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RESOURCE DEVELOPMENT ON CUSTOMARY LAND - USING OPTION PRICING THEORY TO SHARE THE BENEFITS FROM THE EXPLOITATION OF LAND BASED RESOURCES

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ABSTRACT

Building on prior research that identified the benefits of engaging a synergistic value approach to land resource compensation, this paper explores the potential of applying option-pricing theory as a proxy for the economic value of the 'marriage' of stakeholder interests associated with mineral exploitation. Drawing on the example of a copper and gold reserve in Fiji, and equally applicable to other Pacific Islands or African contexts, the research adapts, evolves and explains the findings of recent modeling to recommend equitable stakeholder benefit sharing in the context of customary land. The synergistic compensation model, informed by (and acknowledging the limitations of) option pricing theory, offers a key transparent negotiation tool for all parties – but highlights the need for increased negotiation capacity in developing countries. Informed by publicly available data, it places the onus on the exploration company to prove or disprove the data. It also offers a policy framework that enables the custom landowners to be the direct financial beneficiaries of the scheme (potentially by taking a share in bullion rather than cash), with the national fiscal benefit to the State being derived from standard taxation arrangements over the custom landowners newfound source of revenue.

KEYWORDS: compensation, custom, Fiji, mining, option-pricing

TAKING AN INNOVATIVE APPROACH

In this paper, we build on prior research presented at the World Bank (Boydell and Baya, 2012) that explored how an equitable land resource compensation model could be formulated for resource rich developing countries, such as those in Melanesia, where the principles of customary land ownership are protected by constitutions and traditions alike. Drawing on international best practice, that research

concluded that a synergistic value approach (a valuation method more familiar to the valuation profession than mainstream economists) has more to offer in the context of land resource compensation in Melanesia (and potentially Africa).

Circumstances vary from country to country over rights to minerals under the land, with most constitutions in newly independent states following the Australian lead that minerals are vested in the Crown or State (noting the significant recent change of perspective proposed in Papua New Guinea to recognize the resource ownership of traditional landowners, per Chan, 2011). Although customary owners in Melanesia hold the superior interest in the land, current resource compensation models in Melanesia tend to follow the Australian example of merely compensating customary owners for the loss of access to traditional subsistence and spiritual recognition of the land (i.e., unimproved capital value, plus up to an extra 10% to reflect 'special indigenous value'). Such an approach overlooks the potential benefit sharing opportunities of optionality.

Our challenge to date with the synergistic approach has been the difficulty in quantifying the marriage value between the interests and options of the customary landowners and values of both the State and of the resource exploration companies who, hitherto, have benefited most from such arrangements. Likewise, natural resource exploration companies have options to develop a resource at a particular time or leave it until the value of the underlying asset (the mineral wealth) increases on the commodities market. In financial terms, these undeveloped reserves can be considered as 'call options'. Whilst it is relatively easy to articulate the various heads of resource compensation claims under the synergistic model, hitherto a value has not been placed on the underlying asset - the natural resource (based on the estimated quantity and price of the resource, less extraction costs).

Whilst option-pricing theory is not a new concept, its application to sharing the benefits from the exploitation of land-based resources on customary land offers an innovative approach. Option pricing theory has made vast strides since the publication of the Black and Scholes findings (1972, 1973). In this paper, we test a series of option pricing models to determine the synergistic value of an option to exploit gold and copper reserves on customary land in the Namosi Highlands of Fiji. Our modeling demonstrates the potential for more equitable sharing of benefits to the landowners and the State, whilst enabling greater investment security for the resource exploration companies through minimized conflict and enhanced environmental protocols.

POLICY RELEVANCE

Current models of land resource compensation are commonly based on royalties paid by exploration companies to the State, with a partial allocation to customary owners augmented by facilitation gratuities to key chiefs or 'big men' (Boydell and Baya, 2012). Such models often lead to conflict between custom landowners and the State, with resultant uncertainty (and risk) for the exploration company.

An equitable land resource compensation model (one that shares the benefits from the exploration of land based resources between the stakeholders) reduces risk for the State and provides improved certainty for both the mineral exploration company and the customary landowners. A synergistic compensation model, informed by option pricing theory that is grounded on the anticipated quantity / quality of mineral reserves, the market value of the commodity, and the cost of extraction, affords increased transparency about the entire process. The process incorporates the four dimensions of a resource exploitation partnership between customary landowners (and their representatives), the State and the Mining Company: from prospecting, to extraction, to market, to environmental make-good.

Hitherto, developing country governments have often lacked the technical capacity to provide a realistic estimate of resource returns. Similarly, government officials in traditional societies may lack the aggressive negotiation skills required to broker an equitable deal between the custom landowners (who risk relocation in the 'national interest', given that their land may be damaged/destroyed through the resource exploitation) and the international resource exploration companies (who predominantly hold the key information, knowledge, money and power in such arrangements). A synergistic compensation model that engages option-pricing theory, offers a key transparent negotiation tool for all parties. Informed by publicly available data, it places the onus on the exploration company to prove or disprove the data. It also offers a policy framework that enables the custom landowners to be the direct financial beneficiaries of the scheme, with the national fiscal benefit to the State being derived from standard taxation arrangements over the custom landowners newfound source of direct revenue associated with the marriage value of interests.

METHODOLOGY

Our research design is one of phenomenological transdisciplinarity, which implies our goal is to build models to connect theory to observed reality, allowing us to inform potential policy outcomes.

