INTRODUCTION

Gibrat's law, which predicts that the organic (or internal) growth rates of firms are independent of their size, is one of the most important axioms in the industrial economics literature and one that has been subject to several prior empirical tests for a good summary of prior contemporary empirical tests of Gibrat's Law.[1] In an historical analysis of innovation in the United States (US) automobile industry between 1900 and 1930, and the personal computer industry of the last 25 years of the twentieth century Mazzacuto finds that Gibrat's Law is a good approximation of the independence of firm size-growth patterns particularly in the early phase of product-market and technological development.[2] Therefore, overall conclusion arising from most of the prior research is that self-generated corporate growth rates tend to vary randomly across firms and over time, as predicted by Gibrat's Law of Proportionate Effects.[3] In other words, growth is independent of firm size in single and multi-period states. However, as Audretsch, Klomp, Santorelli and Thurik report, only few tests of Gibrat's Law have been carried out in the financial services sector.[4] Indeed, only two prior tests of Gibrat's Law have been conducted on insurance markets using contemporaneous data sets: Hardwick and Adams on the United Kingdom (UK) life insurance market and Choi on the US property-liability insurance market.[5]

A'Hearn examined the historical relation between profitability and organic rates of growth amongst Italian banks between 1890 and 1910. A'Hearn found inconsistency with the predictions of Gibrat's Law in that banks in Southern Italy achieved slower rates of growth than their counterparts in the North of the country which he attributed to regional variations in information asymmetries and principal-agent problems.[6] However, to the best of our knowledge, no prior tests of Gibrat's Law in the early growth and development of insurance markets have been conducted in the economic history literature. This is surprising as insurance markets in Europe and North America have long been associated with dynamic rates of firm growth, increasing levels of market competition (e.g., from new entrants), and new product-market developments since the early days of the eighteenth and nineteenth centuries. Indeed, insurers in the early industrialized economies were amongst the first companies to expand their markets nationally and internationally.[7] In theory mutual forms of organization emerged in insurance markets to mitigate information asymmetries and principal-agent incentive conflicts and that this economic advantage allowed them to operate successfully and survive alongside stock forms of organization.[8] Indeed, since the late eighteenth/early nineteenth centuries Sweden's insurance market has been characterized by large numbers of small locally-based insurance mutual operating alongside larger national stock forms of organization.[9] Accordingly, an historical analysis of Gibrat's law in Sweden's life insurance market could usefully inform economic historians as to whether or not different organizational forms were able to more effectively manage market imperfections (e.g., information asymmetries and agency costs) to realize better rates of growth over time.

Moreover, utilizing historical time-series and cross-sectional data should help provide clearer insights into the linkage between past performance and firm growth in global insurance markets, which is currently one of the largest but least understood industrial sectors in the world[10]. Indeed, Dunne, Roberts and Samuelson report that one of the greatest impediments to examining the relation between firm size and growth has been the lack of access to longitudinal data sets. The present study thus seeks to address this gap in the literature. Furthermore, the general question of whether small insurers grow as fast as (or faster than) large insurers is an issue of some importance to economic historians. For example, insights into the relation between self-generated corporate growth and firm size could help scholars to better understand the general structure and evolution of financial markets and institutions over time – for example, in terms of regulatory developments (e.g., the licensing of new entrants), the motives for national and global expansion, and the associated growth of insurance industry-specific ancillary and professional services (e.g., brokers and actuaries).

We thus seek to address the dearth of economic historical research on the development of insurance markets using 1855-1947 data from the Swedish life insurance market to test Gibrat's Law and, more generally, to investigate the determinants of the growth of insurance firms.[11] To conduct the study, we apply recently-developed panel unit root tests and panel Generalized Method of Moments (GMM) regression analysis rather than relying on more traditional tests based on cross-sectional data.

The institutional setting for our research – Sweden – is advantageous as in the period covered by our analysis (1855-1947) most Swedish insurance firms grew organically rather than from mergers and acquisitions. After World War II, merger and acquisition activity in the Swedish insurance market became more common as a result of technological progress and regulatory encouragement.[12] This means that our analysis largely avoids the potentially confounding effects of non-organic growth: this should enable us to conduct potentially cleaner tests of our research hypotheses. Furthermore, we focus on life insurance as this was one of the largest lines in the insurance industry during our period of analysis.[13] What is more, the years 1855 to 1947 were ones where a 'deep and efficient' in Sweden either did not exist (as pre-1903 Insurance Act) and/or it was a period when the investment decisions of insurance managers were constrained by precautionary investment rules.[14] This means that during the period of our data analysis the organic growth rates of Swedish insurance firms was largely a function of their underwriting activities and not unduly distorted by the effects of major cyclical movements in stock market prices on the value of their investment portfolios.

