dynamic, computable general equilibrium model of the PNG economy with a detailed database. As such, it provides an ideal framework for measuring the economic impacts of land reform.

As a general equilibrium model, it represents every market and sector of the PNG economy. Combine this with its comprehensive input-output data, and the model is able to measure the impacts of a major policy such as land reform on many different sectors and takes into account the various feedback effects that occur across the economy. Further, because the model is dynamic, it can be used to quantify the economic impacts of a policy such as land reform for many years into the future.

The theoretical underpinnings and database of the PNG CGE model are explained in this section.

Theoretical Framework of the PNG CGE Model

The PNG CGE model was developed by Levantis (1997; 2004). It is derived from the static ORANI model of the Australian Economy (Dixon, Parmenter, Sutton and Vincent, 1982) and ABARE's dynamic Austem model of Australia (Levantis 2002).

Being a general equilibrium model, prices and quantities adjust so that demand is equal to supply in every market and in each period (Dervis 1975 and Dixon, *et al*. 1982). This means that the model takes into account the sometimes complex interactions between various parts of the economy, and comes up with the net change on each sector and in each market.

The model is dynamic in the sense that it is run one year at a time and the database is updated at the end of each year. Therefore, among other things, capital stock and investment are linked through time. Specifically, the closing capital stock of an industry at the end of each year is the opening capital stock at the beginning of next year. Capital stock changes over the year as a result of investment and depreciation. The model can therefore be used to project a path of economic development many years into the future.

The equations of the model reflect the structure of the PNG economy, describing for some time period:

- producers' demands for produced inputs and primary factors;
- producers' supplies of commodities;
- demand for inputs to capital formation;
- household demands;
- export demands;
- government demands;
- the relationship of basic values to production costs and purchasers' prices;
- market-clearing conditions for commodities; and
- numerous macroeconomic variables and price indices.

Within the model, the behaviors of economic agents are assumed to conform to conventional neoclassical microeconomics. Consumers are assumed to maximise their utility subject to a budget constraint, according to a Stone-Geary functional form. Producers are assumed to minimise costs in their use of intermediate inputs and primary factors through a constant elasticity of substitution (CES) function. Further, some primary sector producers supply multiple commodities and in doing so are assumed to maximise revenues under a constant elasticity of transformation (CET) function. There are also equations, mainly derived from identities and definitions, for the government and macroeconomic variables.

All equations are converted into their linear form before being introduced into the model as this makes it easier to arrive at a solution. The ease of computation is also assisted by the separability of functions. Separability means that the components of the model's system of equations can be distinguished and solved separately. This greatly simplifies the specification of demand and supply relationships.

Within the model, commodities used as inputs to production and for final consumption can either be imported or purchased from domestic producers. Commodities from the two sources are treated as imperfect substitutes, in line with the work by Armington (1969). The advantage of the Armington approach is that the choice between imported and domestic commodities is not extremely price sensitive.

This means that while there can be some shift between domestic or imported varieties of a commodity in response to relative price changes, there cannot be a complete shift to the extent that only one variety is used. This is consistent with the real world where one commodity comes with different varieties. For example, furniture in PNG is both imported and manufactured locally. Domestic furniture and imported furniture are not perfect substitutes, so that if the price of locally made furniture was to be reduced, Papua New Guineans would still buy some items of imported furniture.

The whole system of differential equations can be solved by conventional numerical integration techniques. When solving a differential set of equations such as this model, the solution does not take into account the second order differential and therefore becomes inconsistent with the true solution.

This is often called linearisation error. This error is less when the size of shocks to the model is smaller. Therefore, the error can be reduced by dividing assumptions into smaller, equal parts and solving for one part at a time. The error can be further reduced by the standard Euler extrapolation procedure, which predicts where the true solution lies based on a series of multiple steps. For this study, a multiple step Euler solving procedure with extrapolation was employed. It was found that this approach eliminated any significant linearisation errors.

In sum, the PNG CGE model is a general equilibrium model that:

- incorporates inter-temporal capital-investment dynamics;
- derives demand and supply relationships from neo-classical micro foundations;
- specifies multiple products from multiple industries;
- is specified in linear form and employs numerous separability assumptions;
- adopts the Armington assumption for substitution between different varieties of the same commodity; and
- uses a Euler multiple step solution technique.

For other details of the model, refer to Levantis (2004)

The Database for the PNG CGE Model

The PNG CGE model uses input-output tables as the main data input and as the source of the model's initial solution. The database is comprehensive, representing 39 commodities produced by 42 industries (see Table 1). In addition, because of the substantial economic impact of criminal activities in any developing economy, crime is explicitly modelled as an industry that offers the working age population an alternative source of income and that imposes a cost on all other sectors. Further explanation of the modelling of crime is provided in Levantis (1997; 1998).

Table 1: Industries and Commodities in the PNG CGE Database

Industries	Commodities
Subsistence agriculture	Fruit and vegetables
Smallholder coffee	Livestock
Smallholder cocoa	Coffee
Smallholder palm oil	Cocoa
Smallholder copra	Palm oil
Smallholder other tree crops	Copra
Large scale coffee	Other tree crops (rubber and tea)
Large scale cocoa	Other agriculture
Large scale palm oil	Fish
Large scale copra	Forest (logs)
Large scale other tree crops	Copper
Large scale fruit and vegetables	Gold
Other agriculture	Other minerals (silver, nickel)
Fish	Petrol (crude and refined oil)
Forest	Quarrying
Gold	Timber products
Ok Tedi Mining	Food
Other mining	Beverages and tobacco
Crude and refined oil	Metals
Quarrying	Machinery and repairs
Timber	Chemicals
Food	Other manufacturing
Beverages and tobacco	Road transport
Metals	Water transport
Machinery and repairs	Air transport
Chemicals	Education
Other manufacturing	Health
Road transport	Electricity and garbage services
Water transport	Construction
Air transport	Commerce
Education	Hotels
Health	Restaurants
Electricity and garbage services	Finance and investment services
Construction	Government services
Commerce	Other services
Hotels	Security
Restaurants	Informal goods and services
Finance and investment services	Costs of crime
Government services	
Other services	
Security	
Informal sector	
Criminal sector	

The data in the PNG CGE database is summarised in Table 2. The model uses this data to generate the other data required for the purposes of calculation and reporting.

Table 2: Key Data in the PNG CGE Database

Government Revenue
• Tax rates for GST, company income tax, personal income tax, excise, tariffs, production tax and export tax
• Foreign aid
• Receipts from investment and shareholdings
Government Outlays
• Consumption spending by commodity and by source
• Investment spending by commodity and by source
• Transfers to households
• Government savings
Household Sector
• Household spending by commodity and by source
• Income from domestic investment
• Income from foreign investment
• Other income from overseas
• Private savings
Labour Market
• Average wage rate by skill type, by industry and for both rural and urban areas
• Wage bill by industry
Production Sector
• Industry production of each commodity
• Primary factor requirements of each industry
• Intermediate inputs for each industry
• Investment spending by commodity and by source
External Sector
• Exports by commodity
• Imports by commodity

Disaggregating Land from the Database

Given the significance of land for this analysis, the PNG CGE database has been expanded to include land as a separate primary factor for each industry. Hertel, Rose and Tol (2008) is a recent comprehensive review of the literature on the topic of disaggregating land in CGE models. Hertel, Rose and Tol (2008) report land has often been incorporated into the agriculture sectors of a CGE model. Kumar, Asafu-Adjaye and Levantis (2004) go the next step and add land into every industry for a CGE model of Fiji. Likewise, this study adds land into every industry of the PNG model.

Land is represented in the PNG model with a simple framework. The average economy-wide price of land is the share weighted sum of the land price in each industry. The land price in each industry depends on the extent of demand for land within each industry, which in turn reflects the pace of the industry's growth in production.

The aggregate supply of land is set constant in the base case to represent that the disincentives are such that no additional customary land enters the cash economy. Similarly, this assumption is consistent with state owned land remaining underutilised.

