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Of interest? Estimating the average interest rate on debt across firms and over time

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Disclaimer

These results are not official statistics. They have been created for research purposes from the Integrated Data Infrastructure (IDI) and Longitudinal Business Database (LBD), which are carefully managed by Stats NZ. For more information about the IDI and LBD please visit https://www.stats.govt.nz/integrated-data/

The results are based in part on tax data supplied by Inland Revenue to Stats NZ under the Tax Administration Act 1994 for statistical purposes. Any discussion of data limitations or weaknesses is in the context of using the IDI for statistical purposes, and is not related to the data's ability to support Inland Revenue's core operational requirements.

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Abstract

We use tax data from the Longitudinal Business Database to estimate the firm-level average interest rate on liabilities. The mean of this measure has similar time series properties to official statistics on the business borrowing rate, while also enabling detailed disaggregation across different firm types. We document significant variation in interest rate across firms in different industries, and across firms with different apparent borrowing risk. Finally, we compare firms self-reported views on whether they are finance-constrained to an estimated firm-specific interest rate premium, showing that: finance-constrained firms have higher interest rate premia than unconstrained firms; and that at least part of this difference in premia is explained by firm-level differences in risk between constrained and unconstrained firms.

JEL codes

E43; G32; M21

Keywords

Finance constraints; interest rates; risk premia; Longitudinal Business Database

Summary haiku

Finance-constrained firms

face higher interest rates

but are more risky

1 Motivation

It has been hypothesised that "finance constraints" are a key contributor to perceived underinvestment by New Zealand businesses in physical capital and – potentially more problematically – underinvestment in productivity-raising knowledge capital.[1] Empirically, the identification of finance-constrained firms and associated "lost" investment opportunities is difficult, not only because of the unobservable nature of non-investment, but also because a properly-functioning capital market should result in differences in finance costs across firms and over time.

Investor- and lender-imposed variation in finance terms provide useful discipline on managers and their business decisions, and a signal from the market of a reasonable expected return on such an investment accounting for risk. In contrast, the alternative of "unconstrained" finance seems likely to lead to worse aggregate economic outcomes than "constrained" finance since many firms are unexceptional, and have limited growth prospects and/or a non-trivial probability of failure. Providing low quality firms with unlimited, cheap finance would undermine the resource reallocation mechanism from low to high productivity firms that works, in part, through the rationing of inputs and, in extreme, the exit of poor performing firms from the market.

A popular method of identifying finance-constrained firms, based on the work of Fazzari et al. (1988), relies on estimating the firm-level sensitivity of investment to changes in cashflow, applying the logic that – after controlling for any relationship between cashflow and expected future firm prospects – investment decisions should be unrelated to cashflow if firms have adequate access to external finance. Variants of this empirical test have identified finance constraints in a number of countries beyond the original US setting (eg, Bond et al. 2003, for Belgium, France, Germany and the UK).[2]

However, as noted by Kaplan and Zingales (1997), transaction costs create a wedge between internal and external finance costs, implying that most firms should display cashflow sensitivity, potentially invalidating the use of

[1] Pells (2020) provides an excellent summary of the debate on finance and investment in New Zealand, together with the associated empirical evidence.

[2] Fabling et al. (2015) follow Bond et al.'s empirical approach using New Zealand data, focussing on identifying any impact of changes in the user cost of capital on New Zealand firm investment decisions. Fabling et al. estimate an investment-cashflow sensitivity statistically insignificantly different from zero though, due to the data requirements of the method, their results come from a sample of firms with 100+ employees and seven years of consecutive data, which is unlikely to representative of the average (small) firm in the economy.

cashflow sensitivity as a meaningful measure of finance constraints. Furthermore, as Kaplan and Zingales (1997) demonstrate using a simple theoretical model, it isn't even necessarily true that groups of firms with higher estimated investment-cashflow sensitivity are more constrained than groups of firms with lower investment cashflow sensitivity, since such a conclusion relies on a monotonicity assumption between cashflow sensitivity and (unobserved) finance constraint that is unlikely to hold.

In the absence of a compelling empirical method for pinpointing "unwarranted" finance constraints, higher finance costs for more risky investments can be perceived as being unnecessarily restrictive on economic growth, particularly when those risky investments have desirable properties (eg, generating knowledge capital externalities).

In this paper, we take a step back from the task of identifying unwarranted finance constraints. Instead, we establish a methodology for measuring the average cost of (debt) finance for New Zealand firms using microdata from the Longitudinal Business Database (LBD).[3] We take care to reduce measurement error by eliminating inconsistent data, accounting for changes in the way firms are required to file tax returns over time. We check the plausibility of our estimates against aggregate statistics, and against the firm-level liability structure. Both tests suggest that the constructed measure is credible and useful.

We then estimate the relationship between the derived interest rate and a selection of firm characteristics that should attract a positive or negative risk premium, demonstrating relationships that are consistent with expectation – ie, more risky firms and investments are associated with higher borrowing costs. We then relate these empirical estimates of finance costs to reports of being finance constrained in the Business Operations Survey (BOS), showing that (self-reported) finance-constrained firms face higher interest rates than unconstrained firms, and that the difference in finance costs declines once we control for risk-premia attracting firm activities. While this comparison cannot prove that finance constraints are unwarranted, the triangulation of the two data types clearly pins down a link between firm perceptions of finance constraints and the observed cost of debt, which is influenced directly by the characteristics of the firms.

Section 2 explains how we construct the average firm interest rate measure (i) and the other firm-level variables that we use in the analysis. Section

[3]While the marginal interest rate on new debt is more relevant to current investment decisions, data availability restricts us to measuring the average interest rate.

3 reports summary statistics for i, the relationship between i and firm characteristics, and the analysis of BOS responses. Section 4 summarises our findings and suggests avenues for further research.

2 Data & method

2.1 Firm-level average interest rate (i)

We start by using the Fabling-Maré labour and productivity datasets available in the LBD, and currently covering the 2001 to 2018 (March) financial years (Fabling 2011; Fabling and Maré 2015a, 2015b, 2019). These data contain standard production function variables – output (Y), intermediate consumption (M), capital services (K) and labour (L). The last of these is derived from the linking of monthly Pay-As-You-Earn (PAYE) tax filings for employees and annual tax returns for working proprietors (WPs), with downward adjustment to labour input for workers and WPs who are unlikely to be full-time in their job(s) (eg, multiple job holders).

Remaining production function variables are derived from a mix of Annual Enterprise Survey (AES) returns and cleaned annual firm IR10 tax filings, though we only use the IR10-based subsample because of the superior coverage of interest expense and balance sheet variables in that data, and to avoid having to address consistency issues across data sources. Industries not in the Stats NZ "measured sector" are excluded from the productivity dataset (largely industries dominated by public sector providers – education, health, government), and we also exclude the financial services sector to remove financial intermediaries from the analysis.

The main dependent variable in the analysis is the firm-level average interest rate (i), which we approximate by exploiting the panel nature of the IR10 tax data, and the fact that closing total liabilities in the prior financial year ($D_{i,t-1}$) are opening liabilities in the following financial year. Thus, with two consecutive IR10 observations for the same firm, a simple approximation to i, is given by interest paid (I) divided by the average of the opening and closing principal value of total liabilities (D):

$$i_{it} = \frac{2I_{it}}{D_{i,t-1} + (D_{it} - I_{it})}. \tag{1}$$

This formulation follows from assuming: a single debt repayment (or drawdown) occurring midway through the financial year; that i is constant within

the year for each firm; and that i is small enough to make compounding interest ignorable. Given the unknown timing of debt repayment/drawdown, a more complex set of assumptions could easily add computational effort without improving the quality of the estimate of i.

Conversely, simplifying the formulation of i by assuming that total liabilities are constant throughout the year would relax the need for consecutive IR10 returns (setting $i_{it} = I_{it}/(D_{it} - I_{it})$). However, this additional assumption is clearly violated in the data for most firms. While requiring longitudinally-linked IR10s impacts on data coverage, linking means we can create all balance sheet variables as averages of opening and closing stocks, accounting more accurately for balance sheet composition across a number of dimensions, not just total liabilities.

Calculating a robust measure of the firm-level average interest rate, as defined in equation (1), relies on high quality IR10 profit and loss data (for interest paid, I), and on high quality IR10 balance sheet data (for total liabilities, D). The Fabling-Maré productivity data cleaning steps focus on the quality of IR10 variables that feed into productivity components (predominantly profit and loss variables), and do not assess the quality of the entire IR10 balance sheet. For this research, therefore, we must impose an additional set of data cleaning steps in order to remove IR10 returns that should not be used to construct i.

Table 1 itemises these additional data cleaning restrictions, and reports the number and proportion of observations lost at each sequential step. Initially, we drop firms where either the asset (A) side of the balance sheet and/or the liability plus equity ($D + E$) side are zero (2.6% of observations), and where reported interest income or expenditure is negative (0.1% of observations).

The next step checks that the balance sheet balances (ie, $A = D + E$) and makes corrections to balance sheet components where simple reporting errors have been made by respondents.[4] Of particular concern at this step is the reporting of the owners' current account, which is subject to different reporting requirements by Inland Revenue (IR) under the old (to 2012) and new (from 2013) IR10 forms. Under standard accounting rules, business loans from business owners to the firm (a positive current account balance) are reported in the firm balance sheet as a current liability. This accounting-

[4]For example, we replace total assets with the summed components where total assets are zero (missing), and the summed components make the balance sheet balance. All consistency tests applied to the data allow for rounding error as IR10 responses are recorded to the nearest dollar.

consistent approach is a requirement for reporting under the new (from 2013) IR10 form. The IR requirement for the old IR10 form was for the current account to be excluded from reporting in the balance sheet (inconsistent with accounting standards), and reported as a separate line item outside of the balance sheet. Therefore, the main adjustment made at this step is to reincorporate the current account into the liability side of the balance sheet, where this results in the balance sheet balancing, and this adjustment mainly affects years prior to 2013 (ie, where firms were complying with the IR rule that would prevent the balance sheet from otherwise balancing).

Establishing the correct and consistent reporting location of the current account is critical to the estimation of i, both because the current account is a significant proportion of total liabilities for the average firm, and because the lending conditions on the current account may differ substantially from a commercial loan since a positive current account represents a loan from one or more firm owners to their own firm.[5] Using the final cleaned dataset, figure 1 shows the average current account share of total liabilities (solid line), which is the largest component of total liabilities at around 38% (32% when restricting to firms with non-zero i).

Two further cleaning steps verify the correct reporting of the current account: the requirement that liabilities have been itemised into the available types (current account; accounts payable; other current liabilities; term liabilities),[6] and that the reported itemisation is consistent with the current account which, in both the old and new IR10 form, is reported as a separate line item. We lose 2.3% of observations because liabilities are only reported as a total and not itemised, and we lose 5.8% of observations because the reported current account total is not consistent with the reporting of liability components, or the potential reporting of the current account as equity.

