Gazelles in the City: stock market listing and its impact on firm growth quantiles

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Abstract

In this paper, we run quantile regressions to compare the growth rates of companies listed on a junior stock market, the Alternative Investment Market, with those driving comparable unlisted companies. The goal of this analysis is to learn about the functions that stock markets perform for high-growth firms (HGFs), here defined as the companies whose growth rates are in the upper-most quantiles. Does the market allow collecting finance for productive investments, or just provide firms with opportunities for value extracting financialization? Do they function as selection devices or as risk-sharing mechanisms?

Our quantile regression estimates, using a sample of UK manufacturing companies, show that the operating revenues and total assets of AIM-listed HGFs grow faster than for comparable privately-held companies, after controlling for lagged values of size, age, and growth. Yet, companies that decline, do so more rapidly if they are listed on the AIM. These findings are consistent with the stock market performing a selection function and attracting relatively risky companies.

1 Introduction

The *small is beautiful* slogan has dominated scholarly and policy debates on micro-founded growth and innovation since the Nineties, until richer datasets on longer observation horizons have shown how start-ups and SMEs display relatively low survival rates and, even when they survive, their contribution to innovation and job creation is marginal (Shane 2009, Nightingale and Coad 2014). The evidence

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piling up in the last decade has instead thrown light on the relevant contribution of high-growth firms (HGFs), also known as *gazelles*, to job creation (see the results summarized in Bos and Stam 2014, Henrekson and Johansson 2010, and Moreno and Coad 2015). HGFs are found to be younger than non-HGFs (Haltiwanger et al. 2013), giving yet another reason for supporting new firm formation (see also Mazzucato 2011), but contrary to previous beliefs, the contribution of high-tech companies is not disproportionately larger (Mason and Brown 2011). Though, high-growth episodes lack persistence (Parker et al. 2010, Daunfeldt and Halvarsson 2014, Hölzl 2014).

In such a blossoming literature, the link between firm growth and capital sourcing has been neglected. Audretsch and Lehmann (2006) provided an early piece of evidence on the effect of going public on firm growth, using quantile regressions; some preliminary results on the impact of venture capital are available in Coad and Siepel (2012), whereas Bianchini et al. (2015) explore the more general impact of capital structure. But that is it, leaving a gap which is rather surprising, in light of the restrictive banking regulations and of the financial innovation that have characterized the last decades.

As a heritage of the great recession, loans to individuals and companies have been rationed by increasingly risk-averse banks (Amini et al., 2010; Ivashina and Scharfstein, 2009) in compliance with the Basel III accords (Saurina and Trucharte, 2007; Scellato and Ughetto, 2010; see also Cardone-Riportella et al., 2011). As Wehinger (2012) put in an OECD report, "With the banking sector expected to shrink considerably, other actors, especially institutional investors, and new forms of financial intermediation will have to meet the credit needs of the economy." Small, young, and risky companies, which were already very sensitive to the monetary policy channel (Korajczyk and Levy, 2003; Bougheas et al., 2006), have been disproportionately affected. Increasingly, new firms with high growth ambitions need to resort to alternative financial sources, made available by regulatory reforms and institutional innovations that have transformed the financial sector in the last decades. The creation of *junior stock markets* represents a major step in this process. Markets characterized by light listing requirements and information standards as well as by customized regulation, out-sourced to financial intermediaries, allows even the shares of very small and young companies to be publicly floated.

This paper explores the impact of stock market listing on the entire distribution of firm growth rates, focusing on the AIM, 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, productivity, age, and sectoral distribution (sources: Amadeus, Osiris, London Stock Exchange).

The empirical analysis performed in the paper relies on a quantile regression model of firm growth. Quantile regression allows to estimate the effects of the explanatory variables at each point of the conditional distribution of the dependent variable, and hence to track the performance of high-growth firms (those in the upper tail of the growth rate distribution). We ask whether fast-growing AIM-listed and privately-held companies performed differently in terms of growth rates, controlling for lagged size, growth rates, age, and capital structure variables, as well as for sectoral heterogeneity through fixed effects. The same analysis is performed on two different measures of firm size, namely sales and total assets.

