Age Effects, Leverage and Firm Growth*

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Abstract

Recent theories of firm dynamics emphasize the role of financial variables as determinants of firm growth. Empirically examining these relationships has been difficult, since there is a lack of financial data on the small, young, and private firms. Using a unique administrative data set, this paper considers the growth of new firms in Canadian manufacturing from a financial perspective. We find that financial factors, such as leverage and initial financial size, impact growth rates for new firms. Further, the inclusion of leverage has little impact on the economic significance of the conditional age and size relationships with firm growth.

Key Words: Firm Size Dynamics, Leverage, Age Effects, Dynamic Panel Data.
JEL Classification: D21, G3, L3, C23.

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1 Introduction

Recent theories highlight the impact of financial considerations in firm dynamics, especially for young firms. These theories suggest financial variables contain relevant information regarding firm growth. Very little is known about the financial state of new firms. Empirically examining these relationship has been difficult because of the lack of financial data on the small, young, and private firms. This paper considers the role of financial variables in the growth process of new firms in manufacturing using administrative corporate tax files. Once controlling for firm age and size, we find that financial factors, such as leverage and initial financial size, have significant, positive effects on growth of new firms.

Previous empirical firm growth studies by Evans (1987a, 1987b) and Dunne, Roberts, and Samuelson (1989) find a negative correlation between firm growth with size and age. Further, conditional on age, firm growth remains negatively related to size, while conditional on size, firm growth continues to have a negative relationship with age. In response to these empirical findings, theoretical models use alternative mechanisms to try to explain the size and age effects on firm growth. In these models, there is typically one source of heterogeneity across firms. Learning and productivity shocks provide devices which generate different dynamics across firms. Given the simultaneous age and size dependence, a second heterogeneity is needed to better understand growth dynamics.

As a result, newer models, such as Cooley and Quadrini (2001), were built to explain the conditional size and age correlations with growth. This model extends Hopenhayn (1992) by making financial considerations relevant for firm dynamics. In Hopenhayn (1992), size captures productivity differences across firms, which makes growth independent of age. The addition of financial heterogeneity means a conditional relationship between firm growth and age occurs, as age captures the omission of a firm's financial state measured in terms of the debt-to-asset ratio.

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There are alternative reasons for age effects to remain even after controlling for financial variables. Theoretical work by Jovanovic (1982) proposes a learning model of industry dynamics. Firms enter an industry with incomplete information regarding their own productivity but gain information through production.[1] Although the model deals with selection (exit) and not explicitly with growth, the learning effect generates a negative conditional firm growth-age dependence under certain general conditions, see Evans (1987b). Whereas, Klepper and Thompson (2006) suggest conditional age effects in firm growth are due to the creation and destruction of submarkets combined with selection effects.

This paper's main avenue of assessment is the hypothesis that age effects occur because of financial factors; financial measures, such as the debt-to-asset ratio and initial financial size (assets), augment the conditional firm growth relationship. Firm growth relationships with financial aspects are investigated using a new unique universal database compiled by Statistics-Canada called T2LEAP. Financial and balance sheet information is collected from corporate tax files. This information allows us to establish firm growth patterns for young firms related, not only to size and age, but also to financial variables. If age effects occur mainly because of financial frictions, as suggested by Cooley and Quadrini (2001), then the inclusion of financial variables in the firm growth regression should reduce the economic significant of age.[2]

The correlation between growth and leverage (debt-to-asset ratio) is positive as suggested by Figure 1. This figure shows median firm growth across leverage classes and four age groups. For entrant firms at age one, there is a positive correlation between leverage and growth. Further, figure 2 compares growth across size and leverage classes for age: one, four, seven, and ten firms. For age one, firms in the top leverage decile have higher growth

[1] Ericson and Pakes (1995) also allow for learning to affect firm growth through productivity. Unlike Jovanovic (1982), they endogenize the learning process by making it "active". With active learning, a firm knows its own productivity and can invest to improve its relative position within an industry.

[2] Cabral and Mata (2003) have investigated the effect of financial constraints on within-industry size dynamics.

than firms in the lowest leverage decile. Across the age and leverage deciles, firms in the lowest size classes have the highest growth rates. At age four, little difference occurs for firm growth rates across leverage classes. For ages seven and ten, firms in the smaller size classes (one to four) with low leverage still have the lowest growth, while no clear pattern emerges in the upper leverage classes.

Controlling simultaneously for size, age, and leverage, the findings are as follows:

- A positive and nonlinear relationship occurs between firm growth and leverage.
- Negative conditional relationship occurs between firm growth and firm size.
- Youngest firms are the fastest growers (age effects level off at age seven).
- A firm's future growth exhihits a positive relationship with its initial asset size.

The last result indicates that a firm's ability to obtain financial resources provides some information about its future growth. Zingales (1998) shows deep pockets or fatness have a positive effect on the future success of a firm. Higher initial level of assets may provide a proxy for deeper pockets and these deep pockets allows a firm to easily expand in the future. As an alternative view, high levels of initial assets may indicate a firm has higher growth potential. Firm size is measured by sales. A firm with high expected sales growth should be able to obtain more funds initially. A high amount initial financial assets provides the firm with the necessary financial capital to fund future expansionary investment projects. This alternative explanation suggests that firms have deep pockets for a reason. Investors are willing to provide funds to a firm if there is a belief that the firm is high quality with significant growth potential. Further, a firm with strong sales growth potential may choose to initially have a large amount of physical capital in order to meet future sales demands.

The rest of paper is organized as follows. The next section discusses the T2LEAP database. The third section presents our empirical methodology for estimating the firm size dynamics relationships. Section four discusses the results, while the last section concludes.

2 The T2LEAP Database

The database used in this study, known as T2LEAP, was constructed by Statistics-Canada through the linkage of two administrative databases to provide information on the universe of all incorporated enterprises in Canada employing workers. The first database, the Corporate Tax Statistical Universal File (T2SUF), contains balance sheet information collected off a firm's T2 tax record. The second database, Longitudinal Employment Analysis Program (LEAP), contains yearly employment information for all firms hiring employees. LEAP uses a firm's payroll deduction record, filed with Revenue Canada, to track any firm hiring employees.