Figure 2 expands on the nature of the latter test by categorising firms into whether their balance sheet reporting is consistent with their reported current account, where we allow two kinds of consistency: the current account could have been reported in "other current liabilities" (ie, "other current liabilities" are greater than or equal to the reported current account), consistent with accounting practices; and/or the current account could have

[5] We concern ourselves with the correct location of negative current account balances (a business asset) in the reported IR10 only insofar as the current account reconciles an incomplete balance sheet, and to check for the potential misreporting of the sign of the current account (ie, cases where the current account is actually a loan, not an asset, but has been incorrectly reported as an asset).

[6] The IR10 form collects different categories of liability over time and this breakdown reflects a harmonisation of those categories.

been reported in total equity, which is inconsistent with accounting practices but is encouraged by the presentation of the old (to 2012) IR10 form and instructions, and appears to be consistent with the filing practices of many firms. Firm groups one and two in figure 2 are "unadjusted" current account firms where the current account is probably correctly reported in current liabilities, and the IR10 return requires no adjustment. Prior to the IR10 form and instruction change, an average of 34% of firms with non-zero current account appear to have reported the current account in other current liabilities,[7] with this average rising to 56% of firms following the IR10 form and instruction change (from 2013). A minority of the "unadjusted" group – group two in figure 2 – could (mathematically) have reported the current account in total equity since E is greater than or equal to the current account, but we assume these firms are compliant with accounting standards in the absence of evidence to the contrary.

For firm groups three and four, current liability reporting is inconsistent with the current account having being reported correctly in current liabilities, and we assume that the current account is reported in E, shifting the current account from E to current liabilities. For the majority of these firms (group three), the current account could not have been reported in total liabilities because the reported current account is greater than total liabilities. For group four firms, where E and D are both larger than the current account, we assume that the current account has been reported in E not D, since this appears to be the most likely case, based on the relative sizes of groups three and four. Additionally, since we need to know the composition of total liabilities, assuming the current account is reported in E and not D, avoids the need for a complex secondary cleaning step where we would have to specify how the current account may have been incorrectly reported across (incorrect) liability categories.

The final two firm groups (groups five and six in figure 2) are both dropped, either because the current account could only be accommodated in D (group five), and we don't know how the reporting of liability categories should be revised to achieve consistency with the current account reporting, or because the reported current account is larger than D and larger than E (group six). On average, dropped firms account for 10.7% of positive current account observations, which translates to 5.8% of total observations lost at that data cleaning step (table 1).

[7]This total includes firms that follow IR instructions to omit the current account from the balance sheet entirely. For these firms, the balance sheet balancing step adds the current account back into the balance sheet in the correct location.

To construct i using equation (1), we require consecutive IR10 observations, which removes 23.9% of observations, mainly of incumbent active firms that did not file an IR10 in the prior year, or whose IR10 did not meet the quality tests in the prior year. Approximately one fifth of the dropped observations at this step are firms that were inactive in the previous financial year and, therefore, are not expected to file an IR10.

In the final data cleaning step, we drop firms that have no liabilities (averaged over opening and closing balances), or which only have current account liabilities, so that all firms in the sample have external debt (potentially with $i = 0$). We then trim the distribution of i, dropping firms with negative i and with i greater than the 99th percentile (a value of 0.235) to remove observations of implausibly high interest rates from the sample. Combined, these two final restrictions remove 1.8% of initial productivity dataset observations, so that overall we retain 52.1% of productivity dataset firm-year observations. Figure 3 plots this retained data rate by year. Consistent with the productivity dataset cleaning process, new IR10 form data quality appears to be higher resulting in less dropped observations in more recent years (Fabling and Maré 2019).[8]

2.2 Variables correlated with i

To identify a firm-specific borrowing premium, we estimate regressions of the following form:

$$i_{it} = \boldsymbol{\beta}^T.\mathbf{T}_t + \boldsymbol{\beta}^Z.\mathbf{Z}_{it} + \delta_i + \epsilon_{it}, \tag{2}$$

where $\mathbf{T}_t$ is a set of year dummies, $\mathbf{Z}_{it}$ are a set of time-varying firm characteristics that might affect financing costs, δ_i is a firm fixed effect, and ϵ_{it} is the error term.[9] In this paper, we are primarily interested in the permanent component of the firm-specific risk-adjusted borrowing premium (ie, δ_i), and in the unadjusted-for-risk comparator to this premium (ie, where δ_i is estimated without $\mathbf{Z}_{it}$ included in equation 2), which we compare to reported finance outcomes from the BOS sample.

Other parameters in this empirical model are also of interest. The $\boldsymbol{\beta}^T$ coefficients reflect the annual average risk-adjusted cost of borrowing relative

[8] The first year of new IR10 form data (2013) appears similar in quality to old form data because that year relies on a 2012 year return being available for opening book values of assets and liabilities.

[9] We also estimate models where firm fixed effects are replaced by industry dummy variables, and where i is replaced by an indicator variable for whether i is non-zero.

to the base year (2002), which may be of interest to macroeconomists and is comparable to the Reserve Bank of New Zealand (RBNZ) business borrowing cost series. The $\boldsymbol{\beta}^Z$ coefficients indicate which firm characteristics attract a risk premium, and variation in those coefficients over time may be indicative of changes in risk (or perceived risk) over the business cycle. We test for changes in the risk premium over time by allowing coefficients on $\boldsymbol{\beta}^Z$ to differ before and after the Global Financial Crisis (GFC).

Potential firm characteristics that should increase i are well documented in the literature and include balance sheet fragility, poor firm performance, low resale value (including illiquid or firm-specific assets), and high risk investments. To avoid further data loss from linking additional data sources, we focus on $\mathbf{Z}_{it}$ variables that are derivable directly from the productivity dataset and the cleaned IR10 balance sheet data used to derive i.[10] This partial control set for $\mathbf{Z}_{it}$ should be thought of as providing a test of the method, rather than a comprehensive assessment of the impact of risk on i.

Table 2 reports the means and standard deviations of the available variables for the full sample, and for the subsample of firms where interest costs are non-zero, where the latter is the primary sample for estimation. The non-zero i sample size is almost 1.25 million observations, implying that a full quarter of firms with non-zero current account liabilities have zero interest payments, partly reflecting the inclusion of potentially non-interest attracting liabilities, such as accounts payable, in D.

While the consecutive IR10 requirement removes entrant firms, we test for whether new firms experience higher borrowing costs by including an indicator variable for whether a firm entered in the previous year.[11] Table 2 (top row) shows that 6% of all observations (5.4% of $i > 0$ observations) are for firms that entered in the previous year. Labour (l) is log of total firm employment (employees plus working proprietors), taken directly from the productivity dataset, with a mean (all firm) value corresponding to two full-time equivalent employees. Larger firms are more likely to be high performing and less likely to exit, implying that they may attract a lower risk premium.

We include three variables related to the intangibles share of total productive assets: an indicator variable for whether the firm has intangibles; the intangibles share itself, defined as IR10-reported intangibles as a proportion

[10] Fabling and Sanderson (2016) summarise the available datasets in the LBD.

[11] An indicator variable, denoted by $\delta(.)$ is set equal to one if the condition holds, and zero otherwise. Firm entry is a variable taken from the productivity dataset and is defined as a transition from non-activity to activity, based on full coverage administrative tax data, and AES/IR10 data (Fabling and Maré 2015b).

of the sum of intangibles and total fixed assets; and an indicator variable for cases where the denominator in the intangibles share is zero.[12] Slightly over a quarter of firm-year observations have intangibles, with the average intangibles share being 10.5% of productive assets. The intangibles share may have an ambiguous relationship with the risk premium. On the one hand, intangibles may be less liquid and more firm-specific than fixed assets, implying a higher risk premium. On the other hand, high performing firms may be more likely to have intangibles, suggesting the intangibles share could be associated with a lower risk premium.

Profitability is captured by the return on sales (ROS), measured as profit (earnings before interest and depreciation) per unit of output, where we follow Fabling and Maré (2019) and define profit using the productivity dataset as output less intermediate consumption, wages, and rental, leasing and rates expenses.[13] The ROS is naturally bound from above by one, and we set a lower bound at negative one to remove the potential influence extreme negative values could have on the subsequent regression analysis. An indicator variable identifies the 2.4% of firm-year observations where the lower bound has been enforced (table 2).

The average ROS is 18%, though this varies substantially over time as illustrated in figure 4 (dotted line), falling steadily from 2002 through to 2010, before rebounding slightly through to 2018. Figure 4 also illustrates the impact of the data restrictions imposed on the productivity dataset, since ROS can be calculated for all firms in the initial sample. The solid line in figure 4 shows the average ROS for all firms in the productivity dataset (excluding the finance sector), while the dashed line shows the average ROS once internally inconsistent balance sheets have been removed from the data. Both the balance sheet cleaning steps and the restriction to firms with consecutive IR10s raise the average ROS in the sample, at least in years where the old IR10 form is used. This effect is around two percentage points (pp), and does suggest some caution in assuming that the sample is representative of the broader population of New Zealand firms.

The expected relationship between profitability and the risk premium is ambiguous. Higher average profitability is a feature of higher performance

[12] Where the denominator in the intangibles share is zero, we set the intangibles share to zero. Only 1.4% of observations are subject to this treatment, because the productivity dataset is restricted to firms with non-zero capital services (K).

[13] In the Fabling-Maré productivity dataset, rental, leasing and rates costs are included in capital services, rather than intermediate consumption, which necessitates their separate inclusion in the profit variable.

firms and firms with higher capital intensity (greater resale value), implying a lower risk premium for higher ROS firms. Conversely, higher returns should be associated with higher risk investments so that risk-adjusted returns are constant, and higher risk activities should attract a higher risk premium.

To potentially help distinguish between these two channels, we also include an estimate of "permanent" multifactor productivity (MFP) differences between firms. The MFP fixed effect is estimated from an industry-specific translog production function and captures underlying (permanent) productivity differences between firms in the same industry. We expect higher productivity to be unambiguously associated with a lower risk premium. Since the estimated MFP fixed effect is a permanent firm characteristic, we cannot include it in fixed effects regressions and, consequently, estimate some OLS regressions (including controls for productivity industry to be consistent with the MFP measure being a within-industry measure). In the full population of firms the MFP fixed effect is mean zero, by construction, but has positive mean in the analysis sample (table 2), consistent with the sample selection effect observed with the ROS.

