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Effect of Growth Rate on Financial Ratios: Theoretical and Empirical Analysis

Erkki K. Laitinen

ACA Research Group, Faculty of Business Studies, University of Vaasa, Vaasa, Finland
Email: ekla@uwasa.fi

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Abstract

The purpose of the study is to investigate the pure effect of growth on financial ratios (ceteris paribus). This effect is analyzed both theoretically and empirically. Theoretical analysis is consisted of a steady-state model based on growth rate, profitability (IRR), and a lag parameter. Six financial ratios grouped into three categories are examined: cash-flow ratios, profitability ratios, and solvency ratios. The growth effect on these ratios is analytically assessed using partial derivatives and elasticities. Empirical investigation makes use of long-term financial data from Finnish active and bankrupt firms being different in terms of growth, profitability, and lag structures. Theoretical and empirical results demonstrate that profitability ratios are largely insensitive to growth, whereas cash-flow ratios are moderately sensitive, and solvency ratios are highly sensitive. These findings indicate that, when using cash-flow and especially solvency ratios in financial ratio analysis, growth plays an important role.

Keywords

Growth, Profitability, Lag, Financial Ratios, Profitability Ratios, Cash-Flow Ratios, Solvency Ratios, Finnish Firms

1. Introduction

The topic of the current study deals with the growth and profitability of the firm, which are central themes in entrepreneurial research (Pierce & Aguinis, 2013). This study belongs to the family of steady-state models which treat the current observable ratios (profitability ratios, investment rates, revenue growth) of the firm as generated by an underlying true profitability (IRR), a growth rate, and a lag structure that distributes the revenue effects of expenditures over future periods (Peeters, 1996; Millar, 2005; Eberly, Rebelo, & Vincent, 2012; Laitinen, 2017; Laitinen & Laitinen, 2022). The revenue-generation lag captures the delay between expenditure and the revenue-flow that it produces. This kind of model is useful in depicting observable financial ratios theoretically by means of the three parameters. It is central for reconciling measured accounting profitability with the IRR and for explaining cross-sectional patters of financial ratios. The purpose of this study is to use this kind of lagged model to explain how the growth of the firm affects financial ratios ceteris paribus when the IRR and the lag parameter are considered fixed.

This study analyses how the growth of the firm affects financial ratios in the framework where the IRR and the lag parameter are kept constant. The description of the relationship between profitability and growth considerably complicates the model, since studies show a complex non-linear relationship between them (Federico & Capelleras, 2015). Some studies find a positive association, especially for high-growth firms where scale economies and market power improve margins (Davidsson, Steffens, & Fitzsimmons, 2009; Mansikkamäki, 2023). However, other studies find negative or lagged effects, since rapid growth may dilute control or increase costs before profitability improves (Markman & Gartner, 2002). The relation between growth and profitability is not symmetric. Lee (2014) concludes that profit affects growth negatively, but growth affects profit positively. The relationship between the growth and the lag is not as complicated but the relationship may go from growth to lag: because high-growth firms (start-ups, innovation leaders) allocate more to long-gestation R&D, their aggregate revenue lag lengthens. However, there is a strong heterogeneity across spending categories and thus across industries (Grebel & Nesta, 2019). Therefore, the relationship between observed growth rate and aggregate lag is complicated being mediated by the expenditure.

The central research question of the study is as follows: if we compare firms with identical internal rates of return (IRR) and identical lag parameters, to what extent do differences in growth rates generate observable differences in financial indicators? This question is important because the answer reveals the pure effect of growth on key ratios when other factors (IRR and lag) are held constant (ceteris paribus). Through growth management, a firm can regulate its expansion, either decelerating or accelerating it. The findings of this study demonstrate how a company can influence its financial statement indicators solely by adjusting its growth trajectory. For this reason, it is crucial that IRR and the lag parameter remain fixed when assessing the significance of growth effects. The results indicate that growth has a substantial impact on cash flow ratios and on cumulative financial indicators (solvency ratios). By contrast, the pure effect of growth on short-term profitability measures is relatively modest. For the principal profitability metric, the return on investment (ROI), the impact of growth is directly related to the growth rate itself: when growth is slow and close to zero, the return on investment ratio does not diverge significantly from the IRR (true profitability). Consequently, the influence of growth is most pronounced in those indicators used to evaluate the long-term financing position (solvency) of the firm.

The structure of this paper is organized as follows. This introductory section (Section 1) has explained the background, objectives, and significance of the study. Section 2 presents the theoretical framework, which is grounded in the family of steady-state models. The key concepts of the model (expenditures, expenses, revenues, assets, and capital) are first derived mathematically, after which these concepts are used to define the financial ratios analyzed in the study. The model rests on following simplifying assumptions: the expenditures of the firm are assumed to grow at a constant long-run rate and to generate in each period a proportionally identical flow of returns, accumulated according to a fixed lag structure. This implies that, under proportional constant growth, the internal rate of return (IRR) and the lag parameter remain constant, rendering the model sufficiently tractable for analytical examination. Within this framework, the study derives the financial indicators under review, namely (traditional) cash flow ratio, revenue-expenditure ratio, profit margin, return on investment, accumulated retained earnings relative to assets, and the debt-to-assets ratio. The pure effect of growth on these indicators is first assessed on the basis of the mathematical results. Section 3 turns to empirical illustrations of the impact of growth on the indicators. The exemplary parameters of the model are extracted from the financial statements of a sample of Finnish firms separately for acting firms (n = 11,735) and bankrupt firms (n = 476). These estimates are then used to assess the influence of growth on the ratios. The final section of the study summarizes the results, discusses their implications for financial statement analysis, and outlines potential avenues for future research.

2. Framework for the Analysis

2.1. Background of the Model

This study belongs to the family of steady-state models, which focus on the output measures of the firm (profitability ratios, investment rates, revenue growth) as generated by underlying true profitability (IRR), a growth rate, and a lag structure (level, geometric, Almon, Poisson lags) that distributes the revenue effects of expenditures (including investment and R&D) over future periods (Millar, 2005; Hall, 2007; Eberly, Rebelo, & Vincent, 2012; Laitinen & Laitinen, 2022). Within this family, the study relates most closely to the sub-group of models that examine the relationship between the accounting rate of return (ROI or ARR) and true profitability (the economic rate of return, as measured by IRR. The IRR is a key concept in economics, widely used for discounting cash flows. Research in this sub-family primarily investigates the bias in ARR as an approximation of IRR (Harcourt, 1965; Solomon, 1966; Luckett, 1984; Feenstra & Wang, 2000; Brief, 2013). In these models, growth plays a central role. Solomon (1966) concluded that ROI (ARR) is not an accurate measure of IRR, and that the error is neither constant nor systematic. ROI equals IRR only if the growth rate of the firm exactly matches its internal rate of return. Feenstra and Wang (2000: p. 4) summarize the analytical findings of this literature and characterize them as generally pessimistic.

Studies typically analyze the behavior of firms investing in single or multiple projects under alternative assumptions regarding depreciation policy and growth. The findings indicate that, unless very restrictive assumptions are imposed, ARR does not accurately measure IRR, the errors lack systematic patterns, and the resulting biases can be substantial.

This study does not focus on the relationship between ARR and IRR itself but rather on the effect of growth on a broader set of financial ratios. Nevertheless, it adopts a model structure similar to that of the literature in this sub-family to derive long-term (steady) financial ratios and to isolate the pure effect of growth. The analysis should be regarded as long-term, since it is grounded in a steady-state framework. Accordingly, the results describe the steady-state values that financial ratios converge to as growth rate varies. The framework developed here investigates revenue flows at the firm level by applying an infinite geometric lag structure between expenditures and the resulting revenue stream (net sales). In a steady-state setting, all variables grow at the same constant rate, making it possible to analytically investigate the effects of growth. The mathematical structure of this study closely resembles the lagged steady-state model introduced by Laitinen (2024), who examined the impact of expenditure structure on profitability ratios. In contrast, this study extends the set of financial indicators by considering long-term financial ratios in addition to short-term profitability measures. For the sake of simplicity, the framework excludes taxes, interest expenses, and dividends.

