



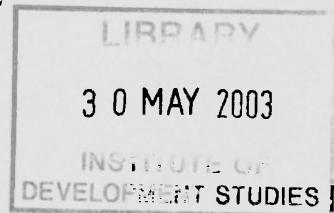
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*BOTSWANA INSTITUTE FOR
DEVELOPMENT POLICY ANALYSIS*

WORKING PAPER

DETERMINANTS OF NON-MINING PRIVATE INVESTMENT IN BOTSWANA

Grace Goitsemodimo Kgakge

BIDPA Working Paper No.23
February 2002



Abstract

The paper seeks to identify factors influencing and determinants of non-mining private investment in Botswana. It presents various studies conducted in other countries with modified assumptions to suit Botswana economy. It makes policy recommendations for investment strategies. The study concludes that in the long run, real GDP has a positive impact on non-mining private investment in Botswana. In line with government's endeavour to diversify the economy, diamond proceeds have been converted into other economic activities resulting in increased output. The real exchange rate also influences non-mining private investment positively. Pula depreciation has a positive effect on non-mining private investment as it increases competitiveness of good and services in the domestic economy. The paper highlights two policy implications from the conclusions drawn: Government should diversify the economy further to increase output. Government exchange rate policy should not encourage high appreciation in the national currency as this would lead to a fall in the non-mining investment as a result of a decline in competitiveness of Botswana goods and services.

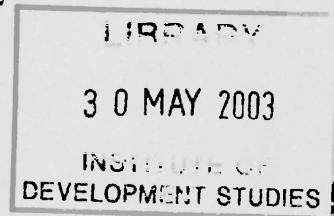
Keywords

Investment
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DETERMINANTS OF NON-MINING PRIVATE INVESTMENT IN BOTSWANA¹

1. OVERVIEW

The main objective of this study is to identify factors that influence non-mining private investment in Botswana and to make policy recommendations regarding the investment strategy in the country. A model for non-mining private investment based on a number of studies conducted in other countries is presented in the paper, with the assumptions modified to suit the Botswana economy. The model developed takes into account the adjustment process of investment between the short run and the long run by using the Johansen Maximum Likelihood Approach that serves as a potential test for the existence of cointegration in a multivariate scenario. The study found that in the long run, real GDP has a positive impact on non-mining private investment in Botswana. In the short run it was found that, the real exchange rate influences non-mining private investment positively with the implication that the choice of an exchange rate policy plays an important role in the determination of non-mining private investment. The coefficient of adjustment is significant implying that investment is converging towards its long run equilibrium level.

2. INVESTMENT AND ECONOMIC GROWTH IN BOTSWANA

Economic development in Botswana has progressed rapidly during the last two decades. Real gross domestic product (GDP) increased on average by 9.2% annually between 1975/76 and 1995/96, while real GDP per capita increased by 6.1% per year during the same period. Much of the strong growth since 1975 is attributed to the growth in the mining sector. GDP originating from the mining sector has been growing at an average annual rate of over 13% since 1975. Strong growth of the mining sector rapidly increased government revenue. Mineral revenues have, as such, been the major instrument that enabled the government to have surpluses in the budget since the early 1980s.

¹ I wish to thank Dr Keith Jefferis who supervised this piece of work and other Senior Research Fellows at BIDPA for their critical and extensive comments in the development of this paper.

However, after running a budget surplus for more than fifteen years, the economy encountered a budget deficit of P1.3 million in 1998/99, mainly due to the sharp reduction in mineral revenues following the poor performance of international diamond markets in 1998 (BIDPA, 2001). Even though the deficit might not be financed through borrowing, it is of vital importance to explore other sources aimed at attaining a long-term sustainable budget.

Although mining remains important, the share of the mining sector in nominal GDP has also been declining since the early 1990's from 51% in 1988/89 to 36% in 1996/97. With the relative decline in the mining sector, it is clear that continued rapid growth of the government sector based on mineral revenues is not sustainable. Given the fact that the mineral sector lacks the potential for further rapid economic growth, emphasis ought to be on influencing investment in other sectors of the economy to encourage diversification (which is a major objective of both NDP7 and NDP8).

The investment rate in Botswana has been characterised by fluctuations since 1974/75 that have tended to be more pronounced in the 1980's. This was primarily due to the timing and implementation of government development expenditures. The investment rate declined from 46% in 1974/75 to a very low level of 7% in 1987/88. It recovered in the next two years (1988/89-1989/90) to reach 38% and, subsequently, declined steadily till the end of 1996/97 to reach 26% (Bank of Botswana, 1997)². The decline in the investment rate in this period is attributed to diamond stockpiles, since diamond stocks are a component of stock-building.

A comparison of the Botswana economy with other countries shows that for the past twenty years the investment rate for the Botswana economy has been relatively high (Table 1).

² Note that in these figures total investment includes both fixed capital formation and stock building.

Table 1: Investment Rates for Botswana and other Countries

	Botswana	Industrial Countries	Developing Countries
1975	46.0	22.9	25.5
1978	34.4	24.0	25.5
1981	40.0	24.0	26.4
1984	22.8	21.9	22.9
1988	7.3	22.4	23.6
1991	36.0	21.5	23.5
1994	25.5	21.0	23.4
1996	25.8	**	**

Source: BoB Annual Report, 1997

Note: the investment rate in this case is defined as Gross Domestic Investment as a percentage of GDP.

Investment rates for industrial and developing countries from 1975-94 are averages across groups of countries.

**- Figures not available

Table 1 shows that investment rates in Botswana have been higher than those of industrial countries and developing countries over the twenty-year period, 1974-1994 (except 1988). However, the rate has been declining from 46% in 1975 to 36% in 1991 and to 26% in 1994. Furthermore, investment rates appear to be lower in the 1990's than in the 1970's. Investment rates in industrial countries have declined from a peak of 24% in 1978 to 21% in 1994. Developing countries on the other hand have seen their investment rates fall from a high of 26% to around 23% in 1994. One other evident feature about the investment rate in Botswana is that it is more volatile compared to others. This is attributed to the instability in the diamond market, which often leads to the stockpiling of diamonds, while the investment rate for other countries has been relatively more stable, although this is partly because the comparative figures are averages across groups of countries.

Besides considering the overall level of investment, it is important to consider the components of investment. Investment by the private sector as a percentage of GDP declined from 18% in 1989 to 10% in 1996, while the household investment rate remained below 5% (Bank of Botswana, 1997). The fall in private investment is partly due to the decline in the share of mining investment to total GDP particularly between 1989 and 1996 when it fell from 5% to 1%. Although mining investment was greater than non-mining private investment in the late 1970's and early 1980's, such that a fall in mining investment had a significant impact on the investment rate, current investment trends indicate that this picture has changed. Since the late 1980's and early 1990's, non-mining private investment exceeds mining investment and as such, a fall in non-mining investment has a

significant impact on total investment. There is therefore a need for designing policies aimed at raising non-mining private investment given that it plays a major role in attaining sustainable economic growth. If investment is to be turned into one of the engines of growth for the economy, it is important that the investment rate be increased and that the recent downward trend be reversed.

