Highlights

- The propensity to save for R&D firms in emerging economies is lower rather than higher, which is contrary to the literature.
- The low propensity to save is due to the concentration of innovation amongst larger and more mature firms in emerging markets that are likely to be unconstrained.
- Access to external finance is a major determinant of the propensity to save and deterrent to investing in innovation.

Does innovation and financial constraints affect the propensity to save in emerging markets?

March 5, 2020

Abstract

Despite the surge in corporate savings and heightened interest in understanding the reasons for this behaviour, little is known about the forces behind this stylised phenomenon in emerging markets (EMs). Using a large sample of firms from nine African countries over the period 2001–2015, we posit and find that the propensity to save is higher in this context due to limited access to external finance. However, when we examine the effects of innovation on corporate savings, we find that the results are reversed as, relative to Non-R&D firms, R&D firms save less of their operating cash flow. This is in stark contrast to the extant literature in advanced economies, which shows that savings are essential to smoothen lumpy, irreversible and risky investments in innovation. We find this is due to the reversal in firm-specific factors, with R&D firms in this context being larger and more mature; hence, relying less on internal financing sources compared to young and less-mature R&D firms in advanced economies. We interpret our results as suggestive of the overarching influence of access to external finance as a major determinant of the propensity to save and deterrent to investing in innovation. Our finding helps explain the glut in innovation amongst small and young firms in emerging markets and calls for policies that promote innovation.

Keywords: The propensity to save, innovation, R&D, financial constraints, emerging markets, Africa.
JEL classification: G01; G31; G32.

Declarations of interest: none

1 Introduction

There is an emerging consensus that corporate cash holdings have increased significantly over the past decades due to the shift of economies from predominantly manufacturing sectors (tangible capital) towards service and technology sectors (intangible or knowledge-based capital).[1] In line with this research theme, several studies in the US link the high propensity to save or cash hoarding behaviour to the rise in innovation (for this study, we use innovation and R&D, interchangeably) which is difficult to finance using external sources as it is lumpy, irreversible, risky and has longer investment horizons (see DMello et al., 2008; Brown and Petersen, 2011; He and Wintoki, 2016; Moshirian et al., 2017). However, these findings may not be generalisable to other countries, especially emerging markets saddled with several institutional deficiencies that not only limit access to external finance (Ojah and Pillay, 2009; Gwatidzo and Ojah, 2014; Guariglia and Yang, 2018), but also moderate how businesses are organised (George et al., 2016; Areneke et al., 2019). We address this research gap using a large sample of publicly listed firms from Egypt, Ghana, Ivory Coast, Kenya, Morocco, Nigeria, South Africa, Tunisia and Zambia as an exemplification of emerging economies. Our choice is motivated by three main reasons.

PLEASE INSERT TABLE 1 HERE

First, of particular interest is not only the low levels of innovation, but also the lack of comprehensive studies in emerging markets, yet, global innovation is increasing, and its marginal benefits are much higher in emerging economies relative to developed economies (George et al., 2016). Figure 1, which plots the average R&D-to-GDP (%) and the number of researchers in R&D per million people, illustrates some interesting patterns in aggregate innovation. Figure 1a which plots the R&D expenditure (% of GDP) shows that all the nine African countries in our sample significantly lag behind exemplary countries such as Japan, USA, Canada, France, UK, China and Italy. Similarly, Figure 1b shows lower numbers of researchers in R&D per million people for most African countries, except for

[1] Several studies report marked increases in corporate innovation over time (e.g., Aghion et al., 2004; Damodaran, 2009; Buera and Kaboski, 2012; Lim et al., 2014; Moshirian et al., 2017).

Tunisia, which ranks above Italy and China. These low levels of innovation are worrisome given that the sustainability of economic growth in emerging markets is highly dependent on the ability of firms to develop new innovative products and services (see Opperman and Adjasi, 2017) as economies transit towards intangible or knowledge-based capital. Interestingly, some African economies are ranked amongst the top nations based on economic growth and contribution to global economic development over the past decade due to the slowdown in advanced economies (Cumming et al., 2017). This highlights the increasing influence of emerging economies on global policy and economic development, which has spurred reforms aimed at attracting further foreign direct investments (FDI) (Diao and McMillan, 2018). The increase in FDI, according to Bokpin (2017), should help ease credit constraints and reduce the over-reliance on internal sources of finance for firms operating in emerging markets.

Second, prior studies have shown that country-level peculiarities such as political institutions (Julio and Yook, 2012), culture (Chen et al., 2015) and investor protection (Iskandar-Datta and Jia, 2014) significantly influence corporate cash holdings behaviour. Similar to other emerging economies, firms in African countries operate within different economic, cultural and political institutions compared to those in the West (Cumming et al., 2017). Accordingly, the absence of enforcement of formal practices (institutional voids), including property rights makes cultural and political institution significant in influencing firm behaviour (George et al., 2016). Drawing on George et al. (2016), institutional voids in Africa manifest as weak market-supporting institutions, lack of specialised financial intermediaries and absence of contract-enforcing structures and protection of property rights. This, as argued by Guariglia and Yang (2018) for the case of Chinese firms, makes non-intermediated or self-financing sources such as retained earnings and cash reserves of prime importance to the survival and growth of firms in emerging markets. Unlike Western economies, where the financial markets operate efficiently, African countries like other emerging markets have strong informal institutions that significantly influence corporate practices (Julio and Yook, 2012; Tunyi et al., 2019). For example, high levels of unethical practices such as corruption predominate (Thakor and Lo, 2015;

Areneke and Kimani, 2019), and firms respond by hoarding cash to strategically benefit from corrupting opportunities. Similarly, Barth et al. (2009) find that for firms to access external finance, they may need to bribe bank officials, which further increases the costs of external finance in this context. Therefore, these institutional peculiarities that increase reliance on internal sources of finance make the African context an interesting case study to validate theory, results from developed countries, and for developing new theoretical frameworks.

Last, several studies find that access to financial markets is essential for innovation (see Hall, 2002; Brown et al., 2012, 2013; Borisova and Brown, 2013). However, access to external finance remains one of the most challenging issues in emerging markets (Asongu, 2017), more so, when firms are financing innovation (Brown et al., 2013). According to Sorge et al. (2017), firms in an emerging market such as South Africa rely mostly on short-term debt (49% of the total debt is short-term). Similarly, Cortina et al. (2017) find significant short-termism in emerging markets, with only large firms being able to issue long-term debt. This short-termism with its attendant roll-over and liquidity risks is less suited for financing innovation, which is risky, costly and has relatively longer investment horizons. These unique features of innovation (Brown et al., 2012) and the limited financing options in emerging markets (Boako and Alagidede, 2018; Meniago and Asongu, 2018) imply an increased reliance on internal sources of finance. This makes the understanding of the propensity to save from operating cash flow within emerging markets context an interesting research question.

In this study, we address the above lacuna by examining the savings behaviour of publicly listed African firms. Specifically, we investigate the following questions: Do firms in emerging markets save from operating cash flow (internally generated cash flow)? Does innovation and financial constraints affect the propensity to save in emerging markets? Using a large sample of 501 publicly listed non-utility and non-financial firms (5,570 firm-year observations) from nine African countries over the period 2001–2015, we find as expected that the propensity to save from internally generated or operating cash flow of 0.36 is three and a half-times higher than the average of 0.10 reported by Riddick

and Whited (2009) for advanced economies.[2] This finding implies a greater need to enhance financial flexibility in less developed capital markets. However, contrary to the extant literature in advanced economies (see Brown and Petersen, 2011, 2015; He and Wintoki, 2016), we find that R&D firms in Africa save less relative to Non-R&D firms. This somewhat puzzling finding suggests that R&D firms in emerging markets have a lower need to accumulate cash reserves that are needed to smoothen innovation in the presence of significant capital market frictions. We further confirm this finding using endogenous switching regression models that account for the endogenous nature of corporate decisions, which if ignored, as in the literature, could potentially bias inferences. Our estimates using endogenous switching regression models affirm that R&D firms in our sample have a lower propensity to save relative to Non-R&D firms. This result, which remains unchanged even for comparisons conditional on financial constraints (constrained *versus* unconstrained firms), suggests that hoarding cash is less valuable for R&D firms relative to Non-R&D firms. The surprisingly low propensity to save for R&D firms in our context is due to their markedly unique characteristics. R&D firms in Africa are larger and more mature as opposed to the concentration of innovation among smaller and younger firms in developed economies. Our results, more importantly, show that access to external finance is a major factor that deters firms from investing in innovation as only mature and larger firms, which have better access to capital markets, account for most of the innovation in emerging markets.