THE EMERGENCE OF SWEDEN'S LIFE INSURANCE MARKET

Between 1830 and 1870 Sweden underwent considerable industrial and commercial development and increased capital investment and growth in real incomes. This national economic development witnessed the establishment and growth of the financial sector including insurance as well as banking services.[15] Economic and development specifically increased the demand for life insurance amongst all social classes in Sweden during the late nineteenth/early twentieth centuries.[16] The first insurance companies to enter the Swedish market were domestic and foreign joint-stock companies. The first company (*Skandia*, 1855) was organized as a joint-stock composite (property and life insurance) company. A composite structure was also adopted by two other prominent life offices in the second half of the nineteenth century (*Svea*, 1866 and *Skåne*, 1884). However, most new entrants to the Swedish life insurance market at this time were specialist life insurance carriers.[17] At the turn of the twentieth century, about 40 domestic and foreign life insurance companies operated in Sweden though the market share of foreign life insurers declined from 10% of gross premiums at the late nineteenth century to less than 1% of gross premiums after 1920. However, over this period small mutual life offices increased their share of the market, particularly in terms of industrial life insurance policies for working class households, from 8% of gross premiums in 1890 to roughly 40% of gross premiums in the run-up to World War I and rising steadily during the interwar and post-World War II years to roughly 70% of gross premiums by 1950. However, a degree of consolidation took place in the domestic life insurance market during the interwar years such that by the end of World War II only about 30 life offices operated in the Swedish life insurance market.[18]

Sweden's insurance market was largely unregulated during in the nineteenth century. However, from around 1870 the market was characterized by close cooperation amongst the larger, mainly joint-stock, companies on matters such as premium rating, financial publicity and principles for reserving.[19] The Insurance Act (1903) formalized solvency standards, introduced new actuarial and financial disclosure rules, and instigated a system of statutory solvency monitoring through an industrial regulatory agency - the National Private Insurance Inspectorate. This new institutional framework remained almost unchanged up to the passing of the Insurance Act (1948) after World War II.[20] This meant that from 1903 to 1947 Sweden's life insurance market was governed by a fairly homogeneous and consistent institutional framework.

GIBRAT'S LAW

Gibrat's Law holds that skewness in populations (such as those relating to size frequencies) reflects an underpinning Gaussian process - according to which a large number of small but independent additive influences generate a normal distribution. Thus, an observed skewed distribution of variate *x* could be modelled by positing that an underlying function of *x* (say, the natural logarithm of *x*) is normally distributed.[21] Applying this stochastic model to cross-sectional/time-series firm-based data from the French manufacturing sector, Gibrat demonstrated empirically that proportionate organic (asset-based) growth was independent of firm size.[22] A basic tenet of Gibrat's Law is that firms face the same probability distribution of self-generated growth rates, with each firm's observed growth pattern determined by a random sampling from that distribution.[23] In its basic form, the stochastic process can be expressed as:

$$(SIZE)_{it} \Big/ (SIZE)_{i,t-1} = \alpha (SIZE)_{i,t-1}^{\beta_1 - 1} \varepsilon_{it} \qquad [1]$$

where $(SIZE)_{it}$ is the size of firm *i* at time *t* and $(SIZE)_{i,t-1}$ is the size of firm *i* in some previous time period; ε_{it} is a disturbance term that is assumed to have a mean equal to one and a constant variance. The value of α may be interpreted as the constant market rate of growth, while the value of β_1 represents the effect of initial size on the subsequent rate of firms' growth. If $\beta_1 = 1$, firm growth is independent of initial size and Gibrat's Law holds (assuming that the disturbances, ε_{it}, are independently distributed over time.[24] If $\beta_1 > 1$, large firms tend to grow faster than smaller firms, and if $\beta_1 < 1$, small firms tend to grow faster than larger firms. The functional form in [1] thus takes into account the dynamic relation between current period changes in firm size and recent past changes in firm size. Taking natural logarithms, the basic stochastic process may be re-written as:

$$\ln SIZE_{it} = \beta_0 + \beta_1 \ln SIZE_{i,t-1} + \mu_{it} \qquad [2]$$

where $\beta_0 = \ln \alpha$ and $\mu_{it} = \ln \varepsilon_{it}$.

Prior empirical studies have also tested the sensitivity of the Gibrat process to various firm-specific influences, such as the cost of capital and labor, and other variables, such as profitability, in order to improve understanding of the determinants of firm growth.[25] The reasoning is that such factors directly influence the output choices of managers in firms and thus may be important determinants of corporate growth rates and the structural evolution of markets. In this study, therefore, we also consider the relative influence of a number of firm-specific factors in the growth of Swedish life insurance firms. These factors are input costs, profitability, age, organizational form and reinsurance. The motivation for including firm-specific variables in the present study, as well as a set of macroeconomic and regulatory control variables, is explained below.

