

# A study on the influence of financial factors on the growth of small and medium-sized enterprises in Portuguese high technology and medium-high technology sectors

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*Abstract:* - The purpose of this paper is to find important financial influential factors to the growth of small and medium-sized enterprises (SMEs) in high technology and medium-high technology manufacturing sectors in Portugal. Using the fixed effects model and the pooled regression model, the impacts of some financial variables in previous year on firm growth are observed. In addition, the total sample is further classified into the young firm group and the mature firm group in order to compare the differences of the impacts at different age stages. The results show that there are more financial factors (such as, receivables, short-term loans, intangibles, long-term debt and industry dummy) impacting on young SMEs compared to mature SMEs, which means that young SMEs tend to be more susceptible. In particular, the impacts of profitability and leverage are constant for both young and mature SMEs; the two factors of trade credit (accounts receivables and payables) are negatively related to growth. By contrast, firm age and GDP show different effects at different age stages. This paper has two main contributions: it can help SME managers identify important financial factors to firm growth and then promote development of SMEs; it also contributes to the empirical studies on SME growth in high technology and medium-high technology manufacturing sectors from financial perspective.

*Key-words:* - Financial influential factors, Growth, SMEs, High technology and medium-high technology manufacturing sectors, Fixed effects model, Pooled regression model

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## 1 Introduction

Small and medium-sized enterprises (SMEs) and technology-based firms are two attractive topics to scholars [1]. SMEs work as an important power that pushes competitiveness, growth, innovation, and employment for European

countries [2]. According to the Annual Report on European SMEs [3], in 2018, 99.8 percent of enterprises were SMEs, which contributed to 56.4 percent of value added and 66.6 percent of employment for European Union countries. So the growth of SMEs can benefit much to the economic growth of European Union countries.

Technology-based firms also play an important role in technology development and economic growth [4]. The firms in both high technology and medium-high technology manufacturing sectors could be identified as technology-based firms, because they are R&D (Research and Development) intensive with relatively higher intensity of R&D expenditure on value added [5]. According to the CaixaBank Research reported by Pinheiro [6] on the basis of the data from Eurostat and the Bank of Portugal, the firms in high and medium-high technology sectors contributed to about one fourth of the total sales in Portuguese manufacturing industry in 2016.

Based on the above mentioned importance of SMEs and technology-based firms, this paper studies the growth of some technology-based SMEs in Portuguese high technology and medium-high technology manufacturing sectors. The necessity of researching on the influential factors on sales growth is highlighted by Voulgaris et al. [7], who also point out some important financial features related to growth (for example, low liquidity and high gearing) and the crucial role of financial control and efficiency in the use of limited resources. However, empirical research on firm growth tends to neglect financial factors, which is caused by three reasons — researching from the perspective of industrial organization, analyzing firm growth as a theoretical production function, and lack of access to panel data in the past [8]. So more empirical research on the impacts of financial factors on firm growth should be done with considering different situations of different countries and different industries; thus, having this paper.

Technology-based small firms (especially high-technology small firms) may face with financial constraints and high costs to outside finance, because of serious asymmetric information between inside managers and outside investors, uncertainty in innovation, and difficulty to monitor R&D investments [9]. Therefore, it is necessary to explore the growth of this type of firms more from

financial perspective. The contributions of this paper are: first, it enriches the empirical research on the growth of high technology and medium-high technology SMEs from financial perspective (particularly, compared to other related empirical studies, including not only the commonly used financial ratios but also the factors related to the main financing sources to SMEs as well as industrial and macro-economic factors), which is a relatively less studied area; second, the results of this paper can help the managers of this type of SMEs (especially the managers of young SMEs) to identify significant financial factors that influence growth, and then to promote firm development under the situation of possible financial constraints. The rest of this paper is organized as follows: literature review, data, variables, and methodology, regression results, and conclusions.

