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# Gazelles and muppets in the City: Stock market listing, risk sharing, and firm growth quantiles


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## Gazelles and muppets in the City: Stock market listing, risk sharing, and firm growth quantiles

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# Gazelles and muppets in the City: Stock market listing, risk sharing, and firm growth quantiles.

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**Abstract**

Financialization is persuading academics and policy-makers that the growth of SMEs can be unleashed by promoting their quotation on stock markets. Is that true? Answering this can give clues on the functions that stock markets actually perform in the financialized world. The market may allow collecting finance for productive investments, or mainly provide firms with opportunities for value extraction. It may work as a selection device or as a risk-sharing mechanism.

In this paper, we test hypotheses linking the shape of the firm growth rates distribution to stock market functions, through quantile regressions. We use a sample of UK manufacturing companies listed on AIM, a *junior* segment of the London Stock Exchange, and comparably small and young unlisted companies. We find that the operating revenues and total assets of AIM-listed *gazelles* grow faster than for their unlisted peers, after controlling for lagged values of size, age, and growth. Yet, there is a loss reinforcing effect for companies listed on the AIM. After controlling for endogeneity by estimating instrumental variable quantile treatment effect (IVQTE), our findings dismiss the existence of a treatment effect of public quotation and are consistent with the stock market attracting relatively risky companies.

**Keywords**: Firm growth; Quantile regression; Stock market; Financialization.

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# 1 Introduction

The explosion of trading volumes in the last decades and the associated *financialization* of economic systems has been convincingly documented by Dore (2008), Lazonick (2010), van der Zwan (2014) among others. Stock market trading is increasingly pervasive in all aspects of economic life. One instance of this trend is the growing involvement of SMEs in equity markets. In 2009 Mr. Lamberto Cardia, then president of Consob, the Italian stock exchange commission, argued that access of SMEs to stock market trading should be simplified (Cardia, 2010), in order to allow them overcome the credit constraints that have become tighter in the aftermath of the financial crisis (Wehinger 2012) and after the Basel accords (Saurina and Trucharte, 2007; Scellato and Ughetto, 2010).

That statement should be understood in light of the increasing *democratization of entry* (Kerr and Nanda, 2009) and the deregulation of the stock market listing process, a *mild* form of financialization whereby a stock exchange creates segments catering to companies that do not satisfy the official listing requirements, and the listing decision is out-sourced to specialized financial intermediaries, called "sponsors" or "nominated advisers". Such market segments were known as *New Markets* in the Nineties (Giudici and Roosenboom, 2004; Posner, 2009) and are now referred to as *junior stock markets* or *second markets for small companies* (Vismara et al., 2012). Junior stock markets have been created by major stock exchanges (e.g. London Stock Exchange, Deutsche Börse, Toronto Stock Exchange), allowing even the shares of very small and young companies to be publicly floated (Lagneau-Ymonet et al., 2014).

The question then arises as to whether young and small firms should go public. As observed in 2007 by Mr. Roel Campos, one of five commissioners at the US market regulator, in reference to the British junior market AIM, "That feels like a casino to me, and I believe that investors will treat it as such", then adding, "If one essentially brags about lower [regulatory] standards and uses that as the advertising principle then over the long-term capital and investors will not be as attracted to that type of market."

Stimulating SMEs to go public can be justified if their growth performance is better than for the unlisted ones - but is that true? And once listing requirements are softened, what is the profile of the young SMEs choosing to go public? Providing answers to the above questions would help making sense of the ultimate functions of the stock market. While it may select promising entrepreneurial projects and allow collecting finance for productive investments, the stock market may provide opportunities for value-extracting financialization, as discussed by Lazonick and Mazzucato (2013) in their risk-reward perspective. The stock market may mainly share the risk among the many to provide rewards for the few.

The wide-ranging detour of the financialization literature in Dosi et al. (2016), indeed, makes it clear that value extraction does often occur in practice, as testified by anecdotal evidence, case studies, and quantitative evidence. What we propose here is to go beyond case studies and search the footprints of financialization in the whole distribution of firm growth rates, thereby bridging the financialization literature with the industry dynamics one, in a somewhat more explicit way than Dosi et al. (2016).

The distribution of growth rates is indeed a precious source of information on the firm growth process. Bottazzi and Secchi (2006) inferred the presence of increasing returns to scale from the evidence of Laplace-distributed firm growth rates, spurring further attempts in the same spirit (e.g. Coad, 2006; Alfarano and Milakovic, 2008). Quantile regression, popularized in industry dynamics by Machado and Mata (2000) and Coad and Rao (2006), allows to follow the time evolution of the growth rates distribution as well as to compare its shape across firm groups. Both approaches, in any case, highlight that the tails of the firm growth distribution are highly informative.

The evidence piling up in the last decade has mainly thrown light on the contribution of high-growth firms (HGFs), also known as *gazelles*, to job creation (see the results summarized in Henrekson and Johansson 2010, Bos and Stam 2014, Moreno and Coad 2015),[1] and has explored the main features of HGFs.[2] The focus on gazelles may lead one to lose the whole picture, underestimating cases in which IPO firms plummet after an initial growth rate boost. Hence it is advisable to track also the dynamics of firms that decline (Coad et al., 2014a).

In the blossoming literatures on quantile regression and gazelles, relatively few works have explored capital structure issues. Finance is deemed essential by Mason and Brown (2013) to turn episodic high growth into a sustained advantage over competitors. Credit constraints, in particular, hamper the performance of potential gazelles (Bottazzi et al., 2014). While the role of private equity for HGFs has not been extensively scrutinized (except for Audretsch and Lehmann 2004 and a preliminary attempt by Coad and Siepel, 2012), Vanacker and Manigart (2010) find that gazelles resort to public equity issues to overcome their debt capacity constraints. Consistently, Bravo-Biosca et al. (2013) have shown that gazelles are more frequent in more financially developed economies. Those works only partly fill a gap which is rather surprising, in light of the financial crisis and the related banking and financial regulatory reforms.

This paper explores the impact of stock market listing on the entire distribution

[1] See Coad et al. (2014a) for a discussion of the various definitions of HGFs.

[2] HGFs are found to be younger than non-HGFs (Haltiwanger et al., 2013), giving a reason for supporting new firm formation, but contrary to previous beliefs, the contribution of high-tech companies is not disproportionately larger among gazelles (Mason and Brown, 2013). Though, high-growth episodes lack persistence (Parker et al., 2010; Daunfeldt and Halvarsson, 2014; Hölzl, 2014).

of firm growth rates in order to compare the performance of gazelles, "static", and declining firms.[3] The research is focused on the AIM, a segment of the London Stock Exchange and the most liquid among the junior stock markets. AIM does not impose any minimal listing requirement and admission is granted by financial intermediaries called Nominated Advisors (Nomads), who perform discretionary suitability assessments and assist their client companies in financial strategy and market information provision. We analyze a sample of UK manufacturing companies observed annually between 1997 and 2008. The sample includes companies listed on AIM and a set of private companies that are comparable to their AIM-listed counterparts in terms of size, age, and sectoral distribution (sources: Amadeus, Osiris, London Stock Exchange). The focus on AIM and not on the LSE main market is motivated by the stronger similarity, in size, age, and governance, between AIM-listed companies and the unlisted ones, which allows to better isolate the sheer impact of stock market listing (if any) on firm growth.

The empirical analysis performed in the paper relies on a quantile regression model of firm growth. We ask whether AIM-listed and privately-held companies in the tails of the growth rates distribution performed differently at each point of the conditional growth rates distribution (and in the tails in particular), controlling for lagged values of size, growth rates, age, capital structure variables, sectoral differences and time trends. The same analysis is performed on two different measures of firm size, namely sales and total assets. Our exercise is similar to Revest and Sapio (2013), who however modeled the average firm growth rates.

Finding significant growth rate differences among listed and unlisted companies may receive two alternative interpretations. Causality may run from stock market listing to growth: companies at all quantiles of the growth rates distribution may benefit from going public thanks to wider analyst coverage, coaching effects by financial intermediaries, or empire building temptations by imperfectly monitored managers. Yet, short-termism in managerial decisions, fueled by financialization, may cause listed companies to underperform with respect to their privately-held peers. A wider growth rate distribution for listed companies obtains if the stock market is effective at sorting out the best and the worst companies, in Schumpeterian fashion. Causality may as well run from growth to stock market listing: listed gazelles may grow faster than the unlisted ones, as the suitability assessment performed by Nomads may filter out companies with weaker growth prospects. In addition, the stock market may attract riskier companies, implying a wider growth rate distribution.

According to our findings, the effect of AIM listing is negative in the lower tail of the firm growth distribution, and positive and increasingly so above the median. Hence, AIM-listed gazelles grow faster than their privately-held coun-

[3]Or gazelles and muppets, as Nightingale and Coad (2013) put it.

terparts, but those that decline experience a deeper contraction. This result is confirmed for both the growth of sales and of assets. Moreover, it is robust to controlling for the availability of internally-generated funds and collateral. We then perform temporal aggregation, using growth rates computed over longer time horizons (up to 5 years), and find that while the results of sales growth are confirmed, the AIM-listing coefficient in the asset growth equation remains positive only in the upper tail. AIM-listed and unlisted decliners do not differ significantly, as long as asset dynamics is concerned. These results would be consistent with three hypotheses. One is a treatment effect: the stock market seems to push investors and customers to shift resources from the "bad" to the "good" companies. The others are selection effects: Nomads select promising firms based on their asset growth expectations, but not based on sales growth; the stock market attracts companies that are relatively risky in their sales growth performance. We attempt to disentangle treatment and selection effects through an Instrumental Variables Treatment Effect (IVQTE) introduced by Abadie et al. (2002). These new estimates confirm that AIM-listed firms differ from their private counterparts in terms of growth performances across the whole growth rates distribution, but dismiss the treatment effects and suggest that the market attracts high risk companies.