This paper contributes to the extant literature along several dimensions. To the best of our knowledge, we make the first attempt to comprehensively examine the effects of the interplay between innovation and financial constraints on corporate savings, especially in under-researched emerging market contexts that is markedly different from the US and Europe where studies are concentrated. By focusing on emerging markets as exemplified by African countries, we investigate whether the results in the extant literature are generalisable within this setting where the need to save is of prime importance given the limited access to external finance. Consistent with this narrative, we find that, on over-

[2] Riddick and Whited (2009) find that the propensity to save is 0.103, 0.053, 0.103, 0.141, 0.126 and 0.078 for United States, Canada, United Kingdom, Japan, France and Germany, respectively.

all, the accumulation of cash reserves is one of the most important corporate objectives in emerging countries. However, we do not find supporting evidence for the increase in savings with innovation as reported for firms in the developed world (see Brown and Petersen, 2015; He and Wintoki, 2016; Machokoto et al., 2019). Instead, we find an irregular concentration of innovation amongst large and mature firms that have better access to external finance; hence, the lower propensity to save relative to Non-R&D firms. In the second instance, we show the overarching influence of the institutional environment on cash holdings behaviour. Specifically, only firms with better access to external finance, as indicated by the low propensity to save, invest in innovation. This helps explain the low levels of innovation in Africa and highlights the need to enhance or improve the financing of innovation that is essential for social and economic development. Finally, we provide sharper tests of the effects of innovation on the propensity to save *via* endogenous switching regression models that account for the endogenous nature of the decision to save and invest in innovation. Our results show that overlooking this form of endogeneity results in overstated estimates of the propensity to save, thereby, leading to biased inferences.

The rest of our paper is organised as follows: Section 2 discusses the literature and hypotheses. Section 3 presents the methodology and data. Section 5 presents and discusses the results. Section 6 presents the robustness tests, and Section 7 summaries and concludes.

2 Literature review and hypotheses

In the absence of market frictions, as proposed by Modigliani and Miller (1958), there is no divergence between the cost of internal and external funds, which dispenses with the need to hoard or accumulate cash reserves (see Keynes, 1936). However, markets are imperfect, especially emerging markets which are fraught with frictions such as information asymmetry and agency costs that significantly increase the cost of external capital relative to internal capital. This results in the adoption of a pecking order approach to firm financing (see Myers, 1984), with internal funds being preferred to external funds;

hence, the observed cash hoarding behaviour. Hoarding cash, however, entails a trade-off between the benefits of enhancing financial flexibility and the forgone or postponed investments that in most cases have comparatively better returns than liquid assets (Khurana et al., 2006).

Interestingly, as several studies document, firms are increasingly opting to hoard cash, which enables them to pursue valuable investment opportunities without being constrained by the availability of funds (see Gamba and Triantis, 2008; Marchica and Mura, 2010; de Jong et al., 2012; Denis and McKeon, 2012; Ferrando et al., 2017; He and Wintoki, 2016). Similarly, Khurana et al. (2006) find that cash holdings are inversely related to financial development. This implies that hoarding cash is more pronounced in developing or emerging markets where access to external finance is limited, and if available, it is costly and often accompanied by restrictive covenants (see Bae and Goyal, 2009; Gwatidzo and Ojah, 2014; Amaeshi et al., 2016; Ding et al., 2016). Al-Najjar (2013) also find that firms hold more cash reserves in environments characterised by low shareholder protection. Collectively, this points to a higher need to enhance financial flexibility *via* corporate savings, which in the context of emerging markets is mostly from internally generated or operating cash flow. We, therefore, formulate and test the following hypothesis:

Hypothesis 1 (H1): *Due to limited access to external finance, firms in emerging markets have high propensity to save from operating cash flow.*

It is well-documented that firms hoard cash to finance valuable projects (Barth et al., 2009; Bates et al., 2009; He and Wintoki, 2016). This hoarding behaviour is increasingly being linked to the need to finance the boom in innovation as economies transit from tangible to intangible or knowledge-based capital (Barth et al., 2009; Brown and Petersen, 2015; Qiu and Wan, 2015). For example, Bates et al. (2009), Falato and Sim (2014) and He and Wintoki (2016) document significant cash hoarding for US firms with riskier balance sheets and investment opportunities that are difficult to finance externally. Similarly, the difficulties associated with the financing innovation are well-documented in the literature (see Brown and Petersen, 2011; Brown et al., 2012; Brown and Petersen, 2015) and are

more pronounced in less-developed economies (Brown et al., 2013, 2017). While the above studies link the increase in corporate cash holdings to the rising innovation, to the best of our knowledge, none examines this important nexus within an emerging market context. Unlike the US and Europe where studies are concentrated, emerging markets are uniquely different as they are characterised by several institutional inadequacies (see, Asongu, 2017; Areneke and Kimani, 2019; Tunyi et al., 2019) which increase reliance on internal funds to finance innovation. Following on the above discussion and pecking order theory, we posit that firms in emerging markets have higher incentives to save from operating cash flow, which enhances financial flexibility, thereby enabling the financing of innovation. We, therefore, hypothesise that:

Hypothesis 2 (H2): *In emerging economies, the propensity to save from operating cash flow increases with innovation.*

The effect of credit constraints and channels through which they affect real decisions are contentious issues (the credit constraints hypothesis) (see Fazzari et al., 1988; Kaplan and Zingales, 1997; Erickson and Whited, 2000). Several studies show that firms hoard cash when they face binding credit constraints (see Almeida et al., 2004; Denis and Sibilkov, 2010). As credit constraints are binding in emerging markets (Khurana et al., 2006), it is not unreasonable to expect a more pronounced cash hoarding behaviour for financially constrained firms in this context, especially when they invest in innovation. The financing of innovation is fraught with difficulties as it is irreversible, risky, has longer investment horizons, and prone to asset substitution and information asymmetry problems. These unique characteristics significantly increase the financing difficulties that firms encounter, especially in the presence of binding credit constraints, as is the case in emerging markets. This increases reliance on internal financing sources. Accordingly, we formulate and test the following hypothesis:

Hypothesis 3 (H3): *The propensity to save increases with credit constraints and this is more pronounced for R&D firms relative to Non-R&D firms in emerging economies.*

3 Methodology

To examine the propensity to save (cash flow sensitivity of cash), we estimate an augmented version of the model of Almeida et al. (2004). We augment the model with an R&D dummy (RDD), the interaction term of the R&D dummy and cash flow (CF), and further controls for firm financing and asset structure which affect the propensity to save as follows:

$$\begin{aligned}\Delta Cash_{ijkt} =& \alpha + \gamma CF_{ijkt} + \varphi RDD_{ijkt} + \Upsilon CF_{ijkt} \times RDD_{ijkt} \\ &+ \boldsymbol{\beta} \boldsymbol{X}_{ijkt-1} + \epsilon_{ijkt} \end{aligned} \tag{1}$$

where $\Delta Cash_{ijkt}$ is the change in cash holdings for firm i in industry j and country k at time t, α is a constant, and γ, φ, Υ and $\boldsymbol{\beta}$ are coefficients to be estimated, CF_{ijkt} is cash flow, RDD_{ijkt} is a dummy variable that takes the value of one for firms that report R&D and zero otherwise, $\boldsymbol{X}_{ijkt-1}$ is vectors of lagged firm-specific characteristics explained below, ν_j and ν_t are country and time-fixed effects, and ϵ_{ijkt} is the error term. The vector, $\boldsymbol{X}_{ijkt-1}$, consists of Tobin's q, the logarithm of total assets ($Size$), total debt (TDA) and property, plant and equipment (PPE).[3]