Listing on a lightly-regulated stock market segment may allow firms to raise capital at a lower cost than similar, privately-held companies, e.g. because of greater competition among providers of finance, wider analyst coverage, or assistance by Nomads. This would imply that AIM-listed companies over-perform the unlisted ones at all quantiles of the growth rates distribution. On the other hand, stock market listing offers greater opportunities for financialisation strategies, such as buy-backs, possibly to the point of crowding out the exploration and exploitation of technological capabilities. Under-performance of the AIM-listed companies should therefore ensue across quantiles. Listing on AIM may however exacerbate the differences between HGFs and decliners if the stock market acts as a selection mechanism, revealing strengths and weaknesses quite fast, or if it is used as a risk-sharing mechanisms, thereby attracting risk-loving entrepreneurs or, more generally, companies with riskier profiles (e.g. young, small, high-tech or plain speculative).

According to our findings, the effect of AIM listing is negative until approximately the 3rd decile of the firm growth distribution, and positive and increasingly so above it. Hence, AIM-listed high-growth firms grow faster than their privately-held counterparts, but those that decline experience a deeper contraction. At the same time, the growth processes of AIM-listed high-growth firms appear as less persistent, as testified by significantly smaller autoregressive coefficients. These results are similar whether growth is measured on the basis of sales or assets. These results support the hypothesized selection and risk-sharing interpretations.

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 Literature review

2.1 Junior stock markets

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 Marche', the EASDAQ) ended up in collapse between 2002 and 2003, leaving the Alternative Investment Market, a segment of the London Stock Exchange (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.[1] The fiercely competitive post-MiFID environment pushed NYSE-Euronext to set up Alternext, a MTF closely modeled on the AIM (Davies, 2008; 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.

The scant existing evidence on the real performance of companies listed on junior stock markets shows that quotation affects the average firm growth rate (e.g. in Audretsch and Lehmann, 2006), but with uncertainties concerning the direction of causality and contrasting results, e.g. boosting sales while productivity growth declines (see Revest and Sapio, 2013). In light of the evidence on the job creation contribution of HGFs, understanding the impact on high-growth firms

[1] 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.

of alternatives to banking, their direction of causality and the persistence of the effects would provide policy-makers with key pieces of information for the design of effective promotion policies and, broadly speaking, for re-drawing the boundaries of the financial systems.

2.2 HGFs and public equity in the existing literature

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 illuminating in this respect, but the availability of financial resources is by no means less crucial to HGFs. Policy-oriented research acknowledges that R&D and finance are on the same ground as critical resources for HGFs, and finance can be essential in order to take-off at trigger points that turn episodic high-growth into a sustained advantage over competitors (Mason and Brown, 2013). After all, the existing evidence is against the common belief that HGFs are more frequently found in high-tech sectors or among R&D-intensive firms.

The question then arises as to what type of finance would be more appropriate to support HGFs. The answer is, of course, sector-specific, but the liability of newness seems to be a common theme among HGFs, suggesting that traditional forms of capital raising be inaccessible or not suited to the peculiar needs of fast expanding new firms. It is for this reason that some scholars have explored the issue of whether receiving venture capital or going public in junior stock markets is beneficial for firm growth. Most often, this research line has focused on the average or on the median firm (e.g. Bertoni et al., 2011; Revest and Sapio, 2013) while attempts at singling out the effects on HFGs are more rare (e.g. Audretsch and Lehmann's 2006 quantile regression analysis on the German Neuer Markt).

There are a number of reasons why we focus on junior stock markets and not on venture capital. One is that venture capital is more sectorally concentrated than junior stock markets, whereas the evidence shows that HGFs are found in nearly every sector of the economy. Hence we expect to find a stronger empirical relationship that if we focused on venture capital. Another reason is that junior stock markets represent an exit route for venture capitalists. In a sort of backward induction applied to research methodology, we believe that understanding the performance of firms going public would help learn also something about the motivations for venture capital backing. Finally, evidence on the Toronto Venture Stock Exchange, by Carpentier et al. (2010), shows that companies listed on the Canadian junior stock market provide comparable if not higher returns than venture capital, highlighting that public and private equity can compete on the very same set of companies.

