Republic of South Africa
Systematic Country Diagnostic

An Incomplete Transition:
Overcoming the Legacy of Exclusion in South Africa

Background note

Exchange Rate Volatility, Uncertainty, and Corporate Investment

Georgios Chortareas and Emmanouil Noikokyris

WORLD BANK GROUP

Exchange Rate Volatility, Uncertainty, and Corporate Investment

Georgios Chortareas[1] and Emmanouil Noikokyris[2]

Introduction

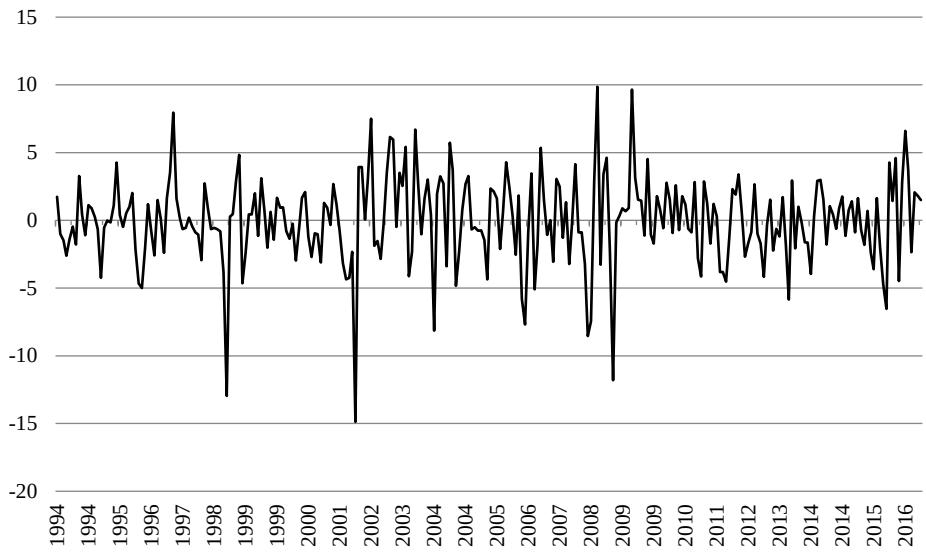
This study examines the implications of exchange rate volatility for corporate investment for the period 1995-2016 in the small open economy of South Africa. During this period, South Africa has experienced notable exchange rate variability, as casual inspection of figure 1 reveals. The depreciation of South African real effective exchange rate (*RER* hereafter) by almost 40% during the period from 1998 to 2001, and the subsequent appreciation by almost 50% until the end of 2004 are only indicative of the variability of the exchange rate. The period thereafter has also been characterised by high exchange rate volatility with persistent fluctuations in the value of the rand. While the identification of the sources of this volatility, as well as of the policy responses to that, is complex and goes through many indirect channels, the impact of volatility on real economy is more direct to observe and quantify. After all, any policy to contain exchange rate volatility should be designed on the basis of a comprehensive understanding of the link between exchange rate variability and the real economy at first place.

Figure 1: Real effective exchange rate

Panel (a) South African rand real effective exchange rate (Price Index)

[1] King's College
[2] Kingston University

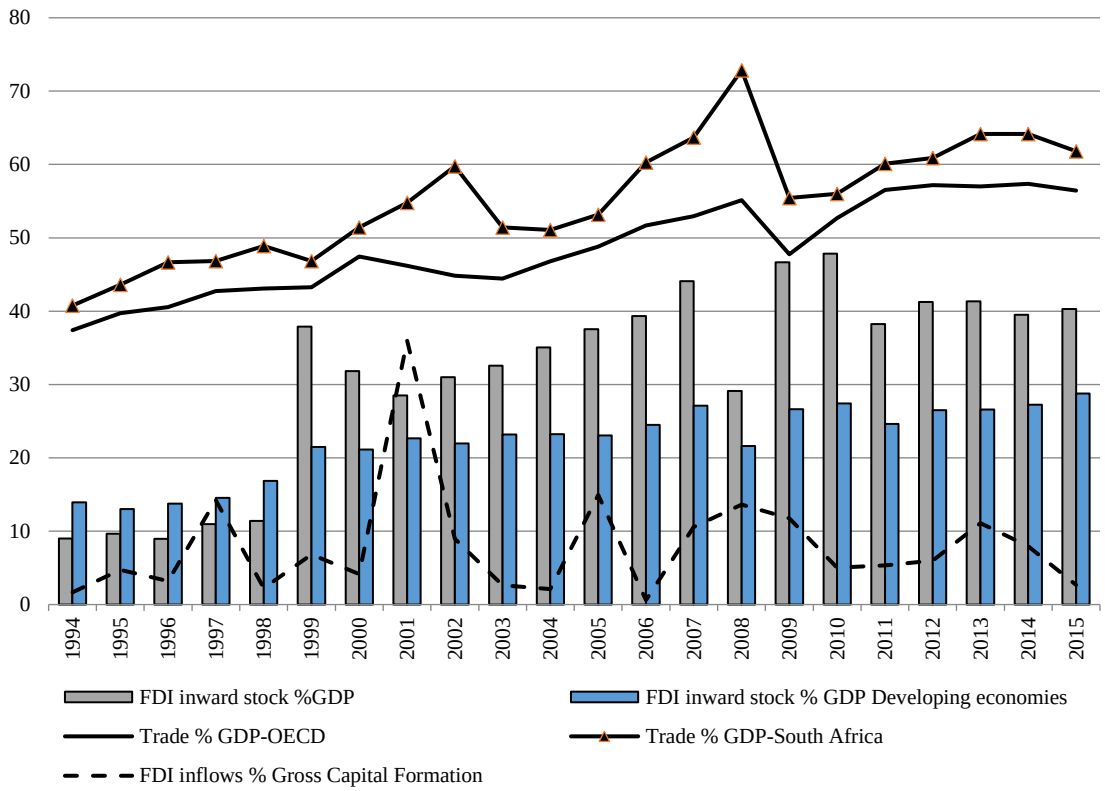
(b) South African rand real effective exchange rate (monthly % change)



Notes: This figure plots the monthly rand real trade-weighted index (not seasonally adjusted) from January 1994-December 2016. Data are from South African Reserve Bank.

Understanding the relationship between exchange rate volatility and investment becomes imperative given our focus on South Africa, which is characterized by a high degree of real and financial integration with the rest of the world. Indicatively, we show in figure 2 that for the whole period we are examining, South Africa's total trade (exports plus imports) as a percentage of its GDP is notably higher than the average trade to GDP ratio of the OECD countries. Similarly, South Africa has a higher percentage of inward FDI stocks as a percentage of its GDP than that of the other developing economies, with volatile FDI inflows that might be affected by exchange rate volatility, as the latter feeds into foreign investors' cost of capital calculations.

