Authors:
NICHOLAS NGEPAH
School of Economics, College of Business and Economics, University of Johannesburg, Auckland Park Kingsway Campus Johannesburg, South Africa
JOEL HINAUNYE EITA
School of Economics, College of Business and Economics, University of Johannesburg, Auckland Park Kingsway Campus Johannesburg, South Africa
MDUDUZI BIYASE
School of Economics, College of Business and Economics, University of Johannesburg, Auckland Park Kingsway Campus Johannesburg, South Africa
CHARLES SABA
School of Economics, College of Business and Economics, University of Johannesburg, Auckland Park Kingsway Campus Johannesburg, South Africa

THE EFFECT OF TRANSNET'S CAPITAL EXPENDITURE AND INVESTMENT IN VARIOUS OTHER SELECTED SECTORS OF THE SOUTH AFRICAN ECONOMY

ABSTRACT

As South African government continues to inject capital into its state-owned enterprises, the question is, has the capital injection into Transnet brought about investment in the different economic sectors? Addressing this question is critical, given the poor performance of state-owned companies in the past two decades. A battery of estimation techniques were utilised to achieve our objective. The findings from the causality results suggest that Transnet's capital expenditure results in investment in the South African economy. The findings robustly confirmed that Transnet's capital expenditures are positively and significantly associated with levels of investment, although the impact differs by sector. The study posits that the impact occurs through the degree of backward and forward linkages that Transnet's activities have with the rest of the economy. It is suggested that significant investment in Transnet should be accompanied by linking Transnet's procurements with local content within South Africa's economic sectors.

Keywords: Fixed Effects-IV, Transnet, Endogeneity, Hausman and Taylor
JEL Classification: C22, C32, E22

RIASSUNTO

L'effetto della spesa in conto capitale di Transnet e degli investimenti in diversi altri settori dell'economia del Sud Africa

Poiché il governo sudafricano continua a immettere capitali nelle sue imprese, la domanda che ne deriva è: l'immissione di capitali in Transnet ha portato ad un aumento degli investimenti nei vari settori economici? Non è facile rispondere a questo quesito, data la scarsa performance delle aziende statali negli ultimi vent'anni. Per realizzare il nostro obiettivo abbiamo utilizzato una serie di tecniche di valutazione. Le evidenze dei test di causalità suggeriscono che la spesa in conto capitale di Transnet si traduce in investimenti per l'economia sudafricana. Infatti, tali risultati confermano che la spesa in conto capitale di Transnet è positivamente e significativamente associata agli investimenti, benché l'impatto sia differente da settore a settore. Secondo lo studio tale impatto si realizza tramite le connessioni che Transnet ha con gli altri settori economici. Le conclusioni suggeriscono che significativi investimenti in Transnet debbano essere accompagnati da appalti di Transnet banditi a livello locale all'interno dei settori economici del Sud Africa.

1. INTRODUCTION

Transnet as a corporate entity is fully owned by the South African government. It is the largest and most crucial part of the freight logistics chain that delivers goods to all South Africans. It further aims at supporting and contributing to the country's freight logistics network. Every day, Transnet delivers thousands of tons of goods around South Africa through its pipelines both to and from its ports. It moves export cargo onto ships and unloads goods from overseas. The operating divisions of Transnet include: (i) Transnet freight rail; (ii) Transnet rail engineering; (iii) Transnet national ports authority; (iv) Transnet port terminals; (v) Transnet pipelines; and (vi) Transnet property. Transnet's objective is to ensure a globally competitive freight system that enables sustained growth and diversification of the country's economy. Despite challenging global and local economic conditions (measured by real GDP growth rate), the outlook for Transnet's investment has remained fairly robust.

According to a Transnet Integrated Report (2017), the company intends to invest in the region of

"R229,2 billion over the Market Demand Strategy (MDS) period, with between R340 billion and R380 billion to be invested over the next 10 years to increase capacity across all commodities and sectors".

Other infrastructure investment highlights for the year include: (i) R2 billion invested in rail infrastructure; (ii) R2,3 billion invested in the wagon build programme; (iii) R137 million invested in expanding capacity for manganese beyond 5,5 metric tonnes (mt), taking the total investment to R811 million so far; (iv) R145 million invested in the coal line expansion to 81 mt, including the upgrade of yards, lines and electrical equipment; (v) R28 million investment in the Waterberg upgrade Stage II to grow rail capacity to 6 mt through incremental upgrades of the existing rail networks and yards using additional loops, while maintaining the existing axle loads, electrical upgrades and improved train control systems; and (vi) R1,5 billion investment in the New Multi-Product Pipeline (Transnet, 2017). The 24-inch main pipeline and 16-inch inland pipelines have been fully commissioned and are operational. The pipelines have transported 15 billion litres of diesel from Durban to inland regions since commissioning. R1 billion has been expended in the maintenance and acquisition of cranes, tipplers, dredgers, tugs, straddle carriers and other port equipment.

The studies of Teboho *et al.* (2019), Phiri (2019), Wiafe and Anning (2021), Zhang (2021), Arogundade *et al.* (2021) etc. that focuse on different geographical location (including South Africa) failed to investigate the effects of Transnet's capital expenditure and investment in various other selected sectors of the South African economy. Despite the significant role played by Transnet in the economy and the large investments it has made, there are few empirical studies that analyse the potential impact of Transnet's activities, especially Transnet's investment in the South African economy. Thus, the purpose of this study is to evaluate the effects of Transnet's different capital expenditure (rail, pipelines, and sea-ports) on the company's total investments and on various sectors of the economy. The latter analysis (sector/industry-level analyses) is important because the impact of Transnet's different capital expenditures could differ among distinct sectors.

