Essays on the Namibian Economy

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Abstract

This thesis consists of an introduction and four papers exploring various aspects of the Namibian economy. These aspects cover shadow pricing, environmental valuation and capital market development in Namibia.

Paper I estimates the shadow prices of capital, labour and foreign exchange for the Namibian economy. The results suggest that the shadow price of capital for Namibia is 7.2%. The economic costs of Namibian labour, as a share of financial costs, are 32% for urban semi- and unskilled labour, and 54% for rural semi- and unskilled labour. The economic cost of foreign labour as a share of financial costs is 59%. The estimated shadow exchange rate factor is 4% for the Namibian economy.

Paper II derives a set of accounting price ratios (APRs) for the various economic sectors of Namibia by using the Semi-Input–Output (SIO) Technique. An *APR* is the ratio between the market or financial price and the efficiency or economic value of a specific commodity or sector, which is useful for the economic analysis of investment or development initiatives. This larger set of APRs, derived on the basis of information contained in a Namibian Social Accounting Matrix (SAM), should be useful in improving the effective appraisal of development projects and other major investment programmes in Namibia.

Paper III analyses returns and volatility on the Namibian and South African stock markets, using the daily closing indices of the Namibian Stock Exchange (NSX) and the Johannesburg Stock Exchange (JSE). The sample covers the period from 4 January 1999 to 20 March 2003. The methodology has three main parts: (i) unit root tests, (ii) cointegration analysis, and (iii) volatility modelling. The results show that the two markets exhibit very low correlations, and there is no evidence of a linear relationship between the markets. Furthermore, a volatility analysis shows evidence of no spillover effects. These results suggest that the NSX could be an attractive risk diversification tool for regional portfolio diversification in southern Africa

Paper IV studies the determinants of property prices in the township areas of Windhoek, the capital of Namibia. The work's major finding is that properties located close to an *environmental bad* (e.g. garbage dump) sell at considerable discounts. On the other hand, properties located near an *environmental good* (e.g. a recreational open space) sell at a premium. These results provide evidence of the importance of environmental quality in lower-income property markets in developing countries. It is important, therefore, for Namibian urban planners to incorporate environmental quality into the planning framework for lower-income areas.

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Michael Nokokure Humavindu

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This thesis consists of an introduction and the following four self-contained papers:

I Humavindu, MN (2008): "Estimating national economic parameters for Namibia". *Umeå Economic Studies* 744. A shorter version of this paper has been resubmitted to the *South African Journal of Economics*.

II Humavindu, MN (2008): "Estimating Namibian shadow prices within a semi-input–output framework". Forthcoming in the *Journal for Studies in Economics and Econometrics*.

III Humavindu, MN & C Floros (2006): "Integration and volatility spillovers in African equity markets: Evidence from Namibia and South Africa". *African Finance Journal*, Vol. 8(2):31–50. Reprinted with permission from the Africagrowth Academy. The version published in the *African Finance Journal* contained typographical errors and a graphical omission; these have been corrected in the version published here.

IV Humavindu, MN & J Stage (2003): "Hedonic pricing in Windhoek townships". *Environment and Development Economics*, 8(2):391–404. Reprinted with permission from the Cambridge University Press.

INTRODUCTION AND SUMMARY

1. Introduction

This thesis consists of four self-contained papers analysing shadow pricing, capital market development, and aspects of environmental economics in Namibia. Paper I estimates shadow prices of capital, labour and foreign exchange for the Namibian economy for use in a social cost-benefit analysis. Paper II extends the analysis set out in Paper I by estimating sectoral accounting price ratios (APRs) for the Namibian economy. Paper III analyses the integration of the Namibian and South African equity markets. The ultimate aim of this analysis is to examine the scope for diversification for investment managers. Paper IV analyses the determinants of property prices in a low-income area of Namibia's capital, Windhoek. The focus is on the implicit valuation of environmental advantages and disadvantages in low-income property pricing markets.

Although these papers cover different aspects of economics, a common thread linking them is that effective project/programme evaluation, be it for developmental projects or capital-market development initiatives, can enhance decision-making. Another link between the papers is that missing or distorted market prices can lead to suboptimal investment decisions in a wide range of circumstances and for a wide range of agents, national planning agencies, local government, and private investors. This is becoming more important in the light of recent Namibian Government efforts to restrict the huge outflows of capital to neighbouring South Africa (IMF 2006, 2008; Bank of Namibia 2003). If successful, these efforts will lead to increased investment in Namibia, increasing the risk of suboptimal investments if markets remain missing or distorted.

Economic tools for project appraisal in developing countries have been well established since the early 1970s. The appropriate appraisal of public investment projects underlines the need to determine the social value of costs and benefits accruing from these investments. In developing countries in particular, social values may diverge from market prices and values. These price distortions may be caused by market imperfections as a result of both government interventions in product and factor markets, structural disequilibria in labour markets, and thin or missing markets. As a result of these distortions, market prices can be unreliable indicators of the real net worth of goods and services (Adhikari 1986). Official trade policy, such as the adoption of various tariff and non-tariff trade barriers, may lead to a distorted market value of foreign exchange. The result is a distortion in the domestic price of all tradables, but also of non-tradables which use tradables in their production. In labour markets, the equilibrium wage may be higher than the market clearing wage as a result of minimum wage laws and a union bargaining presence. In capital markets, the market interest rate may diverge from the marginal productivity of capital. For environmental externalities, there may not be any prices at all, potentially creating biases against decisions that benefit the environment, and in favour of decisions that harm the environment.

In project appraisal, therefore, modifications to market values are essential. A modification is determined by estimating a set of national parameters and conversion factors. These parameters are termed *shadow prices*. Conversion factors give the ratio between the price to be used in evaluating an input or output of a project (the *shadow price*) and the market price of that input or output. In the valuation of inputs used in production, the inherent assumption is that the price of any input should represent the opportunity cost of that input. The *opportunity cost* reflects the value of output forgone on one project when used on another. Thus, shadow prices are useful when the market price for an input or output is unavailable or

does not reflect its opportunity cost. For example, labour is an important input in many investment projects and, therefore, should be valued at its economic cost.

Shadow prices are a crucial link between the macro level and the project level of economic planning, and an important component of the overall process of development planning in developing countries. Only when the costs and benefits of all potential projects are valued at their shadow prices may those projects that most efficiently use scarce resources be selected. Following this strategy allows a developing country to maximise the potential net economic benefits accruing from its public investments, thereby improving its potential to pursue broader social, political and other non-economic objectives (Saerbeck 1989).

In general, national parameters to be estimated for economic analysis are divided into five categories (Potts et al. 1998): primary factors, traded goods, non-traded goods, average estimates, and the discount rate.

Primary factors relate to different categories of labour, the value of domestic resources, and foreign exchange.

Traded goods are goods for which the economic cost or benefit derived from their use is determined by their international prices. Shadow price estimation is essential where there is a significant difference between the border price and the local market price. Deriving the shadow price is also a necessity in situations where a benefit is likely to feature prominently as an input or output for a number of projects.

Non-traded goods are items that, by their nature, cannot be traded across borders, or may not be economically viable for trade. The estimation of a shadow price is prompted by a situation where there is a significant difference between the local market price of a resource and its economic value, or where, as for traded goods, a benefit is likely to feature prominently as an input or output for a number of projects.

Average estimates relate to sectors where cost data do not allow further breakdown. The most important of such estimates, the standard conversion factor, describes the value of a unit of domestic resources in terms of a unit of foreign exchange. The standard conversion factor, in the case of average estimates, is derived indirectly through conversion factors for traded goods.

Discount rates quantify the effect of time on a project's cost and benefit values.

At the national level, classic shadow pricing estimation would involve deriving a general equilibrium economic optimisation model with the following specific features (UNIDO 2003):

- An objective function, describing the effects of the use and generation of resources on a measure of economic value such as the gross domestic product (GDP)
- Constraints on the use of resources (technological coefficients for each economic activity and a limit for the resource as a whole), and
- Non-zero constraints for the value of resources, and non-negativity constraints for resources.

The shadow price is then the effect on the value of the objective function resulting from an increase or decrease by one unit in the availability of a scarce resource.

At the microeconomic level, numerous studies have been made estimating shadow prices for objective functions with one or a few non-market constraints. The distance function methodology, for example, is used in deducing shadow prices for pollutants (Lee et al. 2003). Namibian examples of micro-level shadow pricing include the shadow pricing of environmental goods (e.g. Humavindu & Masirembu [2001]; see Humavindu [2002] for an overview of other examples) and shadow pricing of fishing quotas (Stage & Kirchner 2005).

However, the estimation of nationwide shadow prices in this way is fraught with complexities and numerous constraints, and is usually infeasible in practice (Little & Mirrlees 1974). This has led to the adoption of 'second-best' approaches to shadow price estimations. These methods were developed in the late 1960s and early 1970s by the United Nations Industrial Development Organisation (UNIDO 1972, 1978, and 1980), and by Little and Mirrlees (1974), and Squire and Van der Tak (1975). The departure point of these approaches is the choice of unit of account.

In essence, the UNIDO approach uses a domestic resource as the unit of account, and it estimates the scarcity value of foreign exchange using a shadow exchange rate. This procedure is described as the use of a domestic price numeraire (Potts 2002). A second approach, developed by Little and Mirrlees (ibid.) and Squire and Van der Tak (ibid.), uses the unit of foreign exchange (expressed in local currency units) as the numeraire. The latter method is described as the use of a world price numeraire.

A third approach is based on the premise that all shadow prices are interdependent because their value depends on the value of inputs from other sectors (Potts 2002). These interdependencies are accounted for through conversion factors that are derived by solving a series of simultaneous equations using an input–output approach. Thus, this approach takes into account all the sectoral interrelationships: it is called the *semi-input–output (SIO) analysis*, and is useful for non-traded sectors where the output from each sector may appear as inputs into others.

In estimating shadow prices, the choice of methodology is primarily determined by the nature and extent of available data. Readily available data were a constraining factor in this study. Therefore, an initial attempt is made in Paper I to estimate the three primary factors: capital, labour, and the exchange rate. Paper II recounts how the SIO analysis was employed to determine accounting price ratios for the various Namibian economic sectors.

Despite the clear importance of shadow pricing for a developing country such as Namibia, no set of official national parameters exists; nor has any attempt been made to estimate them until now. The country's development path is guided by five-yearly National Development Plans (NDPs). These NDPs stress the importance of investment/development projects to alleviate chronic unemployment, low industrialisation, poverty, and income inequality. Under such circumstances, it is vital that market signals provide an adequate guide for investment planning and project appraisal. There is an apparent need for a consistent set of prices that reflects the resource costs and social benefits of a proposed course of action. High unemployment (36%), uneven income distribution, and an economy that exports most of its capital are all strong motivations for the estimation of a set of national parameters. Recently released national guidelines (*Guidelines for preparing the Third National Development Plan*

(NDP3): 2007/08 – 2011/12) reassert the importance of investment/development projects for Namibia's economic progress. Moreover, the government recently amended Regulation 28 of the Pension Fund Act, 1956 and Regulation 15 of the Long-term Insurance Act, 1998 to enhance the availability of funds for local investments and to deepen financial markets. The availability of more funds for local and unlisted investments stresses the need for the effective and prudent allocation of resources. In response, Paper I constitutes the first formal attempt to estimate the shadow prices of capital, labour, and foreign exchange for the Namibian economy. The estimation is based on data representing national averages and is to assist in efficient and effective decision-making in investment allocation. Paper II extends the shadow pricing analysis further, by employing an SIO analysis to arrive at sectoral APRs. The availability of sectoral APRs is useful when investment decisions are to be driven by sectoral allocations.

Cottoning on to the new initiatives for deepening Namibian financial markets, Paper III examines whether the NSX offers regional portfolio diversification opportunities for investors away from the JSE. This is essential to analyse, given the amounts of funds that now need to be invested in the Namibian economy. Previous studies have created the perception that the NSX tends to follow the JSE, implying that the scope for diversification by investing in the NSX is limited. This has led to limited interest from investors and to thin trading which, in turn, can lead to potentially misleading and volatile stock prices that may cause underinvestment.

Although the Namibian and South African economies are closely linked, it does not necessarily follow that the two countries' stock markets are linked. The NSX is primarily composed of dual-listed companies. The local firms listed on the exchange comprise only

0.3% of market capitalisation (IMF 2008). Companies having primary listings on the JSE and the London Stock Exchange respectively represent 44% and 55% of NSX market capitalisation. Moreover, the NSX overall index has always tracked the JSE, but the local index tends to follow its own path (IMF 2008, Bank of Namibia 2007). This makes it interesting to study whether the local firms provide more scope for diversification than studies of the overall index have indicated.

The methodology used encompasses correlations, cointegration and volatility modelling (Engle & Granger 1987, Engle 2001). Ceteris paribus, a low correlation between assets, means lower portfolio risk and opportunities for portfolio diversification. However, correlations induced by short-term trading can obscure long-run linkages among stock markets (Chen et al. 1986). To circumvent the problems associated with correlations, unit roots and cointegration analysis are employed.

Financial variables that have time-varying means and variances are termed *non-stationary* and have unit roots (Harris & Sollis 2005). However, non-stationary variables may have common trends, and may form stationary linear combinations (based on equilibrium long-run relationships). *Cointegration* implies a long-run co-movement between trended economic time series, meaning that there is a common equilibrium relation to which the time series have a tendency to revert. Stock markets whose indices tend to follow each other are said to be cointegrated. When they are, the equity markets move in tandem, and there are no long-term gains from international diversification.

Extending cointegration analysis a bit further, volatility modelling may be applied to further examine equity market integration. Moreover, it is important to ascertain whether an adverse

situation in one equity market actually spills over into another equity market. *Volatility* refers to the riskiness of stock prices and is an important determinant of the cost of capital for an investment project underlying the stock or portfolio of stocks in question. The models of conditional volatility commonly used in finance imply that there may be predictable patterns in stock market volatility. Such models imply that investors can predict risk, thereby assisting in investment decisions. Where an investor has forecast future prices to be volatile, they might opt to leave the market or require a much higher premium.

Shadow prices based on national data averages have to be distinguished from sectoral, regional or project-specific parameters (Saerbeck 1989). Ideally, project-specific parameters should be estimated for each individual project because the opportunity costs of the resources used or produced may differ from project to project, due to the specific characteristics of each project. This can be applied, for example, to aspects of urban planning. The economic value of an urban housing project for lower-income residents may be higher if it is located near environmentally beneficial features (such as parks) and public amenities (such as schools and taxi ranks), compared with one located near environmental hazards or far from public amenities.

Paper IV is an application of the hedonic pricing methodology (Rosen 1974) to study the determinants of property prices in a low-income area of Namibia's capital, Windhoek. The methodology uses property prices to estimate buyers' implicit valuation of a property's attributes (such as access to public services, proximity to environmentally beneficial or detrimental features) when trading takes place. Local authorities in Namibia are responsible for the provision, operation and maintenance of most municipal infrastructure and services. Although this simplifies the planning, design, financing and implementation of initiatives for

upgrading poor settlements as well as the development of low-cost housing schemes, for example, it places considerable responsibility on local authorities to ensure efficient urban planning.

Frayne and Pendleton (2001) allude to the high rates of internal migration and urbanisation in Namibia. This puts enormous responsibility on local authorities to ensure efficient urban planning and that the investments made are prudent. Failure to account for this might lead to developing residential areas or serviced plots alongside environmental 'bads' such as garbage dumps, which could prove detrimental to social welfare if households attach importance to such issues.

The valuation of environmental assets and services would underline their economic importance and make a case for their conservation. The incorporation of shadow prices of environmental costs and benefits in planning falls within the ambit of non-market valuation in the environmental economics discipline. Non-market valuation is a measure of the willingness to pay for the value of unpriced environmental goods and services.

Generally, for non-marketable items (those that cannot be sold or bought), two groups of valuation methods are employed (see Hufschmidt et al. 1983). The first group is the *revealed preference approach*, in which consumer behaviour towards environmental goods is analysed and values are inferred. Peoples' preferences are revealed by their choices. The second group of methods is applicable when consumer behaviour towards environmental goods cannot be observed. The solution then is to apply what is termed as the *stated preference approach*. The approach rests on the simple premise of putting hypothetical questions to consumers.

The hedonic pricing method used here is an example of a revealed preference approach, which postulates that the price of a commodity is related to its characteristics. Therefore, variations in demand for a commodity (such as a house) can be statistically related to its attributes (e.g. local air quality, amenities). The hedonic pricing method is used to estimate the value of environmental amenities that affect the prices of marketed goods. Most applications use residential housing prices to estimate the value of environmental amenities. This method is based on the assumption that people value the characteristics of a commodity, or the services it provides, rather than the commodity itself. Thus, prices will reflect the value of a set of characteristics, including environmental characteristics, that people consider important when purchasing the commodity. Property prices can, therefore, be used to estimate local shadow prices for environmental characteristics even though those characteristics are not traded directly.

2. Summary of the papers

2.1 Paper I: Estimating national economic parameters for Namibia

In the first paper of this thesis, shadow prices of capital, labour and foreign exchange for the Namibian economy are estimated. Although the use of shadow prices is essential for sound developmental planning, the application of shadow pricing in Namibia has been limited or virtually non-existent. The interest in deriving Namibian shadow prices arises from both practical and academic points of view.

In practical terms, recognising the need for large-scale investments to drive economic growth prompts the need to apply shadow prices, in order to ensure scarce resources are optimally

allocated. From an academic point of view, the Namibian economy exhibits special features that support the need to estimate national parameters. A highly uneven income distribution, a large informal economy, and minimum wages in certain sectors all validate the necessity of estimating shadow wage rates. Unlike most other developing countries, Namibia is a net capital exporter. Although the economy has high domestic savings, the lack of domestic investment opportunities leads to a capital outflow amounting to 10% of GDP annually. The shadow price of capital can then be reasonably expected to be low. Finally, Namibia's membership of the Southern African Customs Union (SACU) and the Common Monetary Area (CMA) might affect the estimation of the shadow price of foreign exchange in Namibia. SACU groups together Botswana, Lesotho, Namibia, Swaziland (known as the *BLNS countries*) and South Africa, and applies a common external tariff. The SACU Agreement has recently been renegotiated, with key elements revised and given a new focus, in the light of the need to allow BLNS countries greater say in the determination and administration of SACU tariffs. The CMA comprises SACU countries, excluding Botswana, and is a monetary area with a centralised monetary policy aimed at achieving greater financial stability for the southern African region. The monetary policy is controlled by South Africa, and all other CMA currencies are pegged to the South African Rand.

In principle, there should be two Shadow Exchange Rates (SERs): one for convertible currency external to the CMA, and one for Rand-based currencies, which would have a shadow exchange rate of 1 since there are no trade restrictions between CMA countries. The SER calculated in this paper is applicable to transactions with countries outside the CMA, but not to the foreign content of goods purchased from South Africa.

The results suggest that the economic opportunity cost of capital is 7.2% in Namibia. The economic costs of Namibian labour, as a share of financial costs, are 32% for urban semi- and unskilled labour, and 54% for rural semi- and unskilled labour. The economic cost of foreign labour, as a share of financial costs, is 59%. The estimated shadow exchange rate factor is 4% for the Namibian economy.

2.2 Paper II: Estimating Namibian shadow prices within a semi-input–output framework

The purpose of Paper II is to estimate the sectoral shadow prices (Accounting Price Ratios, or APRs) at the national level, using the Semi-Input–Output (SIO) Technique. In contrast to estimates of shadow prices in Paper I, which are limited to a few aggregate shadow prices for capital, labour and foreign exchange, the application of an SIO analysis in Paper II permits the calculation of more shadow prices for the Namibian economy. Utilising the SIO analysis, one is able to (Schohl 1979) –

- readily derive shadow prices for many different sectors of the economy, and
- include the direct and indirect effects of protection on the conversion factors of typically non-traded goods and services.