## 2 Literature review

As pointed out by Almus and Nerlinger [1], there are many different theoretical models researching on the influential factors on firm's growth (especially young firm growth) from different angles: including the U-shaped long-term average costs; the theory of minimum efficient scale; the theory of industrial economics based on passive learning theory of Jovanovic [10] — that is, new firms learn about their effectiveness which is unknown before starting business and the efficient firms can grow and survive; Life-Cycle-Models classifying and researching on various development stages of firms. They further summarize that the determinants on growth can be identified into firm-specific, founder-specific and external characteristics. However, due to the limits of data available, here we mainly study firm-specific characteristics (particularly financial factors).

### 2.1 Size and age

Gibrat's law [11] (proposed in 1931) is a crucial theoretical research on the determinants of firm growth in early period, which believes that firm's growth is independent of its size at the beginning

period [12]. Following that, a number of empirical studies have tried to testify Gibrat's law [11]. However, as summarized by Bartlett and Bukvič [13], the majority of empirical studies support a consistent negative relationship between firm size and growth, which is contrary to the theoretical expectation that (compared to small firms) large firms should have more advantages and should grow faster; and they also list some possible explanations about the negative relationship, such as the passive learning theory [10], diseconomies of scale for large firms, and the short run U-shaped cost curves.

In fact, according to the results of most empirical studies, not only does firm size show a negative relationship with growth, but firm age is also negatively related to growth for the surviving firms [12] [14]. More specifically, the relationship between firm growth and firm size is negative when controlling age, while firm growth is also negatively related to age when controlling firm size [15]. As pointed out by Dunne and Hughes [16], compared to younger firms that lack of experienced management and tend to make mistakes, the growth patterns of old small firms could be similar to that of larger firms. Lotti et al. [17] further state that: considering the prevalence of sub-optimal scale in young and small firms, rapid growth can help these firms decrease average costs; on the other hand, a flattening average cost curve is observed for established mature firms, thus showing Gibrat-like pattern of growth.

## **2.2 Profitability and solvency**

Theoretically, good profitability should work as a positive indicator for growth, as retained earnings can be extracted from profits for investments and then growth, and the positive effect of profitability is also supported by the empirical studies of (for instance) Anton [18] and Delmar et al. [19]. However, Coad [20] points out four possible situations where a negative relationship between growth and profitability may exist: first, due to difference in growth propensity, some high-profit firms may not be interested in business

opportunities and then these opportunities are taken by less profitable competitors; second, for the firms with market power, reducing production capacity would lead to higher profit margin and then higher profit rate in the inelastic demand market; third, when occupying a highly profitable niche market, firms may not have opportunities to expand; fourth, efficiently shrinking in size and concentrating on firm's core competence may cause higher profit rate.

As for solvency and liquidity, according to Cole [21], liquid assets can not only protect firms from financial distress, but can also provide financial slack (which means that firms would not need to increase new outside capital when meeting unexpected investment opportunities). Notwithstanding that, the research of Moreira [2] on the internet and high-tech SMEs shows statistical insignificance regarding the impacts of solvency and liquidity on growth, which means that these two factors do not work as determinants on growth (for the internet and high-tech SMEs). Huynh and Petrunia [15] state that financial variables contain the information about firm growth, and after controlling size and age they find that the relationship between firm growth and leverage is positive and non-linear (being more sensitive for the firms with low and intermediate leverages).

## **2.3 Intangible fixed assets & tangible fixed assets**

Intangible assets play an important role in modern knowledge economy [22]. Intangibles are associated with innovation activities (for example, the invention of new products and services and the improvement of techniques), so intangible assets occupy an important part in high-technology enterprises [23] [24]. In fact, intangible capital is an important contributor to output and productivity growth [25]; in particular, as for European Union countries, intangibles contribute more to the labor productivity in manufacturing sector (due to the high share of intangible investment) than they do in service sector [26].

