

Alkhataybeh, Ahmad

Article

Working capital and R&D smoothing: Evidence from the Tel Aviv stock exchange

Journal of Applied Economics

Provided in Cooperation with:

University of CEMA, Buenos Aires

Suggested Citation: Alkhataybeh, Ahmad (2021) : Working capital and R&D smoothing: Evidence from the Tel Aviv stock exchange, Journal of Applied Economics, ISSN 1667-6726, Taylor & Francis, Abingdon, Vol. 24, Iss. 1, pp. 91-102,
<https://doi.org/10.1080/15140326.2021.1877599>

This Version is available at:

<https://hdl.handle.net/10419/314118>

Standard-Nutzungsbedingungen:

Die Dokumente auf EconStor dürfen zu eigenen wissenschaftlichen Zwecken und zum Privatgebrauch gespeichert und kopiert werden.

Sie dürfen die Dokumente nicht für öffentliche oder kommerzielle Zwecke vervielfältigen, öffentlich ausstellen, öffentlich zugänglich machen, vertreiben oder anderweitig nutzen.

Sofern die Verfasser die Dokumente unter Open-Content-Lizenzen (insbesondere CC-Lizenzen) zur Verfügung gestellt haben sollten, gelten abweichend von diesen Nutzungsbedingungen die in der dort genannten Lizenz gewährten Nutzungsrechte.

Terms of use:

Documents in EconStor may be saved and copied for your personal and scholarly purposes.

You are not to copy documents for public or commercial purposes, to exhibit the documents publicly, to make them publicly available on the internet, or to distribute or otherwise use the documents in public.

If the documents have been made available under an Open Content Licence (especially Creative Commons Licences), you may exercise further usage rights as specified in the indicated licence.



<https://creativecommons.org/licenses/by/4.0/>



Working capital and R&D smoothing: evidence from the Tel Aviv Stock exchange

Ahmad Alkhataybeh

To cite this article: Ahmad Alkhataybeh (2021) Working capital and R&D smoothing: evidence from the Tel Aviv stock exchange, *Journal of Applied Economics*, 24:1, 91-102, DOI: [10.1080/15140326.2021.1877599](https://doi.org/10.1080/15140326.2021.1877599)

To link to this article: <https://doi.org/10.1080/15140326.2021.1877599>



© 2021 The Author(s). Published by Informa UK Limited, trading as Taylor & Francis Group.



Published online: 23 Mar 2021.



Submit your article to this journal [↗](#)



Article views: 3017



View related articles [↗](#)



View Crossmark data [↗](#)



Citing articles: 7 View citing articles [↗](#)

RESEARCH ARTICLE



Working capital and R&D smoothing: evidence from the Tel Aviv stock exchange

Ahmad Alkhataybeh 

Faculty of Economics and Administrative Sciences, Yarmouk University, Irbid, Jordan

ABSTRACT

This paper proposes new tests for financing constraints on R&D investment by directly examining the role played by working capital in smoothing the R&D expenditures of firms listed on the Tel Aviv stock exchange. It emphasizes the importance of working capital, not only for use but also as a source of funds. The findings offer new evidence for why levels of liquidity are important for R&D-intensive firms. Working capital alleviates the effects of transient finance shocks on the level of R&D, thereby averting the high adjustment costs that accompany changes in R&D.

ARTICLE HISTORY

Received 3 June 2020

Accepted 13 January 2021

KEYWORDS

Working capital; financing constraints; R&D investment

1. Introduction

Since the emergence of the great importance of endogenous growth theory on human welfare, recent studies in the corporate finance field have shifted towards focusing on capital market imperfection and the financing menu of R&D (Brown & Petersen, 2011; Chen & Guariglia, 2013; Guariglia & Liu, 2014; He & Wintoki, 2016; Kang, Baek, & Lee, 2017; Mina, Lahr, & Hughes, 2013). This trend has resulted from the acknowledgment that R&D is vital for the growth of companies and economies alike. Together with the employment of technological advances to create new products and services and to develop new production processes, it aims to achieve competitive advantage, thereby securing a larger market share (Cohen & Levinthal, 1989). Since R&D is of high importance for firms, certain obstacles such as the asymmetric information dilemma, low collateral value, and the uncertainty allied with its output make it more prone to financial constraints.

Previous literature on the corporate levels of R&D investment has mainly focused on the availability of internally generated funds (Grabowski, 1968; Himmelberg & Petersen, 1994; Ughetto, 2008), and has evidenced that R&D levels are allied to levels of internal cash flow. However, considering the riskiness and intangibility of R&D, Switzer (1984) and Wang and Thornhill (2010) concluded that debt is not a genuine source of R&D financing. On the other hand, Carpenter and Petersen (2002) and Brown, Martinsson, and Petersen (2012) found that among the external means of funding, equity is the ideal source for this purpose. Since both internally and externally generated funds can experience high volatility, the high adjustment costs of R&D investment make it expensive for

CONTACT Ahmad Alkhataybeh  aaalkhataybeh@yu.edu.jo  Faculty of Economics and Administrative Sciences, Yarmouk University, Irbid 211-63, Jordan.