2.2. Basic Concepts

The present steady-state model is based on the assumptions that each periodic expenditure generates in a constant relation to expenditure an infinite flow of revenue following the geometric lag distribution. In this framework, the revenues of the firm in period t can be calculated as follows:

$$R_t = K \cdot M_t \sum_{i=0}^{t} (1+g)^{-i} q^i = K \cdot M_t \cdot \frac{1+g}{1+g-q} \quad \text{when } t \to \infty \tag{1}$$

In Equation (1), R_t is revenue, M_t is expenditure, K is the height of the revenue flow, g is the growth rate of expenditure, and q is the lag parameter of the geometric distribution. The sum of lagged revenue contributions in (1) converges for infinite t if $q < 1 + g$. The average lag between expenditure and generated revenue flow is defined as $q/(1 - q)$.

Since the revenue contribution generated by periodic expenditures is given in (1), the IRR can be incorporated to the model in the following way:

$$M_t = M_t \cdot K \sum_{i=0}^{\infty} q^i (1+r)^{-i} \to K = \frac{1+r-q}{1+r} \tag{2}$$

In Equation (2), r refers to the constant IRR of the expenditures that is identical for each periodic expenditure. The sum of the lagged contributions in (2) converges if $q < 1 + r$.

Substituting K in (1) into (2) gives the revenue-expenditure ratio as:

$$\frac{R_t}{M_t} = \frac{R}{M} = \frac{(1+r-q)(1+g)}{(1+r)(1+g-q)} \tag{3}$$

Equation (3) shows that the revenue of the firm in period t exactly covers the periodic expenditure if $r = g$. In this case, it means that the firm can finance its expenditure by revenue and does not need external capital. However, if $g > r$, it follows that $R/M < 1$, and thus the firm needs external capital M-R to cover total expenditure. If $g < r$, it means that $R/M > 1$ so that revenue exceeds expenditure, and consequently, the firm can transfer the excess revenue R-M to short-term (financial) assets. The result in Equation (3) is very important from the perspective of growth, since it tells how much the firm needs external finance for given g, r, and q. Equation (3) also indicates that for the long-term finance of the firm it is decisive whether g exceeds r or vice versa.

Subtracting R_t in (1) from M_t in (2) gives an equation for the change in the external capital in the following way:

$$\Delta C_t = M_t - R_t = M_t \cdot \frac{q(g-r)}{(1+r)(1+g-q)} \tag{4}$$

Equation (4) shows that $\Delta C_t = 0$ if $r = g$, > 0 if $r < g$, and < 0 if $r > g$.

The steady-state model is useful in a dynamic analysis, since it makes it easy to transform flow concepts to stock concepts and vice versa as presented below:

$$\text{Stock} = \text{Flow} \cdot \frac{1+g}{g} \tag{5}$$

Equation (5) indicates that the external capital of the firm (stock) can be obtained from the corresponding change (flow) as follows:

$$C_t = M_t \cdot \frac{q(g-r)}{(1+r)(1+g-q)} \cdot \frac{1+g}{g} \tag{6}$$

Equation (6) shows that the stock of external capital is a function of g, q, and r. In this analysis, it is assumed that the external capital of the firm may consist of debt and equity, in accordance with the financing plan. Let us denote the share of debt in the increase of external capital by B. If $g > r$, $D_t = B \cdot C_t$ refers to the debt capital in the balance sheet while $S_t = (1 - B) \cdot C_t$ refers to the (external) equity invested. If $g < r$, $C_t < 0$ referring to excess cash flow. In that case, $-C_t$ is presented under financial assets on the balance sheet.

The asset side of the balance sheet also includes assets extracted from the periodic outlay (expenditure). These assets can be calculated only assuming an expensing (depreciation) method that describes how expenditures are expired along the accumulation of revenues. The most neutral assumption is that expenditures are expired by the same rate as revenues are accumulated over periods (Laitinen, 2024). In that case the lag distributions of revenues and expenses are identical and share a common lag parameter q. Thus, the periodic expense can be calculated in the following way:

$$E_t = (1-q)\cdot M_t \sum_{i=0}^{t}(1+g)^{-i} q^i = M_t \cdot \frac{(1+g)(1-q)}{1+g-q} \text{ when } t \to \infty \tag{7}$$

The sum in Equation (7) converges if $q < 1 + g$. In Equation (7), $1 - q$ refers to the rate of expiration.

Expenses E_t can be used to calculate assets according to the accounting identity as follows:

$$E_t = A_{t-1} - A_t + M_t \to A_t = (M_t - E_t)\cdot \frac{1+g}{g} \tag{8}$$

Substituting E_t in (7) into Equation (8) gives the following result for the assets of the firm at the end of the period t:

$$A_t = q \cdot M_t \sum_{i=0}^{t}(1+g)^{-i} q^i = M_t \cdot \frac{q(1+g)}{1+g-q} \text{ when } t \to \infty \tag{9}$$

The geometric sum in Equation (9) converges if $q < 1 + g$.

The determination of expenses makes it possible to calculate the periodic profit of the firm as subtracting expenses from the periodic revenue as:

$$\Delta P_t = R_t - E_t = M_t \cdot \frac{rq(1+g)}{(1+r)(1+g-q)} \tag{10}$$

Equation (10) shows that the profit of the firm is a function of r, g, and q. The profit as defined in (10) can through Equation (5) be transformed to retained earnings which are reported under the equity of the balance sheet. Substituting Equation (5) into Equation (10) gives the following result:

$$P_t = M_t \cdot \frac{rq(1+g)^2}{(1+r)(1+g-q)g} \tag{11}$$

Equation (11) shows that retained earnings P_t are strongly dependent on the growth rate g.

Table 1 presents a summary of the financial statements (income statement and balanced sheet) constructed using the concepts of the study. Income statement includes three items: revenues, expenses, and profit. In balance sheet, the accounting identity holds so that assets = capital. The asset side of the balanced sheet consists of two items. First, depreciable assets are obtained subtracting accumulated expenses from accumulated expenditures. Second, if $g < r$, the expenditures have generated excess cash flow which is recorded here as financial assets. If $g > r$, excess cash-flow does not exist and financial assets equal zero. The capital side of the balance sheet also includes two items. First, the capital side includes external capital if $r < g$. If $g < r$, the firm does not need external capital to finance its expenditures so that capital equals zero. External capital can be divided into debt and equity capital. Second, the capital side includes retained earnings which correspond here accumulated profits. For simplicity, the present framework does not consider taxes, interest expenses. and dividends at all, which makes retained earnings equal to cumulated profits.

Table 1. Income statement and balance sheet based on the concepts of the analysis.

Panel 1. Income statement.	
Revenues	$R_t = M_t \frac{(1+r-q)(1+g)}{(1+r)(1+g-q)}$
− Expenses	$-E_t = -M_t \cdot \frac{(1+g)(1-q)}{1+g-q}$
= Profit	$= \Delta P_t = R_t - E_t = M_t \cdot \frac{rq(1+g)}{(1+r)(1+g-q)}$
Panel 2. Balance sheet.	
Assets of the firm	Capital of the firm
Depreciable assets $A_t = M_t \cdot \frac{q(1+g)}{1+g-q}$	External capital if $g > r$ $C_t = M_t \cdot \frac{q(g-r)}{(1+r)(1+g-q)} \cdot \frac{1+g}{g}$
Financial assets if $g < r$ $C_t = M_t \cdot \frac{q(r-g)}{(1+r)(1+g-q)} \cdot \frac{1+g}{g}$	Retained earnings $P_t = M_t \cdot \frac{rq(1+g)^2}{(1+r)(1+g-q)g}$

2.3. Financial Ratios

The financial statements in Table 1 make it possible to extract several financial ratios based on the three parameters of the framework: r, g, and q. In this study the focus is set on the pure impact of g on financial ratios when r and q are kept fixed. In the following analysis, the partial derivatives of the financial ratios are considered to learn how g theoretically affects the ratios. The signs of the derivatives are only determined omitting extreme values of the parameters. This means that it is assumed that $q > 0$, $1 + r - q > 0$ and $1 + g - q > 0$, and the signs are determined on these conditions. First, the revenue-to-expenditure ratio REX refers to sufficiency of revenue finance. This ratio and its partial derivative with respect to g can be presented in the following way:

$$\text{REX} = \frac{R_t}{E_t} = \frac{(1+r-q)(1+g)}{(1+r)(1+g-q)} \tag{12a}$$

$$\frac{\partial \text{REX}}{\partial g} = -\frac{(1+r-q)q}{(1+r)(1+g-q)^2} < 0 \tag{12b}$$

The derivative of REX with respect to g (12b) is negative on the current conditions. However, if $r = g$, REX = 1 for all values of q. Thus, the higher is g, the lower is REX ceteris paribus.

