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Do capacity constraints trigger high growth for enterprises?

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ABSTRACT: High-Growth Enterprises (HGEs) have a large economic impact, but are notoriously hard to predict. Previous research has linked high-growth episodes to the configuration of lumpy indivisible resources inside firms, such that high capacity utilisation levels might stimulate future growth. We theorize that firms reaching critically high capacity utilisation levels reach a 'trigger point' involving either broad-based investment in further growth, or shrinking back to previous levels. We analyse EIBIS survey data (matched to ORBIS) which features a question on time-varying capacity utilisation. Overcapacity is a transitory state. Firms enter into overcapacity after a period of rapid growth of sales and profits, and the years surrounding overcapacity have higher employment growth rates. Firms operating at overcapacity make incremental investments (e.g. capacity expansion, process improvements, and modern machinery) rather than investing in R&D and new product development. We find support for the 'fork in the road' hypothesis: for some firms, overcapacity is associated with launching into massive investments and subsequent sales growth, while for other firms, overcapacity is negatively related to both investments and sales growth.

JEL CODES: L25
KEYWORDS: High-Growth Enterprises (HGEs), firm growth, investment, capacity utilisation, trigger points

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1. Introduction

High Growth Enterprises (HGEs) have received substantial interest from policymakers, academics, and investors since the seminal contribution of Birch (1979). A stable finding across countries and time periods is that about 4% of firms create about 50% of the jobs (Storey, 1994). Interest in HGEs has grown with awareness of their disproportionately large contribution to economic growth and job creation (Delmar et al., 2003; Henrekson and Johansson, 2009; Coad et al., 2014; McKenzie, 2017; Grover Goswami et al., 2019; Flachenecker et al., 2020). However, a problem for 'gazelle hunters' is that it is notoriously difficult to predict which firms will become HGEs (Fischer and Karlan, 2015). Part of the problem is that HGE status is often a temporary episode rather than a time-invariant firm characteristic (Daunfeldt and Halvarsson, 2015; Grover Goswami et al., 2019), hence firms may drift in and out of the subsample of 'potential' HGEs.

The episodic nature of high-growth events draws on the stylized fact that firm growth is not a smooth process, but takes place in lumps, bumps, and jumps (Arata, 2019). Firm growth rates follow a heavy-tailed distribution (rather than a normal distribution), such that while most firms do not grow much in any year, a handful of firms will have very fast growth or decline in each year (Bottazzi and Secchi, 2006).

The challenge for policymakers, interested in supporting HGEs on the grounds of their impressive job creation potential, is to target their policy interventions to nudge firms into HGE episodes. The fundamental question for policymakers, therefore, is whether rapid growth can be triggered. If the 'trigger points' of rapid growth can be better understood, then policy interventions that are targeted at these trigger points could be a cost-effective way to 'nudge' hesitant firms that are at a critical decision point in their growth path to launch into rapid growth.[1]

This study takes a step back and theorizes about the reasons why firms might suddenly launch into a period of high growth. Building on Penrose (1959) and her vision of firms as constantly-shifting configurations of lumpy resources, we suggest that firms at a critical state of maximum use of resources will be uniquely positioned at the window of opportunity to launch into high growth. Previous literature has discussed "trigger points" for firm growth (Brown and Mawson, 2013), as well as investigating links between capacity utilization and firm growth on a theoretical (Coad and Planck, 2012) and empirical (Pozzi and Schivardi, 2016) level, but we fill a gap in the literature regarding how high capacity utilization might serve as a critical decision point for firms' growth trajectories.

This study makes several novel contributions. First, amid a paucity of empirical evidence on firm-level capacity utilisation levels and their relationship to firm growth, we explore a rich large-scale questionnaire dataset that includes information on capacity utilisation levels. More specifically, we match the EIBIS survey (European Investment Bank Survey of Investment and Investment Finance) to the ORBIS database maintained by Bureau van Dijk. This dataset provides rich evidence that enables comparisons across many EU member states. Of central interest is the question asking a firm if it is "[o]perating at its maximum capacity attainable under normal conditions?", with four responses: above maximum capacity; at maximum capacity; somewhat below full capacity; substantially below full capacity. Second, we develop a theory of firm growth and capacity utilisation, and formulate our novel 'fork in the road' hypothesis whereby firms operating above maximum capacity will either invest massively in subsequent growth, or shrink back to previous production levels. Third, we investigate the

[1] Such policy interventions could perhaps include access to finance (for financing the expansion) or providing technical support to remove uncertainty surrounding the expansion path. An alternative to direct policy interventions, however, could be attempts to set up an environment whereby private actors (e.g. private equity funds) undertake these actions.

antecedents, characteristics, and consequences of operating above maximum capacity levels, focusing in particular on showing that entry into a state of overcapacity is preceded by rapid growth of sales and profits, and firms in overcapacity have higher employment growth before, during, and after being at overcapacity. This is consistent with firms being pushed into a critically high level of capacity utilisation by rising demand. Firms in a state of overcapacity tend to make incremental investments in capacity expansion for existing products, and modern machinery, rather than investing in R&D and new product development. We find some evidence that firms entering into overcapacity reach a decision point (or fork in the road), with some firms taking overcapacity as an opportunity to launch into subsequent sales growth, while for other firms overcapacity is linked to a decline in sales.

The paper is organized as follows. Section 2 discusses the previous literature and presents our research questions. Section 3 presents our data. Section 4 contains our analysis. Section 5 discusses our results, and Section 6 concludes.

2. Background

2.1 Firm growth as a lumpy bumpy process

Growth is not a smooth process but occurs in lumps, bumps, and jumps. Nearly 100 years ago, Ashton (1926) considered the growth patterns of British textile firms and observes that 'In their growth they obey no one law. A few apparently undergo a steady expansion . . . With others, increase in size takes place by a sudden leap' (Ashton, 1926, pp. 572–3).

Relatedly, Doms and Dunne (1998) observe that firm investment takes place in concentrated bursts, such that in most years firms do not invest in their capital stock – but when they do the investment is huge: "51.9% of plants in a year increase their capital stock by less than 2.5%, while 11% of plants in a year increase their capital stock by more than 20%." (p415). Furthermore, "[t]his implies that, on average, half of a plant's total investment over the 1973-1988 period was performed in just three years.'' (p417).

Recently, researchers have investigated the Laplace distribution of firm growth rates, which is a robust fact of firm growth (Stanley et al., 1996; Bottazzi and Secchi, 2006; Arata, 2019). The Laplace distribution is heavy-tailed compared to the Gaussian, which means that while most firms hardly grow from one year to the next, it is not unusual for a handful of firms, in each year, to experience relatively fast growth. The Laplace distribution of firm growth rates can be explained in terms of firms being composed of lumpy and interdependent resources, bundled together in multiples that do not match up, hence leading to excess capacity in various dimensions, yet striving towards a full utilisation of their resources, such that (depending upon the arrangement of resources within the firm, and the degree of slack) there may be critical junctures at which the firm can only grow by taking a large leap forward (Coad and Planck, 2012; see Figure 1 below).

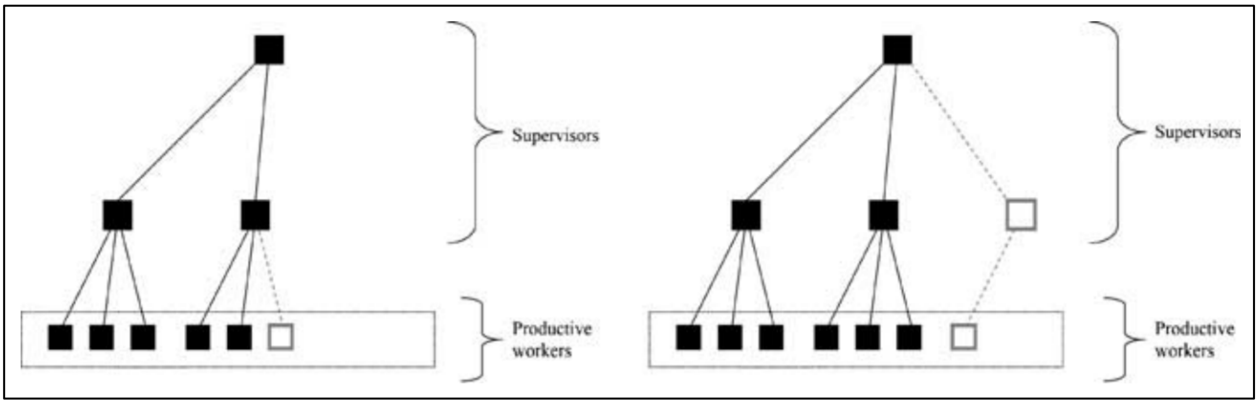
2.2 Firms as bundles of discrete resources

In her influential book on firm growth, Penrose (1959) put forward a theory of firms being composed of 'resources', that are indivisible in nature, and such that the configuration of these lumpy resources provides the impetus and the direction of further growth.

We may consider that present-day firms are complex bundles of resources: including employees, machines, software, raw materials, land and buildings, IPR assets, capabilities, product ranges, distribution networks, etc (Penrose, 1959). Firms combine these resources to assemble their productive capacity. These resources are affected by indivisibilities brought on by integer restrictions (Penrose, 1959): i.e. one cannot build half a building, buy half a machine, or develop half a product. Penrose (1959, chapter 5) discussed the 'balance of processes' to explain that the proper use of a collection of indivisible productive resources requires that the most efficient level of production corresponds to the least common multiple of these factors.[2]

According to Penrose, there are varying degrees of organizational slack, depending upon how the various resources are arranged in the firm. Firms are heterogeneous in their ability to respond to economic stimuli with growth of production capacity (Pozzi and Schivardi, 2016). In some cases, production capacity can be expanded relatively easily, by adding one input (e.g. one production employee), and this new input can draw on existing slack (i.e. spare capacity) throughout the organization. In other cases, adding an input to an organization that is already at a critical state of full utilisation of resources (i.e. with no organizational slack) will require broad-based investment in complementary resources. Some previous work has focused upon how growing firms can 'change gears' to facilitate further growth by rearranging employees and tasks into a new organizational structure that involves the addition of hierarchical layers (Caliendo et al., 2015; Cruz et al., 2018). An important point is that there will be non-constant marginal costs of producing an extra unit, because the costs of expanding production will depend upon the degree of capacity utilisation (Butters, 2020).

Figure 1. Firms as bundles of discrete resources. In this model, each supervisor has a span of control of 3. Depending upon the "criticality" of the system, adding a production worker may lead to an increase in the number of supervisors further up the hierarchy. If there is some slack in the system, a production worker can be added, and new supervisors need not be added (see left). If, however, the attention of supervisors is already at full utilization, the addition of a production worker will require the addition of a supervisor (see right).



Source: Coad and Planck (2012).

In the case of a simple model of a single-product firm, Figure 1 shows that adding a unit of production capacity has non-constant marginal costs that depend upon the degree of capacity utilisation in the organization. In some cases, adding one production unit has cascading knock-on effects that trigger further growth.

The configuration of resources in a firm is continuously shifting. Firms are in a constant state of flux: employees come and go, the productivity of employees generally increases over time through learning effects and process innovations, and heterogeneous productivity growth across tasks means that the sorting of tasks to employees is constantly being rearranged (for example if some tasks are automated using new software). As time goes by, the productivity of resources may change (e.g. due to learning or depreciation). The degree of organizational slack in the firm (as a complex system) is constantly

[2] This resembles the Leontief production function (Butters, 2020).

evolving. In some cases, the configuration of resources in a firm, and opportunities brought on by the idiosyncratic balance of productive assets and capabilities at a particular point in time, can provide an impetus for further growth.

Adding a basic input to the firm can sometimes trigger an 'avalanche' of further investments in productive capacity and firm growth. An analogy could be the 'sandpile' model (Bak et al., 1993): randomly adding grains of sand to a sandpile will cause the sandpile to self-organize to approach a critical slope, and (depending upon the configuration of grains of sand in the pile) the addition of one more grain of sand could trigger avalanches of various sizes. In the context of business firms, an implication is that the marginal costs of growth are non-constant. At some times, it is easier for a firm to expand production by e.g. 5% than at other times. These non-constant costs of growth are intimately related to a firm's state of capacity utilisation and degree of organizational slack, and can be thought of as 'trigger points' (Brown and Mawson, 2013) for high growth episodes.

2.3 High growth firms and 'trigger points'

The concept of 'trigger point' (Brown and Mawson, 2013) recognizes that high-growth is episodic rather than a time-invariant trait of firms, and also it is a concept of policy interest because policymakers are interested in targeting their interventions at these trigger points. Examples of trigger points from Brown and Mawson (2013) include discrete events such as new capital investments, new bank funding, changes in ownership (e.g. management buyouts or buy-ins; MBOs or MBIs), or boosts to sales coming from obtaining a new contract or customer. We could also add some further examples of trigger points: hiring a first employee (a daunting step which corresponds to doubling a firm's size; Coad et al., 2017; Fairlie and Miranda, 2017),[3] first steps into internationalization, introducing a second product, building a second production plant, installing next-generation capital equipment, restructuring a firm's hierarchical layers to be better positioned for subsequent expansion (Caliendo et al., 2015; Cruz et al., 2018) or perhaps overcoming a regulatory threshold for firm size (Schivardi and Torrini, 2008; Garicano et al., 2016; Bornhall et al., 2017). The challenge is to find a juncture where an intervention can have an impact via knock-on effects such as subsequent adjustments, investments, and hires.

We argue that policy interventions targeted at these trigger points could be a cost-effective way to leverage a step-change or a discontinuity in firm's growth paths. However, for such a policy intervention to be effective, it is necessary to accurately identify trigger points, and also to understand what exactly are the needs of firms upon reaching these trigger points (e.g. access to finance, technical support, or temporary relief from the burdens that accompany larger size).

Trigger points are times of discontinuity when the firm is of a certain size and critical configuration of resources and capacity utilisation. Trigger points are ephemeral, and therefore the policymaker only has a short window of opportunity. If successful, however, the policymaker could seize a cost-effective opening to leverage a large impact. However, timing is crucial. Policy interventions targeted at trigger

[3] The hiring of a first employee can be seen as a daunting, once-in-a-lifetime gamble, that effectively corresponds to a doubling of the firm's size. Risk-averse or untrusting entrepreneurs may also underestimate the gains from having an extra employee. Policy might have a role in stimulating firms to hire their first employee. For example, a temporary (e.g. 2-year) employment tax freeze for firms that hire their first employee could give them the time to appreciate how useful the extra employee is, to the point that they do not downsize once the policy is finished. This could bring about further growth, because research shows that growth is an 'acquired taste' in that past growth contributes to the desire for future growth (Wiklund and Shepherd, 2003).

points should, on the one hand, move fast enough to arrive in time of need, and on the other hand, should also be withdrawn shortly after the trigger point circumstances have passed.

Considering the importance of timing, policymakers must quickly assemble the information required to decide upon the eligibility of candidate firms. This presumably places the onus of data collection upon firms to self-select into the pool of candidates for support, instead of placing the onus of data collection upon policymakers.[4] As a consequence, firms should be aware of available support schemes, so that they know when to apply for support. Given the short timescale for intervention, firms applying for such support should not have to prepare large amounts of supporting documentation. There is no time for a case-by-case detailed evaluation of a dossier. Therefore policy must be simple and based on a small number of clearly verifiable indicators (e.g. employee records, tax returns) to avoid cases of fraud.

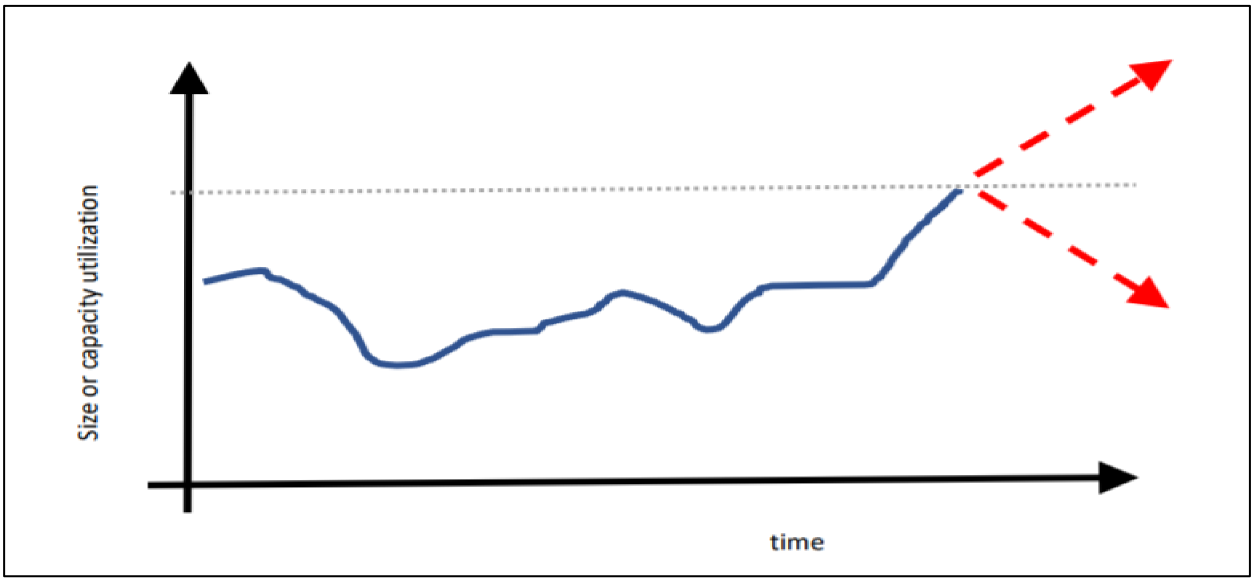
2.4 Capacity constraints as a trigger point: the 'fork in the road' hypothesis

This paper investigates whether firms operating in a critical state of overcapacity are prone to launch into a high-growth episode. A constraint on new firm growth is that their market entry is rarely met by avid consumers, but instead they must overcome informational barriers and slowly develop a reputation in order to accumulate a customer base (Foster et al., 2016). At a certain point, growing demand may pressure firms to increase their level of capacity utilisation, which (taking into account indivisibilities in machinery and installed capital) may result in adding worker shifts at overtime pay rates (Nikiforos, 2013). When firms fluctuate around maximum capacity utilisation levels, they potentially reach a decision-point, or a fork in the road. Firms do not always react to economic stimuli or 'shocks' to launch into further expansion, but when they do, they are more responsive to demand shocks[5] than to productivity shocks (Pozzi and Schivardi, 2016). Therefore, rising demand may push firms into a new regime of prolonged expansion. Figure 2 provides an illustration of this 'fork in the road' hypothesis.