Figure 2: Trade and FDI stock and flows

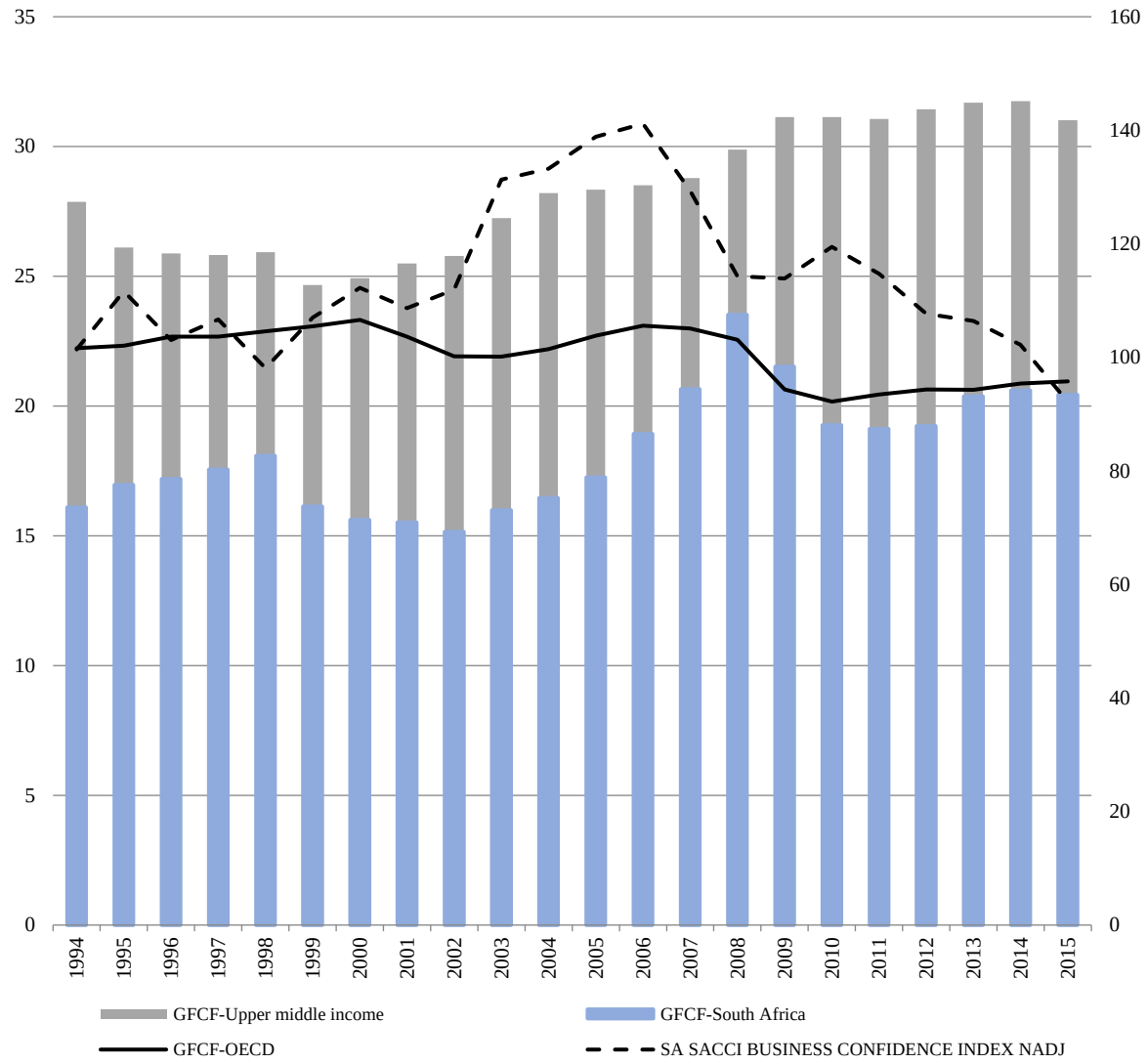


Notes: Data about Trade % GDP and FDI flows and stocks are taken from World bank, OECD and UNCTAD.

Aggregate data on South Africa's gross fixed capital formation, a main economic indicator of investment activity, suggests that investment in the country is lagging significantly that of the other upper-middle income countries (about 10-15% as a percentage of its GDP, as we show in figure 3. While the economic, institutional, and social factors that might account for these cross-country differences are beyond the scope of this study, standard economic theory shows that low investment rates are not conducive of sustained economic growth. The persistent decline in business confidence since 2007, as measured by the South African Chamber of Commerce and Industry's Index (SACCI) plotted in figure 3, is also a matter of particular concern when viewed in conjunction with the low levels of fixed capital formation.[3]

[3] Data in figure 3 stop at the end of 2015. At the time of this study (October 2017), the SACCI Index is at almost the same level as at the end 2015, revealing sustained low levels of business confidence.

Figure 3: Investment in South Africa



Notes: The measurement units for Gross Fixed Capital Formation as a percentage of GDP (*GFCF*) for South Africa, OECD, and upper-middle income countries are shown in the left axis, while those of SACCI Index in the right axis. Data about GFCF are from World Bank and OECD national accounts data files, while data for the SACCI Index are collected from Datastream.

Identifying the determinants of investment at the firm-level is a key aspect of any attempt to characterise the South African economy and has far-reaching implications for economic growth. Nevertheless, the relevant research and evidence for South Africa is scant. In the subsequent sections of this study, we pursue an empirical exercise on the determinants of firms' capital expenditures in South Africa. We focus on the role of rand's volatility, as well as on the role of uncertainty and governance quality. We operationalise our hypotheses by building upon existing literature, and utilising a standard reduced-form investment model. The baseline empirical specification of our investment model consists in the inclusion of firm-specific factors driving corporate investment decisions, such as cash flows and the Tobin's *q*, which we subsequently augment with metrics for exchange rate volatility and uncertainty.
The rest of the paper is laid out as follows. Section 2 presents the baseline empirical design and the data, as well as the results from the estimation of the baseline specification. Section 3 provides and discusses the results from the tests of the impact of exchange rate volatility, uncertainty, and governance quality on firms' capital expenditures. Finally, Section 4 concludes.