The paper is structured as follows. A literature review is outlined in Section 2. Section 3 presents the data and variables and describes the quantile regression method, whereas the results are illustrated in Section 4. Section 5 concludes.

# 2 Background literature

## 2.1 Capital structure and firm growth: beyond the average firm

Scholarly research on the determinants of high-growth performances has mainly concentrated on the availability of technological capabilities (internally developed or acquired through alliances) and market opportunities (e.g. market liberalization, a flexible workforce, export links). The survey in Moreno and Coad (2015) is enlightening in this respect, but the availability of financial resources is by no means less crucial to HGFs. Policy-oriented research conjectures that finance is on the same ground as R&D as a critical resource for HGFs. Finance can be essential for a firm to reach a persistent high-growth performance (Mason and Brown, 2013). Capital structure is at least as important as the sheer availability of capital.

In the unlikely event that the conditions behind the Modigliani-Miller theorem materialized, the value of a firm would be invariant to the firm's capital structure. To the extent that firm value reflects its performance in real terms, the distribution of firm growth rates would be independent of the shares of debt and equity.

However, asymmetric information, pervasive as it is in financial markets, is the central tenet of the pecking order theory, or POT (Myers, 1984; see Revest and Sapio, 2012 for a review of empirical references). Firms apply for loans only if they run into deficits of internal funds, but they may end up fully or partly rationed; equity is issued rarely and only as a last resort. Estimates of the shares of internal and external funding sources have supported the pecking order theory, as they show that firms primarily rely on internal funds, even more if they are small and in high-tech sectors (see Revest and Sapio 2012 and references therein).

Recent updates of the POT have been motivated by the evidence that firms that are most exposed to information asymmetries, such as SMEs, do not appear to follow the POT (e.g. Frank and Goyal 2003); and we take it to suggest that gazelles, that are on average young and small, may resort to external equity, by-passing loans, if internally-generated funds are insufficient. According to the extended POT (Frank and Goyal 2003, Lemmon and Zender 2010), the POT holds when controlling for debt capacity. The larger financing needs to HGFs imply that borrowing constraints for them are reached relatively early. Hence HGFs may resort to an extended POT and issue equity. Consistently, evidence in Barclay et al. (2006) indicates that HGFs use less debt financing. The conditional POT (Halov and Heider 2011) mandates that the POT holds when controlling for asset risk. The crucial insight is that large and small firms face different types of adverse selection. Uncertainty surrounding investment projects by large firms mainly concerns the rates of return, whereas adverse selection against SMEs is mainly triggered by low success probabilities of their investment projects. This may be the case for HGFs, that are prevalently small and young, implying, as from the theoretical results in Halov and Heider (2011), that equity may replace debt in the financing hierarchy of gazelles. The bottom line is that, although only a small fraction of all companies ever receives public or private equity, there are theoretical and empirical reasons to believe that equity is not a marginal financial source for HGFs.

In exploring the linkages between equity and firm performance, papers focusing on the growth of the average firm prevail, and are mostly on venture capital (VC). Mixed results and causal ambiguity are the keywords. In a sample of companies listed on the Euro.NM circuit, Bottazzi and Da Rin (2002) failed to find any significant effect of venture capital funds on employment and sales growth, despite controlling for endogeneity and unobserved heterogeneity. In Engel and Keilbach (2007), German venture-backed firms display faster employment growth than their non venture-backed peers after controlling for endogeneity. However, venture capital funding did not affect post-investment innovativeness, proxied by the number of patents, essentially because venture capital flowed to companies with higher ex ante patent counts, contradicting previous results by Kortum and

Lerner (2000). Work by Baum and Silverman (2004) on Canadian firms and by Colombo and Grilli (2010) on a sample of Italian high-tech SMEs provided some evidence that venture capitalists perform mainly a coaching function, nurturing the firm growth performance.

Since Pagano et al. (1998), doubts have been raised on capital raising as the main reason behind the decision to go public (see also Brau and Fawcett, 2006). Most importantly, stock market listing is a source of agency costs due to separation between ownership and control, driving investments away from the maximum shareholders value - above or below it depending on what makes sense to assume on managerial behaviors in the given financial regime. Based on a sample of listed and unlisted US companies, Asker et al. (2014) show that listed firms invest less than their privately-held counterparts, and their investments are less sensitive to growth opportunities.[4] Adding to these results, the sample of private and listed UK companies analyzed by Revest and Sapio (2013) reveals that the stock market (AIM in that case) tends to attract companies with higher-than-average growth in operating revenues and assets, and has nurtured the growth of employees of its listed companies; but such growth has not translated into superior value added growth, causing listed companies to underperform in productivity terms.

Evidence has recently been produced on HGFs, allowing to assess the role of external finance in the reallocation of resources among firms. As argued by Bravo-Biosca et al. (2013), financial institutions in financially developed countries (e.g. with higher stock market capitalization rescaled by GDP; more competitive banking sectors) are better suited to supply finance to HGFs, while offering second-chance funding to under-performers. Their results, based on the econometric analysis of 3-year growth rates in 10 countries, highlight that firm growth rates distributions in more financially developed countries are wider, meaning that gazelles grow faster and decliners experience deeper drops. The quantile regression estimates by Audretsch and Lehmann (2004) on German companies listed on the Neuer Markt revealed that venture capital is associated with better growth performances for all firms, but not for the HGFs. The endogeneity of receiving equity was not controlled for, and the sample did not allow to assess the effect of stock market listing. Bottazzi et al. (2014) show that financing constraints prevent potentially fast growing firms - especially young ones - from exploiting growth opportunities ("pinioning the wings" effect) but also weakens the growth prospects of already slow growing firms, especially old ones ("loss reinforcing" effect). However, persistent HGFs are not characterized by systematically different financial conditions concerning interest payments and leverage (see Bianchini et

[4]Investment in that paper was proxied by the change in fixed assets, normalized by the value of total assets in the starting year; growth opportunities are measured as the growth rate of sales at the firm level.

al., 2016, studying a sample of French, Italian, Spanish, and UK firms).

## 2.2 Junior stock markets, or: financializing SMEs

The deregulation of the stock market listing process and the outsourcing of the regulatory responsibilities can be counted among the major institutional innovations in finance occurred in the recent decades. In the late Seventies, stock exchanges created the so-called *feeders* (Posner, 2009), namely, second-tier markets characterized by lighter listing requirements and information standards, with the goal of facilitating the quotation of promising SMEs to be fed to the official list. A second wave of junior markets replaced the early, unsuccessful attempts from the mid-Nineties on, this time taking the Nasdaq as a model (light listing requirements coupled with tight information standards; see the discussion in Posner, 2009). The markets appearing as the most successful at the height of the Internet bubble (the Neuer Markt, the Nouveau Marché, the EASDAQ) ended up in collapse between 2002 and 2003, leaving the AIM, a segment of the LSE, as the leader among junior stock markets.

While the Nasdaq frenzy was gaining momentum, investment services were harmonized across large geopolitical areas, e.g. in Europe with the Investment Services Directive (1993), which was further developed by means of the Financial Services Action Plan (FSAP) of 1999, the Lamfalussy process and their main offspring, namely the Markets for Financial Intermediaries Directive (MiFID, 2004), that challenged the dominant positions of the national stock exchanges.[5] The fiercely competitive post-MiFID environment pushed NYSE-Euronext to set up Alternext, a MTF closely modeled on the AIM (Degryse, 2009), recently renamed Enternext, whereas First North was inaugurated by Nasdaq-OMX. Some AIM replicas were created in Italy (AIM Italy in 2009) and in Japan, where Tokyo AIM ended up with competing venues such as Mothers and the JASDAQ. Trading in these markets has perhaps been spurred by the tighter requirements for financial disclosure, imposed by the Sarbanes-Oxley Act of 2002 on public companies and intermediaries quoted on US stock exchanges.

In light of the scant existing evidence on the real performance of companies listed on junior stock markets and of the evidence on the job creation contribution of HGFs, understanding the impact on high-growth firms of alternatives to banking, their direction of causality and the persistence of the effects would provide policy-makers with key pieces of information towards understanding the ultimate roles of stock markets.

[5] It repealed the concentration rule (Art. 14(3) of the 1993 ISD), according to which retail orders handled by financial intermediaries had to be executed on a regulated market; and it allowed the so-called Multilateral Trading Facilities (MTFs) to compete with regulated markets for order flow.

# 3 Hypotheses

Moving beyond the general considerations and the pieces of evidence summarized above, hereby we outline the hypotheses tested through the quantile regression analysis performed in this paper. The hypotheses formulated below concern the comparative growth performance of stock market-listed and privately-held companies in the tails of the firm growth rates distribution. Companies in the right tail are referred to as gazelles or HGFs, whereas those in the left tail are mentioned as decliners. Listed gazelles (decliners) are said to over-perform the privately-held ones if, all else being given, the growth rate of listed companies in the upper (lower) tail is higher than for the unlisted. Under-performance is the term used in the opposite case. We shall discuss two alternative causation channels: from stock market listing to growth (treatment effects), and from growth to stock market listing (selection effects). These two effects need to be disentangled through appropriate econometric means. The hypothesized effects are summarized in Table 1. Let us go through each hypothesis and the underlying theoretical backings.

Table 1: Expected relationship between stock market listing and the growth rates of gazelles and decliners. + and − indicate that AIM-listed firms outperform and underperform their privately-held peers, respectively. *no* stands for no significant difference.

| | **Effects of AIM listing on the growth rates** | |
|---|---|---|
| | **of decliners** | **of gazelles** |
| **Treatment effects** | | |
| Analyst coverage | + | + |
| Cheerleader effects | + | + |
| Coaching effects | + | + |
| Empire building | + | + |
| Quiet life | - | - |
| Short-termism | - | - |
| Schumpeterian sorting | - | + |
| | | |
| **Selection effects** | | |
| Suitability assessment | no | + |
| Sequential divestiture | no | + |
| Risk sharing | - | + |

## 3.1 Treatment effects

Stock market listing changes the set of availability financial sources and may imply a reorganization of corporate governance. Firm growth rates may thus change, for good or bad, *because* of stock market quotation.

