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AN ANALYSIS OF THE DETERMINANTS OF MINING INVESTMENT IN ZIMBABWE: BASED ON THE FLEXIBLE ACCELERATOR MODEL

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ABSTRACT

Despite the existence of diverse and rich deposits of minerals, the mining sector in Zimbabwe remains underdeveloped. The problem apparently lies with low investment. This paper analyses the factors determining mining investment using a simple flexible accelerator model, which is complemented by a subsequent general discussion on other pertinent factors excluded from the model. From the model, the significances of the output variables (current and lagged) and the lagged investment variable as well as estimates of the coefficient of adjustment, the desired capital-output ratio and the annual rate of depreciation for the whole mining sector are determined. The study shows that the gap between the desired and the actual capital stock increases each year, with the desired capital-output ratio at 3.8 and the annual rate of depreciation at 7.3%. Investment is positively related to previous output level. A negative relationship between current investment and current output apparently reflects an inevitable trade-off that is linked to the predominant small-scale nature of the sector. The study confirms, as have other studies elsewhere, that lagged investment is a significant predictor of current investment, implying existence of investment adjustment costs and a budgetary process that uses the previous investment level as default. The whole accelerator model is found to be significant. Besides considerations related to capital intensity and long lead times, the paper discusses the following pertinent factors excluded from the accelerator model: risk and uncertainty, fiscal regime, cash flow, business operational conditions (affecting the marginal efficiency of capital), interest rate and credit availability.

JEL CODE
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KEYWORDS
Flexible accelerator model, interest rate, mining investment, risk

1. INTRODUCTION

Zimbabwe is rich in a wide variety of minerals among other natural resources. Currently there are more than forty different types of minerals mined in the country. Major among them, in terms of production value, are gold, asbestos, nickel, coal, copper, chrome, tin, iron, silver and cobalt (Central Statistical Office, various issues of the Quaterly Digest of Statistics). The Ministry of Mines and Mining Development (2010) estimates that resources of metallurgical quality chrome in Zimbabwe as a percentage of world resources of chrome are 80%. It is also indicated that the country hosts some of the most productive greenstone belts in the world in terms of gold. Platinum group metal resources in the country are ranked second largest in the world. Black granite is abundant ("ubiquitous") in the northeastern part of the country. Besides the existence of kimberlites, the country boasts of extensive deposits of alluvial/placer diamonds in Chiadzwa, which are estimated to have a potential production of 25% of the world's diamond output. Exploration for coal bed methane gas has been carried out in recent years and there are huge estimates of reserves being given, going to billions of cubic metres of gas. But detailed explorations to prove these reserves are yet to be done.

Hawkins (2009) estimates that from 1968 to 2009 the (average) ratio of investment to gross-output in the mining sector was between 10 and 12 percent. Vigorous mining industry expansion was recorded for 1968-1971 period, the period during which nickel and ferrochrome experienced expansion. During this period, investment averaged 21.5% of gross output. From 1973-1996 mining investment averaged 25 percent of output (at current prices) with another period of vigorous expansion in the mid 1990s. During the period 1983-1993, there was negative net investment and a backlog in replacement investment. After 1997, except in the platinum and diamond sectors, exploration and new capacity investments have been minimal. According to the President of the Chamber of Mines at the Chamber of Mines Annual Congress in 2007, since 2003 no new (major) exploration licences had been issued. A lot of the equipment under use now has aged or become obsolete.

2. PROBLEM STATEMENT, RESEARCH OBJECTIVES, HYPOTHESIS AND SIGNIFICANCE OF THE STUDY

Despite the abundance of mineral resources in the country, Zimbabwe remains underdeveloped. The problem apparently lies in the inability of the country to attract investment and the apparent lack of significant transparency in the management of mining revenue, which may engender unmitigated corruption. This paper is concerned with the first issue – determinants of mining investment levels. The importance of investment has always received great emphasis in various mining fora in Zimbabwe. However, a proper modelling of the issue remains. Thus, investment policy making in the sector has not been properly guided. Soludo (2002) argues that policy requires some kind of model, especially an explicit model as opposed to some implicit model (in the head). While investment has been modelled in general, the author is not aware of any attempt to model mining investment in Zimbabwe.