With the perception of high logistics costs, increasing budget deficits and continuous demand for cash injections into state-owned entities like Transnet, the rationale for continuous support of such entities has recently come under scrutiny. These perceptions must be examined against the overall economic benefits of activities of entities like Transnet. It is against this background that the study seeks to investigate the impact of Transnet's capital investment expenditure on

capital formation in the rest of the South African economy. This study focuses on the effects of capitalisation of Transnet's respective operational divisions on investment, as a measure of expansion in the rest of the economic sectors of South Africa. For this purpose, the research first examined whether Transnet's capital injection causes investment in other economic sectors in South Africa. The question of causality versus correlation is a crucial one in making robust statistical inference. Informed by the findings of the causality analyses, the work further employed the Hausman and Taylor (1981) estimation approach, which offers a hybrid of the fixed effects and generalized least squares (random effects) models. This procedure allows simultaneous control of the correlation between regressors and unobserved individual effects (such as fixed effects). The model identifies estimates for time-invariant covariates, such as sectors, as a random effects estimator. Furthermore, it eliminates the uncertainty associated with the choice of instruments, since exogenous variables and their means over time are used as efficient instruments. To ensure robustness of the estimated results, various other methods (i.e. pooled OLS, random effects, fixed effects IV, and the dynamic fixed effect) were used. Moreover, panel Granger causality tests were performed in order to analyse the bidirectional relationship between variables. More specifically, we implemented the Granger (1969) non-causality test for heterogeneous panels developed by Dumitrescu and Hurlin (2012).

The study proceeds as follows: section two reviews the existing empirical literature on the determinants of investment. Section three presents the outputs of the causality findings. Based on the results of causality in section three, section four discusses the appropriate methods and describes the dataset used in this study. Section five provides empirical results on the effects of Transnet's different capital expenditures (rail, pipelines, and seaports) on total investment and various sectors of the economy. The final section provides concluding remarks.

2. Literature review

Literature has shown that capital and investment are key to the growth of various sectors of the economy (see for example, D'Adda and Scorcu, 1996; Karras, 1997; Homaifar *et al.*, 1998; Ghali, 1999; Goel *et al.*, 2004). The empirical literature on the determinants of investment behaviour is broad and is usually divided into two categories: macro studies using time series data, and micro studies using firm-level data (Acosta and Loza, 2005). Based on these two categories, we reviewed previous studies.

2.1. Micro-Studies

Micro-studies that analyse the factors influencing investment typically find regional development, payment delays, loans granted to politically connected firms, uncertainty, cash flow, institutional factors and corporate debt structure to be important determinants of investment. Uncertainty is the key variable commonly investigated in the literature as the determinant of investment. In their seminal paper, Leahy and Whited (1996) examined the nexus between investment and uncertainty in a panel of firms by using the Holtz-Eakin *et al.* (1988) study. The findings suggest that an increase in uncertainty decreases investment, primarily through its effect on Tobin's Q ratio. Studies that concur with these findings include those of Minton and Schrand (1999) and Bulan (2005), even though they used different proxies to measure uncertainty. The view that cash flow and firm investment are positively related is common in the literature (see Fazzari *et al.*, 1988; Hoshi *et al.*, 1991; Fazzari and Petersen, 1993; Hubbard *et al.*, 1995; Kaplan and Zingales, 1997; Cleary, 1999; Vermeulen, 2002; Mizen and Vermeulen, 2005; Bond and Reenen, 2007; Sun and Nobuyoshi, 2009). For example, the results of Carpenter *et al.* (1994) and Fazzari *et al.* (1988), show that firms facing the problem of financial restrictions are more sensitive to cash flow when it comes to investment matters, while on the contrary, Kaplan and Zingales (1997) suggest that the responsiveness of a firm's investment to changes in cash flow is larger for firms that have less financial restrictions.

Ying and Yuande (2013) investigated the effects of bank lending incentives on firms' investment behaviours, based on a sample of 4 012 firm-year observations. The study period spans from 1999 to 2005 and used the pooled regression OLS estimation technique for the case of China. The study findings showed that regional development with regard to market development and government quality improvement reduces the negative impact of politically connected lending on firms' investment efficiency. In addition, the study found that loans granted to politically connected firms are less influenced by those firms' profitability and tangibility. From the Ying and Yuande (2013) study, it clear that China's market development and government quality improvement cannot be compared to other developing countries like Nigeria, Cameroon, Zambia, etc. This is a wake-up call for these and all developing countries to learn from the rapid development of China. Gonzalez-Uribe and Leatherbee (2018) estimated the degree of responsiveness of investment to the cost of outside equity in young firms by applying a difference-in-difference approach. The findings showed that on average, a 10% drop in the cost

of outside equity leads to a 1.6% increase in investment, because the eligible firms usually issued equity in response to a subsidy that would have doubled investors' returns. The study further concluded that there is a large complementarity between outside equity and non-equity liabilities in young firms. Bloom *et al.* (2003) also used the variance of stock returns to measure uncertainty and found similar results – that uncertainty dampens investment. Although the majority of empirical studies seem to suggest that uncertainty and investment are inversely related, the results are far from being unanimous. There is a line of literature that follows Abel's (1983) emphasis on the possible positive effects of great uncertainty on long-term investment.

There are a few attempts in the literature that examine the impact of (cross-country) institutional factors on domestic investment on the basis of firm-level data (see Gaviria, 2002; Batra *et al.,* 2003; Asiedu and Freeman, 2009). For example, the Asiedu and Freeman (2009) study investigated the impact of corruption on investment at both the firm level and country level. The study utilised ordinary least squares (OLS) with heteroskedastic-robust standard errors and iteratively re-weighted Least Squares (IRLS). The study findings suggest that the effect of corruption in investment varies significantly across regions. Specifically, corruption is found to have a negative and significant effect on investment growth for firms in transitioning countries but has no significant impact on firms located in Latin America and Sub-Saharan Africa. Correspondingly, Gaviria (2002) found a negative effect of corruption on firm-level investment growth. This in contrast to the Batra *et al.* (2003) study, which covered 2 612 firms in 29 countries, and found no evidence of the effects of corruption on firm-level investment growth.