The theory is grounded in option pricing models developed by Damodaran (2012), drawing on Black-Scholes (1972, 1973) assumptions, and the binomial models of Geltner et al. (2007) that incorporate Samuelson-McKean formula and Black-Scholes assumptions (with Fisher-Margrabe extension). We test these theoretical models in a range of scenarios in the observed reality of gold and copper reserves in the Namosi Highlands, Fiji.

In the following sections we: (a) provide background to the option pricing literature, (b) offer context for our Fiji based case study to test the model, (c) use publically available data, verified by the Department of Mining and Mineral Resources, to simulate the value of gold and copper 'option', before we (d) draw analysis from the option scenarios to demonstrate both the benefits to the key stakeholders and the importance of short-term mineral exploration/extraction licensing agreements.

BACKGROUND TO OPTION PRICING THEORY

In the context of land based resources, an option is a contract in which the option writer (e.g. the customary landowners, or State on their behalf) gives an exploration company the right, for a certain sum of money, to extract a certain volume of minerals at a fixed (or variable) price within a specified period. Our research contributes to the literature by using option pricing theory to more accurately forecast the potential synergistic value created by the exploitation of land based resources. It adapts, evolves and explains the findings of recent modeling to recommend equitable stakeholder benefit sharing in the context of customary land.

The concept of optionality is not new in property. Property rights in leases have always contained options (to assign, surrender or renew, a point recognised by Geltner et al., 2007) as has the notion of development, albeit the property rights to those options are often tempered by planning policy or building regulations.

The straightforward definition of an option (Ong and Brown, 2001, np) is "a contract in which the option writer "or seller" gives the buyer the right, for a certain sum of money, to buy from/sell to the writer a specified number of assets at a fixed price or exercise price within a specified period". Ong and Brown attribute the term real options to Myers (1987), real options being embedded implicitly in strategic investments and referring to decisions concerning real or tangible assets. Myers highlighted that "it's

impossible to forecast most projects actual cash flows accurately. DCF calculations do not call for accurate forecasts, however, but for accurate assessments of the mean of possible outcomes" (p.11). He went on to say (p.13) that,

> Option pricing methods hold great promise for strategic analysis. The time series links between projects is the most important part of financial strategy. A mixture of DCF and option valuation models can, in principle, describe these links and give a better understanding of how they work. It may also be possible to estimate the value of particular strategic options, thus eliminating one reason for the gap between finance theory and strategic planning.

An arguably more coherent definition of real property options is offered by Patel et al. (2005, p.7)

> Real property options opportunities (and possibly implicit commitments) to acquire or develop or dispose of property (link) real assets at an investment cost determined (or estimated) in the present with the benefits (future rents or Property Sales) delivered in the future.

Whilst a number of examples have been developed, such as Titman's (1985) parking lot example, much of the work errs on the econometric (Ott, 2002) rather than taking a heterodox approach at the nexus of the legal, sociological and environmental reality of mineral resource extraction.

Damodaran (2012, p.87) actually engages the use of the word 'right', in that an option

> Provides the holder with the right to buy or sell a specified quantity of an underlying asset at a fixed price (called a strike price or an exercise price) at or before the expiration date of the option. Since it is a right and not an obligation, the holder can choose not to exercise the right and can allow the option to expire.

He goes on to acknowledge that option pricing theory has made vast strides since the publication of Black and Scholes (1972, 1973) papers. According to Damodaran (2012, pp.89-90) the value of an option is determined by six variables that relate to the underlying asset (which, in the case of the scenario we are about to explore, is the customary land):

- Current value of the underlying asset;
- Variance in the value of the underlying asset;
- Dividends paid on the underlying asset;
- Strike price of the option;

- Time to expiration on the option; and,
- Riskless interest rate corresponding to life of the option.

Damodaran is of the view that the valuation models developed for financial assets are applicable for real assets as well in that they share several common characteristics, "the value should be determined by the cash flows they generate, the uncertainty associated with these cash flows, and the expected growth in the cash flows" (2012, p.739). Of particular relevance to our research is Damodaran's model of natural resource options, to which we will return shortly after explaining the context of our particular scenario.

THE RELEVANCE OF APPLYING OPTION PRICING THEORY TO RESOURCE COMPENSATION – A MELANESIAN CASE STUDY

There is a growing acceptance (Cole and Ostrom, 2012, p.37) that "economists, legal scholars, and other social scientists continue to rely on simplistic, outmoded, and incomplete models that fail to capture the variety and complexity of property arrangements found throughout the world". What we want to do is build on prior research presented at the World Bank (Boydell and Baya, 2012) that explored how an equitable land resource compensation model could be formulated for resource rich developing countries, such as those in Melanesia, where the principles of customary land ownership are protected by constitutions and traditions alike. That work was an evolution of a two-year research project working with landowners and governments in Melanesia, where we drew on a detailed analysis of both institutional arrangements and stakeholder interpretations, combined with insights from other jurisdictions, to explore and analyze a range of potential compensation models. We concluded, after drawing on international best practice, that a synergistic value approach has more to offer in the context of land resource compensation in Melanesia. Whilst it was relatively straightforward to identify the customary landowners 'heads of claim' that should be compensated in any mineral resource exploitation project, the challenge we faced was how to place economic worth on the interests of the parties in a way that was both transparent and equitable, as well as providing the potential of intergenerational equity for the long-term extinguishment of habitat and associated environmental remediation (drawing on dire environmental lessons from other exploration schemes in the region and internationally).