T2LEAP uses a business registry number (BSNUM) to track all incorporated firms operating in a given year. Entry and exit is identified when firms enter and leave the database. A firm's unique BSNUM identifier ensures exit and re-entry does not occur. Further, a name change by a firm is not recorded as a simultaneous exit and entry because the BSNUM does not change for this firm. The database accounts for mergers, acquisitions and spin-offs in a retrospective manner, so these activities do not create false entrants or exits, or false growth due to acquisition.[3]

The database contains information on firms from 1984 until 1998. One problem is there is no observable birth year for those firms operating at the first year of the database (1984). A second problem is the potential for partial reporting by firms in their birth year or exit year. Given truncation due to partial reporting and non-measurable birth year, firms must have a birth year between 1985 and 1996, inclusive, to be part the analyzed sample. This

[3]For example, if firm A merged with firm B in year t, then a new firm, C, is created in year t with a past history synthesized by aggregating the histories of firms A and B. The individual histories of firms A and B do not appear in the database, while firm C emerges in the database to represent the joint operations before, and after, year t. However, we are focusing on small, young and private firms so the number of mergers and spinoffs is trivial.

truncation reduces the usable sample period from 1985 to 1997.

Firm variables include annual employment, sales, assets, equity, debt and other balance sheet information. Firm assets are the sum of current financial assets, capital, both tangible and intangible, and long-term financial assets. Firm sales equals firm revenue plus other revenues. Firm equity is the sum of common shares, preferred shares and retained earning/losses. The data appendix contains a detailed breakdown of the financial variables. Sales is measured as the flow of revenues to the firm within a year. Equity, debt and assets are stock variables measured at the fiscal year end. Accounting rules justify that a firms assets must equal its liabilities (debt plus equity). Assets, equity, debt and sales are measured in nominal terms within the database. We use price index data available through CANSIM to deflate values of these variables. Sales are deflated using Industry Price Indexes (CANSIM table number 329-0001) available at the three digit SIC level. Similarly, assets, equity and debt are deflated using the CPI (CANSIM table number 326-0001). Finally, the database contains information on the industry of the firm. Each firm has a three-digit Standard Industrial Classification (SIC) number. This study limits attention to manufacturing firms. Table 1 presents summary statistics for variables used in this paper.

3 Model Specification

In Cooley and Quadrini (2001), the combination of productivity movements and financial considerations reconciles firm growth's simultaneous size and age dependence. Age controls for the equity (financial) differences across firms, while size captures productivity differences. This model suggests financial variables are relevant when studying firm size dynamics. For example, leverage (debt-to-asset ratio) can provide a direct measure for productivity differences. Higher productivity means a firm wants to be larger to take advantage of its good state. Thus, more productive firms have higher debt levels and higher leverage ratios conditional on their size (equity).

For all specifications, we remove industry specific-time means from all variables. This demeaning provides controls for industry specific-time effects equivalent to including dummy variables in the regressions.[4] The canonical specification for the firm growth is augmented by the first lag of the leverage ($da_{i,t-1}$):[5]

$$\Delta \log(Size_{it}) = \alpha_i + \beta \log(Size_{i,t-1}) + \phi_1 \log Age_{it} + \phi_2 [\log Age_{it}]^2 + \gamma da_{i,t-1} + \epsilon_{it}. \quad (1)$$

where $\Delta \log(Size_{it})$ or the growth in the size of the firm is the difference of the logarithm of firm sales and $\log Age$ is the log of firm age since birth. A quadratic function is used to capture the age dependence.[6] Finally, α_i is the unobserved firm fixed-effect.

To account for the notion of deep pockets or large initial financial size, the following equation is estimated:

$$\begin{aligned} \Delta \log(Size_{it}) &= \alpha_i + \beta \log(Size_{i,t-1}) + \phi_1 \log Age_{it} + \phi_2 [\log Age_{it}]^2 \quad (2) \\ &\quad + \gamma da_{i,t-1} + \delta \log(Assets_{i0}) + \lambda Public_{i,t-1} + \epsilon_{it}. \end{aligned}$$

where $\log(Assets_{i0})$ is the initial assets measures financial size and $Public_{i,t-1}$ is an indicator variable of whether a firm is publicly-traded or not. Less than one percent of these entrants go public during this time period. The firms in our sample are young and generally do not use external equity. Access to public equity markets may indicate a firm has better financial

[4] There is a voluminous literature testing for Gibrat's Law. The implication of Gibrat's Law holding is the growth of firms is a random process or logarithm of firm size follows a unit root or in the parlance of time-series a difference stationary process (DSP). However, most studies reject Gibrat's Law in favour of highly persistent autoregressive with serial correlation. (Hall and Mairesse 2005) conduct a comprehensive study and apply a battery of panel unit root tests on real firm data. They overwhelming reject a unit root. Further, they conduct a large scale Monte Carlo simulation study and find it is quite hard to distinguish between a unit root and highly persistent trend-stationary process (TSP). In an earlier paper, (Petrunia 2008) rejects Gibrat's Law in favour of stationarity with the same dataset. We go further and compute some panel unit root test by (Maddala and Wu 1999) for the 1985-1988 cohorts (cohorts with $T \geq 9$). This test is apropos since our data is largely unbalanced. The results are overwhelming in favour of the rejection of a unit root in our data. Given our findings and the previous findings, we treat firm size as a TSP and demean the data with time, industry, and industry-time interacted dummies to remove any inherent trends in the data.

[5] The leverage is treated as a predetermined variable. For robustness, it has been treated as endogenous variable and instrumented with its second and third order lags. The results remain quantitatively the same and are available upon request.

