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Dutch Disease and the crime epidemic: an investigation of the mineral boom in Papua New Guinea[†]

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Papua New Guinea has pinned its hopes for economic development on its mineral wealth but, so far, this has been a false promise. Given Papua New Guinea's vulnerability, this raises questions of a Dutch Disease effect. Dutch Disease is dismissed in principle, but an appreciating real exchange rate is considered to have important offsetting economic consequences via its implications for crime. Using a CGE model incorporating crime as an economic activity, the contribution to welfare of a resources boom is investigated. The results confirm that a resources boom will deliver a net welfare benefit, but far smaller than the revenues generated would suggest, and at a cost to equity.

1. Introduction

Since independence in 1975, Papua New Guinea has pinned its hopes on the extractive sector as the avenue for economic development and prosperity. But so far, this has been a false promise. Papua New Guinea has extraordinary mineral wealth yet its rate of economic growth has lagged behind that of other middle-income developing nations, especially compared to its neighbours in South-East Asia, and its human development indicators are especially poor and show no sign of improvement. In urban centres, formal employment levels in the private sector were no higher in 1998 than they were in the late 1960s, despite a swelling urban population. Growth in real GDP has averaged 2.4 per cent per annum since independence, just enough to match the population growth rate of 2.3 per cent. Moreover, the source of much of this growth has been the minerals sector, and with non-mining GDP growing at an average of just 1.8 per cent per annum, the bulk of the population has suffered declining living standards.

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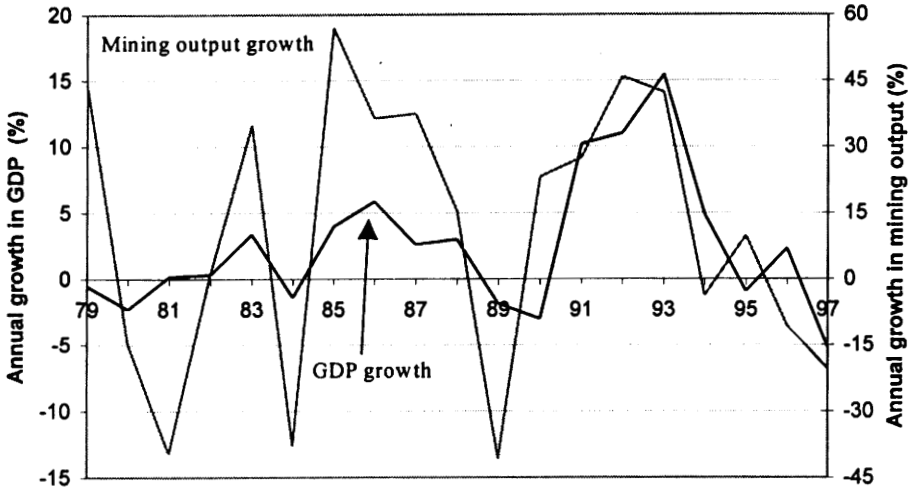

Figure 1 GDP growth and mining output growth

Economic growth in Papua New Guinea since independence has become increasingly erratic (see figure 1). After contracting 3.0 per cent in 1990, GDP quickly turned around and rose by a world best of 15.5 per cent in 1993, but has since just as quickly contracted, recording a fall of 0.9 per cent in 1995 and 5.2 per cent in 1997 under the spell of a severe drought.[1] As is apparent in figure 1, this volatility has followed sharp fluctuations in the output of the extractive sector — growth rates in some years have exceeded 40 per cent, while other years have seen contractions of over 30 per cent. The high GDP growth of the early 1990s was the result of the coming onstream of the Porgera gold mine in 1990 and Kutubu oil in 1992. Some of the slowdown of the last three years is attributable to the economic reforms being undertaken through an IMF-World Bank sponsored structural adjustment program (see Chand and Stewart 1997), but otherwise can be traced back to weakness in the extractive sector (see Mawuli 1996). The welfare implications of such volatility in production for a developing country can be serious given that consumption normally tracks output closely.

The mining industry revolves around a small number of projects that are very large by world standards, for example, Ok Tedi rates as the eighth largest copper producer in the world while Porgera is amongst the top five gold producers. Ongoing prospecting points to further prosperity in extractive sector activity over the short to medium term. The immediate

[1] The drought caused major disruptions to mineral activity, mainly due to the implications for navigation on waterways.

prospects for growth in the mineral sector depend on a number of proposed mines and a gas project involving the construction of a pipeline under Torres Strait for the supply of gas across Eastern Australia. For the foreseeable future, the outlook for the minerals sector is bright, despite the current environment of low commodity prices.