The final $\mathbf{Z}_{it}$ variable we consider is the debt ratio, defined as $D/(D+E)$, which has an average value of 79% for all firm-year observations (81% of $i > 0$ observations). The debt ratio is set to one for firms with negative E, with a separate indicator variable denoting these observations, which account for 21% of firm-years. A higher debt-equity ratio and, particularly, negative equity is expected to be associated with a higher risk premium due to the higher risk of debt non-recovery if the firm fails.

The remaining variables reported in table 2 are the shares of total liabilities in each liability type (and associated indicator variables), where the annual averages of these are reported in figure 1. In general, these shares and indicator variables are not included as regression control variables, since we think of the liability structure of the firm as largely being an outcome of debt financing decisions.

Instead of including these variables in $\mathbf{Z}_{it}$, we test the plausibility of i by confirming that long term debt is more closely associated with higher i than current liabilities are, and by demonstrating that the liability structure explains a significant proportion of overall variation in i, even in the absence of firm fixed effects. These results are shown in table 3, where the dependent variable in columns one and two is an indicator for non-zero i, and in columns 3-6 is i (multiplied by one hundred to improve the presentation of estimated coefficients), either estimated on all firms (columns 3 & 4) or restricted to non-zero i firms (columns 5 & 6). Odd columns exclude year

dummies, while even columns include them. Focussing on the share variable coefficients reported in column 6 of table 3, non-current account liabilities are associated with higher i than current account liabilities, where the latter share is omitted because the share variables add to one. On average, a firm with all liabilities as term liabilities has i 6.2pp higher than a firm with all liabilities as current account.[14] The adjusted R^2 of the regression is 0.255, with a relatively small proportion of that being explained by the inclusion of year dummies (comparing the R^2 of columns 5 and 6).

Firms are also much more likely to have reported non-zero i, the larger their shares of non-current account liabilities (columns 1 and 2), which raises concerns about the inclusion of the current account in the denominator of equation (1). Rather than exclude the current account from D, we instead include the current account share and associated indicator variable in $\mathbf{Z}_{it}$ as controls for owners of firms funding their business through the current account, rather than through equity. These additional controls should go some way towards correcting for the downward effect on i arising from the inclusion of (self-determined) liabilities that do not attract interest. We expect the inclusion of current account controls to have their greatest effect on estimated coefficients on the debt ratio, since that variable depends on the distinction between D and E in the balance sheet, and use of the current account has the ability to undermine that distinction.

2.3 Business Operations Survey financial constraints

Appendix A shows the annual questions in the BOS that relate to reported finance constraints, with these data included in the LBD for all years the BOS has been collected (2005-2019). We use BOS data to show trends in self-reported finance constraints over time, and relate BOS responses to the estimated value of δ_i, with and without risk-adjustment controls. In BOS, firms are first asked if they requested any finance in the year, and are then asked separately about their experience with debt finance and equity finance. For each type of finance, we categorise firms as (self-reported) debt/equity constrained if debt/equity finance was "available, but not on acceptable terms" or "not available." A firm is subject to any finance constraint if they are either debt or equity constrained.

BOS statistics also allow us to address a potential criticism of the anal-

[14]Firms where D is entirely current account are excluded, though firms where the current account is almost one are included.

ysis – that we completely neglect equity finance. While we do not have an equivalent methodology for equity financing, we think equity finance is a second order issue for the firms in this sample for at least two reasons: the average debt ratio (table 2) is 79% indicating that the average firm is predominantly financed through debt; and, the BOS statistics we report later in the paper show that very few finance-seeking firms only seek equity finance. Indeed, the BOS statistics are consistent with a rank ordering in firm funding methods, where new debt is preferred over new equity finance.[15]

The BOS statistics we present differ slightly from official statistics because we compare BOS responses of the same firm over time, and BOS responses of the same firm across questions. To improve those comparisons, we recalculate the survey weights in the data to represent the BOS population after excluding firms that did not answer the finance request (routing) question, and after including firms that are in the longitudinal BOS panel (and not included in official statistics). We also make minor improvements to the consistency of responses across the three asked questions. Unlike the analysis of i, the BOS analysis uses (adjusted) survey weights to provide estimates of population statistics, where the BOS population differs from the productivity population primarily through a minimum firm size of six employees.[16]

3 Results

3.1 Descriptive statistics for i

Figure 5 shows the mean value of i over time for all firms (solid line) and conditional on $i > 0$ (dashed line), together with the probability that a firm with non-current account liabilities has non-zero interest costs (dotted line, and using right axis scale). The patterns over time in i is consistent with statistics from the RBNZ (figure 6) that show interest rates rising up to 2009, and then falling rapidly following the GFC, stabilising in 2014, and then falling again. The key difference between the mean i conditional on $i > 0$ and the business lending rate, is that the latter is about 3pp higher than the former, reinforcing our concern that the denominator in equation

[15]BOS also has supplemental finance questions that could help understand the importance of non-price finance costs (eg, personal collateral requirements), which are not counted in the cost of finance.

[16]Where we present longitudinal BOS statistics, we weight each observation using the firm-level average (adjusted) survey weight.

(1) includes liabilities, such as the current account, that may attract below-market (potentially zero) interest rates.

The decline in the proportion of firms with interest expenses over time is consistent with the falling share of term liabilities over time (figure 1), and also with firms being more likely to have interest costs in periods where interest rates are higher. On this latter possibility, figure 7 plots the mean conditional i against the probability of non-zero i by production function industry (all years pooled), with industries scaled by the total number of firm-year observations. Industries at the extremes of either dimension are labelled, and the dashed line shows the unweighted OLS relationship between the two, confirming a slight positive relationship between the conditional interest rate and the probability of the interest rate being non-zero.

The most interesting feature of figure 7 is the substantial heterogeneity in average i across industries, with road transport mean i (5.8%) almost double the mean i (3.0%) of supermarkets, grocery stores and specialised food retailing. Figure 8 demonstrates this heterogeneity in an alternative way, plotting percentiles of the conditional i distribution over time (for all industries pooled). The gap between the 25th and 75th percentile of conditional i (dashed lines) varies between 4pp (in 2018) and 6.6pp (in 2009), rising and falling in the same pattern as the mean and median. Figure 9 shows this changing distribution of conditional i plotting the cumulative distribution of firms for the first year of data (2002, solid line), the onset of the GFC (2009, dashed line), and the last year of data (2018, dotted line). The difference between 2009 and 2018 is quite striking, and figure 10 plots the change in density of firms (including $i = 0$ firms) from 2009 to three subsequent periods – the following year (2010); the year at which the speed of decline in post-GFC i drops off (2013); and the final year of data (2018). In the years following the GFC, the proportion of firms with i greater than 7% fell by 14.5pp, with roughly half the decline in density coming in the year immediately after the GFC (2010). While outside the scope of the current paper, it would be interesting to establish how much of this changing distribution is due to i declining in incumbent firms, compared to the closure of firms with high i.[17]

[17] High interest rate firms could also potentially exit the sample because they fail to refinance debt, eg, because lenders have a reduced appetite for risk following the GFC.

3.2 Regression analysis of the covariates of i

We now turn to estimating equation (2), initially focussing on the impact that adding $\mathbf{Z}_{it}$ covariates has on the estimated time trend ($\boldsymbol{\beta}^T$, relative to 2002) for conditional i. Related coefficients are reported in table 4, with point estimates plotted in figure 11. For simplicity, we focus on the latter. The solid black line in figure 11 reflect the OLS estimates in column one of table 4, and are equivalent to the mean difference between i in 2002 and subsequent years. The dashed and dotted black lines reflect the firm fixed effects estimates of $\boldsymbol{\beta}^T$ reported in columns three and four of table 4, where column three only includes time dummy covariates, and column four additionally includes $\mathbf{Z}_{it}$ covariates (whose estimated coefficients are reported in column six of table 5).[18] To complete the figure, the dashed grey line shows the March year average of the RBNZ business lending rate (multiplicatively) rescaled to be equal to the mean conditional i in 2002.[19] The inclusion of the business lending rate confirms what we saw earlier, that the mean i series has a similar temporal pattern to comparable aggregate statistics.

When we control for permanent firm characteristics, the estimated annual decline in interest rates following the GFC is steeper than the raw mean difference in i, implying that the composition of firms over time has shifted towards firms that should face higher interest rates. The estimated decline in the time trend of i is slightly weaker once we introduce time-varying firm characteristics, but still shows a more rapid decline than suggested by the mean i statistic, and more similar to the renormalised RBNZ business lending rate.

Table 5 reports coefficients on time-varying firm characteristics estimated using OLS (columns one to three, with time and industry dummies), and firm fixed effects (columns four to six, with time dummies). Columns one and four stack coefficients from a series of "univariate" regressions, where i is separately regressed on each $\mathbf{Z}_{it}$ variable and any associated indicator variables.[20] Columns two and four are multivariate regressions including all $\mathbf{Z}_{it}$

[18] Column two of table 4 acts as a bridge between columns one and three, showing the effect of adding industry dummies to the OLS regression, rather than firm fixed effects. While the mean difference in i across industries is substantial (figure 7), industry dummies do not add substantially to the explanatory power of the model (raising the adjusted R^2 by 0.006, compared to column 1).

[19] The business lending rate is a discontinued series that we splice with the yield on total business loans series (shown in figure 6).

[20] For example, one univariate regression includes the intangibles share, together with δ(has intangibles) and δ(missing intangibles).

covariates, and columns three and six additionally add controls for the current account. Column six is our preferred specification and the associated time dummy coefficients are presented in column four of table 4 (and figure 11).

We focus on the firm fixed effect results, since these control for unobserved permanent differences across firms, and because the subsequent BOS analysis makes use of the fixed effect firm premium (δ_i). The univariate estimates (column 4), produce very similar results to the multivariate estimates (column 5), except in the case of the coefficient on new entrant firms, which switches from an unintuitive negative and significant result, to an insignificant result when other firm characteristics are controlled for. A much larger change to estimated coefficients happens when we control for potential measurement problems caused by the presence of the current account in total D, with four of the nine coefficients either switching sign or gaining or losing statistical significance (at the 10% level), including the debt ratio which we predicted to be particularly susceptible to mismeasurement in the presence of a positive current account.

In our preferred specification (column six of table 5), most relationships between firm characteristics and i conform to our expectations, though economic magnitudes are small, partly due to the identification of coefficients from within-firm changes in characteristics rather than cross-firm variation (comparing OLS and FE estimates in columns three and six respectively). Firms have lower i during periods when they have larger employment, with a one standard deviation increase in log employment (1.028, using conditional statistics from table 2) being associated with a 0.03pp decrease in i.

Conversely, firms have higher i: in the year after they enter; in years where they have intangible assets;[21] and when their return on sales is relatively high;[22] and for negative equity firms. The positive coefficient on return on sales suggests that higher return firms are also higher risk firms. When we switch to OLS and include the MFP fixed effect (column three), the fixed effect coefficient is negative, suggesting that more productive firms (relative to industry peers) face a lower interest rate than less productive firms.