Second, the sufficiency of revenue finance can also be assessed using the (traditional) cash flow ratio that is in this study defined as the ratio of revenue-minus-expenditure to revenue (RER). Analytically, this ratio and its partial derivative can be presented as follows:

$$\text{RER} = \frac{R_t - E_t}{R_t} = \frac{q(r-g)}{(1+r-q)(1+g)} \tag{13a}$$

$$\frac{\partial \text{RER}}{\partial g} = -\frac{q(1+r)}{(1+r-q)(1+g)^2} < 0 \tag{13b}$$

The derivative of RER with respect to g is negative in the same way for REX. These ratios measuring sufficiency of revenue finance are very similar to each other, since RER = (1 − 1/REX).

The financial ratios based on revenue and expenditure are cash-flow measures without any reference to the causal relationship between revenue and subtracted expenditure. Therefore, these ratios do not reflect the profitability of the firm. This study deals with two ratios which measure the short-term profitability of the firm. These ratios are based on the neutral expensing method that makes a connection between cumulated revenue and cumulated expense. First, the profit margin expressed as the ratio of profit-to-revenue (PRR) is considered. This ratio and its partial derivative with respect to growth rate are as follows:

$$\text{PRR} = \frac{R_t - \Delta P_t}{R_t} = \frac{rq}{1+r-q} \tag{14a}$$

$$\frac{\partial \text{PRR}}{\partial g} = 0 \tag{14b}$$

Equation (14a) shows that PRR is only dependent on r and q, but not on g. Thus, the partial derivative with respect to g equals zero. PRR is zero, when r is zero reflecting a close relationship to r.

Second, profitability is in this framework also measured by the profit-to-assets (investment) ratio (PRA) which in analytical studies is used to describe the accounting rate of return (ARR) that should approximate IRR. The asset concept of the ratio is defined on the beginning of period basis following the practice in prior studies. The profitability ratio and its partial derivative with respect to g can be presented in the following simple way:

$$\text{PRA} = \frac{R_t - \Delta P_t}{A_{t-1}} = r \cdot \frac{1+g}{1+r} \tag{15a}$$

$$\frac{\partial \text{PRA}}{\partial g} = \frac{r}{1+r} > 0 \text{ if } r > 0; = 0 \text{ if } r = 0; < 0 \text{ if } r < 0 \tag{15b}$$

The sign of the partial derivative of PRA in (15b) depends on the sign of r. If $r > 0$, then also the partial derivative refers to positive effect of g. Equation (15a) indicates that PRA is not a valid measure of IRR, since there is a bias associated with g. However, for slowly growing firms the bias may be small. Only when in a special case $r = g$, PRA exactly equals IRR.

The last set of financial ratios here is consisted of solvency ratios, which are typically long-term financial performance indicators. In this study, two solvency ratios are considered. First, the ratio of retained-earnings-to-depreciable-assets REA is based on the cumulative sum of periodic profits (retained earnings) and refers thus to the long-term profitability of the firm. REA and its partial derivative with respect to g are defined in the following way:

$$\text{REA} = \frac{P_t}{A_t} = \frac{r(1+g)}{g(1+r)} \tag{16a}$$

$$\frac{\partial \text{REA}}{\partial g} = -\frac{r}{(1+r)g^2} < 0 \ \text{ if } r > 0; = 0 \ \text{ if } r = 0; > 0 \ \text{ if } r < 0 \tag{16b}$$

Equation (16a) shows that REA is independent of the lag parameter q being a simple function of g and r. Equation (16b) indicates that the sign of the partial derivative with respect to g depends inversely on the sign of r: for positive r, the derivative is negative, and vice versa. If r approaches zero, also the marginal effect of g on REA approaches zero.

Second, if the firm in the long run needs external capital to finance its expenditure, it can take debt or increase external equity. In the long run, it is important to the financial performance of the firm, that the amount of debt is not too high. The amount of debt can be measured by the debt to (depreciable) assets ratio DAR, which together its partial derivate can be presented as:

$$\text{DAR} = B \cdot \frac{C_t}{A_t} = B \cdot \frac{g-r}{(1+r)g} \tag{17a}$$

$$\frac{\partial \text{DAR}}{\partial g} = B \cdot \frac{r}{(1+r)g^2} > 0 \ \text{ if } r > 0; = 0 \ \text{ if } r = 0; < 0 \ \text{ if } r < 0 \tag{17b}$$

Equation (17a) indicates that the debt-to-assets ratio is independent of the lag parameter q. Equation is valid only when $g > r$ which creates the need for external capital. If $g < r$, the excess revenue is considered as financial asset in the asset side of the balance sheet. Equation (17b) shows that the sign of r determines the sign of the partial derivative. If $r < g$ and $r > 0$, the derivative is positive indicating that an increase in g makes an increase in DAR.

In summary, the present framework examines the effect of growth g on six financial ratios. The analysis indicates that the partial derivatives of the revenue-to-expenditure ratio REX and the revenue-minus-expenditure-to-revenue ratio RER (cash flow) with respect to growth, are negative. Thus, the higher the growth g, the lower are these cash flow ratios: higher growth rate reduces the ratios. The first of the profitability ratios, the profit-to-revenue ratio PRR (profit margin) is independent of growth rate. Thus, the partial derivative is zero and growth rate does not affect the value of the ratio. The second profitability ratio, the profit-to-assets ratio PRA (return on investment) that is used in financial analyses as the accounting rate of return (ARR) to approximate IRR or r, has a partial derivate with a sign determined directly by the sign of r. Thus, the effect of growth on PRA is positive if $r > 0$, 0 if $r = 0$, and < 0 if $r < 0$. For profitable firms, higher growth rate increases the ratio. This analysis deals also with two solvency ratios, that both are independent of the lag parameter q. The sign of the partial derivative of the first solvency ratio, the retained-earnings-to-assets ratio REA, is inversely determined by the sign of r so that it is < 0 if $r > 0$, 0 if $r = 0$, and > 0 if $r < 0$. Hence, higher growth rate reduces the ratio for profitable firms. However, the sign of the partial derivative for the debt-to-assets ratio DAR is directly determined by the sign of r. Thus, for profitable firms, higher growth rate increases the ratio.

The sensitivity of the financial ratios with respect to g is in practice a question what kinds of data are used in the investigation. However, theoretically it is possible to make rough estimates of the sensitivities using the elasticities of the financial ratios with respect to the growth rate. Table 2 shows these elasticities for the six financial ratios. The elasticity of the revenue-to-expenditure ratio REX is a function of g: the lower g, the lower is the elasticity. The elasticity of the revenue-minus-expenditure-to-revenue ratio RER, is also lower, the lower is g. However, the elasticity also inversely depends on the difference $(r - g)$ so that the sensitivity can be high, if the difference is close to zero. The elasticity of the profit-to-revenue ratio PRR is zero, since the partial derivative is zero. The elasticity of the profit-to-assets ratio PRA is a simple function of g: the lower g, the lower is the sensitivity. For the retained-earnings-to-assets ratio REA, the elasticity approaches unity,

Table 2. Elasticities of the financial ratios (E) with respect to the growth rate (g).