This larger set of APRs is beneficial for project analysis within sectoral projects and, at the same time, should improve overall appraisal results. In general, the APRs for tradables and non-tradables are expected to fall within the range close to unity or less than unity, respectively. The following table summarises results from the estimations:

Table 1: APR estimates for economic sectors, Namibia

Economic sectors			
1. Tradables	APR	2. Non-tradables	APR
Commercial Agriculture – Cereal	0.87	Traditional agriculture	0.66
Commercial Agriculture – Other crops	0.91	Electricity	0.88
Commercial Agriculture – Animal products	0.97	Water	1.13
Fishing	1.00	Trade and repairs	0.53
Mining	1.00	Hotels and restaurants	0.50
Meat processing	1.00	Communications	0.95
Fish processing	1.00	Finance and insurance	0.62
Grain milling	0.91	Other private services	0.84
Beverages and other food processing	0.85	Government services	0.95
Textiles	0.85		
Light manufacturing	0.95		
Heavy manufacturing	0.87		
Construction	1.00		
Transport	1.00		
Market – Real estate and business services	1.00		
Tourism – Non-residents	1.00		
Petroleum products	0.90		

The results shows that most tradable sectors such as fishing and mining have APRs equal to or closer to 1, with deviations explained by import tariffs. The APRs for non-tradable sectors exhibit greater variation, with the water sector having the highest – reflecting the scarcity of water.

2.3   Paper III: Integration and volatility spillovers in African equity markets: Evidence from Namibia and South Africa

The third paper examines the integration between the Namibian Stock Exchange (NSX) and the Johannesburg Stock Exchange (JSE). The study uses daily stock data to analyse returns and volatility between the two equity markets. The methodology employed consists of unit root tests, cointegration analysis, and volatility modelling. The strong economic and historical ties between South Africa and Namibia from the apartheid era suggest that there should be strong integration. Indeed, previous empirical work reports strong integration between Namibian and South African equity markets.

The paper differs from previous empirical work in that it focuses on the local Namibian index, which does not contain dual-listed stocks. Dual-listed stocks are listed on both the JSE and NSX, where they will expectedly have the same returns and volatility on both exchanges. However, it is not necessarily the case that stocks that are only listed on the NSX will also be highly correlated with stocks on the JSE. Thus, the paper examines integration between the local NSX index and the JSE index. The sample covers the period from 4 January 1999 to 20 March 2003.

The results show that, when dual-listed stocks are excluded, the two markets exhibit very low correlations, and no evidence of a linear relationship could be found between the two equity markets. Moreover, volatility analysis does not provide any evidence of volatility spillover from the JSE to the local NSX. The results suggest that the Namibian local equity index can be a risk diversification tool for regional portfolio diversification in southern Africa.

The constraints of not having within-day-trading data from the NSX hamper the further investigations of aspects of simultaneity in the returns. The availability of within-day-trading data would have permitted the analysis of whether there are unidirectional causations within the day between the two stock markets. Brännäs et al (2007) mention that simultaneity is most likely to arise in closely related markets due to geographic proximity, common institutional set up and the presence of large common traders. The presence of dual listed stocks on both the JSE and NSX is an additional reason to expect simultaneity. Further extension of this work might, in addition to investigating simultaneity, specify alternative models to the one applied here to investigate volatility in the two markets returns.

2.4   Paper IV: Hedonic pricing in Windhoek townships

The fourth paper attempts to determine whether property prices in several low-income areas of Namibia's capital, Windhoek, are affected either by positive or negative attributes, and applies the hedonic pricing method in this analysis. Hedonic pricing, as previously stated, involves the implicit price of attributes or characteristics of a commodity rather than the price of the commodity itself. Hedonic pricing models are used to infer the demand for attributes of environmental quality, through the analysis of marketed goods whose value partly depends on these attributes. The methodology is generally applied for the valuation of environmental goods, property and water, and the implicit price of attributes and characteristics of marketed goods in general. The general assumptions of such a model are that all the goods or services brought to the market should be clearly visible, and that property values and the implicit price of attributes or characteristics should be treated as a single market. Under these assumptions, the price of any residence can be described as a function of the environmental, structural, and neighbourhood characteristics of the location of the residence in question. The hedonic model

can, thus, give a realistic estimation of the environmental values attached by households to attributes, as model estimates are based on market information.

In this paper, we use property sales data obtained from the City of Windhoek municipality, and apply the hedonic pricing model. Our findings are that – apart from housing quality, access to the central business district, access to marketplaces, and access to transportation – environmental quality has a large impact on property prices. Properties located close to a garbage dump sell at considerable discounts, while properties located close to a combined conservation and recreation area sell at premium prices. The results suggest, therefore, that the hedonic pricing method can be usefully applied when studying township areas in developing countries, and that this can clarify and emphasise the importance of environmental factors that are otherwise frequently neglected in town planning for such settlements.

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Estimating national economic parameters for Namibia

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Abstract

This paper estimates national economic parameters to be used for project appraisal in Namibia. The shadow prices of capital, labour and foreign exchange are derived. The results suggest that the economic opportunity cost of capital is 7.2%. The economic costs of Namibian labour as a share of financial costs are 32% for urban semi- and unskilled labour, and are 54% for rural semi- and unskilled labour. The economic costs of foreign labour as a share of financial costs are 59%. The shadow exchange rate factor is estimated to be 4% for the Namibian economy.

Keywords: shadow prices; discount rates; Namibia

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1. INTRODUCTION

The purpose of this paper is to estimate shadow prices of capital, labour and foreign exchange for the Namibian economy. *Shadow prices* are defined as the opportunity costs of inputs and outputs consumed or produced by a project (Potts 2002). The value that a resource could have generated elsewhere in the economy is lost if the resource is moved to a project. Therefore, shadow prices are calculated to take into account the true opportunity costs of resources, inputs and any externalities resulting from a developing programme or project.

In many markets, especially in developing countries, financial or market values differ from their real economic values due to distortions brought about by imperfect or underdeveloped markets, government protection policies, and other externalities (Behrman 1986). The most emphasised distortions are with regard to unskilled labour, the cost of foreign exchange, and the cost of financial capital.

Shadow pricing is then used to account for these distortions and value resources to approximate their actual value. The use of unadjusted market prices for labour and capital might lead to underestimating the real costs of capital-intensive projects and tend to promote these at the expense of socially less costly labour-intensive projects. The existence of high levels of nominal and effective tariff protection, in combination with import quotas and overvalued exchange rates, discriminates against the agricultural sector in favour of the import-substituting manufacturing sector. In addition to reflecting – incorrectly – the real terms of trade between, for example, agriculture and industry, such distorted domestic

product prices tend to favour upper-income groups disproportionately in relation to society's lower-income groups.

Thus, the estimation of shadow prices is essential for the practical application of the economic analysis of project evaluation. By way of cost-benefit analysis, project evaluation aims to induce allocation efficiency in the use of a country's resources (Campbell & Brown 2003).

Despite its importance for sound developmental planning, the application of shadow pricing in Namibia has been limited or virtually non-existent. This is unfortunate as Namibia's development strategy, as encapsulated in the five-yearly National Development Plans and in its Vision 2030, underpins the importance of development/investment programmes in addressing the challenges of poverty, high unemployment and inequality, and low industrialisation.[2] Moreover, the launch in 2004 of the Development Bank of Namibia to fund long-term infrastructure projects increases the need to understand the economic costs and benefits of its funded projects. Potential large-scale projects such as the development of the Kudu gas fields, transfrontier tourism parks, and other infrastructure projects would need to be assessed on both financial and economic grounds. Thus, the practical application of shadow pricing in the economic analyses of Namibia's development projects would help ensure that its scarce resources are optimally utilised, and would help attain the country's targets as set out in its development strategy.

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[2] Shadow prices are consistently used in the Ministry of Environment and Tourism (MET), but these are based on educated guesswork rather than real estimates. This framework assumes the economic opportunity cost of capital at 8%, an adjustment (up by 6%) to the value of tradable goods to reflect excess demand for foreign exchange, and an adjustment (down by 65%) to unskilled labour costs to reflect unemployment (Barnes 1994).

Estimating shadow prices for the Namibian economy is also interesting from an academic point of view. Namibia has special features that are not commonly found among other developing countries. Namibia's gross domestic product (GDP) per capita of US$3,100, at 2005 market exchange rates, is relatively high for a developing country. However, according to the World Bank's World Development Indicators for 2006, Namibia has the world's highest Gini index (74.3, compared with Botswana's 63 and South Africa's 57.8).[3] This implies an uneven income distribution that amplifies the interest to estimate shadow wage rates.

The Namibian economy has a large service sector (around 58.7% of GDP), which is unusual for a developing country. In addition, independence in 1990 brought considerable changes to the economy's external and internal migration patterns, especially in relation to the labour market. According to Frayne and Pendleton (2001), internal migration and urbanisation in Namibia is growing rapidly, and is driven largely by employment opportunities in urban centres. In the 1990s, the population of Windhoek, the capital city, grew at an average annual rate of 5.4%. Overall, no substantial research has been done in Namibia on either the scale or the possible consequences of skills emigration. However, according to preliminary analyses by Frayne and Pendleton (2001, 2002) and the Migration Dialogue for Southern Africa (MIDSA 2006), Namibian migratory labour (both skilled and unskilled) to South Africa (SA) and other neighbouring countries is very limited: the overall net migration is estimated at 0.47 per 1,000 members of the population.

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[3] The Gini index is a measure of the degree of income inequality.

Furthermore, unlike most other developing countries, Namibia is a net capital exporter. Although the economy has high domestic savings, these flow out mostly to SA to seek higher returns. The lack of domestic investment opportunities is cited as one reason for persistent capital outflows (Fitch Ratings 2005). These capital outflows amount to 10% of GDP annually, and continue unabated.[4]

The linkages to SA are not only restricted to Namibia's capital outflows. The two economies are members in regional groupings such as Southern African Customs Union (SACU), the Southern African Development Community (SADC), and the Common Monetary Area (CMA). Namibia's currency is pegged to the SA Rand, while 82% of her total imports are from SA. Some 26% of Namibia's total exports go to SA. The SA economy, being the regional economic powerhouse, is approximately 30 times the size of Namibia's.

Recent work by Harberger et al. (2003), Kuo et al. (2003) and Bicak et al. (2004) has estimated shadow prices for the SA economy for labour, capital and foreign exchange. Since these two countries share similar historical political ties and a current close economic relationship, it would be interesting to compare the results from this work with those from

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[4] An anonymous reviewer suggests that this could be a symptom of 'Dutch disease'. However, unlike most other primary product exporters, the Dutch disease phenomenon appears to be a limited risk to Namibia (IMF 2008). This is because Namibian mineral exports have a relatively modest and decreasing share of GDP (20–25%). This share actually overstates domestic expenditures by the mineral sector, as it imports most of its capital equipment and its labour costs are very low (it contributes 2% of national employment). In addition, fiscal revenues from the sector average around 2–3% of GDP. Thus, domestic pricing pressures from the sector are relatively modest, and wage pressures are unlikely to be large.

the SA studies. However, given Namibia's special features not common to a developing economy, it can reasonably be expected for estimates of the two economies' national parameters to be different.

This work will be the first formal exercise to estimate shadow prices for the Namibian economy. The paper is structured as follows: Section 2 discusses economic features pertinent to the estimation of Namibian shadow prices; Section 3 treats approaches to shadow pricing as well as the methodology to be employed; Section 4 describes the data employed as well as the assumptions used for each estimate; Section 5 presents the results; and Section 6 concludes the discussion.

2. FEATURES OF THE ECONOMY PERTINENT TO AN ESTIMATION OF SHADOW PRICES

2.1 Capital market dynamics

The Namibian financial markets exhibit special features that will affect the estimation of a shadow price of capital. As mentioned earlier, overall limited investment opportunities in domestic financial markets have led to sizable outflows of Namibian savings into the liquid and relatively developed South African markets. Membership in the CMA also allows for free capital flows, and requires Namibia to conform to South African exchange control practices for countries outside the CMA. These outflows averaged around N$1.8 billion per year from 1990–1994, and accelerated to about N$2.4 billion per year from 1995 to 2007. Net outflows in both portfolio and other investments drive the capital outflows.

The Namibian economy is primarily resource-based and, thus, has some investments that are highly profitable owing to resource rents. *Resource rents* are economic profits that are obtained by utilising natural resources. These rents exist due to the scarcity of the natural resources in question. Such rents can be an important source of development finance, and countries like Botswana and Malaysia have successfully leveraged natural resources this way. However, in sectors that do not have resource rents, the marginal product of capital appears to drop sharply since many funds are invested outside Namibia.

To stem capital outflows, the Namibian authorities have followed a two-pronged strategy: firstly, imposing regulatory controls to restrict capital outflows, and secondly, developing domestic markets to provide institutional investors with assets denominated in Namibia Dollars. The latter strategy is still in its infancy and has not been developed. In the mid 1990s, the Namibian authorities raised regulatory requirements for both the insurance and pension fund industries (Regulations 15 and 28, respectively), so that 35% of the assets under their management had to be domestic assets (up from an earlier 10%). This action contributed to the growth of the Namibian Stock Exchange due to an increase in dual listings by South African companies. However, even investments in such dual-listed companies were unable to contain capital outflows, and the regulation may not have had much impact on the real economy. As a result, government has proposed further changes to tighten the domestic asset requirements. A 5% minimum for unlisted investments and a 10% maximum on dual-listed shares were among the new proposals gazetted on 4 February 2008.

2.2   Labour market dynamics

The Namibian labour market is governed by a policy framework that includes a Labour Act, a Social Security Act, an Employment Policy, an Affirmative Action (Employment) Act, and incentives for investment and training. However, on balance, unemployment and underemployment remain high. According to the latest Labour Force Survey, conducted in 2004, unemployment was estimated at 36%. The Bank of Namibia Annual Report for 2004 states that underemployment was estimated at 15% of the employed population. Motinga and Tutalife (2006) indicate that Namibia created a mere 22,000 formal jobs between 1991 and 2001. Unemployment falls disproportionately on the youth and the unskilled workforce, while the duration of unemployment is longer in rural areas, and can vary between six months and two years (ibid).

There is also evidence of wage inequality between the skilled and unskilled. Motinga and Mohammed (2002) calculated that the average unskilled person earns 3% of the wages and salaries of top management, and less than 50% of what the average skilled person earns. Westergaard-Nielsen et al. (2003) confirm the huge wage differentials between skilled and unskilled labour. Although there is no formal minimum wage legislation, some industry-specific wage agreements do contain stipulations for minimum wages, namely the construction, agriculture, and security industries. There is also a large informal economy employing at least 133,000 people, of whom 64% are young people. Remuneration in this sector is very low, and there are no benefits such as social security or medical aid.

The presence of a large informal economy and minimum wages, both of which lead to Namibian wages being set higher than the economic opportunity cost of labour, justifies the

case for such an economic adjustment on the grounds of imperfections in the labour markets. The informal economy, which consists of large numbers of small-scale businesses, can be reasonably assumed to be a sector with market-clearing wages. In the formal sector, however, the presence of minimum wages and collective bargaining – and, possibly, efficiency wage issues – leads to wages above the market-clearing levels that exist in the informal economy. As a result, a portion of the 36% unemployed Namibians would prefer formal jobs, but cannot get them due to the presence of these distortions.

2.3   Issues in estimating the foreign exchange premium

Namibia's participation in SACU affects the estimation of the shadow price of foreign exchange (Shadow Exchange Rates, or SERs). SACU groups Botswana, Lesotho, Namibia, SA and Swaziland together under a common external tariff. All customs and excise duties collected by the five SACU members are combined in a Common Revenue Pool (CRP), and distributed to them according to a Revenue Sharing Formula (RSF). The sharing of the revenue from customs duties is determined on the basis of each country's percentage share of total intra-SACU imports, excluding re-exports, and not on the basis of SACU imports from the rest of the world (Flatters & Stern 2005; Kirk & Stern 2005).

Some 82% of Namibian imports are from SA, which increases Namibia's share of revenue from the SACU system (due to the RSF's intra-SACU imports rule). Namibian imports from outside SACU (the remaining 20% of her total imports) are subject to SACU tariffs, but generate very little extra SACU revenue for Namibia: tariff revenues are paid into the SACU system, and Namibia only gets a small portion of that. Most Namibian exports are to countries outside SACU, which therefore do not affect her revenue share from SACU.

Thus, since SACU revenue for Namibia is effectively not linked to the country's out-of-SACU imports, it can be argued that SACU receipts are not relevant to the determination of the shadow exchange rate since they are essentially intergovernmental transfers and do not directly affect the relationship between prices of traded goods at world prices and their domestic prices. Moreover, the SACU revenue pool is gradually declining due to continuing trade negotiations at multilateral and regional levels.

Namibia is part of the CMA, which also includes Lesotho, SA and Swaziland.[5] Apart from Botswana, the CMA has four of the same member countries as SACU; thus, there should be two SERs: one for convertible currency external to the CMA, and one for Rand-based currencies that would have an SER of 1 since there are no trade restrictions between CMA members. The SER to be calculated in this work, therefore, is applicable to transactions with countries outside the CMA, but not to the foreign content of goods purchased from SA. In principle, one would expect the SER – in relation to external economies – to be similar for all members of the CMA because they all use the same tariff structure. However, there might be some variation due to differences in the structure of imports.

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[5] The CMA is described as an area of coordination between the monetary and exchange rate policies of its members under the Multilateral Monetary Agreement of 1992. Under the CMA, the Namibian currency is linked one-to-one to the South African Rand, which is also legal tender. The CMA also guarantees free capital flows among member countries, and guarantees access for Namibian government and financial institutions to South Africa's financial markets. See also Tjirongo (1995) and Vollan (2000).

3.   ANALYTICAL FRAMEWORK (METHODOLOGY)

This section describes the analytical framework to be used in estimating shadow prices in Namibia. Generally, there are two approaches to shadow pricing that hinge on the assumption of the existence of market distortions (Medalla 1982). The first approach may be generalised as an attempt to estimate shadow prices associated with a first-best optimum. In this approach, if market and shadow prices diverge due to policy failures, then the appropriate shadow prices would be the equilibrium prices that would prevail if the distortions were removed. However, if the divergence is caused by market rather than policy failures, then the absence of first-best corrective measures is itself the essence of the problem of non-optimality. The work by Tinbergen (1958) and Bacha and Taylor (1971) in the case of shadow pricing of foreign exchange is associated with this first approach. As Medalla (1982) states, however, this approach is not yet feasible for shadow pricing primary factors such as capital and labour due to inadequate techniques and data.

The second approach treats present distortions as given and assumes that they might persist over the long run (Medalla 1982). Shadow pricing is then a problem of deriving dual solutions to the welfare optimisation problem, while the distortions are treated as constraints. Under this approach the optimisation problem is usually not formally specified, but it forms the conceptual framework for shadow pricing rules. The resulting shadow prices are referred to as *second-best* shadow prices, representing social costs and benefits of inputs at the second-best optimum. This approach is associated with the work of Little and Mirrlees (1969), Harberger (1972), and Dasgupta et al. (1972).

In this paper we follow Harberger's (1972) approach for two principal reasons. Firstly, according to Khan (1979), this is the correct method of estimating the shadow discount rate, namely where the marginal social value is not equal to the marginal social cost of funds at the market equilibrium due to the presence of various distortions. Finally, and most importantly, utilising this approach will enable comparison of the results with those of Harberger et al. (2003), Kuo et al. (2003). and Bicak et al. (2004) for South Africa.

3.1   The discount rate

The economic literature advances four main methods of computing the discount rate .These are the Social Rate of Time Preference (SRTP), the Weighted Opportunity Cost of Capital (SOC), the Shadow Price of Capital (SPC), and the Economic Opportunity Cost of Capital (EOCK).[6] In terms of applicability, only the SRTP and the EOCK are feasible for the Namibian estimations. However, a brief review of first three methods is presented, with a more substantial review of the EOCK method, which allows for comparison with the South African work.