Empirical Model and Data

Baseline empirical specification

In our baseline empirical investment equation, we, first, investigate the significance of Tobin's *q* for corporate capital investment. The *q* theory of investment, pioneered by Tobin (1969), relates a firm's investment rate to the market value of its capital relative to its replacement cost, and occupies a prominent place in both theoretical (e.g., Hayashi, 1982; Wildasin, 1984) and empirical studies (e.g., Baum et al., 2008; Gilchrist et al., 2014; Love and Zicchino, 2006). Hayashi's (1982) result that a firm's investment rate is only a function of its Tobin's *q* stands indicative of the importance attributed to this variable. From this stream of literature, therefore, Tobin's *q* emerges as a fundamental forward-looking factor of investment, positively related with corporate investment.

The early seminal work of Fazzari et al. (1988) heralds the use of cash flows as a fundamental factor in reduced-form models for investment. Initially, the theoretical motivation for the inclusion of cash flows has been to account for firms' financing constraints. Firms facing financing constraints will find it difficult to increase their capital expenditure if they have low cash flows (a typical measure of the less-costly internal funds). An alternative explanation that has been put forward for the excess sensitivity of investment to cash flows is the hypothesized capacity of cash flows to predict future investment opportunities and/or expected profitability that are not appropriately measured by Tobin's *q* (see. e.g., Bond et al., 2004; Gilchrist and Himmelberg, 1995). While the underlying reasons for the investment-cash flow nexus remain a highly contested issue,[4] cash flows constitute an integral factor, along with Tobin's *q*, of empirical investment models (see *inter alia* Baum et al., 2008; Chen and Chen, 2012; Eberly et al., 2012).

Finally, a standard feature of empirical investment models is that they typically include lagged investment as a factor influencing the current level of investment. Including a lagged investment variable in investment models can capture the persistence in firms' investment adjustment process. Eberly et al. (2012), in fact, report that lagged investment is the best explanatory variable for investment, outperforming the combined explanatory power of Tobin's *q* and cash flows.

To identify the determinants of firms' capital investment behaviour, we estimate, following academic convention (see indicatively, Baum et al., 2008; Carpenter and Guariglia, 2008; Chen and Chen, 2012), the following benchmark specification:

$$\frac{CE_{i,t}}{K_{i,t-1}} = c_0 + c_1 \times \frac{CE_{i,t-1}}{K_{i,t-2}} + c_2 \times \frac{CF_{i,t-1}}{K_{i,t-2}} + c_3 \times Q_{i,t-1} + \varepsilon_{i,t}, \qquad (1)$$

where $CE_{i,t}/K_{i,t-1}$ stands for firm's *i* capital expenditure (that is, *CE*) at year *t*, deflated by this firm's capital (that is, *K*) at the beginning of year *t*, which we denote by *t-1*. $CF_{i,t-1}/K_{i,t-2}$ is firm's *i* previous year cash flows, denoted by $CF_{i,t-1}$, deflated by its capital at the beginning of the year. $Q_{i,t-1}$ stands for firm's *i* Tobin's *q*. We provide details about the sources and definitions of the variables used in the estimations in table 1.

[4] A spate of recent papers test and interpret the investment-cash flow nexus (see e.g., Andrén and Jankensgård, 2015; Carpenter and Guariglia, 2008; Chen and Chen, 2012, 2013; Chowdhury et al., 2016; Moshirian et al., 2017).

Table 1: Variable description

Variable	Abbreviation	Description and Sources
Investment to capital:	$\frac{CE_{i,t}}{K_{i,t-1}}$	Firm-level data for firm's *i* capital expenditure (*CE*) are from Worldscope (WC04601). We divide *CE* for year *t* by the firm's capital (*K*) at the beginning of the year (which we denote by *t-1*), derived as the difference between net property, plan and equipment (WC02501) for year *t* minus the capital expenditure for that year (WC04601).
Cash flows to Capital:	$\frac{CF_{i,t-1}}{K_{i,t-2}}$	Firm-level data for firm' *i* cash flows (*CF*) are from Worldscope, and are derived as the product of cash flows to sales (WC08311) and net sales or revenues (WC01001). Subscript *t-1* in this case refers to previous year's cash flows. Capital (*K*) is taken at the beginning of the previous year, which we denote by *t-2*.
Tobin's *q*:	$Q_{i,t-1}$	A firm's Tobin's *q* is derived as the sum of market capitalisation (WC08001) and total liabilities (WC03351) divided by the sum of common equity's book value (WC03501) and total liabilities (WC03351).
RER volatility	$(\sigma.RER_t,$ $RV.RER_t, C.RER_t)$	South African real trade-weighted index (not seasonally adjusted). Monthly frequency. Details in the main body of the text. South African Reserve Bank.
Market uncertainty	(m_t)	South Africa Datastream calculated price index, local currency (TOTMKSA). Details about the calculation of the variable can be found in the main body of the text.
Idiosyncratic volatility	$(I.vol_{i,t}, fs\_vol_{i,t})$	The stock prices of the firms considered in our study are collected from Datastream. Details about the estimation of the variables can be found in the main body of the text.

We estimate equation (1) using the Arellano and Bond (1991) dynamic panel GMM approach.[5] This method takes a first-difference transformation of equation (1), and uses lagged levels of both the dependent and the independent variables as instruments. Removing the unobserved individual effects by first-differencing is necessary as the correlation of the lagged dependent variable with the error term will introduce bias in the lagged investment estimate. Moreover, by including GMM instruments this approach not only deals with the correlation of the lagged first-differenced dependent variable with the disturbance process, but also with the possible endogeneity issues arising from our model. Firms' cash flows and Tobin's *q* enter as endogenous to dynamic firm-level investment models, as current investment might also determine future cash flows and investment opportunities.

Sample

The present study considers the period from 1995, when all remaining United Nations sanctions against South Africa were lifted, to 2016. We obtain the firm-level data for the South African firms included in the estimations of this study from Worldscope. We exclude all financial firms from our estimations, as their balance sheets are likely to reflect regulatory constraints.[6] Excluding financial firms follows

[5] The estimator is available in STATA from (Roodman, 2009).

[6] Based upon Worldscope's general industry classification (WC06010), these are the companies classified under categories 4 (Bank/Savings & Loan), 5 (Insurance), and 6 (Other financial).

academic convention in this type of studies (Baum et al., 2008; Love, 2003; Love and Zicchino, 2006). We also exclude firms for which data for capital expenditure, cash flows, and net property, plant and equipment are not available for three years.