Panel 1. Cash flow ratios.

1. Revenue-to-expenditure ratio REX

$$E(\text{REX}, g) = -\frac{q \cdot g}{(1+g-q)(1+g)} \tag{19a}$$

2. Revenue-minus-expenditure-to-revenue ratio RER

$$E(\text{RER}, g) = -\frac{(1+r) \cdot g}{(1+g)(r-g)} \tag{19b}$$

Panel 2. Profitability ratios.

3. Profit-to-revenue ratio PRR

$$E(\text{PRR}, g) = 0 \tag{19c}$$

4. Profit-to-assets ratio PRA

$$E(\text{PRA}, g) = \frac{g}{1+g} \tag{19d}$$

Panel 3. Solvency ratios.

5. Retained-earnings-to-assets ratio REA

$$E(\text{REA}, g) = -\frac{1}{1+g} \tag{19e}$$

6. Debt-to-assets ratio DAR

$$E(\text{DAR}, g) = \frac{r}{g-r} \tag{19f}$$

when g approaches zero. The elasticity of the debt-to-assets ratio depends on r but inversely also on the difference ($g - r$). For companies with low profitability and high growth rate, the sensitivity is low.

3. Empirical Analysis of the Growth Effect

3.1. Basic Concepts of the Analysis

The purpose of the empirical part is to demonstrate empirically the theoretical results on the pure effect of growth on financial ratios. The analysis is descriptive and any scientific hypotheses are not tested. The empirical data are randomly extracted from the ORBIS data base from a period before the COVID pandemics to avoid potential bias in financial behavior of firms. The latest financial statements in the data are from years 2015 and 2016. The sample firms are Finnish industrial firms which report the total of the balance sheet more than one ME. The data include a long time-series of financial statements from 12.381 active firms and 470 bankrupt firms. Since the background framework is a steady-state model, a longer time-series is needed to describe the behavior of firms. **Appendix** presents background information of the sample firms. First, Panel 1 presents percentiles of the growth rate of net sales from a nine-year period. The median of the growth rate has in active firms strongly declined in the three last years, being slightly negative. In bankrupt firms, the median rate of growth has been negative for the last four years being strongly negative in two last years.

The effect of growth on financial ratios depends on the profitability of the firm and its relationship to the growth. Panel 2 of the table shows the percentiles of the profit-to-assets ratio in both sets of firms. For active firms the median ratio has systematically declined during the time period but is still clearly positive in the last years. In the same way, the median ratio in bankrupt firms has systematically declined and is strongly negative in the two last years. Panel 3 presents the percentile of the (net) debt ratio for the sample firms. For the active firms, the median ratio has been stable over the period reflecting that the profitability is clearly positive and the growth slightly negative, indicating sufficiency of revenue finance. However, in bankrupt firms the median debt ratio systematically increases due to the poor profitability and growth. Thus, the sample firms in both groups are characterized by low growth and profitability. Theoretical findings indicate that in this kind of sample the pure effect of growth on financial ratios is expected to be considerably small.

The objective of this empirical part is only to demonstrate theoretical findings in empirical data. Therefore, advanced statistical estimation methods are not used here and only rough estimates for the basic key concepts, g, r, and q are extracted. See Laitinen & Laitinen (2022) for the estimation methods of the parameters. The concepts of the theoretical framework are long-term steady parameters. Therefore, the estimation procedure applied here makes use of the whole ten-year time-series to extract the estimates in a simple way. Firstly, the growth estimate is calculated by dividing the sum of net sales (revenues) from the last five years by the sum of revenues from the first five years, taking the fifth root of the result, and subtracting 1 (unit). Secondly, the estimation (approximation) of the lag parameter q is more complicated. The first step is to estimate the average lag between expenditures and revenues by dividing the sum of balance sheet totals over a ten-year period by the sum of revenues for the same period. Thereafter, following the theoretical model, the approximated estimate of parameter q is calculated as follows:

$$q = \frac{H}{1+H} \tag{18}$$

In this Equation (18), H denotes the approximated average lag of the geometric lag distribution.

Thirdly, a rough estimate of profitability r (IRR) is calculated simply by dividing the sum of the profits of the period over the last ten years by the sum of balance sheet totals for the same period. This procedure means that weighted ARRs are used as an approximation of IRR that is in practice very difficult to estimate without any bias. Maybe the simplest way to estimate IRR have been presented by Kay (1976) and Peasnell (1982). Kay found that IRR is a weighted average of ARRs plus an error term that depends on opening and closing valuation differences. Kay uses average ARR to overcome creative accounting practices that may distort reported profits. In his analysis, the average ARR refers to the weighted average of the lifetime series of ARRs. Peasnell (1982: p. 371) mentions that "the IRR is defined to be constant throughout the investment holding period whereas ARRs can and do vary through time. Perhaps the most obvious way of utilizing a time-series of ARRs in practice is to take a simple arithmetic average of them and to treat the result as a proxy for the (constant) IRR". Following Kay (1976) and Peasnell (1982), IRR is in this study approximated by the weighted average of ARRs although the estimate may potentially be biased.

Table 3 presents the percentiles of the estimates for parameters g, r, and q. Panel 1 shows that for active firms the median growth estimate of g is 0.028, indicating slow average growth. The sluggishness of growth is further reflected in the fact that the 25th percentile of growth is negative (−0.024). For these firms, the median estimate of profitability r is 0.058, implying that profitability is on average modest. However, in the dataset the profitability estimate r generally exceeds the growth estimate g, which, according to the theoretical model, suggests that active firms should not, ceteris paribus, face significant demand for external capital. This conclusion is supported by the stable development of the (net) debt ratio in recent years. According to Panel 2 of **Table 3**, the average growth rate of bankrupt firms is positive but very close to zero (0.006). By contrast, the median of the profitability parameter estimate r for these firms is negative (−0.030). Since the growth estimate g generally exceeds the profitability estimate r, bankrupt firms tend to have, in the long run, a need to increase external financing, which is typically debt. This conclusion is also empirically supported by the observed increase in the debt ratio.

Table 3. Percentiles of the estimates of g, r, and q.

Panel 1. Active firms.							
	Percentile:						
Estimate of	5	10	25	**50**	75	90	95
Growth (g)	−0.171	−0.095	−0.024	**0.028**	0.086	0.169	0.246
IRR (r)	−0.035	−0.009	0.017	**0.058**	0.114	0.170	0.212
Lag parameter (q)	0.203	0.240	0.310	**0.402**	0.529	0.710	0.825
Panel 2. Bankrupt firms.							
	Percentile:						
Estimate of	5	10	25	**50**	75	90	95
Growth (g)	−0.236	−0.163	−0.073	**0.006**	0.105	0.207	0.286
IRR (r)	−0.189	−0.137	−0.072	**−0.030**	0.002	0.037	0.060
Lag parameter (q)	0.184	0.229	0.279	**0.346**	0.456	0.617	0.704

Table 3 also shows that there are differences in the lag parameter q estimates between the active firms and bankrupt firms. The median estimate of the lag parameter for active firms (0.402) exceeds the corresponding median for bankrupt firms (0.346). Hence, the lag between expenditures and revenues tends to be longer for active firms than for bankrupt ones. This difference indicates that active firms invest more in long-term assets. The differences in the median of the estimates between active and bankrupt firms are (in a median test) statistically very significant (<0.001) for r and q but less significant for g (0.002). The differences in all parameter estimates across the groups of firms can be summarized using a logistic regression analysis, where the binary status Y (1 = bankrupt firm, 0 = active firm) is explained by the estimates of the three model parameters. The results of the logistic regression analysis are reported in Table 4. These results indicate that the profitability estimate r is the most significant explanatory variable, whereas the regression coefficient of the growth estimate g is not statistically significant. The model correctly classifies 70.5% of active firms and 84.9% of bankrupt firms in the estimation sample, when the critical threshold is set equal to the share of bankrupt firms among all firms. The resulted linear logit of the model is as follows:

Table 4. Logistic regression model ($Y = 1$ for bankrupt firms and $Y = 0$ for active firms).