Next, we examine the effects of innovation and credit constraints on the propensity to save using endogenous switching regression models. The advantage of using endogenous switching regression models is that we simultaneously account for the endogenous nature of the decisions to invest in innovation and save from operating cash flow, which are non-random decisions, and if overlooked as in the literature, can lead to biased inferences.[4] The model takes the form of a system of three equations that are estimated simultaneously

[3]The choice of the determinants of the change in cash is informed by the literature (e.g., Almeida et al., 2004; Khurana et al., 2006; He and Wintoki, 2016).

[4]If innovation and corporate savings are non-random decisions, we cannot expect the propensity to save to be similar or the same for R&D and Non-R&D firms. Consistent with this prediction, our results estimating Equation (1), and Equations (2)–(4) show that overlooking this form of endogeneity leads to biased inferences as the estimates of the propensity to save are significantly overstated.

via full-information maximum likelihood (FIML) as follows:-

$$\Delta Cash_{1ijkt} = \alpha_1 + \gamma_1 CF_{1ijkt} + \theta_1 FC_{1ijkt} + \lambda_1 CF_{1ijkt} \times FC_{1ijkt} + \boldsymbol{\beta}_1 \boldsymbol{X}_{1ijkt-1} + \epsilon_{1ijkt} \quad \textbf{iff} \quad y^*_{ijkt} < 0 \tag{2}$$

$$\Delta Cash_{2ijkt} = \alpha_2 + \gamma_2 CF_{2ijkt} + \theta_2 FC_{1ijkt} + \lambda_2 CF_{1ijkt} \times FC_{1ijkt} + \boldsymbol{\beta}_2 \boldsymbol{X}_{2ijkt-1} + \epsilon_{2ijkt} \quad \textbf{iff} \quad y^*_{ijkt} \geq 0 \tag{3}$$

$$I^*_{ijkt} = \zeta \boldsymbol{Z}_{ijkt-1} + \mu_{ijkt} \tag{4}$$

where $\Delta Cash_{1ijkt}$ and $\Delta Cash_{2ijkt}$ are the changes in cash holdings for firm i in regime (1) and regime (2), respectively. α is a constant, and γ, θ, λ, $\boldsymbol{\beta}$ and $\boldsymbol{\zeta}$ are coefficients to be estimated. FC_{1ijkt} is a dummy variable that takes the value of one if a firm is categorised as being financially constrained in a particular year and otherwise zero. ϵ_{ijkt} and μ_{ijkt} are error terms. The vector of lagged firm-specific factors, $\boldsymbol{X}_{ijkt-1}$, is the same as in Equation (1). $\boldsymbol{Z}_{ijkt-1}$ is the vector of variables that determine the probability, I^*_{ijkt}, of being in regime (1) or (2). The vector $\boldsymbol{Z}_{ijkt-1}$ consists of Tobin's q, the logarithm of total assets ($Size$), total debt (TDA) and property, plant and equipment (PPE), dividends ($Dividend$) and cash holdings ($Cash$). To identify constrained firms, we use four widely accepted measures of financial constraints; size, tangibility, firm-age, and WW Index (Whited, 2006). Following Almeida et al. (2004), we categorise a firm as constrained (FC_{ijkt}) in each year if it is in the lower three deciles of the distribution of firm-size and tangibility and in the top three deciles of the WW Index (Whited, 2006). For the categorisation based on firm-age, we classify a firm as financially constrained if its age is below the median firm-age.

We estimate Equation (1) using ordinary least squares (OLS) with fixed effects (see Almeida et al., 2004; Khurana et al., 2006) and general method of moments (GMM5) of Erickson and Whited (2000, 2002) which is based on higher-order moments to correct for potential measurement errors, and Equations (2)–(4) *via* full-information maximum likelihood (FIML) (Lokshin and Sajaia, 2004). For robustness, we also estimate a modified version of our baseline model using the dynamic panel data with a fractional dependent

variable (DPF) estimator (see Elsas and Florysiak, 2011, 2015), difference general method of moments (DIFF-GMM) (Arellano and Bond, 1991) and system general method of moments (SYS-GMM) (Blundell and Bond, 1998). This enables us to account for the dynamic nature of corporate decisions and endogeneity issues that can potentially bias our inferences.

4 Data

Our sample is composed of publicly listed firms from Egypt, Ghana, Ivory Coast, Kenya, Morocco, Nigeria, South Africa, Tunisia and Zambia. The data is drawn from *Datastream* over the period 2001–2015. We exclude financial and utility firms, and firms with negative equity and missing data on key variables (such as total assets and total revenue). We exclude firms with more than 100% growth in assets to avoid potential biases caused by abnormal growth or merger and acquisitions. We replace all missing R&D observations with zero. To reduce the effects of outliers, we winsorise all variables at the upper and bottom 1%. Our final sample consists of 5,570 firm-year observations for 501 firms, of which 108 firms (1,332 firm-year observations) report R&D. We describe, in detail, each of the variables used in Table 1.

PLEASE INSERT TABLE 1 HERE

Table 1 presents the descriptive statistics for all firms, Non-R&D and R&D firms. The mean (median) change in cash ($\Delta Cash$) and cash flow (CF) is 1.8% (0.8%) and 18.2% (16%) with a standard deviation of 7.3% and 11.5%, respectively. These basic statistics are comparable to those in the literature. Table 1 shows that R&D firms have, on average, higher cash flow (CF), size ($Size$), total debt (TDA) and firm-age ($Firm\text{-}Age$), while they have lower Tobin's q, property, plant and equipment (PPE), dividends ($Dividend$) and cash ($Cash$) relative to Non-R&D firms. These summary statistics suggest that R&D firms in Africa significantly differ from those in the USA which are smaller, younger and have low operating cash flow (see Brown et al., 2009, 2012; Brown and Petersen, 2015). These *prima facie* differences suggest that, relative to Non-R&D firms, R&D firms in

Africa are less likely to face binding credit constraints as they are larger, more mature and have higher leverage (debt).

PLEASE INSERT TABLE 2 HERE

Table 2 presents the Spearman (above diagonal) and Pearson (below diagonal) pairwise correlations for all variables used in our analyses. $\Delta Cash$ is positively correlated with cash flow (CF), while it is negatively correlated with Tobin's q, size ($Size$), total debt (TDA), property, plant and equipment (PPE), dividend ($Dividend$), cash ($Cash$) and firm-age ($Firm\text{-}Age$). The correlations are as expected and in line with the literature, except for the change in cash, which appears to contradict Brown and Petersen (2015) and He and Wintoki (2016).[5]

5 Results

In Table 3, we estimate several variants of Equation (1). Columns (1)–(5) of Table 3 present the estimation results for the full sample excluding the RDD and $CF \times RDD$. Columns (2) and (6) present the results for Non-R&D firms, while Columns (3) and (7) present the results for R&D firms. Columns (4) and (8) present the results, including RDD and $CF \times RDD$. Using this approach enables us to directly test whether the propensity to save is statistically different between R&D and Non-R&D firms. Table 3 summarises the results.