© 2021 The Author(s). Published by Informa UK Limited, trading as Taylor & Francis Group.

This is an Open Access article distributed under the terms of the Creative Commons Attribution License (<http://creativecommons.org/licenses/by/4.0/>), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

firms to adjust their R&D flow during transitory finance shocks.¹ Fazzari and Petersen (1993) developed the investment smoothing concept by means of working capital, measured as the difference between current assets and current liabilities on a company's balance sheet. Considering working capital accounts, Bigelli & Sánchez-Vidal (2012) found strong evidence of the significant role of cash holdings in constrained firms. Similarly, Petersen and Rajan (1997) and Nazir and Afza (2009) point out the merits of trade credit and account receivables. Brown and Petersen (2011) and Guney, Karpuz, and Ozkan (2017) were among the first to investigate the role played by precautionary cash reserves in the R&D smoothing process, concluding that financially constrained firms draw upon their precautionary cash holdings to preserve a relatively smooth R&D path.

However, there is little evidence as to whether working capital as a source of liquidity plays a role in the R&D smoothing process (see, for example, Alkhataybeh, 2018). Therefore, this paper intends to fill this gap by underlining the role played by working capital in the smoothing process, as it is regarded as a source and easily reversible store of liquidity, and to explore whether R&D financing constraints do in fact exist. The research adds to the finance literature in two ways. First, related investigation on this subject has yet to be conducted on a developed economy (in this case Israel). The comparative scarcity of evidence as to whether the means of financing is of concern for the R&D of Israeli firms remains a puzzle, raising concerns as to whether financing constraints are hindering R&D investment in this environment. Second, this research employs a more comprehensive and accurate measure for testing the existence of financing constraints on R&D investment; that is, working capital as a whole, rather than only one of its components. As a result, if financing constraints on R&D investment exist, a negative relation with changes in net working capital is expected to be noticed, suggesting that companies resort to liquidity reserves to smooth such investment, thus stressing the importance of working capital in companies' financial policies.

The rationale for studying the Israeli market is as follows. First, Israel is considered to be a prominent economic success story among innovating economies and one of the most recognized innovative hubs in the world (Trajtenberg, 2000). Second, this knowledge-based economy has outperformed many other leading countries in terms of R&D per GDP expenditure. Indeed, it has been ranked first in the world during the last decade (OECD, 2020). In addition, the priority given by the Israeli government to this type of investment, especially as seen in the R&D Law, makes it an ideal choice for investigation (Ministry of Economy, 2014). Finally, as Israel is considered to be a market-based economy, it is assumed that financing constraints on corporate investment are more pronounced than in bank-based economies. Bond, Elston, Mairesse, and Mulkay (2003) propose that market-based economies are weak in channelling desired capital towards companies with potential investment opportunities because of the arm's-length relationship between companies and capital providers. Therefore, the Israeli financial system might result in financial constraints among its listed firms. These reasons are assumed to be sufficiently important to investigate this market, whereas this hub might be considered

¹Adjustment costs refer to recruitment and training costs for new specialists in the case of temporary cuts in the R&D process. Moreover, if these cuts result in the laying off of expert workers, the potential dissemination of firm-specific commercial secrets may harm the value of a firm's innovation process and consequently be more costly.

as a listing choice for firms conducting R&D, or a market diversification choice for equity investors (i.e., it is of economic significance).

Section 2 presents the preliminary analysis and overview of the key variables, and identifies the model employed for the investigation. Section 3 displays the results, while Section 4 concludes by summarizing the paper, drawing implications and providing suggestions for future research.

2. Data and methodology

2.1. Data

The research sample covers all active and inactive firms listed on the Tel Aviv stock exchange between 2008 and 2016. Annual data were retrieved from the Worldscope database through Datastream. The research only targeted firms listed in the manufacturing and service industry category; in addition, as the focus of the research is on R&D performing firms, the sample excluded all non-R&D reporting ones, as they were inappropriate for the analysis.² Therefore, the remaining number of firms in the unbalanced panel was 114. The homogenous purposeful sampling process is summarized in Figures 1 and 2.