Admittedly, only a small fraction of all companies ever receives public or private equity, but studying their relative performance is rife with fruitful insights about firm-level strategic reasoning and, somewhat related, the most appropriate design of entrepreneurial policy. Equity, indeed, occupies a peculiar place in capital structure decision framed according to a pecking order. Adding to the evidence summarized by Revest and Sapio (2012), a pecking order hypothesis, extended to account for debt capacity constraints, was found to correctly describe the capital structure decisions of HGFs in Vanacker and Manigart (2010), meaning that HGFs going public have already been satisfied in their credit demand. Listed HGFs thus appear as companies with relatively large demand for external finance, showing the relevance of market-based sources and justifying the focus on listed companies. Junior stock markets, moreover, hosts companies that had been previously backed by venture capitalists who choice the IPO as their exit route. Mason and Brown (2013) argue that since an IPO exit preserves company independence, it should be supported instead of trade sales. Learning about the real performance of companies listed on the junior stock market can provide materials for discussing that policy recommendation.

2.3 Hypotheses

Moving beyond the general considerations and the pieces of evidence summarized above, hereby we outline the hypotheses tested through the quantile regression analysis proposed in this paper. The hypotheses formulated below concern the comparative growth performance of AIM-listed and privately-held companies in the tails of the firm growth rates distribution. Companies in the right tail are referred to as HGFs, whereas those in the left tail are mentioned as decliners. AIM-listed HGFs (decliners) are said to over-perform the privately-held ones if, all else being given, the growth rate of AIM-listed companies in the upper (lower) tail is higher than for the unlisted. Under-performance is the term used in the opposite case. Let us go through each hypothesis and the underlying theoretical backings.

H1a: *AIM-listed companies over-perform at all quantiles.*

According to this hypothesis, the growth rates distribution of AIM-listed companies is entirely shifted right-wards, so that high-growth performances are stronger and declines are milder for the quoted companies. This might be due to several reasons. One is that in a market characterized by asymmetric information, higher liquidity of the 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, regardless of their growth performance (see also Chemmanur and Fulghieri, 1999). Further, stock

market quotation may make it easier for firms to obtain loans or to issue bonds. The implicit assumption here is that any amount of capital raised on the stock market or through bonds will be channeled to value-creating activities. One may argue that AIM, just as any other junior stock markets, is relatively illiquid, both because it hosts risky companies and because of the absence of 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).

An alternative story that would be consistent with AIM-listed over-performance at all quantiles involves coaching effects due to assistance by Nomads in financial management and in shaping the corporate governance structure. While Nomads are not comparable to venture capitalists, as they do not possess the same competences and are not exposed to the same incentives, they may still help the assisted companies in aligning with the best practice in corporate governance, which can help optimizing the use of strategic resources. Nomads may also provide access to networks of financial intermediaries, thus reinforcing the capital raising channel outlined above. It is worth noting that over-performance associated to Nomads backing may rather signal a scouting effect, as Nomads are the intermediaries that actually perform the suitability assessment preliminary to introduction on AIM.

Two related hypotheses move from the observation that, while liquidity, analyst coverage, and Nomad assistance may yield benefits across all quantiles of the growth rates distribution, such benefits are unlikely uniform across firms. On the one hand, companies displaying a spectacular growth performance supposedly attract more attention; their business is subject to closer scrutiny, thereby reducing information asymmetries more. This insights is summarized in the following

H1b: *AIM-listed HGFs display a higher over-performance than AIM-listed decliners.*

Conversely, one may argue that investors would rather stay away from one-hit wonders (i.e. high-growth performances lacking persistence) and support companies with more stable growth paths. This of course requires that investors be able to correctly identify growth persistence, something that is not granted in a boundedly rational world. This leads to

H1c: *AIM-listed HGFs lacking persistence display a lower over-performance than AIM-listed decliners.*

The same conclusion can be reached if declining unlisted firms are more financially constrained than HGFs. If so, indeed, on the margin they would benefit more than HGFs from stock market capital raising.

The next alternative hypothesis claims that

H2: *AIM-listed HGFs over-perform, AIM-listed decliners do not.*

This can be seen as an outcome of self-selection into the stock market. Discussing about post-IPO sell-out strategies, Chemmanur, Signori, and Vismara (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. 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, hypothesis H2 does not predict any significant difference in terms of firm growth at the lowest quantiles.