In table 6, we relax the constraint that covariates have constant coef-

[21] Oddly, firms have lower i in periods where they have no productive assets – neither fixed assets nor intangibles (ie, δ(missing intangibles)=1), which is inconsistent with expectations that tangible (liquid) capital should be associated with a lower risk premium, all else the same.

[22] When the ROS is negative one, and the related indicator variable is one, the combined coefficients are negative.

ficients, allowing coefficients on $\mathbf{Z}_{it}$ variables to have different values in each of three periods: pre-GFC (2002-2008); GFC (2009-2010); and post-GFC (2011-2018).[23] These coefficients are estimated in a single fixed effects regression (comparable to column six of table 5), but presented in three columns to aid comparison, with the p-value of the test of equivalence between pre- and post-GFC coefficients reported in the right-most column. Aside from intangibles-related variables we reject (at the 5% level or better) the coefficients being the same pre- and post-GFC. The table suggests that the overall risk premium for entering firms is present pre-GFC and during the GFC, but not post-GFC and that, conversely, the discount on i for larger firms is present post-GFC and not pre-GFC. Surprisingly, the estimated overall zero relationship between the debt ratio and i (table 5, column six), breaks down into a negative relationship pre-GFC and a positive relationship during and post-GFC (table 6), where we expect a positive coefficient based on risk.

3.3 BOS finance constraints and the firm premium

The final comparison we make using i is to test whether firms that ever report being finance constrained in the BOS have higher (permanent) interest rate premia (δ_i) than firms that never report being finance constrained, and whether any difference between the two groups is at least partially explained by differences in firm-level characteristics associated with risk.

Figure 12 shows the annual proportion of the BOS population that sought finance that reported being finance constrained (with 95% confidence interval), where finance constraint means that the firm couldn't access finance, or could access finance, but not on acceptable terms (see Appendix A for question wording). The top two panels of figure 12 show results for debt and equity finance requests separately, while the bottom panel shows the measure that we focus on, which is firms being constrained on either debt or equity finance. This combined measure rises and falls with the business borrowing rate in a way that is consistent with at least some of the reported finance constraints on firms being due to the available interest rate on borrowing.

However, i seems unlikely to be the only relevant factor, given that the significantly lower interest rates following the GFC compared to prior to the GFC are not mirrored by lower rates of finance constraint post-GFC

[23] We include 2010 in the GFC period because that year uses 2009 data in the construction of i and other variables.

compared to pre-GFC. Consistent with the interest rate not being the sole determinant of finance outcomes, figure 13 shows that demand for new finance is lower following the GFC (by around 5pp), and has not recovered despite historically low interest rates.

Table 7 reports the average proportion of constrained firms (conditional on seeking finance), by the type of finance sought. A mere 4% of firms seeking finance only seek equity finance, with the majority of firms (almost 60%) only seeking debt finance, and the remaining 36% seeking both debt and equity finance. As discussed earlier, these results give us confidence that our focus on debt is warranted, since it is the main mechanism through which the average New Zealand firm (with six or more employees) seeks finance. Furthermore, firms that seek both debt and equity finance are significantly more likely to have encountered debt finance constraints than firms that only sought debt finance (14.5% compared to 7.9%), consistent with at least some firms preferring debt finance over equity finance, but being forced to seek equity finance after they fail to secure debt finance.

Before we classify firms based on ever reporting being constrained, we demonstrate that this is sensible by considering whether being finance constrained is a persistent characteristic of firms over time. Table 8 shows the year-to-year transition rates for finance outcomes observed over two consecutive years. In this longitudinal sample 10% of firms seeking finance are constrained at time t (second column of table 8). Compared to firms that faced no finance constraints in the prior year, previously constrained firms are 4pp less likely to seek finance in $t + 1$, and much more likely to be finance constrained. Conditional on seeking finance, almost 49% of previously finance constrained firms will continue to report being finance constrained, which is six times the rate for previously unconstrained firms (8.2%) and four and a half times the finance constrained rate for firms that did not seek finance in the previous year (10.7%). Thus is seems to make sense to think of reported finance constraints as potentially being a fixed characteristic of the firm, rather than a transitory event.

Table 9 presents the final set of results where we compare mean fixed effects across the three BOS firm types – never requested finance, never constrained, and ever constrained. Focussing first on the case where fixed effects are calculated in the absence of $\mathbf{Z}_{it}$ controls, the three group means are all significantly different from each other, with ever constrained firms having permanent interest rate components (δ_i), on average, 0.51pp higher than never constrained firms. Both groups that have sought finance have higher average fixed effects than the group that never requested finance, consistent

with internal finance being less costly than external finance, or with firms that primarily rely on internal finance being more likely to have liabilities that have low (or zero) interest. Once we control for firm characteristics in estimating the firm fixed effects (right column of table 9), all (mean) gaps between groups shrink. In particular, the mean difference between ever constrained and never constrained firms falls to 0.34pp.

4 Conclusions

By implementing substantial restrictions on the IR10 component of the productivity dataset, we have constructed a firm-level average interest rate on debt (i) that: has aggregate properties that are consistent with official statistics on the firm borrowing rate; is consistent with reported firm-level liability composition; and that varies systematically with firm-level characteristics that we expect to raise or lower firm borrowing costs.

We compare estimated firm fixed effect components of i with BOS finance constraint responses, finding results that are consistent with at least some of the explanation behind self-reported finance constraints being that constrained firms face higher interest rates than unconstrained firms and that this higher rate is, at least in part, due to constrained firms being higher risk from the perspective of lenders. As a corollary, self-reporting of a finance constraint suggests that respondent firms may not fully understand the market risk premia on borrowing associated with their firm activities, and/or that borrowers and lenders may have different views on the risk associated with various firm activities, which may reflect insider knowledge on the part of the borrower.

The set of risk factors (covariates of i) that we consider is limited to what could be easily derived from the productivity and IR10 data. The LBD has a rich set of additional data sources, and the addition of further risk factors may further explain the interest rate wedge between constrained and unconstrained BOS firms, and shed light on the pricing of risk in borrowing costs for New Zealand firms. The BOS also has additional collected content on firm finance experience, asked in a subset of years, which may also help triangulate the space between firm reporting of finance constraints and the observed firm risk premium.

While we only briefly explore the distributional properties of i, the evolution of this distribution for various subsets of firms may be useful for

identifying risk of firm failure or systemic risk to lenders in the event of another GFC-like event. In particular, the data is well suited to identifying financially fragile firms, and the longitudinal nature of the LBD could be used to explore the relationship between finance costs and firm survival.

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Tables

Table 1: Sample loss from data cleaning

	N(observations)		Proportion	
	Total	Lost	Lost	Retained
IR10 subsample of productivity dataset (2002-2018)	**3,239,205**			
Positive balance sheet		82,746	0.026	0.974
Interest income & expenses non-negative		2,076	0.001	0.974
Balance sheet balances (after adjustment)		371,760	0.115	0.859
Liability components itemised		74,331	0.023	0.836
Current account (CA) reporting consistent		188,919	0.058	0.778
Usable return available in preceding year:				
Non-entrant firms		611,076	0.189	0.589
Entrant firms		161,211	0.050	0.539
Positive (non-CA) liabilities & i <99th percentile		59,718	0.018	0.521
Total number of observations lost		**1,551,837**	**0.479**	**0.521**
Final cleaned dataset (2002-2018)	**1,687,368**			

IR10 observations for the 2001 financial year are excluded from the table, since the inclusion of that year artificially inflates the loss at the usable $t-1$ return step (2001 is the first year of productivity data). Including IR10s from 2001 in the statistics up to the point of requiring lagged returns produces almost identical proportion lost statistics to those reported in the table.

Table 2: Summary statistics for firm characteristics

	All firms		$i > 0$ firms	
	Mean	St dev	Mean	St dev
δ(entrant at $t-1$)	0.060	0.237	0.054	0.226
Labour (l)	0.716	0.992	0.844	1.028
δ(has intangibles)	0.269	0.444	0.293	0.455
Intangibles share	0.105	0.240	0.111	0.244
δ(missing intangibles)	0.014	0.117	0.009	0.092
Return on sales	0.182	0.328	0.179	0.305
δ(ROS<-1)	0.024	0.154	0.020	0.141
MFP fixed effect	0.025	0.491	0.040	0.446
Debt ratio	0.791	0.283	0.809	0.259
δ(has negative equity)	0.213	0.409	0.239	0.427
δ(has current account)	0.724	0.447	0.714	0.452
δ(has acc payable)	0.919	0.272	0.944	0.229
δ(has other curr liabilities)	0.893	0.310	0.928	0.259
δ(has term liabilities)	0.531	0.499	0.675	0.468
Current account share	0.377	0.361	0.318	0.329
Accounts payable share	0.186	0.238	0.180	0.217
Other current liabilities share	0.208	0.257	0.211	0.244
Term liabilities share	0.228	0.303	0.291	0.313
N(observations)	1,687,368		1,249,902	

δ(.) represents an indicator function set equal to one if the condition holds, and zero otherwise. The intangibles share is a share of intangibles plus total fixed assets. The indicator variable δ(missing intangibles) accounts for observations where the numerator in the intangibles share variable is zero (in which case the intangibles share is set to zero). Liability type shares are a share of total liabilities and, therefore, sum to one. The MFP fixed effect is estimated from a translog production function for each production function industry separately, and using all observations in the productivity dataset.

Table 3: Estimated (OLS) relationship between interest rate (i) and liability structure

Dependent variable	All firms $\delta(i>0)$		All firms $i \times 100$		$i>0$ firms $i \times 100$	
OLS	(1)	(2)	(3)	(4)	(5)	(6)
δ(has current account)	0.103***	0.105***	0.238***	0.261***	-0.0151	0.0132
	[0.00112]	[0.00112]	[0.0121]	[0.0120]	[0.0131]	[0.0129]
δ(has acc payable)	0.179***	0.173***	0.629***	0.504***	-0.145***	-0.291***
	[0.00189]	[0.00189]	[0.0141]	[0.0141]	[0.0210]	[0.0210]
δ(has other curr liabilities)	0.166***	0.168***	0.202***	0.239***	-0.301***	-0.238***
	[0.00166]	[0.00165]	[0.0107]	[0.0107]	[0.0168]	[0.0168]
δ(has term liabilities)	0.369***	0.366***	0.925***	0.892***	0.188***	0.169***
	[0.00124]	[0.00124]	[0.0101]	[0.0101]	[0.0121]	[0.0120]
Accounts payable share	0.178***	0.178***	1.371***	1.353***	1.703***	1.686***
	[0.00254]	[0.00254]	[0.0172]	[0.0172]	[0.0240]	[0.0240]
Other current liabilities share	0.268***	0.274***	3.899***	4.014***	5.022***	5.183***
	[0.00247]	[0.00247]	[0.0219]	[0.0219]	[0.0273]	[0.0273]
Term liabilities share	0.198***	0.199***	5.619***	5.627***	6.012***	6.029***
	[0.00198]	[0.00198]	[0.0212]	[0.0209]	[0.0216]	[0.0213]
Year dummies included	No	Yes	No	Yes	No	Yes
N(observations)	1,687,368	1,687,368	1,687,368	1,687,368	1,249,902	1,249,902
Adjusted R^2	0.286	0.287	0.290	0.303	0.237	0.255

Robust standard errors (clustered on firm) reported in square brackets. ***;**;* indicate coefficients significantly different from zero at the 1;5;10% level respectively. The dependent variable, i, is multipled by one hundred to aid the presentation of coefficients. The current account share is omitted from the regression, since liability shares add to one.