[6] An alternative specification uses age dummies with little difference in the fundamental findings.

resources. A firm may choose to go public at an early age in order to have financial resources to grow in the future. This public/private variable captures any differences in the growth patterns of public and private firms in our sample.

3.1 Estimation Methods

T2LEAP is a longitudinal database, which enables the use of dynamic panel data methods to estimate the firm growth relationships. The advantage of using dynamic panel data methods is that they provide consistent estimates and avoid any biases created by spurious correlations due to unobserved heterogeneity. To account for industry and year effects, the data is demeaned before estimating the firm growth relationships.

3.1.1 System-GMM

We use the *System-GMM* dynamic panel data estimator proposed by Blundell and Bond (1998). This estimator has finite-sample properties superior to alternative dynamic panel estimators such as the *Difference-GMM* estimator espoused by Arellano and Bond (1991). Dynamic panel data methods allow for robust inference of lagged dependent variables in the presence of unobserved heterogeneity (α_i).

3.1.2 Serial Correlation

The Lagrange multiplier (LM) test is an important diagnostic which investigates whether differencing the lagged dependent variable results in second-order serial correlation. The instrument set must be adjusted with second order serial correlation, as the second lag level value of the dependent variable is no longer exogenous in the difference equation and the resulting estimates are inconsistent. If the hypothesis of no second-order serial correlation is rejected, then, similar to Chesher (1979), an additional lag is added in the firm size dynamics relationship to soak up this serial correlation. With the extra lag of firm size, the firm growth relationship (1) becomes:

$$\Delta \log(Size_{it}) = \alpha_i + \sum_{k=1}^{2} \beta_k \log(Size_{i,t-k}) + \phi_1 \log Age_{it} + \phi_2 [\log Age_{it}]^2 + \gamma da_{i,t-1} + \delta \log(Assets_{i0}) + \lambda Public_{i,t-1} + \epsilon_{it}. \tag{3}$$

We find that serial correlation exists when including only the first lag of the dependence variable. LM tests of lag order three are also implemented to ensure that the estimates from this two lag firm size dynamics relationship (4) are consistent. We only report consistent estimates, which allow for the presence of serial correlation.

3.1.3 Financial Nonlinearities

In the corporate finance literature, as exemplified by Fazzari, Hubbard, and Petersen (1988), the method of financing occurs in discrete stages - retained earnings, private debt, public debt, and then equity markets. The nonlinear nature of the leverage may lead to insignificant results. The following procedure is used to account for any nonlinearities in the relationship between a firm's growth and its leverage. First, firms are binned into one of five classes based on their leverage quintile value for a given year. Next, a firm's leverage is interacted with leverage quintile dummy variables. This flexible specification allows for nonlinearities by having differential slopes in each leverage class. The nonlinear specification is:

$$\Delta \log(Size_{it}) = \alpha_i + \sum_{k=1}^{2} \beta_k \log(Size_{i,t-k}) + \phi_1 \log Age_{it} + \phi_2 [\log Age_{it}]^2 + \sum_{k=1}^{5} \gamma_k da_{k,i,t-1} + \delta \log(Assets_{i0}) + \lambda Public_{i,t-1} + \epsilon_{it}, \tag{4}$$

where k indicates a firm's leverage class going from the lowest to the highest quintile.

4 Results

We start by comparing the movements of leverage across age classes before examining the firm growth relationships. Cooley and Quadrini (2001) assume young firms have a limited amount of equity and play off the mechanism that external debt financing involves higher costs. Production allows a firm to accumulate equity through retained earnings. A firm's equity grows as it ages. The accumulation of internal equity reduces a firm's reliance on debt. The portion of debt used for financing falls even through a firm may continue to increase its debt with expansion. Within Cooley and Quadrini (2001)'s framework, leverage ratios should fall with age as a firm's need for debt falls.

Table 2 examines this prediction by presenting median leverage across ages. The table also presents initial versus current median leverage of firms surviving until age t.[7] In the table, leverage gradually drops from a median value of 0.908 at age one to 0.608 at age 12. A substantial portion of the fall in the leverage ratio results from survivors using a lower portion of debt in financing. For surviving firms, the current leverage is always lower than initial leverage on average. Cooley and Quadrini (2001)'s prediction of a negative correlation between age and leverage is consistent with the current data.

Tables 3 and 4 present estimates of firm growth relationships. The empirical investigation focuses on new entrants and controls for firm age, firm size and firm leverage.[8] In Table 3, the value on the coefficient for the lagged dependent variable is approximately -0.1 for all specifications. The estimate implies a one percent increase in the previous period's size leads to a 0.9 percent increase in the current period's size. These elasticities are in line with results found in previous studies such as Evans (1987a, 1987b) and Dunne, Roberts, and Samuelson (1989). The coefficient on the second lag of log size is positive, approximately 0.07, and statistically significant. The interpretation of the positive coefficient on the second order lagged term is that there is negative growth persistence (i.e. transitory shocks). Higher

[7]The sample number of firms drop with age for two reasons. First, firms exit. Second, there is a restriction on the maximum observable age for each cohort, since the database ends in 1997. Only the 1985 entry cohort has observations at age 12, only the 1985 and 1986 entry cohorts have age 11, and so on.

[8]A selection model (i.e. probit) was used to account for firm exit. There are no natural exclusion restrictions, so identification is achieved through parametric and semiparametric specifications (inverse mills ratio and its squared term). The results are quantitatively similar and available on request.

growth today leads to lower growth next period, which suggests mean reversion occurs in the firm growth process.

In all specifications, the impact of age on firm growth is non-monotonic since estimates on the linear and quadratic terms have the opposite sign. The coefficient on the linear term is always negative indicating that firm growth rates should fall with age in the early years of a firm's life, while the positive coefficient on the quadratic term suggests firm growth eventually levels off and increases with age. The switch from a negative to a positive firm growth-age relationship occurs between ages 7 and 8 for all specifications. The length of the T2LEAP panel allows us to capture the nonlinear effects of age. The oldest age of firms in the sample is 12 years; in comparison, the oldest age of firms is six in Evans (1987b).