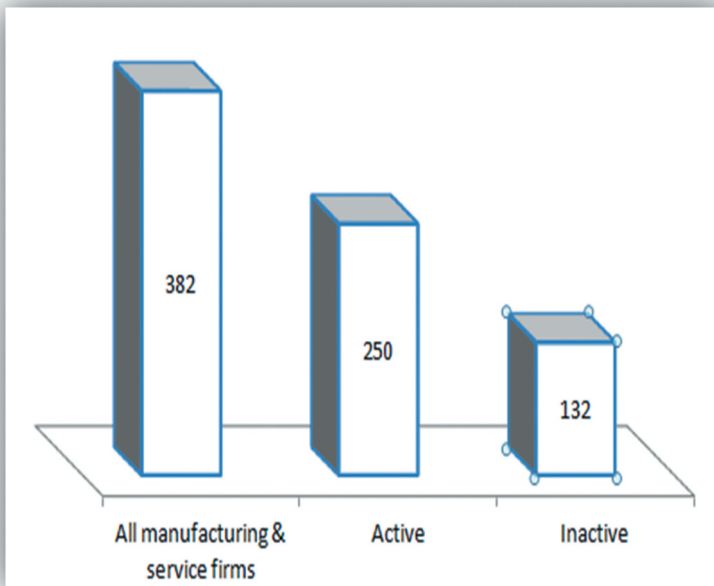


Figure 1. Target population of firms listed on the Tel Aviv stock exchange.

²Among the 382 firms, the actual number of firms included in the analysis is 114, with the remaining 268 firms being categorized as non-R&D reporting firms with missing data (non-zero reports). Further, although 13 out of the 114 firms reported zero R&D expenditure, there remained enough reported observations for them to be included in the sample (i.e., not full zero R&D records), suggesting that corporate engagement decisions are made in spikes, with breaks in the engagement process between periods of normal corporate activities. please refer to Appendix A1. for a comparison of descriptive statistics for reporting and non-reporting R&D firms.

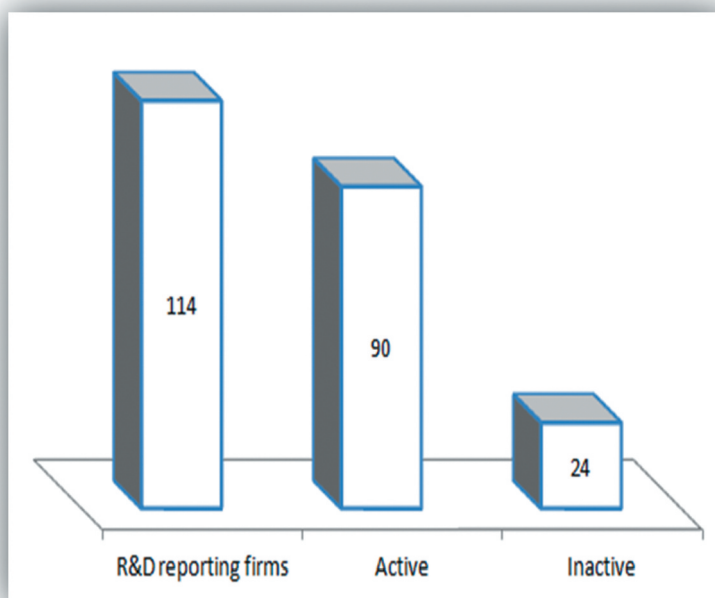


Figure 2. Target population of R&D reporting firms.

2.2. Tel Aviv stock exchange firms

Table 1 shows the operational measures of the variables used in the analysis, while Table 2 displays their summary statistics and correlation matrix. Preliminary analysis showed that the dependent variable (*RD*) was statistically associated with all the

Table 1. Operational measures of the variables.

| Variable name | Measure | Source |
|---|--|------------|
| Research & Development _{<i>it</i>} (<i>RD</i>) | Value of R&D expenses of firm <i>i</i> at time <i>t</i> divided by the value of total assets at time <i>t</i> -1. | Worldscope |
| Market to Book _{<i>it</i>} (<i>MB</i>) | Market value of the total assets of firm <i>i</i> at time <i>t</i> -1 divided by the book value of total assets at time <i>t</i> -1. | DataStream |
| Sales Growth _{<i>it</i>} (<i>SGr</i>) | Change in net sales of firm <i>i</i> between time <i>t</i> and time <i>t</i> -1, divided by net sales at time <i>t</i> -1. | Worldscope |
| Cash Flow _{<i>it</i>} (<i>CFlow</i>) | Gross internally generated cash flow of firm <i>i</i> at time <i>t</i> divided by the value of total assets at time <i>t</i> -1. Gross cash flow is equal to after-tax income before extraordinary items and preferred dividend, plus depreciation, depletion and amortization expenses and research and development expenses. | Worldscope |
| Stock Issues _{<i>it</i>} (<i>Stk</i>) | Net cash raised from stock issues of firm <i>i</i> at time <i>t</i> divided by the value of total assets at time <i>t</i> -1. Net cash raised is equal to the issued minus the purchased common and preferred stocks. | Worldscope |
| Long-Term Debt Issues _{<i>it</i>} (<i>Dbt</i>) | Net cash raised from the long-term debt of firm <i>i</i> at time <i>t</i> divided by the value of total assets at time <i>t</i> -1. Net cash raised is equal to issued minus reductions in long-term debt. | Worldscope |
| Change in Net Working Capital _{<i>it</i>} (<i>NWC</i>) | Change in net working capital of firm <i>i</i> between time <i>t</i> and time <i>t</i> -1, divided by the value of total assets at time <i>t</i> -1. Net working capital is equal to current assets minus current liability. | Worldscope |

The definitions and measurement of the variables are consistent with the literature.