Table 4: Estimated (OLS & FE) interest rate (i) trends with firm controls

Dep var: $i \times 100 \mid i > 0$	OLS (1)	OLS (2)	FE (3)	FE (4)
$\delta(t{=}2003)$	0.0623***	0.0538***	-0.00148	0.0158
	[0.0159]	[0.0158]	[0.0142]	[0.0135]
$\delta(t{=}2004)$	-0.0160	-0.0302*	-0.121***	-0.0818***
	[0.0179]	[0.0177]	[0.0164]	[0.0153]
$\delta(t{=}2005)$	0.0832***	0.0637***	-0.0128	0.0433***
	[0.0187]	[0.0186]	[0.0175]	[0.0162]
$\delta(t{=}2006)$	0.287***	0.259***	0.154***	0.219***
	[0.0193]	[0.0192]	[0.0183]	[0.0170]
$\delta(t{=}2007)$	0.415***	0.381***	0.246***	0.317***
	[0.0199]	[0.0197]	[0.0190]	[0.0176]
$\delta(t{=}2008)$	0.631***	0.590***	0.434***	0.504***
	[0.0205]	[0.0203]	[0.0197]	[0.0182]
$\delta(t{=}2009)$	0.714***	0.670***	0.462***	0.545***
	[0.0207]	[0.0206]	[0.0201]	[0.0185]
$\delta(t{=}2010)$	0.0211	-0.0208	-0.288***	-0.186***
	[0.0199]	[0.0197]	[0.0196]	[0.0181]
$\delta(t{=}2011)$	-0.177***	-0.220***	-0.503***	-0.401***
	[0.0196]	[0.0194]	[0.0196]	[0.0181]
$\delta(t{=}2012)$	-0.406***	-0.451***	-0.741***	-0.627***
	[0.0194]	[0.0192]	[0.0196]	[0.0182]
$\delta(t{=}2013)$	-0.565***	-0.619***	-0.940***	-0.780***
	[0.0192]	[0.0190]	[0.0197]	[0.0183]
$\delta(t{=}2014)$	-0.593***	-0.654***	-0.991***	-0.848***
	[0.0186]	[0.0184]	[0.0197]	[0.0182]
$\delta(t{=}2015)$	-0.498***	-0.563***	-0.917***	-0.770***
	[0.0186]	[0.0184]	[0.0199]	[0.0184]
$\delta(t{=}2016)$	-0.574***	-0.638***	-1.021***	-0.872***
	[0.0186]	[0.0184]	[0.0200]	[0.0186]
$\delta(t{=}2017)$	-0.795***	-0.865***	-1.303***	-1.150***
	[0.0183]	[0.0181]	[0.0201]	[0.0187]
$\delta(t{=}2018)$	-0.873***	-0.953***	-1.416***	-1.270***
	[0.0181]	[0.0179]	[0.0203]	[0.0191]
Industry dummies included	No	Yes	–	–
Firm characteristics included	No	No	No	Yes
N(observations)	1,249,902	1,249,902	1,249,902	1,249,902
Adjusted R^2	0.016	0.022	0.039	0.143

Robust standard errors (clustered on firm) reported in square brackets. ***;**;* indicate coefficients significantly different from zero at the 1;5;10% level respectively. The dependent variable, i, is multipled by one hundred to aid the presentation of coefficients. t=2002 is the omitted year category. Coefficients on the firm characteristics included in the column four regression are reported in column six of table 5.

Table 5: Estimated (OLS & FE) relationship between interest rate (i) and firm characteristics

Dep var: $i \times 100 \mid i > 0$	OLS (1)	OLS (2)	OLS (3)	FE (4)	FE (5)	FE (6)
δ(entrant at $t-1$)	0.392***	0.422***	0.270***	-0.0540***	0.0200	0.0398**
	[0.0163]	[0.0161]	[0.0149]	[0.0169]	[0.0168]	[0.0159]
Labour (l)	-0.126***	-0.0423***	-0.279***	0.0568***	0.0836***	-0.0267***
	[0.00592]	[0.00598]	[0.00570]	[0.00919]	[0.00917]	[0.00869]
δ(has intangibles)	0.0549***	0.148***	0.0699***	0.119***	0.128***	0.0854***
	[0.0177]	[0.0175]	[0.0155]	[0.0222]	[0.0221]	[0.0205]
Intangibles share	-0.125***	-0.0427	0.196***	-0.254***	-0.203***	-0.0665
	[0.0336]	[0.0333]	[0.0295]	[0.0552]	[0.0554]	[0.0509]
δ(missing intangibles)	-0.740***	-0.812***	-1.097***	-0.434***	-0.495***	-0.663***
	[0.0582]	[0.0569]	[0.0566]	[0.0939]	[0.0945]	[0.0925]
Return on sales	1.078***	1.391***	1.377***	0.728***	0.739***	0.607***
	[0.0219]	[0.0217]	[0.0195]	[0.0209]	[0.0205]	[0.0192]
δ(ROS<-1)	0.813***	0.817***	0.785***	0.423***	0.415***	0.370***
	[0.0388]	[0.0378]	[0.0339]	[0.0312]	[0.0304]	[0.0286]
Debt ratio	-1.439***	-1.532***	0.819***	-2.206***	-2.201***	-0.0276
	[0.0243]	[0.0245]	[0.0235]	[0.0314]	[0.0314]	[0.0307]
δ(has negative equity)	1.663***	1.743***	0.188***	0.915***	0.938***	0.133***
	[0.0136]	[0.0135]	[0.0126]	[0.0150]	[0.0149]	[0.0139]
MFP fixed effect	0.0505***	-0.217***	-0.354***			
	[0.0137]	[0.0144]	[0.0128]			
δ(has current account)			0.117***			0.0965***
			[0.0134]			[0.0127]
Current account share			-5.123***			-4.569***
			[0.0181]			[0.0254]
Separate univariate regressions	Yes	No	No	Yes	No	No
N(observations)	1,249,902	1,249,902	1,249,902	1,249,902	1,249,902	1,249,902
Adjusted R^2	0.040-0.069	0.079	0.230	0.037-0.056	0.058	0.143

Robust standard errors (clustered on firm) reported in square brackets. ***;**;* indicate coefficients significantly different from zero at the 1;5;10% level respectively. The dependent variable, i, is multipled by one hundred to aid the presentation of coefficients. All regressions include year dummies, and OLS regressions include (productivity) industry dummies. Coefficients on the year dummies included in the column six regression are reported in column four of table 4. Columns one and three report stacked estimates from a series of separate "univariate" regressions, for each group of independent variables. These groupings (and associated adjusted-R^2 for OLS, FE) are: entrant (0.040,0.037); labour (0.040,0.038); intangibles (0.040,0.038); ROS (0.045,0.040); debt ratio (0.069,0.056); MFP (0.039,–).

Table 6: Estimated (FE) relationship between interest rate (i) and firm characteristics – separate pre- and post-GFC coefficients

Dep var: $i \times 100 \mid i > 0$ FE	Pre-GFC 2002-2008	GFC 2009-2010	Post-GFC 2011-2018	p-value (pre=post)
δ(entrant at $t-1$)	0.0541**	0.181***	-0.0230	0.021
	[0.0241]	[0.0467]	[0.0231]	
Labour (l)	-0.00297	0.00898	-0.0319***	0.005
	[0.0112]	[0.0120]	[0.00940]	
δ(has intangibles)	0.0883***	0.174***	0.0623***	0.369
	[0.0266]	[0.0307]	[0.0239]	
Intangibles share	-0.00353	-0.0324	-0.0960*	0.109
	[0.0640]	[0.0658]	[0.0546]	
δ(missing intangibles)	-1.045***	-0.902***	-0.384***	0.000
	[0.131]	[0.142]	[0.107]	
Return on sales	0.839***	0.716***	0.379***	0.000
	[0.0280]	[0.0374]	[0.0251]	
δ(ROS<-1)	0.644***	0.444***	0.112***	0.000
	[0.0441]	[0.0664]	[0.0404]	
Debt ratio	-0.345***	0.157***	0.146***	0.000
	[0.0424]	[0.0517]	[0.0352]	
δ(has negative equity)	0.156***	0.151***	0.0788***	0.003
	[0.0222]	[0.0274]	[0.0167]	
δ(has current account)	0.149***	0.213***	0.0275*	0.000
	[0.0205]	[0.0269]	[0.0154]	
Current account share	-5.047***	-5.254***	-4.088***	0.000
	[0.0338]	[0.0390]	[0.0283]	
N(observations)		1,249,902		
Adjusted R^2		0.147		

Robust standard errors (clustered on firm) reported in square brackets. ***;**;* indicate coefficients significantly different from zero at the 1;5;10% level respectively. The dependent variable, i, is multipled by one hundred to aid the presentation of coefficients. Coefficients are estimated in a single regression with (unreported) year dummies. Final column reports p-value on test that pre-GFC and post-GFC coefficients are equal.

Table 7: Reported financial constraints by type of finance requested

	Proportion of firm-year observations	Proportion constrained by type of constraint		
		Any	Debt	Equity
Finance requested				
Equity only	0.041	0.125	–	0.125
Debt only	0.596	0.079	0.079	–
Both debt & equity	0.363	0.181	0.145	0.158
Difference (equity only−debt only)		0.046**		
Difference (both−equity only)		0.056***		0.033*
Difference (both−debt only)		0.102***	0.067***	

Weighted using adjusted BOS sample weights. All years (2005-2019) pooled. ***;**;* indicate a difference significantly different from zero at the 1;5;10% level respectively.