Next, the discussion turns to the empirical relationship between leverage and firm-growth. The first column (M1) of Table 3 does not include leverage and serves as a benchmark estimate. Subsequent columns of Table 3 include the leverage. The estimate of the leverage coefficient is positive and statistically significant. The positive relationship between growth and the leverage may proxy for a firm's access to financial markets. To account for the role of financial fatness or deep pockets in firm growth, initial assets and/or an indicator of publicly-traded firms are included in the last three specifications of Table 3. Initial assets has a positive effect on firm growth and marginally alters the coefficient on size and leverage variables in the firm growth regression. The estimated coefficient is statistically significant and implies that a one percent increase in initial assets increases current period size (sales) by about 0.02 percent while holding all other variables constant. However, the long run elasticity implies a one percent increase in initial assets causes a 0.64 percent increase in size.[9] In column M5, the estimated coefficient on the indicator of publicly-traded firms is -0.0177 and statistically insignificant. Initial assets appears to encapsulate the financial size of a firm.

[9]Estimates based on specification M5 in Table 3.

Table 4 presents the results when allowing for a nonlinear relationship between firm growth and leverage. The coefficient estimates on the other variables, such as size, age, public dummy, and initial assets, do not materially change. Focusing on the results of column M9, the estimated slope coefficients suggest a nonlinear response, since the slopes are different across the quintiles. All slope coefficients are positive. The slope coefficients for the first and second quintiles are the largest and statistically significant. The slopes for the third and fourth quintiles are insignificant. The fifth quintile is the smallest coefficient in magnitude, but is statistically significant. Finally, the LM(3) test does not reject the null hypothesis of no third-order serial correlation at the five percent significance level for specifications M1 to M9.

Elasticities of current period firm sales with respect to last period's leverage are presented in Table 5. Elasticities are calculated using the specifications M5 and M9 from Table 4. The five rows in Table 5 contain an estimated elasticity for each of the five leverage classes. The elasticities are evaluated at the mean leverage value within each class. Focusing on column M9, the absolute value of the elasticities vary between 0.012 and 0.068 with the exception of the fifth leverage class, which sees very little response between a firm's current size and last period's leverage. Although always positive, the response peaks at the fourth leverage quintile group with current size increasing approximately 0.068 percent for a one percent increase in leverage while holding the other variables constant. These estimates suggest that firm size movements have a positive but nonlinear relationship with leverage.

For concreteness, Table 6 shows the elasticities between current size and age of a firm across the different specifications. For most specifications, the age elasticity is statistically significant except at ages 7 and 8. Although the ranges differ, age elasticity monotonically increases for all specifications. For example, the age elasticity increases from -0.285 at age one to 0.072 at age twelve for specification M9. Figure 3 presents the two standard deviations confidence interval bands for age elasticities for each specification. As a comparison, each panel contains the confidence interval band from the specification M1 which contains only firm age and size as controls. The confidence interval bands for specifications containing additional financial variables lie close to the confidence interval band for specification M1. Table 6 and figure 3 suggest that including financial variables has little impact on the firm growth-firm age profile.

5 Implications for Models of Firms Dynamics

Since the work by Evans (1987a, 1987b) and Dunne, Roberts, and Samuelson (1989), empirical literature studying firm size dynamics has documented negative age effects on firm growth while simultaneous observing negative size effects. Learning, productivity movements, selection and financial frictions have all been used in theoretical models to explain the empirical findings. However, most of the theoretical models offer to explain only one of the effects at a time. In Jovanovic (1982), learning and selection effects lead to age being the relevant factor determining a firm's dynamic path. Size effects are possible but potentially rendered neutral with age controls. Further, age negatively affects the variance of growth, but is indeterminant for the mean of growth. Hopenhayn (1992) suggests productivity movements drive a firm's size evolution, which implies age effects on growth disappear when controlling for a firm's size.

As a first attempt explain the joint size and age effects in firm growth, Cooley and Quadrini (2001) combine two sources of heterogeneity across firms: productivity differences, a la Hopenhayn (1992), with financing differences. If Cooley and Quadrini (2001)'s model provides a complete description of firm size dynamics then we should observe the following:

1. A negative relationship between age and leverage ratio with firms accumulating more equity than debt as they age;

2. Significant and jointly negative age and size effects on firm growth when only age and

size are included as control variables;

3. The inclusion of a firm's leverage ratio in regressions should result in negative size effects on firm growth, while firm leverage should have a positive coefficient. Size captures the accumulation of equity; larger firms, controlling for productivity, should have more equity with less need to expand. Leverage captures productivity differences as higher leveraged firms, controlling for equity, should be more productive with more desire to expand;

4. If other age effects can be excluded, the firm age-growth profile should be almost flat or at least greatly reduced with the inclusion of leverage in the regressions.

Empirically, predictions 1 and 2 hold, while prediction 3 appears to hold with a caveat. The relationship between growth and leverage is positive and nonlinear, but not necessarily economic or statistically significant across leverage quintiles. Finally, prediction 4 fails to hold in our data as very little change ensues to the age-growth profile when adding leverage to the regressions. The empirical findings show that financial variables provide information regarding size dynamics in addition to a firm's size and age.

The empirical implications of our results are clear; current models of firm dynamics provide only partial explanations of observed relationships for firm size dynamics. The significance of the financial variables clearly show that financial frictions matter as in Cooley and Quadrini (2001). However, age effects still remain after controlling for a firm's debt-to-asset ratio, so that financial frictions alone cannot explain age effects. Thus, it seems that other sources of age effects are likely also to matter empirically. Klepper and Thompson (2006) and Jovanovic (1982) provide two alternatives for age effect, but there are likely to be other reasons as well for age effects to matter empirically.