Under asymmetric information between issuers and potential investors, the higher liquidity of publicly-listed shares and the associated wider **analyst coverage** would reduce the cost for outsiders to collect information about the value of the firms, thus increasing the in-flow of investments in their shares (Chemmanur and Fulghieri, 1999). Further, stock market quotation may enhance the conditions of debt financing (Audretsch and Elston, 1997; Cressy and Olofsson, 1997). Pagano et al. (1998) found that after an IPO, companies enjoy lower costs of borrowing and can access credit from a larger number of banks. AIM-listed companies, thus, would over-perform at all quantiles. The implicit assumption here is that any amount of capital raised on the stock market is channeled to productivity-enhancing activities.

An alternative story that would be consistent with AIM-listed over-performance involves **coaching effects** due to assistance by Nomads in financial management and in shaping the corporate governance structure. Nomads may help optimizing the use of strategic resources, even though they are not comparable to venture capitalists, do not possess the same business competences and are not exposed to the same incentives. Nomads may also provide access to networks of financial intermediaries, thus reinforcing the capital raising channel outlined above.

In listed companies, corporate governance mandates owner-manager separation, leading to agency costs due to imperfect monitoring and conflicting interests. Hubris and the goal of maximizing power can lead managers to over-invest. Such a preference for scale has been dubbed **empire building** by Baumol (1959) and Jensen (1986) and should translate into a faster rate of assets growth for AIM-listed companies. Unless agency costs are skewed across the growth rates distribution, AIM-listed companies should over-perform their privately-held pairs at all quantiles.

Even if investors possess all the relevant information, bounded rationality may bias their decisions. According to the **cheerleader effect** (Walker and Vul, 2014), also known as group attractiveness effect (Van Osch et al., 2015), people seem more attractive in a group than in isolation. This idea is rooted in a cognitive bias and can give an unconventional justification for unconventional high-growth performances. Companies (people) in AIM (group) appear more interesting if investors are biased towards the ensemble average. This is somewhat related to the late Nineties evidence of companies restyling themselves as dot.com companies in order to attract investors. We should hence expect faster growth for AIM-listed companies at all quantiles.[6]

The opposite (AIM-listed underperformance at all quantiles) would entail, should managers have a preference for a **quiet life** and thus slow down the investment pace (Bertrand and Mullainathan, 2003). Similarly, it may be argued that listed companies devote more managerial time/attention and financial resources to short-term financial management than to their core business (**short-termism**). They may, for instance, engage in stock repurchases, as shown e.g. by Lazonick (2007). Such a financialization of industrial companies would depress their growth rate at all quantiles.

Finally, the sign of treatment effects may vary across quantiles. One reason to expect this is that the stock market may perform a **Schumpeterian sorting** function, i.e. it may allow a faster sorting of good and bad companies. It should then lead to a significant reallocation of funding and customers away from declining companies and towards fast growers, thereby amplifying both good and bad performances.[7] AIM-listed gazelles would then grow faster than the privately-held ones; AIM-listed declines would be exacerbated. A similar story holds if stock market flotation magnifies the financial and/or industrial risk of listing companies, which may occur, again, because of short-termist financialized behavior. Stock market listing would thus widen the growth rates distribution.[8]

## 3.2 Selection effects

Gazelles listed on a stock market may appear to grow faster than their privately-held pairs simply because of selection or self-selection into the stock market. As reported by Mallin and Ow-Yong (2010), Nomads may prefer to reject listing applications by companies that are deemed unable to grow, and would rather place their bets on companies with higher growth and survival potential, which guarantee a longer stream of fees. Companies wishing to pass the **suitability assessment** may make an effort to achieve fast growth - thus reverting causality. A positive effect of AIM listing should be felt among HGFs, but not at the lower quantiles.

A self-selection mechanism is rooted in the **sequential divestiture** strategies, in which an IPO is an intermediate stage before selling business to a larger

[6] As far as we know, the cheerleader effect has never been studied in the context of firm growth finance. It can be considered a starting point for future research involving cognitive and behavioral economics.

[7] Thanks to Gerry Silverberg for pointing this out.

[8] One may argue that higher volatility of listed firms would be due to the relative illiquidity of AIM, which as other junior stock markets does not impose a minimal free float rule. Yet, AIM is of similar size, in terms of capitalization, as the national stock exchanges of Poland, Thailand, or Turkey, and much larger than the Argentinean, Irish or Austrian stock exchanges (see the World Federation of Exchanges data illustrated in Nielsson, 2013).

company (Reuer and Shen, 2004; Brau et al., 2010; Mantecon and Thistle, 2011). Discussing about post-IPO sell-out strategies, Chemmanur et al. (2014) argue that firms experiencing greater sales growth rates are more likely to choose an IPO as their initial exit mechanism, since these firms are better able to fend for themselves against product market competition and do not necessarily need the immediate support of an acquirer. Consistently, Shah and Thakor (1988) theoretically show that asset productivity is a positive driver of the going public decision. The motivations for declining firms to go public, if any, would probably be very different; they are not expected to enact post-IPO sell-out strategies. Hence, we should not expect any significant difference in firm growth rates at the lowest quantiles.

Finally, if the stock market is seen as performing a **risk sharing** function, riskier businesses self-select into the stock market, widening the growth rates distribution for AIM-listed companies (see again Shah and Thakor 1988 for a theoretical intuition). Colombelli (2010) has empirically shown that an entrepreneurial orientation, measured in terms of risk taking attitudes, led to higher investor valuation in a sample of IPO firms listed on AIM.

# 4 Materials and methods

## 4.1 Data and variables

We have built a longitudinal data set of limited liability manufacturing firms incorporated in the UK and observed between 1997 and 2009. The samples used in the econometric analysis include companies listed on the AIM or delisted from it in the above mentioned period and UK companies that remained privately held along the whole observation period.

Our interest lies in firm growth, defined here as the annual change in logarithmic firm size. As proxies for size, we alternatively use operating revenues (i.e. turnover) and total assets.[9] Growth in operating revenues signals the ability of a company to gain market shares, whereas growth in total assets captures investments in capital goods and the achievement of new knowledge covered by intellectual property rights. Operating revenues and total assets are deflated using 2-digit NACE Rev. 2 sectoral deflators for the UK, with 2005 as the base year.

In order to assess the relative growth performance of listed and unlisted companies, we define a dummy assuming unitary value whenever a company was listed on the AIM, and zero otherwise. This dummy will only have unit values for com-

[9] Operating revenues is the closest measure of sales available in the UK edition of Amadeus. Another measure of size, the number of employees, is not used here because of its discrete nature (discussed e.g. in Capasso et al., 2013) and because missing values in the dataset were more frequent than for operating revenues and total assets.

panies that stayed on AIM for the whole sample period; all zeroes for companies that were never listed on AIM; sequences of ones and zeroes for companies that went public and then delisted. The AIM dummy, thus, captures the before-after differences in growth rates as well as cross-sectional effects of stock market listing.

In line with the literature on firm growth, we consider age as an explanatory variable, hereby defined as the number of years elapsed from the incorporation date. Growth processes can vary across sectors, due to differences in market size, in barriers to entry and growth, in learning and innovation opportunities as well as in the appropriability conditions of new technological knowledge. We thus use dummies based on a 3-digit NACE Rev. 2 sectoral classification.

In performing the econometric analysis, we considered all the AIM-listed manufacturing companies for which firm size and age data were available in (or computable from) the Amadeus and Osiris databanks, whereas the privately held firms were drawn from a data set including 139,598 companies available in Amadeus, using a sampling procedure to make sure that AIM-listed and private companies are comparable in terms of age, size, and sectoral distribution.[10]

The sampling scheme results in unbalanced panels of, respectively, 4842 and 7511 observations (firm-year pairs) for operating revenues and total assets. The operating revenues sample includes 692 companies; 1245 are included in the total assets sample. AIM-listed companies represent approximately 20% of observations in both samples.

Before proceeding to formally model the effects of an AIM-listing on growth quantiles, let us look at some descriptive statistics. Table 2 (in the Appendix) compares the average size and age of AIM-listed and private companies. The table includes two panels for operating revenues and total assets. Table 3 compares the distribution of AIM-listed and private companies across 2-digit NACE Rev. 2 sectors within manufacturing. Each pair of columns refers to a different sample. The weight of each sector in the distribution is reported in percentage. Three leading sectors can be discerned among AIM companies, each weighing around 20%: manufacture of basic pharmaceutical products and pharmaceutical preparations

[10]The sampling scheme we have adopted goes through the following steps:

1. Take all companies that have been listed on AIM for at least 33% of the years during the sample period
2. Measure their age and (deflated) size on the first year they appear in the sample, as well as their 3-digit NACE Rev. 2 sector
3. Compute quartiles for both size and age, and create size-age-sector cells accordingly
4. For each AIM-listed company in a given size-age-sector cell, draw 4 privately-held companies in the same cell

A different sample of unlisted firms is drawn for each measure of size.

(NACE code 21), manufacture of basic metals (NACE code 24), and manufacture of computer, electronic and optical products (NACE code 26). These sectors are slightly underrepresented among private companies, more so for pharmaceuticals and basic metals. The relevance of such sectors is not surprising as AIM was established in 1995, that is, roughly at the onset of the so-called Internet bubble.