Mateev and Anastasov [27] use the ratio of

intangible assets to total assets to proxy for future growth opportunities; and they propose an expectation of a negative relationship between intangible assets and the growth in operating revenues, as intangible assets (including research and development expenditure, trademarks, patents and copyrights) are the investments for long-term benefits. By contrast, investments in tangible assets can help to satisfy the increasing demand, to buffer against technological obsolescence, and to prepare for launching new products; for example, investing in new machinery can upgrade technology (introducing more recent technology in), which should lead to productivity increase, more market share, and sales and employment growth [28].

#### 2.4 Trade credit & bank credit

Bădulescu [29] points out that access to financing is one of the most pressing problems to the SMEs in European Union, and bank loans and trade credit are important sources for financing SMEs. However, financial constraints make the status of trade credit important, because of firms using trade credit as the substitute to bank credit if being constrained [30]. And this should be especially true for SMEs due to asymmetric information problem [31]. As for empirical studies, both trade credit and bank credit (loans) are verified to be related to growth. For example, the study of Ferrando and Mulier [32] confirms that the trade credit channel is used by firms (especially those that are easily to be impacted by financial

market imperfections) to manage growth; according to Rostamkalaei and Freel [33], high interest rates of loans are related to high-growth firms and small firms that launch new products.

### 3 Data, variables, and methodology

The sample firms are chosen from the Iberian Balance Sheet Analysis System database (SABI; developed by Bureau Van Dijk). More specifically, the small and medium-sized enterprises (SMEs) from high technology and medium-high technology manufacturing sectors in Portugal are chosen with their data from 2011 to 2016, where the firms with missing value, outliers and errors are precluded from the sample (Table 1). Referring to the criteria of European Union as well as the standards in the research of Sogorb-Mira [34] and García-Teruel and Martínez-Solano [35] for the identification of SME, here the standards for SME (being a little more constrained than the criteria of European Union) are: number of employees less than 250; turnover less than or equal to 50 million Euros; and balance sheet total less than or equal to 43 million Euros. Furthermore, following the classification of Haltiwanger et al. [36] where the age of ten years old is the separating point between young firms and mature firms, the total sample in this paper is also categorized into two groups with using this classifying standard.

Table 1 Distribution of the sample firms in industry sectors

Manufacturing sectors (NACE Rev.2 2-digit level)	Technology type	Number of firms in total sample (1519)	Observations in total sample (7595)	Number of young firms (474)	Observations of young firms (2370)	Number of mature firms (1045)	Observations of mature firms (5225)
Manufacture of chemicals and chemical products (20)	Medium-high	290	1450	78	390	212	1060
Manufacture of basic pharmaceutical products and pharmaceutical preparations (21)	High	52	260	13	65	39	195

Manufacture of computer, electronic and optical products (26)	High	87	435	41	205	46	230
Manufacture of electrical equipment (27)	Medium-high	236	1180	83	415	153	765
Manufacture of machinery and equipment n.e.c. (28)	Medium-high	614	3070	184	920	430	2150
Manufacture of motor vehicles, trailers and semi-trailers (29)	Medium-high	178	890	52	260	126	630
Manufacture of other transport equipment (30)	Medium-high	62	310	23	115	39	195

Notes: The technology type is referred to the high-tech classification of manufacturing industries based on NACE Rev. 2 2-digit level from Eurostat.

The study of Achtenhagen et al. [37] shows that sales (turnover) rank as the first choice of the proxy in measuring growth. This is because sales are easy to access, can be suitable for all kinds of firms, and are insensitive to capital intensity and integration [38]. Therefore, the growth of operating revenues is chosen as the dependent variable here. For

independent variables, some financial factors are picked up from the study of Voulgaris et al. [7] on small firm growth, including profitability, debt leverage and structure, asset structure, liquidity, supplier's credit, size, and age. In addition, we also take macro-economic and industry dummy variables into consideration (Table 2).