[4] See however Brown and Mawson (2013, p289), who write: "undoubtedly the key to identifying trigger points is to monitor firms closely." However, policy makers at the national and international level (e.g. the European Commission) often do not have the attention nor resources to constantly monitor firms in the search for their trigger points, therefore it does not seem feasible for these national and supra-national policymakers to offer bespoke policies conditional on the idiosyncratic circumstances of individual firms.

[5] Pozzi and Schivardi (2016) estimate idiosyncratic demand shocks as residuals of the demand function.

Figure 2. The fork in the road hypothesis. Firms that reach a state of excessively high capacity utilisation will face a decision point: either to continue their upwards growth trajectory (which will need require large-scale investment), or shrink back to stay within existing capacity levels.



Source: our elaboration.

The following illustrative example may help: A factory floor only has space for a maximum of six machines, each machine requires only 3 operators per 24 hours (e.g. 8 hour shifts each), and the maximum span of control for bosses is to have one supervisor for up to 9 machine operators. If a firm that is making full use of its existing capacity (i.e. with six machines, 18 machine operators, and 2 bosses) suddenly gets a new production opportunity, it can either increase its production (which would require broad-based new investments in new machine operators, hence new bosses and new machines, hence new factory space) or it can forego the opportunity to expand production (Coad and Planck, 2012). We suggest that such a firm would be at a fork in the road: either it must invest massively in growth, or it will stagnate and drift back from the state of full capacity utilisation.[6]

Box 1 illustrates how marginal costs of growth are not constant, but depend upon the degree of capacity utilisation. In normal times, production can increase with minimal investments in raw materials and production employees. But at critical junctures, growth can only proceed by jumps in production quantities and spikes in average costs and marginal costs, as firms must engage in broad-based investment to scale up their corporate infrastructure.

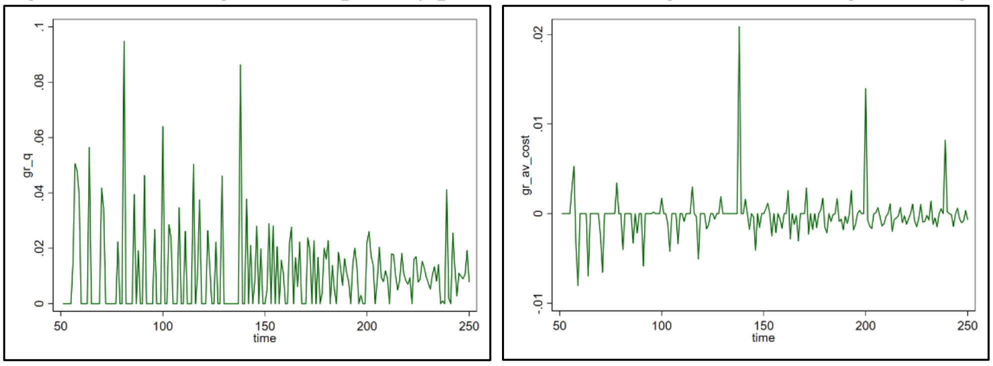
This paper investigates what happens when firms reach a critically high level of capacity utilisation. While some research into the behaviour of growing firms correspond to the concept of trigger points (discussed above), nevertheless there is a gap in our knowledge regarding empirical evidence on how capacity utilisation affects firm growth (partly due to a lack of high-quality data). We contribute novel theory and evidence with survey data from a large number of European countries.

BOX 1: non-constant costs of growth

We revisit the simulation data in Coad and Planck (2012, p198ff), and extend it to obtain some novel results. A firm can produce a quantity of output Q that requires 5 inputs: raw materials, production employees, machines, supervisors, and production plants. Integer restrictions affect all of these inputs (e.g. one cannot grow by adding ½ a machine or $^{1}/_{5}$ of a supervisor), and each input has its fixed price (see Coad and Planck 2012 Table 1 for details). To keep things simple, demand = price × Q = $\beta - \varphi Q$, where $\varphi = 0.5$, and the demand parameter β starts at 100 and grows 1% in each period. In this setup, the integer restrictions affecting the inputs lead to erratic growth dynamics of total quantity produced, and changes in average cost. We focus on changes in average cost (total cost / quantity produced), rather than marginal cost, because the latter is particularly problematic: at any point in time, the marginal cost of producing the infra-marginal q^{th} unit is different from that of producing the $q+1^{th}$ unit, which in turn is different from the marginal cost of producing the $q+2^{th}$ unit, and so on. It is non-trivial to compare the marginal cost for e.g. cases where a firm grows by 2 units (at time t), then by 10 units (at time t+1), then by zero units at time t+2. Focusing on the average cost alleviates slightly these difficulties.

Figure B1 shows the growth rates of quantity and average cost, where growth rates are calculated using log-differences, and where data for the first 50 periods (initialisation) are discarded. Notice that, while demand is growing steadily and smoothly at 1% per period, the firm's growth of quantity produced is erratic (Figure B1, left) as a result of the idiosyncratic time-varying degree of capacity utilisation reflected in the erratic changes in average cost (Figure B1, right). Figure B1 (right) shows that, while most of the changes in average cost are negative (i.e. cost reductions through economies of scale), nevertheless sometimes the average cost jumps upwards, corresponding to broad-based expansionary investment events such as building a new production plant.

Figure B1. Erratic growth of quantity produced (left) and growth of average cost (right).



Source: Authors' calculations based on the Coad and Planck (2012, p198ff) simulation data.

Investigating this area seems worthwhile from a micro-economic perspective, because many growing firms are likely to find themselves running at overcapacity, and better understanding how to overcome these capacity-related challenges will enable firms to continue growing. The topic also seems interesting from a macro-economic perspective: If more firms are able to overcome episodes of high capacity utilisation, this could potentially result in more employment, more value-added, more innovations, aggregate productivity growth through reallocation towards higher-productivity growing firms, etc. From a policy perspective, if timely support is available to firms being dragged over the jagged rocks of an uneven terrain of production possibilities, then HGEs can survive and thrive in order to realise potential macroeconomic benefits.

We therefore state our hypothesis hence:

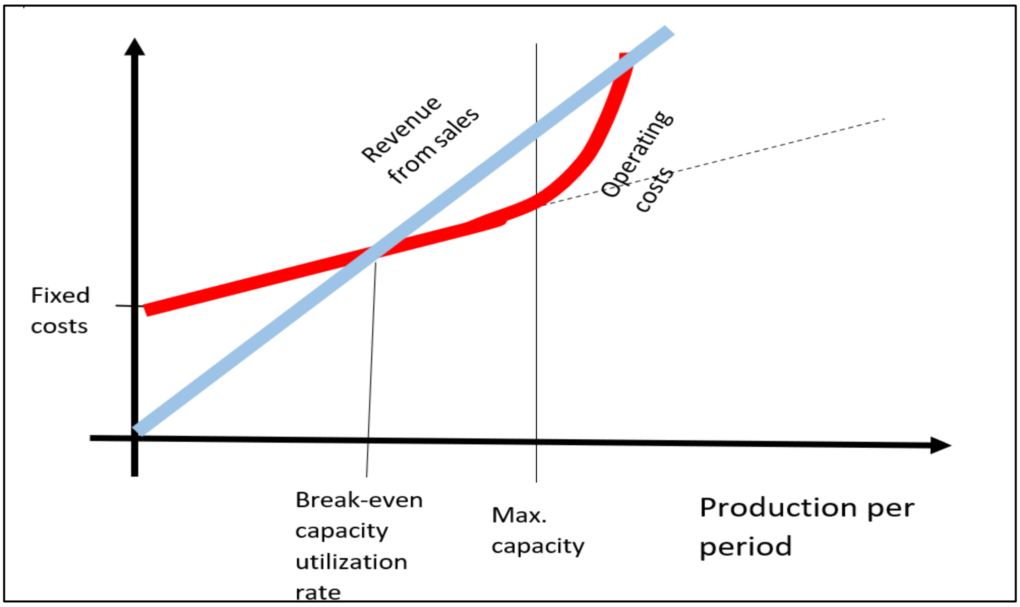
> **Fork in the road hypothesis:** When firms reach a critically high state of capacity utilisation, some firms will respond by investing massively and launching into subsequent growth, while other firms will shrink back operations to a more comfortable level given the current capacity

constraints. Given this heterogeneity, there is a particularly large variation in the growth rates taken by firms that reach a critically high state of capacity utilisation.

2.5 Capacity constraints and financial performance

Previous literature on capacity utilisation rates suggested that firms far below maximum capacity have low performance in terms of productivity and profits (e.g. Shen and Chen, 2017). However, when firms start operating above maximum capacity, there are rising costs such as 'time compression diseconomies,' costs for hiring additional machinery at suboptimal conditions, and overtime pay. Operating above what is normally considered to be maximum capacity can also distort the use of inputs away from the optimal mix, to decrease reliance on inputs whose scale is fixed (e.g. heavy machinery), and to increase reliance on inputs that are more flexible in the short run (e.g. low-wage employment, intermediate inputs), which may increase the unit production costs as firms move above maximum capacity utilisation (ECB, 2007).[7]

Figure 3. Conceptual diagram of how profits are expected to vary with capacity utilisation per period. Red line: operating costs. Blue line: revenue from sales.



Source: our elaboration.

Figure 3 illustrates these effects. Operating costs do not start from zero, because there are fixed costs (e.g. costs of keeping machines unused) that arise even when zero units are produced. Operating costs rise slowly until the point of maximum capacity, where they start rising exponentially. While profits (i.e. revenue minus costs) are higher for firms at maximum capacity compared to firms below maximum capacity, nevertheless it is not entirely clear whether firms operating at a scale slightly above maximum capacity can obtain higher profits than those at maximum capacity. It is possible that the rising costs due to operating at overcapacity are insufficient (at least initially) to offset the rising revenues from selling additional units. This is an empirical question. One of our research questions therefore relates to comparing the profits of these two categories (above maximum capacity vs at maximum capacity).

[7] There is some evidence that higher capacity utilization, due to rising demand, translates into firms increasing their prices and also their profit margins (ECB, 2007). We do not have data on firms' prices, so we cannot investigate this.

2.6 Measuring capacity utilisation: insights from previous literature

A key concept in our analysis is the degree of capacity utilisation at the firm. While it may be optimal to use less than the totality of installed capacity (Pozzi and Schivardi, 2016), especially if demand is volatile (Butters, 2020), nevertheless a degree of capacity utilisation that is too low is inefficient in the sense that installed capacity is unused, and may lead to extra maintenance costs, and these productive resources could be better used elsewhere in the economy. Low capacity utilisation generally corresponds to low productivity, because capacity is being used inefficiently (Butters, 2020). Capacity utilisation varies over the business cycle, with low capacity utilisation common in recessions (Basu, 1996; Baldwin et al., 2013). Low capacity utilisation may be advantageous, though, in the context of monopoly or oligopoly, because it can function as an entry deterrent, since the excess capacity would mean that entrants would have difficulties being profitable (Nikiforos, 2013).

Overcapacity and capacity utilisation mean different things in different studies. The term "overcapacity" often refers to an excess of productive capacity (usually at an industry level) needed to satisfy the corresponding industry-level demand (Henderson and Cool, 2003), often in a context where 'bandwagon' effects of imitating rivals (Henderson and Cool, 2003) or government subsidies (Zhang et al., 2016; Liu et al., 2019) can distort the signals regarding how much capacity is needed in the industry. In this vein, for example, Shen and Chen (2017) investigate "overcapacity" in the sense that China's manufacturing industries (e.g. steel, coal, cement, glass) have excess production capacity, at an industry level, to satisfy the needs of consumers. In their case, the authors recommend that the appropriate response would be the elimination of surplus capacity via the exit of unviable 'zombie' firms. Basu (1996) takes growth of materials as a proxy for capacity utilisation, and finds that variations in capacity utilisation help explain the procyclical nature of productivity over the business cycle.

This paper focuses on capacity utilisation at the firm-level. Capacity utilisation has traditionally focused on physical capital (Berndt and Morrison, 1981), although capacity utilisation considerations can also be applied to other domains such as human resources and managerial attention (Ocasio, 1997). Firm-level capacity utilisation is easier to measure in some industries than others, depending on industry characteristics. In the airline industry, for example, capacity utilisation is measured using the 'load factor' i.e. the share of occupied seats relative to total seat miles flown (e.g. Baltagi et al., 1998; Dana and Orlov, 2014; Butters, 2020[8]).[9] Baltagi et al. (1998) observe that deregulation helped US airlines to improve their degree of capacity utilisation, moving from an average load factor of 0.50 to 0.61 when comparing the post-deregulation period 1990-94 with the period 20 years earlier. Dana and Orlov (2014) found that the US airline load factors increased from 62% in 1993 to 80% in 2007, with this increase being partly explained by increased online reservations from growing internet penetration.

Some studies have developed ways of measuring capacity utilisation that can be applied to a broader range of sectors. For example, Pozzi and Schivardi (2016) develop an indicator of capacity utilisation in the context of a structural economic model. Baldwin et al. (2013) take the ratio of capital income to value-added as a proxy for capacity utilisation, based on the reasoning that variation in the ex-post return to capital reflects variation in capacity utilisation.

Survey data on capacity utilisation is rare. Pozzi and Schivardi (2016), however, analyze such data in their structural estimation of firm growth dynamics. They focus on Italian firms in in the Textile and Leather, Metals, and Machinery sectors, because market structure in these sectors is expected to be

[8] Butters (2020) also investigates capacity utilization in the hotel industry, focusing on room occupancy rates.
[9] However, more technical indicators of capacity utilisation have been put forward for airlines, and they do not always closely correspond to the load factor (Baltagi et al., 1998).

relatively close to monopolistic competition. The focus of their paper is showing that demand shocks can more freely translate into firm growth than TFP (Total Factor Productivity) shocks, because frictions (such as management capabilities and workforce human capital) hinder firms' abilities to draw upon TFP growth as a trigger for subsequent firm growth. Their survey data refers to: "the maximum output that can be obtained using the plants at full capacity, without changing the organization of the work shifts." They find (p614) that "the average degree of capacity utilisation is 81%, with a standard deviation of 13%; the 5th and the 95th percentile are 60% and 98%, respectively."

Interestingly, Pozzi and Schivardi (2016) observe considerable variation of capacity utilisation within firms over time (p614): "the utilized capital variable displays plenty of within-firm variation: a variance decomposition reveals that within variation represents between 83% (for the textile sector) and 92% (for the metals sector) of the between variation." This latter finding is compelling in the context of HGE prediction, because, while most predictor variables used in HGE prediction are relatively time-invariant and stable (e.g. founder's education, founder's previous business experience, geographic region, sector, legal form), high growth status itself is episodic and short-lived. As a result, various scholars have highlighted the need for time-varying explanatory variables when predicting firm growth (Geroski and Gugler, 2004; Storey, 2011; Coad and Srhoj, 2020).

Similar in meaning to the concept of capacity utilisation is the concept of "slack" resources. Cohen et al (1972 p12) write: "Slack is the difference between the resources of the organization and the combination of demands made on it." George (2005, p664) pens a similar definition: "I introduce transient slack, defining it as excess resources available after resource demands for operations have been met." Slack resources may conceptually correspond to machinery or employees that are not being used to their full potential. Nohria and Gulati (1996) develop a composite measure of slack (based on working time and department's operating budget) and find a U-shaped relationship with innovation: some slack is good, but too much reduces innovation outcomes. Most of the previous literature, however, has operationalized slack resources in terms of financial slack (defined in terms of financial resources and financial demands on these resources). This is probably because non-financial resources are hard to measure and quantify. A potential drawback, though, of measuring slack in such financial terms is that highly-productive firms (with considerable free cash flow) selling their products at high prices could be labelled as 'slackers' even if they are operating their production inputs at a lean and highly-efficient level of capacity utilisation. We would therefore prefer concepts such as 'productive slack' or 'operational slack' instead of 'financial slack' as it is often measured in the literature. However, in this paper we prefer the terms "capacity utilisation" and "overcapacity."