This study seeks to estimate a flexible accelerator model for mining investment in Zimbabwe over the period 1976-1997. From this estimation, the significance of some quantitative factors is determined. The study hypothesizes (as null hypothesis) that the flexible accelerator model does not significantly explain mining investment behaviour in Zimbabwe, and the alternative hypothesis is that it does. Also determined are numerical estimates of the coefficient of (capital) adjustment, the desired capital-output ratio and the annual average rate of capital depreciation. The paper also discusses the importance of other pertinent factors (quantitative and qualitative) not included in the model, such as credit availability, risks and uncertainties related to fiscal and regulatory regime stability, political regime stability and the fundamental system of government (long-term national stability).

The importance of this study is in that, if factors significantly affecting mining investment decisions in Zimbabwe were known, policy would seek to influence these factors so that investment can be expanded. Net investment in any sector of the economy, mining included, creates employment, makes the economy grow and makes future consumption possible. Without mining investment, mineral resources remain sleeping resources, with their extent unknown and the country benefiting nothing from them. Following the perspective of the New Growth Theory that technology is embodied in new capital, investment, therefore, combines two important growths - capital growth and technical progress. This is especially the case in Zimbabwe mining sector, where both investment and technical progress significantly derive from the foreign sector.

3. LITERATURE REVIEW AND MODEL DEVELOPMENT

Mining investment is business fixed investment. Business fixed investment is expenditure on capital stock items such as factories, machines and other (man-made) products used in producing other goods (Dornbusch & Fischer, 1981, p.18). Investment is the purchase only of new assets, not those already existing (second hand) because the latter case represents a disinvestment by the one who sells even though the one who buys regards it as investment (Poindexter, 1976, p.143). Developed in the following sub-section is the accelerator model.

3.1 THE FLEXIBLE ACCELERATOR THEORY OF INVESTMENT

The flexible accelerator model assumes the existence of a desired or optimal stock of capital required to produce a given output for a given technology, rate of interest, and so forth (Gujarati 1988, p.519).

Assume:

$$K_t^* = \beta_1 Q_t \quad (1)$$

where K_t^* is desired mining capital stock in period t, Q_t is mining output in period t, and β_1 is the desired capital-output ratio.

The capital adjustment process is defined by the following equation (Pentecost, 2000, p.124; Gujarati, 1988; and Dzawanda, 1994):

$$K_t - K_{t-1} = \delta\left(K_t^* - K_{t-1}\right), \quad 0 < \delta \leq 1 \quad (2)$$

where δ is the coefficient of adjustment. Rearranging (2):

$$K_t = \delta K_t^* + (1-\delta)K_{t-1} \quad (3)$$

Substituting (1) into (3) and simplifying gives:

$$K_t = \delta\beta_1 Q_t + (1-\delta)K_{t-1} \quad (4)$$

From (2), net investment (I_t^n) is given by:

$$K_t - K_{t-1} = I_t^n = \delta\beta_1 Q_t - \delta K_{t-1} \quad (5)$$

If we assume that replacement investment in period t is a positive proportion α of previous period's level of capital, gross investment is given by (See Dzawanda, 1994):

$$I_t^g = K_t - K_{t-1} + \alpha K_{t-1} = I_t^n + \alpha K_{t-1} \quad (6)$$

Or

$$I_t^g = K_t - (1-\alpha)K_{t-1} \quad (7)$$

Substituting (5) into (6):

$$I_t^g = \delta\beta_1 Q_t + (\alpha - \delta)K_{t-1} \quad (8)$$

Lagging (8) once and multiplying the result by $(1-\alpha)$ we get:

$$(1-\alpha)I_{t-1}^g = \delta\beta_1(1-\alpha)Q_{t-1} + (1-\alpha)(\alpha-\delta)K_{t-2} \quad (9)$$

Subtracting (9) from (8) gives:

$$I_t^g - (1-\alpha)I_{t-1}^g = \delta\beta_1 Q_t - \delta\beta_1(1-\alpha)Q_{t-1} + (\alpha-\delta)K_{t-1} - (1-\alpha)(\alpha-\delta)K_{t-2}$$

But from (7):

$$I_{t-1}^g = K_{t-1} - (1-\alpha)K_{t-2}$$

Therefore:

$$I_t^g = \delta\beta_1 Q_t - \delta\beta_1(1-\alpha)Q_{t-1} + (1-\delta)I_{t-1}^g \quad (10)$$