Gross fixed capital formation (GFCF) as a percentage of GDP has also been falling in the last five years from 38% in 1988 to 23% in 1996/97. Of further concern is that the total GFCF emanating from the private sector as a proportion of GDP exhibits a downward trend that is observable since 1989/90 (See Figure 1).

Figure 1 indicates trends GFCF as a percentage of GDP as well as the non-mining GFCF as a percentage of non-mining GDP for the period 1975-1996. The GFCF is used instead of the total gross domestic investment (GDI) because fluctuations in GDI are mostly due to changes in the mining sector which directly affects changes in stock-building which is a component of GDI. As already highlighted above that there is a need to enhance investment outside the mining sector, we need a measure of investment that represents investment in other sectors significantly. It is for this reason that from now onwards, we focus on GFCF as a measure of investment.

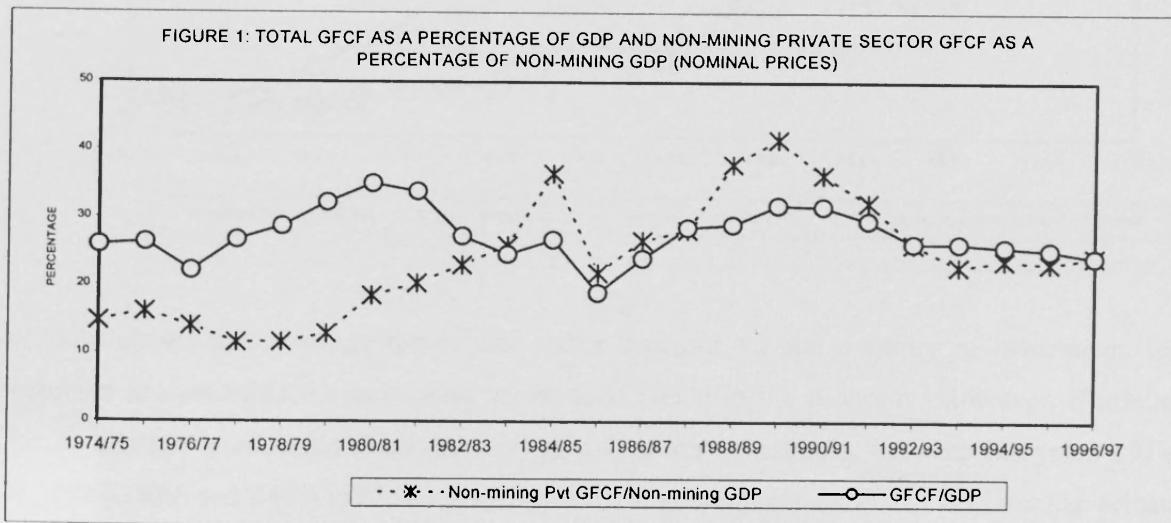
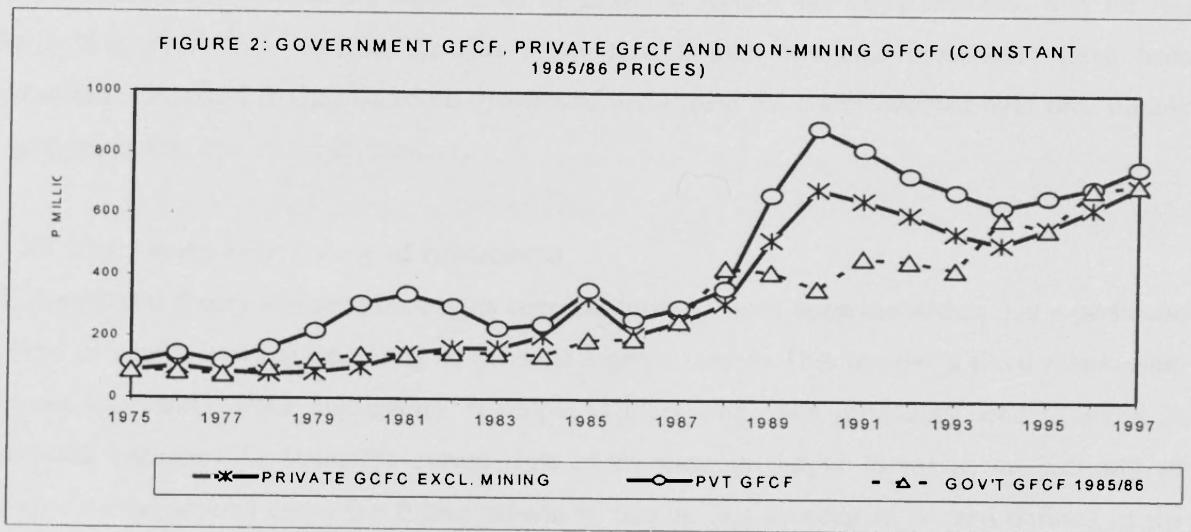


Figure 1 indicates that GFCF as a percentage of GDP fluctuated tremendously in the given time span. From the graph, the investment rate has been declining particularly after 1990. Non-mining

private sector investment³ as a percentage of GDP has also been unstable. The trends show that for most years, non-mining private investment has been lower than the overall investment rate, which is in this case total GFCF as a percentage of GDP. This is despite the government's effort to raise investment by encouraging direct involvement of Botswana citizens in the investment process, through programmes such as the Financial Assistance Policy, and setting up development finance institutions such as the Botswana Development Corporation and the National Development Bank. Tax incentives in the form of reductions in both the corporate and the income tax rates have also been given to investors, mainly to raise the firm's level of retained earnings, as well as the after tax income which could be re-invested in other investment opportunities in the economy.

Also, Figure 2 below illustrates the fact that the government has played a major role in gross fixed capital formation over the past years.



The figure shows that although the private sector accounts for the majority of investment, the government has contributed significantly to the total GFCF in the economy. However, if mining sector investment is excluded from the total private sector investment, between the years 1978-1981, 1987-1989 and 1995-1997, total investment by government exceeded non-mining private sector investment. This also suggests that the mining sector contributed significantly to the total GFCF in the economy, as well as in the private sector.

³ GFCF excluding mining sector and general government.

In the past, the principal sources of investment have been mining and the government. Given the fact that increasing the level of investment, especially private sector investment contributes to long term economic growth, this study sets out to establish factors that influence total investment by the non-mining private sector in Botswana and to identify possible policy instruments that could be used to raise investment in the economy, and reverse its downward trend. This would contribute to the achievement of the major objective of the eighth National Development Plan (NDP 8) for the economy, "Sustainable Economic Diversification". The Government of Botswana is aware that an enterprising and a dynamic private sector is very necessary if Botswana is to develop rapidly.