Table 2: Summary statistics

	Mean	*St.Dev.*	*p25*	*Median*	*p75*	*Obs.*
$\frac{CE_{i,t}}{K_{i,t-1}}$	0.35 *(.007)*	0.207 *(.002)*	0.174 *(.002)*	0.292 *(.005)*	0.458 *(.004)*	2,578
$\frac{CF_{i,t}}{K_{i,t-1}}$	0.643 *(.023)*	0.414 *(.016)*	0.32 *(.007)*	0.544 *(.016)*	0.805 *(.038)*	2,562
Q_t	1.365 *(.008)*	0.423 *(.001)*	1.048 *(.003)*	1.234 *(.019)*	1.574 *(.016)*	2,516
$\sigma.RER_t$	2.971	1.205	2.148	2.582	3.883	3,696
$RV.RER_t$	4.550	0.774	4.051	4.464	5.229	3,696
$C.RER_t$	3.354	1.157	2.451	2.952	4.248	3,696
$fs\_vol_{i,t}$	0.400 *(.006)*	0.153 *(.007)*	0.277 *(.003)*	0.351 *(.003)*	0.465 *(.0064)*	3,003
$I.vol_{i,t}$	.039 *(.0004)*	.011 *(.00007)*	.032 *(.0003)*	.037 *(.0002)*	.044 *(.0005)*	3,003

Notes: This table reports descriptive statistics for the variables used in this paper. The values reported correspond to the median values of the statistics across firms. Abbreviations for the variables can be found intable 1. *p25* and *p75* stand for the first and third quartiles of the variables. *(.)* report the bootstrap standard errors.

In table 2, we report descriptive statistics for the variables used in the estimations of this paper. We calculate the median of each statistic across firms, and we report it along with the bootstrap standard errors. This method of presenting the summary statistics allows a better representation of the firm-level effects (see e.g., Eberly et al., 2012). The mean and standard deviation of investment and cash flows (normalised by beginning of the year capital) in South Africa is higher than that reported in similar studies using Worldscope firm-level data for a cross-section of countries (Love, 2003; Love and Zicchino, 2006), while those of Tobin's *q* appear comparable.

2.3 Results from the estimation of the baseline model.

Table 3 shows parameter estimates of the baseline specification in equation (1). The instruments include two to four lags of the explanatory variables lagged investment to capital, lagged cash flows to capital, and lagged Tobin's *q*, that are all treated as endogenous. The coefficient estimates for all 3 variables in this model are statistically significant, and their signs conform to theoretical priors. Particularly, we find that firms' capital expenditure is positively associated with Tobin's *q*, which proxies for future investment opportunities, and with cash flows. Moreover, we also report a significant lagged investment effect, the economic significance of which is higher than that of the other two explanatory variables, as the numerically larger coefficient estimate reveals. Statistical testing for the validity of the instruments points to a satisfactory model selection. The *p*-value of the Hansen *J*-statistic of overidentifying restrictions suggests that instruments are orthogonal to the errors. Moreover, we cannot reject the presence of second-order serial correlation in differenced disturbances, suggesting that second lags of endogenous variables are valid instruments.

Table 3: Determinants of investment

Investment to Capital	*(a)*	*(b)*	*(c)*	*(d)*
(*lag*) Investment to Capital	.182***	.230***	.191***	.186***
	(3.22)	*(3.54)*	*(3.29)*	*(3.36)*
(*lag*) Cash flows to capital	.107**	.118**	.108**	.107**
	(2.39)	*(2.51)*	*(2.41)*	*(2.48)*
(*lag*) Tobin's *q*	.155***	.126**	.135**	.164***
	(2.75)	*(2.29)*	*(2.40)*	*(3.34)*
RER volatility	-	-.032	-.016*	.014
		(-1.35)	*(-0.91)*	*(0.96)*
(*lag*) RER volatility	-	-.0148**	-.022***	-.014*
		(-2.57)	*(-2.63)*	*(-1.76)*
Obs.	1,685	1,685	1,685	1,657
J test [p-value]	[0.89]	[0.98]	[0.92]	[0.95]
AR(2) [p-value]	[0.41]	[0.48]	[0.41]	[0.49]

Notes: In column *(a)*, this table reports the estimation results of the reduced-form investment model in equation (1). Columns *(b)* – *(d)* report the results from the estimation of equation (2) for all the three measures of exchange rate volatility that we employ. Particularly in column *(b)*, we use $\sigma.RER_t$ calculated as we show in equation (3) in the main body of the text, in column *(c)* we use $RV.RER_t$ calculated as we show in equation (4) in the main body of the text, and in column *(d)* we use the GARCH-measure of exchange rate volatility $C.RER_t$ described in the main body of the text. The row Obs. shows the total firm-year observations included in the estimation of each equation. We report the [*p-value*] of the *J* test of overidentifying restrictions for the null of suitability of the instrument set. AR(2) shows the [*p-value*] of the test for second-order serial correlation in the differenced disturbances of the empirical investment model. */**/*** denote significance at 90%, 95%, and 99% confidence levels respectively.

EXCHANGE RATE UNCERTAINTY AND INVESTMENT

Exchange Rate Volatility on Capital Expenditures.

This section focuses on identifying the effects of exchange rate volatility on capital investment. To capture the role of exchange rate volatility in firms' investing decisions, we augment the baseline specification with a measure of exchange rate volatility. Specifically, we estimate the following equation:

$$\frac{CE_{i,t}}{K_{i,t-1}} = c_0 + c_1 \times \frac{CE_{i,t-1}}{K_{i,t-2}} + c_2 \times \frac{CF_{i,t-1}}{K_{i,t-2}} + c_3 \times Q_{t-1} + \sum_{l=0}^{l=1} c_{4+l} \times v_{t-l} + \varepsilon_{i,t}, \qquad (2)$$

where v_t stands for the exchange rate volatility proxy, which enters as an exogenous variable in equation (1). Coefficient estimates c_4 and c_5 show firms' capital investment sensitivity to current and lagged values of exchange rate volatility respectively.