PLEASE INSERT TABLE 3 HERE

Table 3 shows that all the coefficients of cash flow are positive and statistically significant. Column (1) shows that, on average, a firm in Africa has a propensity to save of 0.363. This suggests that a firm increases cash holdings by 0.0408 for a one standard deviation increase in operating cash flow. We find a similar, but higher estimate of the propensity to save of 0.399 based on GMM5, which shows that our results are robust

[5] Brown and Petersen (2015) and He and Wintoki (2016) find a positive relationship between cash and innovation (R&D) as firms use cash holdings to smoothen innovation.

to the choice of the estimation technique and mismeasurement errors associated with Tobin's q. Our results are consistent with Hypothesis 1 (H1) and in line with Almeida et al. (2004) and Chen and Chen (2012) who find significant positive cash flow sensitivity of cash and investment-cash flow sensitivity for firms in the US, respectively. However, our estimates are relatively higher than those reported for US firms, which implies that maintaining financial flexibility by hoarding cash, is one of the primary objectives of firms operating in emerging markets where access to external finance is limited. The higher propensity to save that we document indicates the presence of binding credit constraints to which firms respond by saving most of the operating cash flow as a way of hedging against future shortfalls.

The coefficients of the interaction term, $CF \times RDD$, in Columns (4) and (8) of Table 3, are negative and significant, which suggests that R&D firms save relatively less than Non-R&D firms. Specifically, for a one standard deviation increase in cash flow, R&D firms save 0.009 and 0.004 less than Non-R&D firms for estimates *via* FE and GMM5, respectively. This finding is contrary to the literature (Brown and Petersen, 2015; He and Wintoki, 2016) and our predictions in Hypothesis 2 (H2), that the propensity to save increases with innovation. Our results show that the observed stylised cash hoarding behaviour in emerging economies is not driven by changes in corporate innovation.

We next explore the reasons why R&D firms save relatively less than Non-R&D firms by examining the effects of credit constraints on the propensity to save. As noted earlier, prior studies on innovation overlook the endogeneity relating to the decision to invest in innovation and save from operating cash flow (e.g., Brown and Petersen, 2011; Borisova and Brown, 2013; He and Wintoki, 2016). To address this limitation, we use endogenous switching regression models that enable us to simultaneously test for the effects of financial constraints on real decisions while accounting for the endogenous nature of corporate decisions. Table 4 presents the results estimating Equations (2)–(4) *via* full-information maximum likelihood (FIML).

PLEASE INSERT TABLE 4 HERE

Our results show that the coefficients of cash flow, in Table 4, are significantly lower

than those in Table 3. This confirms our prediction that the decision to invest in innovation and save cash are endogenous, and that if this form of endogeneity is overlooked as in the extant literature, the results should be interpreted with caution. Column (1) of Table 4 shows that R&D firms consistently save less than Non-R&D firms. This is inconsistent with Hypothesis 2 (H2) and the extant literature in advanced economies (e.g. Brown and Petersen, 2011, 2015; He and Wintoki, 2016). Instead, our results suggest that R&D firms in Africa do not prioritise savings from operating cash flow (financial flexibility). This is somewhat puzzling and surprising, given that these firms operate in emerging markets where access to external finance is limited. As a result, we next explore the reasons for these puzzling findings by augmenting our initial model to include several proxies of financial constraints.

Columns (2)–(4) of Table 3 consistently show that Non-R&D firms have a higher propensity to save when they face binding credit constraints. This is in line with Hypothesis 3 (H3) and the credit constraint hypothesis, which predicts that firms hoard cash when they face binding financial constraints. However, the effect of financial constraints on the propensity to save from operating cash flow is lower and marginally significant for R&D firms. This result, when taken together with those in the previous section, suggests that R&D firms in our context rely less on internal sources of finance relative to Non-R&D firms. Table 1 corroborates this result and shows that R&D firms are larger, mature, and have more tangible assets, which facilitates better access to external finance. This is more pertinent in emerging markets, given that firms operating in this context rely mostly on short-term debt and bank loans for their borrowings (Sorge et al., 2017).

In summary, our results show that R&D firms in Africa save less of their operating cash flow as they are markedly different from those in the developed world. R&D firms in emerging markets are mostly larger, mature, and have more tangible assets. This implies that access to external finance is a major determinant of innovation; hence, the low number of small and young firms reporting R&D in emerging markets.

6 Robustness

In this section, we implement a battery of robustness tests. We first examine the time-variations in the propensity to save by estimating 5-year rolling regressions of Equation (1), excluding the RDD and $CF \times RDD$. We estimate this modified version of our baseline model separately for all firms, innovative and non-innovative firms. Figure 2 plots the coefficients of cash flow over the sample period.

PLEASE INSERT FIGURE 2 HERE

Figure 2 shows consistent and persistent differences in the propensity to save between R&D firms ($RDD = 1$) and Non-R&D firms ($RDD = 0$). Firms that invest in innovation consistently save less from operating cash flow relative to Non-R&D firms. This is consistent with our previous results, but inconsistent with Brown et al. (2009) and He and Wintoki (2016) for US firms. Instead, our results suggest that R&D firms in Africa have a less pressing need to save from operating cash flow relative to Non-R&D firms. This puzzling finding is due to the markedly different firm-specific characteristics of R&D firms in Africa relative to those in developed economies that are mostly younger, smaller and have less-pledgeable assets.[6] Relative to Non-R&D firms, R&D firms in Africa are larger, mature and have more pledgeable assets, which makes it easier to access capital markets, thereby reducing the need to save or hold large cash reserves. This is in contrast to the corporate universe of R&D firms in developed markets - mostly smaller, younger, and with less-tangible assets - which increases their need to save or hoard cash in a bid to hedge against future shortfalls.[7]

We also examine the sensitivity of our results to alternative model specifications and choice of estimation techniques. To ensure the robustness of our results, we estimate a modified version of Equation (1) that includes the lagged change in cash ($\Delta Cash_{ijkt-1}$)

[6] Appendix A shows similar results for cross-industrial analyses, expect for the telecommunication and technology sector (T&T) where R&D firms save more than Non-R&D firms.

[7] Figure 3 also shows that the propensity to save is non-linear and consistently lower for R&D firms relative to Non-R&D firms conditional on the distribution of the changes in cash. This confirms our main results and shows that the differences in the propensity to save conditional on innovation are not driven by differences in the firm's ability to generated cash flow.

as an additional determinant of the changes in cash holdings. We estimate this modified dynamic panel data model using the Dynamic Fractional Dependent Variable (DPF, thereon) estimator of Elsas and Florysiak (2011, 2015), difference general method of moments (DIFF-GMM) (Arellano and Bond, 1991) and system general method of moments (SYS-GMM) (Blundell and Bond, 1998). This modified model enables us to account for the dynamic nature of corporate decisions and address endogeneity concerns that could potentially bias our inferences. In order to check the validity and relevance of our instruments, we present the Hansen-Sargan and second-order autocorrelation (AR(2)) tests for difference general method of moments (DIFF-GMM) and system general method of moments (SYS-GMM). Table 5 summarises the results.

PLEASE INSERT TABLE 5 HERE

Table 5 confirms the validity and relevance of our instruments for the estimates based on difference general method of moments (DIFF-GMM) and system general method of moments (SYS-GMM) as both Hansen-Sargan and second-order autocorrelation (AR(2)) tests show no significant evidence of serial correlation. Our results, most importantly, show that African firms save between 36% to 40% of the operating cash flow, which is consistent with our previous results and the need to hedge against future shortfalls. However, the interaction term $CF \times RDD$ is consistently negative and significant, which shows that R&D firms save less irrespective of the model specification or estimation technique used. This confirms our previous findings and suggests that R&D firms in Africa are uniquely larger, more mature and do not prioritise the accumulation of cash reserves relative to Non-R&D firms.[8] Based on the above tests, we conclude that our results are robust to endogeneity issues that plague research in corporate finance.