A major problem for empirical work into capacity utilisation is that most datasets do not usually contain information on the level of capacity utilisation, or the configuration of discrete resources within firms, despite their central importance in Penrose's theory of firm growth. For example, many administrative datasets collected by national statistical offices focus more on variables related to taxes and social security obligations and easily-observed administrative variables (address, sector of activity, legal form). Instead, we investigate a rich data source that asks firms about their degree of capacity utilisation, to test our conjectures about capacity utilisation and high growth.

3. Data

3.1 Data description

Our analysis is based on the EIBIS dataset merged with the Bureau van Dijk ORBIS database. EIBIS is an EU-wide survey that gathers qualitative and quantitative information on investment activities by non-financial corporates, both SMEs (5-250 employees) and larger corporates (250+ employees), their financing requirements and the difficulties they face. Using stratified sampling, EIBIS aims to be representative across all 27 Member States of the EU, the UK and the US, within countries, four firm size classes (micro, small, medium, and large) and four sector groupings (manufacturing, services, construction, and infrastructure). The survey is carried out through telephone (CATI) interviews in the local language. All interviewed firms are drawn from the BvD ORBIS database, which allows the survey answers to be linked to firms' financials and other administrative information, but firm information remains anonymous. Detailed methodology on the survey is available from IPSOS.[10] EIBIS has been shown to be a reliable data source with no systematic sampling bias (Brutscher et al., 2020).

We use four waves of the EIBIS survey (2016-2019) with information on over 34,500 firms with 50,651 observations. The panel structure of the survey is presented in Appendix Table A2.1. Out of the 34,521 firms, 69 percent are surveyed once, 19 percent surveyed twice, 8 percent three times and 4 percent of the firms are surveyed in all four waves. All in all, 10,600 firms are surveyed multiple times.

Additionally, we merge the EIBIS survey with financial variables derived from the ORBIS dataset (2014-2018). We use two years prior to the survey year to construct the change in variables. The length of the panel information is considerably increased based on the variables derived from ORBIS. Panel information of the financial variables are available for longer period even for firms surveyed once such as: 90 % of firms have ORBIS-derived financial variables for at least two times and 73% of them (more than 17,000 firms) are observed in ORBIS five times or more. Still, few firms (1749) do not have financial variables derived from Orbis for our sample of 2013-2018.The joint structure is described in Table A2.2 for period 2013-2018. The full coverage of ORBIS-derived variables is until 2017 due to a lag in data provision to ORBIS, and this explains the drop from 28,596 in 2017 to 10,525 firms in 2018. Overall, 99,650 observations are available for firms for 2013-2018, including the two years when they are not participating in the survey (see Table A2.3 for a summary of the merged EIBIS-ORBIS dataset).

3.2 Variables definition and descriptive analysis

The main dependent variables of this paper are capacity utilisation and firm growth. Capacity utilisation can be above at maximum capacity; at maximum capacity; somewhat below full capacity; and far below full capacity, as shown in Table 1.[11] In what follows, for conciseness, we sometimes refer to the category of "above maximum capacity" as "overcapacity."

Table 1. Capacity utilisation

	2016		2017		2018		2019		Total
Above maximum capacity	579	4.72%	590	4.85%	809	6.64%	828	6.22%	2,806
At maximum capacity	5,766	47.04%	5,769	47.45%	5,644	46.30%	6,897	51.85%	24,076
Somewhat below full capacity	4,563	37.23%	4,504	37.05%	4,666	38.28%	4,643	34.90%	18,376
Substantially below full capacity	1,349	11.01%	1,295	10.65%	1,070	8.78%	935	7.03%	4,649
Total	12,257	100.00%	12,158	100.00%	12,189	100.00%	13,303	100.00%	49,907

Notes: columns contain frequencies (# of firms) and percentage shares for each year.

[10] https://www.eib.org/attachments/eibis-methodology-report-2019-en.pdf
[11] By normal condition, it is meant the firm general practices regarding the utilisation of machines and equipment, overtime, work shifts, holidays, etc.

In each year, out of the four categories, the least populated is "above maximum capacity," which varies from 4.6% in 2016 to 6.6% in 2018. The most populated category is "at maximum capacity" which corresponds to about 50% of responses. The category of firms "substantially below full capacity" corresponds to about 7%-11% of firms in each year. It is hard to imagine that this category corresponds to firms engaging in deliberate and rational decisions to operate far below capacity.[12] In line with previous literature, our analysis indicates that these firms do not make full use of their production capacity, as this state is associated with low productivity and poor financial performance, see Tables A2.4 and A2.5 in Appendix 2. Such firms could correspond to 'zombie firms' (Shen and Chen, 2017).

Table 2 presents the frequency of consecutive years in overcapacity. Over 90% of firms are never in a state of overcapacity. The vast majority of firms that report ever being in overcapacity are in this state for 1 year only. Being in a state of overcapacity therefore appears to be a one-off event, rather than an enduring state.

Table 2: Frequency of consecutive years in overcapacity. Top panel: total number of observations. Bottom panel: number of firms.

Total number of observations

Number of years		Frequency	Percent	Cumulative
	0	45,902	90.62	90.62
	1	4,276	8.44	99.07
	2	399	0.79	99.85
	3	70	0.14	99.99
	4	4	0.01	100
Total		50,651	100	

Number of firms

Number of years		Frequency	Percent	Cumulative
	0	31,897	92.4	92.4
	1	2,464	7.14	99.54
	2	139	0.4	99.94
	3	20	0.06	100
	4	1	0	100
Total		34,521	100	

Of central interest to our paper is the phenomenon of firm growth, which is measured either using annual growth rates in the years after capacity utilisation states, or in terms of growth over a three-year period. The second definition corresponds to the usual definition of HGEs, which is a dummy variable indicating if the growth of consecutive three-year period is above a threshold. The HGE dummy has the advantage of providing a simple binary indicator of whether a firm is a HGE, whereas annual growth rates have the advantage of providing richer information on the distribution of outcomes, being a continuous variable. They provide also a finer-grained information, given that growth is calculated each year instead

[12] One possible motivation for operating far below the maximum capacity utilisation rates is to provide a credible threat of a price war to potential entrants (Nikiforos, 2013). This entry deterrent motivation could perhaps explain some, but probably not all, of the cases of firms that are operating far below maximum capacity levels.

of over a 3-year period. These two indicators of firm growth, the HGE dummy vs annual growth rates, are therefore seen as complementary.

When firm growth is measured over one year, the log-difference is the preferred way to calculate a growth rate (Tornqvist et al., 1985; Coad, 2009). Growth of X, where X can be either Sales, Employment or Profits for firm i at time t, is calculated as:

$$GR\_X_{i,t} = \log(X_{i,t}) - \log(X_{i,t-1})$$

We measure HGEs by using the cumulative three years growth rate of more than 33% HGFs (from t-3 to t). More exactly, our measurement corresponds to the standard OECD-Eurostat definition of HGEs (Petersen and Ahmad, 2007): an enterprise with an average annualized turnover or employment growth greater than 10% (or alternatively 20%) per year over the past three years, and having 10+ employees at the beginning of the growth period. We use this approach in order to have a heterogeneous focus across size groups (Ferrando et. al, 2019).

Our HGE measurement relies on the EIBIS data, which collected in each year the information on the number of employees both in the current year and three years prior. In this way, even for firms with limited panel information, a 3-years growth can be calculated for the whole EIBIS sample period.[13]

Control variables include investment growth and details on type of investments. We use alternative measurements of investment growth derived both from ORBIS (where investment is defined as a percentage change in fixed assets), and from EIBIS (as firms provide information on the total amount of investment). Nevertheless, two consecutive survey responses are needed to calculate investment growth, which limits considerably the number of observations. Growth rates are winsorized at the 5% and 95% levels. As an alternative way to capture the investment dynamics, a survey variable is used on investment compared to t-1 with three possible answers: above, the same, or less than in previous year. This later measurement, however has the limitation of showing just the direction of change without indicating the size of the change.

We control also for investment types, by relying on the EIBIS variables of investments in: 1) land, business buildings and infrastructure, 2) machinery and equipment, 3) research and development (including the acquisition of intellectual property), 4) software, data, IT networks and website activities, 5) training of employees and 6) organization and business process improvements. Alternatively, we control for investment purposes, such as: 1) investment for replacement, 2) for expanding capacity and 3) for developing new products, processes or services.

We consider also the internationalization activity of the company, captured by two alternative dummy variables for 1) whether the firm is exporting directly, and 2) whether the firm invested in another country. Moreover, our estimations include also a dummy variable that captures whether the firm is a subsidiary of another firm or if it is an independent company.

We control also for firm's performance/profitability, captured by three alternative categorical variables: 1) the firm is generating a) loss, b) profit or c) is at break-even point; 2) profit before tax as a share of turnover being in five different categories from below 2% to above 15%; and 3) business prospects with three alternative responses for a) improving, b) staying the same, or c) deteriorating.

[13] ORBIS financial data are available with a one-year lag compared to the EIBIS.

We check also the innovativeness of the company, defined according to the introduction of new products, processes or services as being either: 1) globally new, 2) new for the country or 3) those less radical innovators with products new only to the company. Additionally, a digitalization dummy is derived from EIBIS according to the adoption of any of the listed new digital technologies. These include 3-D printing, robotics, big data and analytics, virtual reality, internet of things, platform technologies, and drones. This variable equals one if the firm either has implemented partially or organized the entire business around any of the technologies listed. This variable is only available for the year 2018 from EIBIS 2019.

As additional explanatory variables, dummy variables are created on financing from grants [14] and whether the firm had an energy audit in the last 3 years.

It is well known that firm size is a major predictor of firm behaviour and performance, therefore we control for firm size in our regressions. This is done by controlling for log_sales_{it} as well as the quadratic term $log\_sales_{it}{}^{2}$, to allow for a potentially non-linear influence of size (e.g. if size mainly affects performance when firms are below a critical size threshold (Sutton, 1997). Additionally, dummies for year, country and sector are also used as control variables.

Regarding the sector of activity, the EIBIS survey asks respondents about the "main sector of activity of this company." Almost 30% of respondents are in manufacturing. Both the Construction sector, and the Wholesale and retail trade sector, account for over 20% of respondents each.

Summary statistics of these variables appear in Appendix Tables OSM-2 and OSM-3.

3.3 Methodology

Considering the paucity of previous research in this area, we describe a relatively unfamiliar phenomenon using descriptive techniques in an exploratory way. A variety of techniques are applied. We begin with descriptive statistics, to investigate the characteristics of firms in our sample, the frequencies of firms in capacity utilisation categories, and to see how these frequencies vary across EU member states. Transition matrices show the dynamics of entry and exit from various capacity utilisation states. Time series plots show the dynamics of firms in the years before and after capacity utilisation states, for various indicators such as sales growth, profits growth and employment growth. Multivariate regressions can control for potentially-confounding background factors to provide a clearer view of the relationships between capacity utilisation and growth. In addition, quantile regressions (Koenker and Bassett, 1978) explore heterogeneous responses in terms of growth paths after overcapacity, allowing us in particular to evaluate the fork in the road hypothesis.

[14] From the survey, grants could come from various sources, including "financial support or subsidies from regional and national government and funding provided by the European Commission"

4. Analysis

4.1 How do firms transition into and out of capacity utilisation states?

Table 2 shows the transition matrix for capacity categories.[15] For those at maximum capacity, or a bit below maximum capacity, at time *t*, these firms are most likely to stay in these same categories in *t+1* (i.e. to remain positioned along the diagonal). In contrast, those operating above maximum capacity at time (*t*) are relatively unlikely to remain in the same category the next year, but instead are more likely to operate at maximum capacity at time (*t+1*). This raises the question whether those firms transitioning from above maximum capacity to at maximum capacity (about 3% of firms in total) increase their capacity, or whether they maintain their original capacity levels while reducing output accordingly.

Table 2. Transition matrix

		Capacity at *t+1*				
		Above max	At max	Bit below max	Far below max	Row total
Capacity at *t*	Above max	143	463	172	32	810
		17.65%	57.16%	21.23%	3.95%	
	At max	480	4,513	1,751	191	6935
		6.92%	65.08%	25.25%	2.75%	
	Bit below max	199	1,811	3,285	486	5781
		3.44%	31.33%	56.82%	8.41%	
	Far below max	32	233	624	622	1511
		2.12%	15.42%	41.30%	41.16%	
	Column Total	860	7,089	5,889	1,339	15177
		5.67%	46.71%	38.80%	8.82%	

Notes: frequencies (# of firms) and percentage shares. For brevity, “Above max.”, “At max.”, “Bit below max.” and “Far below max.” correspond to the categories "Above maximum capacity", "At maximum capacity", "Somewhat below full capacity", and "Substantially below full capacity", respectively.

4.2 Dynamics of entering into and leaving overcapacity

Figure 4 shows the evolution of key variables relating to mean[16] firm growth and performance in the years before and after particular capacity utilisation states at time t=0. We focus on the years up to *t+3*, which aligns with standard indicators of HGEs that measure growth over a three-year period.

[15] See also Appendix 5 for the frequency of consecutive years in overcapacity.

[16] Figures 4 and 5 show the results for mean growth rates in capacity utilisation categories. In our baseline graphs, presented here, we prefer the mean to the median, because the median employment growth in many cases is precisely 0.0000, due to integer restrictions in employee headcounts. However, the median may be of interest, because it is less sensitive to outliers than the mean (remember, though, that our growth rates variables have been already been winsorized to remove outliers, hence sensitivity to outliers is less of a concern). Appendix 8 contains the corresponding graphs when the median growth rate is taken, instead of the mean. Appendix 8 also shows the corresponding graphs when the growth rate variables are ‘cleaned’ or pre-processed via OLS regression to remove the potential influence of size, country, sector and year components. The results are overall similar, although a major difference concerns the growth of total investment at time *t*=3 for firms above maximum capacity (therefore we prefer not to make any strong interpretations of the growth of total investment for overcapacity firms at time *t*=3).

Figure 4. Event history time-series plots. Mean growth rates for various capacity utilisation categories. Overcapacity is measured at time *t=0*. Growth rates of 6 variables: sales growth (top left), employment growth (top right), profits growth (centre left), value added growth (centre right), wage growth (bottom left), and growth of total investment (bottom right).