Table 8: Reported (any) financial constraints over consecutive years

	Proportion at t		Proportion at $t+1$ Any constraint			
Response at t	All	Conditional on request	No request	No	Yes	Yes, given request
No request	0.722		0.848	0.136	0.016	0.107
Any constraint | request						
No	0.250	0.897	0.467	0.489	0.043	0.082
Yes	0.029	0.103	0.426	0.294	0.280	0.487

Weighted using firm-level average of adjusted BOS sample weights. Sample is conditional on an observed yes/no "any request" response at t and at $t+1$, and doesn't report transition rates for the 0.3% of firms with missing responses to the finance constraints question.

Table 9: Average estimated interest rate fixed effect by BOS status

BOS firm type	N(firms)	Mean i fixed effect	
		No controls	Full controls
Never requested finance	3,789	-0.0101	-0.0125
		[0.0004]	[0.0004]
Never constrained	5,097	0.0022	-0.0034
		[0.0004]	[0.0004]
Ever constrained	1,281	0.0073	0.0000
		[0.0008]	[0.0008]
Difference (never constrained−never requested)		0.0123***	0.0091***
Difference (ever constrained−never requested)		0.0174***	0.0125***
Difference (ever constrained−never constrained)		0.0051***	0.0034***

Unweighted analysis with one observations per firm that is in both the BOS and interest rate samples. Standard errors reported in square brackets. BOS firm type relates to whether a firm is ever observed to have any finance constraint ("ever constrained"), requests finance but never reports being constrained ("never constrained") or "never requested finance." Firm-specific risk premia (i fixed effects) relate to column three of table 4 ("no controls" FE) and column six of table 5 ("full controls" FE). *** indicate a difference significantly different from zero at the 1% level.

Figures

Figure 1: Average composition of firm liabilities over time

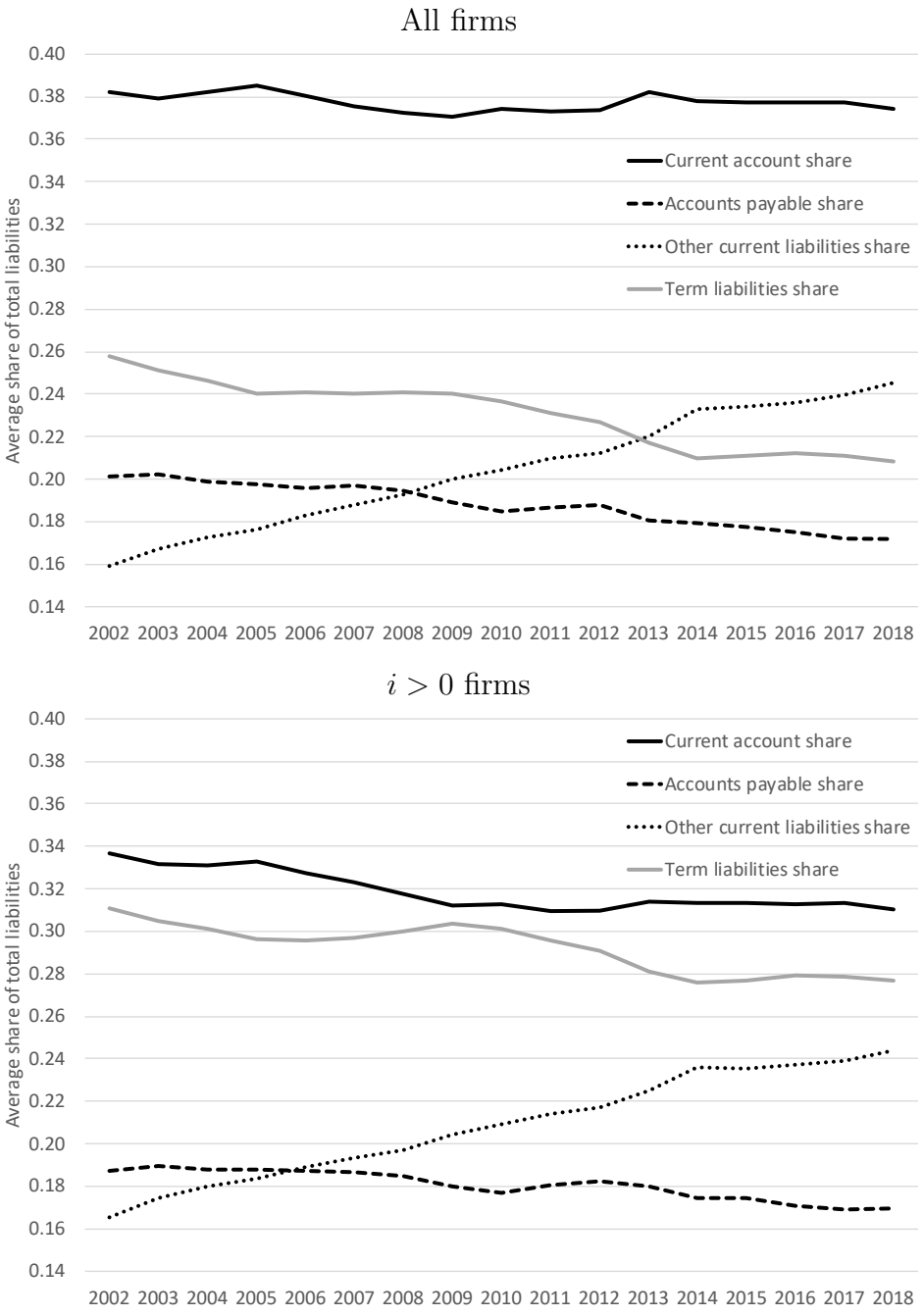
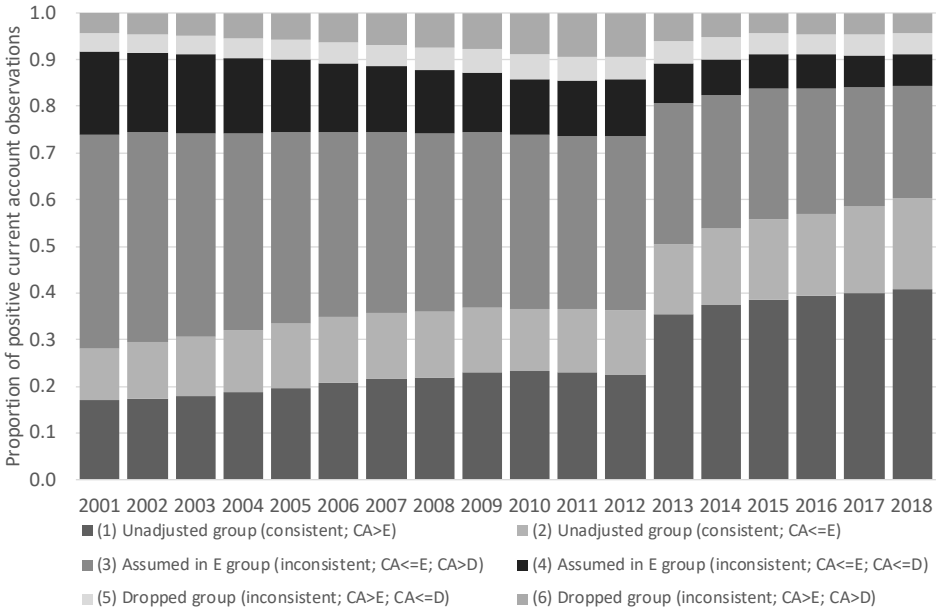


Figure 2: Proportion of observations where current account location assumption required



"Consistent" in this context means "consistent with accounting standards," ie, the current account has been reported in the appropriate current liabilities category on the IR10 form. The "assumed in E group" are IR10 observations where we assume that the current account has been (incorrectly) reported in E, and we move the current account from E to D.