Variables (X):	Coefficient	Std. Error	Wald test	Significance
Growth (g)	−0.441	0.293	2.257	0.133
IRR (r)	−11.155	0.544	420.306	<0.001
Lag parameter q	−2.328	0.307	57.539	<0.001
Constant	−2.029	0.126	257.438	<0.001

$$\text{LOGIT} = -2.029 - 0.441 \cdot g - 11.155 \cdot r - 2.328 \cdot q \quad (19)$$

In Equation (19), g, r, and q refer to the estimates of these parameters. LOGIT (19) can be converted into a conditional bankruptcy probability through the logistic transformation as PROB ($Y = 1|X$) = 1/(1 + exp(−LOGIT)). This probability is later used to assess the effect of growth.

3.2. Numerical Results

Table 5 presents the pure effect of growth on financial ratios for the active firms. In this table, the median values of the parameters r (0.0584) and q (0.4017) are held constant, while the values of growth g are allowed to decrease (to the left) and to increase (to the right) from the median (0.0283) in increments of 0.005 (half a percentage point). The table shows how the values of the financial ratios change as a function of g. In this experiment, growth rates are positive except for the two cases at the left end of the table where $g < 0$. In the table, the estimate of r exceeds the estimate of g except for one case at the right end, where $g > r$. The experiment assumes that $B = 1$, which means that 100% of the external capital is debt. B is set to unity, as the median debt share among the sample firms exceeded 97% in both active and bankrupt firms over the ten-year period. This assumption affects only the absolute level of the debt-to-assets ratio (DAR), which remains independent of growth effect as is showed by Equation (19f) in Table 2.

The results in the table indicate that the financial ratios can be classified into three groups according to the strength of the growth effect. First, the effect of growth on profitability ratios (PRR and PRA) is very limited: PRR is independent of growth and PRA responds only slightly to changes in the growth rate. Second, the cash-flow ratios (RER and REX) are more sensitive to changes in g. Their degree of sensitivity is identical for the ratios, since conceptionally RER = 1 − 1/REX.

Table 5. Values of financial ratios for alternative values of growth (active firms).

								Median g							
	$g<0$	$g<0$	$g>0$	$g>0$	$g>0$	$g>0$	$g>0$	$g>0$	$g>0$	$g>0$	$g>0$	$g>0$	$g>0$	$g>0$	$g>0$
	$g<r$	$g<r$	$g<r$	$g<r$	$g<r$	$g<r$	$g<r$	$g<r$	$g<r$	$g<r$	$g<r$	$g<r$	$g<r$	$g<r$	$g>r$
g	−0.0067	−0.0017	0.0033	0.0083	0.0133	0.0183	0.0233	**0.0283**	0.0333	0.0383	0.0433	0.0483	0.0533	0.0583	0.0633
REX	1.0924	1.0843	1.0763	1.0685	1.0610	1.0536	1.0463	**1.0393**	1.0324	1.0256	1.0190	1.0126	1.0063	1.0001	0.9941
RER	0.0846	0.0777	0.0709	0.0641	0.0575	0.0508	0.0443	**0.0378**	0.0314	0.0250	0.0187	0.0124	0.0063	0.0001	−0.0059
PRR	0.0754	0.0754	0.0754	0.0754	0.0754	0.0754	0.0754	**0.0754**	0.0754	0.0754	0.0754	0.0754	0.0754	0.0754	0.0754
PRA	0.0548	0.0551	0.0554	0.0556	0.0559	0.0562	0.0565	**0.0567**	0.0570	0.0573	0.0576	0.0578	0.0581	0.0584	0.0587
REA	−8.1803	−32.4022	16.7757	6.7031	4.2039	3.0703	2.4233	**2.0049**	1.7122	1.4958	1.3295	1.1976	1.0904	1.0016	0.9269
DAR	9.1803	33.4022	−15.7757	−5.7031	−3.2039	−2.0703	−1.4233	**−1.0049**	−0.7122	−0.4958	−0.3295	−0.1976	−0.0904	−0.0016	0.0731
PROB	0.0263	0.0262	0.0262	0.0261	0.0260	0.0260	0.0259	0.0259	0.0258	0.0258	0.0257	0.0257	0.0256	0.0255	0.0255

Legend: REX = Revenue-to-expenditure ratio; RER = Revenue-minus-expenditure-to-revenue ratio; PRR = Profit-to-revenue ratio; PRA = Profit-to-assets ratio; REA = Retained-earnings-to-assets ratio; DAR = Debt-to-assets ratio; PROB = logistic probability of bankruptcy; g = growth rate; r = IRR = 0.0584; q = lag parameter = 0.4017; B = 1.

Third, the solvency ratios (REA and DAR) appear to be the most sensitive to growth. This outcome is as expected, because solvency ratios are long-term measures based on cumulated growth. These ratios have a consistent interpretation only when $g > 0$. The values of DAR in the table, except for the case where $g > r$, are negative, indicating the presence of excess cash inflow in the long run. Figures 1-3 show graphically the pure effect on the six financial ratios for the active firms. The logistic probability of bankruptcy (PROB) is essentially insensitive to the growth rate g. When $g = -0.0067$ (the lowest value), PROB = 0.0263, and when $g = 0.0633$ (the highest value), PROB = 0.0255. Thus, the change in PROB as a response to the change of growth is negligible.

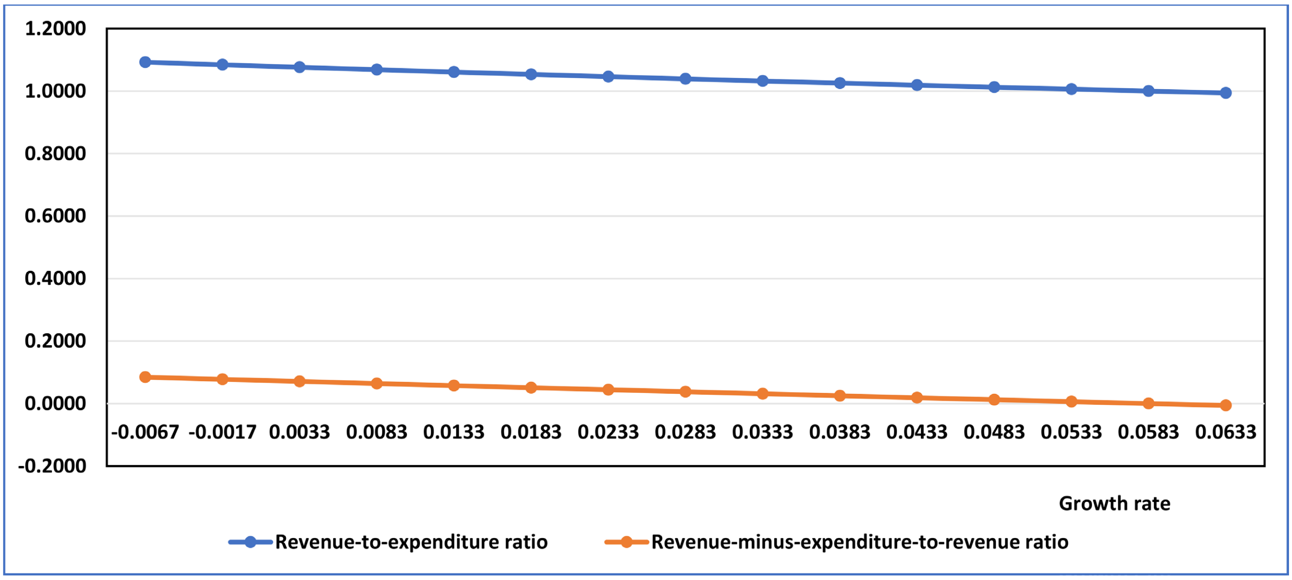

Figure 1. The effect of growth on cash-flow ratios REX and RER (Active firms).