The imminent mineral boom is keenly anticipated, yet Papua New Guinea's failure in economic development since independence is against the contradictory backdrop of an erratic but prosperous extractive sector. The extractive industries account for one-quarter of Papua New Guinea's GDP — up from 10 per cent in the mid-1970s — and minerals account for two-thirds of Papua New Guinea's exports. How can this paradox be reconciled? Why are economic growth and development so difficult to achieve? Is Papua New Guinea victim of the Dutch Disease phenomenon? Certainly, Papua New Guinea is highly vulnerable. For example, despite its share of GDP, the extractive sector employs only 7 500[2] people, accounting for less than 3 per cent of total formal employment and just a fraction of a percentage of the economically active population. Further, the economic, physical, and social impact of mineral activity polarises around enclave developments. To put into perspective the magnitude of the developments in the mineral sector, and hence the extent of Papua New Guinea's exposure to Dutch Disease, each of the top five mineral developments has a greater share in GDP than the entire coffee export industry on which 38 per cent of Papua New Guinean households depend for their livelihood.

The thrust of the Dutch Disease story is that a real exchange rate appreciation leads to the crowding-out of the non-mineral traded sector by the booming mineral and non-traded sectors. Adjustment costs arising out of the relocation of factors towards the booming export sector compound the costs of the mineral boom. In the case of Papua New Guinea, the real appreciation from a mineral boom induces labour migration from rural to urban regions due to a fall in the price of agricultural exports[3] — the main source of cash incomes in rural areas — relative to the price of non-traded output, and most 'marketed' non-tradeables are produced and consumed in urban Papua New Guinea and within mining enclaves.[4] The principle of

[2] Calculated by applying the appropriate employment index produced by Bank of Papua New Guinea (1997) to employment in the mineral sector in 1988 as estimated from the Census of Employment.

[3] Papua New Guinea is a small supplier of agricultural products in world markets — the small-country assumption holds for exports of cocoa, coffee, copra, and palm oil, the main agricultural exports from Papua New Guinea.

[4] This is akin to a worsening of the rural to urban terms of trade.

de-industrialisation is therefore not relevant here, in sharp contrast to the other reported cases of Dutch Disease. Given the small-holder nature of agricultural production and the fact that these outputs are intensive in unskilled labour, a fall in the relative price of rural produce lowers relative returns to rural unskilled labour.[5] Meanwhile, the rise in the relative price of non-tradeable output in urban Papua New Guinea causes a rise in urban wages (relative to rural wages) and hence the rural to urban migration of labour. In turn, the rise in the rural–urban wage gap and rural–urban migration causes a deterioration of the 'surplus' labour problem in urban centres *à la* Harris and Todaro (1970), and most surplus labour in urban centres engages in criminal activity to make a living (Levantis 1997).

Papua New Guinea suffers a law and order problem at least as bad as anywhere else in the world,[6] and Duncan and Lawson (1997), Chand and Levantis (1998), and others have argued that the law and order problem is likely to be the most important barrier to economic prosperity. The severity of the law and order problem is such that any economic analysis with regard to Papua New Guinea would be incomplete without taking account of the implications for law and order. Increases in work-age population of around 50 000 per year, coupled with stagnant employment opportunities in the formal sector and tight regulatory restrictions for legitimate informal activity, have pushed an increasing number of people into illegitimate activities for their livelihood.

In the next section, we explore the hypothesis that Papua New Guinea is victim to Dutch Disease, expanding on the significance of the extractive sector in Papua New Guinea and exploring the links of the sector with the labour market, and crime in particular. In the third section, a computable general equilibrium (CGE) model of Papua New Guinea is used to trace the impact of a mineral boom on output, employment, induced criminal activity, and the consequent impact on aggregate output and national welfare. The recently opened Lihir gold mine on Lihir Island is taken as the basis for the simulation of a new mineral boom; conclusions follow.

2. Mineral boom, Dutch Disease, and labour market response

Mineral booms are an ongoing prospect in Papua New Guinea given the rich geology and the vast expanse of the country that remains to be explored

[5] This is the standard Stolper-Samuelson result from the HOS trade model.

[6] Levantis (1998a), for example, cites United Nations data which compares crime levels across cities of developing nations. Papua New Guinea's urban centres showed up as even worse than notorious cities in Africa and South America.

for deposits of ore and crude oil. These endowments are indeed a blessing, but require careful management of the rents that accrue from their liquidation. The poor record on economic performance is evidence that these blessings have not been optimally used. The presence of rents, from minerals in this case, creates opportunities for rent seeking that then often lead to unproductive activities. Moreover, when such unproductive activities, as with engagement in crime, have negative externalities, the secondary impact of a mineral boom could offset the primary gain of the rise in production from the mineral boom.