Overall our results show consistent and persistent differences in the propensity to save conditional on innovation, which suggests that access to external finance in emerging

[8]Following on the findings of Koh and Reeb (2015) that missing R&D is not equivalent to zero R&D, we use RDD2, a dummy variable that takes the value of one if a firm increases its intangible assets and otherwise zero, as an alternative proxy for innovation. Appendix B shows that our results are robust to changing the way we define innovation as R&D firms consistently save less than Non-R&D firms. However, we acknowledge that our results may be affected by the selective reporting of R&D and the lack of comprehensive alternative firm-level measures of innovation within the context of emerging markets.

markets is a major factor deterring small and young firms from investing in innovation.

7 Summary discussion and conclusion

There is a growing interest in understanding the effects of innovation on corporate decisions given the transition of economies from predominantly manufacturing towards technology and services industries. Virtually all of the literature on innovation and its impact on corporate decisions is concentrated in advanced economies. This is partly due to the lack of data and low levels of innovation in emerging economies. However, improvements in data availability and disclosure of corporate innovation have recently amplified calls for a concerted research effort to address this lacuna. This is of interest to academics, practitioners and policymakers alike as results from developed economies may not be generalisable in a context characterised by institutional inadequacies and limited access to capital markets. These unique peculiarities adversely affect the financing of innovation which is risky, irreversible, has longer investment horizons, and prone to asset substitution and information asymmetry problems.

In line with the literature in the developed world, we find a high propensity to save amongst firms operating in emerging markets, which suggests that enhancing financial flexibility is increasingly becoming one of the most critical goals for firms operating in emerging capital markets. However, our estimates of the propensity to save are lower when we account for the potential bias emanating from the endogenous nature of the decision to invest in innovation and save from operating cash flow using endogenous switching regression models. This finding shows that overlooking the endogenous nature of the two corporate decisions, as in the extant literature, leads to biased inferences on the propensity to save. Interestingly, after addressing this potential bias, we find that R&D firms in emerging economies save less than Non-R&D firms, which is not in line with the extant literature in developed economies. Our results further show that the propensity to save increases with financial constraints only for Non-R&D firms, which confirms the markedly different firm-specific characteristics of R&D firms in emerging

economies to those in advanced economies, as the former are larger and more mature. These differences reduce reliance on corporate savings to finance innovation in the context of emerging markets.

Our findings have two important implications. First, and more importantly, our results show that innovation is mostly concentrated amongst firms that are likely to be less constrained - large and mature firms - which implies that improving access to external finance can significantly boost innovation for small and young firms in emerging economies. Second, we highlight the need to address endogeneity in corporate finance research that can lead to biased inferences as our results show that models in the extant literature significantly overstate the propensity to save from operating cash flow.

We acknowledge that our results may be affected by the selective reporting of R&D and the lack of comprehensive alternative firm-level measures of innovation in the sampled emerging markets. We highlight using alternative proxies of innovation such as patents and citations as a future research endeavour.

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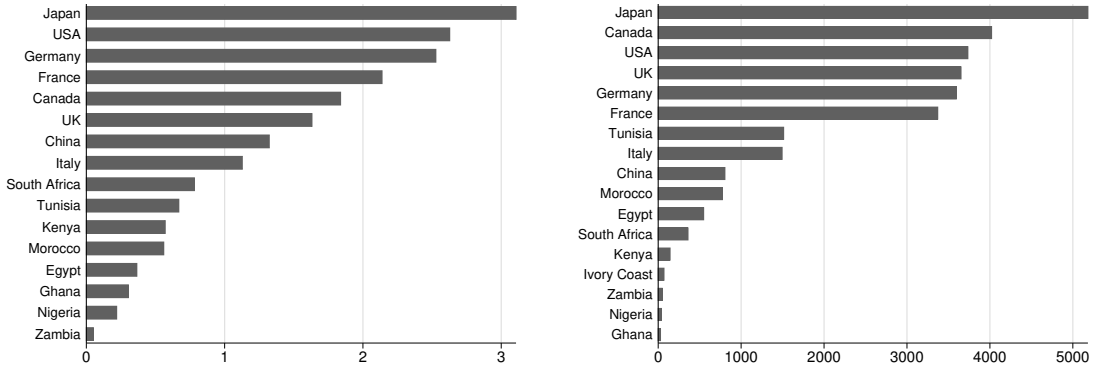


(a) R&D expenditure (% of GDP) **(b) Researchers in R&D (per million people)**

Figure 1 Cross-country variations in research and development

The figures present plots the R&D expenditure (% of GDP) and Researchers in R&D (per million people) across countries over the period 1990–2015. The data is drawn from the World Bank.

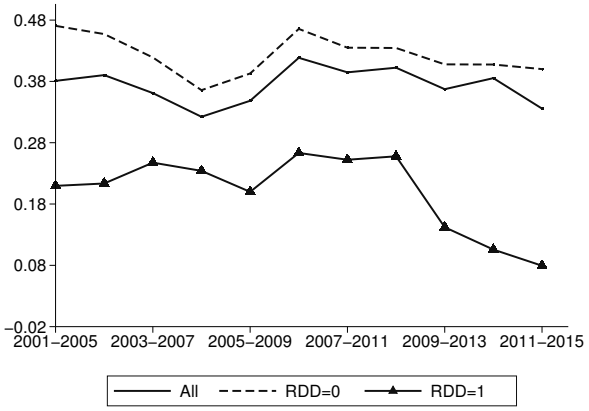
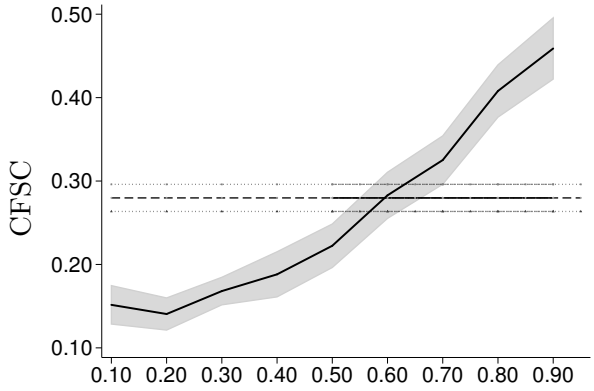
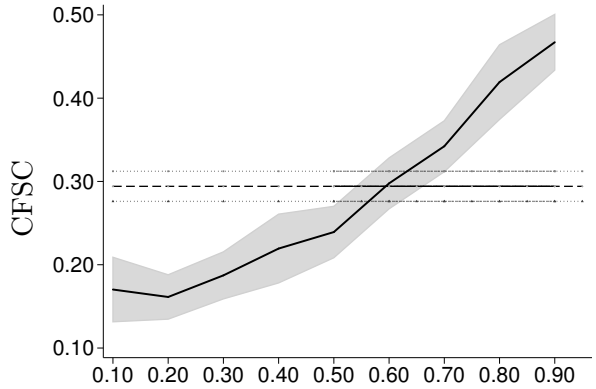


Figure 2 Time variations in the propensity to save

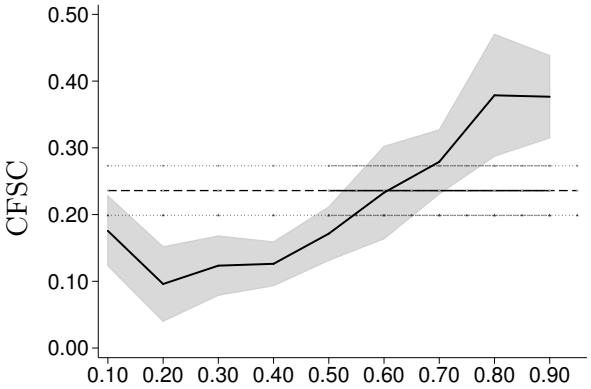
The figure plots the proportion of firms investing in innovation and average innovation over time. The sample consists of publicly listed non-utility and non-financial firms from Ivory Coast, Egypt, Ghana, Kenya, Morocco, Nigeria, South Africa, Tunisia and Zambia. The data is drawn from *Datastream* over the period 2001–2015. All variables used are defined in Table 1 and are winsorised at the lower and upper one percentiles.