Adding a constant β_0 (for investment independent of output and lagged investment variables) and an error term u_t to the right hand side of (10), gross investment is finally specified as a function of current output, lagged output and lagged investment:

$$I_t^g = I_t^g\left(Q_t, Q_{t-1}, I_{t-1}^g\right) = \beta_0 + \delta\beta_1 Q_t - \delta\beta_1(1-\alpha)Q_{t-1} + (1-\delta)I_{t-1}^g + u_t \quad (11)$$

Note that if model (11) can be estimated in full, we can find the values of the coefficient of adjustment (δ), the desired capital-output ratio (β_1) and the depreciation rate (α). However, depreciation rate would indicate depreciation in nominal capital stock values since investment is in nominal terms.

4. ESTIMATION OF THE FLEXIBLE ACCELERATOR MODEL FOR ZIMBABWE MINING INVESTMENT

4.1 MODEL

This study estimates equation (11) developed above.

$$I_t^g = I_t^g\left(Q_t, Q_{t-1}, I_{t-1}^g\right) = \beta_0 + \delta\beta_1 Q_t - \delta\beta_1(1-\alpha)Q_{t-1} + (1-\delta)I_{t-1}^g + u_t \quad (11)$$

We may generalise equation (11) as:

$$I_t^g = \eta_0 + \eta_1 Q_t + \eta_2 Q_{t-1} + \eta_3 I_{t-1}^g + u_t \quad (12)$$

where

$$\eta_0 = \beta_0, \quad \eta_1 = \delta\beta_1, \quad \eta_2 = -\delta\beta_1(1-\alpha), \quad \eta_3 = 1-\delta \quad (13)$$

Thus:

Coefficient of adjustment, $\delta = 1 - \eta_3$, Desired capital-output ratio, $\beta_1 = \frac{\eta_1}{\delta}$, Capital depreciation rate, $\alpha = 1 + \frac{\eta_2}{\eta_1}$ (14)

4.2 ESTIMATION APPROACHES

The above model (equation 12) is both autoregressive and distributed lag. To take care of autoregressiveness we use the instrumental variable technique, while the *ad hoc method* (sequential regression) is used to deal with the problem of distributed lags. We resolve the problem of autoregressiveness first because the distributed lags are not expected to significantly affect the generation of the instrumental variable, which is only a proxy. Unresolved autoregressiveness is likely, instead, to significantly affect the coefficients of the output variables in sequential regression. First, we regress by Ordinary Least Squares (OLS) gross mining investment against the output variables, from which we get estimates of investment (equation 15).

$$Ies_t^g = \alpha_0 + \alpha_1 Q_t + \alpha_2 Q_{t-1} \quad (15)$$

These estimates are lagged to get an instrumental variable for the lagged investment variable (Ies^g_{t-1} in Table 1). By lagging, we loose one observation, hence one degree of freedom.

According to the *ad hoc method* of estimating a distributed lag model, we begin by regressing investment against current output and lagged investment (that is, its instrumental variable), and then regress with lagged output included. In this sequential regression, if the sign of any coefficient of the variable being lagged changes and/or at least one of the variables concerned becomes insignificant, one takes the last stable result.

4.3 DATA

The flexible accelerator model covers the period 1976 - 1997. Data from 1998 to the present could not be used because they are either not available or unreliable. It is assumed that the fundamental relationships between the variables in the model have remained largely the same, even though other factors have come into play recently. Thus, results from the model are discussed in the present tense. The sources of the data are detailed under Table 1.

TABLE 1: MINING GDP AND MINING INVESTMENT (Z$MILLION)

Year	Q_t	I^g_t	Q_{t-1}	I^g_{t-1}	Ies^g_t	Ies^g_{t-1}
1976	152	60	131	40	8	-
1977	149	66	152	60	29	8
1978	156	59	149	66	25	29
1979	226	83	156	59	20	25
1980	285	83	226	83	77	20
1981	250	133	285	83	139	77
1982	243	94	250	133	107	139
1983	393	86	243	94	76	107
1984	320	81	393	86	231	76
1985	335	30	320	81	159	231
1986	372	57	335	30	167	159
1987	434	123	372	57	192	167
1988	529	200	434	123	236	192
1989	602	144	529	200	315	236
1990	845	166	602	144	345	315
1991	1184	273	845	166	522	345
1992	1552	512	1184	273	786	522
1993	1625	518	1552	512	1126	786
1994	2531	785	1625	518	1046	1126
1995	1142	2000	2531	785	2143	1046
1996	1317	2370	1142	2000	784	2143
1997	1384	1552	1317	2370	941	784