Stock market listing may impact growth performance in opposite ways at the two ends of the growth rates distribution, boosting the growth of HGFs while exacerbating the declines. This is the core of the next hypothesis:

H3: *AIM-listed HGFs over-perform, AIM-listed decliners under-perform.*

One reason to expect this is that the stock market may perform a selection function, i.e. it may allow a faster sorting of good and bad companies. It should then amplify both good and bad performances. An alternative story is that stock market flotation magnifies the financial and/or industrial risk of listing companies. In fact, if companies go public in order to obtain a wider risk-sharing, it is riskier businesses that self-select into the stock market.[2]

Finally, it may be argued that listed companies, regardless of their actual and potential growth rate, devote more managerial time/attention and financial resources to financial management than to their core business. They may, for instance, engage in stock repurchases, as shown e.g. by Lazonick (2007). This would depress their growth rate at all quantiles:

H4: *AIM-listed companies under-perform at all quantiles.*

3 Materials and methods

3.1 Data and variables

For the purposes of this article, 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.

[2]Lack of persistence suggests that HGFs today need not be HGFs tomorrow; hence, this hypothesis is better tested on multi-annual time horizons.

Our interest lies in firm growth, defined here as the annual change in logarithmic firm size. As proxies for size, here we alternatively use operating revenues (i.e. turnover) and total assets.[3] 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 have only unit values for companies that stayed on AIM for the whole sample period; all zeroes for companies that were never listed on AIM; sequences of ones and zeros for companies that went public and then delisted. The AIM dummy, thus, captures at the same time the before-after differences in growth rates as well as cross-sectional effects of stock market listing.

As suggested by the literature on high-growth firms, younger companies tend to disproportionately contribute to job creation. Hence, we consider age as an explanatory variable. Age is 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 classify the companies according to 3-digit NACE Rev. 2 sectors.

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

[3]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 the number of missing values in the dataset was higher than for operating revenues and total assets.

are comparable in terms of age, size, and sectoral distribution.[4]

In the sampled panels, the time dimension has an annual frequency and the cross-sectional dimension is marked by the firm ID. The panels are unbalanced because of post-1997 entry, firm mortality, decisions to go public on the LSE Official List, and takeovers.

3.2 Quantile regression

The standard workhorse in the econometric analysis of firm growth is the Gibrat's 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, whereas the literature on HGFs adopting the quantile-based definition of HGFs shifts the focus on the upper quantiles of the firm growth rates distribution. The quantile regression model, introduced by Koenker and Bassett (1978), is thus the appropriate methodology, as it models the dynamics of the firm size distribution as a whole, *quantile by quantile*, relaxing the restrictive assumption of that the error term is identically distributed at all points in the conditional distribution. Several applications of this method in Economics are summarized by Buchinsky (1998) and 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

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

where $s_{i,t}$ denotes firm log-size at time t; $g_{i,t} \equiv s_{i,t} - s_{i,t-1}$ is the firm growth rate between $t-1$ and t; $\text{age}_{i,t}$ is firm age at t; $\text{AIM}_{i,t}$ is a dummy equal to 1 if company i was listed on AIM at time t; $u_{i,t}^p$ is an i.i.d. error term; β_0^p, β_s^p, β_g^p, β_a^p, β_A^p are the associated coefficients to be estimated. The p subscripts indicate that the model coefficients are allowed to vary across quantiles of the conditional size distribution. We shall identify HGFs in the upper tail of the distribution.

[4] 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 (deflated) size and age 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.

The coefficient β_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 β_s^p includes 1, the law of proportionate effect (Gibrat's law) holds, whereas an estimate significantly below one suggests that firm size reverts toward quantile p. The β_g^p coefficient tunes the persistence of firm growth rates. In particular, for p close to 1, a positive value would imply that HGFs persistently outperforms their rivals, whereas a negative value indicates their inability to repeat the *exploit*. β_a^p is expected negative if young firms grow faster.

Our main focus, however, is on coefficient β_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. The reader is referred to Koenker and Bassett (1978) for technical details on the estimator.

4 Results

4.1 Baseline results

The results from estimating Eq. 1 are plotted in a figure for each explanatory variable. Each figure comprises two subfigures, one for each sample (depending whether the size proxy was operating revenues or total assets). All of the figures are reported in the Appendix.

Let us consider size (Fig. 1) and age (Fig. 2) first. 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 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 HGFs (upper tail), the negative and significant coefficient means smaller firms grow faster. Age coefficients imply that older declining firms do not fare better, whereas younger HGFs grow faster than their older peers. Results on the growth of total assets do not differ much. Point estimates of the size coefficients are lower in magnitude, and lack significance for growth rates below the median. Overall, these results on the impact of size and age on the growth of HGFs are in line with the existing evidence on HGFs.