Land that is available to the economy is allocated among different industries in order to maximise the returns to the landowner, using a constant elasticity of transformation function. This function increases the share of land allocated to those industries for which the price is rising at a rate that exceeds that of the economy-wide price. Therefore, those industries with the fastest growing demand will increase their share of land at the expense of slower growing industries.

For example, if the smallholder coffee sector is expanding faster than the large scale coffee sector, the smallholder sector will have a greater need for land and therefore place a higher value on land than the large scale sector. As a result, the smallholder coffee sector will increase its share of the total land supply at the expense of other industries, including the large scale sector.

The extent to which an industry's allocation of land changes in response to the change in its price depends on an elasticity of transformation. The elasticity is the responsiveness or sensitivity of land supply to a change in prices. For the purposes of this study, the transformation elasticity is assumed to be the same for all industries and is set at 0.5, based on Kumar, Asafu-Adjaye and Levantis (2004).

The initial allocation of land is provided in the database. For most industries, this initial allocation is based on the share of land in the industry's total costs reported by the National Statistical Office (1990). However, more detailed data was available for forestry and subsistence agriculture from Kumar, Asafu-Adjaye and Levantis' (2004) Fiji model database. Given that forestry and subsistence agricultural practices across the Pacific are not dissimilar, this data is used in the PNG database.

Updating the Database

For the purposes of this analysis, the database has been updated from 2001 to 2007. The 2001 database and model are documented in Levantis (2004). The 2007 database was created by simulation, targeting the 2007 values for key data. Table 3 lists the data that were targeted together with the relevant sources.

Table 3: Data and Sources Used to Update the Database

Economic Data Targeted	Sources of Historical Data
Government expenditure and tax rates	Department of Treasury (2008)
Exports by industry and total	Bank of PNG (2008)
Private aggregate investment	Bank of PNG (2008); National Statistical Office (2008)
Private aggregate consumption	Bank of PNG (2008); National Statistical Office (2008)
Wage bill – employment and wage rates	Bank of PNG (2008); National Statistical Office (2008)
Foreign aid; net private unrequited transfers; gross private receipts of investment income from abroad	Bank of PNG (2008); Department of Treasury (2008)

SECTION 4: THE BASE CASE SCENARIO

To analyse the economic impacts of land reform, it is first necessary to develop a base case scenario. The base case scenario represents one possible path along which the PNG economy may develop assuming no significant change in policy. The base case provides the backdrop against which the importance of land reform policies can be assessed.

The key assumptions and results of the base case scenario are presented in this section.

A Description of the Base Case Scenario

The base case scenario is simulated for each year in the period 2007 to 2020. Four key factors determine the path of economic growth and development in the base case:

- global economic conditions;
- the decline in capacity of oil wells to 2013;
- macroeconomic policy; and
- improvements in productivity and efficiency.

The base case does not include the development of PNG's vast reserves of natural gas by 2020, estimated at 440 billion cubic metres in 2007 (BP 2008). The recently confirmed proposal to proceed with the PNG LNG project will result in stronger rates of base case growth and will also impact on land reform. However this analysis is left for future study.

The downturn in the global economy is assumed to recover between 2010 and 2013. Beyond 2013, global economic conditions are assumed to stabilise, with strong economic growth in China and India and moderate growth in the developed economies of Japan, the United States, Europe and Australia.

The crisis is represented in the model by its assumed impact on global prices and on domestic production in the export oriented minerals and agriculture sectors. Global price assumptions to 2020 for each of PNG's key minerals and agriculture exporting sectors are sourced from the World Bank (2008). Assumptions about domestic output growth in these same sectors were based on projections from various sources as listed in Table 4.

Table 4: Base Case Assumptions about the Future

Economic Variables	Sources of Assumptions
Government expenditure and revenues.	Department of Treasury (2008).
Commodity export values and/or output volumes.	Department of Mining; Department of Petroleum; Department of Treasury (2008), PNG Commodity Boards and Industry Corporations and Bank of PNG.
International commodity prices.	World Bank (2008).
Labour supply.	Department of Treasury (2008).

At current levels of production, PNG's current proven reserves of crude oil would be exhausted within the decade (United Nations Statistics Division 2008). It is likely that additional capacity will be proven into the future, particularly if world oil prices remain high. However PNG's crude oil companies currently schedule a strong decline in production in the immediate future, particularly from 2010. After 2013, it is assumed that sufficient additional reserves are proven up such that crude oil production recovers moderately at least until 2020. Without assuming some recovery in crude oil production, PNG's economic growth would remain near zero throughout the projection period of the base case.

Macroeconomic policy is a significant determinant of economic growth. The Bank of PNG is assumed to adopt an easy monetary policy stance between 2010 and 2013, in response to slow economic growth associated with the global downturn and the contraction in crude oil production. The Government's fiscal response has already been announced in the 2009 Budget (Department of Treasury 2008). The announced tax and spending measures are assumed in the base case.

Productivity growth occurs in most economies, for example as a result of education, the development of new technologies and the adoption of more efficient production methods. For the purposes of the base case, it is assumed that productivity in PNG improves over time. Primary factor productivity growth is assumed higher in primary industries, such as agriculture and mining, on the grounds that this is where most investment in both human capital and physical capital in PNG is concentrated (see Table 5). Productivity growth rates were calibrated so that from 2013, real GDP grows by over two percent a year – approximating the 2.6 percent growth in real GDP achieved between 2001 and 2006 (National Statistical Office 2008).

Table 5: Annual Growth in Productivity Assumed in the Base Case Scenario, 2007–2020

	Primary Industries (%)	Other Industries (%)
Primary factor productivity	2.0	1.5
Intermediate input efficiency	0.5	0.5

The Economic Path of Development in the Base Case Scenario

Under these assumptions, PNG's real GDP in 2007 kina rises by 17 percent from an estimated K18 620 million in 2007 to K21 733 million in 2020 (see Figure 4). Most of this growth is concentrated in the period from 2013 to 2020, where real GDP increases by 15.5 percent. Prior to 2013, economic growth is undermined by the decline in crude oil production.

Figure 4: GDP in the Base Case Scenario in 2007 Prices
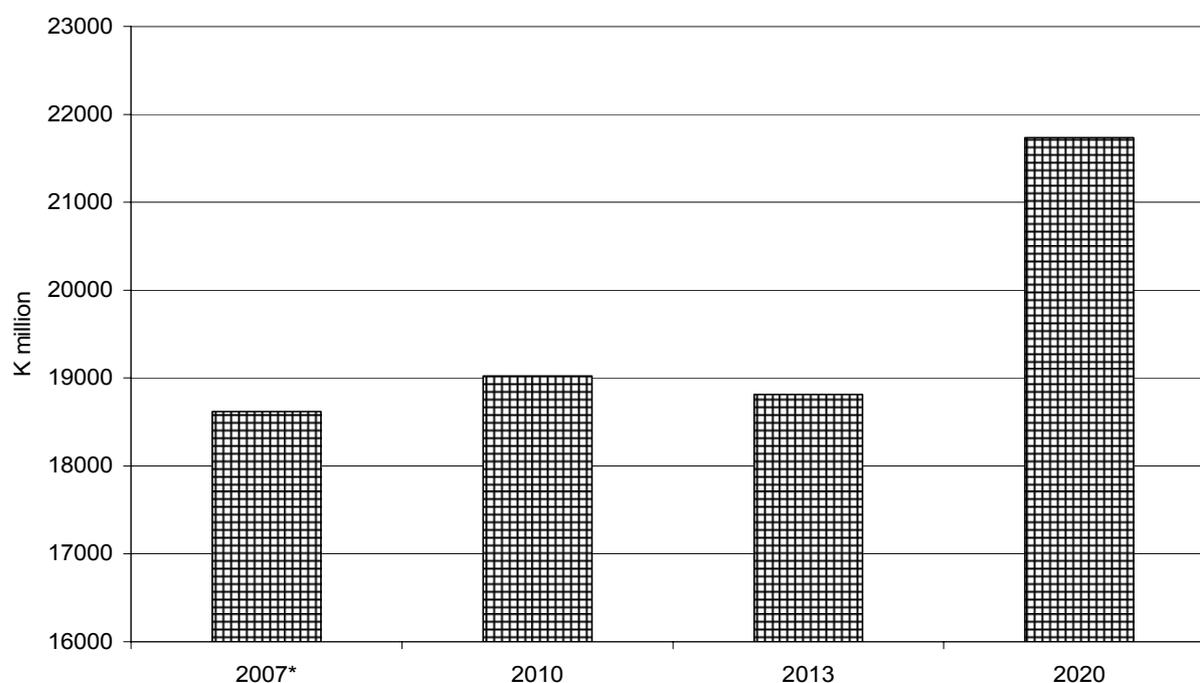
*authors' estimate

Despite assuming a recovery in the global economy from 2010, the base case projects positive growth to 2010 and negative growth in 2010–2013. This is explained by a closer look at exports (see Figure 5).