Sources and notes:

Mining GDP figures (current prices, factor cost) are obtained from Central Statistical Office (CSO) (1984) (for 1975-1982), CSO (1989) (for 1983-1988), CSO (2000) (for 1989-1997). Figures are in Z$million. Mining Gross Investment (Gross Fixed Capital Formation, current prices) figures are obtained from CSO (1984) (for 1975-1981), CSO (1989) (for 1982-1985), CSO (2000) (for 1986-1996), CSO (2004) (for 1997). Figures are in Z$million. $Q_t, Q_{t-1}, I^g_t, I^g_{t-1}, Ies^g_t$ *and* Ies^g_{t-1} *respectively denote mining output, lagged mining output, mining investment, lagged mining investment, estimated mining investment, and lagged estimated mining investment (instrumental variable for lagged dependent).*

5. MODEL RESULTS, FINDINGS AND DISCUSSION

5.1 REGRESSION RESULTS

Using data in Table 1 equation (15) becomes:

$$Ies_t^g = -92.2409 - 0.1649 Q_t + 0.9576 Q_{t-1} \quad (15a)$$

Using equation (15a) investment estimates are obtained which are then lagged to give the instrumental variable for lagged dependent (Ies^g_{t-1}) (last column in Table 1).

Sequential OLS regression: without lagged output variable

$$I_t^g = \underset{(99.1525)}{45.2540} - \underset{(0.1470)}{0.1910 Q_t} + \underset{(0.1798)}{1.3472 I^g_{t-1}}, \qquad R^2 = 0.84$$

$$t = \underset{(0.456)}{} \quad \underset{(-1.300)}{} \quad \underset{(7.493)}{} \qquad df = 18$$

$$F_{2,18} = 46.33 \quad (16)$$

Sequential OLS regression: with lagged output variable

$$I_t^g = -14.5536 - 0.5260Q_t + 0.5715Q_{t-1} + 1.1370I_{t-1}^g, \qquad R^2 = 0.92$$
$$(127.5112)\ (0.2031)\ (0.5299)\ (1.1746) \qquad df = 17$$
$$t = (-5.225)\ (-2.517)\ (4.909)\ (-4.713) \qquad F_{3,17} = 68.44 \qquad (17)$$

We note in the above regressions that (17) is stable because the coefficient of current output does not change sign and becomes more significant, hence we select it.

5.2 COEFFICIENT OF ADJUSTMENT, DESIRED CAPITAL-OUTPUT RATIO AND CAPITAL DEPRECIATION RATE

From (17):

$$\beta_0 = \eta_0 = -14.5536, \quad \delta\beta_1 = \eta_1 = -0.5260, \quad -\delta\beta_1(1-\alpha) = \eta_2 = 0.5715, \quad 1-\delta = \eta_3 = 1.1370$$

Therefore:

Coefficient of adjustment, $\delta = -0.1370$

Desired capital-output ratio, $\beta_1 = 3.8394$

Annual capital depreciation rate, $\alpha = -0.0865$

The value of the coefficient of adjustment is negative but close to zero showing that in every period the gap between the desired stock of capital and the actual stock in the previous period increases slightly rather than reduce. This simply reflects lack of finance to undertake desired investment such that net investment becomes negative. This confirms Hawkins (2009)'s sentiments alluded to in the introduction.

The value of the desired capital-output ratio of approximately 4 shows that in every period, the mining sector desires to hold a capital stock that is 4 times the value of its current output. This result compares well with the result obtained in Investment (n.d., p.48) which is also approximately 4.

The rate of capital depreciation is negative, which would suggest that the value of capital stock appreciates rather than depreciate. However, the negative sign indicates the influence of using nominal investment figures in the estimation. This means that the current values of capital stocks were increasing over the period, even though a valuation based on historic prices would show that there is real depreciation. Thus, the bias is caused by price increases. Since inflation reduces nominal depreciation, in adjusting nominal depreciation to real we add the inflation rate. Annual average inflation over the period of study (1976-1997) was 15.91% (based on consumer price indices in Reserve Bank of Zimbabwe, 1991 and 1998). This gives a real depreciation rate of 7.26% (= 0.0726).