Are firm growth rates serially correlated? This seems to be the case (Fig. 3),

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.

Our variable of interest, the AIM dummy, displays an increasing profile across quantiles in both samples (Fig. 4). As to operating revenues, point estimates ranging from nearly -0.20 (5th quantile) to slightly above 0.30 (95th quantile); statistical significance is lacking between the 2nd decile and the median. In the total assets sample, the marginal effect of an AIM listing goes from nearly -0.20 (lower tail) and 0.40 (right tail), and is significantly different from 0 except at the median. Being listed on AIM, thus, magnifies the growth performance of HGFs while accelerating the fall of the fast-decliners. At the median of the growth rates distribution, AIM-listed and privately-held firms perform alike. All in all, the growth performances of AIM-listed firms appear to be more polarized than for the unlisted ones.

4.2 Serial correlation of firm growth rates

The results on the serial correlation of growth rates are at odds with most previous evidence, as they suggest that slow-growers tend to confirm their mild performance over time, whereas fast-growers and fast-decliners escape prediction. In previous works, instead, the growth rates of HGFs were found to be negatively correlated. One notable exception was Capasso et al. (2013), who showed the co-existence of persistent and occasional HGFs in their sample of Dutch companies. The lack of serial correlation in the growth rates of our HGFs may similarly be due to the superposition, in the same sample, of companies with polar growth patterns. Stock market flotation may be one such confounding factor.

In order to assess if this is the case, we add an interaction term, namely $AIM_{i,t-1} * g_{i,t-1}$, with associated quantile-specific coefficient β^p_{int}. In this way, the serial growth rates correlation for privately-held and AIM-listed companies at quantile p are equal to, respectively, β^p_g and $\beta^p_g + \beta^p_{int}$.

Fig. 5 displays the estimates of β^p_{int} across quantiles, for both measures of firm growth. The previously detected coefficient profile of β^p_g (not shown here) on the total assets sample is basically confirmed, whereas the one based on the operating revenues sample is now mildly declining, with significantly negative point estimates after the 6th quantile, so that the partial correlation of the growth rates of privately-held HGFs at the 95th quantile is about -0.20. Hence, privately-held HGFs manage to repeat their exceptional asset growth performances, but not their sales growth.

AIM-listed and unlisted companies, though, differ as to their growth persistence patterns. The estimated β^p_{int}, however, display opposite signs as β^p_g: it is

significantly negative from the 65th quantile on for the total assets sample; increasing and significantly positive from the 4th quantile on for operating revenues, losing significance in the right tail, but still positive and significant at the 80th and 90th quantiles. As an implication, AIM-listed HGFs are more persistent in their sales success, but more 'discontinuous' as regards asset growth.

4.3 Robustness: Time trends and external finance

This subsection explores the robustness of the above results. First, we will take care of the exogenous, aggregate trends that can influence growth rates; in addition, we control for firm-level heterogeneity in the access to alternatives to stock markets finance, e.g. bank loans and retained earnings.

Our previous results did not take account of external forces that are time-specific and that also determine the firm's growth process. The simplest way of controlling for time is by including temporal dummy variables; an alternative, and perhaps more informative way would be to use stock market indices. We believe that stock market indices represent not only the performance of the stock market and its changes over time, but provide valuable information on the business cycle, investors confidence, and the macroeconomic growth prospects.

Among the various indices of AIM, we only report the results obtained including the FTSE AIM 100 (lagged natural logarithm).[5] The FTSE AIM 100 Index is built upon the market values of the top 100 companies on the Alternative Investment Market, weighted by market capitalization. It comprises a range of businesses - from young, venture capital-backed start-ups to well-established, mature organizations seeking to expand. AIM 100 companies must have their primary listing on the Alternative Investment Market, and are required to meet various eligibility criteria.

The coefficient associated to the AIM 100 index (not reported in figures) is positive at all quantiles and slightly increasing in the right tail. All other effects are approximately confirmed.

In yet another robustness exercise, we follow Bottazzi et al. (2012) and insert in the model two further explanatory variables: operating profits, a 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. We consider logarithmic transformations of both variables, after suitably rescaling operating profits, and include as regressors their annual lags in order to mitigate possible reverse causality problems (see Coad, 2007 for a discussion).