Gold producers as a whole in PNG anticipate growing export volumes by an average of 12 percent a year between 2007 and 2010. At least in part this is in response to higher demand emanating from the global financial crisis. Gold has traditionally been regarded as a safe haven for investors during times of financial crisis. Most recently, demand for gold has risen significantly and as a result, the price of gold has increased from US$709.50 an ounce in November 2008 to remain above US$900 an ounce in January and February of 2009.

In contrast, between 2010 and 2013, crude oil exports contract by an average rate of 20 percent a year. At the same time, there is little to no growth in exports of gold or of other mineral commodities. Non mineral exports grow by between two and three percent a year on average in 2010–2013, driven by the recovery in global demand. However, the share of non mineral exports is too small to offset the decline in crude oil exports.

Figure 5: Exports in the Base Case Scenario in 2007 Prices
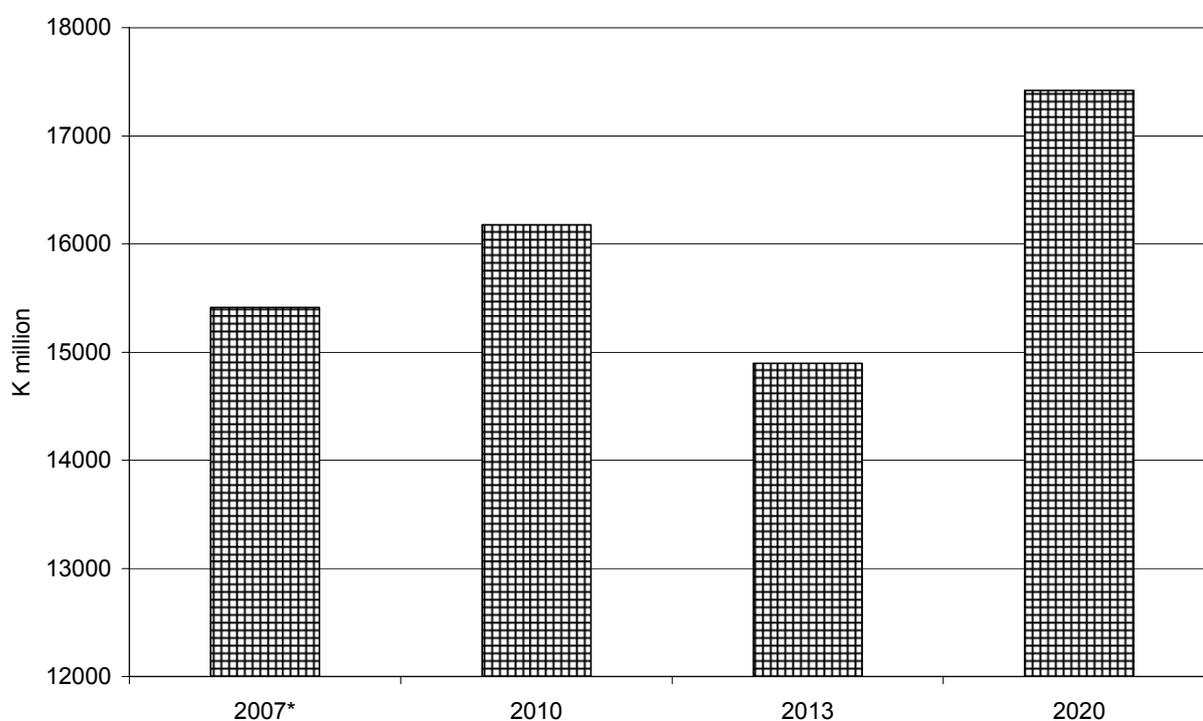
*authors' estimate

The discrepancy between sectors is brought out more clearly in Figure 6, which shows the growth in production by sector. As a result of crude oil production contracting sharply, total mineral output is 10 percent lower in 2013 than in 2007 (as indicated by the index of 0.9 in 2013 where 1 is the level of output in 2007). In contrast, production in all other sectors generally expanded steadily throughout the projection period. For example, the rural sector, which consists of agriculture, forestry and fisheries, is 25 percent larger in 2020 than in 2007 (as indicated by the index of 1.25 in 2020).

Figure 6: Real Output Growth by Sector in the Base Case Scenario

index: 2007=1

Legend: Services, Manufacturing, Minerals, Rural
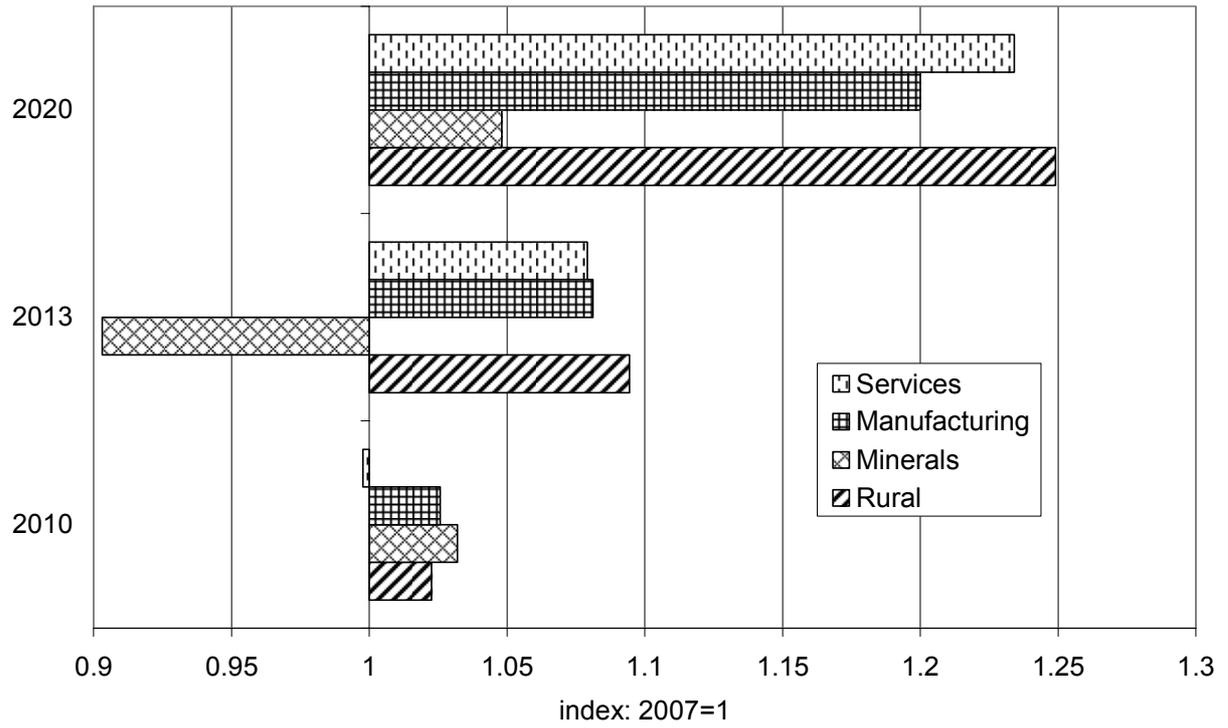
SECTION 5: A DESCRIPTION OF THE LAND REFORM SCENARIOS

To simulate land reform, the change in policy is added to model, on top of the underlying base case assumptions. In response to this change, the model maps out a new path of the economy. The deviation between the two paths is the impact of land reform. The CGE models are designed to undertake this type of analysis (Kauzi, 2003).