3. THEORETICAL LITERATURE: THE THEORY OF INVESTMENT

Since investment is by definition concerned with expectations about future returns on investment expenditure, it is always going to be difficult to produce a consistent theory of investment due to volatile expectations, which are determined by different factors and circumstances. It is for this reason that over time, various theories about factors that influence investment have been formulated. Empirical studies based on theories of investment have also evolved over time mainly to address factors that affect investment.

3.1 The Accelerator Theory of Investment

The accelerator theory of investment in its simplest form is based upon the notion that a particular amount of capital stock is necessary to produce a given output. This implies a fixed relationship between the capital stock and output. If output is increasing, then producers need to invest in additional capacity. As such, the current rate of increase in output serves as an indicator of investor's expectations about the future growth in output. Net investment is then defined as the difference between the capital stock in the current period t and the capital stock in the previous period. It is also equals gross investment minus capital consumption allowances or depreciation.

In this crude form the accelerator theory of investment or the acceleration principle is open to a number of criticisms. Edgemand (1987) criticises the theory on the following grounds:

- (a) The theory assumes that a discrepancy between the desired and the actual capital stock is eliminated within a single period. If industries producing capital goods are already operating at full capacity, it may not be possible to eliminate the discrepancy within a single period.

- (b) Since the theory assumes no excess capacity, it is not expected to be valid in recessions as they are characterised by excess capacity. Based on the theory, net investment is positive when output increases. But if excess capacity exists, expectations are that little or no net investment will occur, since net investment is made in order to increase productive capacity.
- (c) Even if no excess capacity exists, firms will invest in new plant and equipment in response to an increase in aggregate demand only if demand is expected to remain at the new, higher level. In other words, if managers expect the increase in demand to be temporary, they may maintain their present levels of output and raise prices (or let their orders pile up) instead of increasing their productive capacity and output through investment in new plant and equipment.
- (d) The accelerator theory assumes a fixed ratio between capital and output. This assumption is occasionally justified, but most firms can substitute labour for capital, at least within a limited range.
- (e) Finally, the theory explains net, but not gross investment. For many purposes, including the determination of the level of aggregate demand, gross investment is the relevant concept.

In view of these and other criticisms of the accelerator theory of investment, it is not surprising that early⁴ attempts to verify the theory were unsuccessful.

Over the years, more flexible versions of the accelerator theory of investment have been developed mainly to provide solutions to the limitations of the accelerator theory (Precious, 1987). They assume a discrepancy between the desired and the actual capital stocks is eliminated over a number of periods rather than in a single period. According to the accelerator model, the desired capital stock is determined by output. In the crude version of the accelerator model, the desired capital stock is proportional to a single level of output. In the more flexible versions, the desired capital stock is determined by long run considerations. Finally, the crude version of the accelerator may be modified so that it explains gross as well as net investment. To determine gross investment, it is assumed that replacement investment is proportional to the actual capital stock.

⁴ For a review of studies that attempted to verify the accelerator theory of investment, see, Jorgenson (1970) and Tinbergen (1939).

Precious (1987) argues that attempts to verify the more flexible versions have, as such, been much more successful than the earlier attempts to verify the crude version.

3.2 The Internal Funds Theory of Investment

Under the internal funds theory of investment, the desired capital stock, and hence, investment depends on the level of profits. Several different explanations have been offered. For example, Tinbergen (1939) argues that realised profits accurately reflect expected profits. Since investment presumably depends on expected profits, investment is positively related to realised profits.

Alternatively, it has been argued that managers have a decided preference for financing investment internally. Firms may obtain funds for investment from a variety of sources such as retained earnings, depreciation expenses, various types of borrowing including sale of bonds, and the sale of stock. Retained earnings and depreciation expenses are sources of funds internal to the firm while the others are external. Proponents of the internal funds theory of investment argue that firms strongly prefer to finance investment internally and that the increased availability of internal funds through higher profits generates additional investment (Edgeman, 1987). Thus, the desired capital stock and investment are determined by profits.

3.3 The Neoclassical Theory of Investment

The theoretical basis for the neoclassical theory of investment is the neoclassical theory of the optimal accumulation of capital based on the work of Jorgenson (1970). According to the theory, the desired capital stock is determined by the level of output and the price of capital services relative to the price of output. The price of capital services depends, in turn, on the price of capital goods, the interest rate, and the tax treatment of business income. As a consequence, changes in output or the price of capital services relative to the price of output alter the desired capital stock, hence, investment.

As in the accelerator theory, output is a determinant of the desired capital stock. The internal funds theory also recognises the importance of tax treatment of business income in the determination of investment. According to the neoclassical theory, however, business taxation is important because of its effect on the price of capital services, not because of its effect on the availability of internal

funds. In contrast to both the accelerator and internal funds theories, the interest rate is a determinant of the desired capital stock.

According to Edgeman (1987) the neo-classical theory has been criticised on the following grounds:

- (a) the assumption of perfect competition and exogenously given output are inconsistent,
- (b) the assumption of static expectations about future prices, output and interest rates is inappropriate since investment is essentially forward looking; and
- (c) the lags in the delivery are introduced ad hoc.

3.4 The q Theory of Investment

Another important theory is the Tobin's q theory of investment. According to the q theory of investment, the desired capital stock, and hence, investment are positively related to the ratio of the market's valuation of the firm to the replacement cost of the firm's assets (q). The theory states that the stock market value of the firm helps to measure the gap between actual capital stock at a specific period and the desired future capital stock (Artus, 1990). This theory is particularly relevant to countries with developed stock markets.

4. EMPIRICAL LITERATURE

A number of studies have been undertaken on factors that influence the level of investment, as well as the extent to which the postulated investment models reflect investment theories. It is no doubt that there are still other factors that affect investment which are not fully captured by the theories of investment. The literature indicates that much of the research on investment has taken place in developed countries, while only a few studies have been undertaken in developing countries. Most of the earlier studies in the developed economies were based on models such as the neo-classical model of investment, the accelerator and the flexible accelerator model. These include studies by Stancanelli (1990), Chirinko (1993) Jorgenson (1970) and Ford (1990). Jorgenson (1970) identifies the following problems in relation to the use of these models:

- (a) The estimated results are not often satisfactory because of difficulties in specifying the lag structure of the estimated equations in an attempt to reflect changes in the desired capital stock arising from changing economic conditions.
- (b) The models used also required data that in most cases is not available resulting in a lot of estimation in the variables of the equation, which leads to a reduction in the reliability of the model.

Research on investment has as such focused adopting a framework that reflects the economic situations of countries concerned and including relevant variables in the models estimated to improve credibility of the results.

Fielding (1993) constructed an econometric model based on the internal funds theory as well as the neoclassical theory of investment to explain the evolution of private investment in Kenya and Cote d'Ivore over the last twenty years. The model uses variables proposed in the internal funds theory of investment and the neoclassical theory of investment. The log-linear specification adopted in Fielding's study takes into account the possible links between saving and investment and allows for other variables to enter the model. The explanatory variables considered in the study as the relevant determinants of private sector investment are the availability of foreign exchange, savings, a measure of risk and the real return on capital. The study finds that the coefficient on the savings term for Kenya is not statistically different from unity, implying that a fall in savings leads to a proportional fall in investment both in the short run and in the long run.