These controls affect firm growth differently depending on the size proxy (Fig. 7 only reports those for the operating revenues sample). Neither operating profits

[5]Results do not significantly change if we use other AIM or main market indices.

nor tangible fixed assets enter significantly in operating revenues growth regressions. In total assets growth estimates, we spot a decreasing profile in the coefficients associated to operating profits and tangible fixed assets, although it is more pronounced in the last one. Again, the other results holds quite robustly.

5 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 markets, and hence rather 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 and time effects. The same analysis is performed on two different measures of firm size, namely sales and total assets.

Our findings 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 high-growth firms grow faster than their privately-held counterparts, but those that decline, do so more rapidly if they are listed. At the same time, the growth processes of AIM-listed HGFs appear as less persistent, as testified by significantly smaller autoregressive coefficients. As a major goal for future research, we shall try and discriminate among the two possible explanations.

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Appendix

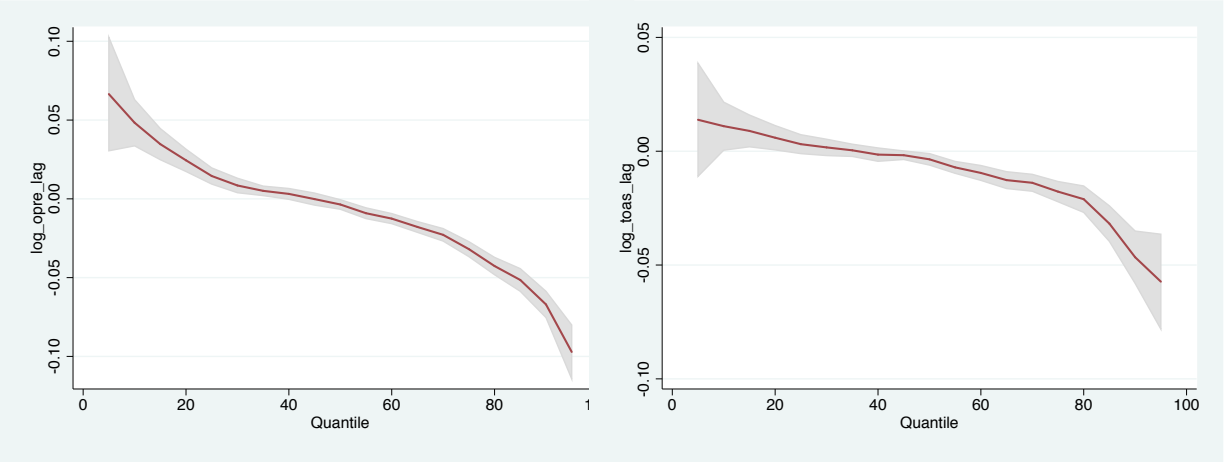

Figure 1: Quantile regression coefficients of lagged firm size. Operating revenues sample (left), total assets sample (right).

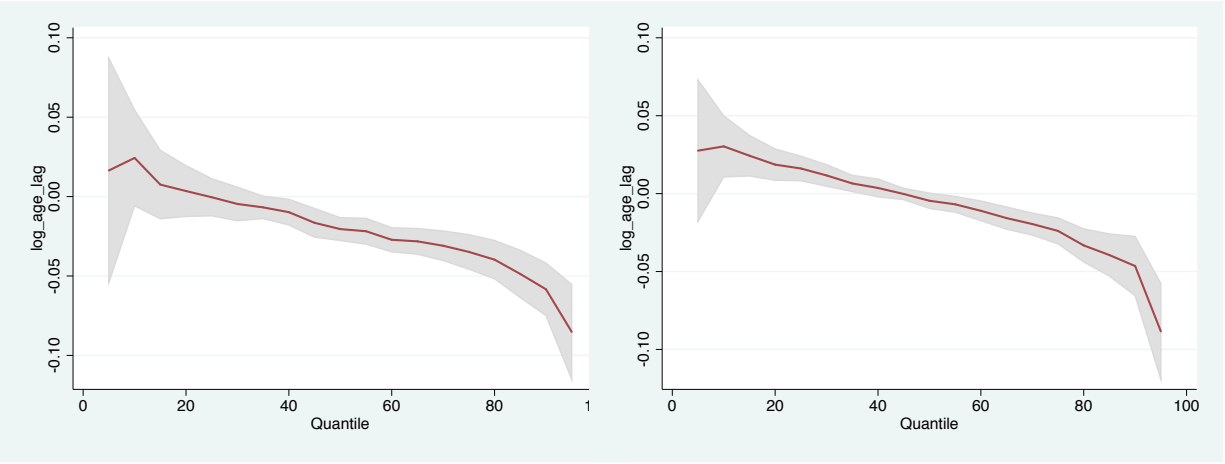

Figure 2: Quantile regression coefficients of lagged firm age. Operating revenues sample (left), total assets sample (right).