The simulations of land reform in the PNG CGE model are based on the review of the literature and of PNG's land reform program in Section 1. In order to simulate land reform, the initial impacts of land reform predicted by the literature are introduced into the model as assumptions. The model then estimates the flow on effects upon all parts of the economy, providing a detailed assessment of the importance of land reform for economic development in PNG.

Five assumptions are introduced into the model to simulate land reform in PNG. These concern:

- timing of the implementation;
- the cost of the land reform package;
- increased productivity;
- a rise in returns to investment; and
- increased supply of customary land, made available to the land market.

There is uncertainty about how much productivity, investment and land prices may respond to land reform. Three alternative scenarios are considered to account for this uncertainty — a moderate scenario, a low impact scenario and a high impact scenario. These assumptions are explained in this section and summarised in Table 7.

For the purposes of this analysis, it is assumed that implementation of each of the four main components of the land reform program is underway by 2010. While the benefits of reform will continue to unfold over time; the model is only applied to the first 10 years of implementation, from 2010 to 2020. Were there are to be delays in implementing reform, the benefits in this period would be commensurately lower.

The Government of Papua New Guinea (2009) estimates that land reform will require a commitment of K81.3 million from the Government over a number of years. For the purposes of this analysis, it is assumed that the K81.3 million is spent evenly over a period of 10 years from 2010 to 2020, amounting to K7.4 million each year. This excludes the increased administrative costs that will be incurred as a result of much more land being brought into the formal system.

According to the literature, providing security of title over land will result in an increase in investment on the newly secured land. This in turn will lead to more productive equipment and practices (see Section 1). Quantitative estimates in the literature include that of Feder *et al.* (1988), which found that secure title to land improved the productivity of farmers in Thailand by between 12 and 27 percent with a 90 percent confidence level.

The extent to which investment and productivity may increase as a result of providing secure land title will vary from country to country and from industry to industry. For example, there are opportunities for oil palm growers to raise productivity in the Hoskins Oil Palm project in West New Britain Province (Chand and Yala 2009). As a result of better management practices and optimal economies of scale, the most efficient set of producers were 31 percent more productive than the average grower, as measured by yield, where yield is output per hectare.

This estimate from Chand and Yala (*ibid.*) is consistent with FAO (2009) yield data. FAO (*ibid.*) provides estimates of the yield for agricultural commodities for 210 countries. Table 6 compares the yield of PNG's cash crop sectors with the average yield of the 10 most efficient countries in the FAO

database. Consistent with Chand and Yala (2009), FAO data indicates that PNG's oil palm sector as a whole could potentially increase its yield by 28 percent.

This FAO data forms the basis for the productivity assumptions introduced into the land reform simulations. Assumed improvements in productivity are reported in Table 7. It is recognised that FAO data will contain inaccuracies. For instance, some of the data for PNG are sourced from unofficial figures (FAO 2009). However the advantages of relying on FAO outweigh the disadvantages. In particular, it is comprehensive in its coverage of key producing countries and key commodities, and the accuracy of the FAO estimate of yield, at least for oil palm, is supported by the work of Chand and Yala (2009).

Table 6: Yield Comparison, Average over 2000–2007

Agricultural Sector	PNG (kg/ha)	Average of the 10 most Productive Countries (kg/ha)	Improvement for PNG to Reach World Best (%)
Oil palm	15 205	19 577	28
Cocoa	428	861	101
Coffee	955	1 950	104
Tea	1 284	2 830	120
Coconut (copra)	3 383	9 580	183
Rubber	5 000	15 756	215

Source: FAO (2009)

When using the FAO data to develop productivity assumptions for the agricultural industries, a distinction is made between smallholder growers, who tend to mix subsistence farming with some cash cropping, and larger scale growers, such as block holders and plantations. The literature presented in Section 1 finds that small scale farmers are generally unable to access credit, despite having secure tenure. Therefore, in line with the literature, it is assumed that smallholder growers benefit less from land reform than larger operators.

FAO data is available for agriculture and not for manufacturing, services and mining industries. Therefore, for these industries it is assumed that productivity improves at a low rate, just below that assumed for palm oil.

Productivity improvements are assumed for capital as well as for land, given that improving the security of land tenure provides the incentive for investing in new capital as well as in new ways of working the land. New equipment or better maintenance of existing equipment will in turn improve the capital productivity of a business. Nonetheless, to allow for uncertainty regarding the extent to which productivity may rise following improvement in land security, productivity assumptions are varied in the alternative land reform scenarios.

To approximate the increase in investment that may follow from land reform, it is assumed that the risk premium on investment in PNG declines by a very conservative one percent per year from 2010 to 2020. This assumption is introduced into the model by reducing the nominal interest rate. A very conservative improvement has been assumed because of the lack of literature and data with which to guide the estimate. Again, this assumption is varied in the alternative scenarios to account for the uncertainty concerning how much the risk premium will be reduced by improving land security.

In the base case, it is assumed that the land available to the mainstream economy is fixed. This is a plausible assumption given that 34 years after independence, approximately 95 percent of PNG's total land area remains unavailable to the formal cash economy. The basis for this estimate is twofold.

Table 7: Assumptions in Each Land Reform Scenario, 2010–2020

	Low Impact	Moderate Impact	High Impact
Cost of Land Reform Package	K7.4 million each year from 2010 to 2020		
Land Productivity – Percentage Improvement between 2010 and 2020			
Smallholder coffee	21	35	52
Smallholder cocoa	20	34	51
Smallholder oil palm	1	10	14
Smallholder copra	42	61	92
Smallholder other tree crops	33	49	73
Large holder coffee	63	104	104
Large holder cocoa	61	101	101
Large holder oil palm	3	29	29
Large holder copra	127	183	183
Large holder tree crops	98	147	147
Other agriculture	58	97	97
Forestry, fish and manufacturing	3	29	55
Commerce, hotels, restaurants and finance	3	29	55
Mining, quarrying and other services	3	29	55
Capital Productivity – Percentage Improvement between 2010 and 2020			
Smallholder coffee	21	35	52
Smallholder cocoa	20	34	51
Smallholder oil palm	1	10	14
Smallholder copra	42	61	92
Smallholder other tree crops	33	49	73
Large holder coffee	63	104	104
Large holder cocoa	61	101	101
Large holder oil palm	3	29	29
Large holder copra	127	183	183
Large holder tree crops	98	147	147
Other agriculture	58	97	97
Forestry, fish and manufacturing	3	29	55
Commerce, hotels, restaurants & finance	2	14	25
Mining, quarrying and other services	0	0	0
Percentage Reduction in Risk Premium on Investment	0.5	1	2
Percentage Change in Average Price of Land between 2010 and 2020	5	0	-5

First, there is the often quoted figure that three percent of PNG's land is currently alienated (Investment Promotion Authority 2009; Hanson *et al* 2001). Secondly, FAO (2009) data reports that just over one percent of PNG's total land area is used to grow cash crops. Given that both alienated land and customary land are used to grow cash crops, but allowing for a margin of error in the FAO data, it is a conservative estimate to say that the current formal cash economy of PNG utilises less than five percent of the nation's total land area.

The purpose of land reform is to create the right incentives and the right framework so that customary landowners can gain from using their land in the cash economy. Therefore, the final assumption in simulating land reform is that from 2010 onwards, the supply of securely titled land is able to rise in response to the demand for land. This influx of new securely titled land will depress the extreme prices currently experienced in urban areas of PNG. In the moderate scenario, land supply rises sufficiently to keep the average price of land at 2010 levels throughout the simulation period. To allow for uncertainty about how much land prices may deviate, the change in the average price of land is allowed to vary in the alternative scenarios as reported in Table 7.

The model endogenously depicts the development of roads and other services that will be required to underpin the projected economic expansion resulting from land reform. To the extent that these required services are not provided, the gains from land reform will be reduced.

SECTION 6: THE ECONOMIC IMPACTS OF LAND REFORM

Land reform is projected to deliver substantial economic benefits to PNG. Land reform contributes not just to stronger economic growth, but to broad based development, to prosperity in rural areas and to the alleviation of poverty. Furthermore, inflated real estate prices will ease as constraints on the supply of secure land are removed.