## 4.2 Quantile regression

The standard workhorse in the econometric analysis of firm growth is the Gibrat model, according to which growth in year $t$ depends on size at year $t-1$ and possibly on control variables. In its traditional form, the model is specified as a relationship between the sample average growth rate and lagged firm size. The quantile regression model (Koenker and Bassett, 1978) is an appropriate methodology if one wishes to study gazelles and decliners, as it models the dynamics of the firm size distribution as a whole, quantile by quantile, and relaxes the restrictive assumption of that the error term is identically distributed at all points in the conditional distribution (see also Buchinsky 1998, Koenker and Hallock 2001).

Let $Q_p(x|y)$ denote the $p$-th quantile of $x$ conditional on $y$, with $p \in (0,1)$. A quantile regression model of firm growth reads

$$Q_p(g_{i,t}) = \beta_0^p + \beta_s^p s_{i,t-1} + \beta_g^p g_{i,t-1} + \beta_a^p age_{i,t-1} + \beta_A^p AIM_{i,t-1} \quad (1)$$

where $s_{i,t}$ is firm $i$'s log-size in year $t$, $g_{i,t} \equiv s_{i,t} - s_{i,t-1}$ is the growth rate, $age_{i,t}$ and $AIM_{i,t}$ are firm age and the AIM dummy, defined as before; $\beta_0^p$, $\beta_s^p$, $\beta_g^p$, $\beta_a^p$, $\beta_A^p$ are the associated coefficients to be estimated. The $p$ superscripts indicate that the model coefficients are allowed to vary across quantiles of the conditional growth distribution. Gazelles are in the top quantiles of the growth rates distribution, decliners in the bottom ones.

The coefficient $\beta_s^p$ is interpreted as the marginal change in firm growth due to a marginal change in initial size, conditional on being on the $p$-th quantile of the firm growth distribution. If the confidence interval built around the estimated $\beta_s^p$ includes 0, the law of proportionate effect (Gibrat's law) holds, whereas an estimate significantly below zero suggests that firm size reverts toward quantile $p$. The $\beta_g^p$ coefficient tunes the persistence of firm growth rates. In particular, for $p$ close to 1, a positive value would imply that gazelles persistently outperform their rivals, whereas a negative value indicates their inability to repeat the *exploit.* $\beta_a^p$ is expected negative if young firms grow faster.

Our main focus, however, is on coefficient $\beta_A^p$. $\beta_A^p > 0$ means that AIM-listed firms grow faster than privately-held firms, conditional on being on the $p$-th quantile of the firm growth distribution. $\beta_A^p < 0$, instead, would testify to the underperformance of AIM-listed firms - growing at a slower pace or declining faster.[11]

# 5 Results

## 5.1 Baseline results

The results from estimating Eq. 1 are plotted in a figure for each explanatory variable, as well as in Tables 4 and 5 for selected quantiles. Each figure comprises two subfigures, one for each sample (depending whether we used operating revenues or total assets as the size proxy). All of the tables and figures are reported in the Appendix.

[Tables 4 and 5 here]

Our variable of interest, the AIM dummy, displays coefficients with an increasing profile across quantiles in both samples (Fig. 1). In the operating revenues sample, point estimates range from nearly -.20 (5th quantile) and -.13 (10th quantile) to .26 (90th quantile) and slightly above 0.30 (95th quantile). In the total assets sample, the effect of an AIM listing in the left tail goes, similarly, from nearly -.20 (5th quantile) to .27 (90th) and .40 (95th). All these estimates are statistically significant at the 95% level. Being listed on AIM, thus, magnifies the growth performance of gazelles while reinforcing the loss of sales and assets of the decliners. At the median of the growth rates distribution, the coefficients are smaller, meaning that AIM-listed and privately-held firms perform quite similarly. All in all, the growth performances of AIM-listed firms appear to be more polarized than for the unlisted ones, apparently supporting the Schumpeterian selection and risk sharing hypotheses.

[Fig. 1, 2, 3, 4 here]

Let us then consider the coefficients associated to size (Fig. 2) and age (Fig. 3). In the operating revenues sample, coefficient profiles for lagged size and age are declining; point estimates are positive in the lower tail close to zero at the median, and negative in the upper tail. Size coefficients are statistically significant away from the median, whereas age coefficients gain significance after the 4th decile. The results on size coefficients show that the law of proportionate effect is verified only for the median firm. Size, however measured, seems to be an advantage for declining firms (lower tail of the growth rates distribution), i.e. a large initial size helps mitigating the decline. As to the upper tail, the negative and significant coefficient means that smaller firms grow faster. Age coefficients imply

[11] The reader is referred to Koenker and Bassett (1978) for technical details on the estimator.

that among the firms that decline more, the older ones do not fare better (age coefficients are not significant), whereas younger gazelles grow faster than their older peers. Overall, these results on the impact of size and age on the growth of gazelles are in line with the existing evidence on HGFs.

Are firm growth rates serially correlated? This seems to be the case (Fig. 6, Tables 4 and 5), with positive albeit mild autocorrelations, except in the tails of the growth rates distribution, where point estimates are slightly higher (lower) in the left (right) tail, but significance fails. This pattern is found on both the total assets and the operating revenues samples. Very good and very bad performances are seldom repeated.

## 5.2 Robustness: Time trends, external finance, and longer horizons

This subsection explores the robustness of the above results. We take care of the exogenous, aggregate trends that can influence growth rates, and control for firm-level heterogeneity in the access to alternatives to stock markets finance, e.g. bank loans and retained earnings. In addition, we re-estimate this augmented model using growth rates computed on longer horizons.

Our previous results did not take account of external forces that are time-specific and that also determine the firm growth process. The simplest way of controlling for time, which we explore, is by including temporal dummy variables.[12]

We also follow Bottazzi et al. (2014) and insert in the model, along with time dummies, two further explanatory variables: operating profits, which proxy for the availability of internally generated financial resources, and tangible fixed assets, which capture the amount of collateral a firm is able to use in credit relationships. Logarithmic transformations of both variables are considered, after suitably rescaling operating profits, and their annual lags are included as regressors in order to mitigate possible reverse causality problems (see Coad, 2007 for a discussion, and Revest and Sapio, 2013 for a similar approach).

As shown by Fig. 5, Table 6 and Table 7, results on the AIM dummy coefficients are confirmed, although magnitudes are smaller (from -.15 to .10 in the operating revenues sample; -.07 to .24 in the total assets sample).

[Fig. 5, 6, 7; Tables 6 and 7 here]

The controls affect firm growth differently depending on the size proxy. We spot a decreasing profile in the coefficients associated to operating profits, pos-

[12] An alternative approach would be to use stock market indices. The latter provide information on the business cycle, investors confidence, and the macroeconomic growth prospects. Our estimates suggest that results do not change in any significant way.

itive statistically significant except for faster growing firms; a U-shaped pattern of coefficients is instead associated to tangible fixed assets in the assets sample (positively impacting, but more so in the tails of the growth rates distribution); and a decreasing profile for tangible fixed assets in the operating revenues sample, with positive (negative) coefficients in the left (right) tail. Again, the other results hold quite robustly.

Finally, we re-run our regressions using, as dependent variables, firm growth rates computed over 2, 3, 4, and 5 year horizons, thereby smoothing out the short-term noise that can affect the previous estimates (see Tables 8 and 9). The results are very similar, except for the magnitudes; we present only those concerning the longest horizon (5 years). We exclude lagged growth rates from the set of explanatory variables and we focus on the coefficients for age, size and AIM listing. According to Fig. 8 (left part, on the growth of operating revenues), we can see that until the ninth decile, AIM coefficients are always increasing: AIM-listed firms in the right tail experience faster growth. Fig. 8 (right part, on asset growth) delivers a similar piece of information. However, in the total assets sample, the AIM coefficient in the left tail lacks statistical significance. The assets of AIM-listed and private companies decline at about the same pace, but gazelles are faster on AIM. Hence, quantile regression estimates of 5-year growth rates confirm the polarization result only for operating revenues; the growth of assets, instead, is guided by the right tail only.

[Fig. 8, Tables 8 and 9 here]

To sum up, these longer-run estimates suggest that, while the growth of sales is compatible with both Schumpeterian and risk sharing explanations, the growth of assets for AIM-listed firms may be indicative of sequential divestiture strategies or may reflect the suitability assessment performed by Nomads. Firms that have a faster asset growth potential may be more eager to go public, in order to sell out later, and/or may be more likely scouted by Nomads.

## 5.3 Endogeneity

The foregoing results hint at two alternative interpretations of the evidence. One is a treatment effect: a wider distribution of firm growth rates *because of* stock market flotation (Schumpeterian hypothesis). The others are selection effect: riskier companies self-select in the stock market (risk sharing); companies with faster asset growth potential self-select into the stock market to sell out (sequential divestiture) or are selected by Nomads (suitability assessment). How to disentangle these effects? Endogeneity in a quantile regression framework is dealt with here through the Instrumental Variables Quantile Treatment Effect (IVQTE) approach introduced by Abadie et al. (2002), that allows to estimate conditional treatment effects under endogeneity (see Coad et al. 2014b for an application in industrial dynamics).

In the IVQTE method, exogenous variation is given by a binary instrumental variable, call it $Z$. In our case, we use a dummy equal to 1 if the firm headquarters are located in Greater London. The use of the *London* dummy as an instrument rests upon the literature on geographical distance and equity issues, as well as on a previous use by Ivanov and Xie (2010) who studied venture capital. It has been shown that investors are biased towards firms that are more closely located, presumably because proximity makes it easier or less costly to collect soft information on firms, e.g. through direct contacts, referrals by acquaintances who work for the firm, local newspapers and so forth (Coval and Moskowitz, 1999; Huberman, 2001; Ivkovic and Weisbenner, 2005). By extension, firms located farther from the main urban or financial centers receive less or less accurate analyst coverage (Malloy. 2005), hence they suffer from wider information asymmetries, discouraging investments. This would explain the evidence in Klagge and Martin (2005) on a bias of funding towards firms that are more proximate to the main financial center (in our case, London), and the lower propensity of provincial or rural firms to go public, even after controlling for sectoral specificities (Wojcik, 2009; Acconcia et al., 2011).[13]

The IVQTE to be estimated is in fact the treatment effect, at quantile $p$, for the so-called *compliers*, i.e. the firms that at time $t$ are listed on AIM ($AIM_{it} = 1$) and display a unit value of the instrument ($Z_{it} = 1$). Finding significant AIM coefficients would be interpreted as evidence of treatment effects, while lack of significance would support the idea that differences in growth rate distributions between listed and unlisted firms are due to selection or self-selection.