(a) All firms



(b) Non-R&D firms



(c) R&D firms

Figure 3 The propensity to save conditional on the changes in cash

The figures present plots the propensity to save at various quantiles. The sample consists of publicly listed non-utility and non-financial firms from Ivory Coast, Egypt, Ghana, Kenya, Morocco, Nigeria, South Africa, Tunisia and Zambia. The data is drawn from *Datastream* over the period 2001–2015. All variables used are defined in Table 1 and are winsorised at the lower and upper one percentiles.

Table 1 Basic statistics

The table presents the basic statistics for all variables used. The sample consists of publicly listed non-utility and non-financial firms from Ivory Coast, Egypt, Ghana, Kenya, Morocco, Nigeria, South Africa, Tunisia and Zambia. The data is drawn from *Datastream* over the period 2001–2015. ΔCash is the change in cash holdings to total assets. Cash Flow is earnings before interest and tax plus depreciation to total assets. RDD is a dummy variable that takes the value of one if a firm reports R&D and otherwise zero. Tobin's q is market-to-book ratio. Size is the logarithm of total assets. TDA is total debt to total assets. PPE is property, plant and equipment to total assets. Dividend is dividends to total assets. Cash is cash and cash equivalent to total assets. WW Index is $-0.091 \times \frac{Cash\ Flow}{Assets} - 0.062 \times DivDummy + 0.021 \times \frac{Total\ debt}{Assets} - 0.044 \times Size + 0.102 \times IndustrySalesGrowth - 0.035 \times SalesGrowth$. The WW Index is based on (Whited, 2006). Firm-Age is the logarithm of the difference between the current year and the first year that the firm appears in the database. All variables used are winsorised at the lower and upper one percentiles. ***, **, * indicate significance of the difference between Non-R&D firms (RDD=0) and R&D firms (RDD=1) at the one, five, and ten percent levels, respectively.

	All firms				RDD=0				RDD=1			
Variables	Mean	Median	Std.Dev	Trend	Mean	Median	Std.Dev	Trend	Mean	Median	Std.Dev	Trend
ΔCash	0.018	0.008	0.073	-0.156***	0.019	0.010	0.074	-0.192***	0.015*	0.006***	0.070**	-0.064
CF	0.182	0.160	0.112	-0.389***	0.186	0.165	0.113	-0.373***	0.171***	0.145***	0.111	-0.548***
RDD	0.222	0.000	0.415	-1.216***	0.000	0.000	0.000	0.000	1.000***	1.000***	0.000***	0.000
R&D	0.001	0.000	0.003	-0.008***	0.000	0.000	0.000	0.000	0.004***	0.002***	0.005***	-0.013***
Mtbv	1.719	1.455	0.913	3.020***	1.734	1.465	0.937	3.192***	1.667**	1.424	0.820***	2.251***
Size	15.034	15.148	1.971	8.083***	14.801	14.819	1.979	10.427***	15.846***	16.092***	1.713***	7.573***
TDA	0.164	0.139	0.142	0.372***	0.159	0.130	0.146	0.514***	0.182***	0.172***	0.123***	0.079
PPE	0.354	0.326	0.219	0.446***	0.358	0.337	0.221	0.472***	0.337***	0.271***	0.209**	0.255*
Dividend	0.052	0.031	0.063	0.121***	0.054	0.031	0.064	0.137***	0.047***	0.032	0.060***	0.037
Cash	0.127	0.099	0.107	-0.314***	0.132	0.101	0.112	-0.333***	0.112***	0.089***	0.090***	-0.400***
Firm-Age	2.407	2.398	0.659	4.444***	2.301	2.303	0.632	5.736***	2.776***	3.045***	0.615	3.519***
N	6,636				5,166				1,470			
Firms	715				567				148			

Table 2 Correlation

The table presents the Spearman (above diagonal) and Pearson (below diagonal) pairwise correlations for all variables used. The sample consists of publicly listed non-utility and non-financial firms from Ivory Coast, Egypt, Ghana, Kenya, Morocco, Nigeria, South Africa, Tunisia and Zambia. The data is drawn from *Datastream* over the period 2001–2015. All variables used are defined in Table 1 and are winsorised at the lower and upper one percentiles. ***, **, * indicate significance at the one, five, and ten percent levels, respectively.

Variables	ΔCash	CF	RDD	R&D	Tobin's q	Size	TDA	PPE	Dividend	Cash	Firm-Age
ΔCash	1	0.328***	-0.029**	-0.031**	-0.018	-0.090***	-0.046***	-0.040***	-0.051***	-0.107***	-0.039***
CF	0.361***	1	-0.082***	-0.076***	0.427***	-0.068***	-0.160***	0.075***	0.323***	0.149***	-0.123***
RDD	-0.016	-0.075***	1	0.989***	-0.006	0.229***	0.113***	-0.038***	-0.014	-0.053***	0.306***
R&D	-0.009	-0.007	0.608***	1	-0.004	0.223***	0.115***	-0.036***	-0.012	-0.051***	0.305***
Tobin's q	-0.020	0.451***	-0.030**	-0.003	1	0.170***	-0.235***	0.025*	0.594***	0.163***	0.077***
Size	-0.102***	-0.060***	0.221***	0.082***	0.128***	1	0.187***	0.296***	0.122***	-0.138***	0.491***
TDA	-0.062***	-0.130***	0.069***	0.016	-0.204***	0.164***	1	0.227***	-0.349***	-0.415***	0.099***
PPE	-0.049***	0.075***	-0.041***	-0.099***	0.048***	0.287***	0.256***	1	0.005	-0.282***	0.093***
Dividend	-0.067***	0.380***	-0.042***	-0.022*	0.653***	0.081***	-0.263***	0.057***	1	0.230***	0.039***
Cash	-0.055***	0.152***	-0.076***	0.015	0.137***	-0.219***	-0.383***	-0.310***	0.202***	1	-0.038***
Firm-Age	-0.041***	-0.134***	0.300***	0.143***	0.016	0.470***	0.072***	0.081***	-0.021	-0.090***	1

Table 3 The effects of innovation on the propensity to save

The table presents the estimation results of Equation (1) that relates the change in cash to firm-specific factors. The sample consists of publicly listed non-utility and non-financial firms from Ivory Coast, Egypt, Ghana, Kenya, Morocco, Nigeria, South Africa, Tunisia and Zambia. The data is drawn from *Datastream* over the period 2001–2015. All variables used are defined in Table 1 and are winsorised at the lower and upper one percentiles. τ^2 is an index of measurement quality of Tobin's q which ranges between zero and one, with zero indicating a poor proxy and one indicating a very good proxy. ***, **, * indicate significance at the one, five, and ten percent levels, respectively.