6 Conclusions

This paper empirically investigates the role of financial variables in firm growth. The study finds the following empirical results. First, the relationship between firm growth and firm leverage is positive, robust to alternative specifications and also nonlinear. The sensitivity of growth to leverage is highest for firms in the lowest to intermediate leverage quintiles. Second, a non-monotonic U-shaped relationship exists between firm growth and firm age. Young firm grow faster but the firm age-growth relationship reaches a minimum at approximately age seven. Further, the inclusion of leverage has little impact on the firm growth-firm age relationship.

Third, current firm growth increases with a firm's initial asset level. These results suggest that deep pockets matter for firm growth. Entrants who start off their life with higher levels of assets have been able to raise substantial amounts of capital indicating significant access to financial resources. These financially fat entrants may face less constraints, and thus, are able to grow faster in the future. An alternative plausible explanation is that new firms with growth opportunities obtain a high level of financial capital as a method to fund future investment projects. Access to financial resources is a function of firm quality; thus, firms with a high level of initial assets likely obtain substantial financing since they are good quality and have good potential investment opportunities. As is the case with leverage, accounting for a firm's financial resources does not greatly change the age-growth relationship.

Fourth, firm growth is found to have a negative relationship with firm size. The finding matches the empirical result of previous studies such as Evans (1987a, 1987b), Hall (1987) and Dunne, Roberts, and Samuelson (1989). Finally, firm growth displays negative growth persistence.

These findings point to the need to account for firm growth's simultaneous dependence on size, age, and financial conditions. Theoretical models of industry dynamics are starting to incorporate financial considerations into determinants of firm size dynamics. Cooley and Quadrini (2001) provide a model where financial and productivity heterogeneity across firms generate a simultaneous size and age dependence for firm growth. However, these results suggest that conditional age effects generated from combining persistent productivity shocks with financial frictions, as done in Cooley and Quadrini (2001), does not provide a complete picture of firm size dynamics. Alternative explanations for the presence age effects include the passive-learning model by Jovanovic (1982) and the model of industry submarkets of Klepper and Thompson (2006).

It is now an open question to determine which of these mechanisms plays the biggest role in firm dynamics. Financial variables are required to separate firm dynamics attributable to financial factors versus other age related aspects. None of the theories should be discounted if their implications do not completely match the empirical findings. Rather we provide empirical evidence to motivate richer models of firm dynamics.

References

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

Blundell, R., and S. Bond (1998): "Initial conditions and moment restrictions in dynamic panel data models," Journal of Econometrics, 87(1), 115–143.

Cabral, L. M., and J. Mata (2003): "On the evolution of the firm size distribution: Facts and theory," American Economic Review, 93(4), 1075–1090.

Chesher, A. (1979): "Testing the Law of Proportionate Effect," Journal of Industrial Economics, 27, 403–411.

Cooley, T. F., and V. Quadrini (2001): "Financial Markets and Firm Dynamics," American Economic Review, 91(5), 1286–1310.

Dunne, T., M. Roberts, and L. Samuelson (1989): "The Growth and Failure of U.S. Manufacturing Plants," Quarterly Journal of Economics, 104, 671–698.

Ericson, R., and A. Pakes (1995): "Markov Perfect Industry Dynamics: A framework for empirical work," Review of Economic Studies, 62(1), 53–82.

Evans, D. S. (1987a): "The relationship between firm growth, size, and age - estimates for 100 manufacturing-industries," Journal Of Industrial Economics, 35(4), 567–581.

——— (1987b): "Tests of Alternative Theories of Firm Growth," Journal of Political Economy, 95, 657–674.

Fazzari, S., R. G. Hubbard, and B. Petersen (1988): "Finance Constraints and Corporate Investment," Brookings Papers on Economic Activity, 1, 141–195.

Hall, B. (1987): "The Relationship between Firm Size and Firm Growth in the US Manufacturing Sector," Journal Of Industrial Economics, 35, 583–606.

Hall, B., and J. Mairesse (2005): "Testing for Unit Roots in Panel Data: An Exploration Using Real and Simulated Data," in Identification and Inference for Econometric Models, ed. by D. W. Andrews, and J. H. Stock, chap. 19, pp. 3229–3296. Cambridge.

Hopenhayn, H. (1992): "Entry, Exit, and Firm Dynamics in a Long Run Equilibrium," Econometrica, 60(5), 1127–1150.

Jovanovic, B. (1982): "Selection and the Evolution of Industry," Econometrica, 50, 649–670.

Klepper, S., and P. Thompson (2006): "Submarkets and the Evolution of Market Structure," RAND Journal of Economics, 37(4), 862–888.

Maddala, G., and S. Wu (1999): "A Comparative Study of Unit Root Tests With Panel Data and A New Simple Test," Oxford Bulletin of Economics and Statistics, 61, 631–652.

Petrunia, R. (2008): "Does Gibrat's Law Hold? Evidence from Canadian Retail and Manufacturing Firms," Small Business Economics, 30(2), 201–214.

Windmeijer, F. (2005): "A finite sample correction for the variance of linear efficient two-step GMM estimators," Journal of Econometrics, 126(1), 25–51.

Zingales, Z. (1998): "Survival of the Fittest or the Fattest? Exit and Financing in the Trucking Industry," Journal of Finance, 53(3), 905–938.

A Data Appendix

The data appendix provides details on the assets, equity, debt and sales variables, and deflation of these variables. The following information lists the components of assets, equity and sales variables. The information is taken from the General Index of Financial Information (GIFI) on the T2 corporate tax return.