Table 2 Definition of variables

Dependent variable	Measurement
Growth (the growth of operating revenues)	Natural logarithm of operating revenues in year t minus natural logarithm of operating revenues in year t-1: $\ln$ operating revenues in year t — $\ln$ operating revenues in year t-1
<b>Independent variables</b>	<b>Measurements (in year t-1)</b>
Firm size (assets)	Natural logarithm of total assets: $\ln$ total assets in thousands of Euros
ROA (return on assets)	Economic profitability: Profits before tax/Total assets
Liquidity	General liquidity: Current assets/Current liabilities
Leverage (solvency)	Indebtedness: (Total shareholders' funds and liabilities — Shareholders' equity)/Total shareholder's funds and liabilities
Intangibles	The ratio of intangible fixed assets to total assets
Tangibles	The ratio of tangible fixed assets to total assets
Receivables	The ratio of accounts receivable to total assets
Payables	The ratio of accounts payable to total assets
Long-term debt	The ratio of long-term debt to total assets
Short-term loans	The ratio of short-term loans to total assets
Age	Natural logarithm of firm age based on 2011: $\ln$ firm age (which changes with the increase in year)

GDP (Gross Domestic Product)	GDP growth in percentage in 2011, 2012, 2013, 2014, 2015 (from the database of the World Bank)
Industry dummy	NACE Rev. 2 2-digit level from Eurostat: 20, 21, 26, 27, 28, 29, 30

Referring to the research of Segarra and Teruel [8] on firm growth where financial ratios in the previous period are used as the independent variables, this paper observes the impacts of financial factors in the previous year (year t-1) on the growth of firms (between year t and year t-1). Following the study of Mateev and Anastasov [27], the data of sampled firms need to cover the whole

studying period from 2011 to 2016, and the balanced panel data (with 1519 firms and 7595 observations for a five-year growth of operating revenues) are built. In particular, the research methods of Pais and Gama [39] regarding the fixed effects model and the pooled regression model are also referred to here.

## 4 Regression results

### 4.1. The results of the fixed effects model with P-value at 0.05 as the statistically significant level (Table 3)

In all the regressions of the fixed effects model, firm size and ROA are negatively related to growth, while indebtedness is positively related to growth. Accounts receivable (mainly for young SMEs) and accounts payable (in all the regressions) are negatively related to growth; short-term loans are too negatively related to growth for young SMEs. The impact of GDP growth is instable, being positive for young SMEs but being negative

for mature SMEs; the impact of age is also instable, being negative for young SMEs but being positive for mature SMEs. Liquidity, intangible assets, tangible assets, and long-term debt are not statistically significant. Here, for the variables showing statistical significance in both the young and the mature groups, the absolute values of young SMEs are larger than those of mature SMEs in most cases (for example, Ln total assets, ROA, indebtedness, and GDP). And there are more variables showing statistical significance in the young group. Therefore, financial factors tend to impact more on young SMEs than on mature SMEs.

Table 3 The results of the fixed effects model

Total SME sample	Young SMEs no more than 10 years old			Mature SMEs more than 10 years old					
Number of groups: 1,519	Number of groups: 474			Number of groups: 1,045					
Number of observations: 7,595	Number of observations: 2,370			Number of observations: 5,225					
R-square: within = 0.124	R-square: within = 0.177			R-square: within = 0.093					
R-square: between = 0.0004	R-square: between = 0.0002			R-square: between = 0.023					
R-square: overall = 0.006	R-square: overall = 0.016			R-square: overall = 0.0001					
Prob > F = 0.000	Prob > F = 0.000			Prob > F = 0.000					
F(12,6064)= 71.44	F(12,1884)= 33.84			F(12,4168) = 35.68					
corr(u_i, Xb) = -0.937	corr(u_i, Xb) = -0.878			corr(u_i, Xb) = -0.965					
Dependent variable: Operating revenues growth									
Independent variables	Coefficients	t	P> t	Coefficients	t	P> t	Coefficients	t	P> t
Ln total assets	-0.342	-17.39	0.000	-0.371	-10.82	0.000	-0.288	-11.65	0.000