Spread over 30 million square kilometers of ocean, the developing countries of the South Pacific region share a combination of geographical, biological, sociological and economic characteristics. All have enduring traditional systems of customary land tenure (with 83 to 100% held in customary ownership),

that conflict with Western notions of land ownership (Hann, 1998, Paterson, 2001). In the resource rich countries of Melanesia (Papua New Guinea, Vanuatu, the Solomon Islands, and Fiji) exploration and extraction of minerals is an ongoing source of conflict between customary landowners, the government and offshore exploration companies. Papua New Guinea has the largest reserves and most developed resource sector, but has recently changed its policy regarding the ownership of mineral reserves that recognize and protect traditional landowners rights to mineral ownership on or under their traditional land and seabed. At the time of writing, significant reserves of bauxite, copper and gold have been identified in Fiji, while some $60 billion seabed nickel reserves are promised in the Solomon Islands.

As Adams et al. (2003, p.1915) highlight "conflicts over the management of common pool resources are not simply material. They also depend on the perceptions of the protagonists". Whilst it is a common assumption that policy relating to the management (and exploration / extraction) of natural resources is self-evident, there is a need to better understand the ways that different stakeholders understand the management problems in order to progress and effective dialogue. These values are the impressions that different individuals (or groups) formulate from their individual (or group) comprehensions of the settings and circumstances in which they are situated, and that understandably can differ from the impressions of those around them. To this end, "policy debates are often flawed because of the assumption that actors involved share an understanding of the problem that is being discussed" (Adams et al., 2003, p.1915). Policy debates therefore often ignore the fact that the assumptions, knowledge, and understandings that underlie the definition of resource problems are frequently uncertain and contested.

When economists offer specific prescriptions about collective choice – indicating which decisions are efficient, correct, rational, best, and socially preferred – we see truth claims from a particular discipline projected onto the individual and collective stage of contending expressions and contending created imaginings about what is the best for the future of those persons (and their descendants) responsible for these contested expressions and contested created imaginings. The pragmatist would challenge these truth claims by asking if those specific truth claims can be justified to all members of that particular community (Bromley, 2006, p.138).

Boydell and Baya (2012) highlight that there is a large body of international literature on economic valuation and resource management, and ecosystem valuation. Much of the resource valuation literature takes a *Total Economic Value* approach, where values are allocated to *use* values (direct and indirect) and *non-use* values (option value, quasi-option value, bequest value and existence, or psychic, value). The valuation techniques engaged in these *use* and *non-use* approaches are those applied by economists (as

opposed to valuers), and include: Effect on Production; Replacement Costs; Damage Costs; Travel Costs; and, the Contingent Valuation Method. These have been variously applied on a range of international situations, with varying success. We consider that, because of the inputs required and the outputs desired, they all fall short of addressing valuation for land resource compensation in a Melanesian context – a point reinforced by Pascual et al. (2010, p.229) highlighting the lack of local research capacity may result in a lack of awareness of valuation methods, and complicated by different value concepts held by mineral exploration companies and the customary landowners.

In our earlier work (Boydell and Baya, 2012) we established that the synergistic value approach has more to offer in the context of land resource compensation in Melanesia. As a valuation method more familiar to the valuation profession than mainstream economists it is easier to engage on the ground, given that land compensation issues are dealt with by valuers representing the parties. The synergistic value approach (also known as marriage value) takes a more holistic approach, engaging with the economic benefits that are gained from providing a mining infrastructure in multiple locations not just at the extraction site, including access to inner reef and marine areas (or, for example, providing a mineral exploration company access to reclaim an area for a wharf facility with associated jetty). It has the ability to be adapted and expanded to also include items that relate to both the positives (e.g., partnership, employment, service sector and food supply, environmental conservation and cultural heritage), as well as the negatives (e.g., potential loss of access, environmental contamination, sedimentation, eutrophication, reef degeneration, loss of amenity / privacy, loss of cultural heritage). We earlier (Boydell & Baya, 2012) recommended that the quantum of compensation will need to be determined on a case-by-case basis, with the synergistic value between the mine, mining infrastructure, depot / wharf and the marine area forming a main component on which to base the negotiated agreement. The valuation components that are derived through this process will produce a much clearer indication of the overall compensation quantum of the compensation package. This package should have regard for the benefits accruing from the scheme (if any), such as employment opportunities, food and service provision, training, and the current package of notionally goodwill items (such as village benefits, medical fees, schooling, donations and material items e.g. boats / vehicles).

The challenge that we have had with the synergistic approach is attempting to quantify the marriage value between the interests and options of the customary landowners and values of both the state and the mineral resource exploration company who, hitherto, have benefited most from such arrangements. Likewise, natural resource exploration companies have options to develop a resource at a particular time or leave it until the value of the underlying asset (the minerals) increases on the commodities market.

These undeveloped reserves can be viewed as 'call options' (Damodaran, 2012, p.796). Whilst it is relatively easy for us to articulate the various heads of claim under our synergistic model (using the International Valuation Standards), hitherto we have not placed a value on the underlying mineral asset based on the estimated quantity and the price of the natural resource less the costs to exploit.

Conveniently, Damodaran provides an example of an oil reserve, which can easily be adapted to a scenario where the underlying asset is the value of the estimated copper and gold reserves, based on the market price of refined gold and copper. Acknowledging that there is a major cost associated with prospecting, development, extraction, transportation, refinement, marketing, and sale of the mineral resource, as well as an environmental liability for site remediation post extraction, the traditional approach is to assume the difference between the estimated reserves and the cost of the development is the profit to the exploration company, less any royalties they have to pay either to the state or the customary landowners. Damodaran refers to the 'owner of the resource', but (as we elaborate in the next section) this is a contested issue, with customary owners not differentiating between the land surface and the resources above or below it. By identifying the level of surplus anticipated (over and above the recoverable exploration-extraction expenditure associated with the prospecting-to-market sale continuum and business return to the exploration company) we are better placed to provide the basis of the marriage value from the interests of the landowners with those of the exploration company as the basis of our synergistic valuation.