We employ three different measures for exchange rate volatility to ensure that our results are not driven by the choice of the measure. The first measure we use is the standard deviation of South Africa's real effective exchange rate changes calculated at the beginning of each year from the 12 preceding monthly changes in the real effective exchange rate. Specifically, the exchange rate volatility in year *t*, denoted by $\sigma.RER_t$, is the standard deviation of the monthly changes in the natural logarithm of the real effective exchange rate from February of year *t-1* to January of year *t*, calculated as follows:

$$\sigma.RER_t = \sqrt{\sum_{k=Feb,t-1}^{k=Jan,t} \left(\Delta \ln RER_k - \overline{\Delta \ln RER}\right)^2 \Big/ 11}. \quad (3)$$

$\Delta \ln RER_k$ stands for the first-difference of the natural logarithm of the real effective exchange rate (RER) in month k of the year (that is, $\ln \mathrm{RER}_{k/12} - \ln \mathrm{RER}_{k-1/12}$). $\overline{\Delta \ln RER}$ is the mean value of all 12 monthly log changes in rand's real effective exchange rate from February of year *t-1* to January of year *t*. Using the standard deviation of exchange rate changes to proxy for exchange rate uncertainty is a common practice in related literature (e.g., Aghion et al., 2009).

The second measure we use is the natural logarithm of the realised variance of South Africa's real exchange rate, calculated using the monthly log changes in South Africa's real effective exchange rate $\Delta \ln RER_k$ from February of year *t-1* to January of year *t*. We calculate *RER*'s annual realised volatility at year *t*, denoted by $RV.RER_t$, in a similar fashion to Cevik et al. (2017), as follows:

$$RV.RER_t = ln\left(\sum_{k=2/12,t-1}^{k=1/12,t} \Delta lnRER_k{}^2\right). \quad (4)$$

Finally, along with the historical measures described so far, we also measure the annual exchange rate volatility using the conditional variance of the monthly change in the natural logarithm of the real effective exchange rate. Specifically, we obtain the monthly measure of real effective exchange rate's conditional variance by estimating a GARCH model. This measure of exchange rate volatility is also very widely used in studies examining the implications of exchange rate uncertainty (see e.g., Asteriou et al., 2016; Pozo, 1992). We choose, using the Schwarz criterion, an ARIMA(1,1,1) specification to model the monthly log real effective exchange rate in the mean equation. Moreover, the conditional volatility of the first-differenced real effective exchange rate is predicted using a GARCH(1,3) specification. The optimal length is chosen using the Schwarz criterion. The 12-month average of real effective volatility's conditional volatility from February in year *t-1* to January in year *t* is the annual exchange rate volatility for year *t*, denoted by $C.RER_t$.

We report the results from the estimation of equation (2) for all 3 measures of exchange rate volatility in table 3. Considering the long-term nature of capital expenditure planning, we capture the dynamics of the impact of exchange rate uncertainty on investment by including along with the current level also a lag of the exchange rate volatility measure. We find that the lagged measure of volatility is inversely related with capital expenditure in all three specifications, suggesting that lower levels of exchange rate volatility lead to higher levels of corporate investment. This result is statistically significant at the 5% level for both historical measures of volatility, and only at the 10% when the conditional volatility measure is employed.

Exchange rate volatility, uncertainty, and capital expenditures

In this section, we draw upon the empirical findings from the previous section, and we explore the role of uncertainty in the firm-level capital expenditure. Previous theoretical and empirical evidence finds that political and economic uncertainty feed through to the volatility of financial assets such as equities and exchange rates (e.g., Krol, 2014; Pástor and Veronesi, 2013). Therefore, to the extent that exchange rate volatility is also reflected in uncertainty proxies, including measures explicitly capturing uncertainty in our model can potentially reduce the sensitivity of investment to exchange rate volatility (i.e., coefficients c_4 and c_5 from equation (2)).

Theoretically, there are several variations in the predicted sign of the relationship between firm-level investment and uncertainty (see indicatively, Caballero, 1991; Leahy and Whited, 1996). Recent empirical work on the role of uncertainty in firms' capital investment decisions is also mixed, and the result hinges upon the measure of uncertainty employed. Firm-specific measures of uncertainty, such as those employed by Baum et al. (2008) and Panousi and Papanikolaou (2012), are negatively related

with investment. On the contrary, market uncertainty enters positively the investment equation in Baum et al. (2008), when the effects of CAPM uncertainty are also accounted for. In this study, we introduce both idiosyncratic and market measures of uncertainty in the empirical model in equation (2), and we assess not only the reaction of investment to uncertainty, but also the changes in the magnitude of the impact of exchange rate volatility on capital investment.

To that end, we estimate the following equation:

$$\frac{CE_{i,t}}{K_{i,t-1}} = c_0 + c_1 \times \frac{CE_{i,t-1}}{K_{i,t-2}} + c_2 \times \frac{CF_{i,t-1}}{K_{i,t-2}} + c_3 \times Q_{i,t-1} + \sum_{l=0}^{l=1} c_{4+l} \times \nu_{t-l}$$
$$+c_6 \times m_{t-1} \quad + c_7 \times I.vol_{i,t-1} + \varepsilon_{i,t}. \tag{5}$$

The variable m_t stands for market uncertainty, which we calculate as in Baum et al. (2008) following the method of Merton (1980). This method constructs an annual measure of uncertainty, adjusted for working days, using daily log stock market returns (that is, r_τ). Stock market returns are obtained from the Datastream-calculated South African aggregate stock market index, expressed in national currency. First, we calculate for each day:

$$\varsigma_\tau = \left(\frac{{r_\tau}^2}{\Delta\varphi_\tau}\right), \tag{6}$$

where $\Delta\phi_\tau$ measures the days between two trading days. Then, the annual measure of market uncertainty is given by:

$$m_t = \sqrt{\sum_{\tau=1}^{\tau=T} \varsigma_\tau}, \tag{7}$$

where *T* is all trading days in year *t*.

We construct the measure for idiosyncratic volatility from daily stock returns for all firms in our sample using the Campbell et al. (2001) method. Panousi and Papanikolaou (2012), who also examine the impact of idiosyncratic risk on firm-level investment, employ a similar proxy for idiosyncratic volatility. Our proxy for firm's *i* annual idiosyncratic volatility at year *t* (that is, $I.vol_{i,t}$) is constructed as the yearly average of monthly idiosyncratic volatilities. To calculate the monthly idiosyncratic risk, we use each firm's *i* idiosyncratic shock $\varepsilon_{i,\tau}$ on day τ of month μ (that is, $^{\tau}/_{\mu}$), which is estimated by a standard one-factor model as follows:

$$r_{i,\tau/\mu} = \alpha_{i,\tau/\mu} + \beta_{i,\tau/\mu} \times \left(r_{m,\tau/\mu} - r_{f,\tau/\mu}\right) + \varepsilon_{i,\tau/\mu}. \tag{8}$$

The term $\left(r_{m,\tau/\mu} - r_{f,\tau/\mu}\right)$ stands for the market returns in excess of the risk-free rate on day τ of month μ. Each firm's *i* monthly idiosyncratic volatility is then calculated as the variance of its daily idiosyncratic return ε_τ for month μ.