ROA	-0.869	-14.96	0.000	-1.113	-9.71	0.000	-0.703	-11.04	0.000
Liquidity	0.0009	0.76	0.444	0.0003	0.11	0.911	0.0011	0.87	0.386
Indebtedness	0.354	5.24	0.000	0.463	3.56	0.000	0.285	3.71	0.000
Intangibles	-0.064	-0.22	0.827	-0.397	-0.87	0.387	-0.027	-0.06	0.950
Tangibles	-0.004	-0.06	0.953	0.012	0.09	0.929	0.010	0.13	0.898
Receivables	-0.208	-4.42	0.000	-0.341	-3.76	0.000	-0.090	-1.72	0.086
Payables	-0.520	-6.56	0.000	-0.497	-3.50	0.000	-0.506	-5.35	0.000
Long-term debt	-0.031	-0.44	0.659	-0.149	-1.16	0.248	0.046	0.57	0.566
Short-term loans	-0.141	-1.68	0.092	-0.388	-2.28	0.023	0.044	0.48	0.630
Ln age	-0.021	-0.58	0.562	-0.115	-2.03	0.042	0.906	8.09	0.000
GDP	1.268	5.13	0.000	3.062	4.85	0.000	-1.242	-3.83	0.000
Constant	2.424	18.14	0.000	2.653	14.14	0.000	-0.989	-2.49	0.013
F test: Prob > F = 0.000			F test: Prob > F = 0.000			F test: Prob > F = 0.012			
Hausman test: Prob>chi2 = 0.000			Hausman test: Prob>chi2 = 0.000			Hausman test: Prob>chi2 = 0.000			

Notes: All the results of F-test show that the fixed effects model is better than the pooled regression model, and all the results of Hausman-test show that the fixed effects model is better than the random model. So there is no need to do Breusch-Pagan test to compare the random model with the pooled regression model.

#### 4.2. The results of the pooled regression model including industry dummy with P-value at 0.05 as the statistically significant level (Table 4)

Compared to the young group, there are much less statistically significant independent variables (only two) in the mature group. In particular, ROA is negatively related to growth in all the regressions; accounts receivable (for the total sample) and long-term debt (for young SMEs) are also

negatively related to growth. Short-term loans, accounts payable, and age are negatively related to growth for the total sample and young SMEs. On the other hand, indebtedness and intangible assets are positively related to growth for the total sample and young SMEs. Firm size, liquidity, tangible assets, and GDP growth are not statistically significant. Industry dummy shows more significance in the young group than in the mature group.

Table 4 The results of pooled regression model with industry dummy

Total SME sample				Young SMEs no more than 10 years old				Mature SMEs more than 10 years old			
Number of observations: 7,595				Number of observations: 2,370				Number of observations: 5,225			
R-square = 0.044				R-square = 0.087				R-square = 0.013			
Adjusted R-square = 0.042				Adjusted R-square = 0.080				Adjusted R-square = 0.009			
Source	Sum of Squares	Drgree of freedom	Mean Square	Source	Sum of Squares	Degree of freedom	Mean Square	Source	Sum of Squares	Degree of freedom	Mean Square
Model	49.053	18	2.725	Model	52.882	18	2.938	Model	6.253	18	0.347
Residual	1063.139	7,576	0.140	Residual	557.211	2,351	0.237	Residual	483.276	5,206	0.093
Total	1112.192	7,594	0.147	Total	610.093	2,369	0.258	Total	489.528	5,224	0.094
Root Mean Square Error = 0.375				Root Mean Square Error = 0.487				Root Mean Square Error = 0.305			