5.3 CONSTANT OF INVESTMENT FUNCTION

Model (17) shows that the constant is negative at –Z$14.5536 million. This coefficient is, however, insignificant at 0.05 with a computed t value of magnitude -0.204 against a critical t value of -2.110. This indicates that with no previous investment, and zero production in the current and previous period, there will be disinvestment (negative investment) in the current period. Consecutive periods of zero production are very costly given the very high fixed costs associated with mining; hence, some mines will be winding up operations.

5.4 CURRENT AND LAGGED OUTPUTS

The results also show that investment in the current period is negatively affected by current output and positively affected by lagged output. Both coefficients are significant. The positive lagged output coefficient apparently indicates that miners, in deciding on investment next period, consider their current production levels. However, the negative current output coefficient is surprising. It may probably reflect the trade-off between scale expansion and expanded variable inputs associated with current (short-run) output expansion in a small-scale operation. Zimbabwe mining industry, in general, is characteristically small-scale.

5.5 LAGGED DEPENDENT VARIABLE

The coefficient of the lagged dependent variable is positive (1.1370) and significant at 0.05. This coefficient shows that every dollar in lagged investment results in $1.14 in current investment, which is almost a one-to-one correspondence. This could be because of a number of factors either in isolation or in combination. It may reflect lack of adequate finance to undertake investment as a lump, given the capital intensity of mining operations, so that it is spread out to take advantage of annual receipts. Kehrig and Vincent (2012) conclude that investment is lumpy at the level of the plant while it is smooth at the firm level; hence, by extension it must be smoother with higher aggregations. They argue, like Eberly *et al* (2012), that lagged investment better explains current investment levels than cash flow and that this reflects the existence of adjustment costs. Eberly *et al* (2012) also allude to Bloom, Van Reenen and Sadun (2009) who find that, in making investment budgets for plant managers, senior managers use previous budgets as the default and the plant manager must argue for any increase. Both adjustment costs and the budgetary process just explained are plausible assumptions in Zimbabwe mining sector.

5.6 WHOLE MODEL

The explanatory power of the model is high at 92%, which means 92% of the variations in mining investment are explained by current output, lagged output and lagged investment. The model as a whole is significant at 5% (level of significance) since computed F (=68.44) > critical F (=3.20). Thus, the study rejects the null hypothesis and accepts that the flexible accelerator model significantly explains mining investment behaviour in Zimbabwe. This is hinged on positive and significant coefficients of lagged variables, indicating that current investment is based on previous year's output and investment levels.

6. GENERAL DISCUSSION ON FACTORS NOT INCLUDED IN THE ACCELERATOR MODEL

The flexible accelerator model is limited in that it does not take explicit account of many other factors, which at least theoretically, affect mining investment. It is the purpose of this section to briefly discuss these factors as they relate to Zimbabwe. Note that, while the flexible accelerator model estimated above is restricted to 1976-1997 period for reasons already given, the discussion in this section extends to the current period.

6.1 IRREVERSIBILITY, CAPITAL INTENSITY AND LEAD TIME CONSIDERATIONS

Investment irreversibility, capital intensity, long lead times and consequently long payback periods associated with mining have made the stability of regulations and security of titles critical factors to investment decisions (Gentry & O'Neil, 1984, p.5; and United Nations Conference on Trade and Development, 2010, p.39). As a result many Zimbabwean local mining enterprises have remained small-scale in order to reduce lead times, payback period and minimise resultant loss of investment in case of loss of titles.

6.2 RISK AND UNCERTAINTY

Mining is, from a market point of view, naturally high-risk business (See Gentry & O'Neil, 1984; and Gocht *et al*, 1988), and in Zimbabwe, it has recently been beset by uncertainty[1]. While export earnings *per se* can theoretically be projected based on international prices and planned output, there is uncertainty on these projections being actually realized where dynamics on property rights are prevalent. Many unfinished issues emanating from the country's land reform programme, for example, outstanding compensations and unending court disputes over farmland, have created perceptions of uncertainty, which have resulted in sustained caution as well as postponement of large-scale investment in exploration and mining. A case in point is the Lupane gas exploration and development project, which has been held back by lack of clarity on shareholding (Mushawevato, 2011, p.B5). The long time it took to get the Indigenization and Empowerment laws finalized has had negative effect on investment along the way. The Mines and Minerals Act amendments are still to be finalized. This whole

[1] Risk is a situation in which the size (or various sizes) of an event occurs with some (known) probability (probabilities) so that we have a probability distribution of occurrences (Pearce, 1986). When the probability of occurrence is unknown we have an uncertainty.

period of waiting has been characterized, at times, by highly inconsistent policy statements and pure political rhetoric, resulting in uncertainty in policy and policy stability.