Table 2. Descriptive statistics and pairwise correlation matrix.

| Variable | Mean | S.D. | Obs | RD | MB | SGr | CFlow | Stk | Dbt | NWC |
|--------------|--------|-------|-----|------------|------------|-----------|------------|-----------|---------|-------|
| RD | 0.152 | 0.237 | 775 | 1.000 | | | | | | |
| MB | 2.260 | 5.303 | 904 | 0.0743** | 1.000 | | | | | |
| SGr | 0.169 | 0.714 | 641 | 0.2664*** | −0.0220 | 1.000 | | | | |
| Cflow | −0.057 | 0.459 | 775 | −0.5604*** | 0.0656 | −0.0692 | 1.000 | | | |
| Stk | 0.232 | 0.859 | 760 | 0.6402*** | 0.0407 | 0.1483*** | −0.6780*** | 1.000 | | |
| Dbt | 0.100 | 0.160 | 731 | −0.1612*** | −0.1296*** | 0.0098 | −0.0031 | −0.0202 | 1.000 | |
| NWC | 0.053 | 0.499 | 775 | 0.3172*** | 0.0926** | 0.0837** | −0.3056*** | 0.7070*** | −0.0123 | 1.000 |

***and ** denote statistical significance at the 1% and 5% levels, respectively.

The financial variables are trimmed at the 1% level.

predictors. The signs of these correlations were as expected, apart from *CFlow* & *NWC*. The condition of non-multicollinearity was verified, and the correlation coefficient matrix displayed no sign of multicollinearity among the variables.

2.3. Methodology

Roodman (2009) advises that the generalized method of moments (GMM) is the best econometric estimator for use in the estimation of dynamic models. It is mostly applicable to panel data analysis that is characterized by many individuals and few time periods. In addition, it is a solution for the endogeneity problem associated with the predictors, as it assumes that valid instruments are available inside the immediate dataset and depends on the lag transformation of the instrumented variables. Following Brown and Petersen (2011), the analysis is based on the following regression model:

$$RD_{i,t} = \beta_1 RD_{i,t-1} + \beta_2 RD_{i,t-1}^2 + \beta_3 MB_{i,t} + \beta_4 SGr_{i,t} + \beta_5 CFlow_{i,t} + \beta_6 CFlow_{i,t-1} + \beta_7 Stk_{i,t} + \beta_8 Stk_{i,t-1} + \beta_9 Dbt_{i,t} + \beta_{10} Dbt_{i,t-1} + \beta_{11} NWC_{i,t} + \beta_{12} NWC_{i,t-1} + d_{ind} + f_i + d_t + \varepsilon_{i,t}$$

In accordance with the dynamic optimization “Euler condition”, the quadratic term of the lagged dependent variable in means was added to the model to control for the target level of R&D expenditure in the presence of adjustment costs. Accordingly, the expected sign of the coefficient of the lagged predetermined variable is positive and close to one, and the coefficient of the quadratic term is negative. Controlling for firms’ investment demand (as explained in Tobin’s Q and accelerator theories), the model includes the variables *MB* and *SGr* (McLean, Zhang, & Zhao, 2012 and Shapiro et al., 1986). In addition, it controls for industry-fixed effects (d_{ind}), firm-fixed effect (f_i) and year-fixed effects (d_t). Finally, all the financial variables in the model are treated as endogenous.

3. Results

Given the dynamic structure of the research model and the endogeneity of its predictors, typical least squares regressions led to fairly inconsistent estimates. Such inconsistency is due to the correlation between the lagged dependent variable and the unobservable fixed effects, as well as the endogenous nature of the right-hand side variables (Flannery & Hankins, 2013). Accordingly, Arellano and Bond (1991) addressed these problems by introducing the differenced-GMM estimator and taking the first difference; however, this process does not

eliminate the correlation between the disturbances and the lagged dependent variable. Therefore, it is necessary to use instruments that are uncorrelated with the disturbances, but are associated with the explanatory variables, in order to overcome this endogeneity problem. However, as pointed out by Blundell and Bond (1998) and Bond, Hoeffler, and Temple (2001), estimates of the difference-GMM are not completely dependable in the presence of weak instruments problem because estimates tend to be downwards-biased.³

To improve the GMM estimator, Blundell and Bond (1998) introduced the system-GMM estimator with a combination of the moment conditions for the differenced equation and those for the equation in level. When applying this estimator, the preference is to use one-step or two-step estimation. The one-step estimator assumes homoscedastic errors, while the two-step version assumes heteroscedastic ones. In this context, Flannery and Hankins (2013) concluded that the two-step estimator was asymptotically more efficient; however, its standard error estimates are typically biased downwards. This therefore encourages the use of finite-sample correction of standard errors. Accordingly, this research takes into account the application of a finite sample correction in the estimation of the two-step system-GMM. It should be noted that in the system specification of this research, the instruments used for the level equation are the lagged difference endogenous variables, and the lagged level endogenous variables (dated $t-2$ to $t-3$) for the equation in difference.