3.1.1   *The Social Rate of Time Preference approach*

The SRTP approach is where the discount rate is composed of two factors: the first is a pure rate of time preference based on people's desire to gain short-term gratification, and the

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[6] See Boardman et al. (2001), Boscolo et al. (1998), Percoco & Nijkamp (2006), Powers (2003), and Zhuang et al. (2007). These sources offer an excellent and detailed review of the major methods on estimating the discount rate.

second an assumption that per capita consumption will grow over time. The formula for the SRTP is given by the following equation:

$$r = \rho + \theta g \tag{1}$$

where ρ is the utility discount rate, θ is the absolute value of the elasticity of marginal utility of consumption, and g is the projected long-run annual growth of real consumption per capita. The advantage of the SRTP approach is its applicability to the Namibian work on discount rates.

3.1.2   The Weighted Social Opportunity Cost of Capital approach

The SOC approach is grounded on the notion that public investment crowds out private investment, thus producing the need to account for the opportunity cost of the use of resources used in the public project, and which could be used by the private sector. The SOC could be approximated by the marginal pre-tax rate of return on riskless private investments.

Zhuang et al. (2007) mention that a good proxy to be used is the real pre-tax rate of top-rated corporate bonds. The application of the SOC is still contentious, however, both on practical and theoretical grounds. A practical difficulty arises since the computation of the SOC relies on a vast array of possible private sector interest rates which may not be readily available. Some theoretical objections to the SOC follow the argument that the private sector return may reflect individual rather than societal premium for risk. This argument is based on the perspective that people may be more willing to accept risks as a group than as

individuals. Thus, a rate based purely on the pre-tax return in investment may overestimate the discount rate: thereby making it more difficult to obtain a benefit-cost ratio of greater than 1, particularly for projects of a longer tenure (Powers 2003).

3.1.3 The Shadow Price of Capital approach

This SPC approach postulates that, while the costs of a public project can displace private investments, its benefits can also be reinvested in the private sector. Thus, it proposes to convert the gains or losses from an investment project into consumption equivalents. The proper conversion rate is then the shadow price of capital (Percoco & Nijkamp 2006). Estimating the SPC is relatively simple if it is assumed that each dollar invested today yields a perpetual return π that is entirely consumed (Boscolo et al. 1998). Thus, the present vale of the annual flow of consumption is given by π/i, where i is the SRTP. By implication, π/i is the shadow price of investments in terms of consumption. A simple formula that applies when investment returns are perpetual but a proportion of the annual return is reinvested is derived as –

$$SPC = \frac{(1-s)\gamma}{i - s\gamma} \tag{2}$$

where $\gamma=(1+\pi)/(1+i)$, s is the marginal propensity to save, and $s\gamma<1$. The shadow price increases with the fraction of π invested. The SPC is conceptually correct as it allows the use of the SRTP as the social discount rate without ignoring the opportunity cost of displaced investment. However, its practical applicability is constrained due to its stringent information requirements.

3.1.4   The Economic Opportunity Cost of Capital

Finally, the EOCK approach postulates that in a small, open, developing economy like Namibia's, there are three alternative sources of public funds. The first is from individual savers who take resources that would have been spent on private consumption and instead then lead to an increase in domestic savings. The second source is from additional foreign capital inflows. The third is from resources whose investment has either been displaced or postponed by the project's extraction of funds from the capital market (Harberger 1972). Based on these three alternative sources of public funds, the economic cost of capital can be estimated as a weighted average of the rate of time preference applicable to –

- additional savings

- the marginal cost of additional foreign inflows, and

- the rate of return on displaced or postponed investments.

In general, various distortions are associated with each of the three alternative sources of funds.

If the weights of these three sources are expressed in terms of elasticities of demand and supply of funds with respect to changes in interest rates, the economic opportunity cost of capital can be calculated as follows (a derivation of this is given in Appendix 1):

$$EOCK = \frac{\varepsilon_s (S_r / S_t) \bullet \gamma + \varepsilon_f (S_f / S_t) \bullet MC_f - \eta \bullet \pi}{\varepsilon_s (S_r / S_t) + \varepsilon_f (S_f / S_t) - \eta} \qquad (3)$$

For a country such as Namibia, with a fixed exchange rate, high capital mobility, and a highly elastic supply of foreign funds, Zerbe and Dively (1994) point out that the social discount rate will be equal to the international borrowing rate. For Namibia, where the foreign funds are domestic savings, this will be the foreign lending rate (approximately equivalent to South African bond returns, or the returns on other South African financial instruments in which surplus Namibian assets are placed). Thus, in the standard EOCK formula (Equation 3 above), the elasticity of foreign funds becomes extremely high compared with the other elasticities. Equation 3 can, therefore, be simplified as follows:

$$EOCK = \frac{\varepsilon_f (S_f / S_t) \bullet MC_f}{\varepsilon_f (S_f / S_t)} = MC_f \tag{4}$$

The EOCK in (4) essentially equals the real rate of return from investing Namibian funds in South African long-term financial instruments. South African assets constitute approximately 80% of both total and portfolio investments from Namibia (IMF 2008). Therefore, a good proxy for the amended EOCK will be the average rate of return on long-term investments in South African bond instruments.

3.2 Economic Opportunity Cost of Labour

The EOCL reflects the value to the economy of the set of activities given up by the workers, including the non-market costs (or benefits) associated when they change employment from one project to another (Harberger & Jenkins 2002). Two approaches are generally applied in estimating the EOCL: the value of marginal product of labour foregone, and the supply price of labour (Bicak et al. 2004).

Under the value of marginal product of labour forgone approach, the EOCL is estimated by starting with the gross-of-tax alternative wage earned in previous employment by the labour hired for the new project (marginal product foregone), and then adjusting for differences in other costs and benefits. Under the supply price of labour approach, the EOCL is determined by starting with the gross-of-tax market wage (the supply price) required to attract sufficient workers to the project, and then adjusting for distortions such as taxes and subsidies. The two approaches have different data requirements, levels of computational complexity, and hence, different degrees of operational usefulness (Bicak et al. 2004). However, it can be shown that, theoretically, the two approaches will produce the same result in estimating the EOCL. Since the supply price of labour is more straightforward and easier to use under a wide variety of conditions in the labour market, and the two approaches are equivalent when data are available, the supply price approach is used.

Bicak et al. (2004) also use the supply price of labour approach, making it easy to compare the South African and Namibian results. It appears that the Namibian labour market does not feature any special characteristics other than those of high wage inequality between skilled and unskilled labour, and the large informal economy. There is little international migration, although interregional migration to urban areas is high.[7] Thus, a new project is most likely to attract workers from both the formal and informal sectors, as well as some foreign labour, if needed; but it may also attract some skilled Namibians currently working in South Africa.

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[7] Harris and Todaro (1970) postulate that high urban unemployment rates could be explained by rationally behaving unskilled rural migrants seeking to maximise expected income. According to this model, more than one rural worker is likely to migrate for each new job created in the urban sector. The effect of this is that the opportunity cost of the new urban job is greater than the marginal product of one rural worker.

It appears that skilled labour is in scarce supply in Namibia, with very little – if any – unemployment experienced in this sector (LARRI 2005, 2006a; Marope 2005). Managers and professionals earn annual remunerations of between N$250,000 to N$400,000. Around 4% unemployment is found among those with a university education. In such a case, the opportunity cost of skilled labour is assumed to equal the domestic market wage (Potts 2002). In this paper, therefore, we concentrate on the shadow prices for unskilled labour and for foreign labour.

The presence of a large informal economy presents the opportunity to determine the free market wage at which everyone could work. From the Labour Resource and Research Institute (LARRI 2006b), the free market wage can be estimated at N$175 per month. Certain Namibian industries, as alluded to in Section 2 above, have minimum wages, and many wages are determined by collective bargaining agreements. In such markets, the wage rates are above their market clearing rates (Bicak et al. 2004). Because of the minimum wage rates, chronic unemployment exists in this segment of the labour market. The illustration in Figure 1 shows how the EOCL for protected jobs can be determined under the conditions of a linear supply curve and a perfectly elastic demand for labour in the informal economy:

Figure caption and axes labels:

Wage Rate (y-axis), Labour (x-axis)

S_i, W_p, W_i, D_i, W_0, O, L_i, $L_i + L_q$
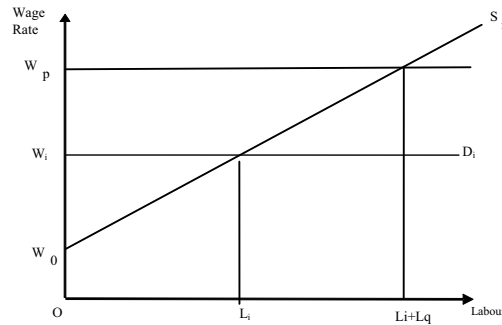
Figure 1: Estimating the Economic Opportunity Cost of Labour for protected sector jobs

Let W_p be the protected sector wage, and let the supply curve of labour for those who are not formally employed be given by $W_o S_i$. Let L_i be the people who are willing to work at W_i, and let L_q be quasi-unemployed willing to work at W_p but not at W_i. To simplify the analysis, W_i is assumed to be the free market at which everyone could work if they wished. The intersection of this supply curve and the free market wage rate of W_i determine the number of people willing to work at this wage, or L_i in Figure 1. In the Namibian case, W_i would be the informal market wage.

When a project creates a demand for protected workers, such demand will be met partly by those working in the free market (i.e. the informal economy in our case), and partly by quasi-voluntarily unemployed workers (Bicak et al. 2004). If it were assumed that workers are recruited randomly from among all those willing to work for the protected sector wage, the economic cost of these jobs would be measured by the weighted average of the free market wage and the supply price of the quasi-voluntarily unemployed. The EOCL will

then fall between the free market wage (i.e. the informal economy wage in our case) and the protected wage rate. In the case of linear supply curves, the average supply price of the quasi-voluntarily unemployed is measured by $(W_i + W_p)/2$. If any tax adjustments are ignored, then the EOCL for protected sector jobs can be expressed as follows:

$$EOCL_p = f_1 W_i + f_2 (W_i + W_p)/2 \qquad (5)$$

where f_1 and f_2, respectively, represent the proportions of the project jobs being filled by those now working in the informal economy and those filled by unemployed individuals who were waiting for new protected project jobs to become available.

The EOCL for skilled foreign labour will be measured by the net-of-tax wage that the worker receives in Namibia, plus an adjustment for the foreign exchange premium that is an additional cost on the share of wages the foreign worker remits back home. A second adjustment is related to the goods and services that foreign workers consume in Namibia. If foreign workers pay any excise or value added taxes on the goods they purchase, these taxes should be deducted from the cost of foreign labour, as they do not represent a cost to the Namibian economy. In some cases, temporary foreign workers might receive subsidised housing or health benefits, for example. These should be added to the EOCL. Combining these factors, the economic opportunity cost of labour for foreign workers (EOCL^F) can be estimated as follows:

$$EOCL^F = W^F(1\text{-}t^F) + W^F(1\text{-}t^F)R[(E^e/E^m)\text{-}1] - W^F(1\text{-}t^F)(1\text{-}R)t^{VAT} \qquad (6)$$

where W^F is the gross-of-tax wage of foreign labour, t^F is the rate of personal income tax levied by the host country on foreign wages and salaries, R is the proportion of the net-of-tax income repatriated by foreign labour, E^e is the economic exchange rate, E^m is the market exchange rate, and t^{VAT} is the average rate of value added tax paid.

For labour from South Africa – the main source of skilled foreign labour – coming to work in Namibia, Equation 6 can be rewritten as follows (since $E^e/E^m=1$):

$$EOCL^{FRSA}=W^F(1-t^F)+W^{FRSA}(1-t^F)(1-R)t^{VAT} \tag{7}$$

Similarly, for Namibian skilled labour attracted back home by the project from out-of-country employment, the EOCL will need to adjust for a loss of remittances:

$$EOCL^{skilled\ Nam\ labour}=W^N(1-t^{RSA})R \tag{8}$$

3.3   Economic Opportunity Cost of Foreign Exchange

The wedge between the Shadow Exchange Rate (SER) and the Official Exchange Rate (OER) can be attributed to a combination of two factors: disequilibria in the balance of payments (BOP) and in the protection structure (Medalla & Powers 1984). Namibia does not suffer from a BOP disequilibrium, but does have trade restrictions through SACU. An SER higher than the OER reflects the premium placed on foreign exchange (used or produced) when evaluating projects to correct the distorted relative prices between traded and non-traded commodities. A higher SER does not suggest devaluation but rather revaluation – to the exact degree of the SER estimate. This distortion in relative prices

arises from the protection system (and BOP disequilibrium) and not only affects price relationships among tradable goods, but also distorts the prices of tradables relative to non-tradables. Among tradable commodities, relative price distortion may be corrected in project evaluation by using their relative border prices. However, further correction is needed for the price distortion between tradables and non-tradables. This, in essence, is the role of the SER in project evaluation. It serves as the conversion factor for non-tradables, making their prices consistent with the border prices of tradables. One would ideally prefer to compute a specific conversion factor for each non-tradable rather than use a standard conversion factor such as the SER, but due to the practicalities involved in decomposing non-tradables into their tradable and primary factor components, the SER is easier to compute.

Lagman-Martin (2004) mentions three alternative approaches to estimating the SER. These approaches are generally based on converting the OER to the SER through a conversion factor known as the *SER factor* (SERF). The first approach is employed where an economy enjoys balanced trade. The formula applied involves calculating the SER based on the tariff-adjusted OER, weighted according to import–export shares. A second approach takes into account the sustainability of the country's trade imbalance through an assessment of the Equilibrium Exchange Rate (EER). The use of the EER rather than the OER emphasises the long-term stability of the exchange rate because of its significant effect on project performance. Finally, in the third approach, when tariffs represent the only distortion to trade and there are no distortions in factor or commodity prices, the SERF can be approximated by 1 plus the weighted average tariff rate. This approach is consistent with the accepted definition of the *SER* as the weighted average of the demand price for foreign exchange paid by importers and the supply price of foreign exchange received by exporters.

This simple trade-weighted formula can be represented as (Potts 2002, Lagman-Martin 2004) –

$$SERF = \frac{M(\mathit{cif}) + X(\mathit{fob})}{(M + M_t - M_s) + (X - X_t + X_s)} \qquad (9)$$
$$= \frac{TT}{TT - NT_t}$$

where M is the total value of imports (cif – cost, insurance, freight), X is the total value of exports (fob – free on board), M_t is total value of import taxes, X_t is the total value of export taxes, TT is the total value of trade, NTt is the total value of net trade taxes, and M_s and X_s represent import and export subsidies, respectively.

Other, more complex, formulas for the SER can be derived if data are available to indicate the types of imports or exports that change with a concomitant change in the availability of foreign exchange. Such formulas use the elasticity of demand for imports and exports with respect to changes in foreign exchange availability to provide weights for different export and import categories. It is usually very difficult to obtain reliable information on these elasticities, so the simple weighted formulas are commonly used. Harberger et al. (2003) employ a general equilibrium model to estimate the SER for South Africa. Their approach illustrates how the foreign exchange premium could be estimated in an economy where the funds used to finance the purchase of tradable and non-tradable goods are obtained via the capital markets. This framework ensures that all repercussions in the economy due to the purchase of tradable goods for a project are taken into account in a consistent manner. Due to data limitations, this work will employ the simple weighted trade formula presented above. Other methods include using semi-input–output models in order to use the weighted

average of the conversion factors for traded goods. The question as to which formula to use is essentially an empirical one (Potts 2002).

4.   DATA

The data are derived from various sources. For the shadow price of capital estimations, the inflation data are derived from the Central Bureau of Statistics' National Accounts from 1996 to 2006, and from the Bank of Namibia's quarterly and annual reports. The rate of return from investing Namibian assets in South African long-term bond instruments was obtained from a local consulting firm, Jacques Malan Consultant and Actuaries.

For the SRTP calculations, we follow Evans and Sezer (2004), where the rate of pure time preference ρ is assumed to be 1.5%, the elasticity of marginal utility of consumption θ is assumed to be 1.3, and the average growth rate of per capita real consumption g is the average annual growth rate per capital real GDP from 1996 to 2006, derived from the National Accounts data. The g was 2.87% over the 1996–2006 period.

The labour estimations used LARRI's Actual Wage Rate Database, the results of the LARRI labour force survey conducted in 2004, the Ministry of Labour's survey on Namibia's informal economy in 2001, and LARRI's study on that economy in 2006. In terms of unskilled labour, we will use the minimum wages determined by LARRI (2005, 2006a) for the various economic sectors in Namibia. The database is derived from wage agreements entered into between various trade unions and corporate entities between 2000 and 2005. This database will represent the urban semi- and unskilled labour pools. We will

also look at special categories such as farm workers and security guards, who are formally paid a minimum wage as set out by legislation.

LARRI (2006b) shows that, on average, the majority of informal workers get paid N$175 per month. The estimated number of people working in the informal sector is 133,000. Unfortunately, there are no disaggregated data available on rural and urban wages. Therefore, wages for the informal sector as well as for farm workers are used as a proxy for rural semi-skilled and unskilled labour. The labour force survey of 2004 estimates that 108,119 people are unemployed. Using these data, we obtain f_1 at 0.55, f_2 at 0.45, and W_f at N$175 to estimate the EOCL equation. For urban semi-and unskilled labour, W_p is the LARRI database's average national wage, namely N$1,475 per month. For rural workers, the W_p is the farm workers' minimum wage of N$428 per month. For estimating the EOCL of foreign labour, t^F is 35%, with t^{VAT} at 15%, and E^e/E^m being the SERF calculated in this study. Finally, we assume R (the proportion of the net-of-tax income repatriated by foreign labour) at 40%.

Namibian trade statistics to estimate the forex premium were obtained directly from the Central Bureau of Statistics and the Bank of Namibia reports.

5.   RESULTS

5.1   Discount rate estimations

The discount rate estimations using the amended EOCK formula yielded the following:

Table 1: Discount rate calculations: Results of estimations

Method	Discount rate
Amended EOCK	7.2%
SRTP	5.3%

The amended EOCK is 7.2%, whilst the results of the SRTP are 5.3%. Thus, the estimates are slightly lower than the informal estimate of 8% from Barnes (1994). The work by Kuo et al. (2003) estimates the South African EOCK at 11%, which is higher than our estimates.

Zhuang et al. (2007) mention that a major criticism of using SRTP is that it is purely a measure of the social opportunity cost in terms of foregone consumption, and that it ignores the fact that public projects could also crowd out private sector investments if they cause the market interest rate to rise. Therefore, it is necessary to reflect what society could have gained from the displaced private investment that can be measured by the marginal social rate of return on private sector investment. As the SRTP is generally low, if it is exclusively used as the social discount rate it may lead to too many low-return investments being undertaken in the public sector.

5.2   EOCL estimation results

The results of the EOCL estimations are presented in Tables 2 and 3 below:

Table 2: EOCL estimations

Namibian minimum wage, by sector	Three-year average 2003–2005	EOCL W_i assumed at N$175	Economic costs as share of financial costs (%)
Agriculture / hunting / fishing / forestry	1,256	417	33
Community services / social services / personal services	1,676	511	31
Construction	1,415	452	32
Manufacturing	1,366	441	32
Mining and quarrying	1,812	542	30
Transport and storage	1,693	515	30
Wholesale and retail trade	1,104	383	35
National average	1,410	452	32
Economic costs as share of financial costs			**32%**

Table 3: EOCL estimations of special categories

Special categories	Protected wages	EOCL W_i assumed at N$175	Economic costs as share of financial costs (%)
Farm workers	428	231	54
Security guards	588	267	46
EOCL of foreign labour factor	n/a	n/a	59
EOCL of Namibian expatriates	n/a	n/a	28

The EOCL estimations show that, as a share of financial costs, economic costs are 32% for Namibian urban semi- and unskilled labour, and around 54% for rural semi- and unskilled labour. The economic costs of foreign labour and Namibian expatriates are 59% and 28% of financial costs, respectively. In comparison, the informal estimate in Barnes (1994) was that

the economic cost was 35% of the financial cost for all unskilled labour. The estimations by Bicak et al. (2004) show the South African accounting price of unskilled labour at 60%, whilst their Namibian counterpart is at 32%. The South African accounting price for foreign labour is 73%, whereas the Namibian estimations yielded an accounting price of 59%.