The Overall Impacts

Land reform is projected to have significant positive impacts on the broad economy of PNG. Under each land reform scenario, PNG's GDP growth is much higher than in the base case scenario. In the base case scenario, GDP grows by an average yearly rate of 1.3 percentage points between 2010 and 2020. Under land reform, GDP growth is higher, averaging an annual rate of 2.5 percent over the same period in the moderate impact scenario, 2.9 percent in the high impact scenario and 1.9 percent in the low impact scenario (see Figure 7).

Figure 7: Average Annual Growth in GDP under Alternative Scenarios in the Years 2010–2020
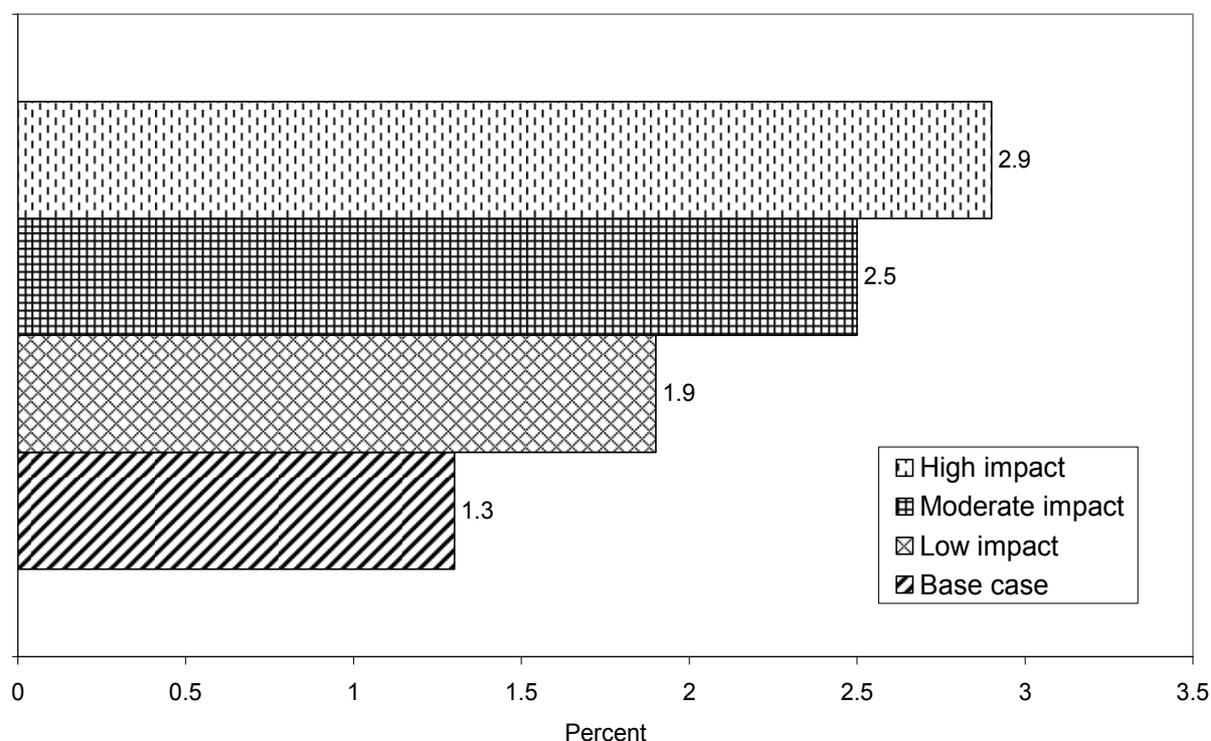

As a result of this stronger growth, the economy of PNG becomes considerably larger than under the base case scenario. By 2020, in the moderate impact scenario for example, PNG's GDP is 14 percent greater than in the base case scenario (see Figure 8). This is equivalent to 3 billion kina of additional GDP in 2020.

Figure 8: The expansion in GDP under land reform compared with the base case
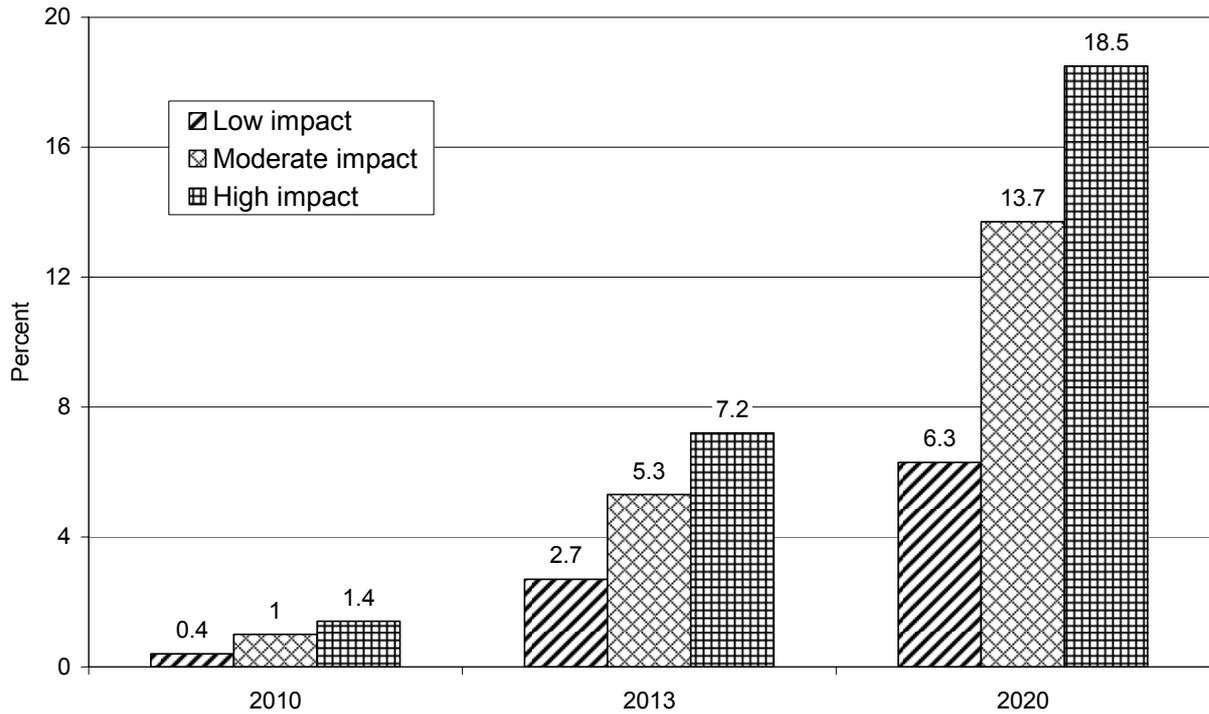

The gain in GDP for each year from 2010 to 2020 can be added together to get a picture of the total present value of implementing land reform. This is only part of the value of land reform, as it only counts the first 10 years of reform. The value in 2010 of future gains is calculated by assuming a discount rate of five percent. Under the moderate impact scenario, the cumulative GDP gain from land reform is valued at 12.3 billion kina in 2010 values (see Figure 9). To put this value into context, the National Statistical Office reported that PNG's GDP was K17 billion in 2006.