The results for Cote d'Ivore indicated that concessional aid and the rate of return influenced investment significantly, suggesting that some Ivorian investors have access to foreign financial markets. The results indicate that domestic funds, aid and concessional loans do affect the growth of investment. Variables reflecting the rate of return to investment are also important factors influencing investment in the study. It was also concluded that the rate of growth of investment could be impaired by an increase in the variability of capital goods prices. The absence of foreign exchange rationing is also important for investment growth, as the results indicate that Kenyan investment has been seriously impaired due to lack of foreign exchange. In this respect the CFA franc zone membership confers important advantages.

Overall, the results for Kenya and Cote d'Ivoire suggest that membership to the CFA franc zone has not led to greater financial openness. Moreover, although prices are less variable in Cote d'Ivoire than in Kenya, Ivorian investment has not benefited due to the greater sensitivity of Ivorian investors to risk. However, the absence of foreign exchange rationing is an important advantage since Kenyan investment has been seriously impaired due to lack of foreign exchange.

Jenkins (1998) in her study of the determinants of private investment in Zimbabwe uses Fielding's framework. The results indicated that foreign exchange shortages were the key constraint on private investment, while the availability of domestic savings has not been a constraint⁵. Uncertainty about political developments, price controls and government policy with respect to labour are cited as obstacles to investment. The results show that private capital formation in Zimbabwe is related, in the long run, positively to gross profits and negatively related to the debt overhang.

Micheal and Fielding (1995) designed a model based on neoclassical theory of investment to illustrate the impact of various types of trade policy reform and financial liberalisation on private investment. The model uses pooled time series data comprising 22 developing countries on a period of 13 years (1975-87). Private investment as a percentage of GDP is assumed to depend on public investment as a percentage of GDP, the United States real interest rate, the local interest rate, output, debt service as a percentage of export revenues, bank credit to the private sector as a percentage of GDP, terms of trade index and real effective exchange rate index. The study finds that changes in output, debt service ratio and private sector credit are the principal determinants of private investment. The coefficient on public investment was positive and suggested that the externality effects of a higher stock of public capital outweigh any crowding out effects of higher public investment.

Hope (1997) analyses the record of growth, savings and investment in Botswana and tests the empirical relationship stemming from that record. The results of the fitted regression suggest that there is a negative statistically insignificant relationship between gross domestic investment and growth. That is, gross domestic investment has not played any role in Botswana's growth. Hope

concludes that the lack of a robust relationship reflects the fact that Botswana's growth performance has been more dependent on output from the mining sector rather than on changes in non-mining domestic investment over time.

Federer (1993), on the other hand, explores the empirical relationship between uncertainty and aggregate investment spending. The main argument underlying the study is that the theoretical framework adopted in modelling investment ignores uncertainty. He argues that, if investors are risk averse, they must be compensated for holding long term bonds which are subject to greater capital gains and losses and this compensation rises when future interest rates become more uncertain. The study uses the risk premium embedded in the term structure to measure uncertainty about interest rates and other macroeconomic variables. The study found that uncertainty has a negative impact on investment and also has a larger impact on investment than does the cost of capital ratio.

4.1 Conclusion

The literature points out that investment is influenced by a number of variables depending on economic conditions prevailing in a particular economy. This indicates that variables that might be considered as the major constraints to investment in one country are not necessarily the major impediments to investment in another country. One other important aspect illustrated from the literature is that a complete investment model should indicate how investment adjusts between the short and the long-term. The model should be flexible to allow for differing assumptions to be incorporated if necessary.

Some of the variables which have been considered as factors influencing private investment are the real return on investment, real interest rate, savings, cost of capital and labour, per capita income, corporate tax rate, the availability of foreign exchange, the availability of credit to the private sector, retained earnings or profits, risk and output.

⁵ Foreign exchange scarcity was found to be a constraint to investment in Zimbabwe and Kenya, while this is not so for Cote d'Ivoire, since it uses the CFA Franc, which is freely convertible into the French Franc so that foreign exchange

5. MODEL SPECIFICATION AND METHODOLOGY

5.1 Model Specification

Because private investment plays a much larger and more important role in the long run growth process than public investment (Jenkins, 1998), the model adopted is restricted to the determination of private investment, which has been identified as the key to diversification in Botswana. The study adapts the model used by Fielding (1993)⁶, that has also been used by Jenkins (1998) in modelling non-mining private investment which takes the following form:

Equation 1.1

$$RNMI = f(REXR, RGOI, RINR, RGDP, RCAP)$$

The variables indicated in the above equation are defined in the table below. Also indicated are the data sources for the respective variables of the model.

Table 2: Definition, Derivation of Variables and Data Sources

Variable	Definition
RNMI	Total Non-mining private investment CSO publishes annual data for Total GFCF (in both real and nominal terms) and for all other economic sectors. These data are used to derive a series for real non-mining GFCF.
REXR	Real exchange rate Data on the real exchange rate is obtained from International Financial Statistics. The formula for the real exchange rate adopted is; $\{BCPI/SACPI\}^* \{R/P\}$, where BCPI is the Botswana consumer price index, SACPI is South Africa consumer price index and R/P is the nominal exchange rate between the Rand and the Pula (i.e., Rand per Pula).
RGOI	Total real government investment This is obtained from the capital stock data published by CSO.
RGDP	Real gross domestic product Data on real GDP is available from the various national accounts published by CSO
RCAP	Real capital price This is the ratio of the capital formation deflator to the GDP deflator.
RINR	Real interest rate This is obtained from the nominal lending rate and the inflation rate. Since some of the data for the nominal lending rate are not available, the bank rate has been used. The following formula will be used to derive the real interest rate: $[(1+r)/(1+\pi)-1]$ where r is the nominal lending rate and π is the inflation rate.

cannot be a constraint to investment in that economy.

⁶ See Fielding (1993) and Micheal and Fielding (1995) for details of the model.