5.3   SERF estimation results

The results of the SERF estimation are presented in Table 4 below:

Table 4: SERF estimations (imports and exports for trade with countries outside SACU)

SERF estimations	2004	2003	2002	2001	2000	1999
Imports (*cif*) (N$)	48,494,118	39,233,302	21,112,383	19,137,768	29,366,773	22,431,392
Exports (*fob*) (N$)	81,766,641	117,776,370	64,175,570	55,621,342	52,919,528	27,512,564
Import taxes (N$)	7,185,927	6,362,725	2,314,213	2,503,542	3,714,767	3,103,544
Export taxes (N$)	29,733	25,727	9,044	9,832	10,279	7,241
Net trade taxes (N$)	7,156,193	6,336,998	2,305,169	2,493,710	3,704,488	3,096,303
Total trade (N$)	130,260,759	157,009,672	85,287,953	74,759,110	82,286,301	49,943,956
SERF	**1.05**	**1.04**	**1.03**	**1.03**	**1.05**	**1.06**
SERF, six-year average	**1.04**					

The SERF estimations indicate a value of 1.04. A more general point is that the SER is not a precise figure since it will be used in projections into an uncertain future. Therefore, there are grounds for using a central approximation (or best estimate) and doing some sensitivity tests around the central value. Thus, in appraising projects, it is best to apply a sensitivity analysis using a range of values around the 4% central value. Harberger et al. (2003)

estimate a value of 6.2% for the South African economy, which is higher than this work's estimate. As mentioned earlier in the paper, these estimates are for out-of-SACU trades as the SERF for SACU is 1.

6.   CONCLUSIONS

This has been the first formal attempt at estimating national economic parameters for the Namibian economy.

In terms of the amended EOCK, the lower value of 7.2% – compared with SA's 11% – clearly reflects the Namibian net saver position. The estimate is also close to the Barnes (1994) guesstimate, which has been used for the last 14 years. The SRTP low value of 5.3% is best used for public projects that are unlikely to displace private investments, such as food-for-work programmes and other non-profit public sector initiatives. On the other hand, the EOCL estimations for farm workers, which are used as a proxy for semi- and unskilled rural labour, are much higher than the Barnes (1994) guesstimates. The SER estimate, while lower than the Barnes (1994) guesstimates of 6%, is for out-of-SACU trades which the latter work did not realise or incorporate.

The results should be useful for efficient and sustainable development planning in Namibia. Further extensions and enhancements of this work should entail estimating shadow prices using input–output analyses in order to estimate conversion factors for the various sectors of the Namibian economy.

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APPENDIX 1

The economic opportunity cost of capital

Theoretically, the social rate of return may be defined by applying national accounting principles. In an open economy, real income can be different from real product because of the servicing of national debt. Let us assume that s is the average interest rate on the stock of foreign debt (D). Then income Y is given by –

$$Y = q - s.D \tag{1}$$

where q is the real product. If we then consider a new public project, –

$$\Delta Y = \delta.\Delta I_g + \rho.\Delta I_p - i_f.\Delta D \tag{2}$$

where $\Delta q = \delta.\Delta I_g + \rho.\Delta I_p$. Δq is the permanent change in real product, ΔI_g is the new public project, δ is the rate of return of the project, ΔI_p is the change in private investment caused by the new project ($\Delta I_p < 0$), ρ is the marginal rate of return that the postponed investment would have generated, i_f is the marginal cost of additional foreign borrowing, and ΔD represents the change in the external debt stock.

The decision rule for accepting the project is that the discounted stream of extra income (ΔY) must be higher than the consumption forgone now (change in savings ΔS). Thus, the project should be accepted if the following condition can be satisfied:

$$\frac{\Delta Y}{r} \geq \Delta S \tag{3}$$

This can then be rewritten as follows:

$$\Delta Y \geq r \Delta S \tag{4}$$

Substituting (2) into (4) gives us –

$$\delta \Delta I_g + \delta \Delta I_p - i_f \Delta D \geq r \Delta S \tag{5}$$

$$\delta \Delta I_g \geq r \Delta S + i_f \Delta D - \rho \Delta I_p \tag{6}$$

Thus, for marginal public investment, we have –

$$\delta = r \frac{\Delta S}{\Delta I_g} + i_f \frac{\Delta D}{\Delta I_g} - \rho \frac{\Delta I_p}{\Delta I_g} \tag{7}$$

where $\dfrac{\Delta S}{\Delta I_g}; \dfrac{\Delta D}{\Delta I_g}; -\dfrac{\Delta I_p}{\Delta I_g}$ represents shares of funds sourced from different parts of the

capital market. We can then solve the following:

$$\Delta I_g = \Delta S + \Delta D - \Delta I_p = \frac{\partial S}{\partial r} \frac{\partial r}{\partial I_g} \Delta I_g + \frac{\partial D}{\partial r} \frac{\partial r}{\partial I_g} \Delta I_g - \frac{\partial I_p}{\partial r} \frac{\partial r}{\partial I_g} \Delta I_g$$

$$= \left(\frac{\partial S}{\partial r} + \frac{\partial D}{\partial r} - \frac{\partial I_p}{\partial r} \right) \frac{\partial r}{\partial I_g} \Delta I_g \tag{8}$$

where $\dfrac{\partial S}{\partial r}, \dfrac{\partial D}{\partial r}, -\dfrac{\partial I_p}{\partial r}$ represent shares of funds.

The weights of (8) can be written in terms of the aggregate elasticity of each source:

$$\varepsilon_s = \frac{\partial S}{\partial r}\frac{r}{S} \Rightarrow \frac{\partial S}{\partial r} = \frac{\varepsilon_s S}{r}, \tag{9}$$

and similarly for D and I_p. Thus, we have –

$$\frac{\partial S/\partial r}{\partial S/\partial r + \partial D/\partial r - \partial I_P/\partial r} = \frac{\varepsilon_s S/r}{\varepsilon_s S/r + \varepsilon_f D/r - \eta\dfrac{I}{r}} = \frac{\varepsilon_s S}{\varepsilon_s S + \varepsilon_f D - \eta I} \tag{10}$$

which represents the share of increased savings (weight, f_1). The other two weights can be derived similarly:

$$\frac{\partial D/\partial r}{\partial S/\partial r + \partial D/\partial r - \partial I_P/\partial r} = \frac{\varepsilon_f D}{\varepsilon_s S + \varepsilon_f D - \eta I} \tag{11}$$

which represents the share of increased foreign borrowing (weight, f_2); and finally,

$$\frac{\partial I_p/\partial r}{\partial S/\partial r + \partial D/\partial r - \partial I_P/\partial r} = -\frac{\eta I}{\varepsilon_s S + \varepsilon_f D - \eta I} \tag{12}$$

which represents the share of displaced private investment (weight f_3).

Thus, where ε_s is the supply elasticity of household savings, ε_f is the supply elasticity of foreign funds and η is the elasticity of demand for domestic investment relative to changes in the interest rates. S_t is the total savings available in the economy, of which S_r is the contribution to the total savings by households, and S_f is the total contribution of net foreign capital inflows.

Barreix (2003) mentions that only this market-driven opportunity cost approach is sufficiently flexible to easily add a new source of financing to the analysis. This approach also has another important advantage: it can be defined as a single value. Thus, no extra adjustment on investment expenditures is required, and no classification of benefits and costs are needed.

Barreix (2003) surveys the empirical literature on the estimation of the shadow price of capital and finds that most studies – especially those relating to developing countries – have used the EOCK approach. The standard method for estimating the EOCK for developing countries is captured in the work of Jenkins and Kuo (1998), where it is measured as a weighted average of the rate of time preference to savers (γ), the cost of additional foreign capital inflows (MC), and the rate of return on displaced investment (π). The weighted average of these three costs can be expressed as follows:

$$EOCK = f_1 \bullet \gamma + f_2 \bullet MC_f + f_3 \bullet \pi \tag{13}$$

where γ, MC_f and π, respectively, equal the costs of the public sector funds obtained at the expense of current consumption, the cost of additional foreign capital inflow to the

economy, and at the expense of other domestic investment. The cost of foreign borrowing (MC_f) is valued at its marginal cost. The weights ($f_1, f_2,$ and f_3) are the shares derived earlier, and are equal to the proportion of funds diverted or sourced from each sector.

If the weights are expressed in terms of elasticities of demand and supply of funds with respect to changes in interest rates, equation (13) can be rewritten as follows:

$$EOCK = \frac{\varepsilon_s(S_r/S_t)\bullet\gamma + \varepsilon_f(S_f/S_t)\bullet MC_f - \eta\bullet\pi}{\varepsilon_s(S_r/S_t) + \varepsilon_f(S_f/S_t) - \eta} \qquad (14)$$

II

Estimating Namibian shadow prices

within a semi-input–output framework

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Abstract

The purpose of this paper is to derive, using the semi-input–output (SIO) technique, a set of accounting price ratios (APRs) for the various economic sectors of Namibia. An *APR* is the ratio between the market or financial price and the efficiency or economic value of a specific commodity or sector. APRs are useful for the economic analyses of investment or development initiatives. In contrast to previous estimates of shadow prices in Namibia, which are limited to a few aggregate shadow prices for capital, labour and foreign exchange, the SIO estimation technique applied here to the Namibian economy permits the easy calculation of many more such prices. The results shows that most tradable sectors such as fishing and mining have APRs equal to or closer to one, with deviations explained by import tariffs. Non-tradable sectors' APRs exhibit greater variation, with the water sector having the highest reflecting its scarcity.

Keywords: semi-input–output; accounting price ratios; Namibia

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1. INTRODUCTION

The purpose of this paper is to estimate shadow prices for the Namibian economy using the semi-input–output (SIO) method. Essentially, this work is an extension of Humavindu (2008) which was limited to only a few aggregate shadow prices for capital, labour and foreign exchange. Applying the SIO analysis would permit the estimation of many more shadow prices for the Namibian economy. A larger set of national shadow prices would improve appraisal results, especially where these are needed for goods and services that are inputs or outputs of a project.

The need for shadow pricing arises due to the notion that the market prices of goods and services and productive factors may not reflect their real worth due to several distortions. The distortions can be of an economic nature, such as import duties, export taxes or subsidies, and other indirect taxes. An economic adjustment is needed for a productive factor like labour due to imperfect labour markets. The presence of minimum wage laws may set wages substantially higher than the economic opportunity cost of labour. This necessitates an adjustment to the prevailing labour market prices, and for those goods and services where labour is an important factor of production.

Humavindu (2008) advances both practical and academic reasons for the need to estimate shadow prices for the Namibian economy. From a practical viewpoint, there is no consistent shadow pricing application at national planning level – despite challenges that include poverty, high unemployment, and low industrialisation. This could lead to suboptimal allocation of resources to ameliorate the enormous development challenges. The country is

contemplating large-scale projects such as the development of the Kudu gas fields, diamond mining in current conservation areas such as the Sperrgebiet, hydropower plants, and a nuclear power plant, and these would need to be assessed on both financial and economic grounds. In the field of energy in particular, the decision whether to promote renewable or nuclear energy to alleviate the imminent energy shortfall is crucial. Both options would be a matter of imported capital equipment, but shadow pricing analysis would aid in assessing which option accrues greater economic benefits to Namibia. Another relevant example is the textile sector, which has grown as a result of government support. However, the sector has caused environmental and labour-relations problems, suggesting that the government decision to support it could have benefited from objective economic assessment.

Academic reasons for the interest in Namibian shadow prices include the country being a net capital exporter while having a large service sector – which is unusual for a developing economy. Also, Namibia's participation in the Southern African Customs Union (SACU), which shares customs revenue amongst its member countries, could affect the estimation of a shadow price of foreign exchange. Humavindu (2008) estimates the economic opportunity cost of capital at 7.2%. The economic costs of Namibian labour as a share of financial costs are 32% for urban semi-skilled and unskilled labour, and are 54% for rural semi-skilled and unskilled labour. The economic costs of foreign labour as a share of financial costs are 59%. The shadow exchange-rate premium is 4%.

The current work extends Humavindu (2008) by employing the SIO analysis: it distinguishes between international sectors that produce tradable goods, and national sectors that produce non-tradable goods (Kuyvenhoven 1978). The aim is to estimate the ratio between the market

price of a resource or commodity and its value at efficiency prices. The ratio between the market price and the efficiency value of a specific commodity or sector is known as the *accounting price ratio* (APR; see MacArthur 1994). This ratio can be applied to the constant price financial values in project analysis to derive the corresponding economic values.

The SIO approach is regarded as the most advanced among those applied in national parameter studies (Saerbeck 1989). This is because it treats two major theoretical areas of concern – the problem of interdependence in the estimation of key parameters, and the valuation of non-traded goods and services – in the most accurate way. Thus, with the SIO method, one may readily derive shadow prices for many different sectors of the economy and include the direct and indirect effects of protection on the conversion factors of typically non-traded goods and services.

2.   METHODOLOGY

2.1   IO and SIO analysis

Generally, input–output analysis (IO) is well suited to assess how changes in one or more economic sectors will impact on the total economy. Input–output analysis is generally applied to assess the impact of a change in the demand conditions for a given economic sector. IO analysis uses matrix algebra to find out how much output will be utilised in productive activities to obtain a final net output and how much will be left over for consumption (Baumol 1977). Thus, an IO model can be used to estimate the amount of income,

employment, and production that will be generated by a given level of demand (Leontief 1986).

In IO analysis, the structure of an economy can be represented by the value of transactions between sectors (primary, manufacturing and services) in a matrix (the *A matrix*). Each sector in the *A* matrix has both a row and column. The rows of this matrix are the sectors that a given sector sells its output to (as intermediate inputs to those sectors), while the columns are the sectors a given sector purchases its intermediate inputs from.

Completing the IO table is the addition of final demand (including demand from consumers and exports), the destination of sales that do not go to other sectors, and primary inputs (labour, land, capital and imports), i.e. the inputs that are not purchased from other sectors. This is called the *Y*. Thus, a simplified IO model can be demonstrated as presented in Equation 1 below:[1]

$$X_{ij} = a_{ij} X_j \tag{1}$$

where X_{ij}, the amount of sector *i*'s output required for the production of sector *j*'s output, is assumed to be proportional to sector *j*'s output – X_j, and a_{ij} is the relevant input–output coefficient. Summing over sectors and adding final demand Y_i to Equation (1) produces the following input–output relationship:

$$X_i = \sum_{j=1}^{n} a_{ij} X_j + Y_i \tag{2}$$

The latter is assumed to hold in first-difference form (depicting changes in the variables).

Equation (2) in matrix form is $X = AX + Y$. Rearranging the equation gives the following:

$$X = (I - A)^{-1}Y \qquad (3)$$

In Equation (3), X is the vector of outputs, Y is the vector of final demands, A is the matrix of input–output coefficients, and I is the identity matrix. In IO analysis, the most common assumption is that all sectors produce output using fixed proportions of inputs and, hence, can increase production with constant marginal cost. If this is the case, the Leontief Inverse $(I-A)^{-1}$ can be used to calculate overall changes in sectoral outputs caused by changes in final demand. All sectors are assumed to be perfectly elastic in supply.

In the IO model, prices are determined by the costs of inputs and primary factors. We have –

$$P = PA + P_f F \qquad (4)$$

where P is the vector of prices, A is the matrix of input-output coefficients, P_f is the vector of prices of primary factors and F is the matrix of coefficients of primary factor requirements in different sectors. Rearranging (4), we have –

$$P(I - A) = P_f F$$

$$P = P_f F (I - A)^{-1} \qquad (5)$$

The SIO approach differs from its IO counterpart in that the assumption of perfectly elastic supply in all sectors is rejected because the assumption leads to an overestimation of output responses following from any intervention. In reality, most developing countries have several sectors that face supply constraints (Haggblade et al. 1991).

The SIO approach retains the basic assumptions of the IO approach, but introduces supply rigidities in some sectors. The SIO approach classifies all economic sectors as either supply-constrained or perfectly elastic in supply. The approach assumes perfect substitutability between domestic goods and imports. Thus, world prices ensure fixed prices for tradable goods. Tradable goods are assumed to be supply-constrained; an increase in domestic demand merely reduces net exports, which are endogenous to the system (Cornelisse & Tilanus 1966; Diao et al. 2007; Dorosh et al. 1992; Kuyvenhoven 1978). For non-tradable goods, on the other hand, supply is still assumed to be perfectly elastic, as in the IO model.

Figures 1 and 2 below provide a simple graphic example of how matrix subdivisions differ in IO and SIO, respectively.[2]

Figure 1: Stylised representation of an input–output transactions table

Purchase by sector: Read down ↓
Sales by sector: Read across →

Quadrant 1 Intermediate inputs to production (**A**)	Quadrant 2 Final demand	Total demand
Quadrant 3 Primary inputs to production (**F**)		

Total output

Quadrant 1 in Figure 1 represents the intermediate inputs matrix, which defines the two-way links between industries and, through these links, the labour, fixed capital and natural resource requirements of final demand. Input–output methods use this information to define a two-way process showing the flow of goods and services between sectors and "to" and "from" processes or entities (*value added* and *final demand*). Therefore, the system can be interpreted as reflecting the technical relationship between the level of output and the required quantities of inputs, and the balancing of supply and demand for each type of good and service. For each sector, total outputs are absorbed as inputs of other industries or in final use (*consumption*, *investment* and *net exports*). In conventional IO models, no distinction is made between tradable and non-tradable goods and services.

Figure 2: Stylised representation of a semi-input–output transactions table

Purchase by sector: Read down ↓
Sales by sector: Read across →

Quadrant 1a Intermediate inputs to tradables from tradable sectors (A_{11})	**Quadrant 1b** Intermediate inputs to non-tradables from tradable sectors (A_{12})	**Quadrant 2a** Final demand tradables	**Total demand**
Quadrant 1c Intermediate inputs to tradables from non-tradable sectors (A_{21})	**Quadrant 1d** Intermediate inputs to non-tradables from non-tradable sectors (A_{22})	**Quadrant 2b** Final demand non-tradables	
Quadrant 3a Primary inputs to tradables production	**Quadrant 3b** Primary inputs to non-tradables production		

Total output

However, in SIO, the transaction table is rearranged to delineate Quadrant 1 in the tradables and non-tradables sectors of the economy. Instead of producing a full *A* matrix as in traditional IO analysis, we produce an A_{22} matrix containing the non-tradable economic sectors. Therefore, A_{22} in Figure 2 represents the matrix coefficients for non-traded inputs that are needed to produce non-traded output. The demand for traded inputs per unit of non-traded output is given by the A_{12} matrix – essentially, the matrix coefficients for traded inputs used to produce non-traded output. Thus, the global demand for each type of input per unit of non-traded output is obtained by adjusting each item by the Leontief Inverse of the A_{22} matrix, $(I\text{-}A_{22})^{-1}$.