Figure 9: The Cumulative Gain in GDP from Land Reform Discounted to 2010 Values
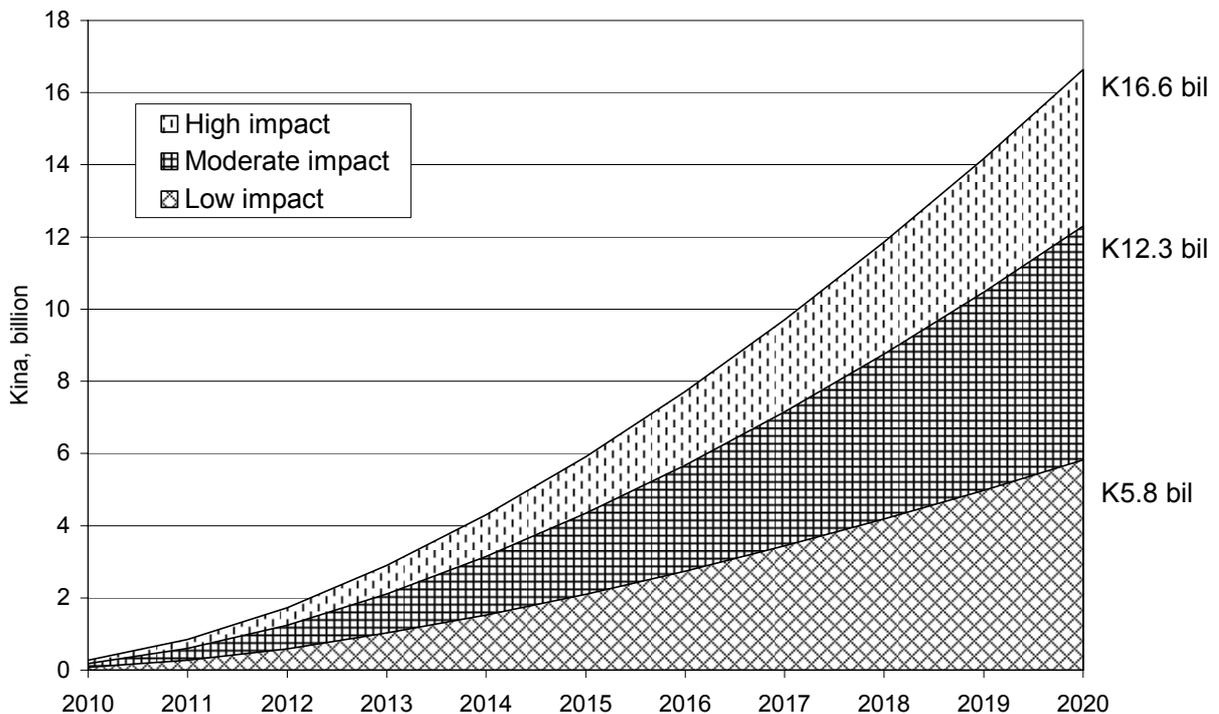
Behind the improvement in GDP is substantially higher growth in investment, exports and consumption (see Figure 10).

Figure 10: Average Annual Growth in Exports, Investment and Consumption under Alternative Scenarios in the Years 2010–2020
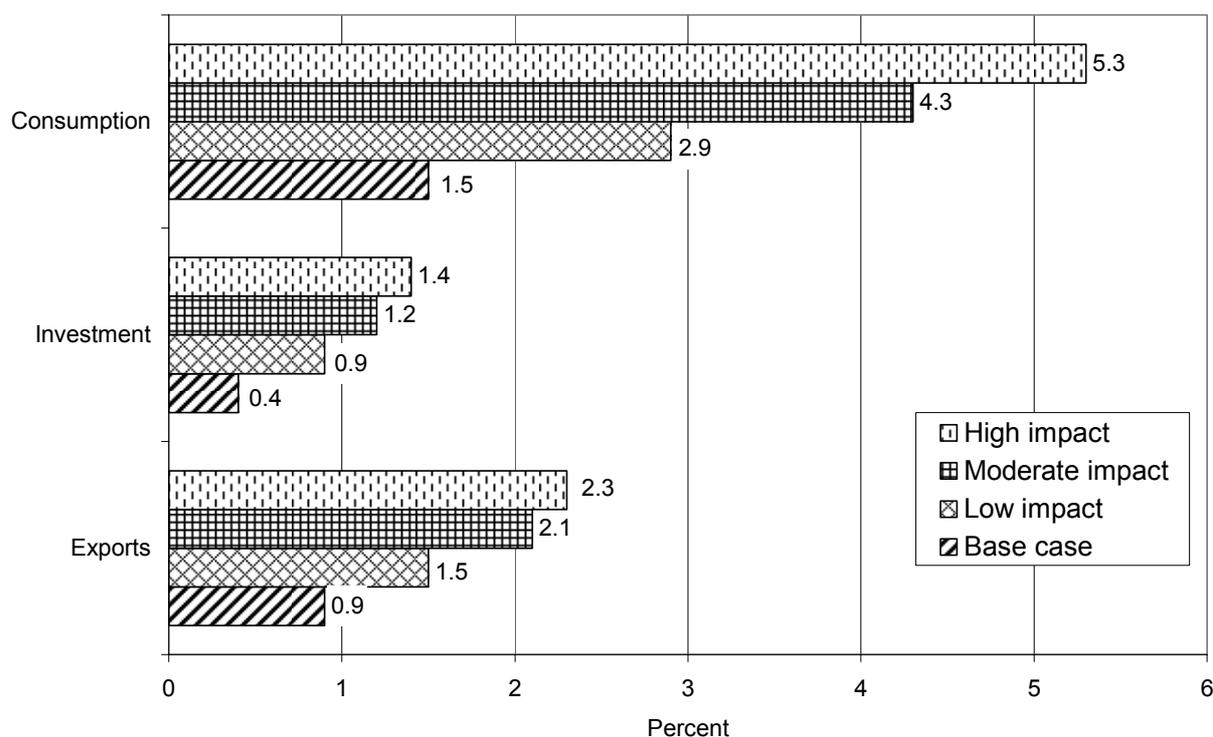
By providing secure land title and thereby reducing the risks associated with investment, land reform creates the incentives to invest more. Investment grows by just 0.4 percent a year on average in the base case, but by between 0.9 and 1.4 percent per year in the land reform scenarios. Through higher investment and greater access to secure land, exporters grow their scale of operations, supplying a larger volume of goods and services to the world market than in the base case. Further, the productivity improvements associated with investing in better technologies, reduce the cost of business in PNG compared with the base case, leading to higher profits.

In response to the increase in profitability, the private sector expands, generating higher incomes. Higher incomes in turn lead to an expansion in consumption. Under land reform, consumer spending in PNG grows by an annual rate of between 2.9 percent and 5.3 percent in 2010–2020, compared with just 1.5 percent in the base case.

Impacts on Broad Based Economic Development

Historically, economic activity in PNG has been concentrated in the mining sector. However, the gains from mining accrue to a relatively small proportion of the population. In contrast, the economic impact of land reform particularly benefits the non-mining economy. Economic growth in PNG therefore becomes much more diversified with land reform than without land reform.

The sectors of the economy that rely most on the use of land are agriculture, forestry, manufacturing and to a lesser extent, tourism (represented by hotels and restaurants) and commerce (National Statistical Office 1990). In the base case scenario, the supply of land is limited, constraining the growth of these sectors in particular. Further, the risks of investing in these sectors are high when the title to their land is uncertain. Therefore, it is these sectors that benefit most when land is freed up by reform (see Figure 11). In the rural sector for example, which includes agriculture, forestry and fisheries, average annual growth in production over the projection period ranges between 4.4 percent

and 6.7 percent per year in the three land reform scenarios, more than double the rate of growth in the base case.