Input costs

Insurance firms can have higher-than-average input costs per unit of output (i.e., be relatively cost inefficient) for a number of reasons. For example, the concept of cost inefficiency can refer either to unexploited economies of scale or diseconomies of scale in an industry, or to the existence of technical or allocative inefficiency. An insurance firm with unexploited economies of scale could reduce average cost by increasing the scale of its operations, but doing so may be difficult as scale inefficiency puts the firm at a competitive disadvantage that may hinder growth. Similarly, an insurer facing diseconomies of scale could reduce average costs by contracting the scale of its operations.[26] Thus, while the existence of economies of scale provides a clear incentive for the organic and acquisition-based growth of firms, such growth may be difficult to achieve – for example, due to agency incentive conflicts in insurance firms (e.g., managerial inertia and the misuse of corporate resources on perquisite consumption).[27] Moreover, diseconomies of scale could provide an incentive for contraction or at least represent a barrier to any further growth.[28]

Previous research from contemporary insurance markets such as the US and UK suggests that many insurers with unexploited economies of scale have operated for many years without going out of business or being the subject of corporate takeover.[29] One possible explanation, alluded to by Fields, is that insurance markets have not been sufficiently competitive and that absent price transparency plus a lack of knowledge about policy conditions and premiums on the part of consumers (i.e., asymmetric information) have allowed such scale-inefficient firms (and their management structures) to survive.[30] In the economic and business history literature, Westall also emphasizes the importance of information asymmetry and intrinsic transaction and agency costs in explaining the continuity of inefficient organizational structures in the UK non-life insurance market in the nineteenth century.[31] Technical and allocative cost inefficiencies refer to the deviation of a firm's actual cost of production from the minimum cost achievable by that size of firm due to inefficient resource allocation.[32] Thus, insurance firms that are cost inefficient could either produce more output with the same quantity and combination of inputs or could produce the same output with lower input quantities and therefore a lower cost of production.[33]

The most likely relation between input costs and firm growth is difficult to determine. If higher costs are caused mainly by the existence if economies of scale in the insurance industry, we would expect higher-cost insurers to grow faster as they seek to take advantage of the available economies of scale. However, if higher costs are caused mainly by diseconomies of scale or technical and allocative inefficiencies, then we would expect insurance firms with higher input costs per unit of output to perform less well than more cost-efficient firms and so grow more slowly.[34] In our empirical study, we measure 'input costs per unit of output' for a life insurance company as total operating expenses divided by gross premium income.

Profitability

Geroski contend that, although firm growth and size may approximately follow a random distribution over time, profitability could nonetheless be an important determinant of corporate growth and development.[35] Sustained profitability over time could enable insurance firms to accumulate reserves and realize positive net present value investment opportunities while concomitantly avoiding the high costs of raising external finance.[36] On the other hand, there could be an inverse relation between profitability and firm size/growth as year-on-year profits could accentuate agency problems in insurance firms by motivating managers to misuse free cash flows, for example, on excessive perquisite consumption rather than investing in profitable growth opportunities.[37] In fact, the empirical evidence of the linkage between profitability and the size and growth rates of firms is ambiguous. With regard to the contemporary US life insurance industry, Santomero and Babbel observe that managers may not accurately predict the timing and impact of severe economic shocks (e.g., adverse interest rate movements) and that this could adversely affect both the level of corporate profitability and the pace of product-market development.[38] This observation suggests that, consistent with Gibrat's Law, if future economic shocks are largely unpredictable, corporate growth rates in the insurance industry are also likely to be unpredictable. Indeed, such a priori reasoning is supported by the recent empirical evidence from contemporary insurance markets in the UK and US.[39] In our empirical study, we measure a life insurer's profitability as total annual net profit divided by gross premium income.

Company Age

Jovanovic predicts that successful firms become more efficient over time while less efficient firms exit the market at an early stage.[40] This means that older firms are more likely to survive in markets compared with younger firms but that surviving younger firms will tend to grow at a faster rate than more established operatives. Therefore, Jovanovic's analysis suggests an inverse relation between the age of a firm and its size/growth. Indeed, empirical evidence from the contemporary US property-liability insurance market cited in Choi supports this prediction, and so we also expect a negative relation between firm age and firm size/growth.[41] In the present study, the age of the life insurance firm is taken from the year that it was licensed to transact insurance business in Sweden.

Organizational Form

Corporate growth rates in insurance markets could also be influenced by whether an insurer is a policyholder-owned mutual form of organization or a stock company owned by shareholders.[42] Our reasoning here is simply that organic growth rates are likely to be influenced by the availability of capital and thus more likely to favor the stock form of organization which has access to the capital markets. In contrast, mutual insurers are unlikely to have such easy access to funds to aid organic growth.[43] We therefore expect mutual insurers to exhibit higher rates of growth than mutual insurers. On the other hand, mutual life insurers held relatively smaller reserves, and thus incurred lower capital costs than their stock life insurance company counterparts. As noted earlier, during the period of our analysis (1855 -1947) mutual life offices were also successful in targeting the growing mass-market amongst the working classes for industrial life insurance products. While the early stock companies business model was adapted from the mid-nineteenth century market to target the life insurance and other financial needs of the upper and middle class, their ability to supply cost-effective but profitable policies for the working classes was limited relative to their mutual insurance competitors.[44] In our empirical study, we measure organizational form by a dummy variable, set equal to 0 for mutual companies and 1 for stock companies.