The difference between IO and SIO assumptions has implications for the determination of prices. In the SIO model, the prices of tradable goods are not determined endogenously; they are determined by world market prices and by taxes and subsidies that distort the domestic prices relative to the world market prices. We have –

$$\text{APR}_{\text{tradables}}: \quad w\frac{1}{(1+t_m)(1+v_m)} + (1-w)\frac{1}{(1-t_x)(1+v_x)} \tag{6}$$

where t_m represents the import tariff, v_m represents indirect taxes (net of subsidies) levied at the point of entry, t_x represents the export tax, v_x represents total indirect taxes (net of subsidies) levied on export sales, and w represents the weights of imports relative to total trade.

The prices of non-tradable goods, on the other hand, are determined endogenously. We have –

$$P_2 = P_2 A_{22} + P_1 A_{12} + P_f F_2$$

$$P_2(I - A_{22}) = P_1 A_{12+} p_f F_2$$

$$P_2 = P_1 A_{12}(I - A)^{-1} + P_f F_2(I - A_{22})^{-1} \tag{7}$$

where P_2 represents the accounting price ratios of non-traded goods, P_1 represents the accounting price ratios of the traded inputs, A_{12} represents the matrix coefficients for traded inputs that are used to produce non-traded output, A_{22} represents the matrix coefficients for non-traded inputs that are needed to produce non-traded output, P_f represents the shadow

price of the primary factors, and F_2 represents the matrix of the coefficients of primary factor purchases and transfer payments per unit of non-traded output.

2.2   The SIO approach

The SIO approach used here may conveniently be broken down into six steps:[3]

- STEP 1: The economic sectors are separated into traded and non-traded sectors.

- STEP 2: APRs are calculated for all traded sectors, using data on import duties and export taxes. The APRs for the traded sector are calculated using the formula in eq. (ref to equation above):

- STEP 3: National economic parameters for labour, foreign exchange and capital are derived. In this case, they were derived from Humavindu (2008).

- STEP 4: The SIO table is used to derive direct-input coefficients for each of the non-traded sectors.

- STEP 5: The resulting sets of equations are solved to yield both the direct and the indirect input coefficients of all sectors into the non-traded sectors. This is done by taking the Leontief Inverse of the submatrix of input coefficients from the non-traded into the non-traded sectors, and premultiplying it with the matrices of direct input coefficients from traded and primary sectors into the non-traded sectors.

- STEP 6: The resulting matrix of the direct and indirect coefficients is multiplied by the vector of APRs of the traded and primary sectors, to yield the APRs of each of the non-traded sectors.

Thus, the APRs for non-tradables are the sum of all the economic values of the traded and non-traded material inputs and factors used to produce them.

Economic profits should have a shadow value of zero in SIO analysis. The usual assumption is that increased demand for a non-traded good will lead to the sector producing that good to expand at the current capital-output ratio, so that, in principle, a need arises to price the additional capital investment at its opportunity costs. In practice, SIO studies frequently assume a range of shadow values for the gross operating margin, or just use the figure derived from a social accounting matrix (SAM). However, when capital stock data are available (as they were for this study), the additional capital can be directly shadow-priced at its opportunity cost.

In the absence of trade distortions, the tradable sectors are expected to have APR values of 1 or very close to unity. Where tradable APRs exceed 1, it is generally an indication of either taxed exports or of subsidies for local consumption. If tradable APRs values are below unity, it is usually an indication of export subsidies (MacArthur 1997).

APRs for non-tradables are expected to have values less than 1. APRs with less than 1 normally arise if the market price contains either significant non-resource cost transfers (for taxes, excess profits, etc.) or large amounts of labour whose market wage is considerably higher than the estimated opportunity costs. APRs with values above 1 imply a heavily subsidised market price, or that the non-tradable contains a higher-than-average content of traded items in the cost structure and is available only in restricted supply, so that one project

can obtain its needs only by denying the product to another willing project/purchaser (MacArthur 1994).

3.   THE NAMIBIAN ECONOMY AND DATA

3.1   Overview of the Namibian economy

The Namibian economy is characterised by dualism: a modern market sector based on a capital-intensive industry and farming, which produces most of the country's wealth, coexists alongside a traditional subsistence sector. The country's gross domestic product (GDP) per capita (US$3,100 at market exchange rates) is relatively high among developing countries, but obscures one of the most unequal income distributions on the African continent. There is also a high degree of openness in the economy, due to the sum of exports and imports having a more than 90% share of GDP.

The economy is also highly integrated with that of South Africa. Three-fourths (75%) of Namibia's imports originate there, and transport and communications infrastructure are strongly linked with South Africa. In addition, the high degree of labour mobility between Namibia and South Africa means that many services (which are usually non-tradables) become tradables for Namibia.

Namibia's imports are mainly machinery and equipment (40%), light manufacturing (21%), and petroleum products (10%). Namibia's exports consist mainly of diamonds and other minerals (44%), fish products (21%), and tourism (15%). Beef and meat products and grapes

are other important exports. The textile sector has grown under the United States of America's African Growth and Opportunity Act (AGOA), thereby increasing apparel exports.

The Namibian economy is largely driven by, in descending order, the tertiary sector, primary sector, fisheries and beef processing. The tertiary sector is currently the biggest contributor to GDP (over 55%), with government services accounting for a third of the tertiary sector's output, whilst the trade, transport and finance sectors contribute to half of this sector's output. Namibian agriculture contributes less than 5% of Namibia's GDP, although 70% of the Namibian population depends on agricultural activities for their livelihood. The manufacturing sector contributes about 11% to GDP. The latter sector's growth has historically been limited by a small domestic market, dependence on imported goods, a limited supply of local capital, a widely dispersed population, a small skilled labour force, high relative wage rates, and competition from South Africa. Tourism is increasingly becoming an important sector, with recent estimates of a 10% contribution to GDP (World Travel and Tourism Council 2006).[4]

3.2   Data

Three sets of data were used for estimating the APRs. Firstly, trade statistics and National Accounts data were obtained directly from the Namibian Bureau of Statistics as well as the Bank of Namibia, the country's central bank. Trade statistics were used to determine the tariffs and subsidy values for tradable sectors, as these are useful for estimating tradable APRs. The National Accounts were used to derive capital stock data.

The second set of data is the inter-industry flow of transactions among sectors of the economy. For this the 2001/2 SAM was used, which is the most recent one available (Lange et al. 2004). The SIO model used here is built around a 2001/2 Namibian SAM. The latter is a 72 x 72 matrix and contains an account for each of 30 production activities, 5 factors of production, and 9 institutions. Following United Nations (1999), the SAM is aggregated into an IO table with 26 tradable and non-tradable sectors. The classification of the 26 sectors is given in Table 1 below:

Table 1: Classification of the sectors

Sector and classification
Tradables
Commercial agriculture – Cereal
Commercial agriculture – Other crops
Commercial agriculture – Animal products
Fishing
Mining
Meat processing
Fish processing
Grain milling
Beverages and other food processing
Textiles
Light manufacturing
Heavy manufacturing
Construction
Transport
Market – Real estate and business services
Tourism – Non-residents
Petroleum products
Non-tradables
Traditional agriculture
Electricity
Water
Trade and repairs
Hotels and restaurants
Communication
Finance and insurance
Other private services
Government services

The shadow prices for primary factors (Humavindu 2008) were used as the third set of data. The shadow price of capital is 7.2%. This discount rate was derived by applying an amended Economic Opportunity Cost of Capital (EOCK) approach. This was to account for the net capital exporter status of the Namibian economy. Two shadow prices for labour are derived: rural and urban unskilled labour. The shadow price for urban unskilled labour is 0.32 of its financial values, while the shadow price of rural labour is 0.54 of its financial values. These shadow prices for labour were derived by utilising the supply price of labour method. In this method, the labour shadow prices are determined by adjusting the gross-of-tax market wage (i.e. the supply price) for distortions in the labour market, such as minimum wage regulations.

An important factor defined in the Namibian SAM is the net operating margin. As noted in Section 2.2, the net operating surplus from the SAM is not used here; instead, the sectoral capital costs were calculated by using unpublished National Accounts data on such stocks in individual sectors. The tariff values obtained are shown in Table 2 below:

Table 2: Tariff values for tradable sectors

Sector	T_m	V_m	T_x	V_x	w	$1-w$
Commercial agriculture – Cereal	14.54%	0	0.00%	0	0.97	0.03
Commercial agriculture – Other crops	16.58%	0	0.00%	0	0.63	0.37
Commercial agriculture – Animal products	16.80%	0	0.66%	0	0.23	0.77
Fishing	0.00%	0	0.00%	0	0.32	0.68
Mining	0.00%	0	0.00%	0	0.07	0.93
Meat processing	0.00%	0	0.30%	0	0.20	0.80
Fish processing	0.00%	0	0.00%	0	0.05	0.95
Grain milling	14.51%	0	0.00%	0	0.74	0.26
Beverages and other food processing	30.93%	0	0.00%	0	0.62	0.38
Textiles	17.15%	0	0.00%	0	0.77	0.23
Light manufacturing	15.57%	0	0.70%	0	0.42	0.58
Heavy manufacturing	15.54%	0	0.00%	0	0.70	0.30
Tourism – Non-residents	0.00%	0	0.00%	0	0.00	1.00
Petroleum	11.97%	0	0.00%	0	0.82	0.18

4.   RESULTS

The main results of our analysis are summarised in Table 3 below:

Table 3: APR estimates for Namibian economic sectors

Economic sectors			
1. Tradables	**APR**	**2. Non-tradables**	**APR**
Commercial agriculture – Cereal	0.87	Traditional agriculture	0.66
Commercial agriculture – Other crops	0.91	Electricity	0.88
Commercial agriculture – Animal products	0.97	Water	1.13
Fishing	1.00	Trade and repairs	0.53
Mining	1.00	Hotels and restaurants	0.50
Meat processing	1.00	Communications	0.95
Fish processing	1.00	Finance and insurance	0.62
Grain milling	0.91	Other private services	0.84
Beverages and other food processing	0.85	Government services	0.95
Textiles	0.85		
Light manufacturing	0.95		
Heavy manufacturing	0.87		
Construction	1.00		
Transport	1.00		
Market – Real estate and business services	1.00		
Tourism – Non-residents	1.00		
Petroleum products	0.90		

As expected, most of the tradables have APRs closer or equal to unity. Sectors such as fishing, mining, meat processing, fish processing and tourism all have APRs of 1. These results once again affirm the high degree of openness of the Namibian economy. However, the beverages sector's economic values show the largest divergence, namely 15%, from their financial values or prices. This divergence is reflected in the high import tariff of 30%. Similarly, all sectors (*Commercial agriculture – Cereal, Commercial agriculture – Other crops*, *Commercial agriculture – Animal products*, *Grain milling, Beverages and other food*

processing, *Textiles*, *Light manufacturing*, *Heavy manufacturing*, and *Petroleum*) that have import tariffs have APRs that are below unity.

The estimated non-tradable APRs show more sectoral variations. It is not surprising that the highest APR (1.13) is for the water sector, reflecting the scarcity of this resource. The communication sector's APR is also high (0.95), reflecting the high capital goods imports and investments that sector makes. Government services constitute 35% of the total tertiary sector and 19% of total GDP. This sector thus plays a major role in the economy. The high APR (0.95) of this sector may also reflect high capital goods imports as well as investments. As expected, the traditional agriculture (0.66), trade and repairs (0.53), hotel and restaurants (0.50), and finance and insurance (0.62) sectors have low APRs.

Macarthur (1994) and Ghani (1999) caution against the need to seek commonality in APR values between economies for comparative analyses. Application of different methodologies partly accounts for different results, whilst the levels of commodity or sectoral disaggregation are another cause. However, the major driver of differences in APR values is the variation in underlying pricing and fiscal approaches of the various economies. Macarthur's (1994) review of 13 studies found in general that tradables' and non-tradables' APRs fell within their expected range close to unity or less than unity, respectively. However, some outliers did occur, with the fuel oil sector of Egypt having an APR estimate of 15.299. This reflected the high subsidisation of fuel in Egypt at the time. On the other hand, some low APR values were evident in sectors such as banking and insurance in Ecuador and Egypt, with values of 0.293 and 0.328, respectively. Most of the APRs reviewed were above 0.50 and below 1. Thus, the results for Namibia are in congruence with previous work on APRs.

Of the non-tradables, the government-involved sectors (electricity, water, communications and government services) have high capital-to-output ratios so that expansion will require a lot of capital, especially for water. This drives up the APRs for these sectors because the current return to capital is less than the opportunity cost of the capital that would be needed for expansion. On the other hand, the opposite is true for several of the privately controlled sectors - presumably because of limited competition, profits (and hence returns to capital) are high and these sectors could expand with relatively little additional capital. Hence, the opportunity cost of the additional capital needed for expansion is less than the current return to capital. At the same time, unskilled labour will tend to pull down the shadow price of all the non-tradable sectors, so sectors for which unskilled labour is an important input will have lower APRs as a result. However, unskilled labour is a more important input to production for government sectors than for the privately managed sectors (apart from traditional agriculture). Thus, it appears that the main reason why private non-tradable sectors have low APRs (and, implicitly, the reason government spending on those sectors would have a lower social than financial cost) is not mainly that they employ a lot of unskilled labour, but mainly that they can expand production considerably with relatively little additional capital.

5.   CONCLUSIONS

The work provides the first detailed estimates of APRs for the various economic sectors in Namibia and demonstrates how SIO analysis can be applied to Namibia. The work is essentially an extension of the first formal shadow pricing analysis for the Namibian economy (Humavindu 2008), which estimated national economic parameters for capital,

labour and foreign exchange. By estimating specific economic sectors' APRs, the work is a useful addition for efficient and sustainable development planning in the country.

Reflecting the high degree of openness of the Namibian economy, the efficiency values for tradables show a slight deviation from their market values. However, the non-tradables' efficiency values show a wide divergence from their market values. As expected, unskilled labour-intensive sectors such as traditional agriculture and trade have very low APRs, which reflects the wide divergence between the shadow wage rate and market wage rate. However, for several of the non-tradable sectors, the main reason for the divergence of the efficiency values from the market values is the difference between the current rate of return to capital in the sector, and the opportunity cost of the capital needed for the sector to expand. Thus, for instance, water is a highly scarce and capital-intensive good in Namibia, and large additional capital investments would be required to expand water delivery. At the same time, the rate of return to the capital currently invested in the sector is low. Water, therefore, has the highest APR of all the economic sectors. On the other hand, several other sectors currently have high returns to capital and the opportunity cost of additional capital is lower, so their APRs are low.

Further extensions to the work will greatly enhance the estimated APRs. Due to data limitations, the work is confined to aggregate economic sectors, with no attention paid to various subsector APRs. Such an activity of including estimating APRs also requires resources that are beyond the capacity of this study. With improved data and adequate resources, future work could aim to estimate subsector APRs.

Furthermore, due to economic conditions changing over time, it is inevitable that the work would require intermittent updating. This would be best done by the central planning agencies of the country. But despite the ample scope for further research with regard to Namibian shadow pricing applications, this work represents a considerable improvement on the current situation.

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ENDNOTES

[1] Treatment of IO theory and applications can be found in Bulmer-Thomas (1982), Leontief (1986) and Miller & Blair (1985).
[2] Weiss (1988) and Potts (2002) provide helpful introductions to the SIO approach. Powers (1981) also provides an account of the theory backed by empirical examples.
[3] See Medalla et al. (1990) and Londero (1996). Various empirical studies employ the SIO methodology for estimating sectoral multipliers in general and sector-specific shadow prices in particular. Examples of such work are Lopes da Silva (1993), Dondur (1996), Potts (1996), Beyene et al. (1998), Nouman (1999), Weiss (1999), Dorosh et al. (2003) and Dorosh & Haggblade (2003) and Diao et al. (2007).
[4] Tourism is not classified as a separate economic sector in the National Accounts; rather, it is a combination of products from various other sectors.

III

Integration and volatility spillovers in African equity markets:

Evidence from Namibia and South Africa

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Abstract

This paper analyses returns and volatility on the Namibian and South African stock markets. We use daily closing indices of the Namibian Stock Exchange (NSX) and the Johannesburg Stock Exchange (JSE). The sample covers the period from January 4, 1999 to March 20, 2003. Our methodology has three main parts: (i) unit root tests, (ii) cointegration analysis and (iii) volatility modelling. The results show that both markets exhibit very low correlations, while there is no evidence of linear relationship between the markets. Furthermore, volatility analysis shows evidence of no spillover effects. Our results suggest that NSX is an attractive risk diversification tool for regional portfolio diversification in Southern Africa.

Keywords: financial returns, volatility, GARCH, cointegration, NSX, JSE

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1.   INTRODUCTION

The purpose of this paper is to re-examine the integration between the Namibian Stock Exchange (NSX) and Johannesburg Stock Exchange (JSE) using daily data. This paper also investigates volatility spillover effects between the markets as a complement to cointegration analysis[2]. The major difference between this work and previous studies is that we focus on the local Namibian index (which does not contain dual-listed stocks). Previous empirical evidence reports strong integration between the Namibian and South African equity markets (see Piesse & Hearn 2002; Tyandela & Biekpe 2001). A possible explanation for this is the fact that they use the overall Namibian index (which contains dual-listed South African stocks). This assertion does not refute the notion that stock prices across countries reflect economic integration through trade linkages and foreign direct investment. The dividend discount model posits that current share prices equal the value of future cash flows. These cash flows are normally dependent on the earnings growth of companies, which are in turn dependent on conditions of the domestic economy and its major trading partners. If macroeconomic variables (inflation, unemployment) exhibit co-movement patterns, then it's likely the same for stock prices in such economies. Namibia and South Africa share strong economic and historical (*Apartheid*) ties and thus high stock market integration is reasonably expected.

Research into the integration of African equity markets is increasing. A possible explanation is that African equity markets are potential outlets for international portfolio diversification (IPD). Portfolio theory asserts that if returns on securities in a portfolio have a correlation of

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[2] Similar papers are given by Booth & Yioman (1997), Chen et al. (2002), and Koutmos & Booth (1995).

less than one, then diversification can reduce risk. IPD is driven by the notion that the returns of securities from different countries exhibit low correlations. Hence, through diversification, risk can be lowered without sacrificing return[3]. Solnik (2000) observes that African markets are less integrated with the capital markets from developed countries, and hence offer diversification options. Consequently, Kenny and Moss (1998) report an increasing trend among foreign investors buying into African stocks to capitalize on high returns and diversification benefits. The surge in capital inflows to African equity markets raises the important question of stock market integration: *Are there in fact any benefits in diversifying into these markets, and what is the extent of their integration*?

Recent empirical evidence on the African markets indicates equity integration in countries with strong economic ties. Piesse and Hearn (2002) investigate equity market integration between JSE, NSX and the Botswana stock market (BSE). They use monthly data for the period August 1993 to January 2000, and find integration between the JSE and NSX markets. Chatterjee et al. (1998) apply cointegration analysis using monthly data and investigate linkages among the Nigerian, Zimbabwean and Ghanaian markets. Their results show no evidence of cointegration and indicate low correlations. Tyandela and Biekpe (2001) perform a correlation analysis between weekly indices in the Southern African Development Community (SADC). They find high correlation (around 90%) between NSX and JSE. This is also followed by a high correlation (around 88.3%) between the NSX and BSE stock indices. Overall the stock markets of South Africa, Namibia and Botswana are highly correlated, impliying little diversification benefits among them. Finally, Appiah-Kusi and Pescetto (1998) investigate volatility spillover aspects among African equity markets. They

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[3] See Grubel (1968).

employ the GARCH *(p, q)* technique and find very little volatility spillover effect between the markets. However, some integrated markets show strong economic links (Botswana, South Africa and Zimbabwe).

This paper gives a comprehensive analysis of the NSX return dynamics and the extent of its integration with the JSE market. Understanding the linkages with the JSE is useful for trading strategies of foreign investors who venture into 'frontier' markets of Africa. The paper is structured as follows. Section 2 describes the data. Section 3 shows the econometric methodology adopted, while Section 4 evaluates the empirical results. Discussion and conclusions are presented in Section 5.