Figure 11: Average Annual Growth in Key Sectors under Alternative Scenarios in the Years 2010–2020
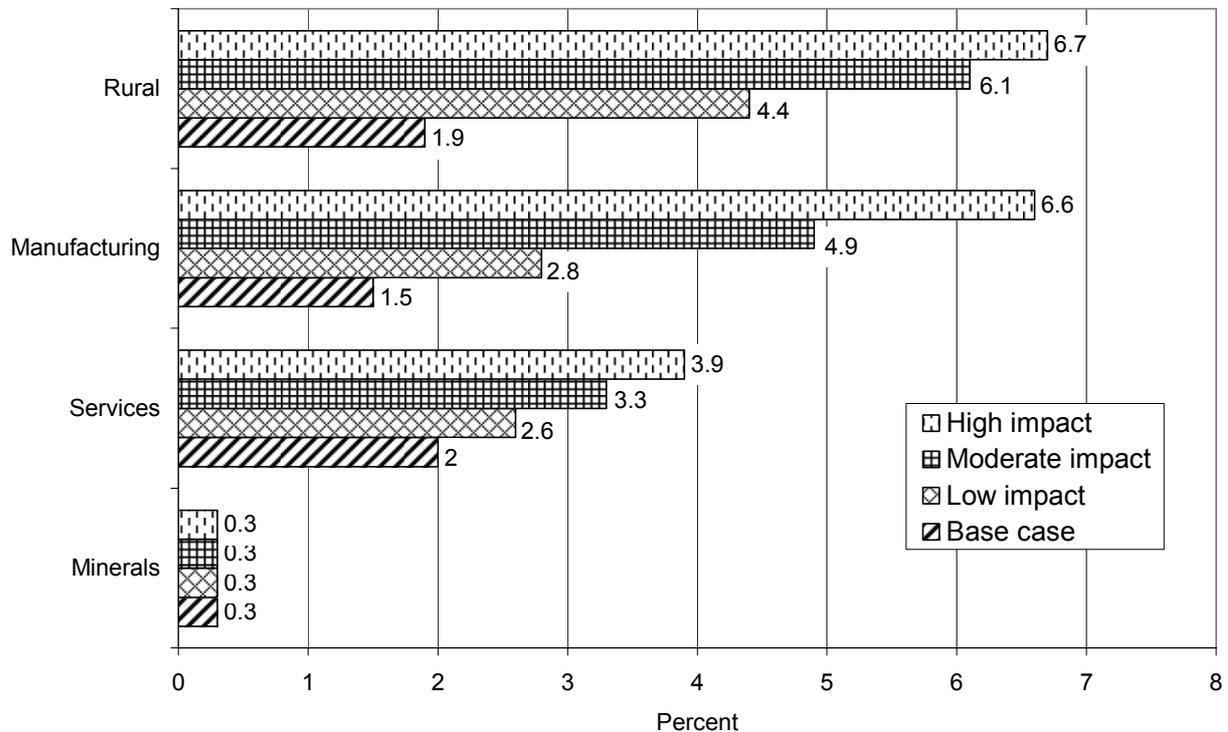

The mining sector does not benefit from land reform in the modelling undertaken here because land is an insignificant share of the total costs of a mining project. However, in reality, the mining sector faces considerable transaction costs associated with the lack of information about landowner identification and what their rights are. By addressing this information asymmetry (through strengthening the ILG process), land reform can be expected to reduce the transaction costs incurred by both mining companies and land owners, benefiting all parties.

Impacts on the Rural Economy and on Rural Poverty

The rural sector is the source of income for close to 85 percent of PNG's population (Hanson *et. al.* 2001). The substantial gains from land reform accruing to the rural sector are therefore worth closer scrutiny.

Subsistence remains a critical source of living for most rural residents, 93 percent of whom earned less than K200 a year from the cash economy in 2000, and 50 percent of whom earned less than K40 a year *(ibid*.). In the base case, subsistence agriculture declines over time, but only marginally by 0.8 percent a year (see Figure 12). In contrast, land reform opens up alternative income earning opportunities for rural residents, leading to a strong shift away from subsistence to market based agriculture, employment and income generation. Under the moderate land reform scenario, production in subsistence agriculture declines by an average 6.1 percent per year in the years 2010 to 2020. Whereas, in that same period and for that same scenario, large scale and smallholder agriculture expand each year on average by 7.8 percent and 4.6 percent respectively.

Figure 12: Average Annual Growth in Agricultural Sub-sectors under Alternative Scenarios in the Years 2010–2020
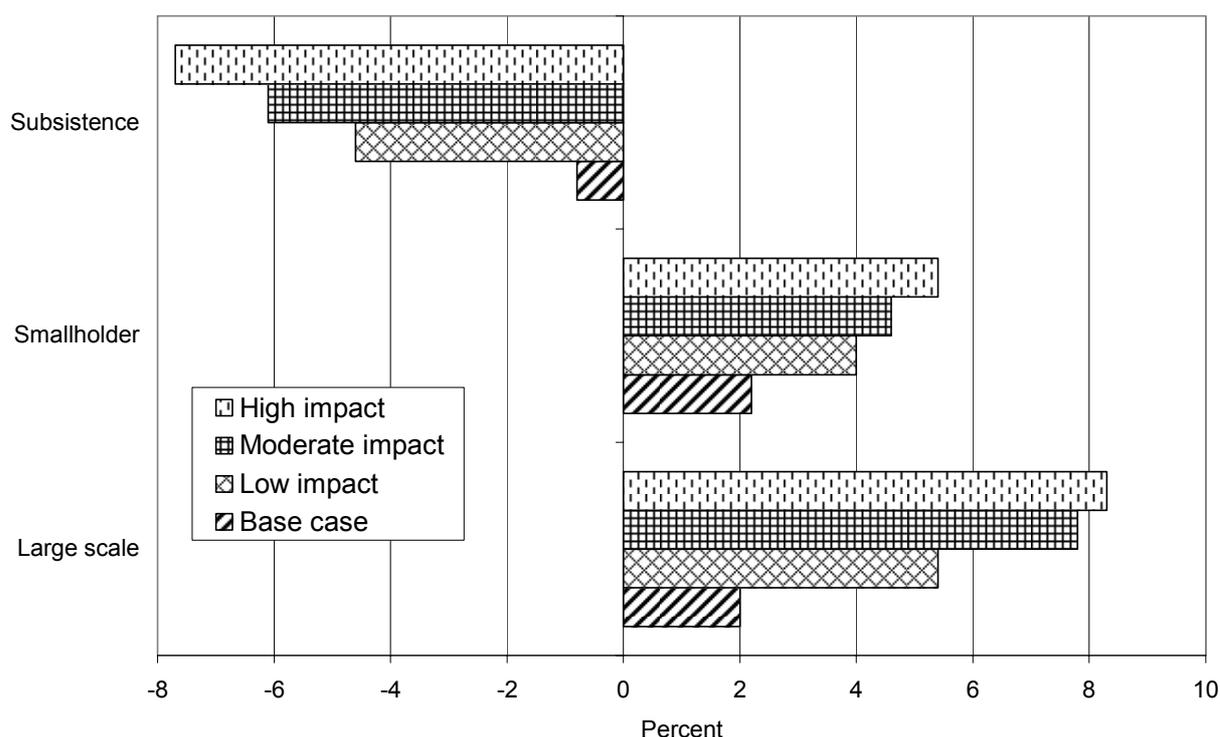
At the same time, land reform leads to a shift away from smallholder agriculture to larger scale operations such as blockholders. In the base case, smallholder agriculture expands marginally faster than the largeholder sector, growing by 2.2 percent per year as compared with two percent per year for the large scale operators. However, the converse is true under land reform, where the large scale sector grows almost twice as fast as the smallholder sector in the moderate scenario. Smallholders certainly benefit from secure land title, but the empirical evidence indicates it is unlikely that they will obtain access to credit to finance investment because of their small scale (see Section 1). In contrast, by obtaining credit, larger scale operators are able to expand investment and improve productivity by more than smallholders in response to secure land title.

There is however a possibility that some smallholder operators do obtain additional access to credit as a result of land reform. For example, they may be able to use their savings from tenure security improvements as collateral. Therefore in the high impact scenario, smallholders are assumed to access some credit, with the result that the discrepancy between large scale agriculture and smallholder agriculture is marginally less in this scenario.

Impacts on Employment

The growth in economic activity that results from land reform is projected to generate 138 000 new jobs by 2020 in the moderate scenario. These are in addition to the jobs that would be available in 2020 without land reform.

Ninety-four percent or 130 000 of these additional jobs are provided in the agriculture sector, particularly in the largeholder sector (see Figure 13). This reflects the importance of land reform for agricultural development, and also illustrates the significant role that the agriculture sector can play in creating jobs in PNG if land reform is pursued.