Table 4 reports the results from the estimation of equation (5) for all the 3 measures of exchange rate volatility employed in this study. Our results show that irrespective of which measure we use, the magnitude of the significance of exchange rate volatility for investment is not dwarfed after the inclusion of the uncertainty proxies. Exchange rate volatility, therefore, emerges as an independent factor causing firms to rearrange their investment policy, even after accounting for the impact of market-wide and idiosyncratic risk.

Table 4: Uncertainty on investment

Investment to Capital	*(a)*	*(b)*	*(c)*	*(d)*
(*lag*) Investment to Capital	.191***	.184***	.188***	.181***
	(3.34)	*(3.24)*	*(3.29)*	*(3.23)*
(*lag*) Cash flows to capital	.088**	.088**	.098**	.081**
	(2.07)	*(2.09)*	*(2.22)*	*(2.11)*
(*lag*) Tobin's *q*	.154***	.160***	.177***	.138***
	(2.87)	*(3.14)*	*(3.31)*	*(3.26)*
RER volatility	-.015	-.026**	.012	.009
	(-1.46)	*(-2.20)*	*(0.93)*	*(0.75)*
(*lag*) RER volatility	-.015***	-.018*	-.027***	-.018**
	(-2.65)	*(-1.93)*	*(-2.66)*	*(-2.02)*
Idiosyncratic volatility	4.41**	3.94*	4.96**	.084
	(2.08)	*(1.84)*	*(2.16)*	*(1.13)*
Market uncertainty	-.436	-.265	-.289	.219
	(-1.22)	*(-0.70)*	*(-0.80)*	*(1.09)*
Obs.	1,592	1,592	1,592	1,592
J test [p-value]	[0.93]	[0.89]	[0.96]	[0.87]
AR(2) [p-value]	[0.48]	[0.43]	[0.48]	[0.41]

Notes: This table reports the estimation results of the reduced-form investment model in equation (5). In columns *(a) – (c)* RER volatility is given by $\sigma.RER_t$, $RV.RER_t$, and $C.RER_t$ respectively, while in column *(d)* we use $C.RER_t$. In columns *(a)-(d)* the measure for market uncertainty is calculated from equations (6) and (7) from the main body of the text using the Datastream-calculated aggregate stock market index for South Africa. In columns *(a)-(c)* the idiosyncratic volatility measure is obtained from equation (8) from the main body of the text, while in column *(d)* we use the firm-specific volatility measure $fs\_vol_{i,t}$ calculated for each firm using equations (6) and (7) from the main body of the text. The row Obs. shows the total firm-year observations included in the estimation of each equation. We report the [*p-value*] of the *J* test of overidentifying restrictions for the null of suitability of the instrument set. AR(2) shows the [*p-value*] of the test for second-order serial correlation in the differenced disturbances of the empirical investment model. */**/*** denote significance at 90%, 95%, and 99% confidence levels respectively.

To derive an alternative measure for firm-specific risk, we use Merton's (1980) method, as shown in equations (6) and (7) for each firm's raw stock returns (denoted by, $fs\_vol_{i,t}$). We include this measure of firm-specific risk, which, however, does not separate idiosyncratic risk (Panousi and Papanikolaou, 2012), along with exchange rate volatility in equation (5), and we report the results in column *(d)* of table 4 Again, our results are indicative of a statistically significant negative association between investment and exchange rate volatility.[7]

In the remaining part of this section, we turn our attention to the reaction of firm-level investment to uncertainty. Our results reveal a strong positive relationship between idiosyncratic risk and investment. This positive relationship does not emerge when we use Merton's (1980) measure of firm-specific risk (equation (5)) instead of idiosyncratic volatility. Moreover, we find that the coefficient estimate of market uncertainty is not statistically significant in any of the estimations of equation (5). A similar result regarding the impact of market uncertainty is produced by Baum et al. (2008), who also report that when standard empirical investment models included together measures of firm-specific and market uncertainty, firm-specific variables exert a larger influence.

On the contrary, our finding of a positive association between idiosyncratic risk and investment is at odds with previous empirical evidence. Shima (2016), for instance, measuring uncertainty by the

[7] For brevity reasons, we report only the results when the conditional volatility-based measure of exchange rate volatility is used. Similar results are produced when the other measures of exchange rate volatility are employed, and are available from the authors upon request.

growth of real sales, finds that uncertainty is negatively related with investment for a sample of Japanese manufacturing listed firms. Other studies using similar estimation methods to our study and measuring uncertainty in a similar manner, also report a negative relationship. Particularly, Baum et al. (2008) using a sample of US manufacturing publicly traded firms, and Panousi and Papanikolaou (2012) using a sample of US publicly traded firms also find a negative relationship between uncertainty (firm-specific and idiosyncratic respectively) and investment.

Earlier theoretical work on the relationship between uncertainty and investment did not typically distinguish between aggregate and idiosyncratic uncertainty.[8] Their focus was rather on the sign of the relationship in question. Factors that have been found to be determining the sign of this relationship include the degree of risk-aversion, the industry structure, the degree of capital expenditure's reversibility, and the convexity of the marginal profitability function to output prices. Indicatively, Craine (1989) shows that in general equilibrium the uncertainty-induced decrease in investment is the outcome of the reallocation of resources away from risky long-term investment. The standard real options approach also predicts a negative relationship between uncertainty and investment. This prediction bases upon the (partial) irreversibility of investments that attaches value to the option to wait, whose value, in turn, is positively related with uncertainty (Dixit and Pindyck, 1994).

Abel (1983), on the other hand, demonstrates that a positive relationship between uncertainty and investment is possible under perfect competition and symmetric investment adjustment costs. Caballero (1991) relaxes the assumption about symmetric adjustment costs, and highlights the role of industry structure, as well as that of increasing returns to scale. At the industry level, evidence suggests that in cases of imperfect competitions it is important to also consider strategic interactions among the rival firms (Ghosal and Loungani, 1996). For instance, they find that a positive relationship between industry uncertainty and investment might arise because firms act pre-emptively to secure market power, and, thus, without specific knowledge of the strategic interactions it is impossible to theoretically predict the sign.