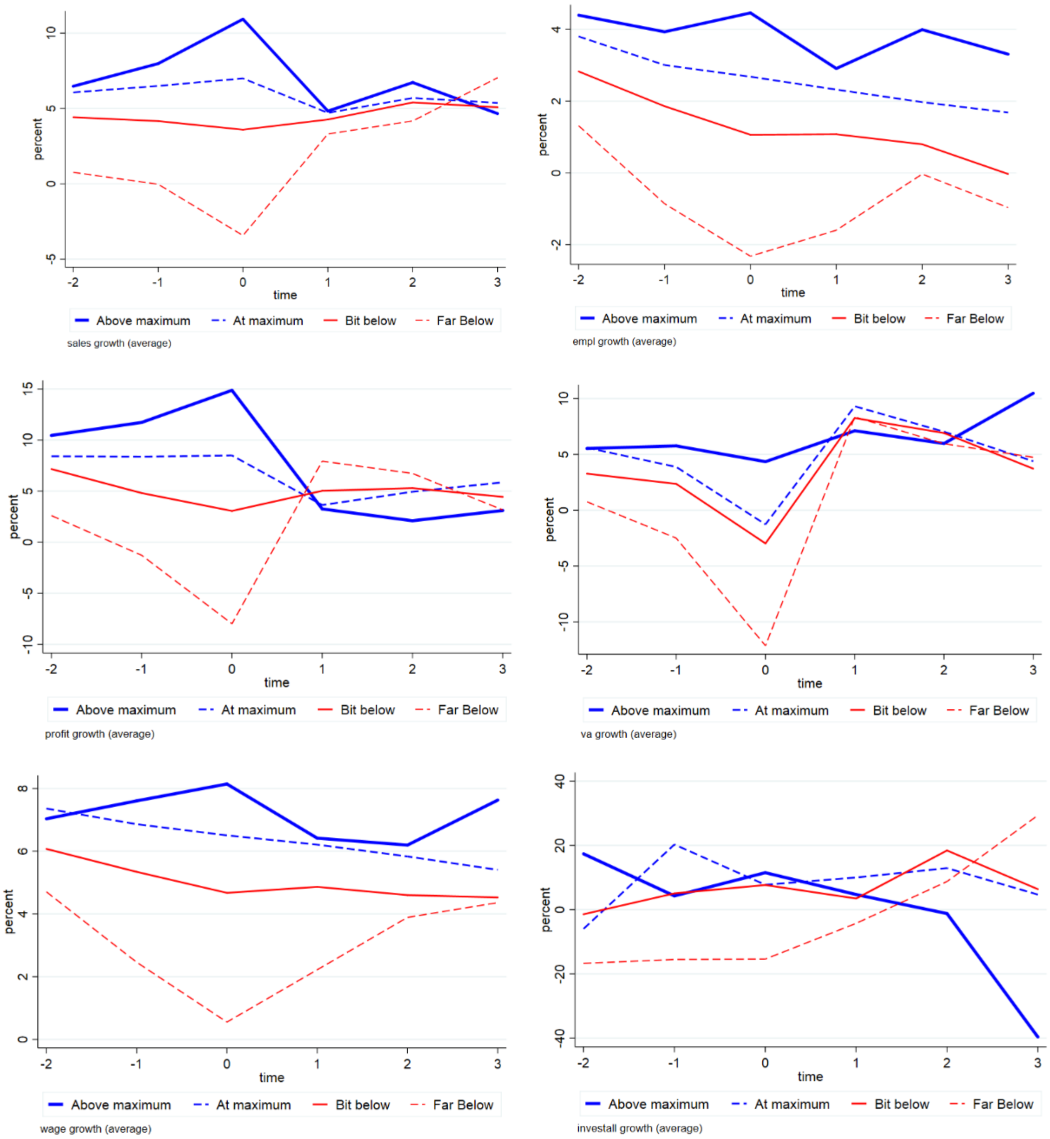


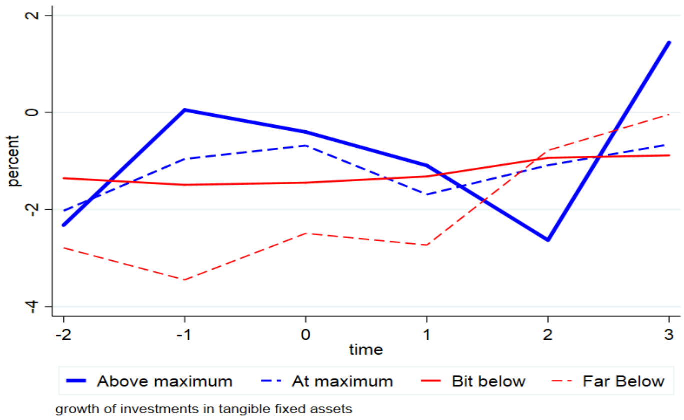
Figure 4 shows many interesting findings. First, there is a rapid growth of sales, employment and profits in the years before being "above max capacity," providing further evidence that entering a state of overcapacity is a rather fortunate state of affairs, resulting from rising sales, employment, and profits in the preceding years. Profits growth is relatively high for overcapacity firms in the years before/during being "Above max capacity," although this quickly levels off to give a mediocre profit growth in the subsequent years.

Second, for the category of firms that are "above maximum capacity" at time *t*, employment growth is always higher than all other categories (before *and* after) being "above max capacity". This suggests that firms operating at overcapacity are major job creators. Relatedly, wage growth (Figure 4, bottom left) is always highest in the category of firms that are "above maximum capacity" at time *t*, both before and after being at overcapacity. There are various interpretations of this wage growth: overcapacity firms might be paying some kind of 'overtime' premium, or seeking to increase the skills of the workforce – but the finding that overcapacity firms are creating more jobs, and relatively better paying jobs, could make them a thought-provoking category for policymakers.

Third, the evolution of these variables allows some cautious speculation about the causal ordering of the variables. One possible interpretation could be that sales growth leads to employment growth as firms push back against overcapacity. This is consistent with vector autoregression evidence that sales growth causes employment growth (Moneta et al., 2013). It is also consistent with suggestions of the key role of rising demand on the capacity choices of new firms (Foster et al., 2016; Nikiforos, 2013).

Fourth, some variables have a mediocre performance in the years after overcapacity status. This could signal that reaching overcapacity is the crest of a wave of rising demand, that cannot be sustained for long. For profit growth and total investment growth, the growth rates end up being the lowest among all categories a few years after the episode of being "above maximum capacity." This could be because such firms undertook their investment in previous years instead. Indeed, growth of total investment (Figure 4, bottom right) is relatively high (but not the highest) for those in the category "above maximum capacity", in the years beforehand, but drops off sharply afterwards. This drop in investment can be explored further, to see which type of investment is cut back. Figure 5 shows that the average growth of investment in fixed assets is relatively high (for overcapacity firms) during the year of overcapacity, then drops in the following two years, but picks up again to reach a high value for the period 3 years after the overcapacity event. This suggests that spending time in overcapacity is associated with high growth of investment in tangible fixed assets at the time of overcapacity, as well as three years later.[17] The sharp decrease in total investment observed in Figure 4 (bottom right) therefore corresponds to investment types that are not tangible fixed assets (e.g. a drop in investment in intangibles or R&D), although the evidence so far is not conclusive because these unconditional line plots could be affected by confounders such as firm size and sector (this is explored below).

Figure 5. Event history time-series plot. Mean growth rates for various overcapacity categories. Overcapacity is measured at time *t=0*. Growth rates of investment in fixed assets.



Regarding firm behaviour at the time of being at overcapacity, we earlier conjectured that firms above maximum capacity face a fork in the road: either they invest massively for subsequent growth, or scale back to stay within existing capacity limits. This would be reflected in a higher variation in growth rates for firms above maximum capacity: while some take the opportunity to launch into rapid growth, others cut back. Appendix 14 investigates this conjecture, and finds some interesting results for investment. For firms above maximum capacity, there is a sharp increase in the variation in growth rates for total investment (i.e. all types of investment) while there is a clear decrease in the variation in growth rates of investment in tangible fixed assets. This could be taken as evidence that firms at a period of overcapacity will subsequently embark on a relatively homogenous strategy of high investment in tangible fixed assets (i.e. relatively high growth rates, but with low variation in growth rates across

[17] We could speculate that this corresponds to a new wave of 'replacement' or 'expansionary' investment in fixed assets to follow through in alleviating previous capacity constraints.

firms), while such firms have high variation in their growth rates for investment in intangible assets: with some overcapacity firms investing heavily in intangibles while others neglect this area.

4.3 Which factors are associated with entering into overcapacity?

Table 3 investigates the determinants of different capacity utilisation categories relying on multinomial logistic regressions, thereby considering the various capacity utilisation categories in an integrated econometric framework. Table 3 shows that rapid growth contributes to overcapacity, because HGEs (where rapid growth is measured from *t-3:t*) are more likely to find themselves in the category of 'above maximum capacity' at time t, and to a lesser extent for the category 'at maximum capacity'.

Table 3. MNL (multinomial logit) regressions for the different capacity utilisation categories.

	(1)	(2)	(3)	(4)	(5)	(6)
	Overcapacity	**At_max_cap**	**Bit_below**	**Overcapacity**	**At_max_cap**	**Bit_below**
HGE dummy	0.974*** [0.0969]	0.576*** [0.0789]	0.329*** [0.0798]	0.707*** [0.166]	0.370*** [0.137]	0.165 [0.137]
log_sales	0.751*** [0.167]	0.501*** [0.0962]	0.388*** [0.0950]	0.309 [0.319]	0.234 [0.221]	0.287 [0.217]
log_sales_sq	-0.0205*** [0.0053]	-0.0112*** [0.0031]	-0.0087*** [0.0031]	-0.0082 [0.0101]	-0.0023 [0.0070]	-0.0050 [0.0069]
Profit status: loss	-1.796*** [0.0955]	-1.689*** [0.0493]	-1.158*** [0.0470]	-1.916*** [0.186]	-1.632*** [0.101]	-1.223*** [0.0933]
Profit status: break-even	-1.088*** [0.111]	-0.928*** [0.0637]	-0.562*** [0.0627]			
log_wagebill	0.0750** [0.0364]	0.0629*** [0.0243]	0.0590** [0.0242]	0.0489 [0.0722]	0.0607 [0.0536]	0.0366 [0.0531]
Age: 2 ≤ age < 5 years	0.266 [0.559]	0.219 [0.387]	0.647 [0.403]	-0.176 [1.328]	0.0280 [1.146]	0.0035 [1.141]
Age: 5 ≤ age < 10 years	0.0405 [0.546]	0.0864 [0.378]	0.401 [0.394]	-0.245 [1.305]	-0.0001 [1.133]	-0.110 [1.128]
Age: 10 ≤ age < 20 years	0.0577 [0.542]	0.0211 [0.375]	0.388 [0.391]	-0.438 [1.300]	0.103 [1.129]	0.0131 [1.124]
Age: 20+ years	-0.235 [0.540]	-0.186 [0.374]	0.275 [0.390]	-0.509 [1.296]	-0.102 [1.127]	-0.0958 [1.121]
Subsidiary	0.0949 [0.0727]	0.0015 [0.0518]	0.0120 [0.0517]	0.183 [0.132]	-0.0308 [0.0988]	-0.0059 [0.0971]
Directly exported	-0.138** [0.0688]	-0.301*** [0.0469]	-0.106** [0.0469]	-0.129 [0.140]	-0.207* [0.106]	-0.115 [0.105]
Invested in another country	-0.198* [0.112]	-0.315*** [0.0800]	-0.188** [0.0788]	-0.232 [0.173]	-0.334*** [0.128]	-0.179 [0.124]
R&D investment dummy				-0.0250** [0.0111]	-0.0181** [0.0082]	-0.0132 [0.0080]
IT investment dummy				-0.0097 [0.0145]	-0.0140 [0.0104]	-0.0073 [0.0102]
Training investment dummy				0.0244 [0.0164]	0.0138 [0.0113]	0.0084 [0.0111]
Business processes inv. dummy				0.0057 [0.0114]	-0.0086 [0.0083]	0.0033 [0.0082]
Replacing capacity - investment (%)				0.0049 [0.0042]	0.0013 [0.0031]	0.0034 [0.0030]
Expanding capacity - inv. (%)				0.0111** [0.0043]	0.0077** [0.0032]	0.0079** [0.0032]
New prod./process inv. (%)				0.0005 [0.0041]	-0.0003 [0.0030]	-2.5×10^{-5} [0.0029]
Investment wrt t-1: broadly stayed the same				-0.398*** [0.124]	-0.225** [0.0931]	-0.196** [0.0921]
Investment wrt t-1: less than prev. year				-0.855*** [0.164]	-0.805*** [0.111]	-0.409*** [0.107]
Innov: new to country				0.105 [0.163]	-0.0796 [0.119]	0.0230 [0.117]
Innov: new to global mkt				0.0294 [0.143]	-0.227** [0.106]	-0.251** [0.103]
Business prospects: same				0.0652 [0.126]	0.279*** [0.0942]	0.135 [0.0931]
Business prospects: deteriorate				-0.420** [0.171]	-0.505*** [0.119]	-0.262** [0.115]
Profits before tax: 2% to 4%				0.373** [0.178]	0.238** [0.121]	0.118 [0.118]
Profits before tax: 5% to 9%				0.368** [0.178]	0.294** [0.122]	0.115 [0.118]
Profits before tax: 10% to 14%				0.591*** [0.205]	0.355** [0.146]	0.0837 [0.143]
Profits before tax: 15% or more				0.595*** [0.204]	0.221 [0.145]	-0.225 [0.142]
Observations	37,415	37,415	37,415	10,089	10,089	10,089

Notes: *** p<0.01, ** p<0.05, * p<0.1. Constant term, country, sector, and year dummies are included in all of the estimations but not reported.

Table 3 also shows that profitable firms are more likely to be 'above maximum capacity'. Making a loss is negatively related to being “above maximum capacity” or “at maximum capacity”, but is positively associated to being “far below capacity.”[18] Furthermore, firms above maximum capacity are less likely to be R&D investors, and more likely to invest for motivations of "expanding capacity." Further analysis of the characteristics of firms across capacity utilisation levels can be found in Appendices 6-12.

4.4 What routes do firms take out of overcapacity?

Table 4. Regression results. Dependent variables: growth (*t+1*) of sales, employment, and profits.

	f1_g_sales				f1_g_empl				f1_g_profit			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
State-of-art machinery/equipmt	0.0001** [4.9×10^{-5}]	0.0001*** [4.9×10^{-5}]	0.0001** [4.9×10^{-5}]	4.6e-05 [8.9×10^{-5}]	0.0002*** [3.6×10^{-5}]	0.0002*** [3.7×10^{-5}]	0.0001*** [3.8×10^{-5}]	0.0001 [6.8×10^{-5}]	-3.4×10^{-5} [0.0002]	1.8×10^{-5} [0.0002]	4.5×10^{-5} [0.0002]	0.0002 [0.0003]
Innov: new to the firm	-0.0105* [0.0060]	-0.0092 [0.0060]	-0.0016 [0.0062]		-0.0026 [0.0044]	-0.0030 [0.0045]	-0.0005 [0.0046]		-0.0052 [0.0186]	-0.0071 [0.0187]	-0.0087 [0.0190]	
Innov: new to country	-0.0032 [0.0062]	-0.0021 [0.0062]	0.0049 [0.0063]	-0.0013 [0.0076]	0.0013 [0.0045]	0.0011 [0.0046]	0.0025 [0.0047]	0.0033 [0.0055]	0.0185 [0.0190]	0.0179 [0.0191]	0.0140 [0.0193]	-0.0167 [0.0231]
Innov: new to global mkt	-0.0020 [0.0082]	-0.0016 [0.0082]	0.0073 [0.0084]		0.0017 [0.0059]	0.0018 [0.0059]	0.0046 [0.0062]		0.0031 [0.0260]	0.0019 [0.0261]	0.0123 [0.0266]	
R&D investment (IHS)	0.0249 [0.0308]	0.0706** [0.0311]	0.0288 [0.0320]	-8.685*** [3.211]	0.0477** [0.0226]	0.0480** [0.0230]	0.0446* [0.0239]	-0.370 [2.471]	-0.117 [0.0959]	-0.0672 [0.0977]	-0.111 [0.0986]	1.955 [9.915]
Above maximum capacity	0.0024 [0.0091]	0.00957 [0.0091]	0.0079 [0.0094]	-0.0096 [0.0159]	0.0393*** [0.00647]	0.0394*** [0.0066]	0.0316*** [0.0068]	0.0330*** [0.0117]	-0.0360 [0.0283]	-0.0300 [0.0285]	0.00130 [0.0288]	0.0047 [0.0502]
At maximum capacity	0.0129** [0.0061]	0.0198*** [0.0061]	0.0164** [0.0064]	0.0079 [0.0115]	0.0347*** [0.00429]	0.0349*** [0.0043]	0.0278*** [0.0045]	0.0241*** [0.0078]	-0.0395* [0.0206]	-0.0331 [0.0207]	0.0006 [0.0209]	-0.0216 [0.0384]
Somewhat below maximum capacity	0.0063 [0.0061]	0.0120** [0.0061]	0.0101 [0.0063]	0.0041 [0.0113]	0.0221*** [0.00428]	0.0217*** [0.0043]	0.0152*** [0.0045]	0.0038 [0.0076]	-0.0304 [0.0207]	-0.0264 [0.0209]	0.0007 [0.0210]	-0.0285 [0.0381]
log_sales		-0.0613*** [0.0097]	-0.0723*** [0.0100]	-0.0705*** [0.0180]		0.0296*** [0.0070]	0.0292*** [0.0079]	0.0402*** [0.0138]		-0.0781** [0.0303]	-0.0681** [0.0320]	-0.0217 [0.0540]
log_sales_sq		0.0017*** [0.0003]	0.0015*** [0.0003]	0.0014** [0.0005]		-0.0009*** [0.0002]	-0.0007*** [0.0002]	-0.0010** [0.0004]		0.00211** [0.0009]	0.0015 [0.0010]	-6.0e-05 [0.0016]
Profit status: loss			-0.0131** [0.0054]	0.0014 [0.0093]			-0.0316*** [0.0038]	-0.0306*** [0.0066]			0.293*** [0.0284]	0.169*** [0.0510]
Profit status: break-even			-0.0247*** [0.0065]				-0.0217*** [0.0049]				0.0360 [0.0238]	
log_wagebill			0.0217*** [0.0023]	0.0212*** [0.0043]			-0.0077*** [0.0016]	-0.0079** [0.0031]			0.0152** [0.0068]	0.0125 [0.0125]
Age: 2 ≤ age < 5 years			0.0081 [0.0338]	0.0289 [0.0518]			-0.0004 [0.0229]	0.0523 [0.0439]			0.140 [0.130]	0.421** [0.196]
Age: 5 ≤ age < 10 years			-0.00749 [0.0328]	0.0129 [0.0485]			-0.0086 [0.0220]	0.0301 [0.0415]			0.182 [0.127]	0.431** [0.188]
Age: 10 ≤ age < 20 years			-0.0252 [0.0325]	0.0027 [0.0478]			-0.0090 [0.0218]	0.0372 [0.0411]			0.133 [0.127]	0.418** [0.187]
Age: 20+ years			-0.0385 [0.0323]	-0.0148 [0.0475]			-0.0242 [0.0217]	0.0164 [0.0409]			0.121 [0.126]	0.397** [0.186]
Subsidiary			-0.0027 [0.0036]	-0.0032 [0.0060]			-0.0048* [0.0027]	-0.0083* [0.0044]			-0.0098 [0.0117]	-0.0090 [0.0188]
Directly exported			0.0145*** [0.0036]	0.0166*** [0.0064]			0.0055** [0.0027]	0.0030 [0.0050]			0.0214* [0.0113]	0.0307 [0.0197]
Invested in another country			0.0097 [0.0063]	-0.0030 [0.0084]			-0.0008 [0.0045]	-0.0059 [0.0062]			0.0101 [0.0183]	0.0229 [0.0238]
R&D investment dummy				0.0917*** [0.0340]				0.0040 [0.0262]				-0.0202 [0.105]
IT investment dummy				0.0007 [0.0007]				0.0008* [0.0005]				0.0007 [0.0019]
Training investment dummy				0.0011 [0.0007]				0.00053 [0.0005]				0.0014 [0.0021]
Business processes inv. dummy				-0.0002 [0.0005]				-0.0004 [0.0004]				-0.0021 [0.0016]
Replacing capacity - investment (%)				-4.5×10^{-5} [0.0002]				2.4×10^{-5} [0.0002]				0.0002 [0.0007]
Expanding capacity - inv. (%)				0.0004 [0.0002]				0.0004** [0.0002]				0.0008 [0.0007]
Investment in R&D				-0.0002 [0.0002]				0.0002 [0.0002]				0.0003 [0.0007]
Investment wrt t-1: broadly stayed the same				-0.0047 [0.0056]				-0.0204*** [0.0041]				0.0141 [0.0172]
Investment wrt t-1: less than prev. year				-0.0165** [0.0077]				-0.0233*** [0.0056]				-0.0064 [0.0241]
Innov: new to country				-				-				-
Innov: new to global mkt				-0.0075 [0.0092]				-0.0020 [0.0067]				-0.0381 [0.0283]
Business prospects: same				-0.0282*** [0.0057]				-0.0105** [0.0043]				-0.0267 [0.0176]
Business prospects: deteriorate				-0.0664*** [0.0086]				-0.0167*** [0.0062]				-0.157*** [0.0274]
Profits before tax: 2% to 4%				-0.0016 [0.0076]				0.0098* [0.0057]				-0.0914*** [0.0256]
Profits before tax: 5% to 9%				-0.0033 [0.0077]				0.0085 [0.0057]				-0.131*** [0.0258]
Profits before tax: 10% to 14%				-0.0137 [0.0093]				0.0002 [0.0070]				-0.159*** [0.0293]
Profits before tax: 15% or more				-0.0124 [0.0105]				0.0095 [0.0077]				-0.197*** [0.0319]
Observations	18,724	18,724	17,277	5,846	14,912	14,521	13,342	4,425	12,880	12,754	12,116	4,106
R^2	0.020	0.027	0.039	0.054	0.018	0.021	0.035	0.061	0.004	0.006	0.025	0.043