F(18,7576)=19.42; Prob > F = 0.000			F(18,2351)=12.40; Prob > F = 0.000			F(18,5206)=3.74; Prob > F = 0.000			
Dependent variable: Operating revenues growth									
Independent variables	Coefficients	t	P> t	Coefficients	t	P> t	Coefficients	t	P> t
Ln total assets	0.002	0.53	0.598	-0.015	-1.85	0.065	0.005	1.62	0.104
ROA	-0.358	-8.38	0.000	-0.537	-6.02	0.000	-0.246	-5.49	0.000
Liquidity	-0.002	-1.90	0.058	-0.002	-0.96	0.339	-0.001	-1.32	0.186
Indebtedness	0.091	2.97	0.003	0.185	2.89	0.004	0.020	0.61	0.540
Intangibles	0.443	4.19	0.000	0.641	3.64	0.000	-0.178	-1.23	0.218
Tangibles	0.007	0.26	0.798	0.064	1.06	0.289	-0.003	-0.13	0.897
Receivables	-0.077	-3.26	0.001	-0.096	-1.84	0.067	-0.043	-1.76	0.078
Payables	-0.112	-2.66	0.008	-0.214	-2.60	0.009	-0.017	-0.37	0.711
Long-term debt	-0.071	-1.93	0.054	-0.156	-2.07	0.039	0.016	0.39	0.697
Short-term loans	-0.113	-2.35	0.019	-0.247	-2.27	0.023	-0.014	-0.28	0.776
Ln age	-0.080	-12.15	0.000	-0.173	-8.58	0.000	-0.020	-1.79	0.073
GDP	0.103	0.49	0.625	0.781	1.52	0.129	0.083	0.40	0.689
Industry dummy 1	0.031	1.30	0.193	0.129	2.46	0.014	-0.024	-1.01	0.310
Industry dummy 2	0.030	0.93	0.351	0.236	3.06	0.002	-0.063	-2.02	0.043
Industry dummy 3	0.037	1.31	0.191	0.105	1.83	0.067	0.019	0.64	0.524
Industry dummy 4	0.003	0.13	0.897	0.080	1.54	0.123	-0.035	-1.43	0.153
Industry dummy 5	0.023	1.03	0.305	0.109	2.23	0.026	-0.015	-0.63	0.526
Industry dummy 6	0.009	0.38	0.704	0.043	0.77	0.440	-0.005	-0.19	0.850
Constant	0.266	6.85	0.000	0.455	5.38	0.000	0.077	1.48	0.140

Notes: There are seven manufacturing sectors in the total sample, so six industry dummy variables are generated.

### 4.3. Summary of the results of the two models

Table 5 The summary of the statistically significant variables at the P-value of 0.05 in two models

Independent variables	Total SMEs		Young SMEs		Mature SMEs		Type of model
	Coefficients	P> t	Coefficients	P> t	Coefficients	P> t	
ROA (6 times)	N	0.000	N	0.000	N	0.000	Fixed effects model
	N	0.000	N	0.000	N	0.000	Pooled regression model
Indebtedness (5 times)	P	0.000	P	0.000	P	0.000	Fixed effects model
	P	0.003	P	0.004			Pooled regression model
Payables (5 times)	N	0.000	N	0.000	N	0.000	Fixed effects model
	N	0.008	N	0.009			Pooled regression model
Ln age (4 times)			N	0.042	P	0.000	Fixed effects model
	N	0.000	N	0.000			Pooled regression model
Receivables (3 times)	N	0.000	N	0.000			Fixed effects model
	N	0.001					Pooled regression model



Short-term loans (3 times)			N	0.023			Fixed effects model
	N	0.019	N	0.023			Pooled regression model
Ln total assets (3 times)	N	0.000	N	0.000	N	0.000	Fixed effects model
							Pooled regression model
GDP (3 times)	P	0.000	P	0.000	N	0.000	Fixed effects model
							Pooled regression model
Intangibles (2 times)							Fixed effects model
	P	0.000	P	0.000			Pooled regression model
Long-term debt (1 times)							Fixed effects model
			N	0.039			Pooled regression model
Tangibles (0 times)							Fixed effects model
							Pooled regression model
Liquidity (0 times)							Fixed effects model
							Pooled regression model
Industry dummy 1			P	0.014			Pooled regression model
Industry dummy 2			P	0.002	N	0.043	Pooled regression model
Industry dummy 3							Pooled regression model
Industry dummy 4							Pooled regression model
Industry dummy 5			P	0.026			Pooled regression model
Industry dummy 6							Pooled regression model

Notes: “P” represents the coefficients with positive sign; “N” represents the coefficients with negative sign; the numbers of times in parenthesis represent the statistics of that variable being statistically significant at the P-value of 0.05 in two models.