Reinsurance

Abdul Kader, Adams, Andersson and Lindmark report that reinsurance was a major factor in enabling non-life insurance firms in Sweden to mitigate their risk exposure (enhance solvency) and increase their underwriting capacity, particularly during the turbulent macro-economic times of the inter-war years.[45] Therefore, the ability of insurance firms to improve their solvency position and underwriting capacity by reinsuring (transferring) assumed risks enables them to reduce their costs of capital, lower premiums, and so realize corporate growth through increased market share. On the other hand, Doherty and Smetters argue that the frictional costs of reinsurance could lead to increased premiums and so stifle the pace of corporate growth. Indeed, recent empirical evidence from the US property insurance market supports an inverse relation between reinsurance and firm growth.[46] Abdul Kader et al. measure reinsurance as the ratio of the annual amount of reinsurance premiums ceded to gross annual premiums written.[47]

Macro-economic and regulatory control variables

Adams, Andersson, Lindmark and Veprauskaite contend that macro-economic and regulatory effects can influence the growth and development of insurance firms. For example, changes in annual rates of inflation and interest can affect the value of assets and liabilities held on the balance sheets, and could result in cross-temporal variations in the ability of insurers to grow their business.[48] Indeed, Adams et al. point out that between 1903 and 1939 high (low) interest rates increased (reduced) bond yields for Swedish property fire insurers thus influencing the level of premiums that could be charged in the market and hence the rate of firm growth. Also, changes in Gross Domestic Product (GDP) affect the level of disposable incomes and the propensity of commercial and household consumers to buy insurance products. Abdul Kader et al. note that macro-economic effects during the inter-war years had a particularly severe impact on solvency levels and rates of new business growth in Sweden's property fire insurance market – a situation that fostered the growth of reinsurance protection.[49] From his analysis of the historical development of the US life insurance industry, Zanjani notes that regulatory developments, such as enhanced licensing and capital maintenance requirements, can impact on the ability of insurers to realize profitable growth.[50] Lindmark et al. point out that the new capital and reserving, and other (e.g., licensing) requirements of the Insurance Act (1903) had important consequences for the financial and operational management of Swedish insurers.[51] In the present study the real rate of interest is represented by the average five-year government bond yield (as insurers rarely held short-term bonds during the period of our analysis) minus the annual rate of inflation (measured as the average annual change in the consumer price index) and real GDP is taken as a measure of aggregate demand in the economy. Regulatory effects are represented using a dummy variable set equal to 1 for the period before 1903 (during which there was relatively weak insurance regulation and inspection in Sweden) and 0 for the period 1903 onwards (during which there was insurance regulation and inspection as specified in the Insurance Act (1903).

EMPIRICAL ANALYSIS

Samples and Data

The insurance firms included in our sample can be categorized into three main types: independent stock companies; independent mutual companies; and subsidiaries of stock or mutual organizations. How to deal with the last group is a problem for a study of this kind. These are firms that retain their names and authorities to operate as insurers; however, they operate in many respects independently of their parent companies, yet are owned by the shareholders of the parent companies and ultimately controlled by the parent companies' board of directors. When independent insurers are taken over by a larger group but continue to operate as before, should the companies be regarded as survivors or non-survivors? In this empirical study we follow previous research and treat such firms as survivors if they continue to report as separate entities under their former corporate names.[52] The years 1855 to 1947 cover the period during which life insurers in Sweden (particularly stock companies) expanded the scale of their business operations primarily by means of organic growth. After this period, regulatory-induced market consolidation became more common in the industry following the passing of the 1948 Insurance Act.[53]

The 38 insurance firms in our sample operated over widely different time periods, giving us an unbalanced panel of 1,237 firm-year observations. The average number of years of data per insurance firm in the sample is 32.6, the longest series being 92 years and the shortest being just 2 years. The inclusion in the sample of both surviving and non-surviving Swedish life insurance companies in such an extremely unbalanced panel should help to mitigate any possible problems arising from survivorship bias resulting from sample attrition. The empirical study is divided into two parts. In the first part, we employ 'panel unit root' tests of Gibrat's Law for the period 1855-1947 and the two sub-periods 1855-

1902 (prior to the Insurance Act 1903) and 1903-1947 (after the Insurance Act 1903 but prior to the Insurance Act 1948). By focusing the analysis on these two sub-periods, we can test whether the historical firm size-growth relation in Sweden's life insurance market was influenced by changes in regulatory and macro-economic conditions. In the second part of the empirical study, we employ dynamic panel Generalized Method of Moments (GMM) regression analysis to examine other possible determinants of the growth of life insurance firms, as discussed in the second section of our paper, also for the period 1855-1947 and the two sub-periods. In both parts of the study, firm size is measured in terms of total assets (deflated by the GDP deflator) and firm growth is measured as the annual rate of change of total assets. Some previous researchers have argued that *annual* growth may be too 'noisy' and so have recommended that firm growth should be measured over longer periods than a single year. As a robustness check of our regression results, therefore, we also measure growth over two-year and three-year periods. The results were essentially unchanged.

The variables included in both parts of the study are measured according to the definitions given in Table 1. Data on firm sizes, input costs, profitability, company age, organizational form and reinsurance were obtained from the Official Statistics on insurance.[54] Data on real interest rates, GDP and the GDP deflator were extracted from secondary sources.[55] Table 1 also summarizes the full set of hypotheses to be tested.