$Z$ is supposed to satisfy the following assumptions (Frölich and Melly 2008):

1 *Existence of compliers*: at least some firms that have gone public are located in London. Sample statistics (Table 2) indicate that the percentage of London-based IPO firms listed on AIM is around 19%.

2 *Monotonicity*: the effect of being located in London will weakly increase the probability of going public; this assumption presupposes the *validity* of the instrument. We run probit regressions showing that the probability of going public in our sample is positively affected by being located in London, whether or not we include control variables such as size, age, growth, and sectoral and time dummies (see Table 10).

[13] We have also considered using, as an instrumental variable, a dummy accounting for the eligibility to receive public subsidies, as in Chemmanur et al. (2014). Yet, in most SME support programs in the UK, criteria include age and size measures, such as the number of employees, a variable which is not available for all firms in our original sample.

3 *Independence*: this is an *exclusion restriction*, since location is supposed not to affect firm growth directly; and firms do not differ from each other purely on the basis of location. One may argue that being located in larger cities provides more and better commercial opportunities, besides the wider availability of finance, leading firms to grow faster. We do not have evidence on this, in fact. Evidence by Ruland (2013) suggests that financial performance is higher for firms in smaller cities. Ivanov and Xie (2010) claim that location should not directly affect a firm's IPO valuation, which may be indirect evidence in favor of our exclusion restriction.

4 *Common support*: the distributions of firms' characteristics are comparable (in terms of distributional support) regardless of location. Our statistics (not reported here) suggest that distributional supports for the main variables (size, age) are in the same order of magnitude, although London-based companies appear to be larger on average in both assets and sales.

Doubts still remain on the possible endogeneity of the proposed instruments, which we shall test after running IVQTE estimates, based on correlation between the outcome variable (firm growth) and the residuals from the second stage regression.

Table 11 reports the estimated AIM coefficients quantile by quantile, based on three models for each sample: 1-year growth rates regressed on lagged size, age, growth rates, AIM dummy, and sectoral dummies (baseline); baseline 1-year growth model augmented with time dummies, fixed assets, and operating profits; augmented 5-years growth model. The table omits coefficients associated to control variables for the sake of space.

In both samples, the previously detected results tend to lose statistical significance. In both samples, the new estimates confirm the patterns found in the baseline estimates of Section 5.1 (negative coefficients in the left tail, positive in the right tail), but statistical significance is missing, with some exceptions (assets sample: the 75% and 90% quantiles in the baseline model, and the 90% quantile in the 1-year growth augmented model). We thus raise doubts on the existence of treatment effects from going public.

The bottom line from this further empirical exercise is: the distribution of growth rates for AIM-listed companies is more dispersed than for privately-held companies, but Schumpeterian sorting does not seem the main reason: a more sound explanation seems to be that companies with riskier industrial projects are more likely to go public.

# 6 Conclusion

In this paper, we have explored the impact of stock market listing on the entire distribution of firm growth rates through a quantile regression analysis performed on a sample of UK manufacturing companies. We have compared privately-held companies with comparable companies listed on the AIM, the most liquid and long-lasting junior stock market, and hence quite representative of the process of deregulation of the stock market listing process and of regulatory outsourcing to private financial intermediaries. AIM does not impose any minimal listing requirement and admission is granted by financial intermediaries called Nominated Advisors (Nomads), who perform discretionary suitability assessments and assist their client companies in financial strategy and market information provision. In the estimated regressions, we have controlled for lagged size, growth rates, and age, as well as for sectoral heterogeneity through fixed effects, as customary in the firm growth literature. We have moreover performed robustness checks including capital structure variables, time effects, and longer growth horizons. The same analysis is performed on two different measures of firm size, namely sales and total assets.

Our findings on annual growth rates are consistent with two stories. In the first, the stock market is rather effective as a selection device, sorting good and bad companies that would grow at more similar rates if they stayed out of the market. In a second story, the stock market is used as a risk-sharing device, i.e. riskier companies self-select into the market. Both stories are compatible with our evidence that AIM-listed gazelles grow faster than their privately-held counterparts, but those that decline, experience a sort of loss reinforcing effect, i.e. they fall more rapidly if they are listed - a finding that is reminiscent of Bravo-Biosca et al. (2013). These stories seem relevant also in regards to 5-year growth rates of sales, although going public seem to favor only companies in the right tail if we focus on the total assets sample.

Discriminating among the two possible explanations is the next step in our research. Controlling for endogeneity through an instrumental variable, indeed, confirms that listing on AIM, as such, is not what magnifies the dispersion of growth rates; rather, it is riskier companies that are more likely to choose a stock market listing.

The recent financial crisis and the addresses of the supervisory authorities have made it clear that it is more and more important for financial institutions, listed firms, and investors to define, understand, and manage the risk in order to ensure profits and financial stability in the long term. Furthermore, in light of the mild admission procedures enacted by AIM, a stronger effort may be desirable on the part of the listed firms; for example, providing more detailed information on risk profiles and more accurate business plans can create virtuous signaling mechanisms and channel investors towards more conscious choices.

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# Appendix

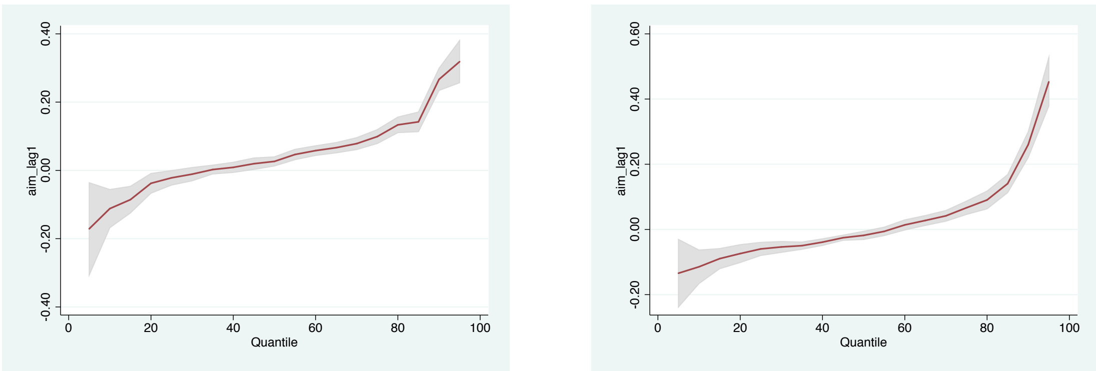


Figure 1: Quantile regression coefficients of the AIM dummy. Operating revenues sample (left), total assets sample (right). Dependent variables: 1-year growth rates. Baseline model.

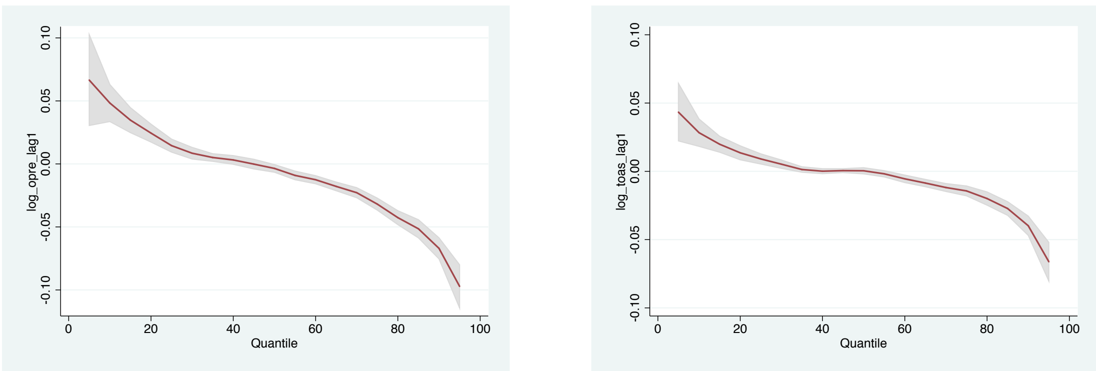


Figure 2: Quantile regression coefficients of lagged firm size. Operating revenues sample (left), total assets sample (right). Dependent variables: 1-year growth rates. Baseline model.

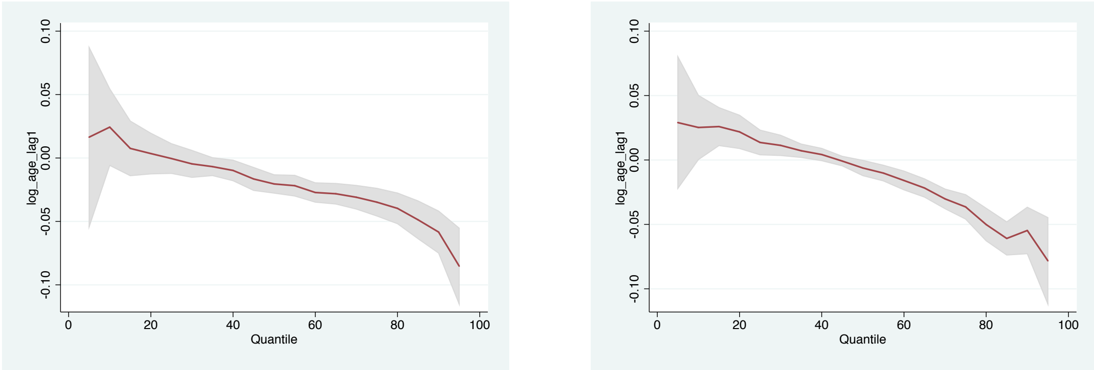


Figure 3: Quantile regression coefficients of lagged firm age. Operating revenues sample (left), total assets sample (right). Dependent variables: 1-year growth rates. Baseline model.