Table 3 presents the two-step system-GMM estimates. The lagged and squared lagged of the dependent variable are statistically significant, with positive and negative effects on the current level of R&D expenses, respectively. This is in line with the specifications of the Euler equation and is also consistent with previous research findings; for instance, those of Bond and Meghir (1994) and Guney et al. (2017). *MB* as a control for investment demand is statistically insignificant, implying weak control for R&D investment demand via Tobin's Q theory, which states that the higher the Tobin's Q value (above unity), the higher the corporate incentives to expand investment activities, and vice versa when the Tobin's Q value is below unity. It is argued that the optimal investment level is reached when the Tobin's Q value is equal to one (Tobin, 1969). The insignificant power of this controller is not surprising and is consistent with the findings of Brown and Petersen (2011) and Borisova and Brown (2013), given that financial policy plays a role in the level of corporate investment decisions.

Similarly, *SGR* is positively insignificant, thus providing weak evidence that sales growth plays a significant role in R&D investment demand, as explained by the accelerator model. The principle of this theory is based on the idea that when the corporate level of sales increases, profits are expected to increase accordingly. Therefore, firms would have an incentive to invest more to minimize the gap between the required stock of capital and the existing ones if sales are expected to last. The increased investments would result in a further increase in sales and profits, consequently causing the multiplier effect. The insignificance, however, can be explained by the fact that this ratio does not

³According to Bond et al. (2001), inconsistent difference-GMM estimates can be detected if the coefficient of the lagged dependent variable ranges between OLS (upward-biased) and fixed-effect (downward-biased) estimates, with the coefficient being closer to the latter. Using the lagged level endogenous variables ($t-2$ to $t-3$) as instruments in the differenced equation results in the OLS and fixed-effect estimates of the lagged dependent variable serving as boundaries for the difference-GMM estimation. Particularly, since the difference-GMM estimate is closer to the fixed effect estimate, this suggests a weak instrument problem that may cause inconsistent estimates. Therefore, a system GMM estimator is used. The results of these estimations are available upon request.

Table 3. Estimation results of the dynamic RD model.

| | Two-step GMM |
|---------------------|--------------------------|
| | RD |
| $RD_{i,t-1}$ | 0.833*** (0.312) |
| $RD_{i,t-1}^2$ | -0.669** (0.339) |
| $MB_{i,t}$ | 0.0006 (0.001) |
| $SGR_{i,t}$ | 0.0152 (0.021) |
| $CFlow_{i,t}$ | 0.170 (0.104) |
| $CFlow_{i,t-1}$ | 0.016 (0.043) |
| $Stk_{i,t}$ | 0.311*** (0.101) |
| $Stk_{i,t-1}$ | -0.012 (0.048) |
| $Dbt_{i,t}$ | 0.149 (0.113) |
| $Dbt_{i,t-1}$ | -0.150 (0.091) |
| $NWC_{i,t}$ | -0.216** (0.033) |
| $NWC_{i,t-1}$ | -0.029 (0.041) |
| Industry dummies | Yes |
| Year dummies | Yes |
| No. of observations | 495 |
| No. of firms | 114 |
| No. of instruments | 89 |
| AR (1) | -1.75 ($p = 0.080$) |
| AR (2) | -1.28 ($p = 0.201$) |
| J-test | 62.89 ($p = 0.444$) |

Standard errors are reported in parentheses.

*** and ** denote significant at the 1% and 5% levels, respectively.

capture other corporate investment determinants, for example, financial constraints (Brown & Floros, 2012; Wang & Thornhill, 2010).

The insignificance of cash flow as an internal means of finance is inconsistent with the pecking-order theory. This means that the R&D investment of the tested firms was not determined by significant internal cash flow. This could be because the firms were still young, and so had had insufficient time to generate additional, or non-negative, cash flow (Borisova & Brown, 2013; Del Canto & Gonzalez, 1999). The coefficient of stock issues is positively and statistically significant, suggesting their importance as an ideal external means of funding to finance R&D investment. When computing the economic significance of stock issues, it is found that a one-standard deviation increase in stock issues increases R&D expenditure by 175.6%.⁴ These findings support the argument that as

⁴In order to assess the economic magnitude, the coefficient of stock issues is multiplied by the standard deviation of stock issues ($0.311 \times 0.859 = 0.267$). Thus, an increase in stock issues by one standard deviation increases R&D expenditure by 0.267. Since the mean of R&D expenditure is 0.152, a change by 0.267 represents 175.6%.