[TABLE 1 HERE]

Panel Units Root Tests of Gibrat's Law

Many earlier contemporaneous studies of Gibrat's Law have used cross-sectional data to compare the growth rates of a sample of companies over a selected time period (usually one year or more) with the companies' sizes at the start of the period. For example, Hardwick and Adams used a cross-section of UK life insurance firms over the period 1987-96 and three sub-periods (1987-90, 1990-93 and 1993-96) to test Gibrat's Law by regressing the natural logarithm of firm growth over each period on the natural logarithm of firm size at the beginning of each period.[56] The method of weighted least squares was applied to deal with heteroscedastic errors and a Heckman two-stage procedure was employed to address the potential problem of survivorship bias in the estimation.[57] The results provided broad support for Gibrat's Law in the context of the UK life insurance industry. Studies that have used similar cross-sectional methods include Dunne and Hughes and Hart and Oulton.[58] More recent developments in the analysis of panel data have opened up the possibility of testing Gibrat's Law using pooled or panel data, rather than cross-sectional data. A general panel data formulation of equation [2] can be written as:

$$\ln SIZE_{it} - \ln SIZE_{it-1} = \alpha_i + \delta_t + (\beta_i - 1)\ln SIZE_{it-1} + \sum_{j=1}^{p} \gamma_{ij} (\ln SIZE_{it-1} - \ln SIZE_{it-j}) + \varepsilon_{it} \qquad [3]$$

where α_i and δ_t represent individual firm and time effects respectively, γ_{ij} represents the coefficients on *p* lagged growth terms (included to control for possible serial correlation arising from growth persistence) and $\beta_i - 1$ is the size coefficient for firm *i*. In this formulation, values of β greater than 1 would imply that larger insurance firms grow faster than smaller insurance firms. Goddard, Wilson and Blandon (2002) point out that, while 'explosive' growth of this type may be possible over short periods, it is unlikely that it could continue over a long period. Values of β less than 1 would imply that smaller firms grow faster than larger firms. And if $\beta = 1$ we can conclude that firm growth is independent of firm size. Thus, if we are unable to reject the null hypothesis that $\beta = 1$, we can conclude that the sample data provide support for Gibrat's law. Recent applications of panel unit root tests of Gibrat's Law include Goddard et al and Oliveira and Fortunato.[59]

For our sample of Swedish life insurers, we conduct two panel unit root tests. The first test was developed by Levin, Lin and Chu, hereafter referred to as the LLC test, and the second was developed by Im, Pesaran and Shin, hereafter referred to as the IPS test.[60] The main difference between the two tests relates to the firm size coefficient (β_i). The LLC test assumes that the size coefficient remains constant across cross-sections, so that $\beta_i = \beta$ for all *i*. So if we exclude the unlikely possibility of explosive growth, in the LLC formulation, the null and alternative hypotheses may be written as: H_0: $\beta = 1$, H_1: $\beta < 1$. The IPS test, on the other hand, allows β_i to vary across cross-sections, so that in this case the null and alternative hypotheses may be written as: H_0: $\beta_i = 1$ for all *i*, H_1: $\beta_i < 1$ for some *i*.

The results of the LLC and IPS panel unit root tests are summarized in Table 2. Both tests were first conducted for the entire sample of 1,237 firm-year observations over the period 1855 to 1947, and both tests allow us to reject the null hypothesis of a unit root. For the entire period, therefore, our results do not support Gibrat's law, but instead suggest that smaller firms have tended to grow faster than larger firms in the Swedish life insurance industry. Table 2 also shows the more mixed results obtained when the two tests are applied to the two sub-samples consisting of 270 firm-year observations over the period 1855-1902 and 967 firm-year observations over the period 1903-47. The LLC and IPS tests both allow us to reject the null hypothesis of a unit root for the later sub-period, but not for the earlier sub-period. Overall, however, the panel unit root tests offer some support for the view that that smaller insurers in Sweden experienced a long-run tendency to grow faster than larger insurers during the period from 1855 to 1947. Our unit root tests are also consistent with Mazzucato's view that Gibrat's law is a good approximation of firms' growth patterns during periods of technological change and product-market innovation.[61]

[TABLE 2 HERE]

Multivariate Analysis of the Determinants of Firm Growth

We turn now to our investigation of the link between the growth of Swedish life insurance firms and the five firm-specific factors discussed in Section 2 (namely, input costs (*IC*), profitability (*PR*), company age (*AGE*), organizational form (*ORG*) and reinsurance (*REINS*)). We also control for changes in the real interest rate (*INT*), real gross domestic product (*GDP*) and the regulatory environment (*REG*). The panel growth model to be estimated may be written as:

$$ln\ (SIZE)_{it} = \beta_0 + \beta_1\ ln\ (SIZE)_{i,t-1} + \beta_2\ (IC)_{it} + \beta_3\ (PR)_{it} + \beta_4 AGE_{it}$$
$$+ \beta_5 ORG_{it} + \beta_6\ (REINS)_{it} + \beta_7\ (INT)_t + \beta_8\ ln\ (GDP)_t$$
$$+ \beta_9\ (REG)_t + \mu_{it} \qquad [4]$$