The following modifications have been made to the model:

- (a) Unlike in the two studies described above, the dependent variable of the model is not total investment by the private sector, but rather total non-mining private investment. In this era, when policy makers are exploring sources of sustainable growth through economic diversification, it is important to determine factors that influence investment outside the mining sector. Further, investment in mining depends to a greater extent on the discovery of profitable mineral deposits, which is for most purposes an exogenous factor that is difficult to quantify to include in the model. Since the mining sector is quite large and has dominated most activities in the economy, its inclusion in total private investment might lead to some bias in the estimated parameters, as well as wrong policy implications.
- (b) This study uses the Johansen Maximum Likelihood Approach to test for cointegration that is a more suited procedure in models with many variables, while the other studies (by Fielding and Jenkins) use Engle-Granger's two-step approach. The Johansen ML approach fully captures the underlying time series characteristics of the data, provides estimates for all the cointegrating vectors that exist within a vector of variables, offers a test statistic for the number of cointegrating vectors and it allows for direct hypothesis testing on the coefficients entering the cointegrating vectors.
- (c) The availability of foreign exchange is not considered as a constraint to investment in the Botswana economy, because unlike other countries, the economy has been running a current account surplus for the past two decades, the main source of such foreign exchange being diamond export sales. Although Jenkins and Fielding's studies consider savings to be a determinant of investment (because they are a constraint to investment in the countries of focus), it is not included in the private investment model for Botswana. The historic pattern indicates a continuous rise in savings and a surplus of domestic savings over investment suggesting that savings have not been a constraint to investment in the Botswana economy.
- (d) Government investment is assumed to play a major role in determining the level of private investment. It can crowd out or crowd-in the level of private investment depending on the nature and extent of the investment. Private investors require potentially good infrastructure that can only be provided by the government through its investment process. The inclusion of

real government investment therefore explains the effect of government investment on private investment.

- (e) Real GDP is used as a proxy for output levels and it is assumed to influence investment positively in the proposed investment model. One of the major assumptions of the neo-classical theory of investment is that the level of output determines investment.
- (f) The real exchange rate is used as a measure of competitiveness. As the pula currency depreciates against other currencies (adjusted for inflation differentials), goods and services in Botswana become cheaper and more competitive. From the derivation of the real exchange rate (in table 2), a positive coefficient would indicate an appreciation of the pula implying a fall in competitiveness of domestic goods and services and hence decline in investment. On the other hand, a negative coefficient implies that a depreciation of the national currency would lead to an increase in non-mining private investment via a rise in competitiveness.
- (g) The capital price has been identified in Fielding's (1993) study as one of the determinants of investment. High costs of inputs act as a constraint to investment.

The determinants of non-mining private investment in Botswana are therefore assumed to be the real exchange rate, real government investment, the real interest rate, real output (real GDP), and the real cost of capital.

The model (equation 1.1) is estimated in log-linear form as follows:

Equation 1.1 (a)

$$\ln RNMI = \beta_0 + \beta_1 \ln RGOI + \beta_2 \ln RGDP - \beta_3 RINR - \beta_4 \ln RCAP + \beta_5 \ln REXR + Ut$$

6. ESTIMATION PROCEDURE AND INTERPRETATION OF RESULTS

6.1 Testing for Stationarity

Although the specified model (equation 1.1a) may reflect the relationship between the dependent variable and the explanatory variables, evidence⁷ has shown that such models face a host of problems when the series *RNMI* and the explanatory variables are non-stationary, as is likely in many macroeconomic models. The essence of the problem lies with the presence of spurious regression that arises where the regression of non-stationary series, which are known to be unrelated, indicates that the series are correlated (Adam, 1992). As a result, the specification might be dominated by the non-stationary time-series characteristics of *RNMI* so that it fails to capture the structural characteristics between the dependent variable and the explanatory variables of the model. Running a regression in which the dependent variable and one or more independent variables are spuriously correlated will result in spurious regression where the t-scores and the overall fit of such spurious regressions are likely to be overstated and untrustworthy. It is for these reasons that each data series is first tested for the presence of unit roots and the order of integration (i.e., how many times the variable needs to be differenced before it becomes stationary).

Figure 3 in the appendix indicates trends in all the variables of the model before testing the individual variables for the presence of unit roots. The graphs clearly indicate that most of the variables exhibit an upward trend over time, while the real interest rate and the real exchange rate appear to be I(0). More formal tests have been used to test the individual series characteristics.

The Augmented Dickey Fuller (ADF) test statistic, as well as the Phillips-Perron (PP) test statistic, have been used to test the individual variables for stationarity. While the ADF test statistic assumes that the errors are statistically independent and have a constant variance, the PP test statistic allows for fairly mild assumptions concerning the distribution of the errors. The PP test statistic can be considered as a modification of the ADF t-statistic that takes into account the less restrictive nature of the errors. Given this advantage of the PP t-statistic over the ADF t-statistic in testing for unit root tests, conclusions about data series characteristics are therefore based on the PP test statistic. Both tests involve testing the null of non-stationarity against the alternative of stationarity. Table 3 reports the results of unit root tests for all the variables expressed in logs. The results of table 3 indicate that all the variables are non-stationary and as such, using the data series to estimate the

model without adjusting for non-stationarity will result in spurious regression. However, this result is not felt to be convincing in the case of the real interest rate and the real exchange rate where policy has consistently involved targeting these variables and attempting to keep their actual values close to target values. This would be an indication of stationarity around these target values. These variables were tested again using quarterly data and the results (not shown here) confirm that they were in fact stationary.

6.2 Adjusting for Nonstationarity

The traditional practice to rid a series of non-stationarity has been to take first differences of the variables. In this instance, if a series is differenced a -times before it becomes stationary, such a series is integrated of order a (i.e., the series is $I(a)$). If the variable is stationary without differencing, then it is integrated of order zero, $I(0)$. With economic data, taking a first difference usually is enough to convert a nonstationary series to a stationary one. In this case, the first differences of the variables have been tested using the ADF and PP test statistics to make sure that the variables are indeed $I(1)$. Table 3 in the appendix reports the results of the respective tests for the variables expressed in first differences and in log form. The results indicate that taking first differences has rid the data series its non-stationary characteristics. A visual inspection of Figure 4 also tentatively suggests that all those variables that were non-stationary appear to be at least $I(1)$.

Unfortunately, there are major disadvantages to using first differences to correct for non-stationarity. The two most important drawbacks are that using first differences;

- (a) changes the inherent theoretical meaning of the differenced variable and
- (b) discards information about the long run trend in that variable.

As a result, first differences should not be used without weighing the costs and benefits of that shift. An important alternative to using first differences to correct for non-stationarity is a concept called cointegration which consists of matching up the degree of non-stationarity of the variables in an equation in a way that makes the residuals of the equation stationary and rids the equation of any spurious regression results (Studemand, 1997). It is therefore essential to seek a method that rejects

⁷ See Adam, 1992.

spurious regression results, but will not, at the same time, reject correlation between non-stationary series where the correlation is, in fact, structural, rather than spurious.

6.3 Cointegration Analysis

Recently, the cointegration of series has been used as a guide to appropriate dynamic specification. The theoretical interpretation of cointegration is that if variables are linked to form an equilibrium relationship spanning the long-run, then even though the variables are non-stationary in their levels, they will nevertheless move closely together over time and the difference between them overtime will be stable or stationary. Cointegration analysis provides a powerful discriminating test for spurious correlation

The procedure for cointegration in this paper is the Johansen Maximum Likelihood (ML) Approach. Dolado (1987) argues that the Johansen ML approach has several advantages over the two-step Engle and Granger⁸ approach, since it allows for multivariate testing, particularly where there may exist more than one cointegrating relationship among a set of more than two variables. The existence of at least one cointegrating relationship among the variables implies that an error correction model (ECM) can be estimated. The ECM is useful in the derivation of the short run impacts on non-mining private investment in Botswana. Table 4 below indicates the results for the long run cointegrating relationship generated in Microfit.