R&D projects are considered resource-consuming and are associated with high uncertainty, this means that firms conducting R&D are exposed to more risks. Therefore, firms view stock issuing as a supportive means of finance for R&D projects and a way to reduce financial obligations, since the benefits of the stockholders are the residual of firms' profits (Alkhataybeh, 2018; Brown et al., 2012).

On the other hand, debt issues have a statistically insignificant influence on R&D investment, with a negative sign for the coefficient of the lagged *Dbt*, indicating that firms place more emphasis on factors that may increase the risk of financial distress and thus the probability of bankruptcy (Brown & Petersen, 2011; Wang & Thornhill, 2010). However, the results on the effect of *Dbt* and *Stk* on R&D provide no evidence that the firms in this investigation were following pecking order or trade-off theory in financing their R&D investment.

Most importantly, the strong link between changes in net working capital and R&D investment provides evidence that firms are financially constrained. A negative coefficient sign indicates that in the presence of financing frictions, companies draw upon liquidity reserves from working capital in order to absorb short-run financing shocks, consequently smoothing their R&D investment path. Further, the negative coefficient sign implies a source of finance that increases R&D expenditure, and hence when computing the economic significance of net working capital, it is found that a one-standard deviation increase in net working capital increases R&D expenditure by 70.3%. The results of this investigation are consistent with the findings of Brown and Petersen (2011), Chung (2017) and Guney et al. (2017) on the corporate smoothing process of R&D investment, who used cash holdings, rather than working capital, as is the case in this investigation. The consistency of the one-step and two-step system-GMM estimates are verified by the findings of Hansen's *J*-test for the validity of the instruments used, and the Arellano–Bond test of autocorrelation.⁵⁶

Overall, as investment in R&D is accompanied by high adjustment costs, companies conducting R&D are more likely to minimize these costs by preserving stable levels of R&D expenditure. However, as sources of funds display more volatility than R&D expenditure, particularly if companies are financially constrained, this research assumes that firms can smooth their R&D expenditure by drawing upon liquidity reserves from working capital during periods of low finance accessibility, and build up positions in which finance is readily accessible.

⁵⁵The overidentification restrictions test (*J*-test) is designed to ensure the validity of the instruments as a group, and confirm that the instruments are exogenous. Considering the two-step GMM estimation, the Hansen *J*-statistics outperform the Sargan statistics, as the latter is not robust to heteroscedasticity or autocorrelation. Under the null hypothesis that the instruments are exogenous, a statistically significant test statistic means that the instruments employed are invalid.

⁵⁶The Arellano–Bond test is designed to check for the lags of the instruments' validity, specifically to remove the unobserved fixed effect that cause the autocorrelation in the error term. Order 1 autocorrelation is predictable in the first differences, where $\Delta \varepsilon_{it} = \varepsilon_{it} - \varepsilon_{it-1}$ correlates with $\Delta \varepsilon_{it-1} = \varepsilon_{it-1} - \varepsilon_{it-2}$ as they both share the ε_{it-1} term. The null hypothesis of this test is that there is no serial correlation in the first differenced equation, hence rejecting the null means that we need to restrict the instruments to lags 3 or longer. However, if the null hypothesis at the second-order condition is rejected, this means the instrument set need to be lags longer than 3 (Roodman, 2009).

4. Conclusion

This research has examined the presence of financing constraints and the role that working capital plays in smoothing the path of the R&D investment of firms listed on the Tel Aviv Stock Exchange. The findings of the dynamic R&D investment model employed provide strong evidence that R&D expenditure is associated with lagged levels of R&D investment, and stock issues are heavily relied on as means of financing R&D. The results also provide evidence that internally generated cash flows and debt issues are not on the menu of R&D financing. Indeed, the companies in this investigation are considered to be financially constrained, as in the short-run they use working capital as a source of funds, thereby buffering transitory financing shocks and smoothing R&D expenditure levels.

Implications for corporate managers include the need and consideration of a market timing strategy to guarantee a solid working capital status, thus assuring a safe escape in the presence of transitory financing shocks. In addition, an important implication for investors is that they should consider a firm's investment nature and its financing ability, prior to making investment decisions. For example, if a firm is suffering from limited access to debt providers and has a weak ability to generate internal funds, but shows promise in current R&D investment, equity investors in the firm might gain the most.

The limitations of the research lead to issues that could be tackled in future research. Due to the specification of the GMM estimators and the small sample size, studying the financing differences between groups was not possible (for example, the differences between dividend paying and non-paying firms, and mature and young ones). In addition, we would recommend future research to investigate the factors that would have an impact on the probability of R&D investment being made.

Disclosure statement

No potential conflict of interest was reported by the author.

Notes on contributor

Ahmad Alkhataybeh is an Assistant professor of Investment & Finance. He Joined Yarmouk University on September, 2018. Previously, he worked as a senior credit officer at First Finance Co, and a senior Economic Adviser at BDO international. Ahmad received his Ph.D. in Finance and MSc in Investments from the University of Birmingham.