2.   DATA

The data employed in this paper consists of daily closing values of the NSX local index and the JSE overall index. The sample covers the period from January 4, 1999 to March 20, 2003. The data for JSE was obtained from the *Datastream*, while the NSX data was obtained from the Namibian Stock Exchange[4]. Daily data usually introduces the problem of non-synchronous trading periods. However the trading periods of both exchanges are highly synchronous (NSX does not trade on the public days of the JSE). We also circumvent this problem by including the trading days of both exchanges during this period.[5]

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[4] On balance, the NSX local index is defined by no more than 15 securities during any year of the studies. In fiscal year 2002 there were 14 locally listed firms and in 2005 there are 8 firms.

For the empirical analysis, all index values are converted to returns. Brooks (2002) mentions that there are various statistical reasons to avoid analysing stocks prices directly. To convert our prices into returns we employ the following expression:

$$r_i = ln(P_t/P_{t-1}) \tag{1}$$

where P_t is the index value in the current period and P_{t-1} denotes the lagged (previous period) value of the index.

3.   ECONOMETRIC METHODOLOGY

3.1   Unit roots

Unit root tests (with and without a deterministic trend) are employed for the lagged data series in both levels and first differences following the Augmented Dickey Fuller (ADF) approach[6]. The approach has its origins in Dickey and Fuller (1979) method and accounts for possible variations in autocorrelations and ensures random residuals. The initial equation is augmented by a sequence of differenced terms, and the overall model is assessed according to the Akaike information criterion (AIC) and the Schwarz Bayesian criterion. The ADF test for a unit root incorporating a deterministic trend is defined as –

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[5] The JSE does not stop trading on Namibian public/holidays. There are 1128 days of trading, while 52 days removed to circumvent non-sychronous trading.

[6] See Piesse & Hearn (2002).

$$y_t = \alpha + (1 - \phi_i)\delta_t \phi y_{t-1} + \sum_{i=1}^{p+1} \phi_i y_{t-1}\varepsilon_t, \qquad\qquad t=1,\dots,n \qquad\qquad (2)$$

where y_t is the data series, δ_t is a deterministic time trend and α is a constant. Under the null hypothesis, H_0: $\phi = 1$, the coefficients ϕ_i are assumed to be stochastically generated. We can also define the corresponding test in first differences[7]:

$$\Delta y_t = \alpha + \rho\delta_t \rho y_{t-1} + \sum_{i=1}^{p} \gamma_i \Delta y_{t-1} + \varepsilon_t, \qquad\qquad t=1,\dots,n \qquad\qquad (3)$$

Except for the terms $(1-\phi)\delta_t$ and $\rho\delta_t$, the corresponding test equations for unit roots without a deterministic trend are as above.

3.2 Cointegration

Before testing for co-integration, we employ the Vector Autoregressive (VAR) model[8]. The general VAR model is given by –

$$y_t = a + A_1 y_{t-1} + .. + A_p y_{t-p} + Bx_t + \varepsilon_t \qquad\qquad (4)$$

where y is a k vector of endogenous variables, x is a d vector of exogenous variables, $A_1,\dots,A_p$ and B are matrices of coefficients to be estimated, and ε is a vector of innovations that may

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[7] With the null H_0: $\rho = (1-\phi)=0$.

[8] See Harris (1995, p. 77-124))

be contemporaneously correlated with each other but are uncorrelated with their own lagged values and uncorrelated with all of the right-hand side variables.

Furthermore, we test for cointegration between the series under consideration. Given a group of non-stationary series, we can determine whether there is co-movement between the series, and if there is, we can identify the long-run equilibrium relationship (based on the Johansen's cointegration test, see Johansen 1991, 1995). Johansen's method tests the restrictions imposed by cointegration on the unrestricted VAR. We use the Johansen approach (Johansen 1988; Johansen & Juselius 1990) because it has several advantages over the *Engle-Granger two-step* approach. The method of Johansen is given by the equation of the form –

$$\Delta y_t = \delta + \Pi y_{t-1} + \sum \Gamma \Delta y_{t-i} + \varepsilon_t \qquad (5)$$

where the *i* determines the number of lags specified in the dynamic VAR relationship[9]. y_t is a column vector of the two indices. If Π has zero rank the variables in y_t are non-cointegrated. However, if the rank is *r*, there will be *r* possible stationary linear combinations.

3.3   Volatility modelling

We model the dynamics of volatility on the NSX following the GARCH approach (Engle 1982; Bollerslev 1986; Taylor 1986; Bollerslev et al. 1992). GARCH is an alternative model to the ARCH model and has a more flexible lag structure than its predecessor. The

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[9] The method of Johansen method is based on the optimal lag structure of a VAR model.

conditional variance of the error term in the GARCH model is given as a linear function of the lagged squared residuals and the lagged conditional variance. A GARCH (p, q) process is defined as –

$$R_t = a + \varepsilon_t, \qquad\qquad \varepsilon_t Đ\ \Omega_{t\text{-}1} \sim N\ (0,\ h_t)$$

$$h_t = \alpha_0 + \sum_{i=1}^{p} \alpha_i \varepsilon_{t-i}^2 + \sum_{j=1}^{q} \beta_j h_{t-j} \qquad\qquad (6)$$

$$\alpha_j \geq 0,\ \beta_j \geq 0,\ for\ i= 0,...,p\ ;\quad j= 1,...., q$$

where R_t is the return for day t, a is the unconditional mean of R_t, ε_t is an error term, h_t is the conditional variance of R_t based on past available information included in the information set $\Omega_{t\text{-}1}$. A major problem of this model is that constraints are necessary on the coefficients α_j and β_j to ensure non-negativity. Another major deficiency of GARCH models is that they do not capture the asymmetric response of volatility to news, since the sign of returns plays no role in the specification of the model.

Furthermore, we capture asymmetries in the volatility using the Exponential GARCH (EGARCH) model (Nelson 1991). EGARCH models captures skewness and allows the ARCH process to be asymmetrical. The conditional variance is formulated as an exponential function of the previous conditional variances and excess returns. The EGARCH model is defined as –

$$Log h_{i,t}^2 = \alpha_0 + \alpha_1 \frac{\varepsilon_{i,t-1}}{h_{i,t-1}} + \alpha_2 \left[\frac{|\varepsilon_{i,t-1}|}{h_{i,t-1}} - (2\pi)^{0.5} \right] + \beta Log h_{i,t-1}^2 \qquad\qquad (7)$$

$h_{i,t}^2$ is the conditional volatility at time t and $/\in_{i,t-1}/$ is the absolute value of standardized residuals. The asymmetric response to the last period shocks on current volatility is measured by α_1. This implies that if $\alpha_1 < 0$, negative past errors have greater impact on current variance than the analogous positive errors. Since the coefficient is typically negative, positive return shocks generate less volatility than negative return shocks. Thus, $h_{i,t}$ is a function of both the magnitude and the sign of the lagged errors. In this paper we also investigate volatility spill-overs using a univariate EGARCH(1,1) model (for the NSX), which is augmented by including conditional volatility of JSE. The model is given by –

$$Logh_{i,t}^2 = \alpha_0 + \alpha_1 \frac{\varepsilon_{i,t-1}}{h_{i,t-1}} + \alpha_2 \left[\frac{|\varepsilon_{i,t-1}|}{h_{i,t-1}} - (2\pi)^{0.5} \right] + \beta Logh_{i,t-1}^2 + \theta h_{j,t-1}^2 \tag{8}$$

where i denotes the primary country and j refers to the secondary country, while h_j is the conditional volatility of country j. The θ coefficient measures the extent of volatility spillovers across markets. A significant θ implies that innovations in country j spill over to country i.

3.4   Adjusting for thin trading

Dimson (1979), Miller, Muthuswamy and Whaley (1994) show that thin trading can potentially lead to serial correlation in the return series. Thin trading is the outcome of either non-synchronous trading or non-trading. Non-synchronous trading occurs when stocks trade at every consecutive interval, but not necessarily at the close of each interval. This form of thin trading has been studied by Scholes and Williams (1977a, 1977b) and Muthuswamy

(1990). Non-trading occurs over a much shorter trading interval than non-synchronous trading and thus all stocks in the market are unlikely to be traded at least once over that interval. Fisher (1966), Dimson (1979), Cohen et al. (1978, 1979), Lo and MacKinlay (1990), and Stoll and Whaley (1990a) also explain non-trading. Non-synchronous trading is distinguished from non-trading by the interval over which price changes or returns are computed. As the trading interval shrinks, non-synchronous trading becomes non-trading.

A major effect of thin trading is that an asset value over a certain time cannot be directly observed if the asset is not traded during that period. As most market indices are computed based on recent stock transactions, the reported index becomes stale if thin trading is present Thus the observed index does not reflect the true value of the underlying stock portfolio. Thin trading induces spurious serial correlation in the observed index returns. Thus the observed dependence should not be construed as evidence of predictability, but rather a statistical illusion due to thin trading.

There are different approaches to correct for thin trading. Bassett, France, and Pliska (1991) suggest the use of a Kalman filter to estimate the distribution of the true index. Stoll and Whaley (1990b) use the residual from an ARMA (*p,q*) regression as a proxy of the true index. Jokivuolle (1995) proposes a modified version of the Stoll and Whaley approach to estimate the true unobserved index from the history of the observed index. The correction consists of decomposing the log of the observed index in its random and stationary components, using the Beveredge and Nelson (1981) methodology. For this, the random component can be shown to be equal to the log of the true index.

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In this paper we follow Miller, Muthuswamy, and Whaley (1994) to correct for thin trading. Their methodology proposes the estimation of a moving average model (MA) that reflects the number of non-trading days and then adjusts returns accordingly. Yet, in practice it is difficult to identify non-trading days, under which Miller et al. (1994) show that it is equivalent to estimating an AR (1) model. Such a model involves estimating the following equation (i.e. random walk model):

$$R_t = a_1 + a_2 R_{t-1} + \varepsilon_t \tag{9}$$

The residuals from the regression are then used to estimate the adjusted returns as follows

$$R_t^{adj} = \frac{\varepsilon_t}{(1 - a_2)} \tag{10}$$

where R_t^{adj} is the return at time t adjusted for thin trading.

The model by Miller et al. (1994) assumes that non-trading adjustment is constant over time (which is true for highly liquid markets but not for emerging markets). Hence, equation (9) is estimated recursively.

4.   EMPIRICAL RESULTS

4.1   Descriptive statistics

First, the descriptive statistics are displayed in Table 1, while the plots of the data are in Figure 1 (Time-series) and Figure 2 (Histograms). Table 1 shows that only JSE shows a positive (but insignificant) mean return. The mean return for the NSX is negative over the sample period. In terms of market volatility, as measured by standard deviations, NSX has the highest value. The coefficients of skewness indicate that none of the two markets have positively skewed returns. Thus, in terms of series distribution properties normality is rejected (the probability of Jarque-Bera[10] is < 0.05). These small and negative values indicate long lean left tails. The kurtosis statistics indicate the peakedness of the distributions (NSX return has the highest value). To indicate lean tails, the excess kurtosis statistic should have a value of 3. The NSX kurtosis for returns indicates 'fat tails' and a sharp peakedness. Holmes and Wong (2001) argue that presence of fat tails in returns supports the application of ARCH models for the variance processes of returns.

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[10] The Jarque-Bera statistic has a chi-squared distribution with two degrees of freedom under the null hypothesis of normally distributed errors.

Table 1: Descriptive Statistics for price and returns of the NSX & JSE indices

	JSE	**LOGJSE**	**LOGNSX**	**NSX**	**RJSE**	**RNSX**
Mean	8490.572	9.030883	4.433984	90.83240	0.000474	-0.000611
Median	8512.745	9.049320	4.406719	82.00000	0.000000	0.000000
Maximum	11653.36	9.363350	5.123964	168.0000	0.051979	0.120144
Minimum	5207.400	8.517355	3.850148	47.00000	-0.076893	-0.179586
Std. Dev.	1458.194	0.178537	0.389700	34.85873	0.011745	0.014207
Skewness	-0.020144	-0.459647	0.056722	0.375768	-0.141163	-0.881318
Kurtosis	2.584055	2.874449	1.526222	1.747203	6.249677	45.57039
Jarque-Bera	7.814853	38.52373	97.77381	95.51028	476.1449	81236.68
Probability	0.020092	0.000000	0.000000	0.000000	0.000000	0.000000
Observation	1074	1074	1074	1074	1074	1074

The plots show interesting results. The NSX index declines for most part of the sample period. Local Namibian equities hardly trade and most institutional investors who buy them prefer to hold them (and not trade them)[11]. The JSE index shows persistently upwards trend, but with some downturns across the sample period. This feature indicates the susceptibility to world markets downturns (especially for the 2000-2002 trading period). The graphs for the returns (Figure 1) are useful in depicting some volatility features. Volatility seems to be more prevalent in the JSE than in the NSX market. Also, the histograms (Figure 2) show that price series and returns are not normally distributed.

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[11] The NSX market exhibits significant jumps (often referred to as seasonality in microstructure).
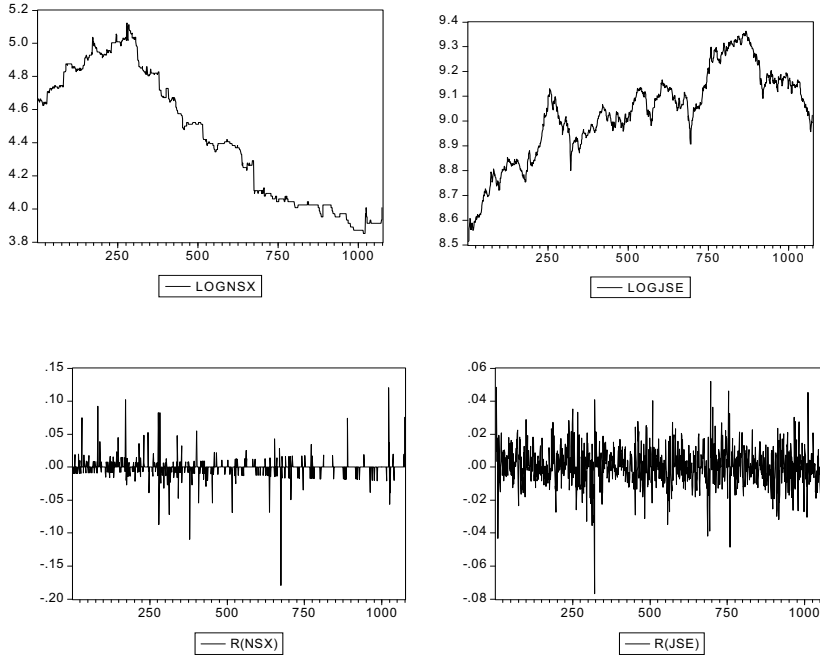
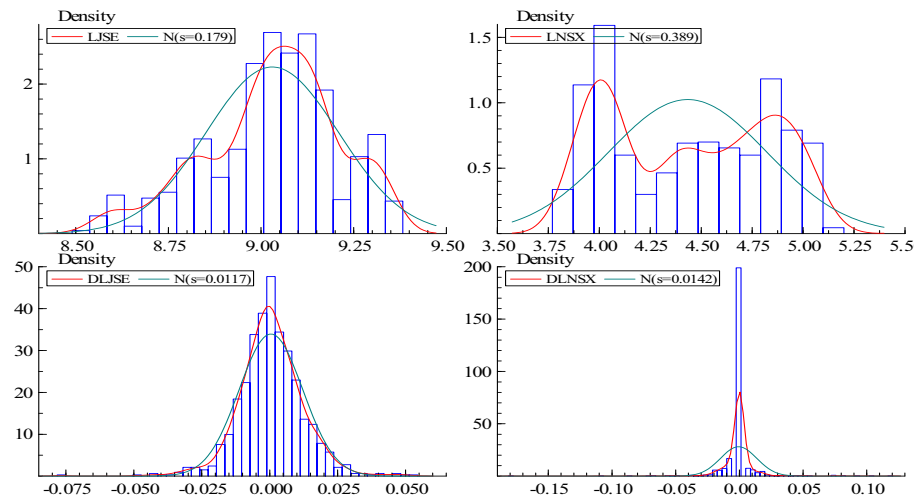**Figure 1: Time series plots of price and returns for NSX & JSE indices**

Figure 2: Histograms of price and return series for the NSX and JSE

4.2   Correlation results

Table 2 presents the results from the correlation analysis. The results indicate negative and significant correlations for both logarithmic series. However for the returns, the relationship is positive but not high significant. This may suggest that there are opportunities for risk diversification between the markets. The results obtained from the correlation matrix are not quite useful for our analysis. Therefore, other methods (cointegration, GARCH) need to be used.

Table 2: Correlation Matrix: Log index prices and index returns

	LOGJSE	**LOGNSX**	**RJSE**	**RNSX**
LOG(JSE)	1	-0.7121458	-0.0264246	-0.0402273
LOG(NSX)	-0.7121458	1	0.0488854	0.0291513
R(JSE)	-0.0264246	0.0488854	1	0.0499905
R(NSX)	-0.0402273	0.0291513	0.0499905	1

4.3   Unit roots and cointegration results

The results from the ADF tests on both series (daily index in logarithms) and the first differences are presented in Table 3 (JSE) and Table 4 (NSX). The results show that the log-prices of both markets contain unit roots. However, the presence of unit roots is rejected in the returns series of the two markets. The results show that daily indices in both markets are integrated of order one, I(1). Furthermore, we employ a VAR model in order to specify the number of lags we need for Johansen test. The results from the selected VAR model (with 4

lags) are presented in Table 5. We find that previous periods' log-prices depend (and show a positive/negative effect) on the current log-prices for both markets. Furthermore, the results of the cointegration analysis based on the Johansen test are presented in Table 6. Both the *Trace* and *Max-eigenvalue* tests indicate no cointegration at both the 5% and 1% significant levels. So, we conclude that there is no co-movement and long-run relationship between the (logarithmic) indices of JSE and NSX stock markets.

Table 3: Unit roots results for the JSE market

Null Hypothesis: LOGJSE has a unit root

Exogenous: Constant

Lag Length: 3 (Automatic based on AIC)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-2.577347	0.0980
Test critical values:	1% level	-3.436238	
	5% level	-2.864028	
	10% level	-2.568146	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: D(LOGJSE) has a unit root

Exogenous: Constant

Lag Length: 2 (Automatic based on AIC)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-18.65232	0.0000

Table 4:Unit roots results for the NSX market

Null Hypothesis: LOGNSX has a unit root

Exogenous: Constant

Lag Length: 3 (Automatic based on AIC)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-0.097304	0.9478
Test critical values:	1% level	-3.436238	
	5% level	-2.864028	
	10% level	-2.568146	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: D(LOGNSX) has a unit root

Exogenous: Constant

Lag Length: 2 (Automatic based on AIC)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-20.53571	0.0000

Table 5: VAR estimates for cointegration analysis

Vector Autoregression Estimates with 4 lags

Sample (adjusted): 6 1076

t-statistics in [ ]

	LOGJSE	LOGNSX
LOGJSE(t-1)	1.134741	0.026966
	[37.0476]*	[0.71489]
LOGJSE(t-2)	-0.085892	-0.120242
	[-1.86253]*	[-2.11727]*
LOGJSE(t-3)	-0.126232	0.106807
	[-2.74062]*	[1.88298]*
LOGJSE(t-4)	0.070514	-0.022042
	[2.31529]*	[-0.58768]
LOGNSX(t-1)	-0.036432	0.979411
	[-1.44658]	[31.5782]*
LOGNSX(t-2)	0.044029	-0.006386
	[1.24776]	[-0.14696]
LOGNSX(t-3)	-0.035612	-0.058540
	[-1.00998]	[-1.34815]
LOGNSX(t-4)	0.027002	0.082693
	[1.07522]	[2.67382]*
C	0.066847	0.088713
	[2.22958]*	[2.40269]*
Log likelihood		6314.230
Akaike information criterion		-11.75767
Schwarz criterion		-11.67403

* Significant at 5% level.