Aygun *et al.* (2014) examined the relationship between corporate debt structure and levels of investment in Turkey, using regression and correlation analysis. The results revealed that corporate debt structure is positively and significantly associated with investments made by firms. The study concluded that the results support to the view that higher levels of long-term debt in total debt structure reduce investment for firms with high growth opportunities. Bialowolski and Weziak-Bialowolska (2014) used data from a customised survey on receivables to investigate the determinants of investment decisions of companies in Poland. The results of the study suggest that there are two driving forces determining the investment decisions of Polish companies: (i) macroeconomic factors; (ii) law-related factors, with the relative importance of the former lower than the latter.

2.2. Macro-Studies

Acosta and Loza (2005) examined the macroeconomic determinants of investment decisions for the case of Argentina. The study applied the Engle and Granger cointegration technique. Firstly, the findings of the study showed that investment decisions in the short run, are significantly associated with shocks in returns (exchange rate, trade liberalisation). Secondly, in the long run, the capital accumulation path seems to be significantly associated with well-developed financial and credit markets and perspectives of fiscal sustainability. Salahuddin and Islam (2008) investigated gross investment behaviour in a panel of 97 developing countries. A fixed effects model was employed to analyse the data for their study. The results suggested that investment decisions still seem to be significantly affected by traditional determinants such as growth, domestic savings, etc. Their results however, showed a non-significant effect of real interest rate and uncertainty on investment.

de Mendonça and Lima (2011) examined the macroeconomic determinants of investment under inflation targeting by GMM models for the case of Brazil. The findings of the study highlighted the importance of macroeconomic variables for the determination of investment. In particular, they found that the success of inflation targeting creates a stable macroeconomic environment that promotes private investment. On the one hand, changes in the public debt, according to Serven and Solimano (1993), may have an impact on investment. An increase in public debt can lead to a decline in private investment as interest rates rise and lending becomes tighter. On the other hand, when public debt is channelled towards public investment and is complementary to private investment (particularly infrastructure), the result operates as a stimulus for aggregate investment in the economy. Furthermore, changes in the exchange rate (currency devaluation) can also affect investment decisions by increasing the real interest rate, according to the views of de Mendonça and Lima (2011). Periods of economic prosperity obviously contribute to stimulating an increase in investment (see Blejer and Khan, 1984; Greene and Villanueva, 1991). Indeed, understanding the behaviour of an economy's investment requires an understanding of aggregate demand factors. Macroeconomic stability, as a result of effective monetary and fiscal policy management, is particularly important for guiding investment. Thus, the primary argument is that a reduction in uncertainty about key macroeconomic factors can lead to an increase in investment (Caballero, 1993; Serven and Solimano, 1993).

3. ESTIMATION METHODS AND DATA

3.1. Estimation Methods

Against the background of the described literature, this study attempted to quantify the effects of Transnet's different capital expenditure (rail, pipelines, and seaports) on total investment for the overall sample and related sectors (agricultural, forest and fisheries, mining, manufacturing, electricity, gas and water, construction, and wholesale and retail). Studying the effects of Transnet's different capital expenditure on investment, the researcher was faced with the challenges of potential "reverse causation" effects (from GDP to investment), the possible misspecification of the model, and statistical problems with data availability.

Hausman and Taylor (1981) offered a remedy to these problems by providing an estimator that is a hybrid of the Fixed Effects and Generalized Least Squares (random effects) models. This procedure allows simultaneous control of the correlation between regressors and unobserved individual effects (as fixed effects). It also enables identification of the estimates for the time-invariant covariates, such as sectors, as a random effects estimator. Furthermore, it eliminates the uncertainty associated with the choice of instruments, since exogenous included variables, and their means over time, are used as efficient instruments. To ensure robustness of the estimated results, various other methods such as pooled ordinary least squares random effects, fixed effects IV, and dynamic fixed effects were used. Detailed descriptions of these estimation methodologies are presented in the appendix.

3.2. Datasets

The study employed annual data (described in Table 1 below) for the period 1992-2016 for various sectors of the South African economy. The sample contained a representative panel of sectors covering agricultural, forest and fisheries, mining, manufacturing, electricity, gas and water, construction, and wholesale and retail. The time frame and the number of sectors used in this study were carefully chosen based on the availability of data. Data for aggregate capital formation (i.e., based on all economic sectors minus transport, storage and communications) was collected from Quantec. Transnet's data for capital expenditure on rail, pipelines and seaports was derived from Transnet's financial reports. The e-data for the control variables'

interest rates, gross national product, consumer price index, and central and government expenditure as a share of GDP was collected from the South African Reserve Bank.

The study's main independent variable of interest is investment, and it was expected that Transnet investment would be positively associated with aggregated investment and other sectors. Several other variables have an impact on investment and thus, a selected set of macroeconomic and institutional variables affecting investment in South Africa were employed as controls in our model. The controls, which were broadly informed by the related literature on investment and data availability, fell into two main categories. Firstly, the average ratio of broad money (M2) to GDP, trade openness, general government expenditure, and labour force. The second pertained to the proxies for institutional capacity such as the rule of law and regulatory quality, among others. A brief description of the variables and their *a priori* expectations is discussed as follows:

- The average ratio of broad money (M2) to GDP is a common measure of financial deepening and is expected to have a positive and significant effect on investments.
- Interest rates are important determinants of investment. Following neoclassical theory, a negative coefficient of real interest rates is expected to impact negatively on investment.
- GNP *per capita* measures overall levels of a country's economic development. We expect a positive relationship between countries with higher levels of development and improved access to water and sanitation facilities.
- Inflation is measured by the consumer price index (CPI). It reflects the annual percentage change in cost to the average consumer of acquiring a basket of goods and services that may be fixed or changed at specified intervals. *A priori*, we expect a negative relationship between investment and inflation.
- Total government expenditure as a share of GDP captures government expenditure for all its operating activities in providing goods and services, including compensation of employees, interest and subsidies, grants, and social benefits. *A priori*, we expect a negative relationship between government spending and investment. This is due to the crowding out effect.

Table 1 presents a summary of the variables and descriptions and their sources. It also presents the expected impact of the variables on investment in other sectors of the South African economy.