Having provided some context, it is appropriate to interrogate the theory through the lens of a contemporary natural resource option. To illustrate the application of option pricing theory in the determination of synergistic value we offer the example of a 723.5 km² mining tenement 30 km west of Sua, Fiji's capital on the island of Viti Levu. The government of Fiji granted the mining tenement to a resource exploration consortium known as Namosi Joint Venture (NJV). NJV is "a joint venture between Newcrest (Fiji) Limited (Newcrest), Nittetsu Mining Co Ltd, and Materials Investments (Fiji) Ltd (Mitsubishi). Newcrest's interest is 69.94% and it is the operator and manager of the NJV" (Newcrest Mining Limited, 2012, p.1). The valuation modeling that follows relies on publicly available data from the Newcrest website, gold price data, the Reserve Bank of Fiji, and the Economist (amongst others). Newcrest have identified more than 15 significant copper and gold prospects within this particular tenement.

Natural resource companies, such as Newcrest, are able to generate cash flows from their existing reserves but it is their new explorations that have potential optionality. The option to develop is much

more likely for undeveloped reserves if the price of the resource (in this case gold and copper) increases, as witnessed by the significant increase in gold prices over the last decade and most significantly the market escalation since the global financial crisis.

Drawing on the work of Damodaran (2012, pp.796-803), in a natural resource example like the Namosi,

> The underlying asset is the natural resource and the value of the asset is based on the estimated quantity and the price of the resource. Thus, in a goldmine, the underlying asset is the value of the estimated gold reserves in the mine, based on the price of gold. In most such investments, there is an initial cost associated with developing the resource; the difference between the value of the estimated reserves and the cost of the development is the profit to the owner of the resource.

As detailed above, there is a need to clarify what is meant by ownership in the resource from a customary perspective. In the Fiji context, there has been a tendency to grant exploration licenses based on the promise of a share of the return coming to the State by way of royalties, the assumption of increased trade and employment, and the associated spin-off benefits to service providers. Conversely, ownership in the way that Damodaran articulates it relates to ownership of a set of property rights associated with exploration and mineral resource removal from the site. It is not to be confused with the inalienable rights of the customary landowners. Rather, these interconnected and overlapping 'rights' offer a framework for compensation to the customary landowners who, through (in the case of Fiji) the iTaukei Land Trust Board (iTLTB) as trustees for the customary landowners are the potential gatekeepers of the opportunity to 'marry' the rights of the parties.

Since political independence, the status of Fiji's vibrant constitutional history is well documented. Counting Fiji's first Constitution of 1970, recent procedural developments include (at time of writing) the facilitation of a constituent assembly a new constitutional draft. Once assented, the proposed document, earmarked for 2013, will be its fourth constitution in 33 years. The 1997 Constitutional document was suspended in December 2006 and abrogated in 2009 (Fiji Times, 2009).

As McLeod and Naidu (1998, pp.6-7) explain,

> In Fiji the state is legally sole owner of all mineral resources and therefore entitled to the royalties paid as economic rent on the exploitation of the resource. However, landowners believe that they own all the land that is above and below the land including the minerals. As a concession to this belief part of the royalties in Fiji are paid to the government and

part are given to the landowners.

The confusion over landowners surface and subsurface land rights in Fiji is elaborated on by Niumataiwalu (2009), who explains that the Fiji Constitution of 1997 (and subsequent amendments) did not clarify the distinctions of customary ownership from the earth's core to space in regards to mineral royalties and compensation. At the time of writing (February 2013), in the absence of a Constitution in Fiji, all laws remain the same unless wholly or parts of pre-existing law are specifically stated to be otherwise through a decree. In the absence of a decree, the presence of customary ownership and its recognition in the residual laws is in a state of flux.

Despite the manner of changes, the Constitutional provisions (1997) safeguarded private property rights ownership against deprivation without just (equitable) compensation including the definition of 'property' under s.40(3) to include 'interest in property'. This, the section qualifies, must be done in accordance with a law and is permissible for public purposes only. In addition, it enshrined under s.6 non–justiciable compact articulating principles of the conduct of government that includes *inter alia* due regard to the ownership of customary land according to Fijian custom. More specifically, s.186 offers precise treatment, under the heading 'Customary Laws and Customary Rights' obligating parliament that it [m]ust make provisions granting the owners of land or of registered customary fishing rights owner equitable share or royalties or other monies paid to the State of rights to extract minerals from land or sea be[d]. The extent to which this enabling provision was further developed and implemented is unknown although a working committee comprising various industry stakeholders to review of the compensation provisions of the Mining Act (1978) was initiated in 1999 (McLeod, 2000a).

As stated, between constitutional transition and barring any specific annulling decree, all laws remain the same. Fiji presently resorts to the currency of its Mining Act (1978) and associated regulations in all dealings with matters pertinent to mineral resource developments. Considering that the current Act is largely a scion of its colonial past, this does not preclude the opportunity to continually improve ways of host economic retention from the increased mining interest through policy level developments (see, for example, McLeod, 2000b and, McLeod, 2000c). This must include advice on acceptable standards of pro-development equitable compensation options that considers the inclusive nature and extent of customary ownership and overall environment considerations at the same time seeking to improve the economies of scale nationally.