With capital in the mineral sector mainly foreign-owned, injections into the Papua New Guinea economy come mostly via payments to labour, payments for domestically produced inputs, dividend and royalty payments to landowners, and payments to the government via taxes or through returns on the state's compulsory shareholdings. By far the most important contributions by the mineral sector to the Papua New Guinea economy are payments to the state. The benefits of mineral boom are therefore contingent on the government successfully redirecting these windfall gains. For example, these windfalls could be used to finance a number of actions including: reductions in economic distortions (e.g. taxes), increases in productive investment (e.g. infrastructure), or improvements in the delivery of services such as health and education.

In principle, a real exchange rate gain is a reflection of overall productivity growth, and Auty (1993), Gelb *et al.* (1988), Davis (1995) and others correctly redirect the blame for the woes of resource-strong economies to government policy rather than Dutch Disease *per se*. Flush with funds, governments are lured into corrupt practices or poor policies, such as increasing the size but not the effectiveness of the government, or implementing protectionist programmes (subsidies, for example). In the case of Papua New Guinea, success in the allocation of income from mineral ventures has been mixed. Other than progress in the delivery of health and education services in urban centres, in the capital Port Moresby in particular, infrastructure demands in the country are largely unmet and conditions have not improved since independence in 1975. Mining and petroleum companies continue to act as primary providers of basic health and education, and of road and communication networks within the vicinity of their enclave developments. Since the 1990s, and particularly in the period to 1994, there have been indications that the government has allocated its windfall gains wastefully, with changes in recurrent government expenditure tending to follow changes in output of the mining sector (see figure 2).

The magnitude of the law and order problem in Papua New Guinea introduces a new dimension to the implications for national welfare of a mineral boom. Lack of employment opportunities together with rural–urban

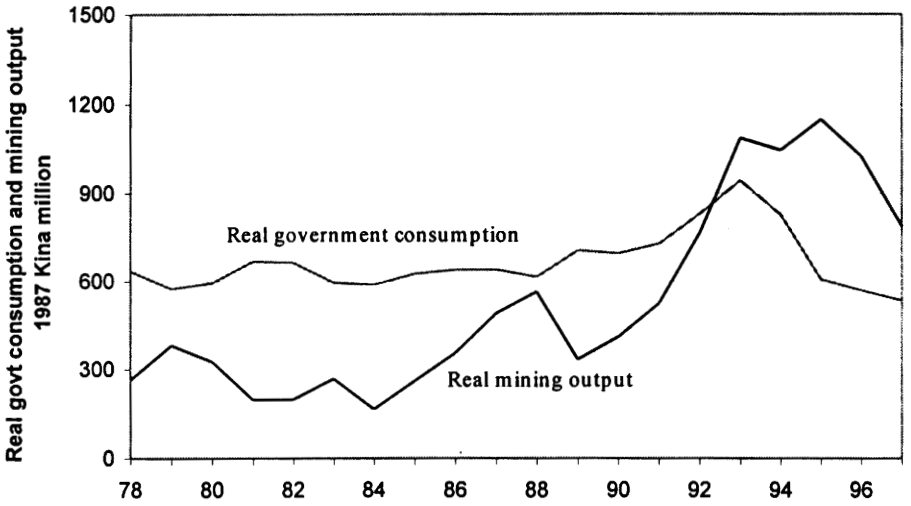

Figure 2 Government consumption expenditure and mining output in constant kina

wage disparities that induce rural–urban migration have, in conjunction with weakness in law enforcement, been the major factors responsible for high crime rates in urban Papua New Guinea (Chand and Levantis, 1998). According to the 1990 census, 30 per cent of the urban workforce in Papua New Guinea was labour surplus to formal employment opportunities. Levantis (1997) found through field surveys that more than half of this surplus labour depended on 'illegitimate' activities for its livelihood and, on average, received earnings from their illegal transfers (theft) similar to that earned by those engaged in other informal activities. Apart from the distortionary cost of tying up labour resources in non-productive activity, this market-determined mechanism carries with it substantial negative external effects.[7] The principal external costs of crime most relevant to Papua New Guinea include:

- personal (non-financial) harm to members of the community by way of fear and anxiety about crime and the loss of freedom of movement;
- injury (both physical and psychological) to victims of crime;
- costs incurred by victims over and above that transferred to criminals due to damage to property during a crime;
- lost production opportunities due to the impact on business costs of losses and damage due to theft and of additional security costs; and,
- lost production opportunities due to the impact of crime on demand for tourist services.