Table 4: Johansen Cointegration Test based on the Trace and Maximal Eigenvalue Statistic

List of variables included in the cointegrating vector: LRNMI, LRGDP and LREXR

Null	Alternative	Maximal Eigenvalue		Trace Statistic	
		Statistic	95% C.V.	Statistic	95% C.V.
r = 0	r = 1	16.0456	14.8800	21.7441	17.8600
r <= 1	r = 2	5.6985	8.0700	5.6985	8.0700

Note; VAR assumption: unrestricted intercepts and no trends; Order =2.⁹

⁸ Engle and Granger's two-step approach is based on the premise that for all I (1) series, cointegration exists if the residuals from a bi-variate regression of the dependent variable and other explanatory variables are stationary. This procedure is suitable for bivariate models. For a detailed discussion of the two-step Engle and Granger approach to cointegration analysis, refer to Engle (1987).

⁹ The Akaike Information Criterion (AIC) has been used to derive the optimum lag length for use in the VAR, which indicates that the optimum lag length from the estimated unrestricted VAR is 2. Trends have not been included in the VAR since there is no economic reason to believe that the cointegrating relationship will be characterised by a trend.

The results indicate that both the maximal eigenvalue, as well as the trace statistic, indicate the presence of one cointegrating vector in the vector autoregressive regression (VAR). For both test statistics, the cointegration is highly significant at 5% level. Different assumptions on the treatment of both the trend and intercept on the cointegrating vector have been carried out and the results show that there is one cointegrating vector. Table 5 reports the coefficients for the long run cointegrating equation, as well as the t-ratios. For further details on the choice of the long run cointegrating equation in table 5, refer to the summary table of results in the appendix.

Table 5: Johansen Cointegrating Vector

Variable	Vector 1 (coefficient)	Standard Error	T-ratio
LRNMI	1.0000	(None)	
LRGDP	1.5252	0.1292	11.8050

Note: The t-ratio in the table has been obtained through dividing the coefficient with the standard error. The dependent variable of the model has been normalised.

The results indicate that in the long run, non-mining private investment is positively related to the real output, LRGDP. The coefficient for real GDP of 1.53 implies that a 1% change in GDP results in a 1.5% change in non-mining private investment. These results are in line with the hypothesis. The coefficient of 1.5 for real GDP found to be rather high in economic terms, but this could reflect the steadily increasing importance of the non-mining private sector in the economy over this period.

6.4 The Error Correction Model

A dynamic model of investment reflecting the short run determinants of investment, as well as the convergence of investment to its long run equilibrium, will include an error correction term such that:

Equation 1.1(b)

$$\begin{aligned}\Delta \ln RNMI(t) = & \beta_0 + \beta_1 \ln REXR(t) + \beta_2 \ln REXR(t-1) + \beta_3 \Delta \ln RGOI(t) + \beta_4 \Delta \ln RGOI(t-1) + \beta_5 \Delta \ln RGDP(t) \\ & + \beta_6 \Delta \ln RGDP(t-1) - \beta_7 \Delta \ln RCAP(t) - \beta_8 \Delta \ln RCAP(t-1) - \beta_9 RINR(t) - \beta_{10} RINR(t-1) \\ & - \lambda [\ln RNMI(t-1) - \ln RNMI^*(t-1)] + U_t\end{aligned}$$

In the equation the term $[\ln RNMI(t-1) - \ln RNMI^*(t-1)]$ is a measure of deviation in period $t-1$ of $RNMI$ from the equilibrium $RNMI^*$. Therefore λ measures the speed with which private investment converges on its long-run equilibrium, $RNMI^{*10}$. The other variables included in the model are the short-run determinants of investment. The specification thus relates the short run change in the dependent variable $\Delta RNMI$ to the short run changes in the explanatory variables (the impact effect), but ties the change to the long run proportionality between $RNMI$ and the explanatory variables (the long run effect), through a feedback mechanism. In doing so, it allows us to exploit information on the equilibrium relationship between non-stationary series within a stationary, and therefore statistically consistent model.

Estimating equation 1.1b yields the following results for the error correction model:

Table 6: OLS estimated error correction model

Dependent variable: DLRNMI

Variable	Coefficient	Standard Error	T-Ratio[Prob]
ΔLRGDP (-1)	0.7910	0.3523	2.2453 [0.039]
ΔLRCAP	0.5708	0.1883	3.0321 [0.008]
LREXR	-0.4184	0.1981	-2.1125 [0.051]
ECM(-1)	-0.6289	0.1721	-3.6539 [0.002]
<i>Adj. R-Squared: 0.655</i>	<i>F(3, 16):13.0482 / 0.001</i>		<i>DW-statistic: 2.1628</i>

For details on why this model was chosen as the final model, see summary table of results in the appendix.

The estimated adjustment model indicates that all the variables have the expected signs, except for the price of capital. According to production theory, an increase in the cost of inputs is expected to lead to a reduction in production, as well as a reduction in the profits. As such, we expect

¹⁰ We expect $\lambda < 0$. This is because if investment ($RNMI$) is less than the equilibrium investment ($RNMI^*$), then $[\ln RNMI(t-1) - \ln RNMI^*(t-1)] < 0$ and $\lambda[\ln RNMI(t-1) - \ln RNMI^*(t-1)] > 0$ so next period's investment increases, $\Delta \ln RNMI_t > 0$, towards its long run equilibrium. If investment is greater than the equilibrium then $[\ln RNMI(t-1) - \ln RNMI^*(t-1)] > 0$ and $\lambda[\ln RNMI(t-1) - \ln RNMI^*(t-1)] < 0$ so next period's investment decreases, $\Delta \ln RNMI_t < 0$, towards its long run equilibrium. That is, $\ln RNMI_t$ fluctuates around its long run equilibrium value.

investment to be negatively related to the price of capital. However, the theory of demand postulates that excess demand for capital exerts an upward pressure on the price of capital. Unlike production theory, investors will in this case invest more to satisfy the excess demand, as well as to maximise profits, and hence a positive relationship could exist between investment and the capital price. The positive coefficient could also be due to the fact that the construction sector is included as one of the sectors producing capital goods.

The results indicate that in the short run, non-mining private investment is positively related to lagged changes in real output, DLRGDP(-1). The coefficient for real GDP implies that if real output increases by 1%, non-mining private investment will increase by 0.8%.

A negative coefficient for the real exchange rate has the implication that there exists an inverse relationship between the real exchange rate and the rate of change of non-mining private investment. That is, a depreciation of the Pula leads to a rise in the competitiveness of exports of goods and services, and hence an increase in investment. The coefficient for the real exchange rate of 0.4% indicates that if the pula depreciates by 1% against the Rand, non-mining private investment will go up by 0.4% and vice versa. This coefficient is highly significant indicating that the choice of an exchange rate policy plays an important role in the determination of non-mining private investment. Lagged changes in the dependent variable were found to be consistently not significant and were dropped from the equation.