Figure 13: Where are the New Jobs Generated by Land Reform at 2020 in the Moderate Scenario?
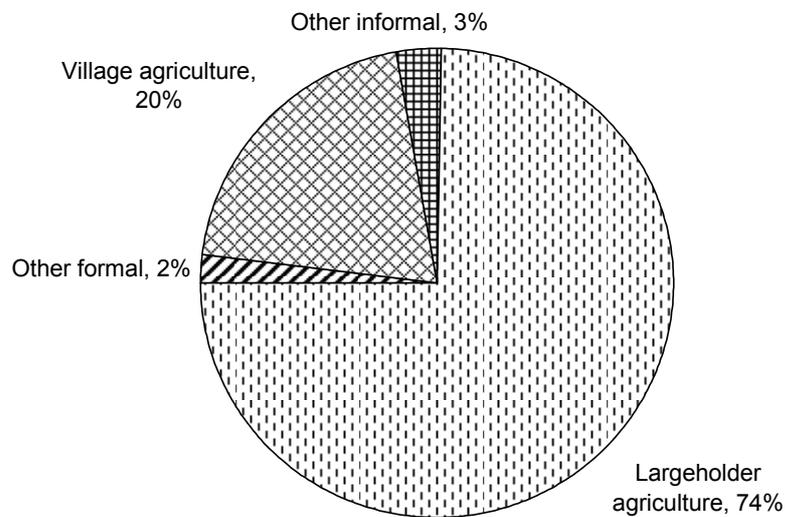
Impacts on the Real Estate Market

Land reform provides income earning opportunities to customary landowners, including the nation's poorest, and at the same time averts the growing crisis in the affordability of land.

FAO data reports that just over one percent of PNG's land is used to grow the country's key export agricultural commodities. Yet seven percent of the nation's land has high to very high potential for agriculture and an additional 23 percent has moderate agricultural potential.

Under the land reform scenario, growing demand for land is met by customary landowners bringing their land into the cash economy. In the model, this additional land is allocated to the highest bidder. It is estimated that by 2020, almost seven percent of PNG's land is brought under formal administration and is contributing to the formal economy. A similar share is projected in each of the land reform scenarios (see Figure 14).

The results (see Figure 14) are very similar between scenarios because the result is being driven by the base case. Demand for land in the base case is already very strong, even before the additional demand that arises because of land reform.

In the base case, the supply of land is not able to grow in response to the increase in demand for land and as a result, the price of land rises. This assumption reflects the reality of extremely high prices in urban areas of PNG today. However, it also implies that prices will continue to climb unless land reform is initiated. In the base case, the average price of land is projected to rise to 41 percent above current prices by 2020, and this is after removing the effect of general price increases as measured by the consumer price index (CPI). This would greatly increase the cost of living in areas where secure land is in short supply, and would potentially exacerbate social unrest surrounding customary landowners in such areas.

Were the LNG project to be added to the base case, the rise in demand for land would be much greater than in the current base case, contributing to a more extreme rise in the price of land.

Figure 14: The Share of Total Land Covered by Formal Tenure
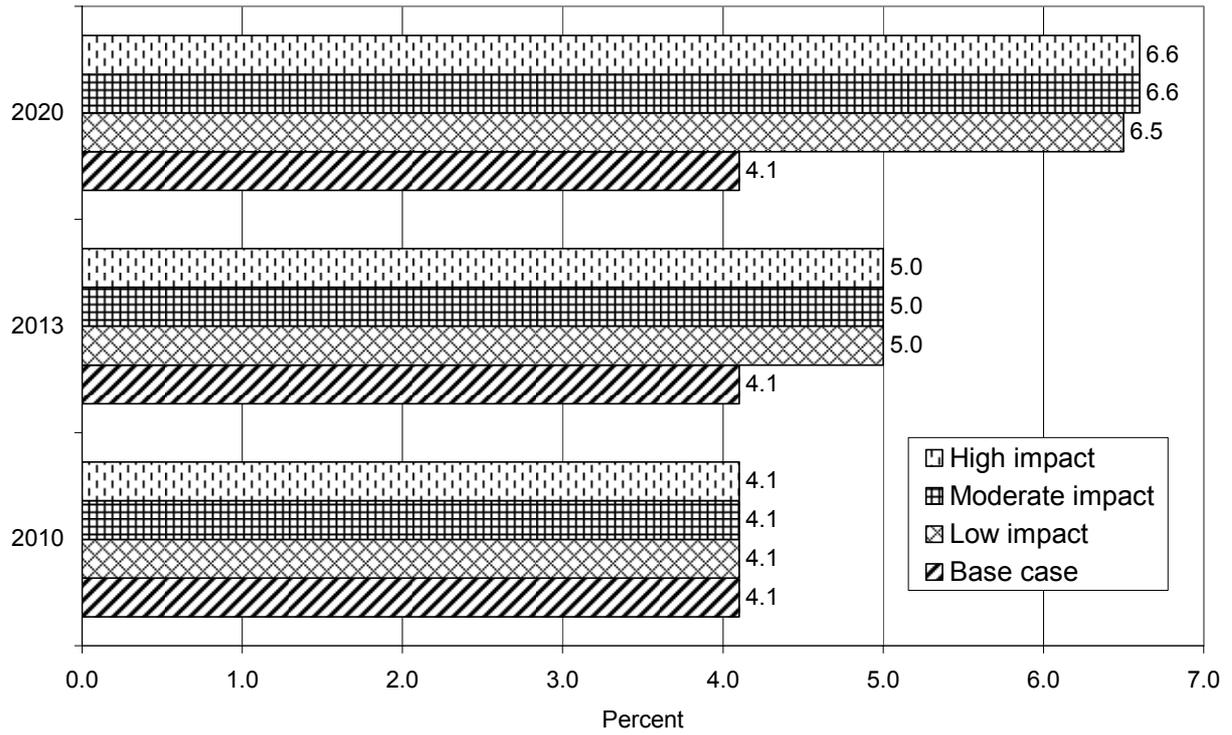
SECTION 7: POLICY IMPLICATIONS AND CONCLUSIONS

PNG's land reform program will deliver substantial benefits. Over just the first 10 years of reform, the gain in terms of additional GDP is estimated at between K5.9 billion (in the low impact scenario) and K16.5 billion (in the high impact scenario). This estimated gain is comparable to the current size of the PNG economy, reported to be K17 billion in 2006 (National Statistical Office 2008).

Land reform is demonstrated to be of great benefit to the non-mining economy. For many years, PNG's development plans have sought broad based economic growth in the recognition that the gains from mineral activity are constrained by mine capacities, among other things. In the future, oil reserves and production are expected to decline and to decline sharply, raising the importance of developing non-mining sectors such as agriculture and tourism. In this paper, land reform has been shown to be critical for achieving strong growth in the non-mining sectors. Land reform frees up customary landowners to use their land in a way that maximises their incomes by allocating land to whatever is the highest paying activity. Land is most critical for the agriculture, manufacturing and for some service sectors including, hotels and restaurants. The increased supply of land therefore results in strong, sustainable growth in these sectors.

Time has also been shown to be critical. Delays will exacerbate the current crisis in the affordability of land. Modelling implies that the very high land prices and land rents currently experienced in PNG are the result of constraints on the supply of secure land. Further, in the absence of land reform, the real cost of land is projected to rise by 41 percent between 2010 and 2020. This represents a dramatic increase in the cost of living and is therefore likely to trigger an escalation of social pressures surrounding customary landowners and underutilised state land in regions where population growth is outstripping the supply of secure land.

Somewhat ironically, the extremely high demand for secure land would greatly benefit customary landowners if they were given the right opportunities to market their land. Land reform would provide income earning opportunities to customary landowners, including the nation's poorest, and at the same time avert the growing crisis in the affordability of land.

This study makes a unique contribution to the literature on the analysis of land reform. More importantly, the results provide clear direction to PNG's policy makers. There is however room for improving and for extending the analysis.

A key constraint in this study has been the availability of data. This deficiency was well accommodated by modelling three alternative scenarios, in which uncertain parameters were allowed to vary. Future work could, however, focus on improving data, for example, estimating the investment risk premium associated with insecure land tenure in PNG and updating the FAO estimates of yield in PNG agriculture.

The value of this analysis for policy makers would be greatly enhanced by comparing the impacts of land development in PNG with other major developments, for example the proposed LNG project. Among other things, this would clarify the high priority that should be afforded to the land development program as opposed to other initiatives.

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