1. Assets =
   - Current (Cash and deposits + Accounts receivable + Allowance for doubtful accounts + Inventories + Short term investments + Loans and notes receivable + Other currents assets)
   - Capital (Land +Depletable assets +Accumulated amortization of depletable assets +Buildings +Accumulated amortization of buildings +Machinery and Equipment +Accumulated amortization of machinery and equipment +Furniture and Fixtures +Accumulated amortization of furniture and fixtures +Other tangible assets +Accumulated amortization of other tangible assets)
   - Intangible capital assets (Intangible assets (*i.e.* goodwill, quota, licenses, incorporation costs, trademarks/patents, customer lists, rights, and research and development). + Accumulated amortization of intangible assets + Resource rights + Accumulated amortization of resource rights)
   - Long term (Due from shareholder(s) and/or director(s) + Investment in joint venture(s) and/or partnership(s) + investment in related parties + Long term investments + Long term loans + Other long term assets)
2. Equity = Common shares + Preferred shared + Retained earnings/deficit
3. Debt = Assets - Equity
4. Sales =
   - Revenue (Trade sales of goods and services + Sales from resource properties
   - Other revenue (Investment revenue + Divided income + Commission income + Rental income + Fishing revenue + Realized gains/losses on disposal of assets + Income/loss on subsidiaries/affiliates + Income/loss on joint ventures + Income/loss on partnerships + Alberta royalty tax credits

Table 1: Descriptive Statistics

Variable	Average	Median	Std Dev.	25th Quartile	75th Quartile
Sales	2585.045	496.7565167	23939.49	210.3136525	1311.596006
Growth Rate Sales	0.0676	0.0568	0.487	-0.093	0.2242
Age	4.9552	4.000022556	2.6085	2.999963134	6.999928957
Leverage ratio	0.8665	0.7664	2.9801	0.5262	0.9907
Growth Leverage	0.0614	-0.0168	3.6304	-0.1143	0.0805
Public	0.0089	0	0.094	0	0
Initial Assets	1625.7	175.7038663	22789.56	78.84626943	436.8107347

Note: Summary statistics are calculated using observations from the estimation sample with the exception of the logarithm of initial assets. The summary statistics for the logarithm of initial assets are calculated using the firm sample from the estimations to avoid double counting on firms that appear multiple times.

Table 2: Age versus Leverage

		Survivors		Exitors	
Age	Leverage_t	Number	Leverage_1	Number	Leverage_1
1	0.908	28742	0.908	0	.
2	0.857	23569	0.892	5173	0.990
3	0.813	19253	0.878	9489	0.974
4	0.782	15966	0.868	12776	0.962
5	0.759	13365	0.858	15377	0.952
6	0.735	11215	0.849	17527	0.947
7	0.714	9208	0.836	19534	0.942
8	0.693	7421	0.822	21321	0.939
9	0.675	5732	0.804	23010	0.933
10	0.650	4123	0.789	24619	0.928
11	0.630	2708	0.779	26034	0.922
12	0.608	1281	0.787	27461	0.914

Note: The columns contain the median leverage and number of firms within each category. Column two presents median leverage of survivors at age t, while column four presents median leverage at age one for those firms surviving until age t.

Table 3: Firm Growth Relationship

$$\Delta \log(Size_{it}) = \alpha_i + \beta_1 \log(Size_{i,t-1}) + \beta_2 \log(Size_{i,t-2}) + \phi_1 \log Age_{it} + \phi_2 [\log Age_{it}]^2 + \gamma da_{i,t-1} + \delta \log(assets_{i0}) + \lambda public_{i,t-1} + \epsilon_{it}.$$

	M1	M2	M3	M4	M5
$\text{Size}_{i,t-1}$	-.1046	-.1044	-.0986	-.1029	-.0969
	(.0100)***	(.0100)***	(.0096)***	(.0101)***	(.0097)***
$\text{Size}_{i,t-2}$	.0688	.0688	.0693	.0682	.0687
	(.0100)***	(.0097)***	(.0096)***	(.0098)***	(.0097)***
$\text{Leverage}_{i,t-1}$	.	.0016	.0017	.0016	.0017
		(.0003)***	(.0005)***	(.0003)***	(.0005)***
Age	-.3112	-.3115	-.3087	-.3071	-.3047
	(.0347)***	(.0347)***	(.0350)***	(.03471)***	(.03499)***
Age^2	.0773	.0775	.0750	.0763	.0739
	(.0100)***	(.0100)***	(.0100)***	(.0100)***	(.0100)***
$\text{Assets}_{i,0}$	.	.	.0190	.	.0180
			(.0064)***		(.0063)***
$\text{Public}_{i,t-1}$	.	.	.	.0175	-.0177
				(.0298)	(.0267)
Constant	.3181	.3183	.3219	.3137	.3180
	(.0290)***	(.0290)***	(.0287)***	(.0291)***	(.0290)***
Observations	89283	89283	88856	88740	88319
Number of Firms	19233	19233	19125	19149	19042
Hansen-Sargan χ^2	0	0	0	0	0
LaGrange Multiplier(1) χ^2	0	0	0	0	0
LaGrange Multiplier(2) χ^2	.1350	.1365	.1078	.1634	.1304
LaGrange Multiplier(3) χ^2	.1070	.1061	.1010	.1000	.0958

Note: All results are estimated using the System-GMM estimator due to Blundell and Bond (1998). The measure of firm size in the paper is sales. All variable have been demeaned of two-digit SIC and year variation. Standard errors, in parentheses, are estimated using a two-step robust correction due to Windmeijer (2005). *, **, *** indicate significance at the 10%, 5% and 1% level, respectively. The Hansen-Sargan and LaGrange Multipliers χ^2 test statistics are reported as p-values.