ORCID

Ahmad Alkhataybeh  <http://orcid.org/0000-0001-5073-6380>

References

Alkhataybeh, A. A., (2018). Determinants of research and development on the alternative investment market (AIM). [Doctoral dissertation, University of Birmingham].

- 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(2), 277–297.
- Bigelli, M., & Sánchez-Vidal, J. (2012). Cash holdings in private firms. *Journal of Banking & Finance*, 36(1), 26–35.
- Blundell, R., & Bond, S. (1998). Initial conditions and moment restrictions in dynamic panel data models. *Journal of Econometrics*, 87(1), 115–143.
- Bond, S., Elston, J. A., Mairesse, J., & Mulkay, B. (2003). Financial factors and investment in Belgium, France, Germany, and the United Kingdom: A comparison using company panel data. *The Review of Economics and Statistics*, 85(1), 153–165.
- Bond, S., Hoeffler, A., & Temple, J. (2001). GMM estimation of empirical growth models. *CEPR Discussion Paper, September*, (No. 3048).
- Bond, S., & Meghir, C. (1994). Financial constraints and company investment. *Fiscal Studies*, 15(2), 1–18.
- Borisova, G., & Brown, J. R. (2013). R&D sensitivity to asset sale proceeds: New evidence on financing constraints and intangible investment. *Journal of Banking & Finance*, 37(1), 159–173.
- Brown, J. R., & Floros, I. V. (2012). Access to private equity and real firm activity: Evidence from PIPEs. *Journal of Corporate Finance*, 18(1), 151–165.
- Brown, J. R., Martinsson, G., & Petersen, B. C. (2012). Do financing constraints matter for R&D? *European Economic Review*, 56(8), 1512–1529.
- Brown, J. R., & Petersen, B. C. (2011). Cash holdings and R&D smoothing. *Journal of Corporate Finance*, 17(3), 694–709.
- Carpenter, R. E., & Petersen, B. C. (2002). Capital market imperfections, high-tech investment, and new equity financing. *The Economic Journal*, 112(477), 54–72.
- Chen, M., & Guariglia, A. (2013). Internal financial constraints and firm productivity in China: Do liquidity and export behavior make a difference? *Journal of Comparative Economics*, 41(4), 1123–1140.
- Chung, H. (2017). R&D investment, cash holdings and the financial crisis: Evidence from Korean corporate data. *Applied Economics*, 49(55), 5638–5650.
- Cohen, W. M., & Levinthal, D. A. (1989). Innovation and learning: The two faces of R & D. *The Economic Journal*, 99(397), 569–596.
- Del Canto, J. G., & Gonzalez, I. S. (1999). A resource-based analysis of the factors determining a firm's R&D activities. *Research Policy*, 28(8), 891–905.
- Deloof, M. (2003). Does working capital management affect profitability of Belgian firms? *Journal of Business Finance & Accounting*, 30(3–4), 573–588.
- Fazzari, S. M., & Petersen, B. C. (1993). Working capital and fixed investment: New evidence on financing constraints. *The RAND Journal of Economics*, 24(3), 328–342.
- Flannery, M. J., & Hankins, K. W. (2013). Estimating dynamic panel models in corporate finance. *Journal of Corporate Finance*, 19, 1–19.
- Grabowski, H. G. (1968). The determinants of industrial research and development: A study of the chemical, drug, and petroleum industries. *Journal of Political Economy*, 76(2), 292–306.
- Guariglia, A., & Liu, P. (2014). To what extent do financing constraints affect Chinese firms' innovation activities? *International Review of Financial Analysis*, 36, 223–240.
- Guney, Y., Karpuz, A., & Ozkan, N. (2017). R&D investments and credit lines. *Journal of Corporate Finance*, 46, 261–283.
- He, Z., & Wintoki, M. B. (2016). The cost of innovation: R&D and high cash holdings in US firms. *Journal of Corporate Finance*, 41, 280–303.
- Himmelberg, C. P., & Petersen, B. C. (1994). R & D and internal finance: A panel study of small firms in high-tech industries. *The Review of Economics and Statistics*, 76(1), 38–51.
- Kang, T., Baek, C., & Lee, J. D. (2017). The persistency and volatility of the firm R&D investment: Revisited from the perspective of technological capability. *Research Policy*, 46(9), 1570–1579.
- Martinsson, G. (2010). Equity financing and innovation: Is Europe different from the United States?. *Journal of Banking & Finance*, 34(6), 1215–1224.