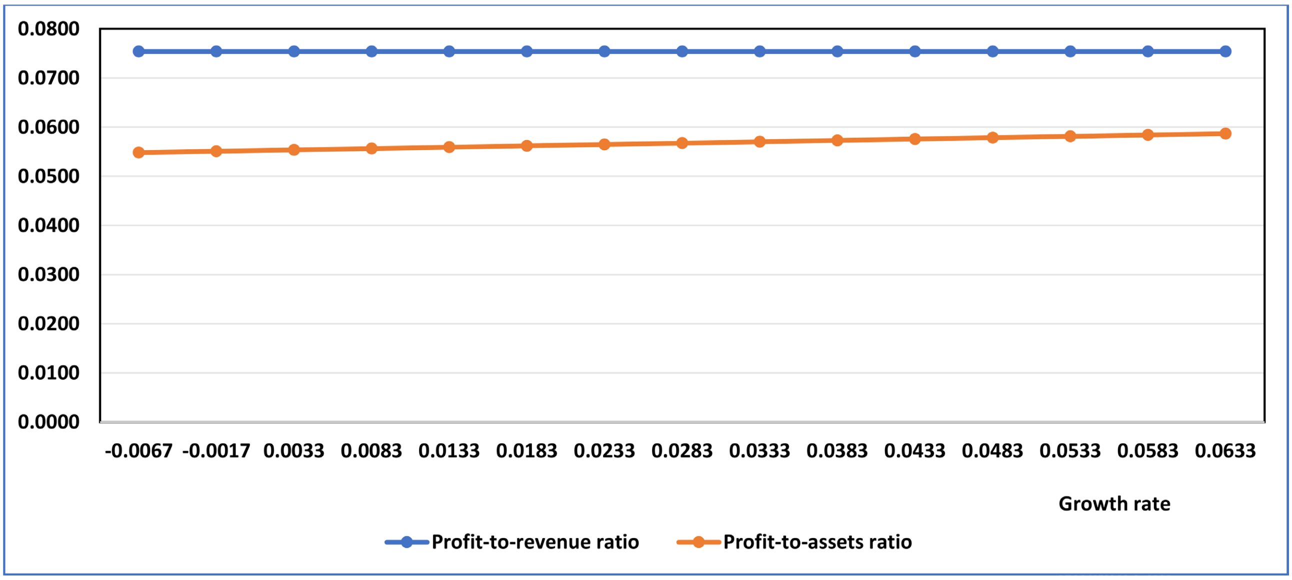

Figure 2. The effect of growth on profitability ratios PRR and PRA (Active firms).

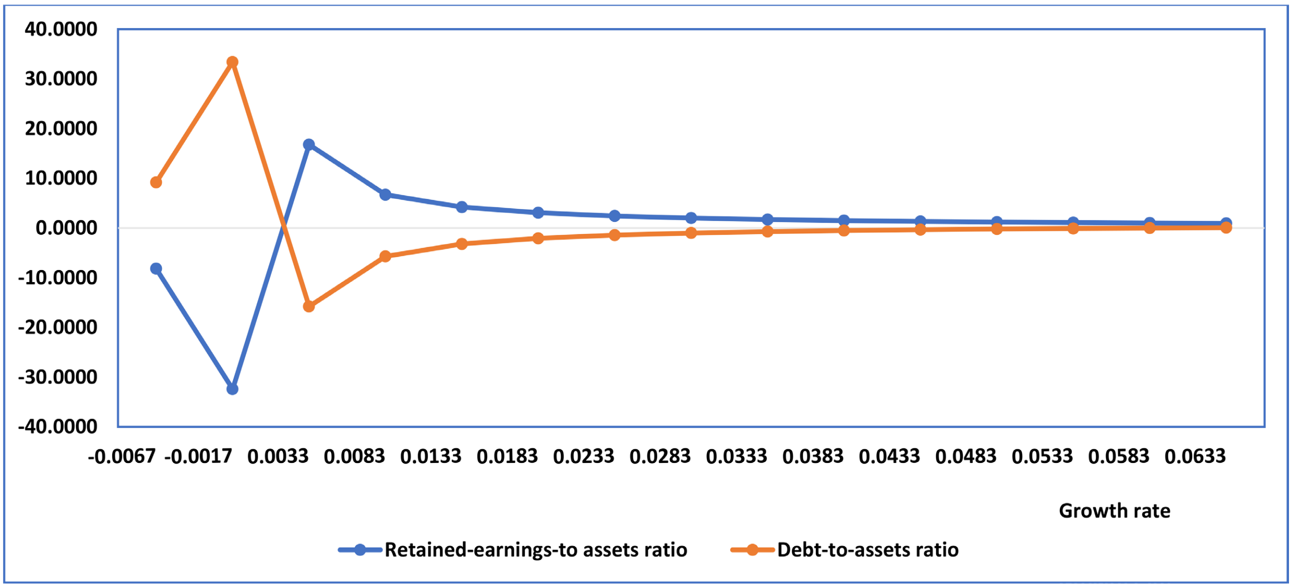

Figure 3. The effect of growth on profitability ratios REA and DAR (Active firms).

Table 6. Values of financial ratios for alternative values of growth (bankrupt firms).

								Median g							
	$g < 0$	$g < 0$	$g < 0$	$g < 0$	$g < 0$	$g < 0$	$g > 0$	$g > 0$	$g > 0$	$g > 0$	$g > 0$	$g > 0$	$g > 0$	$g > 0$	$g > 0$
	$g > r$	$g > r$	$g > r$	$g > r$	$g > r$	$g > r$	$g > r$	$g > r$	$g > r$	$g > r$	$g > r$	$g > r$	$g > r$	$g > r$	$g > r$
g	−0.0290	−0.0240	−0.0190	−0.0140	−0.0090	−0.0040	0.0010	**0.0060**	0.0110	0.0160	0.0210	0.0260	0.0310	0.0360	0.0410
REX	0.9979	0.9874	0.9773	0.9674	0.9579	0.9486	0.9396	**0.9309**	0.9224	0.9141	0.9061	0.8983	0.8907	0.8833	0.8760
RER	−0.0021	−0.0128	−0.0233	−0.0337	−0.0440	−0.0542	−0.0642	**−0.0742**	−0.0841	−0.0939	−0.1036	−0.1132	−0.1227	−0.1322	−0.1415
PRR	−0.0622	−0.0622	−0.0622	−0.0622	−0.0622	−0.0622	−0.0622	**−0.0622**	−0.0622	−0.0622	−0.0622	−0.0622	−0.0622	−0.0622	−0.0622
PRA	−0.0300	−0.0302	−0.0303	−0.0305	−0.0306	−0.0308	−0.0310	**−0.0311**	−0.0313	−0.0314	−0.0316	−0.0317	−0.0319	−0.0320	−0.0322
REA	1.0355	1.2577	1.5969	2.1782	3.4055	7.7010	−30.9588	**−5.1856**	−2.8425	−1.9639	−1.5037	−1.2205	−1.0286	−0.8900	−0.7853
DAR	−0.0355	−0.2577	−0.5969	−1.1782	−2.4055	−6.7010	31.9588	**6.1856**	3.8425	2.9639	2.5037	2.2205	2.0286	1.8900	1.7853
PROB	0.0769	0.0767	0.0765	0.0764	0.0762	0.0761	0.0759	0.0758	0.0756	0.0755	0.0753	0.0752	0.0750	0.0748	0.0747

Legend: REX = Revenue-to-expenditure ratio; RER = Revenue-minus-expenditure-to-revenue ratio; PRR = Profit-to-revenue ratio; PRA = Profit-to-assets ratio; REA = Retained-earnings-to-assets ratio; DAR = Debt-to-assets ratio; PROB = logistic probability of bankruptcy; g = growth rate; r = IRR = −0.0300; q = lag parameter = 0.3455; B = 1.