The error correction term is statistically significant with the implication that investment is converging towards its equilibrium level RNMI*. The coefficient for the ECM of -0.63 indicates the magnitude of the adjustment between the short run and the long run. That is, 63% of the disequilibria from the long-run relationship in period $t-1$ is eliminated in the current period. The goodness of fit for the model is 0.66 and this indicates that the identified explanatory variables explain 66% of total variations in non-mining private investment. The DW-statistic, which is a measure of serial correlation, is close to 2 showing that the errors between two periods are not serially correlated.

The alternative formulation of the error correction model with GDP as the dependent variable yields error correction term that is not significant. This serves as an indirect method of testing for

the long run direction of causality between non-mining private investment and the GDP. Such an observation suggests that in the long run, non-mining private investment is dependent on changes in GDP, while the reverse that GDP is a function of non-mining private investment is not true.

6.5 Explanatory Power of the Model

The model is tested for the overall explanatory power using the F-test which tests the overall significance of the regression. This is a two-sided hypothesis about more than one regression coefficient at a time.

The computed F-ratio¹¹ is 13.05, while the critical F-statistic at the 5%¹² level of significance is 3.06, which is well below the calculated value of 13.05. This implies that we can reject the null hypothesis and conclude that the investment equation does indeed have a significant overall fit. That is, changes in the identified key explanatory variables jointly influence changes in non-mining private investment significantly.

7. CONCLUSIONS AND POLICY IMPLICATIONS

The study finds existence of a positive statistically significant long-run relationship between non-mining private investment and the level of output. This indicates that the growth of GDP in Botswana is good for investment. Much of the high growth in GDP has been driven by government spending through the conversion of diamond mining proceeds into other economic activities in the economy. This is in line the government's economic diversification policies. The policy implication of this relationship is that the government should further diversify the economy as to increase output, which, in turn, will have a positive impact on non-mining private investment.

An interesting observation is in the relationship between non-mining private investment and the real exchange rate as an indicator of competitiveness. The results show that short run variations in the real exchange rate have a significant impact on changes in non-mining private investment. A Pula depreciation has a positive effect on non-mining private investment via an increase in the

¹¹ The computed F-ratio is obtained from the regression results of the model.

¹² The critical f-statistic of 3.06 is obtained from tables of the inverted beta (F) distribution by Merrington and Thompson (1943). Degrees of freedom used for the numerator is 3 (i.e. the number of estimated parameters) while those for the denominator are 13 (i.e. the number of observations – number of estimated parameters – 1).

competitiveness of goods and services in the domestic economy. In the long run, the real exchange rate causes non-mining private investment to rise via an increase in competitiveness. The implication of this relationship is that the government should have an exchange rate policy that does not lead to a high appreciation of the national currency given that this would result in a fall in non-mining private investment via a decline in the competitiveness of Botswana's goods and services.

The real interest rate as well as government investment were found not to play any significant role in the determination of non-mining private investment, both in the short and the long term. This lack of sensitivity of non-mining private investment to the real interest rate is perhaps surprising since it is not compatible with economic theory and as such could be a topic for further research. In theory, lower interest rates are conducive for investment as they lower the cost of borrowing.

Finally, there is a positive relationship between the price of capital and non-mining private investment. We expected a negative relationship between these variables. The positive relationship might be because of the way the price of capital variable has been derived (capital formation deflator as a ratio of the GDP deflator). It cannot be concluded that the relationship is in line with the theory of production, which stipulates a positive relationship between investment and the capital price, the driving force being excess demand. This is because the Botswana economy is not a producer of capital goods. However, one reason behind the positive relationship between non-mining private investment and the real capital price could be that the construction sector is included as a sector producing capital goods. As such, whenever there is a boom in the construction sector (especially in the early 80's and 90's), the capital price and investment outside the mining sector will be positively related, with the price of capital goods being driven by the excess demand in construction. Given the ambiguity in this relationship, making any policy recommendations about the pricing of capital goods seems unrealistic at this time. This is due to the fact that it cannot be proved with certainty that the inclusion of the construction sector in the production of capital goods, as well as the booms in the sector have anything to do with the positive relationship found between non-mining private investment and the price of capital.

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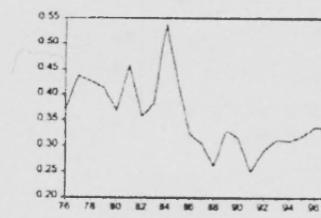
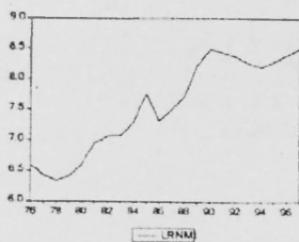
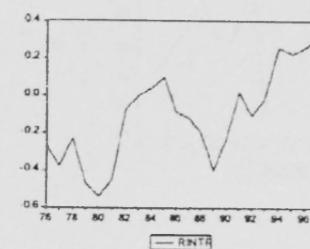
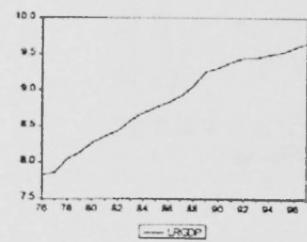
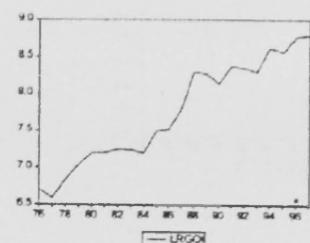
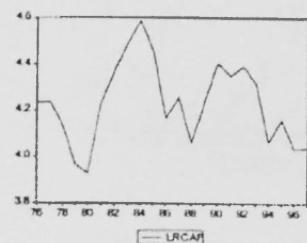
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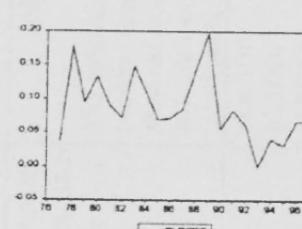
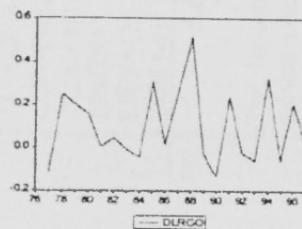
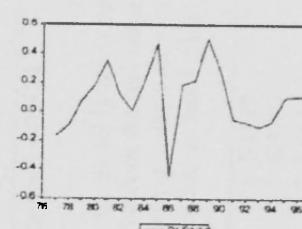
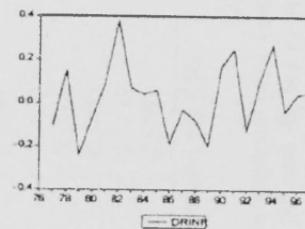
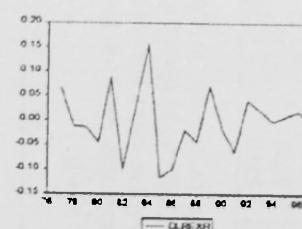
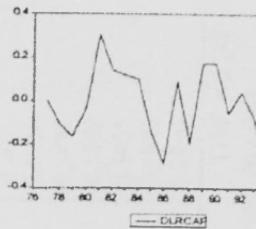
Variable	Model 1 (with intercept)				Model 2 (with trend & intercept)				Model 3 (none)		Differences		Conclusions	Lag	
	ADF	PP	Intercept (I)	ADF	PP	Trend (I)	ADF	PP	PP	1 st	2nd	PP	PP		
L.RCAP	-2.33	-2.16	2.90(*)	-2.22	-2.10	-0.45	-0.32	-0.33	-4.12***			I(1)	I		
L.REXR	-0.72	-0.36	-2.63	-2.29	-2.06	-1.84	0.13	0.57				I(0)			
L.RGDP	-2.72(*)	-2.02	2.59	-0.94	-0.51	0.18	2.76	6.08	-4.73***			I(1)	I		
L.RGOI	-0.92	-0.44	0.79	-2.48	-2.95	2.84	2.86	3.34	-5.70***			I(1)	I		
R.NR	-1.31	-1.11	0.17	-2.32	-2.31	2.01	-1.65	-1.39				I(0)	I		
L.RNM1	-1.04	-0.63	0.81	-2.27	-2.37	2.04	1.68	1.79	-3.54***			I(1)	I		
Critical Values															
1% (***)	-3.83	-3.81	-4.53	-4.53		-2.70		-2.69							
5% (**)	-3.03	-3.02	+/-2.85	-3.67	-3.66	+/-3.11	-1.96	-1.96							
10% (*)	-2.66	-2.65		-3.28	-3.27		-1.63	-1.62							