[7] The analysis here is static, but the external costs on investment from crime will have growth effects. This issue is to be explored in future work.

For Papua New Guinea, the law and order situation has imposed particularly large economic costs due to the last two points. The potential of the tourism industry is enormous, yet it has been completely disabled in its development by the law and order problem.[8] For businesses in general, the added costs by way of losses due to crime and on expenditure on security services impose a substantial burden, with important implications for the premium required on the rate of return gross of these costs.[9]

The interrelationship between mineral boom and crime comes via the impact of a mineral boom on rural to urban migration. A real exchange rate appreciation caused by a mineral boom will impact upon the agricultural sector via a fall in the relative returns from export crops. Production in urban centres is principally of non-traded goods and services with the public sector dominating, so returns to labour and the levels of output in urban Papua New Guinea rise from a mineral boom (in relative terms). Rural–urban migration will result from the improvement in relative prospects of locating in urban centres, but with labour demand in the formal sector subject to a high distorting wage for unskilled labour, migration will only feed the chronic surplus-labour and crime problem. As anticipated in the Harris–Todaro framework,[10] migration will continue until surplus labour increases sufficiently so that the expected benefits of the person at the margin moving to an urban centre matches the opportunity cost of leaving the rural environment. A mineral boom will therefore come with an associated disease — a Harris–Todaro disease, where labour is diverted from the productive rural export sector to the heavily distorting illegitimate sector.

The effects of a mineral boom using a CGE model of Papua New Guinea with the Harris–Todaro labour market structure incorporated into the analysis are now investigated.

3. A mineral boom and its effects

The CGE model used to analyse the mineral boom is a static model following an ORANI type framework,[11] and is succinctly explained by Dervis (1975, p. 78) as postulating 'neo-classical production functions and

[8] For example, see Duncan and Lawson (1997), Levantis (1998a).

[9] One newspaper report states that a premium of 20 to 30 per cent is required relative to that in Australia (*Sydney Morning Herald*, 18 March 1997, p. 12).

[10] The seminal article by Harris and Todaro (1970) explains the process of rural–urban migration under conditions of high urban unemployment.

[11] Refer to Dixon *et al.* (1982) for an overview of the 'ORANI' type of models.

price responsive demand functions, linked around an input-output matrix in a Walrasian general equilibrium model that endogenously determines quantities and prices'.[12] In the spirit of Becker (1968) participation in criminal activity is modelled as an alternative form of employment. Given that more than 15 per cent of the urban labour force rely on crime as the principal means of earning a living, it is imperative that crime is dealt with in the CGE model as an industry in its own right providing employment for the *Raskols*.[13] The interpretation of crime as an industry is given additional credence with the finding by Harris (1988) that the criminal sector in Papua New Guinea is highly organised and hierarchical in structure. Only crimes with a motivation of theft are captured in the model and crime is interpreted as an activity with the sole purpose of transferring income from victims to the criminal industry. The output of the crime industry is the value of these transfers and all of the output is returned to criminals who are the providers of labour, the only input to the crime industry. In a crude sense, the 'employees' in crime act as income arbitragers in the economy.

A difficulty with modelling crime as an industry is that the 'demand' side of output comprises involuntary transfers from the victims, and so conventional demand functions are not relevant for determining the level of 'purchases' from the crime industry. In the model there are three types of victims of crime: households, government, and urban-based industries. In the case of households, involuntary consumption expenditure on crime directly impacts on the budget constraint for desired commodity purchases, which are then determined according to conventional utility maximisation theory. The government budget constraint is similarly affected by involuntary purchases of crime. Expenditure on crime by urban industries is treated as involuntarily imposed intermediate input purchases. Output of the crime industry is determined on the supply side according to the supply of surplus labour, and the proportions allocated between the victims is assumed fixed. Hence the level of involuntary demand for crime by each of the three types of victims is determined according to the level of supply.

The use of labour resources in crime is wasted resources as the criminals engage in no productive activity, but merely facilitate transfers involuntarily from the victims. The opportunity cost of labour utilised by the crime industry is therefore the full market wage for labour engaged in legitimate activity. In this sense, labour employed in the crime industry is akin to unemployed labour, but an important difference is that those engaged in criminal activities are foregoing leisure time to participate in the activity (Becker 1968).

[12] Cited in Dixon *et al.* (1982), p. 5.