In contrast, Papua New Guinea's current mining stance is proactive through utterance of the Mining Minister, Hon. Byron Chan, towards the full recognition of ownership of minerals by customary owners rather than the State. In a speech in 2011, the Minister pointed to the fact that the constitutional premise

of PNG was in fact shared at source from its colonial ties with Australia, where most of its laws including property ownership of minerals and extractive resources were mere reception of its colonial past (see Chan, 2011 and analysis from, Arvanitakis and Boydell, 2011). The colonial premise of unoccupied land and the international law concept of *terra nullius*, was proven otherwise in Australia by Mabo and Others v State of Queensland (No. 2) (1992). According to the Hon. Byron Chan (2011) Papua New Guinea has a contrasting history and therefore cannot continue to perpetuate the distinction between customary ownership of land as different to that of minerals. Owing to the inclusive nature of customary title, the two accordingly are inseparable and must be treated as one. Whilst mining companies are understandably jittery of this development, vesting ownership of minerals to customary owners may least affect tax and other huge revenues from the mining boom to the State.

Perhaps the interesting constitutional development and resulting resource laws are to be expected in the case of the Autonomous Region of Bougainville, Western island province of Papua New Guinea (formerly known as Northern Solomons). Richly endowed with minerals, the island region attracted global attention in its fight for better compensation from the island copper and gold mine (Panguna) that started in the 1960s that erupted into a civil war in 1988-1989. From the experiences and lessons learnt, since achieving political autonomy status in 2000 there is an expectation of a comprehensive pro development equitable compensation regime that would complement customary incidents of ownership of land and minerals.

SCENARIO ANALYSIS – GOLD & COPPER RESERVE

To bridge the gap between the current situation where customary landowners, the iTaukei Land Trust Board as the trustees, and the State are poorly compensated for mineral resource exploitation, we decided to test the veracity of option pricing models to provide an economic proxy for synergistic value. Our purpose was to test the efficacy of option pricing as a bridge between unjust and equitable compensation.

Our starting point was in the work of New York-based professor Aswath Damodaran who teaches corporate finance and the valuation at the Stern School of Business at New York University. As mentioned, he offers an illustration of valuing am Oil Reserve in explaining the modeling of natural resource options (Damodaran, 2012, pp.796-804) with his Excel spreadsheet available freely from his website (see http://people.stern.nyu.edu/adamodar/New_Home_Page/spreadsh.htm#optinval <natres.xls> - A model that uses option pricing to value a natural resource company; useful for valuing oil or mining

companies). We cross-reference this approach with the work of Geltner et al. (2007, in particular Chapter 27: Real Options and Land Value). Like Damodaran, Geltner et al. offer a series of Excel models for real options and the call option model of land value and optimal development. Included in the Excel file are a simple option valuation model, a binomial model, a perpetual horizon model, and a continuous time formula (the Samuelson-McCain formula). By utilizing the same parameters, probabilities and input data, we found that both spreadsheet files (and their multiple variants) produced consistent results.

Whilst natural resource companies rely on the cash flows from existing reserves, they are more likely to extract from undeveloped reserves if the price of the resource (e.g. gold copper) increases. The value of the underlying asset is based on the estimated quantity and price of the resource. In our Namosi example, we relied on publicly available data (sourced from Newcrest Mining Limited's own site, the published price of gold, and extraction costs for gold sourced from the Economist, and relied on Fiji government infrastructure bond prices as a proxy for risk – including political, currency and site). It is understood that NJV mining tenement represents a 900,000,000 ton copper and gold resource, with an anticipated yield of 0.43 g of copper per ton and 0.14 g of gold per ton. This indicates a potential 387 tons of copper and 126 tons of gold. Interestingly, whilst Namosi has always been referred to as a copper resource, based on published data there is only around $4.4 million worth of copper at prevailing prices, wheras given the expectation that extraction costs will be around $4 billion, the real value of this natural resource lies in the gold, which has an estimated current market value of around $6.25 billion.

All of the models we engaged dealt with similar inputs, namely the available reserves of the resource, an estimated value of extracted resource at current market prices, the estimated cost of developing the resource, the time to expiration of the option, the variance in value of the underlying mineral asset, and the cost of delay. For the purposes of this research, we modeled the values in July 2012, using data available at that time, when there was parity between the US$ and the Australian$. At the time of finalizing this paper (February 2013) the value of gold has increased slightly, as has the AUD$ against the US$. Similarly, the latest release of Fiji Infrastructure Bonds (05 September 2012) is marginally more secure than the July release we initially modeled. Given that we have used Australian gold prices (being, as we are, a Sydney based research center) and reviewing an Australian led Joint Venture Exploration Company, a case could be made for adopting the Australian 10 year bond rate as a proxy for risk. This has increased in recent months to around 3.6% compared with the US 10-year bond rate of 2.028% yield. Just as the gold price is at a relative ten-year high, likewise 10-year bond rates are at a relative low (serving as a proxy for the risk free rate).

We also ran our models through a Monte Carlo analysis in proprietary Crystal Ball software to simulate the probabilities and relative accuracy of the inputs and variables. With the caveat that we have conducted this analysis and simulation as purely a research exercise, as opposed to commissioned professional advice or as a formal consultancy, our findings are indicative that there could potentially be a significant synergistic value liberated by the extraction of the gold in the identified copper and gold resource at Namosi. We include our adaptation of the Damodaran model in Appendix 1, by way of example only.