Table 3: Unit Root Tests

**FIGURE 3: DATA SERIES CHARACTERISTICS
VARIABLES IN LOGS**



**FIGURE 4: ADJUSTING FOR NON-STATIONARITY
VARIABLES IN LOGS OF FIRST DIFFERENCES.**



SUMMARY TABLE OF RESULTS: LONG-RUN RELATIONSHIPS AND THE ADJUSTMENT MECHANISM OF NON-MINING PRIVATE INVESTMENT

Long Run Model 1					Short Run Error Correction Models				
Variable	Coefficient	Standard Error	Variable	Coefficient	Standard Error	Variable	Coefficient	Standard Error	T- Ratio(Prob)
LRNMI	1.0000	None	$\Delta LRNMI(1)$	0.1678	0.2428				0.6910 [0.502]
LRGDP	4.2808	1.2351	$\Delta LRGDP(1)$	0.3841	0.6756				0.5685 [0.579]
LRGOI	-4.6109	0.9990	$\Delta LRGOI(1)$	0.0620	0.3432				0.1807 [0.859]
LRCAP	-3.8337	0.7186	$\Delta LRCAP(1)$	0.1986	0.5249				0.3783 [0.711]
LREXR*			$LREXR^*$	-0.5475	0.3405				-1.6079 [0.132]
RINR*			$RINR^*(1)$	-0.1153	0.1895				-0.6083 [0.613]
			$ECM(-1)$	-0.9593	0.2796				-3.4309 [0.004]
The coefficients on the above long run model are too high to make any economic meaning.					Adj. R-Squared = 0.539	DW = 2.39			F-Statistic (6, 13) = 4.707 [0.009]
The variables in the short-run error correction model are insignificant and the R-squared which measures how well the data fits the model is too low indicating that the model has no explanatory power.					Adj. R-Squared = 0.611	DW = 2.05			F-Statistic (6, 13) = 8.473 [0.001]
The coefficient for LRGDP is too high in economic terms. Although the coefficient for LRGOI has the right sign, the coefficient is barely significant at 5% level of significance.					Adj. R-Squared = 0.611	DW = 2.05			F(4, 15) =
The indicated short run model is much comparable with short run model 5. Since there is need to conserve degrees of freedom, the real interest rate RINR which is insignificant has been dropped from short run model 2 resulting in short run model 5. It can also be observed that this model has a good fit and changes in variables included jointly influence changes in non-mining private investment significantly.					Adj. R-Squared = 0.611	DW = 2.05			F(4, 15) =
Long-Run Model 3					Adj. R-Squared = 0.611	DW = 2.05			F(4, 15) =
LRNMI	1.0000	None	$\Delta LRGDP$	0.1090	0.6210				0.1755 [0.863]
LRGDP	2.1231	0.3182	$\Delta LRGOI$	0.5789	0.3077				1.8814 [0.081]
LRGOI	-0.5217	0.2516	$\Delta LRCAP$	0.9831	0.3368				2.9191 [0.011]
RINR*			$LREXR^*$	-0.4382	0.2748				-1.5950 [0.133]
			$RINR^*$	-0.1260	0.1898				-0.6641 [0.517]
			$ECM(-1)$	-0.1151	0.1397				-0.8742 [0.424]

		Adj. R-Squared = 0.462	DW=1.705	F
The coefficient for LRGDP is still too high while that for LRGOI is still barely significant at 5% level of significance implying that the coefficient is not statistically different from zero.		(5, 14) =4.2646 [0.014]		
Long-run Model 4	Coefficient	Standard Error		
LRNMI	1.0000	0.3556	0.6723	T-Ratio [Prob]
LRGDP	2.1578	0.2906	0.2518	1.3642 [0.193]
LRGOI	0.5457		0.9172	1.9505 [0.070]
LREXR*			0.4911	-1.1472 [0.269]
			-0.3637	0.3022 [0.767]
			0.0775	-1.3036 [0.212]
			-0.2053	
This model has similar limitations as long run model 2 and 3 in the sense that LRGDP has a high coefficient while that for LRGOI is not statistically different from zero.			Adj. R-Squared = 0.407	DW = 1.996
			1.5) =4.4577 [0.017]	F (4,
Long run Model 5#				
LRNMI	1.0000	None	0.7910	2.2453 [0.039]
LRGDP	1.5252	0.1292	0.5708	3.0321 [0.008]
LREXR*			-0.4184	-2.1125 [0.051]
			-0.6289	-3.6539 [0.002]
			0.1980	
			0.1721	
Among all the estimated long run models of investment, this model is much more reliable in the sense that the coefficient for LRGDP is not too high in economic terms. Those variables that have been consistently insignificant (LRGOI, RINR, LRCAP) have been left out in this model.			Adj. R-Squared = 0.655	DW: 2.163
			1.6) = 13.048 [0.001]	F-Statistic(3,

N.B.

A star (*) has been attached to all I(0) variables while # indicates the model that has been selected and reported in the paper.

For all the short-run equations, the error correction term [ECM (-1)] is obtained from the respective LR model. Dependent variable is DLRNMI

The assumption used in the VAR is unrestricted intercepts and no trends. Order of VAR=2



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