We classify the independent variables into different levels on the basis of the frequency of showing statistical significance at the P-value of 0.05 (Table 5). First, ROA, indebtedness, and payables are classified as the top level, not only because these three variables are statistically significant in all the three regressions of the fixed effects model and at least two out of three regressions of the pooled regression model but also due to their constant signs of coefficients. Second, the variables that are categorized as the second level include age, receivables, short-term loans, total assets and GDP, as they are statistically significant in three or four regressions out of the total six regressions in the two models. And here we should notice that both the positive effect and negative effect are observed for age and GDP in the fixed effects model. Besides, receivables and short-term loans do not work as statistically significant variables in the regressions for mature SMEs. Third, intangibles

and long-term debt are classified as the third level, which only show statistical significance one or two times in total. Forth, tangibles and liquidity are not statistically significant in both two models. Fifth, industry dummy shows statistical significance three times for young SMEs (with positive effects) but only one time for mature SMEs (with negative effect) in the pooled regression model.

#### 4.4. Discussion

Generally speaking, the differences of the results between the fixed effect model and the pooled regression model are quite obvious. However, ROA is statistically significant in all the regressions of both two models; thus being the most important influential factor. Here, the negative relationship between profitability (ROA) and growth seems to be divergent to the traditional expectation (that is, good profitability can help to accumulate internally generated funds for growth), but it is possible after considering the features of high and medium-high technology sectors. This is because, compared to

growth, investing in R&D and generating intangible assets should be more important for profitable SMEs in high and medium-high technology sectors. The barrier here that hinders transferring profits to growth may to some extent supports the statement of Srhoj et al. [40] that high-growth firms tend to become less common in high-tech industries.

Following ROA, indebtedness is statistically significant in most regressions. The positive relationship between leverage (indebtedness) and growth found here corresponds to the findings of most empirical studies on SMEs or young companies [41]. This relationship can be explained by possible financial constraints to SMEs in high and medium-high technology sectors. Under financial constraints, the positive effect of obtaining external financing becomes more manifest to growth.

Both accounts receivable and accounts payable tend to be negatively related to growth and compared to accounts receivable the impact of accounts payable tends to be more obvious. The results here confirm that growth can be managed by trade credit channel [42]. Theoretically, an increase in accounts receivable means granting trade credit to client firms which should be helpful to promote sales [43], while an increase in accounts payable means obtaining trade credit from suppliers which can help to reduce financial pressure [44]. However, due to possible financial constraints on SMEs, an increase in receivables may cause troubles in cash collection and then lead to financial distress. On the other hand, plenty of payables may finance firms in the short run, but these firms need to prepare large amount of cash for those payables which would make these firms lose future investment opportunities (especially long-term investments in R&D for high and medium-high technology SMEs).

Both short-term loans and long-term debt tend to be negatively related to growth especially for young SMEs, since neither shows statistically significance in the regressions of the mature group.

The negative relationships may be caused by high interests charged by financial institutions to SMEs in high and medium high technology sectors, because of the problems pointed out by Bădulescu [29] — information asymmetry between the lenders and the borrowers and the high risks. Further comparing the absolute values of the coefficients of short-term loans and long-term debt in the pooled regression model of the young group, the results show that the impact of long-term debt is lower than that of short-term loans. This may be because young SMEs are granted less long-term debt compared to short-term loans. In fact, the cost of capital for younger firms is driven by banks using collateral agreements and loan guarantees to reduce moral hazard [45] and this should be especially true when young SMEs apply for long-term loans; thus, resulting in less long-term loans granted. Therefore, compared to long-term loans, short-term loans are more easily used by SMEs in high and medium high technology sectors.