Notes: Robust standard errors in brackets. *** p<0.01, ** p<0.05, * p<0.1. A constant, country, sector, and year dummies are included in all of the regressions but not reported in detail.

[18] Regressions with full country dummies coefficients available upon request.

Table 4 investigates which variables are associated with firm growth in the following period. In line with the event study line plots in Figure 4, being above maximum capacity is related to subsequent employment growth, but there is no statistical relationship with subsequent growth of sales or profits. Some possible explanations for why employment growth occurs later than sales and profits growth could be the following. First, it could be that the processes of hiring suitable employees takes time. Second, the temporal lag could reflect the case that sales growth and profits growth are the causal drivers of subsequent employment growth (for example, if growth of sales and profits are a signal to executive decision-makers and investors, as well as means of generating cash flow, that are useful to justify the need for new hires). Third, it could be that existing employees are willing to accept the pressures of heavy workloads and overtime, but only in the short run, such that new employees are needed later on.

Appendix 13 repeats the analysis in Table 4, but with a HGE dummy (for rapid growth in employment from *t:t+3*) instead of the firm growth variables (*t:t+1*). Although the number of observations is strongly reduced, nevertheless we detect a positive and statistically significant relationship between operating above maximum capacity at time t, and the subsequent probability of being an HGE in terms of employment growth (*t:t+3*).

Table 4 also shows that some 'usual suspects' (investment in IT, innovation, R&D) do not go far in explaining subsequent growth. The R^2 statistic from the growth rate regressions in Table 4 never rises above 6%, which is admittedly low but comparable to previous studies.[19]

Table 4 shows that capacity utilisation continues to play an important role in predicting growth of employment and also sales in the following period. One possible reason for this, in line with our 'fork in the road' hypothesis, is that the average effect of overcapacity on subsequent growth masks the heterogeneity within the overcapacity category: that some firms take overcapacity as an opportunity to invest massively in a new growth trajectory, while others get 'back to normal' (following the dynamics of mean reversion, perhaps) after a period of overcapacity. Quantile regression is a suitable econometric tool to investigate such heterogeneity in the effect of overcapacity across the growth rates distribution.

Figure 6 shows the quantile regression results, where the dependent variable is growth of sales, growth of employment, or growth of investment (Figure 6 left, centre, and right, respectively), and the main explanatory variable of interest is an overcapacity dummy (which equals 1 for firms in a state of overcapacity). Details on regression results are in Tables 5-7. Figure 6 (left) shows that overcapacity is a significant predictor of subsequent sales growth, and furthermore that the role of overcapacity depends on a firm's growth experience. For firms that have rapid sales growth in the year after overcapacity (at the upper quantiles of the conditional dependent variable), the overcapacity status is positive and statistically significant, hence associated with faster growth for these firms. However, for firms that have a decline in sales in the year after overcapacity, the overcapacity status is negative and statistically significant, which is consistent with the interpretation that overcapacity has a dampening role on sales growth for those firms that choose to shrink back after overcapacity. Similar results are found in Figure 6 (right) for investment growth. These results are consistent with the 'fork in the road' hypothesis.

For sales growth, the coefficient at the 90% quantile is 0.033 (Table 5). This means that, all else equal, a rapid-growth firm (at the 90% quantile of the conditional growth rates distribution) will have a (log-difference) growth rate that is 0.033 higher if it is operating above maximum capacity, compared to firms that are not operating above maximum capacity. This increase in the sales growth rate of 0.033 is not negligible, considering that sales growth has a mean of 0.05 and a standard deviation of 0.21 (see the summary statistics in Appendix 3). At the lower quantiles of the conditional growth rate distribution, the coefficient is even larger in magnitude (-0.0465), indicating that firms above maximum capacity

[19] See e.g. Coad (2009, Table 7.1) for a review.

shrink faster than their counterparts in other capacity utilisation categories at the 10% quantile of the (conditional, log-difference) sales growth distribution.

Figure 6 (centre) shows the corresponding results for employment growth. The coefficients are positive and significant at the upper end of the conditional employment growth distribution, which indicates that overcapacity is associated with faster employment growth for those firms that experience rapid employment growth in the year after overcapacity. However, the results at the lower quantiles are indistinguishable from zero instead of being negative (as we observed in Figure 6 for growth of sales and investment). The employment growth results only confirm one of the two prongs of the 'fork': overcapacity is positively linked to growth for some growing firms, but overcapacity is not related to employment decline for the other firms. This 'asymmetry' in the quantile regression results for employment growth (compared to sales growth) could be due to firing restrictions, that discourage layoffs, leading the regression coefficient of overcapacity to be prevented from taking negative values (associated with job destruction) and instead taking values close to zero (corresponding to zero job growth from overcapacity).

Figure 6. Quantile regression results where the dependent variable is sales growth (left), employment growth (centre) or investment growth (right). Tables 5-7 contain the corresponding regression output.

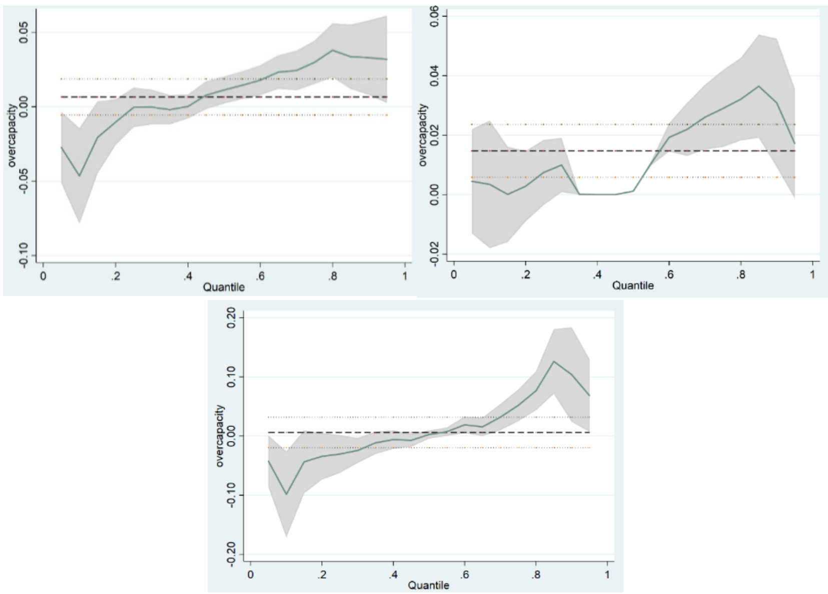


Table 5. Quantile regression results. Dependent variable: growth of sales in the following period (i.e. in *t:t+1*), where the predictor variables are measured at time *t*. The main explanatory variable of interest is the overcapacity dummy, which takes value 1 if firms report currently operating at above their maximum normal capacity.

	(1)	(2)	(3)	(4)	(5)
	10% quantile	**25% quantile**	**50% quantile**	**75% quantile**	**90% quantile**
d_overcapacity	-0.0465***	-0.00041	0.0118**	0.0299***	0.0330**
	[0.0161]	[0.0078]	[0.0054]	[0.0083]	[0.0140]
log_sales	0.0428**	0.0171*	-0.0288***	-0.109***	-0.146***
	[0.0185]	[0.0089]	[0.0062]	[0.0095]	[0.0160]
log_sales_sq	-0.0022***	-0.0009***	0.0006***	0.0027***	0.0032***
	[0.0006]	[0.0003]	[0.0002]	[0.0003]	[0.0005]
Age: 2 ≤ age < 5 years	0.0708	-0.0019	-0.0064	-0.0073	-0.0354
	[0.0602]	[0.0291]	[0.0201]	[0.0311]	[0.0522]
Age: 5 ≤ age < 10 years	0.0894	0.0089	-0.0146	-0.0347	-0.0700
	[0.0584]	[0.0282]	[0.0195]	[0.0302]	[0.0507]
Age: 10 ≤ age < 20 years	0.105*	0.0014	-0.0314	-0.0617**	-0.110**
	[0.0579]	[0.0280]	[0.0193]	[0.0299]	[0.0502]
Age: 20+ years	0.123**	0.0039	-0.0364*	-0.0810***	-0.145***
	[0.0576]	[0.0278]	[0.0192]	[0.0298]	[0.0500]
log_wagebill	0.0519***	0.0226***	0.0097***	0.0088***	0.0164***
	[0.0041]	[0.0020]	[0.0014]	[0.0021]	[0.0036]
Constant	-1.173***	-0.411***	0.243***	1.127***	1.673***
	[0.151]	[0.0730]	[0.0504]	[0.0781]	[0.131]
Observations	22,740	22,740	22,740	22,740	22,740

Notes: Standard errors in brackets. These quantile regressions do not control for country, year and macro-sector fixed effects, because of computational issues of non-convergence. Key to significance stars: *** p<0.01, ** p<0.05, * p<0.1.

Table 6: Quantile regression results. Dependent variable: growth of employment in the following period (i.e. in *t:t+1*), where the predictor variables are measured at time *t*. The main explanatory variable of interest is the overcapacity dummy, which takes value 1 if firms report currently operating at above their maximum normal capacity.

	(1)	(2)	(3)	(4)	(5)
	10% quantile	**25% quantile**	**50% quantile**	**75% quantile**	**90% quantile**
d_overcapacity	0.0034	0.0074	0.0029**	0.0290***	0.0309***
	[0.0121]	[0.0070]	[0.0013]	[0.0076]	[0.0112]
log_sales	0.0949***	0.105***	-0.0046***	0.0342***	-0.0103
	[0.0142]	[0.0082]	[0.0015]	[0.0089]	[0.0131]
log_sales_sq	-0.0024***	-0.0028***	0.0002***	-0.0008***	0.0005
	[0.0004]	[0.0003]	[4.88e-05]	[0.0003]	[0.0004]
Age: 2 ≤ age < 5 years	-0.0827	-0.0191	0.0003	0.0400	0.0374
	[0.0539]	[0.0312]	[0.0059]	[0.0340]	[0.0500]
Age: 5 ≤ age < 10 years	-0.0668	-0.0222	0.0003	0.0459	0.0277
	[0.0527]	[0.0305]	[0.0057]	[0.0333]	[0.0489]
Age: 10 ≤ age < 20 years	-0.0515	-0.0189	0.0003	0.0199	0.0066
	[0.0524]	[0.0303]	[0.0057]	[0.0330]	[0.0486]
Age: 20+ years	-0.0380	-0.0178	0.0002	-0.0083	-0.0517
	[0.0522]	[0.0302]	[0.0057]	[0.0330]	[0.0484]
log_wagebill	0.0030	-0.0057***	1.6×10^{-5}	-0.0129***	-0.0222***
	[0.0032]	[0.0018]	[0.0003]	[0.0020]	[0.0029]
Constant	-1.031***	-0.896***	0.0286**	-0.0796	0.549***
	[0.119]	[0.0688]	[0.0129]	[0.0750]	[0.110]
Observations	17,791	17,791	17,791	17,791	17,791

Notes: Standard errors in brackets. These quantile regressions do not control for country, year and macro-sector fixed effects, because of computational issues of non-convergence. Key to significance stars: *** p<0.01, ** p<0.05, * p<0.1.

Table 7: Quantile regression results. Dependent variable: growth of investment in the following period (i.e. in *t:t+1*), where the predictor variables are measured at time *t*. The main explanatory variable of interest is the overcapacity dummy, which takes value 1 if firms report currently operating at above their maximum normal capacity.

	(1)	(2)	(3)	(4)	(5)
	10% quantile	25% quantile	50% quantile	75% quantile	90% quantile
d_overcapacity	-0.0986**	-0.0305*	0.0025	0.0517***	0.104**
	[0.0407]	[0.0175]	[0.00431]	[0.0163]	[0.0440]
log_sales	0.00851	0.0106	0.00216	0.0174	-0.145***
	[0.0512]	[0.0220]	[0.00542]	[0.0205]	[0.0553]
log_sales_sq	-0.0001	-0.0004	-0.0001	-0.0005	0.00433**
	[0.001]	[0.0007]	[0.0002]	[0.0006]	[0.002]
Age: 2 ≤ age < 5 years	0.0479	0.174**	0.0976***	0.0759	0.267
	[0.195]	[0.0841]	[0.0207]	[0.0782]	[0.211]
Age: 5 ≤ age < 10 years	0.116	0.212***	0.111***	0.0741	0.267
	[0.191]	[0.0823]	[0.0203]	[0.0765]	[0.207]
Age: 10 ≤ age < 20 years	0.362*	0.296***	0.121***	0.0574	0.132
	[0.190]	[0.0818]	[0.0201]	[0.0761]	[0.206]
Age: 20+ years	0.456**	0.337***	0.125***	0.0415	0.0394
	[0.190]	[0.0816]	[0.0201]	[0.0759]	[0.205]
log_wagebill	0.0349***	0.0166***	0.000649	-0.00898**	-0.0490***
	[0.0104]	[0.00449]	[0.00111]	[0.00418]	[0.0113]
Constant	-1.462***	-0.765***	-0.149***	0.0472	2.229***
	[0.434]	[0.187]	[0.0460]	[0.174]	[0.470]
Observations	19,315	19,315	19,315	19,315	19,315

Notes: Standard errors in brackets. These quantile regressions do not control for country, year and macro-sector fixed effects, because of computational issues of non-convergence. Key to significance stars: *** p<0.01, ** p<0.05, * p<0.1.

5. Discussion of the findings

The discussion of our main results can be organized into six themes.

First, it appears that entering into a state of overcapacity is generally a felicitous state, rather than a costly mistake of misjudging one's ability to satisfy incoming orders. This in itself was not clear in the previous literature. At a country-level, larger shares of firms operating above maximum capacity are positively related to higher scores for management capabilities.[20] At a firm level, rapid growth of sales and profits is observed in the years before, and also during, entry into a state of overcapacity (Figure 4). Sales growth and profits growth return to normal levels after the overcapacity event, however, suggesting perhaps that the fortuitous swelling in demand must eventually come to an end. Employment growth of the category of firms operating at overcapacity at time t is high in the years before, during, and after the overcapacity event, which – coupled with the lasting growth of the wage bill of these firms – suggests that firms that reach a state of overcapacity are more likely to be HGEs that create many jobs of good quality (Figure 4).