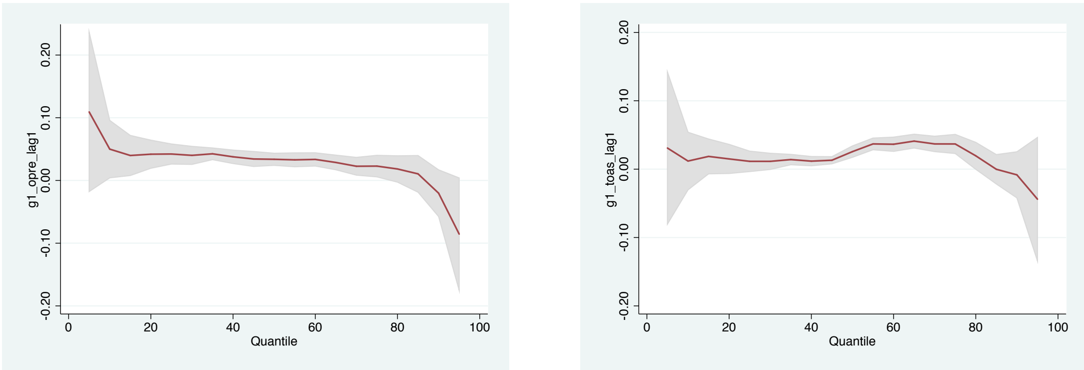


Figure 4: Quantile regression coefficients of lagged firm growth rate. Operating revenues sample (left), total assets sample (right). Dependent variables: 1-year growth rates. Baseline model.

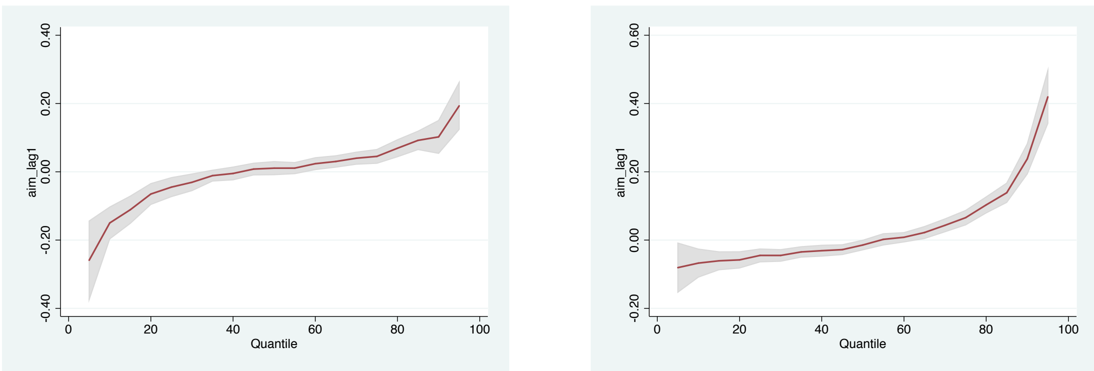


Figure 5: Quantile regression coefficients of the AIM dummy. Operating revenues sample (left), total assets sample (right). Dependent variables: 1-year growth rates. Model specification including total fixed assets and operating profits.

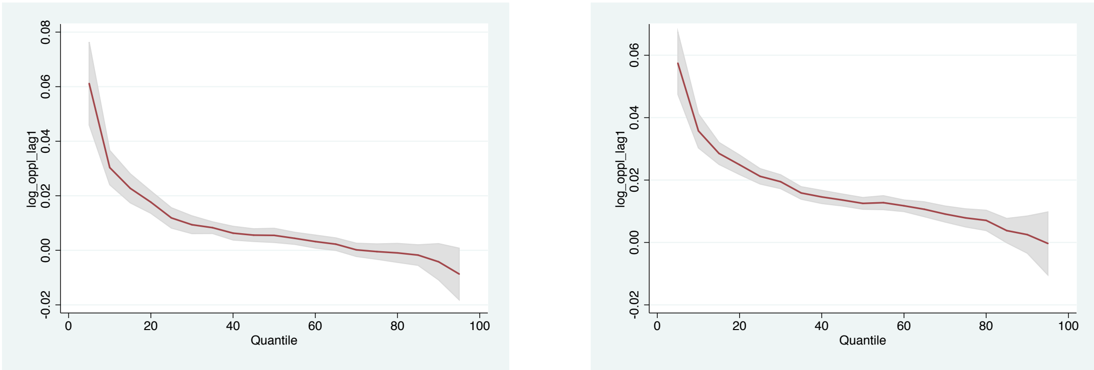


Figure 6: Quantile regression coefficients of operating profits: operating revenues (left) and tangible fixed assets (right) samples. Dependent variables: 1-year growth rates. Model specification including total fixed assets and operating profits.

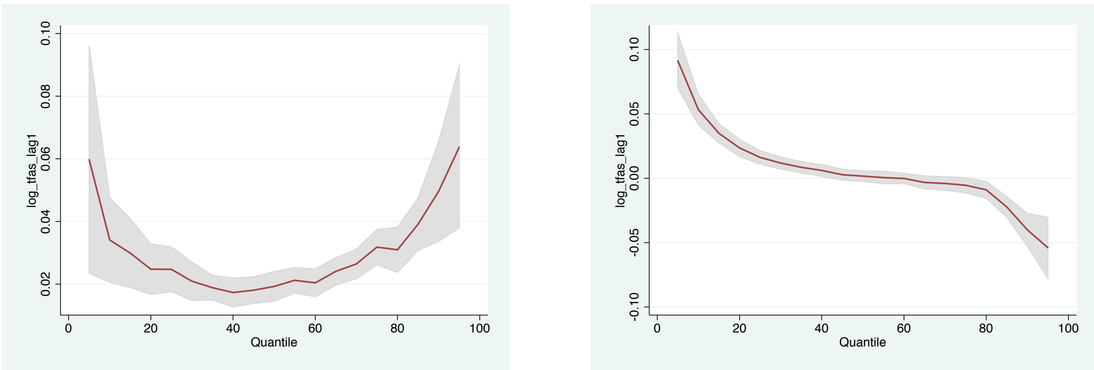


Figure 7: Quantile regression coefficients of tangible fixed assets: operating revenues sample (left), total assets sample (right). Dependent variables: 1-year growth rates. Model specification including total fixed assets and operating profits.

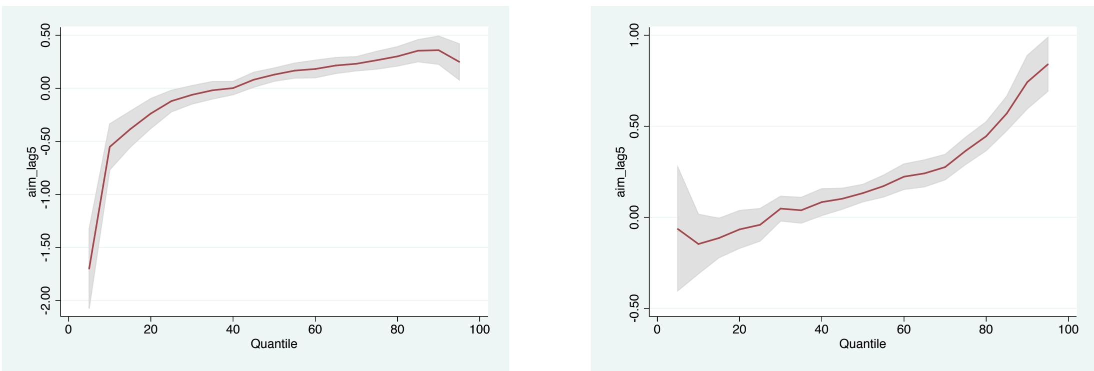


Figure 8: Quantile regression coefficients of the AIM dummy: operating revenues (left) and tangible fixed assets (right) samples. Dependent variables: 5-years growth rates. Model specification including total fixed assets and operating profits.