Table 6: Cointegration results (Johansen method)

Trend assumption: Linear deterministic trend

Series: LOGJSE LOGNSX

Lags interval (in first differences): 4

Unrestricted Cointegration Rank Test (Trace)

Hypothesized		Trace	0.05	
No. of CE(s)	Eigenvalue	Statistic	Critical Value	Prob.**
None	0.011167	12.97655	15.49471	0.1157
At most 1	0.000898	0.960772	3.841466	0.3270

Trace test indicates no cointegration at the 0.05 level

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized		Max-Eigen	0.05	
No. of CE(s)	Eigenvalue	Statistic	Critical Value	Prob.**
None	0.011167	12.01577	14.26460	0.1101
At most 1	0.000898	0.960772	3.841466	0.3270

Max-eigenvalue test indicates no cointegration at the 0.05 level

* denotes rejection of the hypothesis at the 0.05 level

**MacKinnon-Haug-Michelis (1999) p-values

4.4   Mean and volatility spillover effects

First we run AR(1) from equation 9 in order then to estimate adjusted returns. Table 7 presents the results from AR(1) for JSE (Part A) and NSX (Part B). Part A shows positive and significant slope coefficient, while Part B shows negative but not significant coefficient. In other words, previous' period returns for JSE market depend (they have positive effect) on the current returns. The estimated adjusted returns[12] (using the residuals from AR(1) models) are plotted in Figure 3. Both plots confirm that returns are stationary.

Table 7: AR (1) results for the JSE and NSX

PART A

Dependent Variable: R(JSE)

Method: Least Squares

Sample (adjusted): 4 1076

White Heteroskedasticity-Consistent Standard Errors & Covariance

Variable	Coefficient	Std. Error	t-Statistic	Prob.
a_1	0.000403	0.000360	1.121161	0.2625
a_2	0.143736	0.045125	3.185289*	0.0015

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[12] The ADF test in adjusted returns suggest that both series are I(0). These results are available upon request.

PART B

Dependent Variable: R(NSX)

Method: Least Squares

Sample (adjusted): 4 1076

White Heteroskedasticity-Consistent Standard Errors & Covariance

Variable	Coefficient	Std. Error	t-Statistic	Prob.
a_1	-0.000621	0.000434	-1.428626	0.1534
a_2	-0.013584	0.024004	-0.565899	0.5716

*Significant.
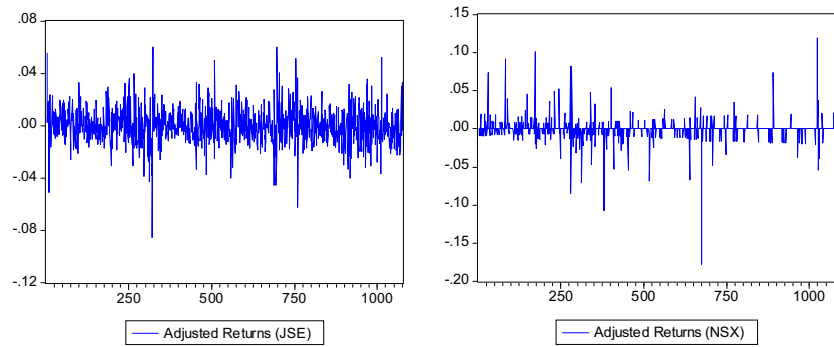
Figure 3: Adjusted returns of the JSE and NSX indices

Furthermore, Table 8 presents the results from the Exponential-GARCH (EGARCH) model. The results indicate significant EGARCH effects in the data (for both markets) [13]. The leverage effect term (denoted as α_2) is present only in the JSE market (α_2 is negative and statistically different from zero).

Table 8: EGARCH (1, 1) for NSX and JSE

Equation and variables NSX returns JSE returns

Mean Equation	Coefficient	**Coefficient**
	0.000155	0.000530
a	(0.374703)	(1.624306)
Variance equation		
	-1.200539	-0.737571
α_0	(-1.675187)	(-3.632725)*
	0.048753	0.216813
α_1	(0.831296)	(3.587454)*
	0.150220	-0.065734
α_2	(2.172064)*	(-2.040622)*
	0.861507	0.936613
β	(10.28913)*	(47.18847)*

*Note: Figures in parentheses are t-statistics. * Significant at 5% level.*

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[13] The results of the simple EGARCH models with R_t^{adj} are available upon request.

The conditional variance (continuous volatility) series from EGARCH models are plotted in Figure 4 and Figure 5 for NSX and JSE, respectively. The variance series obtained from EGARCH models confirm that variance for both JSE and NSX markets is changing over time (i.e. volatility is time-varying). This characteristic is captured well from EGARCH models.
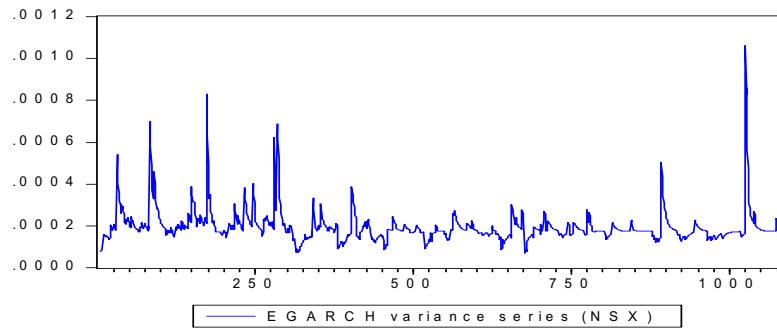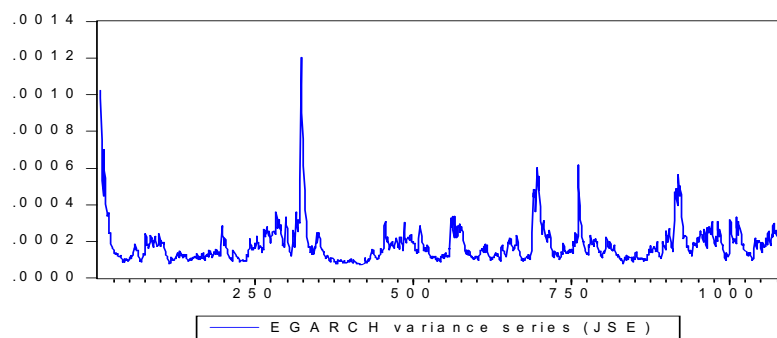

Figure 4: NSX EGARCH volatility

Figure 5: JSE EGARCH volatility

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Over the sample period, JSE is characterised by volatility clustering, with periods of high volatility followed by less volatile periods[14]. Furthermore, NSX does exhibit volatility clustering, but for most periods the plot seems to indicate a market that hardly trades[15]. The volatility spillovers effects between the markets are reported in Table 9. The variables of volatility spillover for both markets (indicated by θ) are not significant. In other words, there is no empirical evidence of volatility spillover between the markets under consideration[16]. Our results confirm the previous findings from the correlations and cointegration analysis.

Table 9: Mean and Volatility spillovers estimated from EGARCH (1, 1) model

PART A. JSE

Dependent Variable: R_{JSE}^{adj}

Method: ML - ARCH (Marquardt)

Sample(adjusted): 5 1076

Bollerslev-Wooldrige robust standard errors & covariance

Mean Equation	Coefficient	Std. Error	t-Statistic	Prob.
a	-9.41E-05	0.000371	-0.253615	0.7998
	Variance Equation			
a_0	-0.629032	0.180506	-3.484822*	0.0005

---

[14] The results are in line with Appiah-Kusi and Pescetto (1998) for the South African market.

[15] Sherbourne and Stork (2004) indicate that the NSX local market is characterized by investors who 'sit' on the stocks (to fulfil legislation requirements) and hardly trade in these local equities.

[16] The results from AR(1)-EGARCH(1,1) model, not reported here, support this evidence.

Mean Equation	Coefficient	Std. Error	t-Statistic	Prob.
a_1	0.199992	0.061398	3.257317*	0.0011
a_2	-0.068405	0.035607	-1.921086*	0.0547
β	0.945746	0.018040	52.42467*	0.0000
θ	15.09191	131.9428	0.114382	0.9089

PART B. NSX

Dependent Variable: R_{NSX}^{adj}

Method: ML - ARCH (Marquardt)

Sample(adjusted): 5 1076

Bollerslev-Wooldrige robust standard errors & covariance

Mean Equation	Coefficient	Std. Error	t-Statistic	Prob.
a	0.000372	0.000424	0.878391	0.3797
Variance Equation				
a_0	-2.107921	1.661831	-1.268433	0.2046
a_1	0.138169	0.049074	2.815500*	0.0049
a_2	0.159867	0.079372	2.014132*	0.0440
β	0.745396	0.202474	3.681448*	0.0002
θ	-708.5497	559.2028	-1.267071	0.2051

* Significant at 5% level

5. DISCUSSION AND CONCLUSIONS

This paper reports evidence of portfolio diversification between the NSX and JSE markets for the period January 1999 - March 2003. We investigate correlations, cointegration and volatility spillover effects using daily data. Formal relationship between the two markets has implications for investors who want to diversify their portfolio regionally.

The results show that returns exhibit very low correlations.[17] In addition, cointegration analysis shows no long-run relationship between the markets. Hence, the NSX local market may offer an attractive opportunity for investors to diversify risk regionally. However the results are not consistent with previous papers (Piesse & Hearn 2002; Tyandela & Biekpe 2001). They find high correlations and cointegration between the markets. A possible explanation is that they consider the NSX overall index (which includes dual-listed stocks on both exchanges).

In this paper we use the NSX local index (which is constituting of Namibian non-dual listed shares only). The volatility analysis shows asymmetric leverage effects for both markets under consideration. However there is no evidence of spillover effects from the JSE market to the NSX market, while there are no volatility spillover effects from the NSX to the JSE. In general, this paper provides little evidence of integration between the NSX local market and the JSE market. The results suggest that NSX is an attractive risk diversification tool for regional portfolio diversification in Southern Africa.

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[17] Our focus on the applicability of the findings is directed at portfolio composition.

The fact that the NSX local market hardly trades diminishes the implications of the results. The NSX should strive to adopt strategies that can ensure trading in local equities since they do provide risk diversification potential. A good strategy, that should gain currency, is to promote exchange-traded funds (ETFs) and invest in all of the stocks contained in the NSX overall index. This will ensure that some trading in local equities does take place.

We strongly believe that our results are helpful to financial analysts and managers as well as academics and investors. Certainly the findings can benefit those who want to trade (assuming there is a liquid NSX market). Future work should incorporate practical modelling realities. We should therefore employ monthly and weekly time series for comparisons of results. We should also examine whether the asymmetries are in a way with the traditional leverage effect explanation. We also need to estimate time-varying risk premia (using Multivariate-GARCH models) to further investigate whether volatility changes are accompanies by compensating changes in the estimated market risk premia. Finally, a bivariate Markov switching model can be used to empirically investigate whether changes of volatility in one market precedes the changes in volatility to the other.

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IV

Hedonic pricing in Windhoek townships

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ABSTRACT. This study applies the hedonic pricing model to property sales in the township areas in Windhoek, the capital city of Namibia, where municipal authorities have pursued a programme of selling plots of land to settlers in order to encourage them into a formalized economic situation. We find that, apart from house quality, access to the central business district, access to marketplaces and access to transportation, environmental quality also has a large impact on property prices. Properties located close to a garbage dump sell at considerable discounts, while properties located close to a combined conservation and recreation area sell at premium prices. The results thus suggest that the hedonic pricing method can be useful for studying townships in developing countries, and that this can help to clarify the importance of environmental factors which are otherwise frequently neglected in town planning for township settlements.

1. Introduction

The objective of this paper is to study whether property prices in the township areas in Windhoek, the capital city of Namibia, are influenced by attractive attributes in a similar fashion to prices in more developed property markets. This is analysed using the hedonic pricing method. This method has been applied in developing countries only rarely (see Malpezzi, 1999, for an overview), and hardly ever in township areas.

It might seem obvious that households living in townships will spend what little money they have on goods which are crucial for their short-term survival, and are unlikely to be willing to pay extra for a property with, for instance, a pleasing view. It might also seem obvious that even if township dwellers are in fact willing to pay premia for slightly more attractive dwellings, they are unlikely to have the necessary overview of the property market to know when attractive properties are available and be able to bid for them. However, if attributes such as environmental quality do affect property prices, even among extremely poor households, it is important to town planners to be aware of this, as these preferences should be reflected in policy decisions.

Only a few hedonic pricing studies have been carried out in Africa,[1] and these did not look at property markets in townships; in most of the informal and semi-formal settlements around large African cities the settlers do not have clear title to their land, and even when there are permanent or near-permanent property rights, trade in these properties is usually poorly documented.

In Windhoek, the municipality has pursued a policy of selling plots of land by instalments to low-income households and ultra low-income households – currently defined as households with monthly incomes of less than 1860 N\$ (160 US\$) and less than 500 N\$ (45 US\$), respectively – moving in from rural areas, in order to encourage them into a more formalized economic situation. Due to this policy, reliable information on property prices is more easily available for township areas in Windhoek than it is in most similar areas in developing countries. This means that Windhoek is one of the few places where the hedonic pricing method can be applied relatively easily to ultra low-income housing, in order to examine which factors are considered important by township inhabitants and what impact these factors have on property prices.

In the next section, the political and demographic background to the current township policies in Windhoek is presented. This is followed by a section which explains the theoretical framework for the study and discusses property attributes which might affect prices. The next section describes the econometric model and the data set used, followed by a section describing the results of the analysis. The concluding section discusses implications of the results.

2. The Windhoek townships

Windhoek lies in central Namibia. It was the colonial capital of what was then called South West Africa during the German colonial period, and subsequently during South African rule, which ended in 1990. The city is now the capital of independent Namibia and serves as the administrative, legislative, and judicial centre of the country.

The first of the present-day township areas in Windhoek was established during the South African apartheid system. Before the 1960s, the black population of Windhoek lived in the Old Location, a site west of the central business district. Residential blocks were rented from the municipality and

[1] Asabere, 1981a, 1981b; Megbolugbe, 1989; Arimah, 1992; Akpom, 1996.

inhabitants built their own houses. During the late 1950s through to the 1970s, the expansion of the 'white section' of Windhoek towards the Old Location led to the forcible relocation of black residents to a site north-west of the city centre. The new site was called Katutura, which means 'the place where we do not stay' in one of the local languages.

The South African authorities adopted new housing policies as well, in order to minimize the construction of urban dwellings and to focus more on the provision of 'temporary' accommodation. Katutura initially consisted of 4,000 rental houses, a barrack-like single quarters area and a walled compound to accommodate migrant labour. The rental units were divided into ethnic group sections and were uniform in appearance, quality, and size. There were also general regulations to stem the influx of blacks into Windhoek (Pendleton, 1974).

The 1970s and 1980s witnessed a liberalization of the regulations governing black residents of Windhoek and other urban centres (Haines and Tapscott, 1991). From the 1980s, plots of land – called 'erven' in Namibia – and houses could be privately owned in Katutura. New areas west of the established townships were also opened for settlement (Pendleton, 1994).

As a result of the liberalized laws, urbanization increased dramatically. The population of Windhoek grew from approximately 100,000 in 1985 to approximately 145,000 at independence in 1990 (Windhoek City Council, 1996). Squatter settlements sprang up on the outskirts of Katutura and the other township areas.

Windhoek's population has continued growing after independence and is now believed to be roughly 250,000. Most of the urban expansion has taken place in the township areas to the north and north-west of Windhoek. Before the apartheid regulations were relaxed, the entire black settlement was limited to an area of about 400 hectares located between 4.5 and 7 km from the city centre; currently, the furthest township settlements are over 12 km from the city centre, and the entire township area covers well over 2,300 hectares.

The average monthly household income in the townships is estimated (Windhoek City Council, 1996) to be about N$850 (approximately 75US$). These very low incomes seriously limit the level of services that can be provided at cost to the inhabitants of these areas. Many city governments in Africa faced similar problems with low-income settlers in the 1960s and 1970s. These local governments often attempted to provide subsidized full-service housing for city residents who could not afford cost-recovery tariffs, and limit migration to the city in order to keep down the costs of subsidies to low-income areas. However, the result has frequently been that these cities have ended up both with costly subsidies to the formally recognized low-income areas, and also (since the city governments cannot afford to provide subsidized full-service housing for all settlers) with large informal settlements where residents have no access to any municipal services and no legal rights whatsoever. The uncertainty of tenure and constant threat of eviction in the informal settlements have led to low levels of community involvement; these settlements are often characterized by high crime rates and other problems.

The local government in Windhoek, which faced the problem of rapid urbanization later than local governments elsewhere in Africa, has attempted to learn from these experiences. The municipal township policies aim both towards being financially viable and towards integrating settlers in the formal economy.

Rather than provide subsidized full-service housing, the municipality permits settlers to lease or purchase unused municipal land. Land purchases can be paid either in cash or through loans from the municipality at market interest rates, with the purchased property as collateral. Once the municipality has sold a property there are no restrictions on the resale price, provided that any remaining debt to the municipality is paid in full. Municipal services, such as water and electricity, are optional, but are available at cost-recovery prices for those who choose to make use of them.

Refuse collection is the only municipal service which is compulsory for all erven; each erf has its own refuse bin which is emptied once a week either by municipal trucks (in the older townships) or by private contractors. Illegal garbage dumping in open areas was becoming a major problem throughout the city in the early 1990s, but after municipal authorities improved refuse collection, converting some of the illegal dumps into officially recognized dumping sites in the process, nearly all garbage is now collected and dumped in the officially recognized locations. Unlike many township areas in developing countries, Windhoek's townships therefore do not have any widespread sanitation problems related to uncollected refuse at present.

Several public sector agents have been involved in the provision of affordable housing in the township areas after independence. The government's Build Together Programme was designed shortly after independence to provide credit for building and building improvements to ultra low-income households. The programme also provided technical assistance to the program beneficiaries. Poor repayment levels, and high subsidies from government, characterized the programme. The state-owned National Housing Enterprise (NHE) was also set up in order to provide low-cost housing. However, due to profitability problems, the NHE moved away from catering for the ultra low-income groups and began targeting slightly higher-income groups. The NHE is currently reorganizing and plans to start building houses for the lowest-income categories once more, but at present most construction in the township areas is thus done either by residents or by other private agents.

There are few employment opportunities in the township areas; only about 10 per cent of the township population are estimated to work there. Those township residents who are formally employed primarily work in the central areas of the city in the central business district or in the nearby (no longer very aptly named) Windhoek North area, while unemployed gather in the open areas in the central parts of the city in the hope of being picked up by households or small businesses which need to hire labour for short-term jobs. Nearly all work-related travel in the township areas is therefore to and from the central business district, either on foot or by car. There is a considerable number of relatively cheap, privately operated taxis which carry large numbers of passengers at a time; rates are fixed by

a central association so that travellers from the townships pay the same rates for a specific destination regardless of where in the township areas they are picked up. In principle, these taxis are only permitted to pick up passengers at specially designated taxi ranks throughout the city, but this rule is only enforced intermittently; however, while taxis are permitted to drop off passengers anywhere, they charge less for delivering passengers to a designated taxi rank than they do for delivering passengers elsewhere. Since Windhoek is still a fairly small city, many people with steady jobs are picked up by their employers, while people without steady jobs may walk into town to search for employment (Windhoek City Council, 1996).

Although there are few employment opportunities in the township areas, there is a great deal of other activity going on. Schools are available throughout the area. The municipality has also established a number of market places, where commodities are traded and where cultural activities take place. A large area around the Goreangab dam, where water is stored for the dry season, was set aside as a combined conservation and recreation area in the late 1960s. Although the townships have since expanded and now almost surround it, the area has been preserved and is one of the largest open areas in Windhoek. It has considerable scenic appeal and is used for activities such as barbecues, hiking, boating, and picnicking.