Second, our observations that growth of sales and profits precede entry into overcapacity is consistent with suggestions in the previous literature that firms enter into a state of operating above maximum capacity because of surging demand (Nikiforos, 2013; Foster et al., 2016; Pozzi and Schivardi, 2016). This is also in tune with evidence (in Appendix 9) that firms at overcapacity are less likely to report major barriers related to demand, or uncertainty about the future.

[20] See Appendix 15.

Third, our results connect to our novel 'fork in the road' hypothesis, which posits that firms that find themselves in a state of critically high capacity utilisation can respond in one of two ways: either they build upon the current momentum to make broad-based investment in various areas, or else they wait for the wave to subside, remaining within the current capacity limits while the capacity utilisation rate falls. Therefore, the 'fork in the road' hypothesis suggests that firms in a state of overcapacity are a heterogeneous group and therefore have a high variation in their growth rates.

We observed some support for the 'fork in the road' hypothesis. An indicator of variation (the interquartile range) was high for the category of firms "above maximum capacity," although the highest IQR values were observed for firms "far below maximum capacity."[21] Focusing on investment dynamics, we observed a sharp increase in the variation in growth rates for total investment in the year after the overcapacity event (Appendix 14). Clearer support came from our quantile regressions for sales growth (Figure 6, Table 5): overcapacity status was observed to have a significant positive association with growth of sales and investment at the upper quantiles of the growth rates distribution (for the fastest growing firms), while having a significant negative association with growth of sales and investment at the lower quantiles. Overall, therefore, our evidence on the 'fork in the road' hypothesis highlights the relevance for future theorizing and empirical investigations about overcapacity as trigger points for subsequent high-growth episodes.

Fourth, it appears that firms in a state of operating above maximum capacity are not currently investing massively in R&D, but rather firms that are making more incremental investments as they continue riding the wave of surging demand. This was also not clear from the previous literature. Appendix Table A6.2 shows their investment plans are relatively focused on "capacity expansion for existing products", and that firms at overcapacity invest a relatively small share in "development and introduction of new products." Figure 4 shows how overcapacity firms cut back on total investment (although they continue to invest heavily in fixed assets). Similarly, Appendix 10 shows that firms above maximum capacity are more likely (than firms far below capacity) to invest in buildings and new equipment. Appendix 10 also shows that firms at or above maximum capacity are actually *less* likely to invest in R&D. Furthermore, Appendix 10 shows that firms above maximum capacity are more likely to invest in training and also organization/business process improvements, which are investments with more immediate and certain payoffs that could help these firms to alleviate the pressures of overcapacity through a more efficient use of their inputs. There is also evidence that firms in a state of overcapacity have a higher share of their equipment that is state-of-the-art, and invest more in digitalization (Appendix 11), and have recently introduced process innovations. A tentative explanation could be that firms operating above maximum capacity are the victims of their success, since they do not have enough slack to engage in exploratory innovation investments. Instead, they take a relatively short-term investment horizon, coasting along on their current wave of surging demand for successful products, rather than attempting to introduce radical changes or implementing long-term investment plans.

Fifth, we can cautiously propose a sequential co-evolutionary model of firm growth around the time of operating above maximum capacity. Initially, a rise in demand leads to growth of sales, which subsequently pushes up profits, because the firm can sell larger quantities and cover its fixed costs of operations. At the same time, growing firms hire new employees to help release the pressure of overcapacity. This is in line with other research using causal methods (e.g. Moneta et al., 2013; Coad and Grassano, 2019): with sales growth and employment growth at the start, and profits growth as a useful by-product rather than the stimulus, and finally where R&D investment comes later on (if at all) as firms invest available funds into R&D. This model of growth dynamics is also consistent with

[21] See Appendix 14.

suggestions of the key role of rising demand on the capacity choices of new firms (Foster et al., 2016; Nikiforos, 2013; Pozzi and Schivardi, 2016).

Sixth, overcapacity can be seen as a firm-specific problem, as firms face their own workflows and bottlenecks, and as such it may be difficult to generalize an appropriate policy response when the barriers faced by firms are so heterogeneous (Fischer and Karlan, 2015). We therefore suggest that policy could focus on a narrow set of specific junctures or 'trigger points' that may be related to capacity utilisation (as discussed in section 2.3): hiring a first employee,[22] first steps into internationalization, introducing a second product, building a second production plant, investing in next-generation capital equipment, overcoming a regulatory threshold for firm size, and so on. For example, an initiative to help firms overcome regulatory thresholds for more stringent employment protection requirements could include a temporary (e.g. 2 year) freeze on the costs of growth, until firms become accustomed to operating at a larger size.[23]

6. Conclusions and future research

High Growth Enterprises (HGEs) make a disproportionately large contribution to economic dynamism, innovation, and productivity growth (Birch, 1979; Henrekson and Johansson, 2009; Coad et al., 2014). It is no surprise, therefore, that they receive considerable policy interest (Grover Goswami et al., 2019; Flachenecker et al., 2020). However, previous research has shown that HGEs are difficult to predict, thus making them a difficult policy target. A major problem is that rapid growth events are episodic, rather than being a stable time-invariant characteristic of firms (Daunfeldt and Halvarsson, 2015). This study takes a different approach. On the one hand, we develop a theory of capacity utilisation constraints as critical junctures in the growth process, showing in particular how operating above maximum capacity could be a springboard for subsequent HGE episodes. We investigate this theory by drawing on a unique and novel data source to provide a multifaceted view on firm growth and capacity utilisation, thereby giving a rich set of new results.

Firms begin to operate above maximum capacity after a period of rapid growth of sales and profits, consistent with explanations that capacity constraints follow on from rising demand. Firms at overcapacity have rapid employment growth both before and after being at overcapacity. Firms at overcapacity make investments in future growth, but more from the angle of capacity expansion, process improvements, and investment in modern machinery, rather than in R&D and new product development. There is evidence that firms take two routes out of overcapacity: either overcapacity is linked to subsequent rapid growth of sales (as firms launch into subsequent growth), or overcapacity is linked to declining sales (as firms shrink back to 'normal' production levels) – in line with our 'fork in the road' hypothesis.

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[22] Please bear in mind, however, that our analysis cannot provide any direct evidence on the hiring of the first employee, since firms in our sample have 5+ employees.

[23] In France, a critical threshold is reached when a firm has 50 employees, because this is when many restrictive labour regulations come into force. As a result, many firms stay just below this threshold, with just 49 employees (see Garicano et al. 2016, Figure 2). Policy could help firms overcome this size threshold in such a way that the costs of growth are delayed – e.g. by fixing that firms only have to apply these regulations 2 or 3 years after they cross the threshold, as long as firm size remains above this threshold. If firms shrink back below this threshold before 2-3 years, then they will not be affected by these labour regulations. This way, risk-averse firms could taste the benefits of larger size before having to face the full costs. This strategy of promoting growth could help firms overcome their short-termism, and could be politically feasible in the corporate world, a cynic might suggest, e.g. if top managers serve fixed terms and seek to be rewarded for growth, while 'dumping' the costs of growth on their successors.

We contribute to the literature by demonstrating a "fork in the road" effect: i.e. showing that operating above maximum capacity corresponds to a 'trigger point' or decision point, whereby firms can either respond by investing massively in further growth, or by shrinking back to stay within current capacity utilization limits. Future research could build on this finding to investigate the heterogeneity between firms that reach this decision-point and grow, and those that reach this decision-point and shrink.[24] Future research could also use fine-grained industry classification codes to explore how the relationship between capacity utilization and growth is moderated by sector.

The approach taken in this study is descriptive and exploratory, and the results are presented in the form of (conditional) associations rather than causal effects. While our results can be useful for making predictions, nevertheless they cannot *per se* conclusively identify the causal mechanisms in place. Future work could potentially find clever ways to investigate whether being above maximum capacity is entirely demand-led (i.e. if firms struggle to satisfy their hungry customers) or a proactive business decision (i.e. if firms produce as much as possible while hoping to find buyers, or while making proactive marketing efforts to find new buyers).

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[24] One reason why we did not do this is because of a small number of observations in the overcapacity category. Relevant characteristics could include age, exporter status, and multiplant firms, as well as subsequent survival as an alternative performance outcome.

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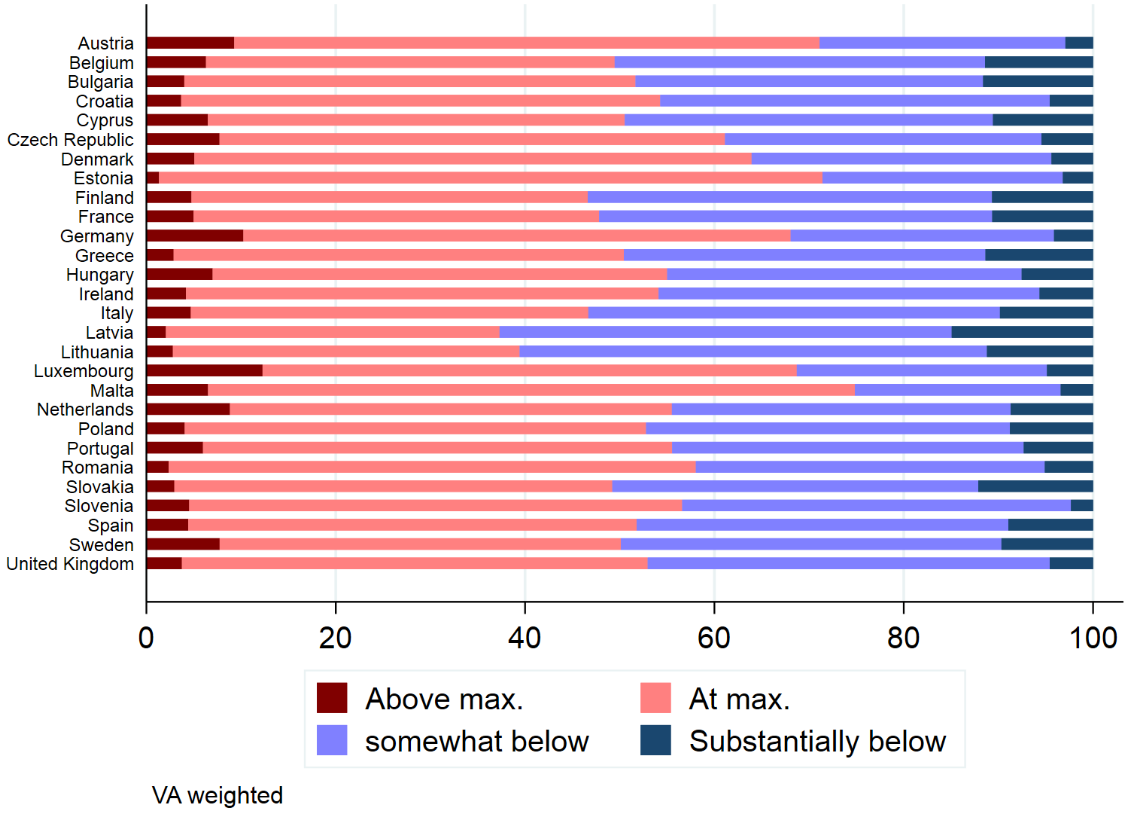
Appendix 1. Capacity utilisation categories for different countries

Figure A1.1. Capacity utilisation categories for different countries, weighted by Value Added.



Appendix 2. Data description

Table A2.1. Panel characteristics of EIBIS

Number of times surveyed	number of firms	percentage
1	23,916	69.28
2	6,444	18.67
3	2,797	8.10
4	1,364	3.95
multiple times (2 to 4)	10,605	30.72
total	34,521	100.00

Table A2.2. Panel dimensions of EIBIS-ORBIS merged dataset.

		number of times surveyed				
		1	2	3	4	Total
ORBIS financial data-years covered	0	1,243	311	138	57	1,749
	1	1,019	168	59	30	1,276
	2	574	97	36	17	724
	3	989	210	93	32	1,324
	4	2,478	612	268	97	3,455
	5	12,191	3,548	1,529	765	18,033
	6	5,422	1,498	674	366	7,960
Total		23,916	6,444	2,797	1,364	34,521

Table A2.3. Number of observations by year in EIBIS and ORBIS

survey year	financial year	EIBIS	ORBIS
	2013	-	28,721
	2014	-	30,070
2016	2015	12,483	30,189
2017	2016	12,338	30,340
2018	2017	12,355	28,596
2019	2018	13,475	10,525
TOTAL		50,651	99,650

Table A2.4: Firm performance by capacity state:

Dep. Var.: Labour productivity	[1]
At maximum capacity	-0.0614***
	[0.0179]
Somewhat below full capacity	-0.149***
	[0.0182]
Substantially below full capacity	-0.347***
	[0.0215]
Year FE	yes
Country FE	yes
Sector FE	yes
Number of Observation	40,109
R-squared	0.384

Notes: The table shows regression results on labour productivity (log of value added over employment) by capacity categories with firm that are in the state of overcapacity as the baseline group.

Table A2.5: Firm profitability by capacity state:

	profitable	making loss
Above maximum capacity	84%	5%
At maximum capacity	82%	7%
Somewhat below full capacity	76%	7%
Substantially below full capacity	53%	11%

Notes: The table shows frequency results for the survey question on capacity utilisation and profitability: Did your company generate a profit or loss before tax? The statistics report weighted average.

Appendix 3. Descriptive statistics

Table A3. Continuous and dummy variables

Variables	**Source**	**N. obs**	**mean**	**sd**	**p10**	**p50**	**p90**
sales growth	EIBIS/ORBIS	109513	0.05	0.21	-0.21	0.04	0.34
employment growth	EIBIS/ ORBIS	104242	0.02	0.14	-0.15	0.00	0.22
profit growth	EIBIS/ ORBIS	85953	0.07	0.55	-0.67	0.06	0.82
investment growth (% change in fixed assets)	ORBIS	84022	-0.01	0.41	-0.52	0.00	0.47
investment growth (survey)	EIBIS	14754	0.06	2.30	-2.34	0.00	2.40
log of sales (log EUR)	EIBIS/ ORBIS	146239	15.20	2.16	12.55	15.10	18.04
log of sales squared (log EUR)	EIBIS/ ORBIS	146239	235.71	66.44	157.52	228.03	325.39
Wage bill (log EUR)	EIBIS	126844	13.69	2.02	11.14	13.62	16.33
investment in R&D (in logs)	EIBIS	44810	2.55	4.78	0.00	0.00	11.39
~ in IT (in logs)	EIBIS	44810	5.93	4.97	0.00	7.78	11.57
~ in trainings (in logs)	EIBIS	44810	5.96	4.57	0.00	7.60	11.00
~ in business process and organization (in logs)	EIBIS	44810	2.99	4.70	0.00	0.00	10.79
Replacing capacity - investment (%)	EIBIS	40606	49.01	39.76	0.00	50.00	100.00
Expanding capacity - inv. (%)	EIBIS	40606	27.94	33.98	0.00	11.00	95.00
Developing new products – inv. (%)	EIBIS	40606	15.87	27.08	0.00	0.00	50.00
Dummy: high growth	EIBIS	47777	0.10	0.30	0.00	0.00	1.00
Dummy: subsidiary	EIBIS	50644	0.74	0.44	0.00	1.00	1.00
Dummy: Exporter	EIBIS	50432	0.46	0.50	0.00	0.00	1.00
Dummy: Invested in another country	EIBIS	50432	0.07	0.26	0.00	0.00	0.00
dummy: Energy audit in past 3 years	EIBIS	38168	1.47	0.85	1.00	2.00	2.00
dummy: grants	EIBIS	17726	0.11	0.31	0.00	0.00	1.00
dummy: digitalization	EIBIS	13333	0.17	0.37	0.00	0.00	1.00
dummy: invested in land	EIBIS	41132	0.34	0.47	0.00	0.00	1.00
dummy: invested in machinery	EIBIS	41132	0.81	0.39	0.00	1.00	1.00
dummy: invested in R&D	EIBIS	41132	0.25	0.43	0.00	0.00	1.00
dummy: invested in IT	EIBIS	41132	0.67	0.47	0.00	1.00	1.00
dummy: invested in training	EIBIS	41132	0.72	0.45	0.00	1.00	1.00
dummy: invested in business process	EIBIS	41132	0.33	0.47	0.00	0.00	1.00

Note: When firm growth is measured over one year, the log-difference is the preferred way to calculate a growth rate (Tornqvist et al., 1985; Coad, 2009). Growth of X, where $X \in \{Sales, Employment, Value, \text{Profit}\}$, for firm *i* at time *t*, is calculated as $GR\_X_{i,t} = \log(X_{i,t}) - \log(X_{i,t-1})$

Appendix 4. Descriptive statistics

Table A4. Categorical variables from EIBIS

Variable	Categories	N. obs	percent
Firm profitability	Profit	38,914	78.91
	Loss	6,016	12.2
	Break even	4,385	8.89
Firm age	Less than 2 years	250	0.49
	2 years to less than 5 years	2,087	4.12
	5 years to less than 10 years	5,479	10.82
	10 years to less than 20 years	12,696	25.08
	20 years or more	30,119	59.49
Investment compared to t-1	more than in the previous year	16,675	37.93
	broadly stayed the same	19,173	43.61
	Less than in the previous year	8,118	18.46
Innovation	No innovation	23,884	60.88
	New to the company	10,182	25.95
	New to the country	2,346	5.98
	New to the global market	2,819	7.19
Business prospects	Improve	21,032	44.36
	Stay the same	19,661	41.46
	Deteriorate	6,723	14.18
Profits before tax	Under 2%	7,669	19.41
	2% to 4%	10,633	26.91
	5% to 9%	10,949	27.71
	10% to 14%	5,438	13.76
	15% or more	4,826	12.21

Appendix 5. Frequency of consecutive years in overcapacity

Table A5. Frequency of consecutive years in overcapacity. Left panel: Firm-years. Right panel: firms.