Table 2: Summary statistics for AIM-listed and private companies. A sample of private companies has been drawn for each indicator of firm size.

| **Variables** | **Statistics** | | | | | | |
|---|---|---|---|---|---|---|---|
| | N. | Mean | Std | Skew | Kurt | Min | Max |
| **AIM-listed** | | | | | | | |
| Op. revenues | 1798 | 22566.4 | 52470.7 | 14.74 | 339.21 | 1 | 1408300 |
| o.r. 1-year growth | 1515 | .1476 | .9424 | .6058 | 19.06 | -6.472 | 8.105 |
| o.r. 5-year growth | 677 | .3645 | 1.573 | -.473 | 7.041 | -7.893 | 6.096 |
| Total assets | 1798 | 26493.7 | 84150.5 | 18.73 | 449.22 | 20 | 2352500 |
| t.a. 1-year growth | 1574 | .1121 | .6813 | 2.174 | 24.77 | -4.734 | 7.006 |
| t.a. 5-year growth | 723 | .3748 | 1.131 | .9579 | 5.959 | -4.046 | 5.485 |
| Age | 1798 | 21.68 | 26.08 | 1.570 | 4.377 | 0 | 108 |
| Total fixed assets | 1798 | 13585.4 | 64260.4 | 23.65 | 668.68 | 0 | 2053100 |
| Operating profits | 1798 | 579.86 | 10194.9 | -.042 | 292.13 | -226349.3 | 230700 |
| London | 1798 | .1941 | .3956 | 1.547 | 3.393 | 0 | 1 |
| **Private** | | | | | | | |
| **Op. revenues sample** | | | | | | | |
| Op. revenues | 5220 | 31341.2 | 156904.9 | 15.29 | 289.61 | 1 | 3907880 |
| o.r. 1-year growth | 4156 | .0431 | .5049 | .0375 | 39.00 | -7.536 | 6.413 |
| o.r. 5-year growth | 1742 | .1677 | .8207 | -.4304 | 9.173 | -4.282 | 5.106 |
| Age | 5220 | 18.87 | 20.44 | 1.959 | 7.009 | 0 | 128 |
| Total fixed assets | 5220 | 7021.5 | 33362.5 | 12.53 | 194.65 | 0 | 652250 |
| Operating profits | 5220 | 910.53 | 7615.4 | 8.912 | 328.09 | -141483 | 260264 |
| London | 5220 | .0816 | .2738 | 3.057 | 10.34 | 0 | 1 |
| **Total assets sample** | | | | | | | |
| Total assets | 5818 | 65472.1 | 494090.8 | 18.13 | 375.17 | 5 | 1.17e+07 |
| t.a. 1-year growth | 5022 | .0492 | .3921 | 4.344 | 66.97 | -2.560 | 7.657 |
| t.a. 5-year growth | 2311 | .2245 | .8264 | 1.422 | 14.160 | -4.745 | 6.897 |
| Age | 5818 | 19.16 | 20.97 | 1.932 | 6.655 | 0 | 120 |
| Total fixed assets | 5818 | 16892.9 | 142243.8 | 18.72 | 437.90 | 0 | 4438000 |
| Operating profits | 5818 | 1585.5 | 38840.6 | 3.818 | 277.29 | -885200 | 885600 |
| London | 5818 | .0956 | .2940 | 2.751 | 8.570 | 0 | 1 |

denotes the number of observations. Std stands for standard deviation, "Skew" for skewness, "Kurt" for kurtosis. Operating revenues and total assets are expressed in British pound sterlings at constant 2005 prices.

Table 3: Sectoral composition of the samples, based on a 2-digit NACE Rev. 2 classification of manufacturing. The reported figures are percentages.

| **Sample** | **Op. Revenues** | | **Total Assets** | |
|---|---|---|---|---|
| NACE 2-digit | AIM | Private | AIM | Private |
| 10 | 3.72 | 3.89 | 3.30 | 4.45 |
| 11 | 1.36 | 1.37 | 1.20 | 1.34 |
| 13 | 1.14 | 3.95 | 1.26 | 3.75 |
| 14 | 3.57 | 3.19 | 3.12 | 2.14 |
| 15 | 1.29 | 1.61 | 1.08 | 1.68 |
| 16 | 0.29 | 0.46 | 0.36 | 0.52 |
| 17 | 1.29 | 1.60 | 1.08 | 1.62 |
| 18 | 2.36 | 2.23 | 2.16 | 2.39 |
| 19 | 0.21 | 0.13 | 0.24 | 0.18 |
| 20 | 7.22 | 6.04 | 7.39 | 7.30 |
| 21 | 14.94 | 6.83 | 15.56 | 7.52 |
| 22 | 2.29 | 2.71 | 1.92 | 2.58 |
| 23 | 3.50 | 5.77 | 3.84 | 5.31 |
| 24 | 5.50 | 7.58 | 12.25 | 7.50 |
| 25 | 2.14 | 4.35 | 1.92 | 4.35 |
| 26 | 24.09 | 19.63 | 20.42 | 20.70 |
| 27 | 3.79 | 6.17 | 3.90 | 5.68 |
| 28 | 5.58 | 7.73 | 5.11 | 6.39 |
| 29 | 2.07 | 2.97 | 2.04 | 2.78 |
| 30 | 2.14 | 1.74 | 1.80 | 1.41 |
| 31 | 3.65 | 3.86 | 3.06 | 3.36 |
| 32 | 7.22 | 5.69 | 6.37 | 6.27 |
| 33 | 0.64 | 0.48 | 0.60 | 0.78 |
| Tot. | 100.00 | 100.00 | 100.00 | 100.00 |

Legend: 10 = Manufacture of food products; 11 = Manufacture of beverages; 12 = Manufacture of tobacco products; 13 = Manufacture of textiles; 14 = Manufacture of wearing apparel; 15 = Manufacture of leather and related products; 16 = Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials; 17 = Manufacture of paper and paper products; 18 = Printing and reproduction of recorded media; 19 = Manufacture of coke and refined petroleum products; 20 = Manufacture of chemicals and chemical products; 21 = Manufacture of basic pharmaceutical products and pharmaceutical preparations; 22 = Manufacture of rubber and plastic products; 23 = Manufacture of other nonmetallic mineral products; 24 = Manufacture of basic metals; 25 = Manufacture of fabricated metal products, except machinery and equipment; 26 = Manufacture of computer, electronic, and optical products; 27 = Manufacture of electrical equipment; 28 = Manufacture of machinery and equipment n.e.c.; 29 = Manufacture of motor vehicles, trailers, and semi-trailers; 30 = Manufacture of other transport equipment; 31 = Manufacture of furniture; 32 = Other manufacturing; 33 = Repair and installation of machinery and equipment.

Table 4: Baseline estimates of a quantile regression model of 1-year growth in operating revenues: selected quantiles.

| **Variables** | **Quantiles** | | | | |
|---|---|---|---|---|---|
| | .10 | .25 | .50 | .75 | .90 |
| $\log S_{i,t-1}$ | 0483*** | .0145*** | -.0036** | -.0319*** | -.0670*** |
| | (.0075) | (.0026) | (.0015) | (.0024) | (.0043) |
| $\log age_{i,t-1}$ | .0243 | -.0004 | -.0205*** | -.0348*** | -.0584*** |
| | (.0154) | (.0060) | (.0037) | (.0056) | (.0084) |
| $AIM_{i,t-1}$ | -.1119*** | -.0218** | .0263*** | .0991*** | .2665*** |
| | (.0284) | (.0108) | (.0068) | (.0103) | (.0164) |
| $g_{i,t-1}$ | .0500** | .0422*** | .0337*** | .0229*** | -.0203 |
| | (.0233) | (.0082) | (.0049) | (.0087) | (.0190) |
| constant | | | | | |
| sector dummies | yes | yes | yes | yes | yes |
| n.obs. | 4842 | 4842 | 4842 | 4842 | 4842 |

Bootstrapped standard errors in parentheses.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 5: Baseline estimates of a quantile regression model of 1-year growth in operating revenues: selected quantiles.

| **Variables** | **Quantiles** | | | | |
|---|---|---|---|---|---|
| | .10 | .25 | .50 | .75 | .90 |
| $\log S_{i,t-1}$ | .0283*** | .0091*** | .0004 | -.0143*** | -.0398*** |
| | (.0051) | (.0019) | (.0011) | (.0018) | (.0036) |
| $\log age_{i,t-1}$ | .0252** | .0136*** | -.0062** | -.0364*** | -.0547*** |
| | (.0127) | (.0049) | (.0030) | (.0048) | (.0092) |
| $AIM_{i,t-1}$ | -.1145*** | -.0597*** | -.0182*** | .0665*** | .2603*** |
| | (.0261) | (.0102) | (.0063) | (.0104) | (.0199) |
| $g_{i,t-1}$ | .0118 | .0114 | .0256*** | .0368*** | -.0083 |
| | (.0215) | (.0076) | (.0042) | (.0071) | (.0172) |
| constant | | | | | |
| sector dummies | yes | yes | yes | yes | yes |
| n.obs. | 7511 | 7511 | 7511 | 7511 | 7511 |

Bootstrapped standard errors in parentheses.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 6: Estimates of a quantile regression model of 1-year growth in operating revenues, augmented to include operating profits and fixed assets: selected quantiles.

| **Variables** | **Quantiles** | | | | |
|---|---|---|---|---|---|
| | .10 | .25 | .50 | .75 | .90 |
| $\log S_{i,t-1}$ | -.0180* | -.0281*** | -.0313*** | -.0636*** | -.1173*** |
| | (.0098) | (.0050) | (.0033) | (.0038) | (.0110) |
| $\log age_{i,t-1}$ | .0147 | .0008 | -.0192*** | -.0288*** | -.0510*** |
| | (.0113) | (.0068) | (.0047) | (.0050) | (.0120) |
| $AIM_{i,t-1}$ | -.1499*** | -.0449*** | .0106 | .0452*** | .1022*** |
| | (.0238) | (.0142) | (.0098) | (.0103) | (.0246) |
| $g_{i,t-1}$ | .0185 | .0284*** | .0418*** | .0335*** | -.0140 |
| | (.0175) | (.0095) | (.0064) | (.0082) | (.0270) |
| $\log oppl_{i,t-1}$ | .0303*** | .0119*** | .0055*** | -.0005 | -.0042 |
| | (.0032) | (.0019) | (.0013) | (.0014) | (.0034) |
| $\log tfas_{i,t-1}$ | .0341*** | .0247*** | .0193*** | .0318*** | .0496*** |
| | (.0069) | (.0036) | (.0024) | (.0029) | (.0081) |
| constant | -.4313*** | .0361 | .2565*** | .6517*** | 1.1530*** |
| | (.0963) | (.0575) | (.0407) | (.0448) | (.1161) |
| sector dummies | yes | yes | yes | yes | yes |
| year dummies | yes | yes | yes | yes | yes |
| n.obs. | 4636 | 4636 | 4636 | 4636 | 4636 |

Bootstrapped standard errors in parentheses.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 7: Estimates of a quantile regression model of 1-year growth in total assets, augmented to include operating profits and fixed assets: selected quantiles.