The sample means and standard deviations of asset sizes, input costs, profitability, company age, organizational form and reinsurance plus the real rate of interest and GDP are shown in the first part of Table 3 for the full period and the two sub-periods. The average asset size of the Swedish life insurance firms in our sample grew from an average of SK12.9 million in the period 1855-1902 to SK39.2 million in the period 1903-47. The average expense ratio varied from 0.21 in 1855-1902 to 0.26 in 1903-47. At the same time, the average profitability ratio rose from just 0.13 in 1855-1902 to 0.46 in 1903-47. It is clear from the standard deviations that there is a large degree of within sample variation in all these variables. The second part of Table 3 shows the Pearson coefficients of correlation for the independent variables included in the regression equation (except *REG*) for the full 92-year period. These are all less than 0.64 in magnitude, so the possibility of inefficient estimates resulting from multicollinearity is very small. As a further check on the possibility of multicollinearity, variance-inflation factors (VIFs) were calculated for each independent variable for each period.[62] None of these exceed 4.5 (and similar results were obtained for the two sub-periods), confirming that problems associated with multicollinearity are unlikely in this model.

[TABLE 3 HERE]

Equation [4] was estimated separately for the full period and the two sub-periods and the results are shown in Table 4. The estimation was undertaken using panel GMM. GMM estimation is a form of 'instrumental variable' regression which mitigates the effects of correlation between the independent variables and the residual, such as that caused by heteroscedasticity and endogeneity among the explanatory variables. The GMM approach produces consistent and asymptotically efficient estimates and so is well suited to relatively large samples or panels. All of our independent variables are included in the regression for the entire period 1855-1947, but *REG* is (necessarily) omitted from the regression relating to the two sub-periods. All three regression equations have adjusted R^2 values in excess of 0.9, indicating a good fit in all periods.

[TABLE 4 HERE]

We now consider the results in the light of the seven hypotheses listed in Table 1.

Hypothesis H1: The estimate of β_1 in the full-sample regression (1855-1947) is 0.970, which is significantly less than one at the 5% level. In the two sub-periods, the estimates are 0.949 in 1855-1902 and 0.982 in 1903-1947, both significantly less than one at the 5% level. Taking these findings together with the results of the panel unit root tests above, we have evidence which supports the conclusion that (contrary to Gibrat's Law) smaller firms had a tendency to grow faster than larger firms in the Swedish life insurance industry during the period 1855 to 1947. This could be the result of inherent inhibiting factors in large insurers (e.g., managerial inertia and excessive risk aversion) compared with the more innovative practices of small insurance firms. In fact, Westall makes similar observations from his historical analysis of the economic development of the UK's non-life insurance market. We conclude that *H1* is rejected.[63]

As a robustness check on these results, we repeated the GMM regression with firm growth measured over two- and three-year periods (rather than annually). With a two-year growth rate, the estimate of β_1 was 0.817 and with a three-year growth rate the estimate was 0.740, both significantly less than one at the 5% level. There were no significant changes in the estimates of the other coefficients.

Hypothesis H2: The estimates of β_2 (the coefficient on the input cost variable, *IC*) are mixed. Over the entire 92-year period and in the two sub-periods, the estimates of β_2 are positive, but only significantly different from zero (at the 10% level) in the period 1855-1902. Overall, therefore, the evidence suggests a weak positive relation between firms' growth rates and their input cost ratios. This lends some weight to the hypothesis that firms with higher costs because of unexploited economies of scale may grow faster as they attempt to benefit from the available economies. It is also possible that firms incurred higher costs as a result of offering greater financial inducements to staff and increased expenditure on training and marketing, both of which may have led to faster growth. Westall also notes that during the interwar years the lack of local market competition meant that large (oligopolistic) insurers in the UK could pass on the costs of business expansion (e.g., increased brokerage commissions) to policyholders in the form of higher premiums.[64] A similar situation is likely to have occurred in Swedish non-life insurance market during our period of analysis.

Hypothesis H3: With regard to the importance of profitability as a predictor of Swedish life insurance firms' asset growth, the estimate of β_3 is positive and significant at the 5% level over the entire period (1855-1947). For the two sub-periods, the estimates are also positive but statistically insignificant. Overall, therefore, we find some evidence that firm growth and profitability in the Swedish life insurance industry were positively related between 1855 and 1947, which supports the view that higher levels of profitability could enable insurance firms to realize new investment opportunities and so encourage firm growth. This observation accords with firm growth patterns in the UK property fire insurance market during the eighteenth and nineteenth centuries.[65]

Hypothesis H4: The estimate of β_4 (the coefficient on the company age variable) is positive but insignificant in the full sample. Interestingly, though, the estimated coefficient is positive and significant in the earlier sub-period, 1855-1902, during which there is evidence that older companies were growing faster than younger companies. This finding is consistent with the growth of large national stock insurance firms in Sweden noted by Lindmark et al.[66] In the later period, 1903-47, the estimate is insignificant. Overall, *H4* is not supported by our results.

Hypothesis H5: The estimate of β_5 (the coefficient of organizational form) is negative and significant over the entire sample period, 1855-1947. For the two sub-periods, the estimates are also negative, though only significant in the earlier period, 1855-1902. These results support the view that mutual companies' were more successful in targeting the growing life insurance market. This strategy was an important factor in determining growth potential. Hypothesis H5 is supported by our results.