Table 4: Firm Growth Relationship: Leverage Nonlinearities

$$\Delta \log(Size_{it}) = \alpha_i + \beta_1 \log(Size_{i,t-1}) + \beta_2 \log(Size_{i,t-2}) + \phi_1 \log Age_{it} + \phi_2 [\log Age_{it}]^2 + \sum_{k=1}^{5} \gamma_k da_{k,i,t-1} + \delta \log(assets_{i0}) + \lambda public_{i,t-1} + \epsilon_{it}.$$

	M6	M7	M8	M9
$\text{Size}_{i,t-1}$	-.1249	-.135	-.1283	-.1219
	(.0107)***	(.0106)***	(.0111)***	(.0107)***
$\text{Size}_{i,t-2}$	.0794	.0713	.0696	.0712
	(.0113)***	(.0110)***	(.0111)***	(.0110)***
$\text{Leverage}_{i,t-1}$	.0670	.0886	.0784	.0878
Quintile 1	(.0082)***	(.0089)***	(.0090)***	(.0089)***
$\text{Leverage}_{i,t-1}$	.0287	.0756	.0446	.0758
Quintile 2	(.0209)	(.0182)***	(.0209)**	(.0183)***
$\text{Leverage}_{i,t-1}$	-.0437	.0133	-.0535	.0144
Quintile 3	(.0506)	(.0447)	(.0508)	(.0449)
$\text{Leverage}_{i,t-1}$	.0337	.0643	.0754	.0699
Quintile 4	(.0513)	(.0532)	(.0539)	(.0535)
$\text{Leverage}_{i,t-1}$	.0015	.0013	.0013	.0013
Quintile 5	(.0003)***	(.0002)***	(.0002)***	(.0002)***
Age	-.3039	-.2927	-.2944	-.2850
	(.0357)***	(.0364)***	(.0357)***	(.0363)***
Age^2	.0776	.0741	.0768	.0719
	(.0102)***	(.0103)***	(.0102)***	(.0103)***
$\text{Assets}_{i,0}$	.	.0364	.	.0352
		(.0082)***		(.0082)***
$\text{Public}_{i,t-1}$	.	.	.0575	-.0138
			(.0322)*	(.0282)
Constant	.3171	.3200	.3054	.3129
	(.0305)***	(.0304)***	(.0306)***	(.0303)***
Observations	89283	88856	88740	88319
Number of Firms	19233	19125	19149	19042
Hansen-Sargan χ^2	0	0	0	0
LaGrange Multiplier(1) χ^2	0	0	0	0
LaGrange Multiplier(2) χ^2	.0204	.0496	.0858	.0598
LaGrange Multiplier(3) χ^2	.0875	.0916	.0891	.0863

Note: All results are estimated using the System-GMM estimator due to Blundell and Bond (1998). The measure of firm size in the paper is sales. All variable have been demeaned of two-digit SIC and year variation. Standard errors, in parentheses, are estimated using a two-step robust correction due to Windmeijer (2005). *, **, *** indicate significance at the 10%, 5% and 1% level, respectively. The Hansen-Sargan and LaGrange Multipliers χ^2 test statistics are reported as p-values.

Table 5: Firm Size/Leverage Elasticities

Leverage	M6	M9
Quintile 1	0.0208	0.0272
Quintile 2	0.0175	0.0462
Quintile 3	-0.0350	0.0115
Quintile 4	0.0327	0.0678
Quintile 5	0.0027	0.0024

Note: The table provides the elasticity of end of period size with respect to beginning of period debt-to-asset ratio. Mean debt-to-asset ratio values within each quintile group are used to calculate elasticity values. The columns represent two estimated specifications. Column one includes only the first two lags of firm sales and firm age controls as additional regressor (column one of table 4), while column two contains two lags of firm sales, firm age controls, initial firm assets and public/private dummy variable as additional regressors (column four of table 4).

Table 6: Age Effects on Firm Size

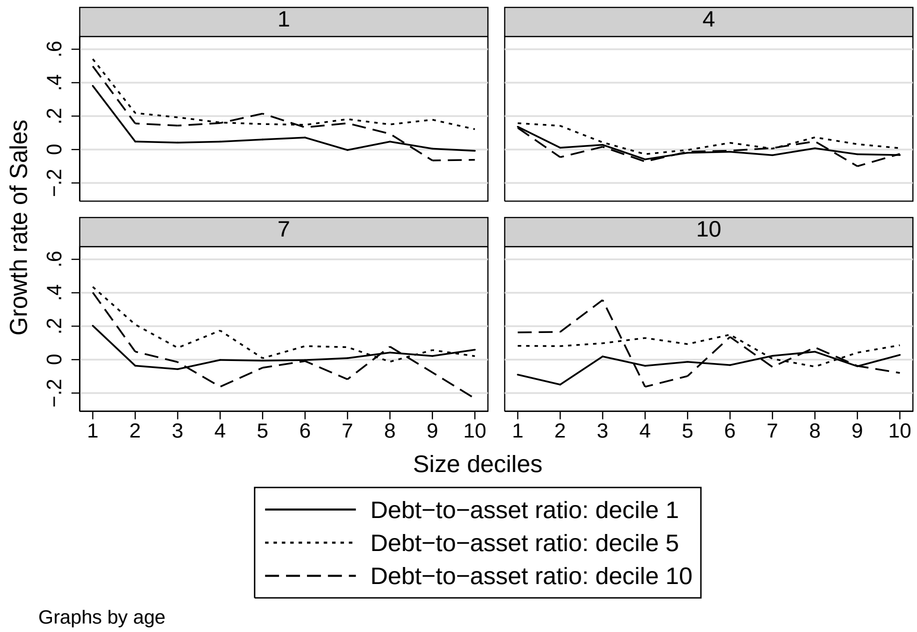
Age	M1	M2	M5	M9
1	-0.311***	-0.312***	-0.305***	-0.285***
2	-0.204***	-0.204***	-0.202***	-0.185***
3	-0.141***	-0.141***	-0.142***	-0.127***
4	-0.096***	-0.097***	-0.100***	-0.086***
5	-0.062***	-0.062***	-0.067***	-0.054***
6	-0.034***	-0.034***	-0.040***	-0.027***
7	-0.010	-0.010	-0.017***	-0.005
8	0.011	0.011	0.003	0.014
9	0.029***	0.029***	0.020*	0.031***
10	0.045***	0.045***	0.036***	0.046***
11	0.060***	0.060***	0.050***	0.060***
12	0.073***	0.074***	0.063***	0.072***

Note: The table provides the elasticity of end of period size with respect to beginning of period age. The figure provides the 95% confidence interval bands of the elasticity of end of period size with respect to beginning of period age. Specification M1 and M2 calculate elasticities using coefficient estimates from Table 3, respectively. Specification M6 and M9 calculates elasticities using coefficient estimates from Table 4. *, **, *** indicate significance at the 10%, 5% and 1% level, respectively. For a graphical representation, see figure 3.