[13] Criminals in Papua New Guinea are referred to as *Raskols*.

Further to wasting labour resources, participation in criminal activities imposes substantial external losses referred to in the second section above. It is assumed in the CGE model that for every Kina transferred to criminals there is an external loss of about K3.50. This value is calculated as the aggregate level of external costs (K400 million) divided by the total value of transfers to criminals (K115 million). Given the difficulty in quantifying external costs, a conservative approach is taken such that these effects are the minimum that can be expected. This is justified on the basis that, in the absence of a serious crime problem, tourism would have the potential of injecting at least K400 million into the economy. Duncan and Lawson (1997), for example, consider K1 billion a conservative estimate of potential international tourist revenues. External costs require special treatment in the model as they are losses for which there are no beneficiaries. In the sense that these losses are the same as tossing the funds into the sea, they are treated as unrequited transfers abroad. For more details of how crime and the external costs of crime are dealt with in the model, see the Appendix.

The way in which the CGE model analysis is carried out is that a shock is imposed on the system via the exogenous variables of the model, and the endogenous variables adjust until the system moves from the initial Walrasian equilibrium to a new Walrasian equilibrium. In this case, the shock is the impact of an increase in activity in the gold mining industry by applying an appropriate shock to capital consumption in the industry. The closure of the model is such that real capital consumption for each industry is exogenous. Implicitly, by applying a shock to capital consumption, the simulation is representing the impact of new investment, and hence an expansion in the gold mining industry. As a benchmark for a mineral boom we use the estimated impact of the Lihir gold mine which came onstream in late 1997.[14] In this way we can follow the implications a single mineral development can have on the economy. The Lihir mine is projected to add around K320 million to exports annually — amounting to more than 4 per cent of GDP and almost 10 per cent of exports.

Table 1 reports the impact of the simulated shock on macroeconomic variables. The consumer price index increases 4.8 per cent, reflecting a substantial increase in relative prices of non-traded goods compared to traded goods[15] — this effect is consistent with the predictions from the Dutch

[14] Testing for the impact of Lihir in this way was considered legitimate as the cost structure was found to be similar to the existing gold mining industry.

[15] The model assumes Papua New Guinea to be a small player on world markets for most traded commodities, so prices of traded goods change little.

Table 1 Impact of a mineral boom on macroeconomic variables

	K million	% change
Real Gross Domestic Product	192.1	2.5
Real consumption expenditure	83.5	2.5
Trade surplus	108.6	8.7
Consumer Price Index		4.8

Notes: 1. The real estimates are based on 1997 Kina.
2. The simulation of a mineral boom is represented by the opening of the Lihir gold mine.

Disease literature. Real consumption expenditure increases 2.5 per cent, the trade surplus improves 8.7 per cent (1.4 per cent as a percentage of GDP), and GDP increases 2.5 per cent (the model fixes real investment and government expenditure). With the economy's output increasing in response to the new mineral venture, there are therefore no surprises or paradoxes due to Dutch Disease; this is despite the detrimental impact on law and order which is elaborated on later in the text.

Of note is that the predicted increase in the trade surplus of K109 million is significantly less than the contribution to exports from the new development of K320 million. There are three sources contributing to the subdued impact of the shock on net exports: an offsetting increase in imported intermediate inputs due to increased mineral activity; a crowding out of production and labour resources from other export industries; and the shift in production patterns in the non-mineral sector from traditional exports to non-traded sectors of the economy.

A modified version of the Harris–Todaro mechanism is used in the CGE model to explain the structure of the labour market.[16] Briefly, the labour market is dichotomised between urban[17] and rural regions where the urban sector is subject to a distorting formal sector wage. This entices labour to relocate from rural to urban areas in pursuit of more lucrative employment opportunities. Because the wage is sticky downwards, employment does not respond to the increased supply and so rural to urban migration feeds a labour-surplus. Migration continues until the *expected* return for an urban resident, given that a surplus labour problem means formal employment will be achieved with less than certainty, equals the opportunity cost of leaving the rural environment. This surplus-labour feeds into the 'murky' sector

[16] This model is due to Harris and Todaro (1970) and the modifications employed are similar to those of Fields (1975) where a 'murky' sector was included in the model.

[17] For the purposes of the model, employment in mining is a subset of urban employment.