| **Variables** | **Quantiles** | | | | |
|---|---|---|---|---|---|
| | .10 | .25 | .50 | .75 | .90 |
| $\log S_{i,t-1}$ | -.0614*** | -.0268*** | -.0152*** | -.0197*** | .0009 |
| | (.0083) | (.0036) | (.0027) | (.0040) | (.0086) |
| $\log age_{i,t-1}$ | .0102 | .0089* | -.0016 | -.0276*** | -.0531*** |
| | (.0107) | (.0046) | (.0034) | (.0050) | (.0104) |
| $AIM_{i,t-1}$ | -.0674*** | -.0450*** | -.0145** | .0656*** | .2379*** |
| | (.0209) | (.0096) | (.0072) | (.0108) | (.0225) |
| $g_{i,t-1}$ | .0333 | .0109 | .0256*** | .0273*** | -.0179 |
| | (.0202) | (.0078) | (.0055) | (.0091) | (.0242) |
| $\log oppl_{i,t-1}$ | .0358*** | .0212*** | .0125*** | .0079*** | .0025 |
| | (.0028) | (.0013) | (.0010) | (.0015) | (.0030) |
| $\log tfas_{i,t-1}$ | .0532*** | .0162*** | .0016 | -.0055* | -.0400*** |
| | (.0060) | (.0027) | (.0021) | (.0030) | (.0065) |
| constant | -.2515*** | -.0595 | .0841*** | .3429*** | .6740*** |
| | (.0878) | (.0400 | (.0300) | (.0447) | (.0921) |
| sector dummies | yes | yes | yes | yes | yes |
| year dummies | yes | yes | yes | yes | yes |
| n.obs. | 5664 | 5664 | 5664 | 5664 | 5664 |

Bootstrapped standard errors in parentheses.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 8: Estimates of a quantile regression model of 5-year growth in operating revenues, augmented to include operating profits and fixed assets: selected quantiles.

| **Variables** | **Quantiles** | | | | |
|---|---|---|---|---|---|
| | .10 | .25 | .50 | .75 | .90 |
| $\log S_{i,t-1}$ | -.2473*** | -.1372*** | -.1392*** | -.2050*** | -.3162*** |
| | (.0473) | (.0198) | (.0110) | (.0156) | (.0291) |
| $\log age_{i,t-1}$ | .0329 | -.0411* | -.0798*** | -.1012*** | -.1559*** |
| | (.0492) | (.0225) | (.0136) | (.0182) | (.0293) |
| $AIM_{i,t-1}$ | -.5520*** | -.1203** | .1290*** | .2651*** | .3596*** |
| | (.1104) | (.0517) | (.0316) | (.0426) | (.0676) |
| $\log oppl_{i,t-1}$ | .0640*** | .0244*** | .0007 | -.0053 | -.0062 |
| | (.0165) | (.0076) | (.0044) | (.0057) | (.0088) |
| $\log tfas_{i,t-1}$ | .1590*** | .0801*** | .0772*** | .0804*** | .1224*** |
| | (.0302) | (.0137) | (.0080) | (.0117) | (.0217) |
| constant | .2073 | .7322*** | 1.2279*** | 2.374*** | 3.548*** |
| | (.4254) | (.1940) | (.1154) | (.1578) | (.2591) |
| sector dummies | yes | yes | yes | yes | yes |
| year dummies | yes | yes | yes | yes | yes |
| n.obs. | 2456 | 2456 | 2456 | 2456 | 2456 |

Bootstrapped standard errors in parentheses.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 9: Estimates of a quantile regression model of 5-year growth in total assets, augmented to include operating profits and fixed assets: selected quantiles.

| **Variables** | **Quantiles** | | | | |
|---|---|---|---|---|---|
| | .10 | .25 | .50 | .75 | .90 |
| $\log S_{i,t-1}$ | -.2167*** | -.0848*** | -.0457*** | -.0882*** | -.0961*** |
| | (.0343) | (.0175) | (.0090) | (.0132) | (.0256) |
| $\log age_{i,t-1}$ | .0465 | .0330* | -.0149 | -.0802*** | -.1130*** |
| | (.0359) | (.0193) | (.0100) | (.0149) | (.0287) |
| $AIM_{i,t-1}$ | -.1465* | -.0409 | .1332*** | .3652*** | .7427*** |
| | (.0833) | (.0455) | (.0243) | (.0380) | (.0746) |
| $\log oppl_{i,t-1}$ | .0759*** | .0414*** | .0289*** | .0331*** | .0085 |
| | (.0116) | (.0061) | (.0032) | (.0050) | (.0095) |
| $\log tfas_{i,t-1}$ | .1351*** | .0210 | -.0172** | -.0200* | -.0277 |
| | (.0259) | (.0132) | (.0072) | (.0107) | (.0201) |
| constant | -.4031 | .1842 | .5531*** | 1.4730*** | 2.0310*** |
| | (.3097) | (.1677) | (.0873) | (.1326) | (.2433) |
| sector dummies | yes | yes | yes | yes | yes |
| year dummies | yes | yes | yes | yes | yes |
| n.obs. | 3344 | 3344 | 3344 | 3344 | 3344 |
| pseudo $R^2$ | .0644 | .0329 | .0452 | .0941 | .1593 |

Bootstrapped standard errors in parentheses.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 10: Probit regression estimates of the probability to be listed on AIM, conditional on location and firm-level variables. Dependent variable: AIM dummy.

| **Variables** | **Op. revenues sample** | | | | **Tot. asset sample** | | | |
|---|---|---|---|---|---|---|---|---|
| | coef. | std. err. | coef. | std. err. | coef. | std. err. | coef. | std. err. |
| *London* | .7637*** | (.0350) | .6328*** | (.0549) | .5692*** | (.0332) | .5886*** | (.0455) |
| log op. $\text{revenues}_{i,t-1}$ | | | .0370*** | (.0096) | | | | |
| log tot. $\text{assets}_{i,t-1}$ | | | | | . | | .1088*** | (.0102) |
| log $\text{age}_{i,t-1}$ | | | -.0537** | (.0221) | | | -.0964*** | (.0189) |
| growth op. $\text{rev.}_{i,t-1}$ | | | .0934*** | (.0266) | | | | |
| growth tot. $\text{ass.}_{i,t-1}$ | | | | | | | .0402 | (.0283) |
| constant | -.9640*** | (.0126) | -.9479*** | (.2567) | -.9351*** | (.0128) | -1.8863*** | (.2280) |
| sector dummies | no | | yes | | no | | yes | |
| year dummies | no | | yes | | no | | yes | |
| n. obs. | 15413 | | 5887 | | 15093 | | 8373 | |

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 11: Instrumental Variables Quantile Treatment Effect (IVQTE) estimates. Dependent variable: firm growth rate (of operating revenues or total assets depending on the sample).

| **Quantiles** | **AIM coeff.** | **std.err.** | **Model** |
|---|---|---|---|
| **Op. revenues sample** | | | |
| .10 | -.2155 | (.2528) | **dep. var.**: growth op. rev.$_{i,t}$ |
| .25 | -.0468 | (.1265) | **other regressors**: log op. rev.$_{i,t-1}$, log age$_{i,t-1}$, |
| .50 | .0288 | (.0781) | growth op. rev.$_{i,t-1}$, |
| .75 | .1226 | (.0993) | sectoral dummies, year dummies |
| .90 | .3412 | (.2099) | |
| .10 | -.3017 | (.4307) | **dep. var.**: growth op. rev.$_{i,t}$ |
| .25 | -.0937 | (.1171) | **other regressors**: log op. rev.$_{i,t-1}$, log age$_{i,t-1}$, |
| .50 | 6.20e+06 | (.0815) | growth op. rev.$_{i,t-1}$, log fixed assets$_{i,t-1}$, log op. profits$_{i,t-1}$, |
| .75 | .0736 | (.0974) | sectoral dummies, year dummies |
| .90 | .1428 | (.1706) | |
| .10 | -2.4087 | (1.4808) | **dep. var.**: 5-yr. growth op. rev.$_{i,t}$ |
| .25 | -.8846 | (.8751) | **other regressors**: log op. rev.$_{i,t-5}$, log age$_{i,t-5}$, |
| .50 | -.2387 | (.4353) | log fixed assets$_{i,t-5}$, log op. profits$_{i,t-5}$, |
| .75 | .0037 | (.3163) | sectoral dummies, year dummies |
| .90 | .1724 | (.6188) | |
| **Total assets sample** | | | |
| .10 | .0049 | (.3332) | **dep. var.**: growth tot. assets$_{i,t}$ |
| .25 | -.0221 | (.0815) | **other regressors**: log tot. assets$_{i,t-1}$, log age$_{i,t-1}$, |
| .50 | .0385 | (.0622) | growth tot. assets$_{i,t-1}$, |
| .75 | .1404* | (.0795) | sectoral dummies, year dummies |
| .90 | .3726* | (.2183) | |
| .10 | -.0387 | (.1078) | **dep. var.**: growth tot. assets$_{i,t}$ |
| .25 | -.0302 | (.0617) | **other regressors**: log tot. assets$_{i,t-1}$, log age$_{i,t-1}$, |
| .50 | .0234 | (.0555) | growth tot. assets$_{i,t-1}$, log fixed assets$_{i,t-1}$, log op. profits$_{i,t-1}$, |
| .75 | .1248 | (.0852) | sectoral dummies, year dummies |
| .90 | .3670* | (.1937) | |
| .10 | -.2683 | (.3329) | **dep. var.**: 5-yr. growth tot. assets$_{i,t}$ |
| .25 | -.1645 | (.1806) | **other regressors**: log tot. assets$_{i,t-5}$, log age$_{i,t-5}$, |
| .50 | -.0310 | (.1578) | log fixed assets$_{i,t-5}$, log op. profits$_{i,t-5}$, |
| .75 | .1608 | (.2978) | sectoral dummies, year dummies |
| .90 | .3244 | (.6168) | |