Hypothesis H6: The estimates of β_6 (the coefficient for reinsurance) are positive and significant over the entire sample period and in the later sub-period, but the estimate is insignificant in the earlier sub-period. Overall, this finding lends some weight to the view reported in Abdul Kader et al. that reinsurance enables insurance firms to reduce their cost of capital and reduce their premiums, and so achieve higher annual growth.[67] As a result, *H6* is supported by our results.

Hypothesis H7: The estimates of β_7 (the coefficient on the real interest rate variable) are positive and significant in all periods. Thus our results suggest that there is a positive link between variations in the real rate of interest in Sweden and the annual growth of life insurance firms. This observation is consistent with Waldenström who notes that from the early twentieth century the yields on the investment portfolios of Swedish institutional investors (such as insurers) became increasingly reliant on interest-bearing securities.[68] Consequently, H7 is supported by our results.

Hypothesis H8: The estimate of β_8 (the coefficient on real GDP) is positive and significant at the 10% level over the entire period, but insignificant in the two sub-periods. This suggests a weak positive long-term link between the growth of life insurers and the Swedish economic cycle. Thus, our results provide some limited support for *H8*.

Hypothesis H9: The significantly positive estimate of β_9 (the coefficient on *REG*) suggests that growth rates were higher in the period 1855-1903 when there was relatively little insurance regulation in Sweden. This finding lends weight to the view that tighter financial regulation and control can impede the growth of insurance firms.[69] Therefore, *H9* is supported by our results.

CONCLUSION

Using 1855-1947 data, this study tests empirically the predictions of Gibrat's Law of Proportionate Effects in the Swedish life insurance industry and investigates the influences of a set of firm-specific and control variables on corporate growth. Our main conclusions can be summarized as follows.

Taking the 92-year period as a whole and applying panel unit root tests and panel GMM regression, we have found a significant difference between the growth rates of small and large Swedish life insurance firms (with smaller firms tending to grow faster than larger firms), a result that clearly contradicts Gibrat's Law as a long-run tendency in the Swedish life insurance sector. We have also found significant influences on firm growth from profitability, organizational form and reinsurance. The results for the two sub-periods in our sample are more mixed, except for the result that smaller firms tend to grow faster than larger firms, which is found unambiguously in our regression results for both sub-periods.

With regard to the macroeconomic and regulatory control variables, we have found that the real rate of interest in Sweden had a significantly positive effect on firm growth in the Swedish life insurance industry over the entire period and in each of the two sub-periods. However, real GDP had only a weak positive effect on the growth rates of life insurers. We have also found that the regulatory environment had an effect on insurers' growth rates, with compelling evidence that the tighter financial regulation and control imposed by the Insurance Act 1903 had the effect of impeding the growth rates of our sample of Swedish life insurance companies.

In conclusion, we believe that there is scope for more historical economic research into the determinants of the growth of firms operating in international insurance markets and other sectors of financial services (e.g., banking). An investigation into the effects on the growth of small and large firms of changes in macro-economic and regulatory conditions is well overdue. An historical economic study of the effects of cost inefficiency arising from technical, allocative and scale inefficiencies in financial firms would also make a potentially valuable contribution to the literature.

Notes

[1] Santarelli, et al., 'Gibrat's Law'.

[2] Mazzacuto, 'Risk, Variety and Volatility'.

[3] Geroski, et al., 'Corporate Growth and Profitability'.

[4] Audretsch ,et al., 'Gibrat's Law'.

[5] Hardwick and Adams, 'Firm Size and Growth'; Choi, 'U.S. Property and Liability Industry'.

[6] A'Hearn, 'Finance-Led Divergence'.

[7] e.g., see Lindmark, Andersson and Adams, 'Evolution and Development'; Lindmark and Anderson, 'All Fired up'; Pearson, 'Mutuality Tested'; Pearson, 'Insuring the Industrial Revolution'; Ryan, 'Expansion of the Norwich Union'; Zanjani, 'Pricing and Capital Allocation'.

[8] Smith and Stutzer, 'Mutual Formation and Moral Hazard'

[9] Lindmark Andersson and Adams, 'Evolution and Development'; Adams, et al., 'Mutuality as a Control for Information Asymmetry'.

[10] For example Swiss Re 'World Insurance in 2006' report that in 2006 gross global insurance premiums written amounted to roughly US4 trillion, while Browne et al. 'International Property-Liability Insurance' estimate that approximately 8% of the world's GDP is spent on insurance products, mostly in European and North American markets.

[11] Life and non-life insurers are regulated, taxed and accounted for on a different basis. As a result, we consider that any improved statistical precision possibly emanating from the pooling of both life and non-life insurance firms would be offset by the problem of measurement bias in estimating the linkage between firm size and growth rate patterns, see eg. Hardwick and Adams, 'Firm Size and Growth'.

[12] Skogh, 'Returns to Scale'.

[13] Andersson, Eriksson and Lindmark, 'Life Insurance and Income Growth'.

[14] See e.g. Waldenström, 'Taxing Emerging Stock Markets'.

[15] Lindmark, Andersson and Adams, 'Evolution and Development'

[16] Andersson, Eriksson and Lindmark, 'Life Insurance and Income Growth'.