Figure 3: Proportion of productivity sample retained after data cleaning

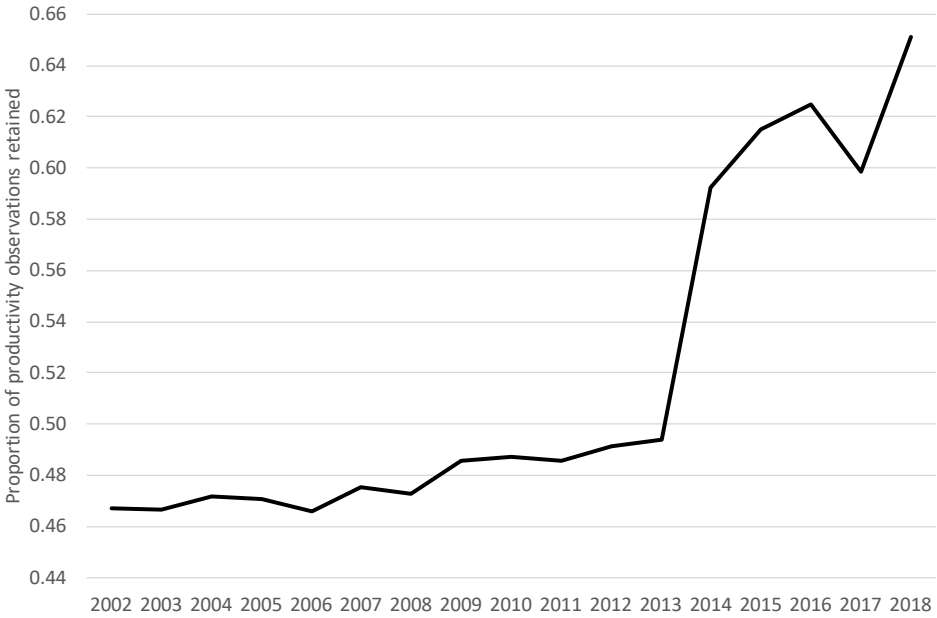


Figure 4: Effect of data cleaning on average return on sales

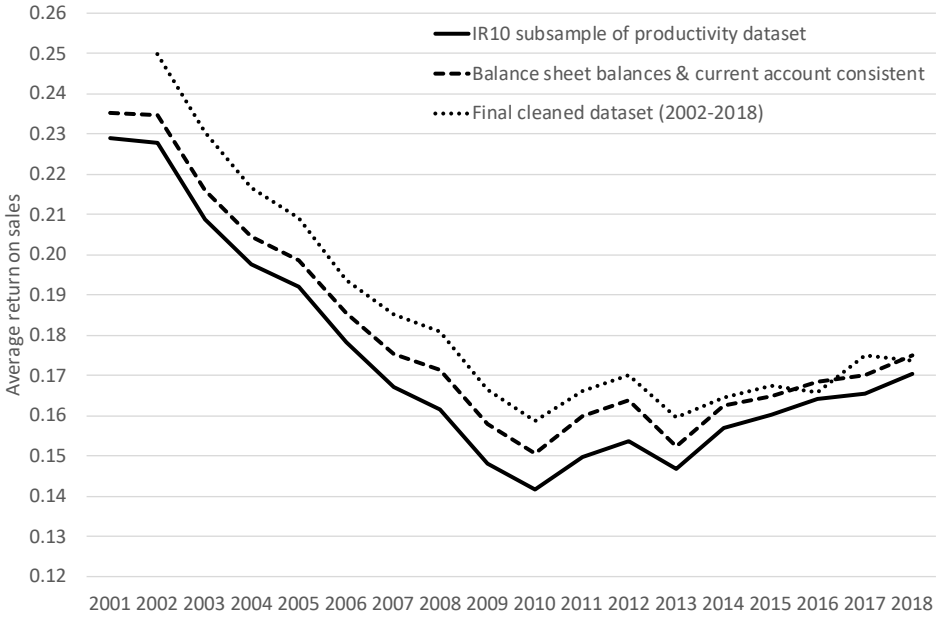


Figure 5: Mean interest rate (i) and probability of $i > 0$ over time

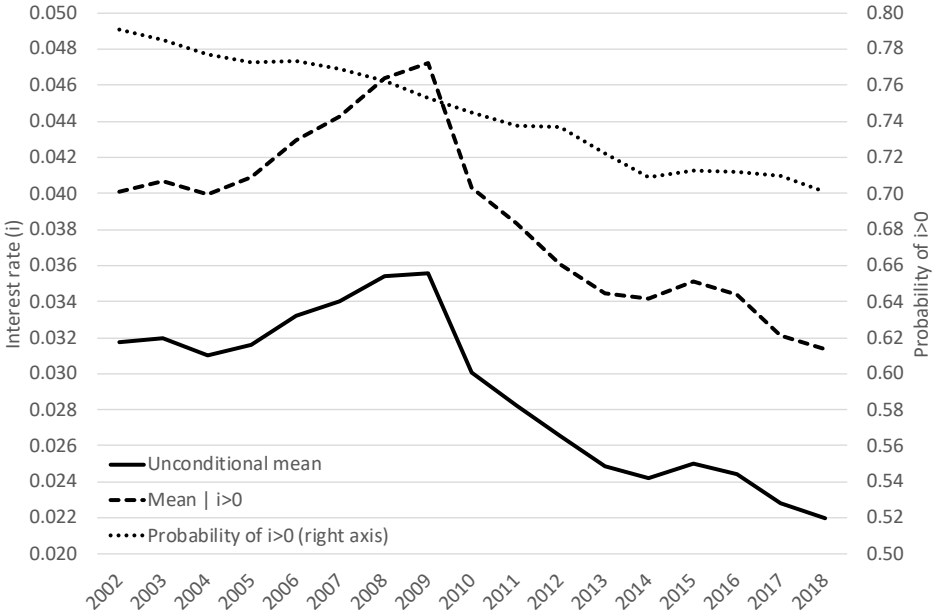
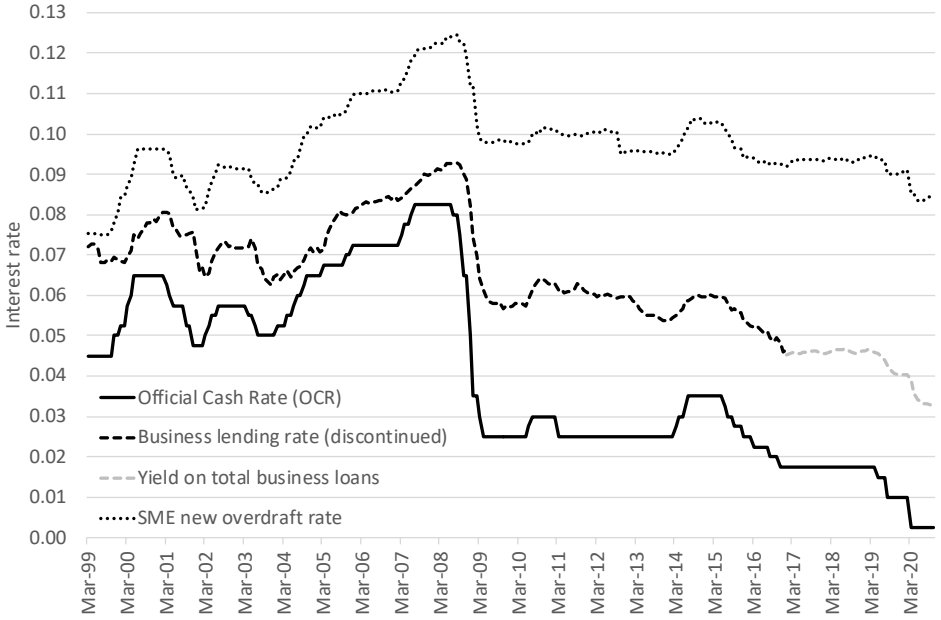
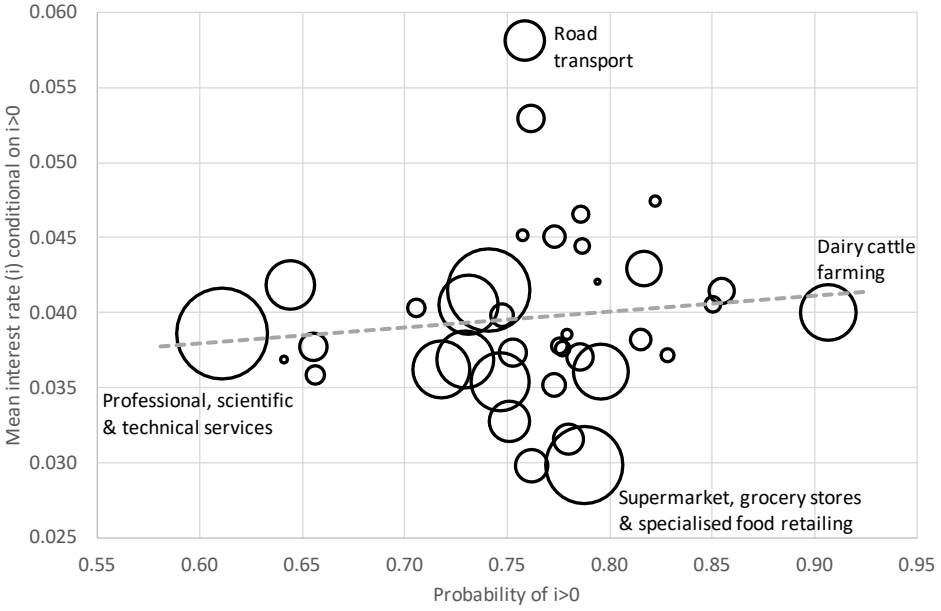


Figure 6: Business lending rates and official cash rate



Source: Reserve Bank of New Zealand

Figure 7: Mean conditional interest rate vs probability of $i > 0$ by industry



Each bubble represents a production function industry, and is scaled by the number of firm-year observations in the industry (all years pooled). The dashed line is the unweighted OLS relationship between the mean conditional interest rate (i) and the probability of non-zero i.