TABLE 1 - *Variables, Description and Data Sources*

Variables	Meaning	Data source	Theoretical expectation
k_fdef (dependent variable)	capital formation in all economic sectors minus transport, storage and communications	Quantec	
k_raildef	capital expenditure by Transnet on the rail	Transnet's financial reports	positive
k_pldef	capital expenditure by Transnet on pipelines	Transnet's financial reports	positive
k_portdef	capital expenditure by Transnet on the sea ports	Transnet's financial reports	positive
ir	interest rates	SARB	negative
gni	gross national income	SARB	positive
cpi	consumer price index	SARB	negative
ngovexgdp	central government expenditure as a share of GDP	SARB	positive
year	trend		
metro	metropolitan municipality dummies		positive
sector1 (reference group)	Agriculture, forestry and fisheries		
sector2	Mining and quarrying		
sector3	Manufacturing		
sector4	Electricity, gas and water		
sector5	Construction		
sector6	Wholesale and retail trade, catering		
sector7	Finance, insurance, real estate		
sector8	Community, social and personal services		

Note: SARB means South African Reserve Bank.

4. EMPIRICAL ANALYSIS

4.1 Preliminary Analysis

In this section, the correlation matrix and panel causality test results are not reported in order save space, but are available upon request. The correlation matrix results reveal that the correlation coefficients between Transnet's different capital expenditures have the correct *a*

priori positive signs, while the results for the control variables differ. Although the correlation matrix results provide a good initial sketch of the links among variables, it does not imply causality in either direction. To ascertain these *a priori* expectations we performed panel Granger causality tests and proceeded with an empirical estimation of the data.

Prior to the econometric results, we applied the Dumitrescu and Hurlin (2012) heterogeneous panel causality test to examine the causal relationship among the variables. In summary, the results revealed strong evidence of bidirectional causality between the variables, regardless of the number of lags included in the model. This suggests that the appropriate econometric models are those that control for endogeneity.

In conclusion, Transnet capital expenditure on seaports, pipelines and railway cause capital formation/investment, and capital formation/investment causes Transnet's capital expenditure on seaports, pipelines and railway in the economy of South Africa. We use this information for proper econometric specifications in the next sections.

4.2 Pooled OLS, Random Effects, and Dynamic Fixed Effect Analysis

Table 2 presents the baseline empirical estimates carried out using the pooled OLS, random effects, and dynamic fixed effect. Specifically, columns 1, 2, 3 and 4 in Table 2 present the pooled OLS, random effects, and dynamic fixed effect estimates of Transnet's different capital expenditure (rail, pipelines, and seaports) on total investment for the overall sample. For an explanation of the results, we focused on the dynamic fixed effect estimates because of the advantage they have over other techniques. The dependent variables are log-transformed capital formation in all economic sectors minus transport, storage and communications. All models (i.e., pooled OLS, random effects, and dynamic fixed effect) used a continuous independent variable for Transnet's different capital expenditure (rail, pipelines, and seaports). Each of the models was estimated separately for each of the investment levels considered.

The baseline estimates suggested that the coefficients of the variables of interest displayed expected signs, with lagged investment showing a negative relationship. The dynamic fixed

effect results seemed to agree on signs of coefficients with slightly different magnitudes and levels of significance[1].

TABLE 2 - *The Baseline Estimation Results for the Overall*

Models	(1)	(2)	(3)
Variables	Pooled	FE	RE
k_raildef	**0.003*** **	**0.003*** **	**0.003*** **
	(0.001)	**(0.000)**	**(0.000)**
k_pldef	**0.003**	**0.003*** **	**0.003*** **
	(0.002)	**(0.001)**	**(0.001)**
k_portdef	**0.003**	**0.003*** **	**0.003*** **
	(0.003)	**(0.000)**	**(0.000)**
ir	-1.015***	-1.015***	-1.015***
	(0.161)	(0.077)	(0.077)
gni	0.000*	0.000***	0.000***
	(0.000)	(0.000)	(0.000)
cpi	-0.974***	-0.974***	-0.974***
	(0.191)	(0.070)	(0.070)
ngovexgdp	1.102***	1.102***	1.102***
	(0.390)	(0.077)	(0.077)
Year	2.947***	2.947***	2.947***
	(0.541)	(0.196)	(0.196)
	(0.003)	(0.000)	(0.000)
Constant	-5,878.636***	-5,878.636***	-5,878.634***
	(1,076.252)	(393.042)	(391.975)
Observations	47,344	47,344	47,344
R-squared	0.026	0.093	
Municipality FE	NO	YES	NO
Number of sgid		2,152	2,152

Robust standard errors in parentheses.
*** p<0.01, ** p<0.05, * p<0.1.

[1] But the pooled OLS estimates for example, suggest that only one of the three levels of investment is positively and significantly associated with total investment (capital expenditure by Transnet on rail). Although positive, none of the other levels of investment (capital expenditure by Transnet on the pipelines and seaports) have a significant impact on the total investment.

The other explanatory variables added explanatory power to the estimation and are mostly significant. Unsurprisingly, the interest rate was negatively related to investment and statistically significant across the baseline models. For example, this is in line with the Gilchrist and Zakrajsek (2007) study, which suggested that a one percentage point increase in the user cost of capital implies a reduction in investment of 50 to 75 basis points and in the long run, a one per cent reduction in capital stock.

Consistent with previous investigations (such as Ciżkowicz and Rzońca, 2013) the estimated coefficient on inflation presented an expected negative and statistically significant estimate on the investment level. The results are in line with the Ciżkowicz and Rzońca (2013) study that investigated the relationship between corporate investment and inflation on a sample of 21 OECD countries in the years 1960-2005. They found that inflation and investment were inversely related. Their result was robust to changes in the specification of the estimated equation, data frequency and the sample considered.

The empirical results in Table 2 point to a positive and significant link between gross national product and the level of investment, consistent with our expectations. The coefficient of the government expenditure as a share of the GDP variable had a theoretically unexpected positive sign and is highly statistically significant, implying that the higher the government expenditure, the higher the investment level.