[17] Ibid.

[18] Ibid.

[19] Ibid.

[20] Lindmark, Andersson and Adams, 'Evolution and Development'.

[21] Sutton,'Gibrat's Legacy'.

[22] Gibrat '*Les Inegalites Economiques'.*

[23] Hardwick and Adams, 'Firm Size and Growth'.

[24] Chesher, 'Testing the Law of Proportionate Effect'.

[25] See e.g. Dunne and Hughes, 'Growth and Failure'; Geroski, Machin and Walters, 'Corporate Growth and Profitability'; Hardwick and Adams, 'Firm Size and Growth'.; Choi, 'U.S. Property and Liability Industry'.

[26] Hardwick, 'Measuring Cost Inefficiency'.

[27] Cummins, Tennyson and Weiss, 'Consolidation and Efficiency'.

[28] Hardwick and Adams, 'Firm Size and Growth'.

[29] See e.g Cummins et al., 'Consolidation and Efficiency'; Hardwick, 'Measuring Cost Inefficiency'.

[30] Fields 'Expense Preference Behavior'.

[31] Westall 'Invisible, Visible and 'Direct' Hands'.

[32] Hardwick, 'Measuring Cost Inefficiency'.

[33] Hardwick and Adams, 'Firm Size and Growth'.

[34] Ibid.

[35] Geroski et al., 'Corporate Growth and Profitability'.

[36] Zanjani, 'Pricing and Capital Allocation'.

[37] Jaffee and Russell, 'Catastrophe Insurance'.

[38] Santomero and Babbel, 'Financial Risk Management'.

[39] See e.g., Hardwick and Adams, 'Firm Size and Growth'.; Choi, 'U.S. Property and Liability Industry'.

[40] Jovanovic 'Selection and Evolution of Industry'.

[41] Choi, 'U.S. Property and Liability Industry'.

[42] (Adams et al., 'Mutuality as a Control for Information Asymmetry'.

[43] Ibid.

[44] Andersson et al., 'Life Insurance and Income Growth'.

[45] Kader, Adams, Andersson and Lindmark 'Determinants of Reinsurance'.

[46] Doherty and Smetters, 'Moral Hazard in Reinsurance Markets'; Choi, 'U.S. Property and Liability Industry'.

[47] Kader, Adams, Andersson and Lindmark 'Determinants of Reinsurance'.

[48] Adams, Andersson, Lindmark and Veprauskaite 'Competing Models of Organizational Form'.

[49] Abdul Kader et al. 'Determinants of Reinsurance'.

[50] Zanjani 'Regulation, Capital, and the Evolution of Organizational Form'.

[51] Lindmark, Andersson and Adams, 'Evolution and Development'.

[52] See e.g., Hardwick and Adams, 'Firm Size and Growth'.

[53] The 1948 Insurance Act introduced a suite of new and radical changes that affected the structure of the Swedish insurance market right up to the mid-1980s. These measures included, amongst other things, tighter solvency

requirements and investment controls, premium tariffs, and tougher licensing rules (e.g., see Lindmark et al., ‘Evolution and Development’.

[54] Sveriges Officiella Statistik, Enskilda Försäkringsanstalter.

[55] Waldenström *’Svenska Aktiekurser, Aktieavkastningar*’; Edvinsson, Jacobson and Waldenström, ’Historical Monetary and Financial Statistics’; Krantz and Schön, ’Historical National Accounts’.

[56] Hardwick and Adams ‘Firm Size and Growth’.

[57] Heckman, ‘Sample Selection Bias’.

[58] Dunne and Hughes, ‘Age, Size and Survival’; Hart and Oulton, ‘Size and Growth of Firms’.

[59] Goddard et al., ‘Panel Tests of Gibrat’s Law’; Oliveira and Fortunato, ‘Testing Gibrat’s Law’.

[60] Levin, Lin and Chu, ‘Unit Root Tests in Panel Data’; Im, Pesaran and Shin, ‘Testing for Unit Roots in Heterogeneous Panels’.

[61] Mazzucato’s ‘Risk, Variety and Volatility’.

[62] The variance-inflation factor for the *ith* independent variable is calculated as: $VIF_I = 1/(1 - R_I^2)$, where R_i is the multiple correlation coefficient when the *ith* independent variable is predicted from the other independent variables in the model. As a rule-of-thumb, variables can be regarded as highly collinear if a VIF exceeds 10 (see Gujarati, ‘Basic Econometrics’ p. 339). The results were: $ln(SIZE)_{t-1}$*: 2.70; IC: 1.72; PR : 2.86; AGE: 4.35; ORG: 2.13; REINS: 1.30; INT: 1.02* and *ln(GDP): 3.45.*

[63] Westall ‘Invisible, Visible and ‘Direct’ Hands’.

[64] Ibid.

[65] Pearson, ‘Insuring the Industrial Revolution’.

[66] Lindmark, Andersson and Adams, ‘Evolution and Development’.

[67] Abdul Kader et al. ‘Determinants of Reinsurance’.

[68] Waldenström, ‘Taxing Emerging Stock Markets’.

[69] See e.g., ‘Regulation, Capital, and the Evolution of Organizational Form’.

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