The question of political regime stability (see definition in Otto, 1992) has also been a significant factor affecting mining investment in Zimbabwe for the past decade. Before 2007/2008 elections the country was in a mode of a '50-50' anticipated government change. After the elections, the resultant temporary inclusive government (including three main political parties) has only served to perpetuate perceptions of uncertainty regarding regime stability. In a situation where the ruling party may change there are questions regarding whether or not the new regime would respect bilateral mining agreements that would have been made by the previous regime. However, on a positive note, the fundamental system of government (see definition in Otto, 1992) has been stable in Zimbabwe for a long time. Zimbabwe has regularly held elections since independence in 1980, and most of these have been successful by average African standards.

6.3 FISCAL REGIME

Minerals are non-renewable and this gives rise to critical issues in the use of these resources (Gentry & O'Neil, 1984, p.6). The 'natural heritage theory' argues that mineral exploitation should benefit all people in the society (country). This, in practice results in a broad fiscal regime comprising not only corporate taxes and government fees for the ground surface rentals (Government of Zimbabwe, n.d.) and for the various mining-related activities (prospecting, registration, mining and inspections), but also royalties and resource rent taxes on private mining companies. Recently most rates on the above various charges were hiked which resulted in intense and protracted engagement between Government, the Chamber of Mines and representatives of small miners. Royalties on some minerals, for example, copper and chrome,are far higher than objectively measured mineral depletion/depreciation levels (Mlambo, 2012).

In the past, there has been significant scope for determining tax obligations in advance of investment because of the availability of such information and its long-term nature (until it was changed recently). Among some of the fiscal incentives that have significantly promoted mining investment are: (a) the right to market directly subject to reporting requirements to the Minerals Marketing Corporation of Zimbabwe; (b) import duty exemption on capital goods imported for purposes of mining in the first five years; (c) tax deductibility at 100% of all capital expenditure; and (d) the right to have offshore accounts for major mining projects (Government of Zimbabwe, n.d.).

6.4 INTERNAL RATE OF RETURN AND INTEREST RATE

Keynes' theory of investment suggests that the rate of interest (r) relative to the internal rate of return (i) is an important decision variable on whether or not a piece of capital equipment should be purchased (Pentecost, 2000; Shapiro, 1974). It would be profitable to purchase the equipment if $r < i$. Thus a change in either r or i affects net investment (Shapiro, 1974). The downward movement in i reflects increasing operational costs and constraints bearing upon the particular activity (mining, in this case).

Until recently, a number of factors have affected the internal rate of return adversely, at a time when the rate of interest was rising. Lack of foreign currency especially for non-exporting mines severely restricted their capacity to import new investment capital. Before the multi-currency regime (2002- early 2009), companies have had to apply for foreign currency at the Reserve Bank of Zimbabwe (RBZ) and most of the times would not get it. Rising cost of imported spares due to the high parallel market exchange rates and general domestic inflation caused an escalation of operating costs, including rises in the wage bill. The National Railways of Zimbabwe failed and still fails to adequately meet the needs of mining due to old equipment. Electricity tariffs rose and continue to rise steeply while at the same time power outages have become a frequent phenomenon. The recent economic difficulties in the country have also resulted in the flight of skilled labour in all categories, including geologists, engineers, technicians and managers (This paragraph is based on Chamber of Mines, 2010; Roussos, 1988; Mining in Zimbabwe Magazine, 2002/2003; and Hawkins, 2009)

Interest rates have not had significant effect on mining investment in Zimbabwe partly because there have not been any significant lines of credit to the mining sector for fixed capital investment from the local credit market due to low savings. For example, in December 2009, total deposits in the local banking sector amounted to US$1.3 billion, an insignificant figure considering the country's requirements (Chamber of Mines, 2010). Studies have also concluded that a negative relationship between investment and interest cannot be supported in Zimbabwe (Mlambo, 2010; and Dzawanda, 1994), while others, which have obtained results consistent with classical theory, have found them to be insignificant (Dailami & Walton, 1989). However, the local banking sector is sometimes an important source of working capital. In this case, interest rate becomes an important factor that affects the operation of mines hence affects the general business outlook (Chamber of Mines, 2010).