Table 6 reports the sensitivity of the six financial ratios to growth for bankrupt firms. In this case, the median growth rate (0.0060) is close to zero, such that only two downward steps of 0.005 (to the left of the median) make the growth rate negative. However, on the right-hand side of the table, the cases are characterized by $g > 0$ and $g > r$. In comparison with active firms, the principal differences originate from the negative profitability parameter r (−0.0300) and the very low level of g observed. Then, as with active firms, the profitability ratios (PRR and PRA) are insensitive to growth g. For bankrupt firms, these ratios are negative because $r < 0$. Since $g > r$ in all cases, the cash-flow measure RER is negative and REX is below 1. These cash-flow ratios are more responsive to growth than the profitability ratios, as PRR remains constant and PRA is only marginally affected by changes in g. The most sensitive measures, however, are the long-term solvency ratios REA and DAR, which should be interpreted only when $g > 0$. The solvency ratio REA is negative for $g > 0$ due to the negative value of r. By contrast, DAR is positive, indicating reliance on external capital. In this table, it is assumed that $B = 1$, which implies that the increase in external capital consists entirely of debt. Note that when g is close to zero, the solvency ratios are extremely sensitive to small variations in growth. In conclusion, the empirical findings on the pure effect of growth on financial ratios are parallel with those obtained for active firms. The ranking of sensitivity across the three classes of ratios is therefore: profitability ratios (least sensitive), cash-flow ratios, and solvency ratios (most sensitive). Figures 4-6 describe graphically the effect

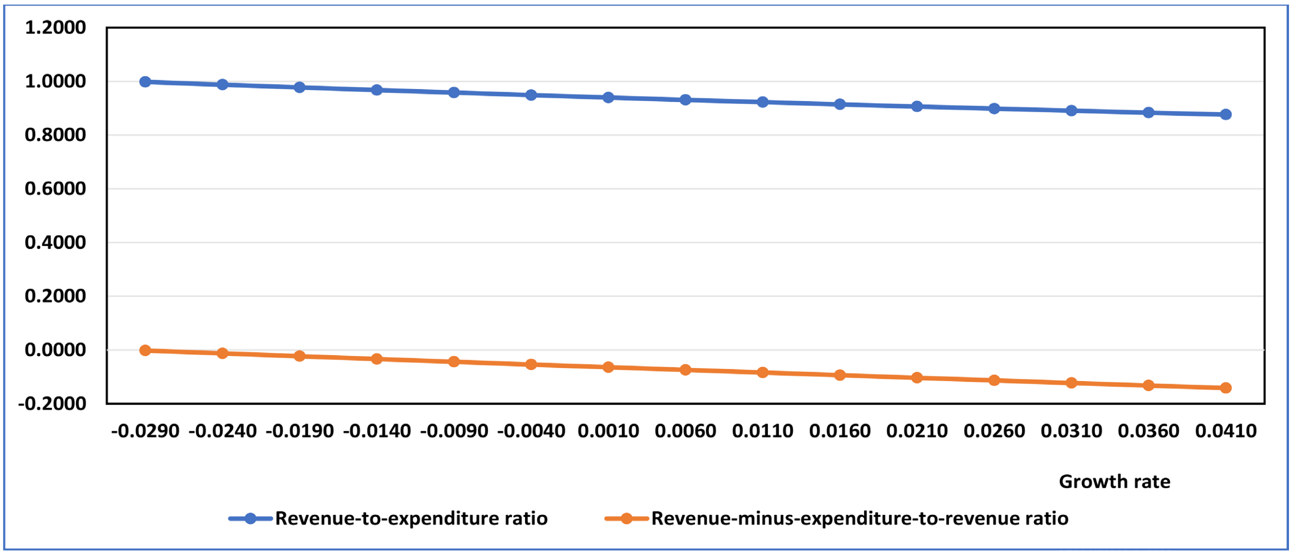

Figure 4. The effect of growth on cash-flow ratios REX and RER (Bankrupt firms).

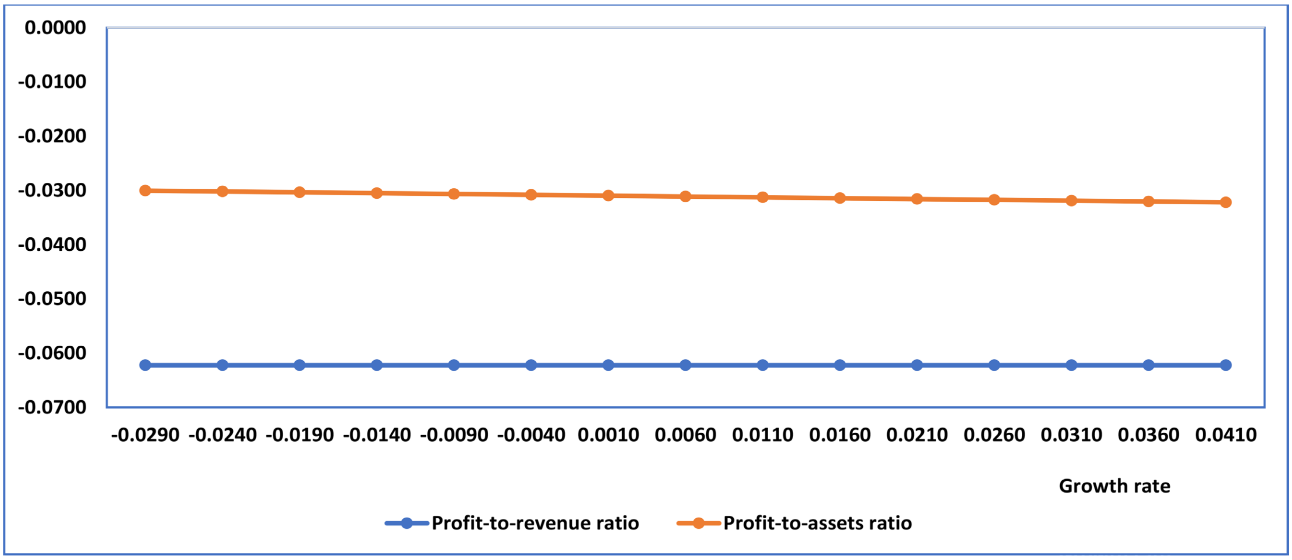

Figure 5. The effect of growth on profitability ratios PRR and PRA (Bankrupt firms).

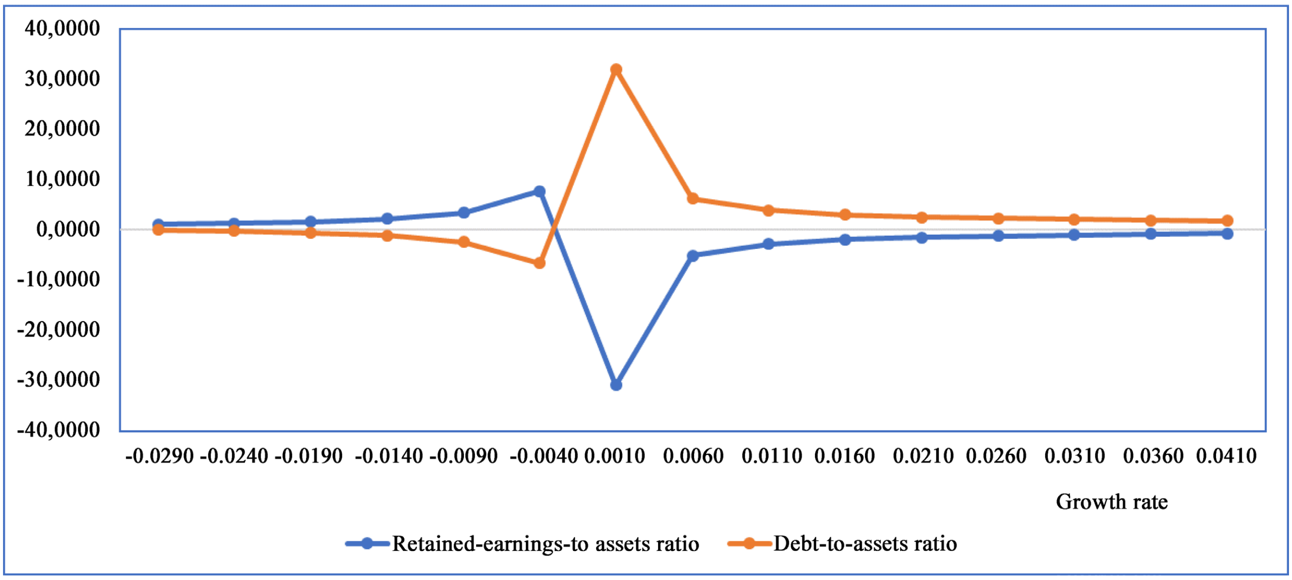

Figure 6. The effect of growth on solvency ratios REA and DAR (Bankrupt firms).