FIRM-YEARS				FIRMS			
Number of years	Frequency	Percent	Cumulative	Number of years	Frequency	Percent	Cumulative
0	45,902	90.62	90.62	0	31,897	92.4	92.4
1	4,276	8.44	99.07	1	2,464	7.14	99.54
2	399	0.79	99.85	2	139	0.4	99.94
3	70	0.14	99.99	3	20	0.06	100
4	4	0.01	100	4	1	0	100
Total	50,651	100		Total	34,521	100	

Table A5 presents the frequency of consecutive years in overcapacity. Over 90% of firms are never in a state of overcapacity. The vast majority of firms that report ever being in overcapacity are in this state for 1 year only. Being in a state of overcapacity therefore appears to be a one-off event, rather than an enduring state. Initially, we were concerned that some employees might be constantly seeking to claim overtime pay supplements, even when there is not much work that needs doing. We were concerned that this behaviour could result in inflated and biased indicators of overcapacity at the firm level. Fortunately, however, very few firms seem to be in a perpetual state of overcapacity.

Appendix 6. What are the characteristics of firms in a state of overcapacity?

Figure A6.1 shows that firms in overcapacity at time (*t*) have higher mean growth of sales (Figure A6.1, left) and profits (Figure A6.1, right) over the period (*t-1:t*). This is consistent with notions that overcapacity is associated with rising demand (Nikiforos, 2013). Figure A6.1 also shows that firms with lower levels of capacity utilisation have lower growth rates of sales and profits.

Figure A6.1 therefore provides some early evidence that overcapacity is a rather felicitous state, rather than a catastrophic misjudgement: firms in overcapacity seem to have recently enjoyed a surge in demand that has brought with it rising sales. In each, moving to lower categories of capacity utilisation, Figure A6.1 shows that the median growth rate decreases monotonically (on average), until the lowest sales growth rates (mainly *negative* growth rates) are found for the category of lowest capacity utilisation.

Figure A6.1. boxplot of growth (*t-1:t*) of sales (left) and profits (right) across capacity categories (*t*). Box plot outliers not plotted here.

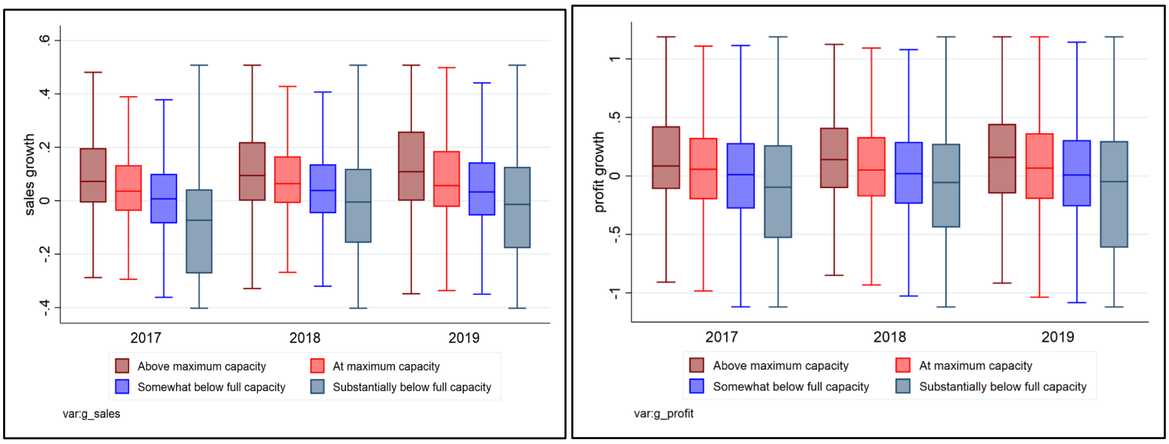


Figure A6.1 also shows information on the variation in growth rates for each category. Our 'fork-in-the-road' hypothesis predicts high variation in growth rates for firms at "above maximum capacity." While we observe that the variation in growth rates for these firms is relatively high, nevertheless the category with the highest variation in growth rates is the category of firms "substantially below full capacity." This finding that firms that are "substantially below full capacity" have the highest variation in growth rates is confirmed with the additional analysis in Appendix 14.

Table A6.1 shows that firms above maximum capacity were mainly making a profit, and were not performing worse than those at maximum capacity. Interestingly, the share of firms that are making profits increases with the level of capacity utilisation. This casts doubt on the idea that firms in the category "above maximum capacity" are suffering financially for their misjudging their production capacity. In an uncertain world, an occasional spell of 'overbooking' could be a rational profit-maximizing strategy.

Table A6.1. Cross-tabulation of these two questions: "Operating at its maximum capacity attainable under normal conditions"; and "Did your company generate a profit or loss before tax, or did you break even?"

	Profit	Loss	Break even	TOTAL
Above maximum capacity	2,360	191	179	2,730
	86.45%	7.00%	6.56%	100.00%
At maximum capacity	19,648	1,883	1,836	23,367
	84.08%	8.06%	7.86%	100.00%
Somewhat below full capacity	13,928	2,424	1,684	18,036
	77.22%	13.44%	9.34%	100.00%
Substantially below full capacity	2,487	1,432	637	4,556
	54.59%	31.43%	13.98%	100.00%

Further support for our interpretation of overcapacity being a state reached after a surge in demand is shown in Appendix 9, where firms that are operating "above maximum capacity" are the least likely to report facing obstacles relating to demand for their products or services. Interestingly, they also are the least likely to report struggling with "uncertainty about the future", perhaps because rising demand brings a sense of security, and even if they are uncertain about how their fast-paced business environment will change, they are less uncertain about their survival. Appendix 9 also presents some other interesting results on barriers perceived by firms operating above maximum capacity.[25]

Table A6.2 shows that, for those operating above maximum capacity, the largest category is "replacing capacity" (32.86% of respondents), which is also the largest category for all the other capacity utilisation groups. Firms that are "above maximum capacity" are also especially likely (31.10% of respondents) to invest in capacity for existing products. While these firms are clearly interested in expanding capacity rather than replacing existing capacity, nevertheless they do not score especially highly for "developing or introducing new products" – this latter is only reported by 24.45% of firms, which is lower than the corresponding share for firms "far below full capacity" (29.24%) and firms "somewhat below full capacity" (26.34%). A tentative explanation could be that firms operating above maximum capacity take a relatively short-term investment horizon, coasting along on their current wave of surging demand for successful products, rather than attempting to introduce radical changes or implementing long-term investment plans.

Table A6.2. Capacity utilisation and investment priorities. Cross-tabulation of these two questions: "Operating at its maximum capacity attainable under normal conditions"; and "Investment priority in the next three years?"

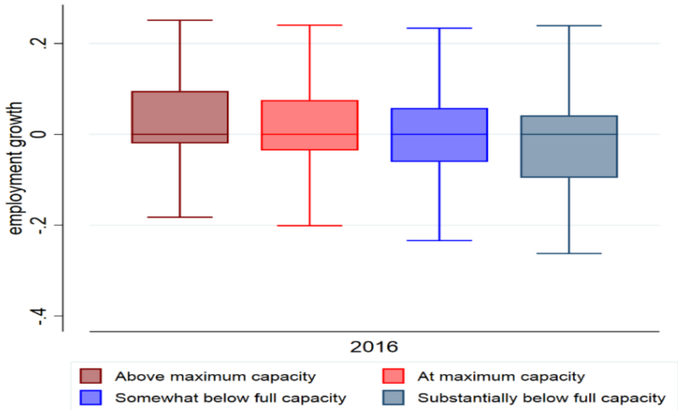
	Replacing capacity	Capacity expansion for existing products	Dev/intro new products	No inv. planned	TOTAL
Above maximum capacity	899	851	669	317	2736
	32.86%	31.10%	24.45%	11.59%	*100.00%*
At maximum capacity	8,404	6,757	5,132	3,153	23446
	35.84%	28.82%	21.89%	13.45%	*100.00%*
Somewhat below full capacity	6,283	4,996	4,756	2,018	18053
	34.80%	27.67%	26.34%	11.18%	100.00%
Far below full capacity	1,409	990	1,327	812	4538
	31.05%	21.82%	29.24%	17.89%	100.00%

[25] Appendix 9 shows that firms operating above maximum capacity are the least vulnerable to energy costs, and are relatively unaffected (comparing with other capacity utilisation categories) by obstacles relating to availability of finance. However, firms at overcapacity are the most vulnerable to the availability of staff with the right skills. They also appear to be slightly more vulnerable to obstacles relating to access to digital infrastructure, and availability of adequate transport infrastructure, in the sense of being more likely to report these as being a "major obstacle". Finally, firms at overcapacity are similar to other capacity utilisation groups with regards to business regulations (e.g. licences, permits) and taxation, as well as labour market regulations.

Appendix 7 shows that firms "above maximum capacity" have the highest expected employment growth from investment (see table notes for a detailed variable explanation). Interestingly, the second-highest value for the expected employment growth from investment is found for the category "substantially below full capacity."[26]

Another interesting observation is that the extreme categories of "above maximum capacity" and "substantially below full capacity" have the highest variability in expected employment growth, considering the values for the standard deviation. This is similar to the findings for sales growth in Figure A6.1: where variability in sales growth was highest for the two extreme categories of "substantially below full capacity" and "above maximum capacity."[27] While our fork-in-the-road hypotheses expects that those above maximum capacity would have high variation in expected employment growth, nevertheless it is more surprising to see high variation in expected employment growth for those operating "substantially below full capacity."

Figure A6.2. Employment growth (*t:t+3*) for different capacity groups (at time *t*). Those at overcapacity have higher employment growth afterwards. Outliers not plotted.



The strong job creation of firms at overcapacity is highlighted in Figure A6.2, which shows employment growth in the three years following the period of overcapacity status. Figure A6.2 shows that those firms operating at a level above maximum capacity have the highest employment growth in the following three years, followed by those operating at maximum capacity and by those below maximum capacity.

[26] However, as we can see elsewhere (e.g. Figure 4), for some reason these firms operating at "substantially below full capacity" display lower employment growth in subsequent years, despite their relatively high expectations for employment growth from investment (Appendix 7).

[27] The high variability in sales growth for the extreme category of "substantially-below-full-capacity" is interesting. We could speculate about a similar 'fork-in-the-road' effect for these firms, who might be facing declining demand, and react to this either passively (i.e. declining further) or by making a last-ditch desperate struggle to boost production by whatever means possible, and having some success (i.e. reversing their past mediocre performance to have a comeback in sales growth).

Appendix 7. Expected employment growth

Table A7. Expected employment growth from investment by capacity utilisation categories. Responses in the first column refer to the question: "Operating at its maximum capacity attainable under normal conditions?" Top panel: expected employment level change. Bottom panel: expected percentage change.

	Mean	SD	Median	N
A. Expected employment change, absolute change in levels				
Above maximum capacity	8.45	30.7	0	2,434
At maximum capacity	5.62	24.14	0	20,164
Somewhat below full capacity	5.65	23.58	0	16,033
Substantially below full capacity	7.49	43.59	0	3,636
B. Expected employment change, in percentage terms				
Above maximum capacity	0.64	3.98	0	2,434
At maximum capacity	0.42	3.12	0	20,164
Somewhat below full capacity	0.5	4.73	0	16,033
Substantially below full capacity	0.94	9.13	0	3,636

Notes: The survey question is the following: "How much, if at all, do you expect the number of employees in your business to increase or decrease as a direct effect of your investment in the last financial year? Please count employees who were and will be recruited as a direct result of your investment and subtract all employees who were and will be rationalised."

Appendix 8. Growth rates of key variables around the time of overcapacity

Figure A8.1. Event history time-series plots. Mean growth rates for various capacity utilisation categories. Growth rates of 6 variables: sales growth, employment growth, profits growth, value added growth, wage growth, and growth of total investment. Capacity utilisation is measured at time *t=0*. Growth rates have been pre-processed to remove the influence of size and size-squared (where size is measured in terms of total sales), and dummies for country, sector and year.

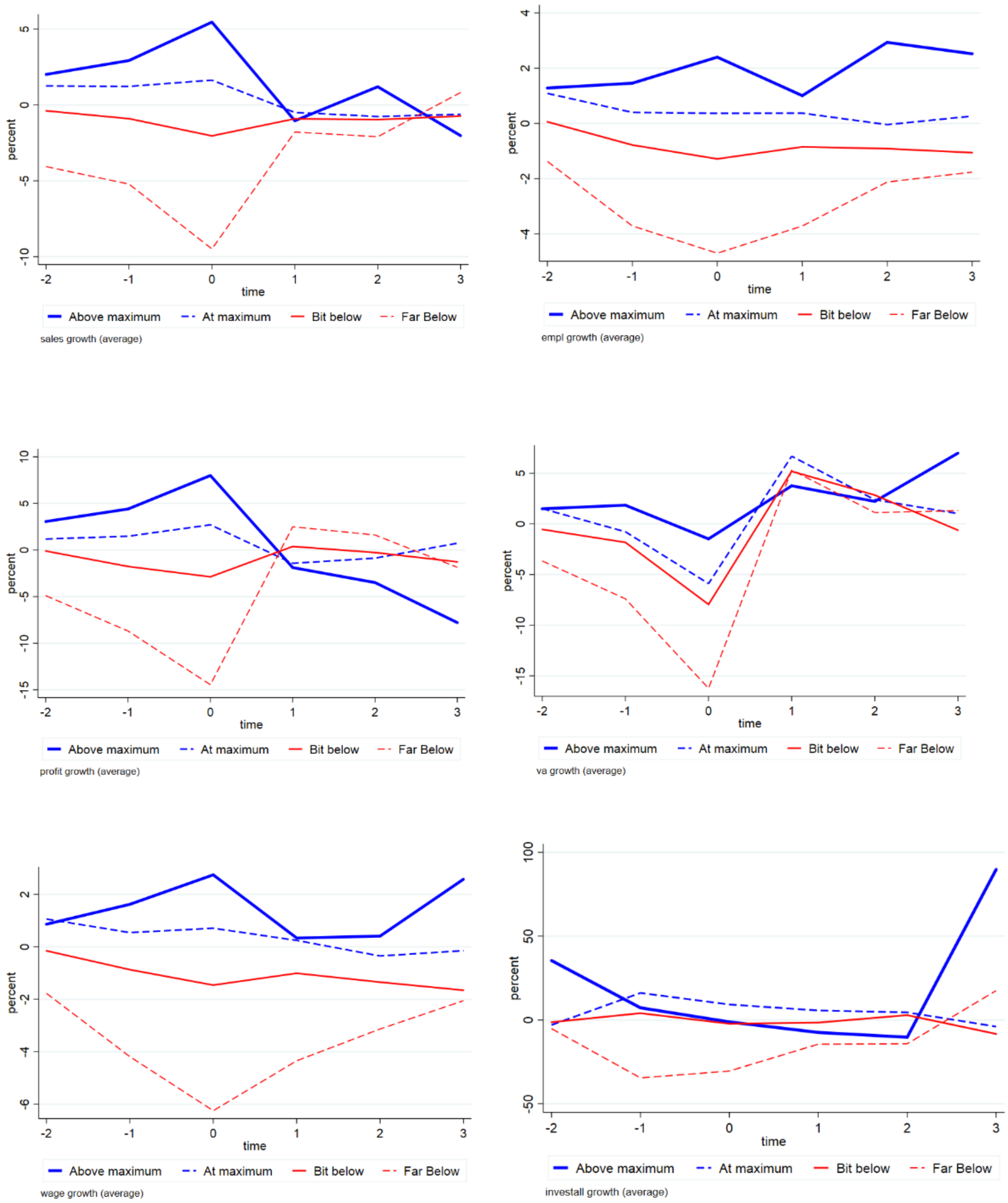


Figure A8.2. Event history time-series plots. Median growth rates for various capacity utilisation categories. Growth rates of 6 variables: sales growth, employment growth, profits growth, value added growth, wage growth, and growth of total investment. Capacity utilisation is measured at time *t=0*.