Figure 8: Percentiles of i (conditional on $i > 0$) over time

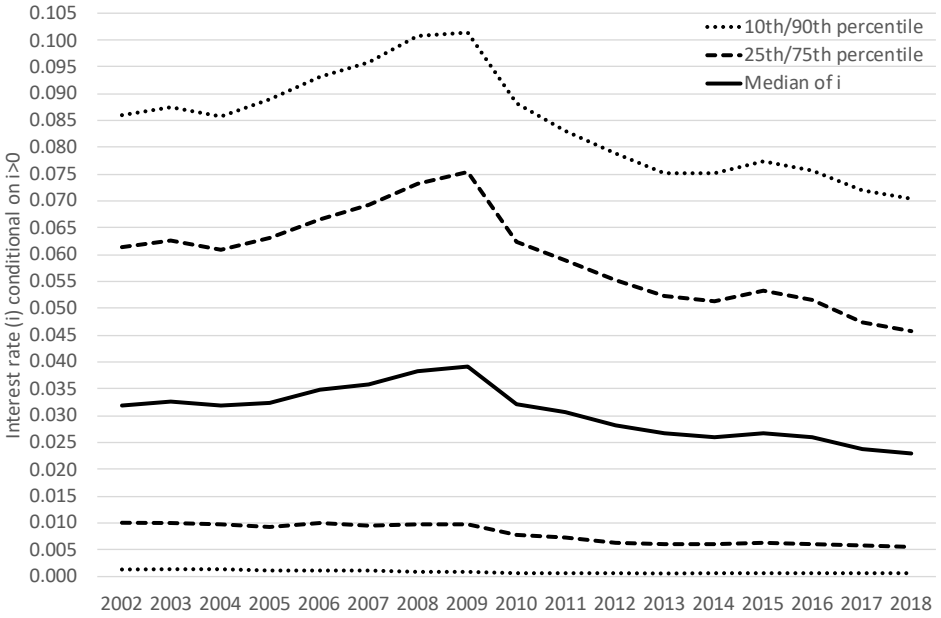


Figure 9: Cumulative distribution of interest rate (i) for selected years

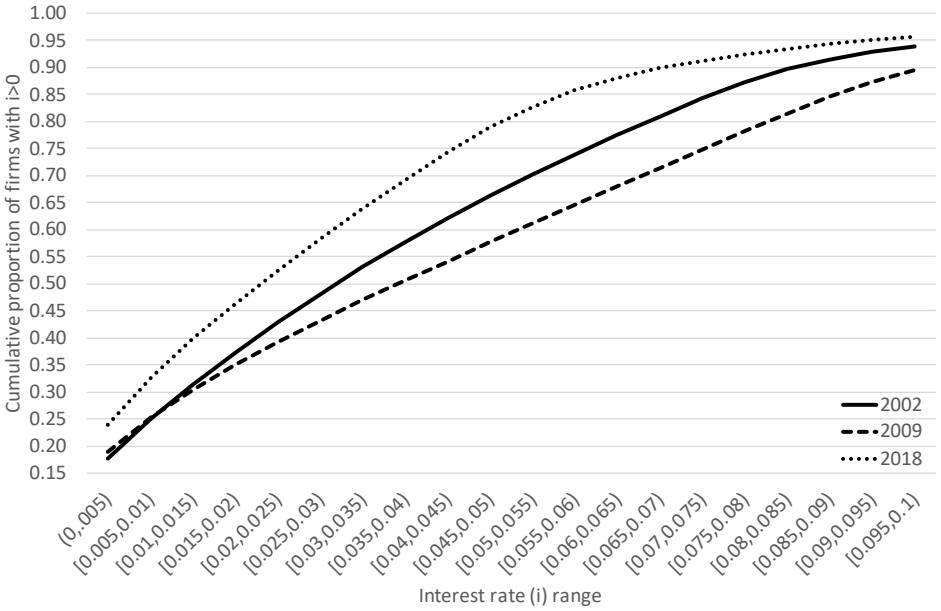


Figure 10: Change in interest rate (i) distribution following the GFC

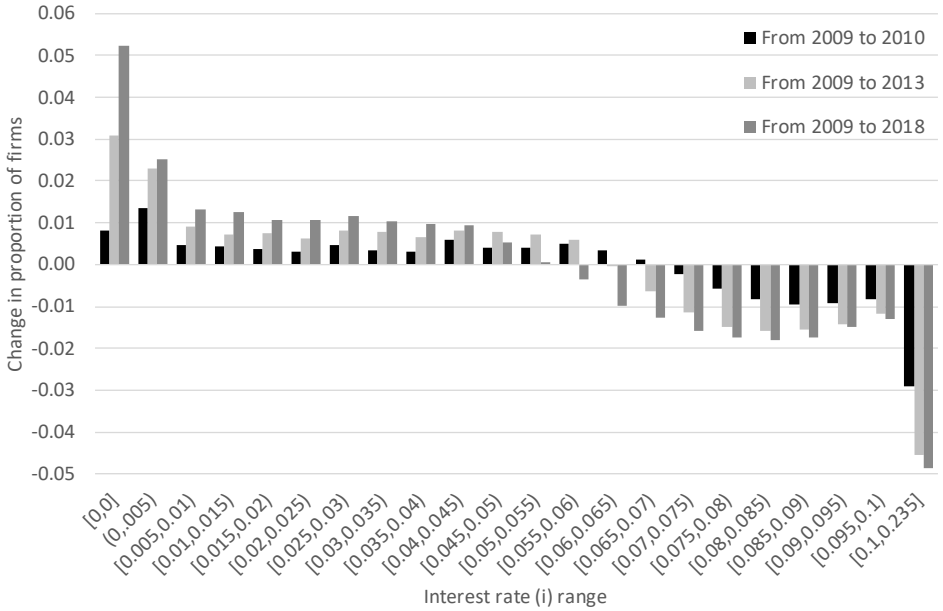
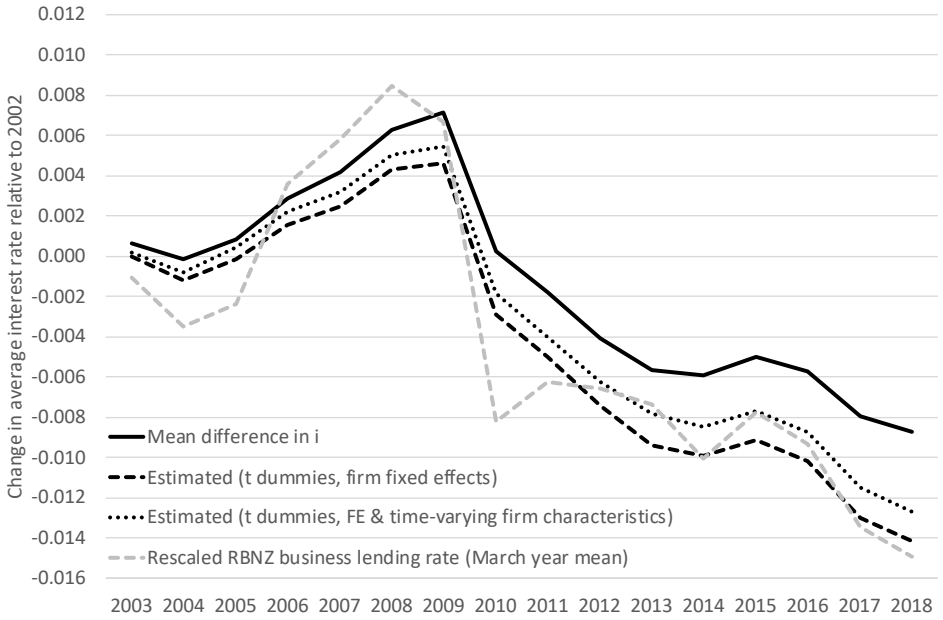
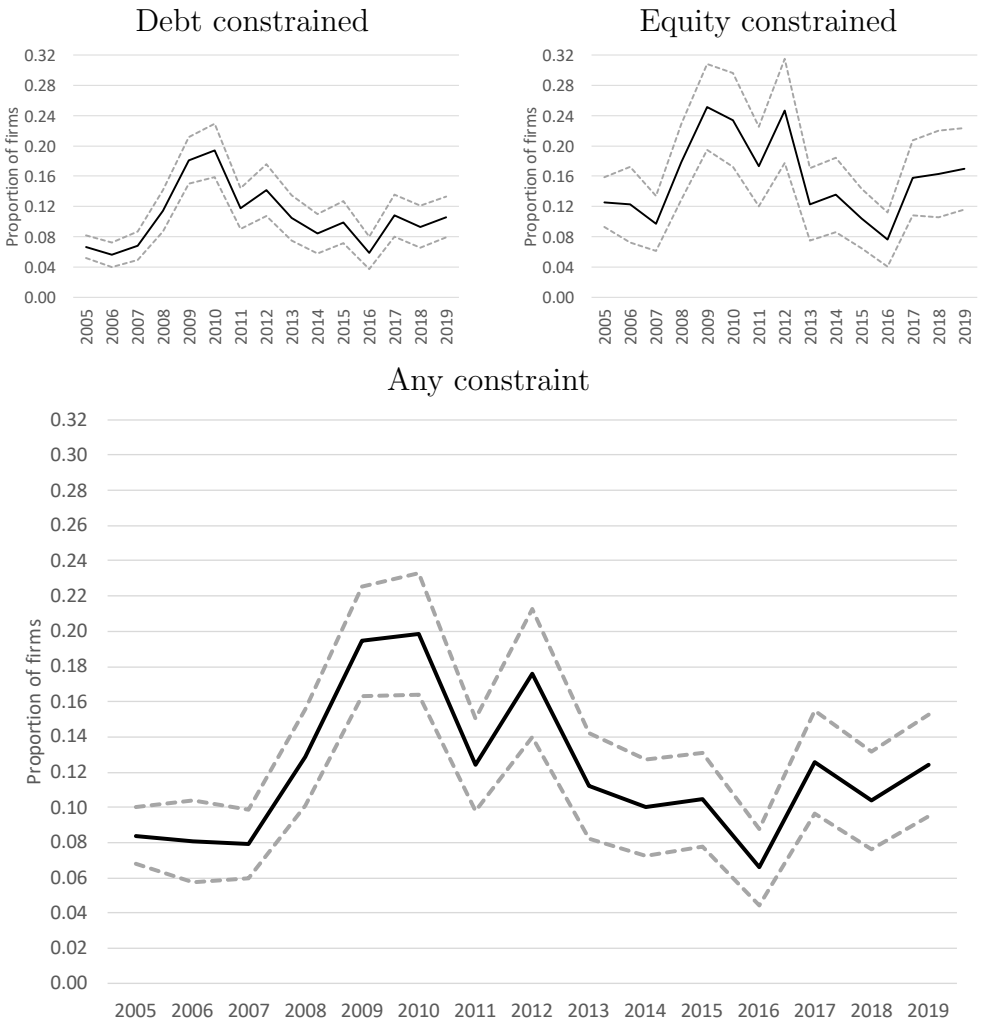


Figure 11: Change in interest rate (i) over time controlling for firm characteristics



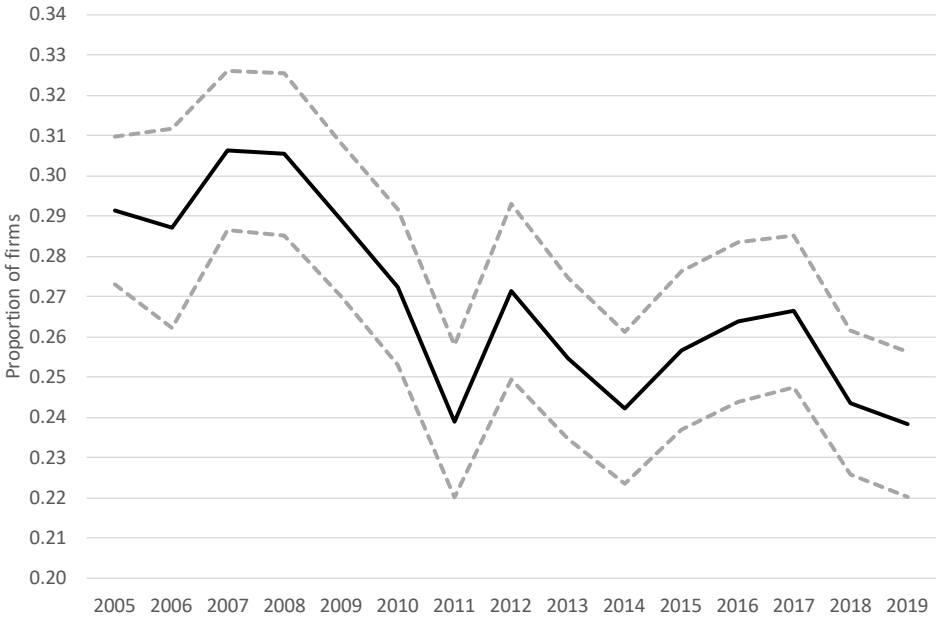
"Estimated" series relate to columns three and four of table 4. The business lending rate is a discontinued series and has been spliced with the yield on total business loans series (see figure 6). The combined series is converted to a March year average that has been (multiplicitively) rescaled so that the March 2002 value matches the mean value of i in 2002.

Figure 12: Proportion of requesting firms that are finance constrained



Weighted using adjusted BOS sample weights. Solid line is mean and dashed lines are 95% confidence interval. Constrained defined as "available, but not on acceptable terms" or "not available." "Any constraint" is debt or equity constrained.

Figure 13: Proportion of BOS firms requesting finance



Weighted using adjusted BOS sample weights. Solid line is mean and dashed lines are 95% confidence interval.

A. Appendix – BOS finance questions

50 **Over the last financial year, did this business request any new or additional debt or equity finance?** A5000

Note:
- **Debt finance** is any finance that the business must repay (eg overdrafts, credit cards, convertible debt)
- **Equity finance** is any finance which is provided in exchange for a share in the ownership of this business

Include:
- requests that were fully approved, partly approved, withdrawn or declined

1 yes → go to **51**
2 no
3 don't know → go to **Section B** on page 14

51 **Mark all that apply. When requesting new or additional debt finance, were funds:**
- available on acceptable terms A5101
- available, but not on acceptable terms A5102
- not available A5103
- don't know A5104
- did not request debt finance A5105

52 **Mark all that apply. When requesting new or additional equity finance, were funds:**
- available on acceptable terms A5201
- available, but not on acceptable terms A5202
- not available A5203
- don't know A5204
- did not request equity finance A5205

These questions have been taken from the 2005 BOS form. The survey questions are unchanged over time.