of pure growth on the six financial ratios for bankrupt firms. In the same way as for active firms, the sensitivity of bankruptcy probability (PROB) to growth is marginal: when $g = -0.0290$ (lowest value), PROB = 0.0769, and when $g = 0.0410$ (highest value), PROB = 0.0747.

4. Conclusion

The purpose of this study was to investigate the pure effect of growth on financial ratios. The framework was based on a steady-state lagged model that mathematically characterizes the relationship between financial ratios and the fundamental parameters of the research design. The model is specified by three parameters: growth, profitability, and lag (the latter referring to the delay between expenditure and the generated revenue stream). Because the model assumes steady state, the analysis concerns the long-run values of financial ratios under the condition that these three parameters remain constant. The study focuses on six financial ratios, grouped into three categories: cash-flow ratios, profitability ratios, and solvency ratios. The effect of growth on these ratios was first analyzed theoretically using partial derivatives and elasticities. The theoretical findings were then illustrated with empirical data from Finnish active and bankrupt firms. By "pure effect of growth" it is meant that profitability and lag are held constant, while only the growth parameter varies. Conceptually, this corresponds to a set of firms identical in terms of profitability (IRR) and lag structure, differing solely with respect to growth. The aim was to examine how financial ratios respond to variation in growth under otherwise identical conditions. The results of this analysis highlight the importance of explicitly accounting for growth in financial ratio analysis. When growth-sensitive ratios are applied, the assessment of future growth potential becomes particularly critical.

The study provides a set of theoretical results on the pure effect of growth, offering a general overview of how growth influences financial ratios. Since the exact outcomes depend on the numerical values of the parameters, the results were illustrated with empirical data. The dataset was especially informative, as it included financial information from both active and bankrupt firms: active firms exhibited modest profitability and low positive growth, whereas bankrupt firms showed negative profitability and near-zero growth. Despite these differences, both groups yielded broadly similar results regarding the impact of growth. The analyses suggest that the six ratios can be classified into three groups according to their sensitivity to growth. Profitability ratios (profit-to-revenue ratio and profit-to-assets ratio) were the least sensitive to variation in growth. Cash-flow ratios (expenditure-to-revenue ratio and revenue-minus-expenditure-to-revenue ratio) were more sensitive. Solvency ratios (retained-earnings-to-assets ratio and debt-to-assets ratio) exhibited the highest sensitivity. These findings imply that growth plays a limited role when assessing profitability through financial ratios, but is more consequential for cash-flow ratios and especially for solvency ratios. Because solvency measures accumulate financial flows over longer horizons, growth assumes particular importance in their interpretation.

This study has several limitations that suggest directions for future research. First, the model is based on steady-state assumptions, which enhance analytical tractability but limit generality. The steady financial ratios should therefore be interpreted as long-term equilibrium figures toward which firms converge over time. Future research could extend the framework to non-steady-state contexts, allowing for short-term fluctuations in financial ratios. Second, the model employs an infinite, geometrically distributed lag structure. Subsequent studies could incorporate more complex lag formulations, such as finite Poisson or Almon lags, to capture alternative temporal dynamics. Third, the empirical analysis relies on data from Finnish firms during a period characterized by low profitability and modest growth, making it challenging to identify distinct growth effects. Future studies would benefit from data drawn from economies exhibiting higher profitability and stronger growth performance. Fourth, in the empirical part relatively simple estimation procedures were applied, with steady-state parameters approximated through coarse methods. More sophisticated econometric techniques, including advanced time-series or panel-data analyses, could yield deeper insights into the pure effect of growth. Fifth, the current analysis did not consider taxes, dividends, or interest expenses, all of which could play significant roles in determining cash-flow and solvency ratios. Incorporating these elements in future analyses would enhance the realism and explanatory power. Finally, applying the theoretical findings to practical financial ratio analysis would provide valuable insights for both academic research and financial practice.

Conflicts of Interest

The author declares no conflicts of interest regarding the publication of this paper.

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Appendix

Percentiles of net sales growth, profit-to-assets ratio and net debt ratio in active and bankrupt Finnish firms.

Panel 1. Net sales growth rate						
		Percentile: Active firms:			**Percentile: Bankrupt firms:**	
Period	**25**	**50**	**75**	**25**	**50**	**75**
t-0	−11.389	**−0.174**	10.642	−33.638	**−12.802**	5.761
t-1	−10.776	**−0.375**	10.196	−29.810	**−12.756**	2.460
t-2	−10.332	**−0.089**	10.657	−19.662	**−1.700**	18.497
t-3	−8.482	**2.137**	13.982	−15.852	**−1.351**	14.883
t-4	−3.474	**7.025**	21.770	−14.907	**2.060**	22.983
t-5	−3.958	**8.083**	24.681	−19.806	**3.549**	22.022
t-6	−21.035	**−4.097**	10.226	−13.155	**7.579**	33.603
t-7	−6.781	**5.593**	20.630	−2.920	**10.454**	29.520
t-8	−0.256	**10.943**	30.178	−6.499	**8.743**	31.896

Panel 2. Profit to assets ratio						
		Percentile: Active firms:			**Percentile: Bankrupt firms:**	
Period	**25**	**50**	**75**	**25**	**50**	**75**
t-0	1.225	**6.927**	15.140	−17.611	**−4.500**	3.255
t-1	1.356	**7.134**	15.577	−19.402	**−7.001**	1.977
t-2	1.544	**7.361**	16.059	−8.280	**0.060**	6.522
t-3	1.959	**8.049**	17.412	−7.578	**1.202**	6.495
t-4	2.540	**9.196**	18.746	−3.686	**2.144**	9.420
t-5	2.398	**9.295**	19.127	−2.129	**3.573**	11.925
t-6	1.754	**8.370**	18.648	−1.010	**6.236**	15.580
t-7	3.852	**11.833**	23.445	2.947	**8.913**	17.179
t-8	5.363	**13.859**	26.081	2.811	**9.918**	18.037

Panel 3. Net debt ratio						
		Percentile: Active firms:			**Percentile: Bankrupt firms:**	
Period	**25**	**50**	**75**	**25**	**50**	**75**
t-0	4.320	**21.956**	50.797	36.513	**64.965**	137.916
t-1	4.362	**21.722**	49.590	33.340	**61.478**	115.833
t-2	4.669	**21.260**	47.933	26.398	**49.813**	92.173

Continued

t-3	4.767	**21.024**	46.238	28.845	**46.302**	83.668
t-4	4.581	**21.228**	46.868	25.714	**42.163**	81.055
t-5	4.697	**20.982**	47.621	22.122	**40.234**	72.801
t-6	3.698	**20.339**	48.885	20.125	**37.576**	60.104
t-7	4.160	**19.732**	45.238	19.141	**35.199**	60.620
t-8	6.252	**21.006**	46.298	15.780	**31.477**	64.359