3. Hedonic pricing

Real estate characteristics such as the area of the plot or the distance to the nearest school are not themselves traded in any markets; they are tied to the individual property being sold and are only traded as parts of the bundle of characteristics constituting that particular property. However, by examining the prices paid for different bundles of characteristics, it is possible to estimate the value attached to a specific characteristic. This is the basis for the hedonic pricing model (Rosen, 1974; Sheppard, 1999).

A property is characterized by a vector of attributes, $H = h_1, h_2, \ldots, h_k$, and the hedonic pricing method attempts to establish the relationship between housing expenditure $P(H)$ and the levels of the various attributes, $P(H) = f(h_1, h_2, \ldots, h_k)$. If the price relationship is correctly specified, and if property markets are functioning efficiently, it becomes possible to determine households' implicit marginal valuation of each attribute, $P_i = \partial P(H)/\partial h_i$. Attributes which have been studied in hedonic studies fall into two major groups; structural attributes of the property, such as the plot size, the size of the house, the number of rooms, and the building materials used; and location-specific property attributes, such as the distance to the city centre, access to transport, and environmental and socio-economic characteristics of the neighbourhood.

The few empirical studies which have been made of housing markets in African countries have all indicated that access variables are important in determining property prices. Asabere (1981a, 1981b) found that nearness to the city centre and quality of nearby roads had an impact on property prices in two Ghanaian cities. Megbolugbe (1989), Arimah (1992), and Akpom (1996), in their studies of different Nigerian cities, similarly found that a number of variables, measuring access to labour markets and/or

access to services, were important. The coverage of structural attributes in these analyses varied considerably, from studies which only looked at the sizes of the traded plots to studies which had access to detailed information on building materials as well as on the number and type of rooms of each house. Most studies, however, ignored the issue of environmental quality. The two studies by Asabere did include variables measuring environmental bads (and found these to have significant impacts on property prices in the two cities studied), but the later studies did not take such factors into account.

There are generally two stages to a hedonic pricing study; the first stage is the estimation of implicit prices for various attributes, while the second stage is the estimation of the implicit demand functions determining these prices. The implicit prices of different attributes in a property market, which reflect the marginal valuation of these attributes, can be estimated using sales prices of properties and data on the attributes involved. However, these implicit prices are in turn determined by the equilibria of implicit supply and demand functions, which are affected by a large number of factors. The market clearing implicit prices will be set through a bargaining process between the agents in the property market and will be affected by factors specific to the households buying and selling properties – household sizes, income levels, income distribution, and so on.

It is only possible to estimate the underlying implicit demand functions for different attributes by including data, not only on the traded properties, but also on the households involved in the property market at hand. Of the African studies cited above, only Arimah (1992) had this type of household information and was able to proceed beyond estimating implicit prices to estimating the implicit demand functions. In Windhoek's township areas, there is no detailed household-level information available on variables, such as income, employment, or household size. At the moment, there are in fact not even reliable figures available on the total number of inhabitants in the different township areas, let alone inhabitants in individual households, and the only data on income levels are estimated average figures which are not sufficient for any detailed analysis. This analysis is therefore limited to estimating the implicit prices, rather than the implicit demand functions, for different property attributes.

Although formal segregation has been abolished for over a decade, it is still unthinkable for white or coloured households in Windhoek to move into the township areas in the northern and north-western parts of town, regardless of household income or house price. Likewise, although the former white neighbourhoods have seen an influx of black families in the past years, there is still considerable reluctance on the part of white home-owners to sell their houses to blacks. This means that there are, effectively, two separate housing markets in Windhoek, making it problematic to apply one single hedonic model for the entire area.

Frequently, hedonic studies have attempted to capture market segmentation between different areas by using switching regressions; the area being studied is divided into discrete segments, the model is estimated for each segment separately, and the results for different segments are then compared to see whether the differences are significant. However, there

are problems with using this approach on spatial data such as property prices, since the delineation of the areas becomes crucial for the results. Variation within the studied areas will produce misleading results, and where there are significant differences between different market segments the model will predict unrealistically large price differences between neighbouring plots at the borders between those segments (Can, 1992). The same problems occur when dummy variables are used for different market segments, an approach used in many hedonic pricing studies (including several of the African applications discussed earlier). In this study, rather than attempting to model the precise relationships between pricing of attributes in different sections of the city, we have chosen to limit the analysis to the township area. Moreover, since the township areas are all located in close proximity to each other rather than spread around the city – the latter frequently being the case with townships in other cities – we have also chosen not to subdivide the area by introducing neighbourhood dummies, in order to avoid the delineation problems noted above.

For the individual properties being traded, information on the sizes of the relevant erven is readily available. Unfortunately, detailed information on the structural attributes of individual houses, which could also be expected to affect prices, is not. However, when a house has been built, the municipality makes a valuation of the replacement cost of that house. Any changes made to the house have to be reported to the municipality, which then makes a new valuation. This means that the municipal replacement cost valuation can be used as a measure of overall house quality. Still, experiences from other hedonic pricing studies indicate that factors such as house size, number of rooms and building materials are very important in determining property prices, and, although a measure of plot size and a proxy measure of overall house quality are considerably better than nothing, it would definitely have been preferable to have more specific information on the buildings.

A number of access variables might be expected to be of importance in determining property prices in townships. Namibian roads are of high quality compared to those in other African countries and, unlike several of the studies cited earlier, we have therefore not included any measure of road quality. However, other access variables which are more likely to play a role in determining property prices are the distances to the central business district and to the nearest major market. Factors such as the access to taxi ranks, and the walking distance to the nearest school, might also play an important role in determining real estate prices in townships, where few households own their own car (Blaauw *et al.*, 1998).

While economic valuation of public goods has not been a major part of urban planning in Windhoek or elsewhere in Namibia, a recent survey (Humavindu and Masirembu, 2001) indicated that the Goreangab dam recreation area was perceived as important by township inhabitants and that they wished to have it preserved. It is of interest to see whether this stated preference for the site is also reflected in actual market behaviour, in which case properties with easy access to the area should be regarded as attractive and might be expected to sell at premium prices. Alternatively, the municipal garbage dumps which are located throughout the city are

probably not appreciated by their neighbours. If this lack of appreciation for the dumps is reflected in property prices, one would expect a downward pressure on property prices in the vicinity of a dump.

4. Econometric specification and data

Economic theory provides no *a priori* reason to prefer one functional form for the hedonic price function over others, and hedonic pricing studies have frequently used Box–Cox transformations to find the functional form that fits the data best. However, several authors (Cassel and Mendelsohn, 1985; Cropper, Deck, and McConnell, 1988; Sheppard, 1999) have argued that it is problematic to use Box–Cox transformations in hedonic pricing studies, both because the resulting parameter estimates tend to be highly sensitive to small variations in the data and also because those parameter estimates are frequently difficult to interpret. These authors have suggested using simpler functional forms which produce more stable parameter estimates.

The use of a simple functional form is especially recommended in situations such as the one studied here, where some potentially important attributes (such as house size or number of rooms) are not included due to limitations in the data set. Rather than using polynomial expressions or Box–Cox transformations, we have therefore chosen to test the following, quite simple, model for the price of property i

$$P_i = \alpha + \beta_1 Size_i + \beta_2 RCH_i + \beta_3 dCBD_i + \beta_4 dMarket_i + \beta_5 dSchoool_i + \beta_6 dRank_i + \beta_7 Garbage_i + \beta_8 Gorean_i + \beta_9 dGor_i + \varepsilon_i$$

Size is erf size in square meters and *RCH* is the official municipal valuation in N\$ of the replacement cost of the house. *dCBD* is the distance to the central business district where most of the township inhabitants find employment (if any), *dMarket* is the distance to the nearest major marketplace where they are likely to make most of their purchases, *dSchool* is the distance to the nearest school, and *dRank* is the distance to the nearest taxi rank; all these distances are measured in meters. It is assumed here that the Euclidean distance is a reasonable approximation of the actual travel distance, which is usually the case for dense road networks (Puu, 1997) such as those in Windhoek's township areas.

In order to study whether environmental quality has an impact on property prices, two dummy variables and one continuous variable are used. *Garbage* is a dummy variable for proximity to garbage dumps, which takes the value 1 for plots which are less than 250 m from a garbage dump and 0 for plots which are not. The reason for using a dummy rather than the continuous Euclidean distance is that the perceived aesthetic difference between a plot adjacent to a garbage dump and one 500 m away is likely to be considerably greater than the perceived aesthetic difference between a plot 1 km away from a dump and one 1.5 km away. While this type of consideration might alternatively have been captured by using both linear and quadratic forms of the distances, this would have increased the risk discussed earlier of making the estimates highly sensitive to small variations in the data and estimating parameters incorrectly, because of the missing variable problem caused by the lack of structural information on houses.

The reason for choosing 250 m as a cutoff distance is that this captures properties in housing blocks adjacent to a garbage dump, while excluding properties located in housing blocks further off. Similarly, *Gorean* is a dummy variable which takes the value 1 for plots which are less than 250 m from the Goreangab dam recreational area and 0 for plots which are not; this variable is intended to capture the value of living directly adjacent to the recreational area, with an attractive view and extreme ease of access to the area. *dGor*, finally, is the distance to the recreational area, and is intended to capture the ease of access to the area for those plots which are located further off.[2]

Windhoek municipality registers sales prices, official property valuation, and erf area when individual erven are traded, and also if the property is being sold by the municipality or by a close relative of the buyer. The full data set (Windhoek City Council, 2001) consisted of 551 recorded sales of residential erven in the northern and north-western suburbs (Goreangab, Hakahana, Katutura, Okuryangava, and Wanaheda) during 1999. Of these, 72 were sales either by the municipality or by a close relative of the buyer and were excluded from the sample, leaving a total of 479 sales in the reduced data set. Combining detailed maps of Windhoek (Windhoek City Council, 2001) with GIS software, it has been possible to calculate the distances from the centre point of each traded erf to the centre points of, respectively, the central business district, the nearest major marketplace, the nearest school, and the nearest taxi rank, as well as to the nearest garbage dump and to the Goreangab dam recreation area.

It deserves to be noted (table 1) that the average valuation of building investments in the traded properties is close to 47,000 N$, so many households clearly spend large amounts of time and/or money improving their dwellings once they have bought them. One of the goals of the settlement formalization programme has, of course, been to encourage people in the township areas to take greater responsibility for their surroundings, so this effect was to be expected, but similar behaviour has been observed in township areas in other developing countries where households only have semi-permanent squatter rights and do not actually own their properties (Jimenez, 1982). However, for some of the traded properties (28 of the properties which remained in the reduced data set) the official valuation of the replacement cost is zero, i.e. any existing structures are of such poor quality that the municipality believes that, if destroyed, they could be rebuilt at negligible cost. This means that the sample includes houses ranging from the extreme lower end of the market to fairly high-quality dwellings.

One may also note the considerable variation in the size of plots. Until 1997, the smallest erf size permitted by the Ministry of Regional and Local Government and Housing was, in principle, 300 m^2, a minimum which has since been lowered to 200 m^2, and well over half of the traded plots have sizes between 200 m^2 and 400 m^2. However, some plots have sizes which

[2] An earlier version of this paper used only the dummy variable; we thank a referee for pointing out that this would only capture the 'view' aspect of the Goreangab area.

Table 1. *The data set*

	Unit	Average	Minimum	Maximum
Price	N$	60,192	2,060	220,000
Size	m²	337	131	1,191
RCH	N$	46,737	0	266,300
dCBD	m	6,862	4,587	9,323
dMarket	m	870	103	2,763
dSchool	m	435	57	1,468
dRank	m	344	41	2,223
Garbage	Dummy	0.06	0	1
Gorean	Dummy	0.01	0	1
dGor	m	2,661	118	4,955
N = 479				

Notes: Price is the sales price of each property; Size is the plot size; *RCH* is the municipal valuation of the replacement cost of the house on the property; *dCBD*, *dMarket*, *dSchool*, and *dRank* are the Euclidean distances to the central business district, the nearest market, the nearest school, and the nearest taxi rank, respectively; *Garbage* is a dummy variable which is 1 for plots which are less than 250 m from a garbage dump and 0 for plots which are not, while *Gorean* is a dummy variable which is 1 for plots which are less than 250 m from the Goreangab dam recreation area and 0 for plots which are not; finally, *dGor* measures the Euclidean distance to the Goreangab dam recreation area.

are less than the official minimum, while a few plots are far greater than the official minimum size.

The distance to the city centre varies by almost 5 km for the traded properties. As noted earlier the townships currently extend to a distance of approximately 12 km from the city centre, but many of the outermost settlements have been established relatively recently and the properties there have not yet been resold. Most properties are located relatively close to a school and a taxi rank, but the average distance to the nearest major market is considerably greater. The distance to the Goreangab reserve, finally, varies from dwellings located in blocks directly adjacent to it to dwellings located almost 5 km away.

5. Results

The model presented above was estimated using an ordinary least squares regression. As a White test indicated the presence of heteroscedasticity, the standard errors in the regression were corrected for heteroscedasticity using a White estimator (White, 1980). The results are presented in table 2. Results using semi-log and log formulations[3] are shown for comparison in tables 3 and 4; the results in terms of significant variables are largely similar, but the linear form has greater explanatory power.

Some attributes which could potentially be important, such as individual attributes of houses, were not included in the available data,

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[3] In the log formulation, we used zero rather than ln(*RCH*) for those properties where the replacement cost was valued at 0.

Table 2. *Estimation results for the linear form*

	Coefficient	Robust SE	t-value
Size	5.13	19.94	0.26
RCH	0.72	0.07	10.47
dCBD	−6.64	2.10	−3.16
dMarket	−9.88	3.57	−2.77
dSchool	6.42	8.42	0.76
dRank	−16.18	6.92	−2.34
Garbage	−34706.26	4086.45	−8.49
Gorean	21801.38	8032.49	2.71
dGor	−3.32	1.82	−1.82
Constant	92367.02	19553.41	4.72
$R^2 = 0.4520$			
$F(9, 469) = 42.28$			

Notes: See table 1.

Table 3. *Estimation results for the semi-log form*

	Coefficient	Robust SE	t-value
Size	0.000339	0.000379	0.895
RCH	0.000011	1.59E-06	6.936
dCBD	−0.000211	0.0000532	−3.971
dMarket	−0.000344	0.0000963	−3.575
dSchool	0.0000875	0.000209	0.42
dRank	−0.000582	0.000186	−3.125
Garbage	−0.769	0.149	−5.149
Gorean	0.740	0.286	2.588
dGor	−0.000051	0.000046	−1.109
Constant	12.060	0.451	26.723
$R^2 = 0.3720$			
$F(9, 469) = 34.77$			

Notes: See table 1. The regression used the logarithm of the dependent price variable.

Table 4. *Estimation results for the log form*

	Coefficient	Robust SE	t-value
Size	0.728	0.120	6.044
RCH	0.125	0.019	6.72
dCBD	−0.904	0.385	−2.351
dMarket	−0.226	0.077	−2.951
dSchool	−0.011	0.087	−0.123
dRank	−0.172	0.081	−2.117
Garbage	−0.886	0.144	−6.153
Gorean	0.794	0.213	3.736
dGor	−0.033	0.102	−0.321
Constant	15.961	4.150	3.846
$R^2 = 0.3477$			
$F(9, 469) = 67.27$			

Notes: See table 1. The regression used the logarithms of all variables except the two dummy variables; for the variable RCH, the value 0 rather than ln(RCH) was used in the 28 cases when RCH took zero values.)

leading to a relatively low R^2 of 0.45 (the R^2s for the other specifications were even lower). Even so, at a 5 per cent significance level the results support the hypothesis that several other attributes of the traded properties have an effect on property prices in the township areas. The R^2 is not much lower than those in several of the other hedonic pricing studies cited earlier, and the F statistic for the entire regression is 42.28, which is also significant at the 5 per cent level.

Erf size does not appear to have a significant impact on property prices, while housing quality and nearness to the city centre do have significant impacts. This suggests that the recent decrease in the statutory minimum erf size can potentially be welfare enhancing because it means that the municipality can open up for further densification of the older township areas, making it possible for people in recently established townships further out to move closer to the city centre. (Incidentally, the marginal valuation of an additional N$'s worth of building investments is lower than 1, which means that there are no arbitrage gains to be made by sellers through making additional investments before selling.)

Proximity to a school has no significant effect on property prices – the point estimate of the parameter even has the 'wrong' sign. This is presumably due to the fact that the distance to a school is fairly short for most properties in any case, so that an additional meter is not perceived as particularly important. Despite the limited enforcement of the rank system (which should mean that many commuters are able to catch a taxi wherever they want to anyway) the distance to the nearest taxi rank has a significant impact on property prices. Many people use commuter taxis to travel into town and back, and it appears that they attach considerable importance to having easy access to taxi transport. This indicates that the municipal policy of establishing taxi ranks and taxi services quickly in newly settled areas is likely to be appreciated by inhabitants and may play an important role for the municipality's success in integrating new settlers into the local economy.

The distance to the nearest major market has a significant effect on property prices (the marginal valuation of an additional meter is actually higher for the distance to the nearest market than it is for the distance to the city centre), indicating that households attach considerable importance to having access to major marketplaces. Although one cannot say anything with confidence without having estimates of the underlying implicit demand functions as well, it is possible that the cost of establishing additional market places might be more than offset by the resulting increase in social welfare. This is, at any rate, something that deserves to be studied more closely.

The two dummy variables for environmental quality both had significant impacts on property prices. Proximity to a garbage dump is clearly viewed as unattractive; the mean effect is to reduce the value of a property by almost 35,000 N$. Close proximity to the Goreangab dam recreation area, on the other hand, raises the value of a property by almost 22,000 N$. The distance to the Goreangab area, on the other hand, does not appear to have a significant impact on property prices. Thus, having a pleasant view is valued highly while the ease of access does not have an impact on prices

for plots further away.[4] This finding is in line with an earlier study (Humavindu and Masirembu, 2001) which indicated that travel distance to Goreangab did not affect how frequently people living in the township areas visited the site. One possible explanation for this might be that many people go to Goreangab by taxi and thus pay a fixed rate regardless of where in the township area they start.

6. Conclusions

This paper has shown that property prices in Windhoek's townships reflect attractive and unattractive location-specific characteristics, including proximity to environmental goods and bads. Public policy determines many of these location-specific attributes, and the results indicate that the hedonic pricing method can be useful for evaluating public policy not only in affluent neighbourhoods but also in townships. Keeping track of property sales in townships, in the way that municipal authorities have done in Windhoek, can thus provide urban authorities responsible for administering townships with a powerful additional tool for policy analysis.

Lack of reliable detailed information on household characteristics is likely to be a problem for township studies in other cities as well. The usefulness of the method could nonetheless be increased further by at least recording household characteristics at the time of sale/purchase of a property, even if it is likely be difficult for many municipal authorities to update this household-level information on a regular basis. Property market segmentation, and the welfare effects of this, also warrants further exploration, as this is likely to be a complicating factor in the analysis of property markets in many developing country cities.

An important finding in this study is the high value that inhabitants in the township areas clearly attach to environmental quality. Proximity to a conservation area or to garbage dumps have remarkably large impacts on property prices. Townships in other developing country cities have often been allowed to expand under less organized circumstances than in Windhoek, and the issues of maintaining refuse disposal and secluding garbage dumps from residential areas, as well as maintaining open spaces in township areas have frequently been neglected by urban authorities. Our results indicate that where this neglect has occurred it may have been a very serious omission.

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[4] Dropping one of the two 'Goreangab' variables does not affect the result for the other one, so it would appear that the two different aspects of the Goreangab area studied here are not closely related.

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