4.3 Robustness Checks: Hausman-Taylor Estimates

Table 3 presents the Hausman-Taylor results, which account for endogeneity among the variables. As noted earlier, we used the lagged value of Transnet's different capital expenditures as an instrument, and first checked that our instrument was valid (the lagged value of Transnet's different capital expenditure is correlated with the dependent variable). The rule of thumb is that the Cragg-Donald Wald F statistic and Kleibergen-Paap Wald F statistic test in fixed effect-IV results should exceed a value of 10 for the instrument to be valid. The results of these specification tests (the Cragg-Donald Wald F statistic and Kleibergen-Paap Wald F statistic tests) rejected the hypothesis that the endogenous variable is weakly identified and are both above the value of 10. Comparing these results to the OLS coefficients, the Hausman-Taylor estimates are slightly larger in magnitude, and statistically significant, implying that the

unaccounted-for sector specific heterogeneity and endogeneity in the pooled OLS version of the model could lead to some considerable and significant distortions.

The positive link between Transnet's different capital expenditure and total investment is statistically significant across both the pooled OLS and the Hausman-Taylor estimations. The link is even stronger in the latter case when the endogeneity is accounted for. Regarding the effects of other explanatory variables on investment, the Hausman-Taylor estimate (which accounts for endogeneity among the variables) bore a resemblance to the results of the pooled OLS estimates. Specifically, coefficients for inflation (measured by the consumer price index) and the interest rate, remain an important determinant of economic total investment, and enter negatively and significantly in both specifications. In line with the pooled OLS, coefficients for government expenditure as a share of GDP and gross national product, once again matter in explaining economic growth and enter with predictable positive signs.

Table 3: Other Estimations Results for the Overall Models

Variables	(7) Hauman-Taylor (HT)	(8) HT with Bootstrapped SE	(9) Dynamic FE
L.k_fdef			-0.802***
			(0.063)
k_raildef	0.003***	0.003***	0.010***
	(0.000)	(0.000)	(0.001)
k_pldef	0.003***	0.003***	0.010***
	(0.001)	(0.001)	(0.004)
k_portdef	0.003**	0.003***	0.025***
	(0.001)	(0.000)	(0.003)
ir	-1.015***	-1.015***	-8.814***
	(0.102)	(0.069)	(0.966)
gni	0.000***	0.000***	0.004***
	(0.000)	(0.000)	(0.001)
cpi	-0.974***	-0.974***	-6.555***
	(0.111)	(0.062)	(0.736)
ngovexgdp	1.102***	1.102***	8.131***
	(0.242)	(0.080)	(0.880)
year	2.947***	2.947***	17.518***
	(0.364)	(0.182)	(1.938)
	(0.001)	(0.000)	(0.003)
sector2	14.911***	14.911***	
	(4.558)	(5.092)	
sector3	29.251***	29.251***	
	(4.558)	(4.256)	
sector4	13.304***	13.304***	
	(4.558)	(2.324)	
sector5	-3.796	-3.796***	
	(4.558)	(0.479)	
sector6	5.943	5.943***	
	(4.558)	(1.565)	
sector7	34.787***	34.787***	
	(4.558)	(6.209)	
sector8	-2.448	-2.448***	
	(4.558)	(0.568)	
Constant	-5,890.130***	-5,890.130***	-34,985.903***
	(723.824)	(364.837)	(3,871.411)
Observations	47,344	47,344	5,649
R-squared			0.918
Municipality FE	YES	YES	YES
Number of sgid	2,152	2,152	
Number of groups			269
CD Stat			666.57
CD p-value			0.000

Robust standard errors in parentheses.
*** p<0.01, ** p<0.05, * p<0.1.

4.4. Analysis by Different Sectors

Table 4 presents the results for the different economic sectors, while Table 5 reports the marginal investment response to a billion-rand capex in Transnet's divisions. This section looked at whether Transnet's capital expenditure effects are different across the various sectors (agriculture, forest and fisheries; mining; manufacturing; electricity, gas and water; construction and wholesale & retail). For convenience, the impact of Transnet's capital expenditures were estimated exclusively by the Hausman-Taylor specification, which accounts for the endogeneity that the baseline estimators (pooled OLS, random effects, and dynamic fixed effect) fail to address. Several results for the different economic sectors are noteworthy. The investment for different economic sectors was found to respond positively to Transnet's capital expenditure, and the sensitivity of investment to Transnet's capital expenditure were comparatively higher for the mining sector compared to other sectors.

Besides Transnet's capital expenditure, investment for different economic sectors (agriculture. forest and fisheries, mining, manufacturing, electricity, gas and water, construction and wholesale & retail) were also significantly influenced by other control variables. These results are broadly consistent with the baseline results regarding the effect and significance of the control variables across the six groups of sectors. Consistent with the baseline estimation, the interest rate once again presented a negative relationship with the investment for different economic sectors. Inflation also showed negative and significant parameters across the six groups of sectors. On the other hand, government expenditure as a share of GDP was only insignificant in the mining sector, showing a positive link, as in the baseline estimation. It is noteworthy that the estimated coefficient on gross national product presented negative estimates.

TABLE 4 - *Hausman-Taylor Estimator (with Bootstrapped SE) for Different Economic Sectors*