Intangible assets are positively related to growth in the pooled regression model but not for mature SMEs. This positive relationship to some extent reflects the importance of intangible assets to the firms (for example, as a contributor to output growth — Muntean [25]). Furthermore, the results here show that young SMEs are more advantageous to use intangible assets to enhance sales than mature SMEs are in high and medium-high technology sectors. Thereby, it is reasonable to believe that new technology should be more easily used by young firms to drive growth (which also means the importance of technological distinctiveness for young firms to achieve advantages [46]).

Firm size is negatively related to growth in the fixed effects model. The result here corresponds to the main stream empirical studies supporting the negative relationship between size and growth [12] [14]. Furthermore, the absolute value of the mature group is lower than that of the young group. This is to some extent in accord with the research of Nurmi [47] confirming relative weakness of the

negative relationship between size and growth for older plants. The impact of age is instable in the fixed effects model, while it is negatively related to growth in the pooled regression model. In particular, a positive relationship between age and growth is found for mature SMEs in the fixed effects model. Here, it is necessary to consider the features of high and medium-high technology sectors. In concrete, for young SMEs younger firms should be easier to use the newest technology to develop productivity and then increase sales, whereas for mature SMEs older firms may develop technology internally and then drive sales through internal technology development.

The impacts of GDP growth is instable (being positive for young SMEs but being negative for mature SMEs) in the fixed effects model, while industry dummy shows more significance for young SMEs (three times with positive effects) than for mature SMEs (one time with negative effect) in the pooled regression model. The results here show that young SMEs tend to rely more on positive macro-economic environment and industrial environment. According to the theories of selection effects, passive learning theory of Jovanovic [10], and learning-by-doing effects, older firms should have higher productivity than younger firms do [48]. Therefore mature SMEs should be more stable than young SMEs when facing with the change of industrial environment or macro-economic environment.

General liquidity and tangible assets are not statistically significant in both models. The insignificance of general liquidity is not surprise, because the main purpose for holding liquid assets is to protect firms from financial distress [21]. And this corresponds to the research results of Moreira [2] about the internet and high-tech SMEs, where statistical insignificance is observed regarding the impact of liquidity on growth. The result of insignificance of tangible fixed assets can be explained by the statement of Perić and Đurkin [49] showing the importance of investing in fixed assets for long-term (rather than short-term) success and

competitive advantage. Besides, it may also indicate that in high and medium-high technology sectors tangible fixed assets are not as important as they are in other manufacturing sectors.

## 5 Conclusions

All in all, as pointed out by Segarra and Teruel [8], financial factors are less considered in the empirical research on firm growth; thus, using the fixed effects model and the pooled regression model on panel data, this paper studies the influence of financial factors on the growth of high technology and medium-high technology manufacturing SMEs in Portugal because of the importance of this type of SMEs to technology development. Compared to other related empirical studies, this paper not only considers some commonly used financial ratios, but also studies factors from the financing sources to SMEs (trade credit and bank credit) as well as industrial and macro-economic factors. So this paper firstly contributes to the country-specific empirical research on the growth of high technology and medium-high technology SMEs from financial perspective which is a less studied area; secondly, it can also assist SME managers to identify significant financial influential factors on growth in order to promote firm development under the situation of possible financial constraints for high technology and medium-high technology SMEs (especially the young SMEs where the managers are relatively less experienced).

The results of this paper show that: aside from profitability, leverage, and accounts payable that show stable influence on both young and mature SMEs, there are more statistically significant variables (such as, accounts receivable, short-term loans, intangibles, long-term debt and especially industry dummy) in the young group. Therefore, financial factors tend to impact more on the growth of young SMEs than they do on mature SMEs, which means that young SMEs tend to be more susceptible. This may be caused by the relatively

serious financial constraints on young SMEs in high and medium-high technology manufacturing sectors. Given that financial constraints on SMEs (especially on young SMEs) may commonly exist, it is possible that some results here could be suitable for other European countries. This paper goes one step further in the research of the impacts of financial factors on technology-based SME growth in one particular European country; future research should continue to explore the influence of financial factors on this type of SMEs in other European countries.

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