	FE				GMM5			
Sample	All	RDD=0	RDD=1	All	All	RDD=0	RDD=1	All
Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
CF	0.363***	0.404***	0.239***	0.383***	0.399***	0.444***	0.339***	0.415***
	(0.016)	(0.019)	(0.022)	(0.018)	(0.022)	(0.025)	(0.023)	(0.024)
RDD				0.024***				0.003***
				(0.005)				(0.001)
CF×RDD				-0.100***				-0.088***
				(0.028)				(0.029)
Tobin's q	-0.015***	-0.016***	-0.004	-0.015***	-0.036***	-0.052***	-0.049***	-0.035***
	(0.002)	(0.002)	(0.007)	(0.002)	(0.010)	(0.011)	(0.011)	(0.010)
Size	-0.013***	-0.005	-0.043***	-0.014***	0.005	0.010**	0.007	0.005
	(0.004)	(0.005)	(0.005)	(0.004)	(0.004)	(0.004)	(0.005)	(0.004)
TDA	0.006	0.006	0.014	0.003	-0.014	-0.013	-0.081**	-0.016
	(0.014)	(0.015)	(0.028)	(0.014)	(0.016)	(0.016)	(0.040)	(0.015)
PPE	0.207***	0.188***	0.312***	0.208***	0.196***	0.171***	0.265***	0.199***
	(0.019)	(0.021)	(0.048)	(0.019)	(0.019)	(0.022)	(0.047)	(0.020)
Constant	0.125**	-0.017	0.599***	0.125**	-0.000	-0.001**	0.002**	-0.001**
	(0.060)	(0.075)	(0.087)	(0.059)	(0.000)	(0.000)	(0.001)	(0.000)
N	5,921	4,599	1,322	5,921	5,921	4,599	1,322	5,921
R^2	0.23	0.26	0.18	0.23				
ρ^2					0.24	0.28	0.15	0.24
τ^2					0.45	0.40	0.13	0.47
J p-value					0.000	0.000	0.000	0.000

Table 4 The estimation of endogenous switching regression models

The table presents the results estimating Equations (2)–(4), the endogenous switching regression models, relating the change in cash to firm-specific factors. The endogenous switching regression models with unknown sample separation are estimated via maximum likelihoods. The sample consists of publicly listed non-utility and non-financial firms from Ivory Coast, Egypt, Ghana, Kenya, Morocco, Nigeria, South Africa, Tunisia and Zambia. The data is drawn from *Datastream* over the period 2001–2015. All variables used are defined in Table 1 and are winsorised at the lower and upper one percentiles. ***, **, * indicate significance at the one, five, and ten percent levels, respectively.

	Financial Constraint	None	Size	Tangibility	WW Index	Firm-Age
	Variables	(1)	(2)	(3)	(4)	(5)
RDD=0	CF	0.326***	0.296***	0.298***	0.283***	0.280***
		(0.017)	(0.019)	(0.019)	(0.017)	(0.020)
	FC		-0.009*	-0.003	-0.009*	-0.018***
			(0.006)	(0.005)	(0.005)	(0.004)
	CF×FC		0.079***	0.108***	0.115***	0.069***
			(0.028)	(0.027)	(0.028)	(0.024)
	Tobin's q	-0.020***	-0.019***	-0.020***	-0.018***	-0.019***
		(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
	Size	0.001	0.002**	0.001**	0.003***	0.000
		(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
	TDA	-0.019***	-0.018**	-0.018**	-0.019***	-0.017**
		(0.007)	(0.007)	(0.007)	(0.007)	(0.007)
	PPE	-0.036***	-0.036***	-0.013*	-0.036***	-0.036***
		(0.005)	(0.005)	(0.007)	(0.005)	(0.005)
	Constant	-0.007	-0.022	-0.020*	-0.018	0.034***
		(0.011)	(0.016)	(0.012)	(0.014)	(0.012)
RDD=1	CF	0.191***	0.175***	0.186***	0.170***	0.171***
		(0.020)	(0.021)	(0.029)	(0.021)	(0.028)
	FC		-0.014	0.004	-0.009	-0.015***
			(0.009)	(0.005)	(0.008)	(0.005)
	CF×FC		0.076*	0.009	0.087**	0.040
			(0.046)	(0.028)	(0.041)	(0.029)
	Tobin's q	-0.028***	-0.028***	-0.029***	-0.028***	-0.028***
		(0.004)	(0.005)	(0.005)	(0.005)	(0.005)
	Size	0.022***	0.022***	0.022***	0.023***	0.021***
		(0.004)	(0.004)	(0.004)	(0.004)	(0.004)
	TDA	0.102***	0.105***	0.100***	0.105***	0.105***
		(0.031)	(0.031)	(0.031)	(0.031)	(0.031)
	PPE	-0.092***	-0.091***	-0.083***	-0.092***	-0.091***
		(0.026)	(0.026)	(0.029)	(0.026)	(0.026)
	Constant	-0.439***	-0.435***	-0.440***	-0.443***	-0.420***
		(0.065)	(0.067)	(0.064)	(0.065)	(0.063)
Switching function	Tobin's q	-0.135***	-0.138***	-0.132***	-0.136***	-0.138***
		(0.047)	(0.047)	(0.048)	(0.047)	(0.047)
	Size	0.207***	0.209***	0.206***	0.210***	0.208***
		(0.022)	(0.023)	(0.022)	(0.023)	(0.022)
	TDA	0.824***	0.830***	0.831***	0.833***	0.841***
		(0.279)	(0.278)	(0.279)	(0.277)	(0.278)
	PPE	0.824***	0.830***	0.831***	0.833***	0.841***
		(0.279)	(0.278)	(0.279)	(0.277)	(0.278)
	Dividend	0.988***	0.955***	0.923***	0.904***	0.983***
		(0.324)	(0.315)	(0.353)	(0.312)	(0.318)
	Cash	1.746***	1.774***	1.771***	1.795***	1.831***
		(0.389)	(0.379)	(0.406)	(0.367)	(0.402)
	Constant	-3.847***	-3.873***	-3.838***	-3.884***	-3.874***
		(0.352)	(0.354)	(0.352)	(0.354)	(0.354)
Statistics	N	5,921	5,921	5,921	5,921	5,921
	Log-Likelihood	4,914.00	4,924.00	4,947.00	4,939.00	4,926.00
	$/lns0$	-2.694***	-2.694***	-2.701***	-2.695***	-2.694***
	$/lns1$	-2.104***	-2.100***	-2.104***	-2.100***	-2.099***
	$/r0$	0.572***	0.588***	0.569***	0.603***	0.584***
	$/r1$	2.052***	2.070***	2.052***	2.073***	2.076***
	χ^2	270.10	278.40	253.60	283.50	268.20
	$Prob > \chi^2$	0.000	0.000	0.000	0.000	0.000
	Differences					
	$\gamma_1 = \gamma_2$	0.000	0.000	0.001	0.000	0.001
	$\gamma_1 + \lambda_1 = \gamma_2 + \lambda_2$		0.008	0.000	0.001	0.000

Table 5 Alternative estimations of the effects of innovation on the propensity to save

The table presents the estimation results of a modified version of Equation (1) that relates the change in cash to the lagged change in cash ($\Delta Cash_{ijkt-1}$) and firm-specific factors. The sample consists of publicly listed non-utility and non-financial firms from Ivory Coast, Egypt, Ghana, Kenya, Morocco, Nigeria, South Africa, Tunisia and Zambia. The data is drawn from *Datastream* over the period 2001–2015. The results are estimated using unbalanced dynamic panel data with a fractional dependent variable (DPF) estimator (see Elsas and Florysiak, 2011, 2015), difference general method of moments (DIFF-GMM) (Arellano and Bond, 1991) and system general method of moments (SYS-GMM) (Blundell and Bond, 1998). All variables used are defined in Table 1 and are winsorised at the lower and upper one percentiles. τ^2 is an index of measurement quality of Tobin's q which ranges between zero and one, with zero indicating a poor proxy and one indicating a very good proxy. ***, **, * indicate significance at the one, five, and ten percent levels, respectively.