	(1)	(2)	(3)	(4)	(5)	(6)
Variables	Agric. Forest & Fisheries	Mining	Manufacturing	Electricity, Gas & Water	Construction	Wholesale & Retail
k_raildef	**0.003*** **	**0.003*** **	**0.004*** **	**0.007*** **	**0.000*** **	**0.002*** **
	(0.000)	**(0.001)**	**(0.001)**	**(0.001)**	**(0.000)**	**(0.000)**
k_pldef	**0.002*** **	**0.017*** **	**0.001*** **	**0.007*** **	**0.003*** **	**0.003*** **
	(0.000)	**(0.004)**	**(0.000)**	**(0.001)**	**(0.000)**	**(0.000)**
k_portdef	**0.002*** **	**0.011*** **	**-0.007*** **	**0.012*** **	**0.002*** **	**0.002*** **
	(0.000)	**(0.003)**	**(0.001)**	**(0.001)**	**(0.000)**	**(0.000)**
Ir	-0.279***	-0.353***	-2.465***	-0.309***	-0.178***	-0.800***
	(0.015)	(0.104)	(0.320)	(0.027)	(0.020)	(0.076)
gni	-0.000***	-0.000	0.002***	-0.001***	-0.000***	0.000***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
cpi	-0.450***	-0.256***	-2.551***	-0.239***	-0.181***	-0.858***
	(0.024)	(0.083)	(0.337)	(0.019)	(0.019)	(0.080)
ngovexgdp	0.030***	0.049	1.563***	2.313***	0.201***	0.767***
	(0.007)	(0.116)	(0.226)	(0.234)	(0.021)	(0.072)
year	1.189***	1.441***	6.854***	1.881***	0.617***	2.501***
	(0.069)	(0.425)	(0.937)	(0.179)	(0.065)	(0.233)
metro	-0.347	-17.691***	132.782***	48.627***	9.782***	38.415***
	(0.924)	(6.127)	(15.783)	(5.982)	(1.133)	(5.610)
Constant	-2,352.425***	-2,854.149***	-13,683.578***	-3,770.298***	-1,229.973***	-4,995.081***
	(136.154)	(844.044)	(1,869.830)	(359.292)	(129.073)	(465.838)
Observations	5,918	5,918	5,918	5,918	5,918	5,918
Number of sgid	269	269	269	269	269	269
Municipality FE	YES	YES	YES	YES	YES	YES

Bootstrapped standard errors in parentheses.
*** p<0.01, ** p<0.05, * p<0.1.

TABLE 5 - *Marginal Investment Response to a Billion Rand Capex in Transnet's Divisions*

Effect of 1 Billion Rand Capex on	Agric. Forest & Fisheries	Mining	Manufacturing	Electricity, Gas & Water	Construction	Wholesale & Retail
Railway	3000000	3000000	4000000	7000000	0	2000000
pipeline	2000000	17000000	1000000	7000000	3000000	3000000
sea ports	2000000	11000000	-7000000	12000000	2000000	2000000

The implications of the results are that a billion-rand injection into Transnet's divisions would collectively bring about seven million rand in corresponding investment in agriculture; thirty-one million rand in mining; twenty-six million in electricity, gas and water; five million in construction and seven million rand in the wholesale and retail sectors. The net effect of Transnet's capital injection is negative in the manufacturing sector, particularly from the seaports. A more detailed analysis is required to understand the dynamics of the seaports that bring about such effects, as this may come through competitiveness effects. Overall, we conjecture that the positive effects of Transnet's capital injection on investment in other sectors of the economy come through a combination of forward and backward linkages of the freight transport sector with the rest of the economy.

5. CONCLUSION AND POLICY IMPLICATIONS

This paper undertook to assess the impact of Transnet's capital expenditure on investment in other economic sectors in South Africa. Transport infrastructure can play a significant role in spurring the expansion of other sectors of an economy, and the results of the study suggest this. Investing in a parastatal or state-owned company such as Transnet can therefore have significant beneficial effects in terms of business expansion through the corresponding investment it provokes.

Overall, the effects of investment in all three of Transnet's divisions (rail, pipe and seaports) are positive. This positive relationship is significantly present in most of the economic sectors. A billion rand capital expenditure by Transnet collectively provokes seven million rands corresponding investments in agriculture; thirty-one million rands in mining; twenty-six million rands in electricity, gas and water; five million rands in construction, and seven million

rands in the wholesale and retail sectors. These positive effects could come about through a combination of forward and backward linkages of the freight transport sector with the rest of the economy.

The effects in the manufacturing sector are worrisome and call for a more detailed investigation as they correspond to the summary of findings in the earlier background exploration. The key suspect in this would be competitiveness of the ports and/or low levels of linkages between manufacturing and Transnet's activities. It is suggested that significant investment in Transnet should be accompanied by linking Transnet's procurements to local content within South African economic sectors.

Conflict of interest: The author(s) declare no potential conflict of interest with respect to the research, authorship, and/or publication of this article.

REFERENCES

Abel, A.B. (1983), "Optimal Investment under Uncertainty", *American Economic Review,* 73(1), 228-233.

Acosta, P. and A. Loza (2005), "Short and Long Run Determinants of Private Investment in Argentina", *Journal of Applied Economics*, 8(2), 389-406.

Aizenman, J. and N. Marion (1995), "Volatility, Investment and Disappointment Aversion", NBER Working Paper No. 5386, National Bureau of Economic Research, Cambridge: MA.

Aizenman, J. and N. Marion (1996), "Volatility and the Investment Response", NBER Working Paper No. 5841. National Bureau of Economic Research, Cambridge, MA, 02138.

Arogundade, S., M. Biyase and J.H. Eita (2021), "Foreign Direct Investment and Inclusive Human Development in Sub-Saharan African Countries: Domestic Conditions Matter", *Economia Internazionale/International Economics*, 74(4), 463-498.

Asiedu, E. and J. Freeman (2009), "The Effect of Corruption on Investment Growth: Evidence from Firms in Latin America, Sub-Saharan Africa, and Transition Countries", *Review of Development Economics*, 13(2), 200-214.

Aygun, M., I.C. Suleyman and M. Sayim (2014), "The Impact of Debt Structure on Firm Investment: Empirical Evidence from Turkey", *Archives of Business Research*, 2(2), 24-30.

Batra, G., D. Kaufman and A. Stone (2003), "Investment Climate around the World: Voices of the Firms from the World Business Environment Survey", The World Bank: Washington, DC.

Bleaney, M. (1996), "Macroeconomic Stability, Investment and Growth in Developing Countries", *Journal of Development Economics,* 48(2), 461-477.

Blejer, M. and M. Khan (1984), "Government Policy and Private Investment in Developing Countries", *IMF Staff Papers*, 31(2), 379-403.