FINDINGS AND COMMENTARY ON A POSSIBLE COMPENSATION FRAMEWORK

The time duration until the rights in the resource will be relinquished is a highly sensitive variable in option pricing models. For example, using our preliminary calculations based on publicly available data we estimated the value of the natural resource option for the Namosi to be around US$1.8 billion (FJD$3.4 billion) after all extraction costs and expenses on the basis of a 5-year Option. If the length of the Option is extended to a more realistic 10 years (refer Appendix 1), this figure reduces to US$1.5 billion (FJD$2.8 billion), this figure being based on the value of the gold only (as the impact of the copper reserves appears negligible at around US$4 million, based on estimated volumes and prevailing market rates).

Using our synergistic (marriage) value approach, as a starting point for negotiation you could assume a 40% share of the profits (the synergistic value of the surplus) for NJV, a 20% allocation into an environment fund (realizing that with the best will in the world there will be significant environmental damage from this project given that a mountain will effectively be removed in the process of extracting the gold and copper), and a 40% share to Fiji.

In our initial calculations, we divided this 40% Fiji share into a 10% management fee for iTLTB (the standard management fee charged by the trustees in dealing with customary land in Fiji), with 90% of the Fiji share going to the landowners on the basis (using the PNG example) that this amount would be taxed by the government (notionally at 23%), rather than the government receiving a direct royalty. On this basis (and assuming a 10 year option), we estimated a revenue for the iTLTB to be in excess of US$60 million (FJD$113 million), US$125 million (FJD$234 million) to the government in tax (which is presumably more than any current estimate of royalty payment which would have to be shared with the landowners and cover damage costs to the environment) and a potential return to the landowners of

around US$420 million (FJD$785 million), assuming all current mineral reserves are removed within a 10 year option period. All figures are based on July 2012 data, when there was approximate parity between the US$ and the AUD$.

This can be summarized as:

- US$1.5 billion (FJD$2.8 billion) = Synergistic value based on option pricing theory and publicly available data about Namosi Joint Venture, extraction costs and gold value
- US$606 million (FJD$1.13 billion) = 40% NJV share (which is the investor share of gross profit, representing a 36% margin on revenue, a 27% investor share of gross profit, and a 25% hurdle rate or internal rate of return on shareholder equity)
- US$303 million (FJD$566 million) = 20% into Environmental Protection Bond / Trust
- US$606 million (FJD$1.13 billion) = 40% Fiji share

We suggested that the 40% Fiji share could be allocated as follows:

- US$60 million (FJD$113 million) = iTLTB management fee (i.e. 10% of Fiji share)
- US$546 million (FJD$1 billion) = Gross income to customary landowners (i.e. 90% of Fiji share) to be taxed at 23%
- US$124 million (FJD$234 million) = Government Taxation Revenue (based on 23% of gross landowner income)
- US$420 million (FJD$785 million) = net proceeds to Landowners, presumably to be managed on their behalf in trust by iTLTB

CAPACITY BUILDING AND KNOWLEDGE TRANSFER

Our goal in this research was to find a better way of determining the synergistic value associated with resource development on customary land. We have used option-pricing theory as the best proxy available to calculate the benefits from the exploitation of land based mineral resources, and proffered an example of how they could potentially be shared. We have identified four key findings from this research, which we discuss below, that relate to both capacity building and knowledge transfer. The findings have informed policy advice locally in Fiji, and the modeling is currently being expanded to test stakeholder values associated with land-based resources in the Solomon Islands, Papua New Guinea and the

Autonomous Region of Bougainville. The research team is also in discussion with a range of resource stakeholders in several African countries.

Importance of the length of the Option: From the perspective of a developing island country like Fiji, this represents significant amounts of money to the stakeholders. It is critical to note that if long leases (i.e. 30-99 years) are granted, all of this benefit potentially goes to NJV and is essentially lost to the state, the iTLTB, and most importantly the customary landowners. Given the time preference of money, changing the period when the rights to resource would be relinquished by NJV from say 5 to 30 years reduces the figures by 70%, and if you change it from 5 to 99 years, it reduces the figures by 97%. The example we provided is based on a 10-year option. It was evident that the assumption of a five-year extraction license was unrealistic, as it will probably take 3 or 4 years to put the base infrastructure in place for a scheme like Namosi. This means Namosi may have 5 or 6 years productive capability during the first term of the a ten year extraction license. At this stage we have not other 'options' for years 10 to 15 (i.e. a 10+5 option), 15 to 20 (i.e. a 10+5+5 option), and 20 to 25 (i.e. a 10+5+5+5 option), as it all becomes a little hypothetical at that stage without richer geotechnical information and enhanced statistical capability to model the various probabilities, risks, and uncertainties. There needs to be appropriate remuneration for that level of site-specific research endeavor.

Option pricing theory is only a starting point: We would suggest that option pricing theory is only a starting point in that it presents the best proxy of synergistic value for a mineral resource scheme thus far. Option pricing theory is not without its significant limitations, and as Mandelbrot and Hudson (2004, pp.268-271) highlight, there has been significant research undertaken on studying the errors in the Black-Scholes model, with many attempting to just fix the underlying formula. However, and far more importantly, what we have demonstrated by using publicly available data should be sufficient for the State, Landowners and their Trustee (in Fiji, the iTaukei Lands Trust Board) to realize that hitherto they have been failing to maximize the return to Fiji from resource exploitation projects, such as the copper / gold reserve in Namosi, whilst ensuring significant environmental remediation funds are also secured. Rather, we see the benefits of the option pricing model proffered as a proxy for determining the synergistic value as the basis for bringing the stakeholders together to progress serious and mutually beneficial negotiation around the ramifications of site / project specific resource exploitation. The figures that we have used, whilst based on publicly available data, are produced for research purposes only and thus are indicative only.