- McLean, D., Zhang, T., & Zhao, M. (2012). Why does the law matter? Investor protection and its effects on investment, finance, and growth. *The Journal of Finance*, 67(1), 313–350.
- Mina, A., Lahr, H., & Hughes, A. (2013). The demand and supply of external finance for innovative firms. *Industrial and Corporate Change*, 22(4), 869–901.
- Ministry of Economy (2014). R&D incentive programs. Retrieved September 9, 2020, from. http://www.economy.gov.il/Publications/Publications/DocLib/RnD_IncentivePrograms_English.pdf
- Nazir, M. S., & Afza, T. (2009). Impact of aggressive working capital management policy on firms' profitability. *IUP. Journal of Applied Finance*, 15(8), 19–30.
- OECD (2020). Gross domestic spending on R&D, 2008–2019. Retrieved September 9, 2020, from. <https://data.oecd.org/rd/gross-domestic-spending-on-r-d.htm>
- Petersen, M. A., & Rajan, R. G. (1997). Trade credit: Theories and evidence. *The Review of Financial Studies*, 10(3), 661–691.
- Roodman, D. (2009). How to do xtabond2: An introduction to difference and system GMM in Stata. *The Stata Journal*, 9(1), 86–136.
- Shapiro, M. D., Blanchard, O. J. & Lovell, M. C. (1986). Investment, output, and the cost of capital. *Brookings Papers on Economic Activity*, (1), 111–164.
- Switzer, L. (1984). The determinants of industrial R&D: A funds flow simultaneous equation approach. *The Review of Economics and Statistics*, 66(1), 163–168.
- Tobin, J. (1969). A general equilibrium approach to monetary theory. *Journal of Money, Credit and Banking*, 1(1), pp. 15–29.
- Trajtenberg, M., (2000). R&D policy in Israel: An overview and reassessment. *NBER working paper, October*, (No. w7930).
- Ughetto, E. (2008). Does internal finance matter for R&D? New evidence from a panel of Italian firms. *Cambridge Journal of Economics*, 32(6), 907–925.
- Wang, T., & Thornhill, S. (2010). R&D investment and financing choices: A comprehensive perspective. *Research Policy*, 39(9), 1148–1159.

Appendix A1: A comparison of descriptive statistics for reporting and non-reporting R&D firms

| | | R&D reporting firms | Non-reporting R&D firms | <i>p</i> -Value ^a |
|--------------|-------------------------|---------------------|-------------------------|------------------------------|
| <i>RD</i> | <i>Mean</i> | 0.152 | | |
| | <i>S.D.</i> | 0.237 | | |
| | <i>Obs</i> ^b | 775 | | |
| <i>MB</i> | <i>Mean</i> | 2.260 | 1.445 | 0.000 |
| | <i>S.D.</i> | 5.303 | 1.617 | |
| | <i>Obs</i> | 904 | 1398 | |
| <i>SGr</i> | <i>Mean</i> | 0.169 | 0.049 | 0.000 |
| | <i>S.D.</i> | 0.714 | 0.303 | |
| | <i>Obs</i> | 641 | 1086 | |
| <i>Cflow</i> | <i>Mean</i> | −0.057 | 0.024 | 0.000 |
| | <i>S.D.</i> | 0.459 | 0.085 | |
| | <i>Obs</i> | 775 | 1087 | |
| <i>Stk</i> | <i>Mean</i> | 0.232 | 0.003 | 0.000 |
| | <i>S.D.</i> | 0.859 | 0.013 | |
| | <i>Obs</i> | 760 | 1070 | |
| <i>Dbt</i> | <i>Mean</i> | 0.100 | 0.182 | 0.000 |
| | <i>S.D.</i> | 0.160 | 0.190 | |
| | <i>Obs</i> | 731 | 1046 | |
| <i>NWC</i> | <i>Mean</i> | 0.053 | −0.007 | 0.000 |
| | <i>S.D.</i> | 0.499 | 0.120 | |
| | <i>Obs</i> | 775 | 1002 | |

^a*p*-Value of the equality of means test statistics.

^bThese statistics are based on firm-year observations.

This table presents the descriptive statistics for reporting and non-R&D reporting firms of the main variables used in the analysis. By comparing the two groups and considering the means equality tests results, it is found that reporting R&D firms have a: (i) significantly larger **MB** implying that investors are valuing R&D performing firms more than non-performing ones; (ii) significantly larger **SGr** suggesting that R&D reporting firms might have more services, products, or process innovations, that in turn accelerate their sales growth; (iii) significantly lower (negative) **Cflow** indicating that although R&D reporting firms have a significantly higher SGr mean, they may not be profitable enough due to their expenditures on R&D investment;⁷ (iv) significantly more (less) **Stk (Dbt)** implying a preference towards stock issuance as a mean to finance their R&D investments which can mitigate their financial obligations and risk of financial distress (Wang & Thornhill, 2010; Martinsson, 2010; Brown et al., 2012); and (v) higher **NWC** suggesting that these firms are more intent towards having solid liquidity position in the form of current accounts, through which it can smooth their investments in periods of cash flow shortfalls.

⁷In untabulated results, it was found that average R&D reporting firms are younger and smaller in size as compared to non-R&D reporting firms. Therefore, an alternative justification for the negative **Cflow** is that R&D reporting firms might have had little time to generate operating profits (Brown & Petersen, 2011).