Białowolski, P. and D. Weziak-Białowolska (2014), "External Factors Affecting Investment Decisions of Companies", *Economics:The Open-Access, Open-Assessment E-Journal*, 8, 1-22.

Bloom, N., S.R. Bond and J. Van Reenen (2003), "Uncertainty and Company Investment Dynamics: Empirical Evidence for UK Firms", CEPR Discussion Paper No. 4025, Centre for Economic Policy Research: London.

Bond, S. and J. Van Reenen (2007), *Microeconometric Models of Investment and Employment*, in: J.J. Heckman and E.E. Leamer (Eds), "Handbook of Econometrics", Volume 6, Part A, North-Holland: London.

Bulan, L.T. (2005), "Real Options, Irreversible Investment and Firm Uncertainty: New Evidence from US Firms", *Review of Financial Economics*, 14(3-4), 255-279.

Caballero, R. J. (1993), *On the Dynamics of Aggregate Investment*, in: L. Serven, A. Solimano (Eds), "Striving for Growth after Adjustment", Part A, The World Bank: Washington, DC.

Carpenter, R., S. Fazzari and B. Peterson, (1994), "Inventory Investment, Internal-Finance Fluctuations, and the Business Cycle", *Brookings Papers on Economic Activity,* 25(2), 75-138.

Cleary, S. (1999), "The Relationship between Firm Investment and Financial Status", *Journal of Finance*, 54, 673-692.

Ciżkowicz, P. and A. Rzońca (2013), "Does Inflation Harm Corporate Investment? Empirical Evidence from OECD Countries", *Economics: The Open Access, Open Assessment E-Journal*, 7(16), 1-38.

D'Adda, C. and A.E. Scorcu (1996), "What is the Degree of International Capital Mobility in Advanced Economies?", *Economia Internazionale/International Economics*, 49(2), 197-219.

de Mendonça, H.F. and T. R. V. D. S. Lima (2011), "Macroeconomic Determinants of Investment under Inflation Targeting: Empirical Evidence from the Brazilian Economy", *Latin American Business Review*, 12(1), 25-38.

Dumitrescu, E. and C. Hurlin (2012), "Testing for Granger Non-Causality in Heterogeneous Panels", *Economic Modelling*, 29(4),1450-1460.

Fazzari, S., G. Hubbard and B. Petersen (1988), "Financing Constraints and Corporate Investment", *Brookings Papers on Economic Activity,* 1, 141-206.

Fazzari S. and B. Petersen (1993), "Working Capital and Fixed Investment: New Evidence on Financing Constraints", *Rand Journal of Economics,* 24(3), 328-342.

Gaviria, A. (2002), "Assessing the Effects of Corruption and Crime on Firm Performance: Evidence from Latin America", *Emerging Markets Review*, 3(3), 245-268.

Ghali, K.H. (1999), "Capital Ownership and its Impact on International Trade and Economic Growth: An Empirical Analysis", *Economia Internazionale/International Economics*, 52(3), 357-371.

Gilchrist, S. and E. Zakrajsek (2007), "Investment and the Cost of Capital: New Evidence from the Corporate Bond Market", NBER Working Paper Series No. 13174, National Bureau of Economic Research, Cambridge: MA.

Goel, R.K., I. Hasan and R. Ram (2004), "Effect of General Uncertainty on Venture-Capital Investments: A Cross-Country Study", *Economia Internazionale/International Economics*, 57(3), 305-313.

Gonzalez-Uribe, J. and M. Leatherbee (2018), "The Effects of Business Accelerators on Venture Performance: Evidence from Start-up Chile", *Review of Financial Studies*, 31(4), 1566-1603.

Granger, C.W.J. (1969), "Investigating Causal Relations by Econometric Models and Cross Spectral Methods", *Econometrica*, 37(3), 424-438.

Greene, J. and D. Villanueva (1991), "Private Investment in Developing Countries: An Empirical Analysis", *IMF Staff Papers*, 38(1), 33-58.

Hausmann, R. and M. Gavin (1995), *Overcoming Volatility*, in: "Inter-American Development Bank, Economic and Social Progress in Latin America: 1995 Report", Inter-American Development Bank: Washington, DC.

Hausman, A.J. and E.W. Taylor (1981), "Panel Data and Unobservable Individual Effects", *Econometrica*, 49(6), 1377-1398.

Holtz-Eakin, D., W. Newey and S. Rosen (1988), "The Value of Changes in Life Expectancy", *Journal of Risk and Uncertainty*, 1(3), 285-304.

Homaifar, G.A., J. Zietz and O. Benkato (1998), "Determinants of Capital Structure for Multinational and Domestic Corporations", *Economia Internazionale/International Economics*, 51(2), 189-210.

Hoshi, T., A. Kashyap and D. Scharfstein (1991), "Corporate Structure, Liquidity, and Investment: Evidence from Japanese Industrial Groups", *Quarterly Journal of Economics,* 106(1), 33-60.

Hubbard, R.G., A.K. Kashyap and T.M. Whited (1995), "Internal Finance and Firm Investment", *Journal of Money, Credit and Banking*, 27(3), 683-701.

Kaplan, S.N. and L. Zingales (1997), "Do Investment-Cash Flow Sensitivities Provide Useful Measures of Financing Constraints?", *The Quarterly Journal of Economics,* 112(1), 169-215.

Karras, G. (1997), "Is Government Investment Underprovided in Europe? Evidence from a Panel of Fifteen Countries", *Economia Internazionale/International Economics*, 50(2), 223-235.

Leahy, J.V. and T.M. Whited (1996), "The Effect of Uncertainty on Investment: Some Stylized Facts", *Journal of Money, Credit and Banking*, 28(1), 64-83.

Minton, B.A. and C. Schrand (1999), "The Impact of Cash Flow Volatility on Discretionary Investment and the Costs of Debt and Equity Financing", *Journal of Financial Economics*, 54(3), 423-460.

Mizen, P. and P. Vermeulen (2005), "Corporate Investment and Cash Flow Sensitivity: What Drives the Relationship?", European Central Bank Working Paper Series No. 285.