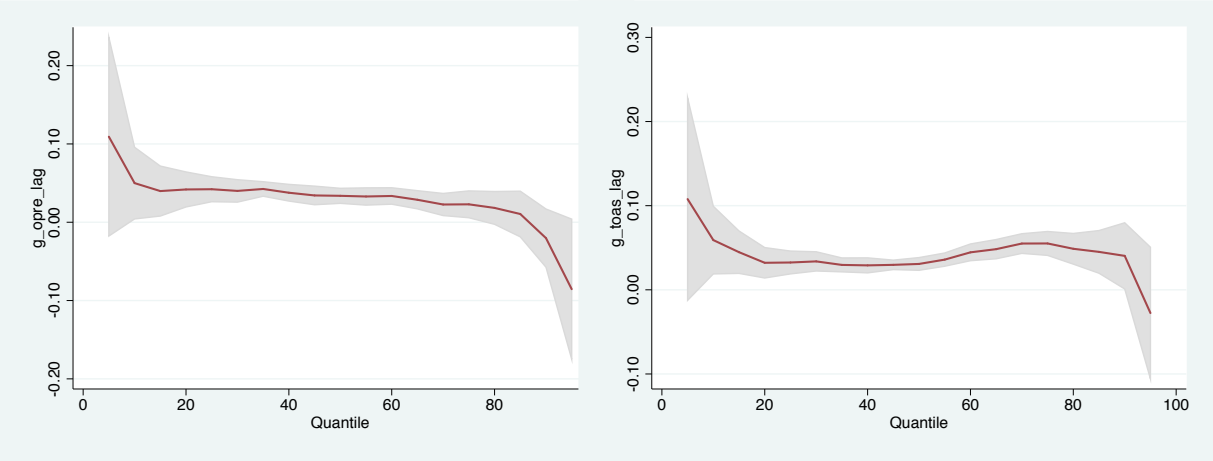

Figure 3: Quantile regression coefficients of lagged firm growth rate. Operating revenues sample (left), total assets sample (right).

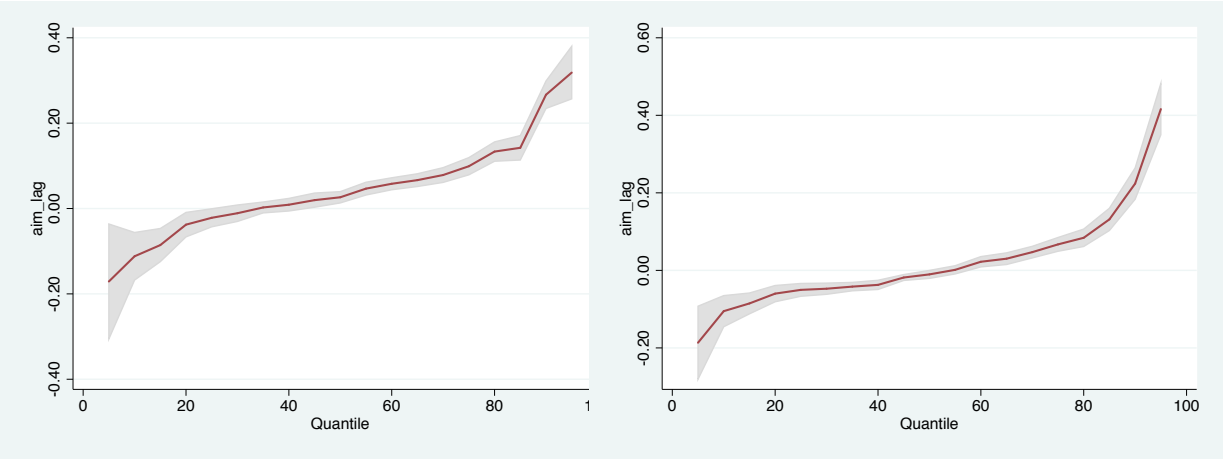

Figure 4: Quantile regression coefficients of the AIM dummy. Operating revenues sample (left), total assets sample (right).