	DPF		DIFF-GMM		SYS-GMM	
Variables	(1)	(2)	(3)	(4)	(5)	(6)
ΔCash$_{ijkt-1}$	-0.047***	-0.045***	0.229	0.254	0.514	0.525
	(0.014)	(0.014)	(0.243)	(0.253)	(0.367)	(0.363)
CF	0.395***	0.415***	0.381***	0.418***	0.361***	0.390***
	(0.012)	(0.013)	(0.035)	(0.045)	(0.026)	(0.033)
RDD		0.015**		0.050***		0.040***
		(0.007)		(0.017)		(0.012)
CF×RDD		-0.098***		-0.159***		-0.131***
		(0.027)		(0.054)		(0.043)
Tobin's q	-0.013***	-0.013***	-0.002	-0.001	-0.017***	-0.016***
	(0.002)	(0.002)	(0.003)	(0.004)	(0.002)	(0.002)
Size	-0.008**	-0.008**	-0.098***	-0.098***	-0.003***	-0.004***
	(0.003)	(0.003)	(0.028)	(0.028)	(0.001)	(0.001)
TDA	-0.003	-0.003	0.069**	0.055*	-0.007	-0.012
	(0.015)	(0.015)	(0.030)	(0.029)	(0.010)	(0.010)
PPE	0.164***	0.167***	0.636***	0.647***	0.046*	0.050*
	(0.018)	(0.018)	(0.144)	(0.150)	(0.026)	(0.027)
Constant	0.050***	0.051***			0.006	0.007
	(0.010)	(0.010)			(0.015)	(0.014)
N	5,921	5,921	5,206	5,206	5,921	5,921
Firms	715	715	715	715	715	715
ρ^2	0.030	0.030				
σ_u	0.012	0.012				
σ_e	0.067	0.067				
Log-Likelihood	2,829	2,835				
AR(2) p-value			0.243	0.225	0.095	0.084
J p-value			0.237	0.224	0.309	0.289

Appendix A The effects of innovation on the propensity to save across industries

The table presents the estimation results of Equation (1) that relates the change in cash to firm-specific factors. The industries are categorised as follows: BM is basic materials. CG&S is consumer goods and services. IND is industrials. OT is others which comprises health care and oil & gas. T&T is telecommunications and technology. The sample consists of publicly listed non-utility and non-financial firms from Ivory Coast, Egypt, Ghana, Kenya, Morocco, Nigeria, South Africa, Tunisia and Zambia. The data is drawn from *Datastream* over the period 2001–2015. All variables used are defined in Table 1 and are winsorised at the lower and upper one percentiles. ***, **, * indicate significance at the one, five, and ten percent levels, respectively.

	BM	CG&CS	IND	OT	T&T	BM	CG&CS	IND	OT	T&T
Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
CF	0.253***	0.371***	0.446***	0.608***	0.350***	0.259***	0.399***	0.458***	0.630***	0.334***
	(0.029)	(0.031)	(0.031)	(0.068)	(0.035)	(0.040)	(0.034)	(0.033)	(0.066)	(0.037)
RDD						0.022	0.027***	0.022***	0.035	0.019
						(0.015)	(0.009)	(0.008)	(0.029)	(0.022)
RDD×CF						-0.024	-0.197***	-0.079*	-0.090	0.125**
						(0.043)	(0.048)	(0.045)	(0.119)	(0.053)
Tobin's q	-0.017***	-0.009***	-0.007	0.014	-0.019**	-0.017***	-0.009**	-0.008	0.014	-0.018**
	(0.004)	(0.004)	(0.006)	(0.011)	(0.008)	(0.004)	(0.004)	(0.006)	(0.011)	(0.008)
Size	-0.007	-0.022***	-0.007	-0.053**	-0.014	-0.007	-0.022***	-0.010*	-0.049*	-0.013
	(0.009)	(0.006)	(0.005)	(0.023)	(0.008)	(0.009)	(0.006)	(0.005)	(0.025)	(0.009)
TDA	0.152***	0.040**	-0.116***	-0.014	0.106**	0.147***	0.042***	-0.118***	-0.044	0.113**
	(0.033)	(0.016)	(0.022)	(0.093)	(0.050)	(0.032)	(0.016)	(0.022)	(0.122)	(0.051)
PPE	0.248***	0.184***	0.273***	0.132	0.258***	0.242***	0.186***	0.271***	0.142	0.277***
	(0.034)	(0.032)	(0.040)	(0.093)	(0.048)	(0.032)	(0.032)	(0.040)	(0.093)	(0.048)
Constant	-0.019	0.242**	0.020	0.646*	0.113	-0.020	0.235**	0.063	0.570	0.085
	(0.147)	(0.093)	(0.079)	(0.377)	(0.133)	(0.146)	(0.095)	(0.082)	(0.407)	(0.138)
N	1,212	2,119	1,687	297	606	1,212	2,119	1,687	297	606
R^2	0.28	0.23	0.33	0.49	0.25	0.28	0.23	0.34	0.49	0.26
RDD=1 (#)	476	385	456	82	71	476	385	456	82	71
RDD=1 (%)	35%	16%	24%	23%	10%	35%	16%	24%	23%	10%
% of Sample	23%	40%	32%	6%	11%	23%	40%	32%	6%	11%

Appendix B Alternative measure of innovation

The table presents the estimation results of a modified version of Equation (1) that relates the change in cash to the lagged change in cash ($\Delta Cash_{ijkt-1}$) and firm-specific factors. RDD2 is a dummy variable that takes the value of one if the firm increases its intangible assets and otherwise zero. The sample consists of publicly listed non-utility and non-financial firms from Ivory Coast, Egypt, Ghana, Kenya, Morocco, Nigeria, South Africa, Tunisia and Zambia. The data is drawn from *Datastream* over the period 2001–2015. The results are estimated using fixed effects (FE), general method of moments (GMM5) of Erickson and Whited (2000, 2002), unbalanced dynamic panel data with a fractional dependent variable (DPF) estimator (see Elsas and Florysiak, 2011, 2015), difference general method of moments (DIFF-GMM) (Arellano and Bond, 1991) and system general method of moments (SYS-GMM) (Blundell and Bond, 1998). All variables used are defined in Table 1 and are winsorised at the lower and upper one percentiles. τ^2 is an index of measurement quality of Tobin's q which ranges between zero and one, with zero indicating a poor proxy and one indicating a very good proxy. ***, **, * indicate significance at the one, five, and ten percent levels, respectively.

	FE	GMM5	DPF	SYS-GMM	SYS-GMM
Variables	(1)	(2)	(3)	(4)	(5)
ΔCash$_{ijkt-1}$			-0.052***	0.111	0.486
			(0.015)	(0.207)	(0.344)
CF	0.403***	0.414***	0.425***	0.420***	0.387***
	(0.019)	(0.023)	(0.016)	(0.036)	(0.028)
RDD2	-0.017***	-0.026***	-0.014***	-0.017***	-0.025***
	(0.004)	(0.002)	(0.004)	(0.005)	(0.006)
RDD2×CF	-0.083***	-0.014	-0.088***	-0.104***	-0.059**
	(0.023)	(0.024)	(0.019)	(0.027)	(0.030)
Tobin's q	-0.013***	-0.038***	-0.008***	-0.000	-0.016***
	(0.002)	(0.009)	(0.002)	(0.003)	(0.002)
Size	-0.011***	0.007**	-0.006*	-0.081***	-0.003***
	(0.004)	(0.003)	(0.003)	(0.023)	(0.001)
TDA	0.013	-0.011	0.011	0.069**	-0.008
	(0.013)	(0.015)	(0.016)	(0.027)	(0.011)
PPE	0.226***	0.206***	0.188***	0.607***	0.044*
	(0.019)	(0.019)	(0.020)	(0.126)	(0.025)
N	5,921	5,921	5,206	5,206	5,921
Firms	715	715	715	715	715
R^2	0.28				
ρ^2		0.282	0.049		
τ^2		0.403			
σ_u			0.015		
σ_e			0.064		
Log-Likelihood			2,622		
$AR(2)$ p-value				0.367	0.081
J p-value				0.566	0.624