There have also been studies where idiosyncratic risk is isolated from the aggregate, and insights are drawn into the channels through which it feeds through to investment (Caballero and Pindyck, 1996; Dixit and Pindyck, 1994). These studies show that idiosyncratic shocks reflect the ability of the firm to operate under the lack of pressures from competition. Unlike aggregate, idiosyncratic shocks do not trigger any reaction from competition, suggesting that firms neither will share the excess profits with competition nor will need to hasten their investing decisions due to competitive pressures. Idiosyncratic shocks, therefore, reflect firms' ability to support monopolistic rents, as Bhamra and Shim (2017) characteristically argue. And firms' investing decision will ultimately depend on their assessment of the relative benefits from delaying versus investing.

The finding of a positive relationship between idiosyncratic risk and investment translates into confidence that greater idiosyncratic risk can increase the marginal profitability of capital. It reflects firms' capacity to exploit good outcomes from idiosyncratic shocks, while limiting the downside from adverse developments. While this result contradicts Caballero's (1991) theoretical predictions, in a market with a high degree of concentration and mark-ups, such as South Africa (see Fedderke et al., 2017) might be indicative of Aghion's et al. (2009) "escape the competition effect". Alternatively, this finding may reflect a confidence effect, emanating from the arrangements of the business environment which allows increasing returns to scale for the large listed firms of our sample. In any case, although, theoretically, there are many contradicting explanations for the sign of this relationship, a consensus exists that one should consider the particulars of the economic environment (e.g., Ghosal and Loungani, 1996; Gilbert, 2006).[9]

[8] A comprehensive review of the uncertainty-investment relationship is presented in Carruth et al. (2000).

[9] This empirical result adds to broad corpus of literature empirically addressing this issue, and provides prompts for further research which will allow us to provide a structural interpretation for this result. For instance, it is worth exploring the robustness of the sign of this relationship *vis-à-vis* factors that have been found to influence it, such as risk aversion and ability to hedge (e.g., Miao and Wang, 2007), market power and returns to scale (e.g., Caballero, 1991; Aghion et al., 2009), financial distortions (Gilchrist et al., 2014).

Governance quality and Investment

The final section of this paper considers the importance of governance quality for corporate investment in South Africa. Particularly, we examine the extent to which aspects of governance quality, as measured by the indices of the Worldwide Governance Indicators (WGI) project, are related to firms' investing behaviour. To do so, we estimate the following equation:

$$\frac{CE_{i,t}}{K_{i,t-1}} = c_0 + c_1 \times \frac{CE_{i,t-1}}{K_{i,t-2}} + c_2 \times \frac{CF_{i,t-1}}{K_{i,t-2}} + c_3 \times Q_{t-1} + c_4 \times gov_{t-1} + \varepsilon_{i,t}, \quad (9)$$

where gov stands for each one of the WGI measures of governance quality. These measures have become available only since 1996, but for South Africa data for every year are available only after 2002, so our sample is limited to that period. We report the results from equation (9) in table 5. We find that control of corruption, regulatory quality, voice and accountability, and government effectiveness are important determinants of corporate investment. Particularly, the results from our estimations show statistically significant reaction estimates to these four governance elements, suggesting that better governance quality leads to higher investment.

Table 5: Governance and investment

Investment to Capital	*(a)*	*(b)*	*(c)*	*(d)*	*(e)*	*(f)*
(*lag*) Investment to Capital	.169**	.147*	.157	.229***	.156**	.154*
	(2.11)	*(1.77)*	*(1.61)*	*(2.98)*	*(1.97)*	*(1.86)*
(*lag*) Cash flows to capital	.158**	.157**	.213**	.143**	.119**	.159***
	(2.46)	*(2.47)*	*(2.46)*	*(2.43)*	*(2.11)*	*(2.62)*
(*lag*) Tobin's *q*	.207**	.245	.561**	.324***	.204**	.250***
	(2.33)	*(2.51)*	*(2.49)*	*(3.67)*	*(2.03)*	*(2.83)*
(*lag*) Governance Quality	.253**	.277**	-1.29	.367	3.447**	.360**
	(2.35)	*(2.66)*	*(-1.55)*	*(0.82)*	*(2.00)*	*(2.28)*
Obs.	1,095	1,095	1,095	1,095	1,197	1,095
J test [p-value]	[0.25]	[0.39]	[0.92]	[0.32]	[0.68]	[0.40]
AR(2) [p-value]	[0.44]	[0.38]	[0.20]	[0.43]	[0.66]	[0.47]

Notes: This table reports the estimation results of the reduced-form investment model in equation (9). In columns *(a)* – *(f)*, the variable *Governance Quality* measures control of corruption, regulatory quality, political stability, rule of law, voice and accountability, government effectiveness, respectively. The row Obs. shows the total firm-year observations included in the estimation of each equation. We report the [*p-value*] of the *J* test of overidentifying restrictions for the null of suitability of the instrument set. AR(2) shows the [*p-value*] of the test for second-order serial correlation in the differenced disturbances of the empirical investment model. */**/*** denote significance at 90%, 95%, and 99% confidence levels respectively.

Conclusion

This study provides an empirical examination of the determinants of corporate investment decisions in South Africa. Using data from a cross-section of listed South African firms and panel GMM techniques, we explore the impact of firm-level factors, Tobin's *q* and cash flows, as well exchange rate volatility, idiosyncratic risk and governance quality on corporate investment. We find that firm-specific characteristics influence corporate investment in a manner intuitively expected. Both Tobin's *q* and cash flows are positively associated with firms' future capital expenditures. The largest reaction of capital expenditure, however, is to its lagged value, and this estimate remains robust for all specifications used in this study.

The second objective of this paper pertains to the exploration of the implications of exchange rate volatility for corporate investment. We use three alternative measures of exchange rate volatility, both historical and conditional, and we establish an inverse relationship. The magnitude of this relationship

is less pronounced compared to that of the firm-level characteristics. The relationship remains robust even after the inclusion of the uncertainty measures. That is, exchange rate uncertainty enters firms' cost of capital calculations influencing future investment decisions.

The extant empirical literature on the relationship between idiosyncratic volatility and investment finds a negative uncertainty-investment nexus. In this study, we report a positive association between idiosyncratic volatility and investment. This result suggests that South African firms can capitalise on idiosyncratic risk, and hence respond by increasing their investment. To reinforce this result, it would be necessary to gather additional evidence by interacting the relationship between investment and idiosyncratic risk with other factors which account theoretically for this relationship.

References

Abel, A.B., 1983. Optimal Investment Under Uncertainty. American Economic Review, 73, 228–233.

Aghion, P. Blundell, R. Griffith, R. Howitt, P. Prantl. S. 2009. The effects of entry on incumbent innovation and productivity. The Review of Economics and Statistics, 91, 20-32.