Send in the dogs: Given the potential revenue that the iTLTB and the government could derive just from

this one mineral example, the trustees and the state really cannot afford not to invest money to fully research this matter properly. With the identification of more resource options across Fiji, there is a desperate need for the iTLTB (and landowner representative in other countries) to build valuation and negotiation capacity in this area. What is important is that the mining companies who completely dominate the political landscape in a country like Australia, and are attempting to do likewise in Fiji do not take Fiji for a ride. In the Fiji context, it is our view that the iTLTB needs to maximize the return to customary landowners on these resources and take leadership. Hitherto in the Pacific there has been a reliance on donor funding in Pacific island countries, and this ties in with the 'sustainable mining' support of AusAID. However, such a handout mentality is inappropriate when a country is sitting on a $6 billion gold reserve (which is just one of many current resource explorations / exploitations underway in Fiji). From a western commercial perspective the situation was simple. The base return that the customary landowners, iTLTB and the State require is determined (e.g. based on the synergistic value), and the iTLTB as commission an aggressive negotiating team to represent the interests of the customary landowners (and the State, as fiscal beneficiary) in the (inevitably protracted and heated) discussions with the mining company. The landowners / State team is remunerated on a percentage of the margin they achieve over and above the base return. Essentially, the landowners need a 'pack of dogs' who will fight with the 'pack of dogs' representing the mining companies interests. There is obviously a significant trust issue in such an arrangement, and the dogfight is clearly representative of low culture society (and thus outside the traditional understanding of how to deal with people in a high context society like Fiji).

Compensate in gold, not cash: This suggestion may be seen to undermines the validity of option pricing theory other than its ability to provide a proxy for value and compensation that has hitherto been absent. It relates to a simplification of the whole process. Simply stated, forget monetary compensation. Monetary compensation brings in all kinds of risks relating to ease of access, time, variation in gold price, and international currency risk for all stakeholders. Instead, you acknowledge the fact that Fiji (i.e. the customary landowners and the State) is currently sitting on what is estimated to be a US$6 billion gold reserve with approximately US$4 billion of extraction costs. Those figures are at today's value, in other words they encompass all sorts of assumptions on the time preference of money and the basis of valuation being 'as at now'. Instead of compensating in monetary terms, the parties agree to the synergistic value being, by way of example, say 40% NJV/ 20% Environmental Bond / 40% Fiji of the gold bullion and agree for all compensation to be paid in gold bullion rather than cash. Realistically, based on earlier figures, the percentage of gold being kept in Fiji would have to be negotiable and ultimately this depends on how good the 'dogs' Fiji uses to negotiate are. Gold is easy to monitor assuming that the gold is smelted on site, as a small team could provide observer status every time gold is poured. Obviously there

would need to be secure storage for the gold reserves, be it in the vaults of the Reserve Bank of Fiji or overseas. Either way, with that level of gold reserves in a vault the country would be able to raise capital for future development independently of donor aid, relying instead on using the gold reserve as equity. Likewise any risks associated with the volatility of the gold price are negated. The gold is not necessarily sold by Fiji, and a percentage of the intergenerational value of the mineral resource stays in country, potentially in perpetuity. This allows for future remediation work in terms of the inevitable environmental damage (especially if there is pressure to slow down production due to a change in demand for gold internationally, or speed up production and refinement using major dangerous contaminants.