Table 2 Impact on employment of a mineral boom

	Employment	% change
Unskilled employment levels:		
Village sector	−7,825	−1.3
Plantation sector	−2,856	−5.2
Formal urban	513	2.0
Mining	566	14.1
Informal sector	790	3.0
Participation in crime	2,962	5.5
Skilled employment levels:		
Plantation sector	−875	−8.4
Formal urban	860	0.7
Mining	256	11.8

Notes: 1. The simulation of a mineral boom is represented by the opening of the Lihir gold mine.
2. Due to qualitative differences, it is assumed the rural wage will be exceeded by the urban wage even under a completely liberal labour market. To deal with this differential we assume a person can either supply 1 unit of urban labour or 1.95 units of rural labour (2.2 in the skilled case). For a full discussion refer to Levantis and Fane (1999).

(Fields 1975) which includes both legitimate informal employment and crime. The model assumes no open unemployment.[18]

The mineral boom causes the Kina-value of productivity of labour to decline in export industries relative to non-traded industries. In turn, the labour-intensive rural agricultural export sector sheds labour and the ensuing difference in returns to labour between the non-traded urban industries and the rural industries causes urban-drift of work-age population until any differences are arbitraged away. Table 2 reports the results of the estimated impact on labour resources, and as anticipated, there will be a significant drop in rural labour. The plantation sector is hit particularly hard with a predicted drop in employment of 5.2 per cent. This is due to the high exposure of the plantation sector to world prices for its output, whereas the impact on the village sector is softened by non-traded production — particularly subsistence production. Although the percentage fall in village labour is relatively small, by far the majority of Papua New Guinea's workforce is village-based and so the absolute numbers are large. In turn, the percentage increase in the urban labour force due to rural to urban migration is also large. Employment opportunities for unskilled labour are limited given the capital-intensive nature of mining and the limited capacity of urban industries to absorb these unskilled workers. Most migrant labour

[18] Levantis (1997) found open unemployment to be less than 5 per cent of the urban labour force whereas total surplus labour was 30 per cent.

Table 3 Welfare effects of a mineral boom

	K'000	% of GDP
Impacts on welfare due to tax distortions:		
Production tax distortions	−231	−0.00
Tax distortions on intermediate inputs	5,435	0.08
Consumption tax distortions	1,468	0.02
Income tax distortions	2,054	0.03
	8,725	0.12
Labour resource reallocation effects:		
Village sector	2,762	0.04
Formal urban and mining sector	938	0.01
Informal sector	−50	−0.00
Crime sector	−16,894	−0.23
	−13,245	−0.18
Effect of a change in the labour supply	6,030	0.08
Gross returns on new venture	183,472	2.55
Effect on net outflow of capital returns	−71,960	−1.00
Effect of a change in the terms of trade	−6,311	−0.09
Price effect on external cost of crime	−12,465	−0.17
Equivalent variation	94,245	1.31

Notes: 1. The equivalent variation equates to the sum of the components in these tables.
2. The estimates are in 1997 Kina.
3. The simulation of a mineral boom is represented by the opening of the Lihir gold mine.

therefore moves into crime with the model predicting a 5.5 per cent rise in participation in crime due to the mineral boom.

The CGE model estimates the equivalent variation and so permits an objective assessment of the welfare effect of the mineral boom. The mineral boom is predicted to bring about an expansion in welfare of K94.2 million, equal to 1.3 per cent of GDP (see table 3). The contribution to Papua New Guinea's economic welfare is therefore less than a third of the K320 million in additional export revenues created by the resources boom. Looking at the components, gross returns to capital on the new venture contributes K183.5 million to welfare, equivalent to 2.6 per cent of GDP. Additional to this will be the returns to labour in the new venture, but this gain is swamped by the losses due to the manner in which labour resources are reallocated in the economy. The movement of labour resources to crime causes a loss of K16.9 million — equivalent to 18 per cent of the total welfare gain, and the net effect of labour resource reallocation is a loss of K13.2 million. The gain of K6.0 million due to changes in aggregate labour supply is mainly due to the increased supply of skilled labour to the mineral industry and to urban centres. Papua New Guinea's terms of trade deteriorate slightly in most part due to the impact on world prices of the increased volume of gold exports.

The effect on welfare is a loss of K6.3 million.[19] The net outflow of returns on capital is K72.0 million and is mainly a reflection of the repatriation of net returns on the new venture. A further K12.5 million loss is due to the price effect on the external cost of crime. The 'price' of the external cost of crime is linked in the model to inflation (refer to Appendix), and so an increase in inflation will mean an increase in 'funds thrown to sea'. Finally, there is a net gain of K8.7 million due to an increase in purchases of goods subject to tax distortion and in changes of supply of labour subject to income tax distortions. The principle applied here is due to Harberger (1971) who showed that a tax distortion drives a wedge between the marginal social value and marginal social cost of a commodity (or a unit of labour supplied).