6.5 CASH FLOW

The Chamber of Mines (2010) identifies two sources of cash flow problems for the mining sector in Zimbabwe. The first is stiff surrender requirements. For the gold sector mines were required to surrender 100% of their proceeds since 1997 (up to 2009 at the advent of the multi-currency regime) by being forced to sell their produce to the Reserve Bank of Zimbabwe (RBZ) in return for Zimbabwe Dollars. Miners surrendered at rates that were tremendously lower (especially over 2002-2009) than those obtaining in the parallel market where they sourced a significant share of foreign currency for imports. Secondly, the Reserve Bank of Zimbabwe owed mining companies substantial amounts of money in foreign currency - this debt emanating either from the unauthorized use by the Bank of funds in private accounts of mines to fund critical areas of need during the economic crisis, or unpaid mineral deliveries. With such restrained cash flows it was very difficult for mines to meet operational requirements let alone to achieve net investments. This actually led to many mines closing down and most placed on care-and-maintenance at the peak of the economic crisis in the country.

7. CONCLUSIONS AND RECOMMENDATIONS

The study shows that current investment is positively related to previous output level. The negative relationship between current investment and current output apparently reflects an inevitable trade-off that is linked to the small-scale nature of a significant section of the mining sector in Zimbabwe. The study confirms that lagged investment is a significant predictor of current investment, exhibiting an almost one-to-one correspondence. This has been linked in other studies to the existence of investment adjustment costs and a budgetary process that uses the previous investment level as default. The whole accelerator model is found to be significant.

The paper, however, notes that the estimated flexible accelerator model is limited in that it does not take into account other factors that are generally known to have affected investment in Zimbabwe in recent years. Besides considerations related to capital intensity and long lead times, these include political risk and uncertainty, fiscal regime, cash flow, credit availability, business operational conditions and interest rate. Risk and uncertainty are related to the current empowerment drive, outstanding amendments on the Mines and Minerals Act and perceived political regime instability. The direct influence of interest rate on mining investment in Zimbabwe is however insignificant because of limited credit availability, although it has affected the cost of working capital and, consequently, the marginal efficiency of capital.

Promotion of mining production through enhancing availability and affordability of mining sector services such as geo-surveys and analytical services, would maximize the positive effect of lagged output while minimizing the trade-off between current output and investment. Risks and uncertainties in the sector may be reduced through creation of an accessible economic database, and promotion of finality and clarity of pertinent legislation and its orderly implementation. There is need to espouse macroeconomic policies that further stabilize the economy (Driver and Moreton, 1992), and to review the mining fiscal regime in order to have a long-term rather than short-term view of mining development.

8. LIMITATIONS OF THE STUDY AND SCOPE FOR FURTHER RESEARCH

The flexible accelerator model estimated in this paper is very simplified. The desired level of capital is not only a function of the output variable but also of rental cost of capital which, in turn, is affected by several variables including the nominal rate of interest, the expected rate of inflation, depreciation costs, corporate taxes and so forth. As Chan and Williams (1999, p.2) confirm, the most common version of the accelerator model ignores factor prices. The relevant output variable in the desired capital equation (equation 1) is actually the expected output, which is not observable (Investment, n.d., p.47). The desired capital-output ratio is dependent on the relative prices of labour and capital, and is not a constant, though in the current study it is assumed to be a constant (See also Parker,

2010, and Chan and Williams, 1999). A major component of mining investment in Zimbabwe is Foreign Direct Investment (FDI). Thus, factors related to foreign capital markets as well as the exchange rate become important in the modelling of mining investment. All these issues mean that the flexible accelerator model in this study is limited by its narrowness. Further studies on this topic would do well to allow for a variable desired-capital output ratio, incorporate some expectation formation processes on output and inflation, and find a way of incorporating the fiscal regime and FDI into the modelling of investment.

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