Phiri, A. (2019), "The Feldstein-Horioka Puzzle and the Global Financial Crisis: Evidence from South Africa using Asymmetric Cointegration Analysis", *Economia Internazionale/International Economics*, 72(2), 139-170.

Ramey, G. and V.A Ramey (1995), "Cross-Country Evidence on the Link between Volatility and Growth", *American Economic Review*, 85(5), 1138-1151.

Salahuddin, M. and M.R. Islam (2008), "Factors Affecting Investment in Developing Countries: A Panel Data Study", *Journal of Developing Areas*, 42(1), 21-37.

Serven, L. and A. Solimano (1993), "Striving for Growth after Adjustment: The Role of Capital Formation", The World Bank: Washington, DC.

Sun, J. and Y. Nobuyoshi (2009), "Regional Disparities and Investment-Cash Flow Sensitivity: Evidence from Chinese Listed Firms", *Pacific Economic Review*, 14(5), 657–667.

Teboho, J.M., J.H. Eita and T.C. Nthebe (2019), "Does Corruption Hamper Inward FDI in South Africa from other African Countries?", A Gravity Model Analysis, *Economia Internazionale/International Economics*, 72(4), 513-532.

Transnet, (2017), "Integrated Report 2017", Transnet: Johannesburg.

Vermeulen, P. (2002), "Business Fixed Investment: Evidence of a Financial Accelerator in Europe", *Oxford Bulletin of Economics and Statistics*, 64(3), 213-231.

Wiafe, E.A. and L. Anning (2021), "Effects of SINO FDI on the Growth of South Africa", *Economia Internazionale/International Economics*, 74(1), 1-24.

Ying, Z. and Z. Yuande (2013), "Bank Lending Incentives and Firm Investment Decisions in China", *Journal of Multinational Financial Management*, 23(3), 146-165.

Zhang, K.H. (2021), "Upgrading Industries through Globalization: The Case of China", *Economia Internazionale/International Economics*, 74(4), 439-462.

APPENDIX

A1. ESTIMATION METHODS

In this paper, we follow the panel causality test suggested by Dumitrescu-Hurlin (2012). This test is a simple version of the Granger (1969) non-causality test for heterogeneous panel data models with fixed coefficients. It also accounts for two dimensions of heterogeneity: the heterogeneity of the regression model used to test the Granger causality and the heterogeneity of the causality relationships. The Dumitrescu–Hurlin panel causality test is based on a bivariate model. Equation 1 to 6 is used to analyse the causal relationship between Transnet capital expenditure on Sea Port, Pipeline, Railway and capital formation/investment in the economic sectors of South Africa from 1993 to 2016. Following the contribution of Dumitrescu and Hurlin (2012), this study will use the following models to test the Granger-causality between the variables.

A1.1. Panel Causal Relationship between Transnet Capital Expenditure on Sea Port and Capital Formation/Investment in other Sectors

Equation (1) tests the causality running from capital formation/investment to Transnet capital expenditure on Sea Port:

$$Inkf_{i,t} = \tau_{i,t} + \sum_{j=1}^{p} \lambda_i^{(j)} Inkf_{i,t-j} + \sum_{j=1}^{p} \beta_i^{(j)} lnTkxpport_{i,t-j} + \mu_{1i,t} \quad (1)$$

Equation (2) tests the causality running from Transnet capital expenditure on Sea Port to capital formation/investment:

$$lnTkxpport_{i,t} = \varphi_{i,t} + \sum_{j=1}^{p} \lambda_i^{(j)} lnTkxpport_{i,t-j} + \sum_{j=1}^{p} \beta_i^{(j)} Inkf_{i,t-j} + \mu_{2i,t} \quad (2)$$

A1.2. Panel Causal Relationship between Transnet Capital Expenditure on Pipeline and Capital Formation/Investment in other Sectors

Equation (3) tests the causality running from capital formation/investment to Transnet capital expenditure on pipeline:

$$Inkf_{i,t} = \tau_{i,t} + \sum_{j=1}^{p} \lambda_i^{(j)} Inkf_{i,t-j} + \sum_{j=1}^{p} \beta_i^{(j)} lnTkxppls_{i,t-j} + \mu_{1i,t} \quad (3)$$

Equation (4) tests the causality running from Transnet capital expenditure on pipeline to capital formation/investment:

$$lnTkxppls_{i,t} = \varphi_{i,t} + \sum_{j=1}^{p} \lambda_i^{(j)} lnTkxppls_{i,t-j} + \sum_{j=1}^{p} \beta_i^{(j)} lnkf_{i,t-j} + \mu_{2i,t} \quad (4)$$

A1.3. Panel Causal Relationship between Transnet Capital Expenditure on Railway and Capital Formation/Investment in other Sectors of the Economy

Equation (5) tests the causality running from capital formation/investment to Transnet capital expenditure on railway:

$$lnkf_{i,t} = \tau_{i,t} + \sum_{j=1}^{p} \lambda_i^{(j)} lnkf_{i,t-j} + \sum_{j=1}^{p} \beta_i^{(j)} lnTkxprail_{i,t-j} + \mu_{1i,t} \quad (5)$$

Equation (6) tests the causality running from Transnet capital expenditure on railway to capital formation/investment:

$$lnTkxprail_{i,t} = \varphi_{i,t} + \sum_{j=1}^{p} \lambda_i^{(j)} lnTkxprail_{i,t-j} + \sum_{j=1}^{p} \beta_i^{(j)} lnkf_{i,t-j} + \mu_{2i,t} \quad (6)$$

Where, kf is capital formation/investment, $Tkxpport$ is Transnet capital expenditure of Sea Port, $Tkxppls$ is Transnet capital expenditure on pipeline, $Tkxprail$ is Transnet capital expenditure on railway β and λ are the slope coefficients, i indicates each economic sector under study (i = 1,..., N), t indicates time period (t = 1, ..., T), p is the number of lag length, τ is the intercept and $\mu_{i,t}$ refers to the error term. The findings from the panel causality tests are sensitive to the lag length. In this study, the maximum lag length was set to five.