The equivalent variation estimates of the impact on welfare are based on a utilitarian welfare function and thus take no account of the implications for equity. The real exchange rate appreciation means that existing exporters and those competing with imports (of which there are few apart from a token number of heavily protected industries) will be worse off. Over 75 per cent of the people of Papua New Guinea depend on agricultural exports (mainly coffee, cocoa, copra and palm oil) for their livelihood, so a deterioration in prices of these commodities has far-reaching consequences for the welfare of the bulk of the population. Without any countering measures from the government, most Papua New Guineans will be losers to the small number of beneficiaries of the mineral boom in the mineral and non-traded sectors of the economy. The welfare results outlined in table 3 need to be strongly qualified with this equity consideration.

The windfall revenue gains to the state from the new venture will be around K70 million. This can be thought of as a component of the equivalent variation in the sense that this amount of the equivalent variation accrues to the state. If the government were to allocate these gains prudently by funding reductions in distortions, then the predicted welfare benefit of the mineral boom would be compounded. With labour resources in crime imposing particularly strong distortions in the labour market, the most evident way in which these funds could be allocated prudently is to direct them towards enforcement of law and order so as to divert labour away from crime. Alternatively, the funds could be used for investment in rural infrastructure, thereby offsetting some of the inequities for those in the rural sector. But as was discussed earlier, more typical in mineral-rich developing nations is a squandering of these resources by less than prudent governments. Typically, this arises due to the funding of an

[19] The model reflects in its export demand elasticities the fact that Papua New Guinea is a big player in world gold and copper markets and a small player in other markets. The predicted impact on the world gold price of the new mine is a drop of 1.4 per cent.

increase in non-sustainable recurrent expenditure without a corresponding improvement in the effectiveness of government (hence losses due to the reduction in productivity), or by the tapping of these funds by corrupt government officials. Important in our findings is that even if there is the unrealistic result of all windfall gains to the state being squandered away, say, by the full amount being transferred by corrupt officials to off-shore accounts, then the mineral boom will not result in a net loss in welfare, bar the distributional considerations. The model will still predict a net gain of around K24 million (K94 million welfare gain due to the mineral boom less K70 million wasted by the state).

4. Conclusion

Dutch Disease in its pure form is little more than hypochondria. But where a mineral boom can bring disease is in secondary effects. In this article we show that labour market imperfections can have partial offsetting effects on the benefits of a mineral boom where displaced labour from traded goods sectors ends up becoming surplus to formal labour opportunities and moves into crime. The peculiarities in the case of Papua New Guinea which lead to this result are a labour market characteristic of the Harris–Todaro framework, a high rate of transfer of surplus labour into crime, and an economic structure such that traded sector production is rural-based and non-traded production is urban-based.

The recent Dutch Disease literature suggests that the experience of adverse implications of resources booms for many nations is mostly the result of poor government policy with respect to the management of the windfall benefits. When most of the gains of a mineral boom accrues to the government, the extent to which a mineral boom will improve welfare is very much in the hands of the state. Prudent management of the funds to reduce distortions, or use of these funds for productive public investment, will compound the windfall gains from a mineral boom. Just as easily, a government may squander the funds by wasteful expenditure. In the case of Papua New Guinea there is little evidence of prudent management of the windfall gains from mineral booms.

The Dutch Disease literature also considers the possibility that the 'winners' from a mineral boom would be limited and the 'losers' would represent the vast majority of the population. This is certainly the case for Papua New Guinea, but with appropriate government policy this inequitable outcome need not be the case — it is both possible and pertinent for revenue windfalls to be reallocated effectively and efficiently (e.g. by investment in rural infrastructure) so that the 'winners' from a resources boom are more widespread.

As a final note, the analysis highlights the flaws in assessing the contribution of the mineral sector to economic activity according to its output as a percentage of GDP when capital in the sector is by and large foreign-owned. Indeed, this principle applies to any sector intensive in foreign-owned capital. After discounting returns accruing to foreign capital and purchases of imported intermediate inputs, net output of the entire mineral sector accruing to the Papua New Guinea economy is about one-third of total output. It is this net figure which should be thought of as a guide to understanding the true contribution of a mineral development to economic activity. This is reflected in our results where the welfare gains were found to be just less than one-third of the gross output effect from a mineral boom.

In summary, the perceived failure of the mineral sector to catapult Papua New Guinea to economic prosperity has much to do with exaggerated impressions of the mineral sector's contribution to economic activity, is in part to do with losses in reallocation of labour resources and losses due to inefficient allocation of windfall revenues by the state, but has little to do with Dutch Disease.