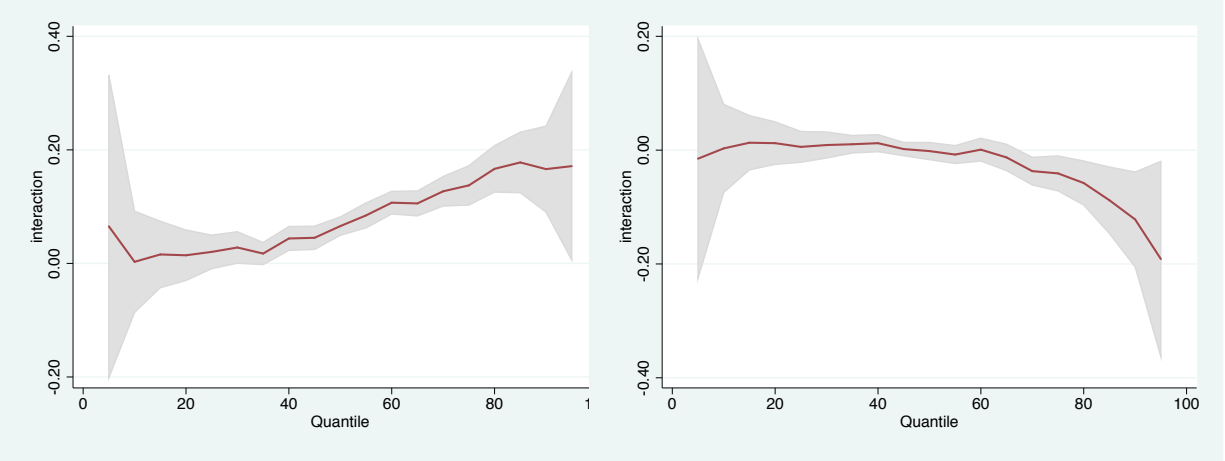

Figure 5: Quantile regression coefficients of the interaction term between lagged growth rates and the AIM dummy. Operating revenues sample (left), total assets sample (right).

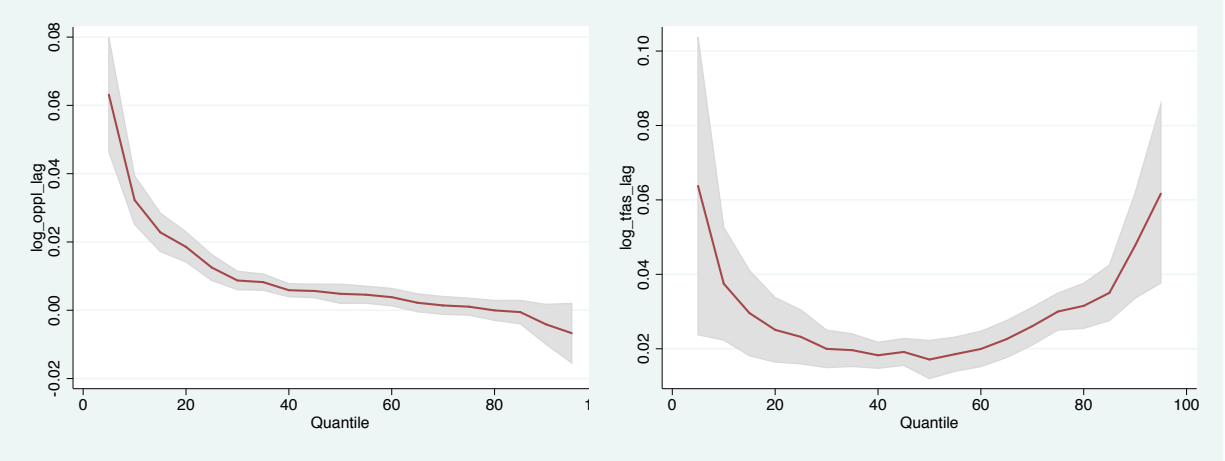

Figure 6: Quantile regression coefficients of operating profits (left) and tangible fixed assets (right) for the operating revenues sample.