Aghion, P., Bacchetta, P., Rancière, R., Rogoff, K., 2009. Exchange rate volatility and productivity growth: The role of financial development. Journal of Monetary Economics, 56, 494–513.

Andrén, N., Jankensgård, H., 2015. Wall of cash: The investment-cash flow sensitivity when capital becomes abundant. Journal of Banking and Finance, 50, 204–213

Arellano, M., Bond, S., 1991. Some Tests of Specification for Panel Data: Monte Carlo Evidence and an Application to Employment Equations. The Review of Economic Studies 58, 277–297.

Asteriou, D., Masatci, K., Pılbeam, K., 2016. Exchange rate volatility and international trade: International evidence from the MINT countries. Economic Modelling 58, 133–140.

Baum, C.F., Caglayan, M., Talavera, O., 2008. Uncertainty determinants of firm investment. Economic Letters 98, 282–287.

Bhamra, H.S., Shim, K.H., 2017. Stochastic idiosyncratic cash flow risk and real options: Implications for stock returns. Journal of Economic Theory, 168, 400-431.

Bond, S., Klemm, A., Newton-Smith, R., Syed, M., Vlieghe, G., 2004. The roles of expected profitability, Tobin's Q and cash flow in econometric models of company investment (No. 222), Bank of England working papers. Bank of England.

Caballero, R.J., 1991. On the Sign of the Investment-Uncertainty Relationship. American Economic Review, 81, 279–288.

Caballero, R.J., Pindyck, R.S., 1996. Uncertainty, Investment, and Industry Evolution. International Economic Review, 37, 641–662.

Campbell, J.Y., Lettau, M., Malkiel, B.G., Xu, Y., 2001. Have Individual Stocks Become More Volatile? An Empirical Exploration of Idiosyncratic Risk. Journal of Finance, 56, 1–43.

Carpenter, R.E., Guariglia, A., 2008. Cash flow, investment, and investment opportunities: New tests using UK panel data. Journal of Banking and Finance, 32, 1894–1906.

Carruth, A., Dickerson, A., Henley, A., 2000. What do we know about investment under uncertainty? Journal of Economic Surveys, 14, 119-153.

Cevik, S., Harris, R.D.F., Yilmaz, F., 2017. Soft power and exchange rate volatility. International Finance. 1-18.

Chen, H. (Jason), Chen, S. (Jenny), 2012. Investment-cash flow sensitivity cannot be a good measure of financial constraints: Evidence from the time series. Journal of Financial Economics, 103, 393–410.

Chen, Y.-S., Chen, I.-J., 2013. The impact of labor unions on investment-cash flow sensitivity. Journal of Banking and Finance, 37, 2408–2418.

Chowdhury, J., Kumar, R., Shome, D., 2016. Investment–cash flow sensitivity under changing information asymmetry. Journal of Banking and Finance, 62, 28–40.

Craine, R., 1989. Risky business: The allocation of capital. Journal of Monetary Economics, 23, 201–218.

Dixit, A.K., Pindyck, R.S., 1994. Investment under Uncertainty. Princeton University Press.

Eberly, J., Rebelo, S., Vincent, N., 2012. What explains the lagged-investment effect? Journal of Monetary Economics, 59, 370–380.

Fazzari, S.M., Hubbard, R.G., Petersen, B.C., Blinder, A.S., Poterba, J.M., 1988. Financing Constraints and Corporate Investment. Brookings Papers on Economic Activity, 1, 141–206.

Fedderke, J., Obikili, N. and Viegi, N., 2017. Markups and Concentration in South African Manufacturing Sectors: An Analysis with Administrative Data. South African Journal of Economics.

Ghosal, V., Loungani, P., 1996. Product market competition and the impact of price uncertainty on investment: Some evidence from US manufacturing industries. The Journal of Industrial Economics, 44, 217-228.

Gilbert, R. 2006. Looking for Mr. Schumpeter: Where Are We in the Competition-Innovation Debate? In: Innovation Policy and the Economy, Volume 6, 159-215. National Bureau of Economic Research, Inc.

Gilchrist, S., Himmelberg, C.P., 1995. Evidence on the role of cash flow for investment. Journal of Monetary Economics, 36, 541–572.
Gilchrist, S., Sim, J.W., Zakrajšek, E., 2014. Uncertainty, Financial Frictions, and Investment Dynamics. NBER Working Paper 20038.
Hayashi, F., 1982. Tobin's Marginal q and Average q: A Neoclassical Interpretation. Econometrica 50, 213–224.
Krol, R., 2014. Economic Policy Uncertainty and Exchange Rate Volatility. International Finance, 17, 241–256.
Leahy, J.V., Whited, T.M., 1996. The Effect of Uncertainty on Investment: Some Stylized Facts. Journal of Money Credit and Banking, 28, 64–83.
Love, I., 2003. Financial Development and Financing Constraints: International Evidence from the Structural Investment Model. The Review of Financial Studies, 16, 765–791.
Love, I., Zicchino, L., 2006. Financial development and dynamic investment behavior: Evidence from panel VAR. The Quarterly Review of Economics and Finance, 46, 190–210.
Merton, R.C., 1980. On estimating the expected return on the market: An exploratory investigation. Journal of Financial Economics, 8, 323–361.
Miao, J., Wang, N., 2007. Investment, consumption, and hedging under incomplete markets. Journal of Financial Economics, 86, 608–642.
Moshirian, F., Nanda, V., Vadilyev, A., Zhang, B., 2017. What drives investment–cash flow sensitivity around the World? An asset tangibility Perspective. Journal of Banking and Finance, 77, 1–17.
Panousi, V., Papanikolaou, D., 2012. Investment, Idiosyncratic Risk, and Ownership. Journal of Finance, 67, 1113–1148.
Pástor, Ľ., Veronesi, P., 2013. Political uncertainty and risk premia. Journal of Financial Economics, 110, 520–545.
Pozo, S., 1992. Conditional Exchange-Rate Volatility and the Volume of International Trade: Evidence from the Early 1900s. The Review of Economics and Statistics, 74, 325–329.
Roodman, D., 2009. How to do xtabond2: An introduction to difference and system GMM in Stata. Stata Journal, 9, 86–136.
Shima, K., 2016. Negative uncertainty sensitivity of investment and market structure. Economics Letters, 147, 93–95.
Tobin, J., 1969. A General Equilibrium Approach to Monetary Theory. Journal of Money Credit and Banking, 1, 15–29.
Wildasin, D.E., 1984. The q Theory of Investment with Many Capital Goods. American Economic Review, 74, 203–210.