Appendix

The following exposition of the CGE model is simplified but captures the basic elements and gives an understanding of the treatment of crime and its externalities. In principle, the CGE model is a disaggregation of the Walrasian general equilibrium condition. The Walrasian equilibrium is broken down into the four conditions (1)–(4) below, and all other equations in the model feed back into the variables of these central four equations.

production sector

$$P_j X_j = \sum_i P_i X_{ij}^{int} + Y_j^{lab} + Y_j^{cap} + T_j^{prod} + A_j^{prod} \qquad \text{for all } j \text{ industries} \tag{1}$$

household sector

$$\sum_j (Y_j^{lab} + Y_j^{cap}) = \sum_i P_i C_i + T^{hh} + A^{hh} \tag{2}$$

government sector

$$T_j^{prod} + T^{hh} + F = \sum_i P_i G_i + A^{gov} \tag{3}$$

external sector

$$M = E + F - \left(\sum_j A_j^{prod} + A^{hh} + A^{gov} \right) \tag{4}$$

and P is price of commodities, X is quantity, subscript j is industry, i is commodity (assume for this exposition that each industry supplies a single commodity), X_{ij}^{int}

is intermediate input purchases of commodity i by industry j. Y_j^{lab} and Y_j^{cap} are industry j's expenditures on labour and capital with the revenues accruing to the household sector. C_i and G_i are purchases of commodities by the household sector and government sector, T_j^{prod} and T^{hh} are taxes paid by producers and households to the government, F is foreign grants, M is imports, and E is exports. The external costs due to crime incurred by producers, households and government are represented by A_j^{prod}, A^{hh} and A^{gov} and the proceeds are treated as unrequited transfers abroad through equation 4.

Crime is treated in the model as an industry and commodity. The crime industry is assumed not to use intermediate inputs or capital or incur any external costs, so for $j = crime$, equation 1 becomes:

$$P_{crime}X_{crime} = Y_{crime}^{lab} = W_{crime}^{lab}.X_{crime}^{lab} \tag{5}$$

where W^{lab}, X^{lab} are the wage rate and quantity of labour. The output of the crime industry is the quantity of crimes committed, and from the demand perspective, these are involuntarily purchased by producers, households and the government sector. The price is the value of a payoff from a crime. The demand-supply identity will be:

$$X_{crime} = \sum_j X_{crime,\,j}^{int} + C_{crime} + G_{crime} \tag{6}$$

The involuntary demands are assumed to be in fixed proportion to the aggregate supply of crime, so:

$$\begin{aligned} X_{crime,\,j}^{int} &= \beta_j^{prod} X_{crime} \\ C_{crime} &= \beta^{hh} X_{crime} \\ G_{crime} &= \beta^{gov} X_{crime} \end{aligned} \tag{7}$$

where $\sum_j \beta_j^{prod} + \beta^{hh} + \beta^{gov} = 1$. Based on police statistics, we have in the database $\sum_j \beta_j^{prod} = 0.574$, $\beta^{hh} = 0.156$, $\beta^{gov} = 0.270$. The external costs incurred by the victims due to crime are assumed to be a fixed proportion of the value of involuntary crime purchases, so:

$$\begin{aligned} A_j^{prod} &= \alpha.P_{crime}X_{crime,\,j}^{int} \\ A^{hh} &= \alpha.P_{crime}C_{crime} \\ A^{gov} &= \alpha.P_{crime}G_{crime} \end{aligned} \tag{8}$$

and as discussed in the third section, $\alpha = 3.5$.

The real price of crime is set exogenous in the model (i.e. it moves with inflation[20]) which leaves the supply of crime to be determined according to the supply of labour to the crime industry. A Harris–Todaro framework is set up in the model as discussed in Section 3, and the Harris–Todaro equilibrium condition is:

[20] This implies too that the 'price' of the external cost of crime also moves with inflation.

$$W^{lab}_{rural} = \frac{X^{lab}_{formal}}{X^{lab}_{formal} + X^{lab}_{murky}} . W^{lab}_{formal} + \frac{X^{lab}_{murky}}{X^{lab}_{formal} + X^{lab}_{murky}} . W^{lab}_{murky} \quad (9)$$

where W^{lab}_{formal} is rigid and competitive conditions ensure that W^{lab}_{murky} is the wage both in the informal sector and crime. The supply of labour in crime is then determined as:

$$X^{lab}_{crime} = X^{lab}_{murky} - X^{lab}_{informal} \quad (10)$$

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