Figure 1: Growth and Leverage

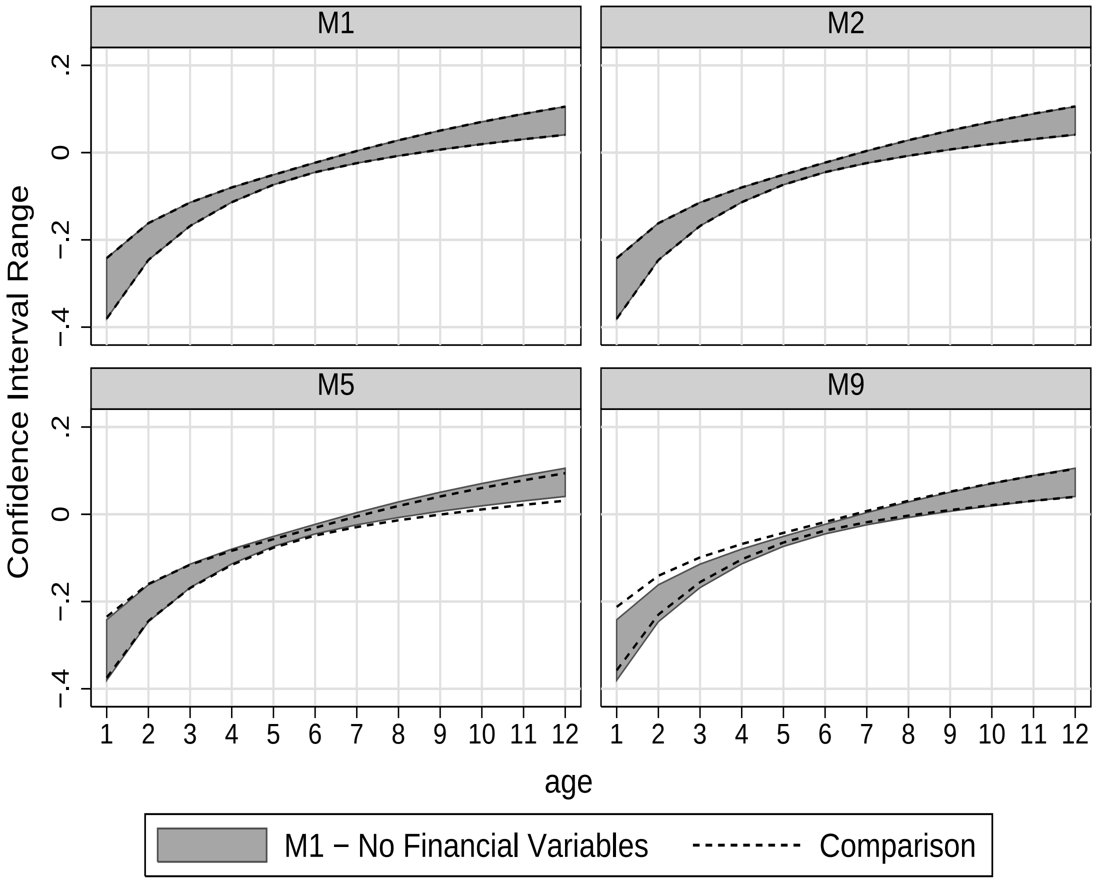
Note: The figure shows the median firm growth rate across the three age groups and ten leverage (debt-to-asset ratio) classes. Age one leverage decile points are used as cutoff values. Firms are then placed into leverage classes at a particular age given these cutoff values. Firm growth is calculated as $\Delta\log(size_{i,t})$, where sales is used to measure size.

Figure 2: Growth, Age, Size and Leverage



Note: The figure shows the median firm growth rate across age, size, and leverage (debt-to-asset ratio). There are four different ages (one, four, seven, and ten), ten size deciles, and three leverage deciles. Firms growth is calculated as $\Delta\log(size_{i,t})$, where sales is used to measure size.

Figure 3: Age Effects



Note: The figure provides the 95% confidence interval bands of the elasticity of end of period size with respect to beginning of period age. Specification M1 and M2 calculate elasticities using coefficient estimates from Table 3, respectively. Specification M6 and M9 calculates elasticities using coefficient estimates from Table 4.

$$
\begin{aligned}
\text{M1}: \Delta \log(size_{it}) &= \alpha_i + \sum_{k=1}^{2} \beta_k \log(size_{i,t-k}) + \phi_1 \log Age_{it} + \phi_2 [\log Age_{it}]^2 + \epsilon_{it}. \\
\text{M2}: \Delta \log(size_{it}) &= \alpha_i + \sum_{k=1}^{2} \beta_k \log(size_{i,t-k}) + \phi_1 \log Age_{it} + \phi_2 [\log Age_{it}]^2 + \gamma da_{i,t-1} + \epsilon_{it}. \\
\text{M5}: \Delta \log(size_{it}) &= \alpha_i + \sum_{k=1}^{2} \beta_k \log(size_{i,t-k}) + \phi_1 \log Age_{it} + \phi_2 [\log Age_{it}]^2 \\
&\quad + \gamma da_{i,t-1} + \delta \log(assets_{i0}) + \lambda public_{i,t-1} + \epsilon_{it}. \\
\text{M9}: \Delta \log(size_{it}) &= \alpha_i + \sum_{k=1}^{2} \beta_k \log(size_{i,t-k}) + \phi_1 \log Age_{it} + \phi_2 [\log Age_{it}]^2 \\
&\quad + \sum_{k=1}^{5} \gamma_k da_{k,i,t-1} + \delta \log(assets_{i0}) + \lambda public_{i,t-1} + \epsilon_{it},
\end{aligned}
$$