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	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T
1	**APPENDIX 1: VALUING A NATURAL RESOURCE OPTION**							GOLD	NAMOSI											
2			This spreadsheet calculates the value of a natural resource option.																	
3		**Assumptions**																		
4		1. All the assumptions underlying the Black-Scholes model apply					**NOTE**: This option pricing model is originated from DAMODARAN, A. 2012. Investment valuation : tools and techniques for determining the value of any asset, Hoboken, N.J., Wiley (pp.796-804), and the Excel spreadsheet available freely from his website (see http://people.stern.nyu.edu/adamodar/New_Home_Page/spreadsh.htm#optinval <natres.xls> - A model that uses option pricing to value a natural resource company; useful for valuing oil or mining companies). We cross-reference this approach with the work of GELTNER, D., MILLER, N. G., CLAYTON, J. & EICHHOLTZ, P. 2007. Commercial real estate analysis and investments, Mason, Ohio, Thompson South-Western (in particular Chapter 27: Real Options and Land Value). Like Damodaran, Geltner et al. offer a series of Excel models for real options and the call option model of land value and optimal development. Included in the Excel file are a simple option valuation model, a binomial model, a perpetual horizon model, and a continuous time formula (the Samuelson-McCain formula). By utilizing the same parameters, probabilities and input data, we found that both spreadsheet files (and their multiple variants) produced consistent results. We also ran our models through a Monte Carlo analysis in proprietary Crystal Ball software to simulate the probabilities and relative accuracy of the inputs and variables. The model has been adapted by SPIKE BOYDELL and ULAI BAYA (both of UTS: APCCRPR), with assistance from PAUL ZAHARA (of Cedar Hill Pty Ltd / UTS), <u>for illustrative purposes only</u> in respect of their research for a World Bank Land and Poverty 2013 paper (and should be read in conjunction with that Boydell & Baya paper). It is included as a appendix to that paper with the caveat that we have conducted this analysis and simulation of gold reserves in a copper and gold resource in Namosi, Fiji, as purely a research exercise, as opposed to commissioned professional advice or as a formal consultancy. The publicly available data was sourced in July 2012, which was the notional date of this simulation.													
5		2. The estimated reserves of the natural resource are known.																		
6																				
7		**The user has to input the following variables**																		
8		1. Present value of estimated reserves, net of royalties and marginal costs.																		
9		2. Variance in the price of the natural resource.																		
10		3. Present value of the cost of developing the natural resource.																		
11		4. Riskless interest rate that corresponds to relinquishment period.																		
12		5. Length of the relinquishment period on resource reserves.																		
13		6. Expected annual after-tax cashflow from resource after it is developed.																		
14																				
15		**Inputs relating the underlying asset**																		
16		900,000,000	tonne open pit copper gold resource		Grams	Tonnes	Market Price July 2012		Gross Resource Value		Enter the estimated reserves of the natural resource =			126000000	(in units)	source	http://www.newcrest.com.au/projects.asp?category=6			
17		0.43	grams copper per tonne		387,000,000	387	$ 11,500	$AUD/tonne	$ 4,450,500								http://www.newcrest.com.au/projects.asp?category=6			
18		0.14	grams gold per tonne		126,000,000	126	$ 49.65	$AUD/gram	$ 6,255,900,000		Enter the current price of the natural resource, per unit =			$49.65	(in currency)	source	Market price source http://goldprice.org/gold-price-per-gram.html			
19		857	$cost to extract 1 oz gold			Convert oz to grams		28.35		$ 30.23	Enter the marginal cost per unit of extracting the natural resource =			$30.23	(In currency)		(source http://www.economist.com/node/187746240)			
20		21500000	cost to date	so cost to develop could be		10	times this =	$ 215,000,000												
21																				
22		Enter the standard deviation in the price of the natural resource (ln) =				5.03%	source: http://www.tradingnrg.com/wp-content/uploads/2012/07/Standard-deviation-Gold-price-forecast-silver-prices-outlook-2012-July-10.jpg							5.03%	(in %)					
23																				
24		Enter the estimated annual after-tax cashflow after developing resource =				100,000,000	After tax cash flow after developing the resource (hard to estimate?)				THIS seems to be the wildcard variable?			$100,000,000	(in currency)					
25																				
26		**Inputs relating to the option**																		
27		Enter the present value of the cost of developing the resource option =												$215,000,000	(in currency)					
28																				
29		Enter when the rights to resource will be relinquished =			10	(note, a 5 year lease granted on Vatukoula - not clear for Namosi)								10	(in years)					
30		**General Inputs**																		
31		Enter the riskless rate that corresponds to the option lifetime =				6.80%	15 year due date							6.80%	(in %)		Fiji Government Infrastructure Bonds 18 July 2012 source: Reserve bank of Fiji: http://www.reservebank.gov.fj/docs2/Advert%20-%20%2018%20July.pdf			
32																				
33	**VALUING A LONG TERM OPTION/WARRANT**																			
34	Stock Price=		**$2,447,011,111**		T.Bond rate=		**6.80%**													
35	Strike Price=		**$215,000,000**		Variance=		**0.00253009**				Background									
36	Expiration (in years) =		**10**		Annualized dividend yield=		**4.09%**				723.5	km2 mining tenement with >15 significant copper and gold propects already identified				source	http://www.newcrest.com.au/projects.asp?category=6			
37											5.45%	6 year due date	Fiji Government Infrastructure Bonds 18 July 2012 source: Reserve bank of Fiji: http://www.reservebank.gov.fj/docs2/Advert%20-%20%2018%20July.pdf							
38											5.45%	8 year due date	Fiji Government Infrastructure Bonds 18 July 2012 source: Reserve bank of Fiji: http://www.reservebank.gov.fj/docs2/Advert%20-%20%2018%20July.pdf							
39		d1 =	17.07487359								6.26%	10 year due date	Fiji Government Infrastructure Bonds 18 July 2012 source: Reserve bank of Fiji: http://www.reservebank.gov.fj/docs2/Advert%20-%20%2018%20July.pdf							
40		N(d1) =	1								5.45%	Median bond rate - but nearest to life = 15 years								
41																				
42		d2 =	16.91581102																	
43		N(d2) =	1		$ 1,841,754,666															
44					**US/AUD $**		FJD$													
45		Currency Conversion			1		1.8667						July 2012 source http://www.xe.com/ucc/convert/?Amount=1&From=AUD&To=FJD							
46	**Value of the natural resource option =**			**US/AUS $**	**$1,517,211,497**	FJD$	**$2,832,178,701**		$6,255,900,000	= AUD$million gross gold value (Revenue)										
47																				
48	**Value Sharing**			100%					$4,023,888,889	= AUD$million gross extraction costs										
49		NJV 40% share		40%	$606,884,599		$1,132,871,481													
50		Environmental Fund Share of Revenue		20%	$303,442,299		$566,435,740.26		$2,232,011,111	= AUD$million gross profit										
51		Fiji Share		40%	$606,884,599		$1,132,871,480.52													
52		iTLTB (10% of Fiji Share)		10%	$60,688,460		$113,287,148		36%	= Margin on Revenue										
53		Gross Landowners			$546,196,139		$1,019,584,332													
54		Tax to Govt (23% of Gross Landowner share)		23%	$125,625,112		$234,504,396		$ 606,884,599	=Investor Share of Gross Profit (AUD$)										
55		Net to Landowners			$420,571,027		$785,079,936													
56									27%	=Investor Share of Gross Profit (%)										
57									25%	= Hurdle Rate (IRR on Shareholder Equity)										
58																				

APPENDIX 1: Sample Option Pricing Model for Namosi Gold reserve, Fiji, source Boydell & Baya for this research