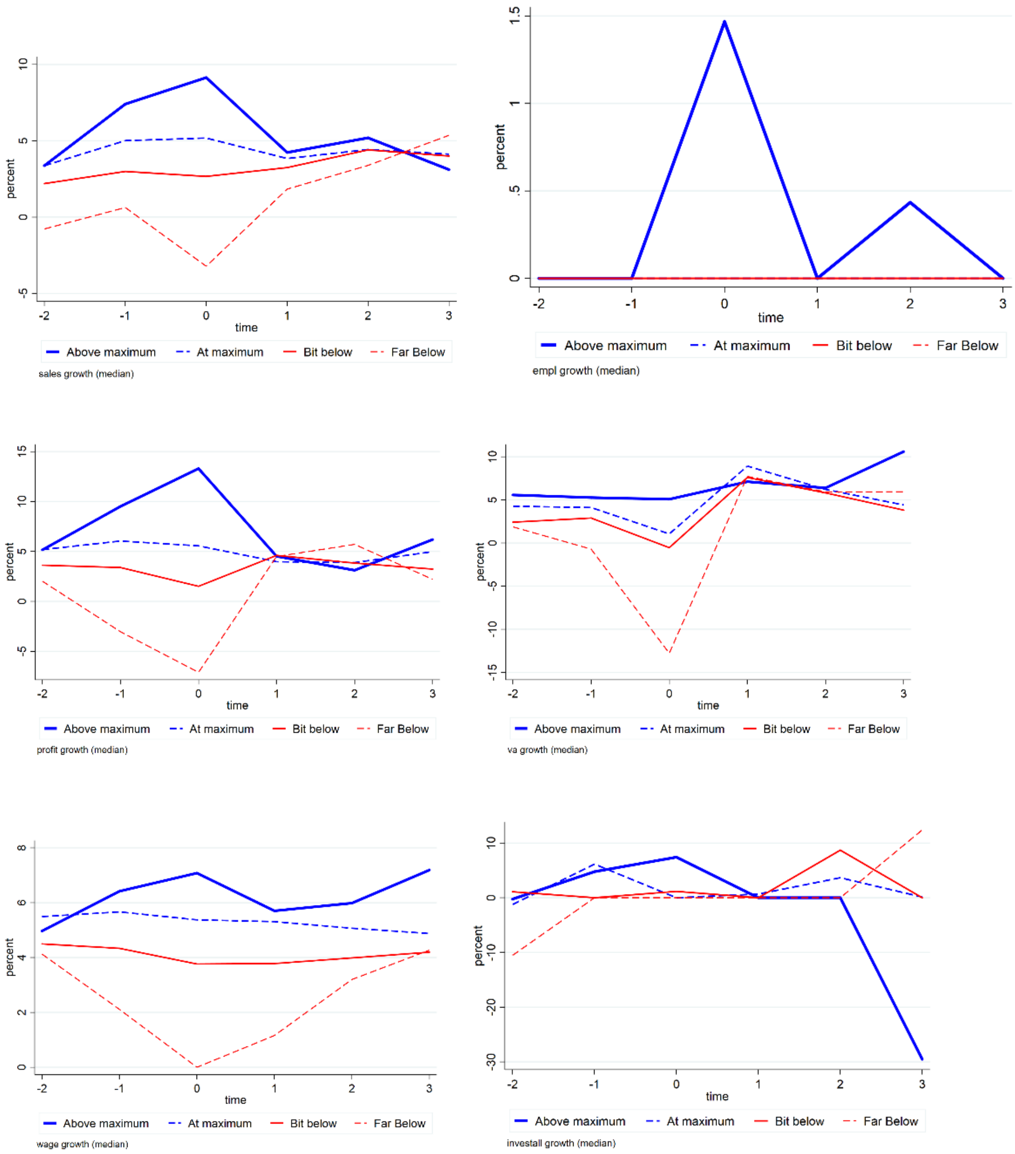
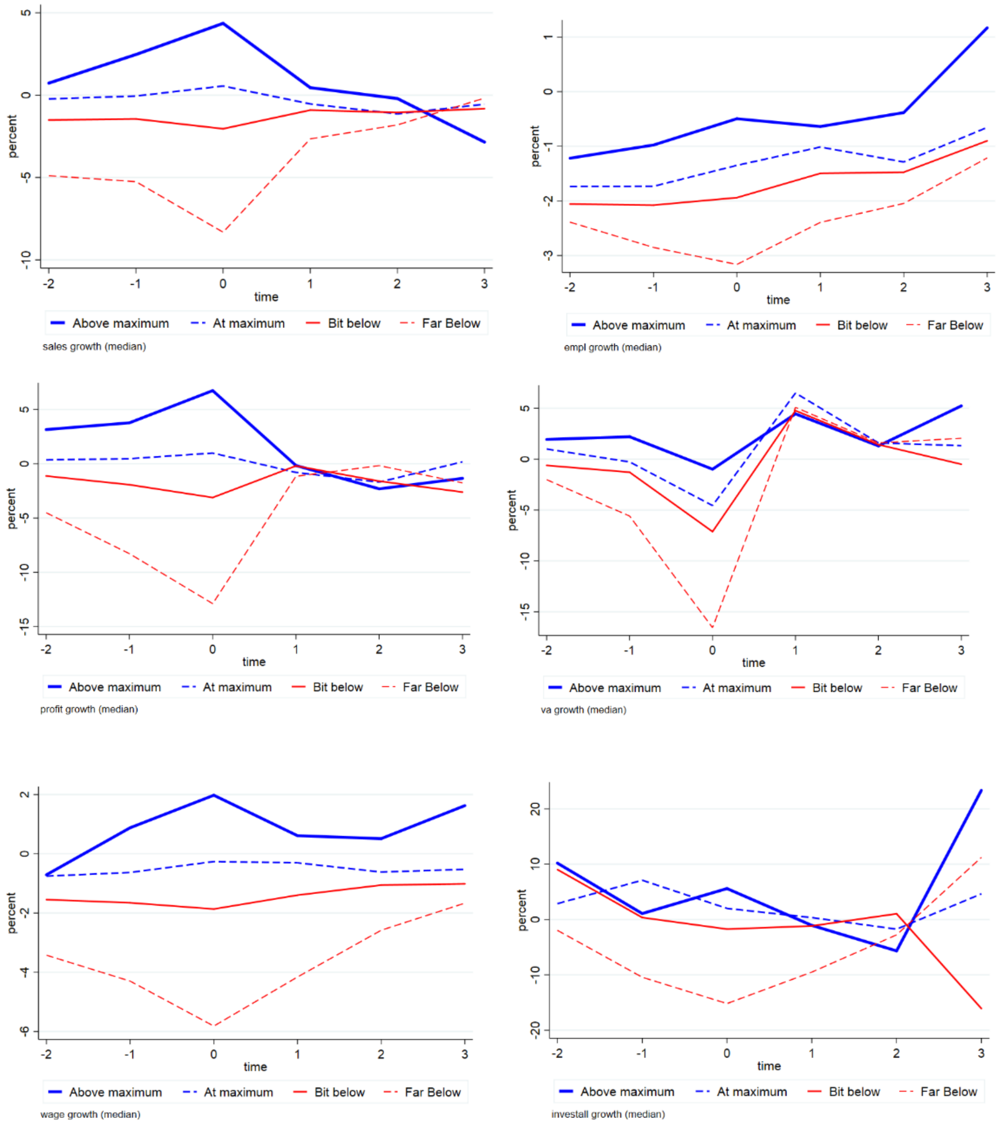


Figure A8.3. Event history time-series plots. Median growth rates for various capacity utilisation categories. Growth rates of 6 variables: sales growth, employment growth, profits growth, value added growth, wage growth, and growth of total investment. Capacity utilisation is measured at time *t=0*. Growth rates have been pre-processed to remove the influence of size and size-squared (where size is measured in terms of total sales), and dummies for country, sector and year.



Appendix 9. Cross tabulations of capacity utilisation and obstacles

Table A9. Cross tabulations of capacity utilisation categories and obstacles variables.

Capacity utilisation	**A. Demand for product or service**			
	A major obstacle	A minor obstacle	Not an obstacle at all	**ROW TOTAL**
Above maximum capacity	452 *16.48%*	752 *27.42%*	1,539 *56.11%*	2,743
At maximum capacity	3,955 *16.78%*	6,523 *27.67%*	13,095 *55.55%*	23,573
Somewhat below full capacity	4,351 *24.08%*	5,708 *31.58%*	8,013 *44.34%*	18,072
Substantially below full capacity	1,688 *37.15%*	1,237 *27.22%*	1,619 *35.63%*	4,544
	B. Availability of staff with the right skills			
	A major obstacle	A minor obstacle	Not an obstacle at all	**ROW TOTAL**
Above maximum capacity	1,547 *55.53%*	667 *23.94%*	572 *20.53%*	2,786
At maximum capacity	10,807 *45.30%*	6,738 *28.24%*	6,311 *26.45%*	23,856
Somewhat below full capacity	8,456 *46.31%*	5,467 *29.94%*	4,337 *23.75%*	18,260
Substantially below full capacity	2,165 *46.97%*	1,189 *25.80%*	1,255 *27.23%*	4,609
	C. Energy costs			
	A major obstacle	A minor obstacle	Not an obstacle at all	**ROW TOTAL**
Above maximum capacity	561 *20.27%*	891 *32.19%*	1,316 *47.54%*	2,768
At maximum capacity	5,129 *21.57%*	7,692 *32.35%*	10,955 *46.08%*	23,776
Somewhat below full capacity	4,718 *25.92%*	6,461 *35.50%*	7,023 *38.58%*	18,202
Substantially below full capacity	1,354 *29.39%*	1,498 *32.52%*	1,755 *38.09%*	4,607
	D. Access to digital infrastructure			
	A major obstacle	A minor obstacle	Not an obstacle at all	**ROW TOTAL**
Above maximum capacity	290 *10.52%*	750 *27.21%*	1,716 *62.26%*	2,756
At maximum capacity	2,048 *8.67%*	6,265 *26.51%*	15,318 *64.82%*	23,631
Somewhat below full capacity	1,760 *9.72%*	5,351 *29.55%*	11,000 *60.74%*	18,111
Substantially below full capacity	382 *8.37%*	1,303 *28.54%*	2,880 *63.09%*	4,565
	E. Labour market regulations			
	A major obstacle	A minor obstacle	Not an obstacle at all	**ROW TOTAL**
Above maximum capacity	837 *30.30%*	885 *32.04%*	1,040 *37.65%*	2,762
At maximum capacity	6,133 *25.97%*	7,742 *32.79%*	9,739 *41.24%*	23,614
Somewhat below full capacity	5,318 *29.35%*	6,448 *35.59%*	6,351 *35.06%*	18,117
Substantially below full capacity	1,597 *35.02%*	1,409 *30.90%*	1,554 *34.08%*	4,560
	F. Business regulations (e.g. licences, permits) and taxation			
	A major obstacle	A minor obstacle	Not an obstacle at all	**ROW TOTAL**
Above maximum capacity	860 *31.22%*	877 *31.83%*	1,018 *36.95%*	2,755
At maximum capacity	6,859 *28.93%*	7,622 *32.15%*	9,228 *38.92%*	23,709
Somewhat below full capacity	6,012 *33.11%*	6,132 *33.77%*	6,015 *33.12%*	18,159
Substantially below full capacity	1,850 *40.33%*	1,304 *28.43%*	1,433 *31.24%*	4,587
	G. Availability of adequate transport infrastructure			
	A major obstacle	A minor obstacle	Not an obstacle at all	**ROW TOTAL**
Above maximum capacity	460 *16.66%*	701 *25.39%*	1,600 *57.95%*	2,761

At maximum capacity	3,200 *13.53%*	6,224 *26.32%*	14,221 *60.14%*	23,645
Somewhat below full capacity	2,787 *15.36%*	5,286 *29.13%*	10,075 *55.52%*	18,148
Substantially below full capacity	698 *15.28%*	1,294 *28.33%*	2,575 *56.38%*	4,567
	H. Availability of finance			
	A major obstacle	A minor obstacle	Not an obstacle at all	**ROW TOTAL**
Above maximum capacity	503 *18.27%*	697 *25.32%*	1,553 *56.41%*	2,753
At maximum capacity	4,188 *17.73%*	6,285 *26.61%*	13,147 *55.66%*	23,620
Somewhat below full capacity	4,206 *23.23%*	5,206 *28.75%*	8,697 *48.03%*	18,109
Substantially below full capacity	1,662 *36.42%*	1,130 *24.76%*	1,772 *38.83%*	4,564
	I. Uncertainty about the future			
	A major obstacle	A minor obstacle	Not an obstacle at all	**ROW TOTAL**
Above maximum capacity	831 *30.15%*	1,001 *36.32%*	924 *33.53%*	2,756
At maximum capacity	7,506 *31.88%*	8,783 *37.30%*	7,258 *30.82%*	23,547
Somewhat below full capacity	7,574 *41.86%*	6,679 *36.91%*	3,841 *21.23%*	18,094
Substantially below full capacity	2,623 *57.43%*	1,178 *25.79%*	766 *16.77%*	4,567

Notes: responses for "Refused" and "Don't Know" have been dropped from these tables.

Appendix 10. Investment of firms across capacity utilisation states

Table A10.1 shows that firms above maximum capacity are more likely (than firms far below capacity) to invest in buildings and new equipment, although this effect fades when additional control variables are introduced. Furthermore, there is not much difference in the sign or effect sizes across the three categories "Above max capacity", "at max capacity" and "somewhat below max capacity".

Table A10.1. Regression results for investment activity according to capacity utilisation states.

	Inv_buildings				Inv_equipmt			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Above maximum capacity	0.0597*** [0.0125]	0.0280** [0.0128]	0.0093 [0.0137]	4.5×10^{-5} [0.0243]	0.0626*** [0.0105]	0.0519*** [0.0107]	0.0303*** [0.0112]	-0.0046 [0.0182]
At maximum capacity	0.0445*** [0.0083]	0.0118 [0.0085]	-0.0054 [0.0092]	0.0046 [0.0175]	0.0560*** [0.0076]	0.0411*** [0.0077]	0.0200** [0.0081]	-0.0014 [0.0136]
Somewhat below maximum capacity	0.0502*** [0.0084]	0.0202** [0.0086]	0.0078 [0.0092]	0.0091 [0.0172]	0.0676*** [0.0076]	0.0541*** [0.0077]	0.0372*** [0.0081]	0.0138 [0.0133]
log_sales		-0.0412*** [0.0126]	-0.0462*** [0.0139]	-0.0343 [0.0247]		0.0062 [0.0098]	-0.0131 [0.0111]	0.0070 [0.0188]
log_sales_sq		0.0031*** [0.0004]	0.0028*** [0.0004]	0.0024*** [0.0008]		0.0005* [0.0003]	0.0004 [0.0003]	-0.0002 [0.0006]
Profit status: loss			-0.0724*** [0.0078]	-0.0580*** [0.0145]			-0.0695*** [0.0071]	-0.0359*** [0.0115]
Profit status: break-even			-0.0611*** [0.0092]				-0.0411*** [0.0087]	
log_wagebill			0.0232*** [0.0032]	0.0099* [0.0060]			0.0334*** [0.0027]	0.0167*** [0.0045]
Age: 2 ≤ age < 5 years			5.8×10^{-5} [0.0406]	0.102 [0.0827]			-0.0085 [0.0355]	-0.0241 [0.0645]
Age: 5 ≤ age < 10 years			0.0068 [0.0395]	0.135* [0.0805]			-0.0286 [0.0345]	-0.0349 [0.0625]
Age: 10 ≤ age < 20 years			0.0187 [0.0391]	0.138* [0.0798]			-0.0392 [0.0342]	-0.0253 [0.0618]
Age: 20+ years			0.0251 [0.0390]	0.157** [0.0795]			-0.0363 [0.0340]	-0.0272 [0.0615]
Subsidiary			-0.0687*** [0.0064]	-0.0660*** [0.0108]			-0.0325*** [0.0050]	-0.0254*** [0.0074]
Directly exported			-0.0336*** [0.0059]	-0.0574*** [0.0112]			-0.0041 [0.0051]	-0.0184** [0.0086]
Invested in another country			0.0339*** [0.0104]	-0.0011 [0.0149]			-0.0078 [0.0076]	0.0060 [0.0099]
R&D investment dummy				0.0044*** [0.0009]				0.0001 [0.0006]
IT investment dummy				0.0062*** [0.0012]				0.0004 [0.0009]
Training investment dummy				0.0035*** [0.0013]				0.0043*** [0.0010]
Business processes inv. dummy				0.0045*** [0.0009]				-0.0003 [0.0006]
Replacing capacity - investment (%)				0.0006* [0.0003]				0.0017*** [0.0003]
Expanding capacity - inv. (%)				0.0010*** [0.0004]				0.0010*** [0.0003]
Investment in R&D				-0.0017** [0.0003]				-0.0013*** [0.0003]
Investment wrt t-1: broadly stayed the same				-0.137*** [0.0100]				-0.0395*** [0.0068]
Investment wrt t-1: less than prev. year				-0.104*** [0.0136]				-0.0476*** [0.0096]
Business prospects: same				0.0008 [0.0134]				-0.0070 [0.0095]
Business prospects: deteriorate				-0.0144 [0.0125]				-0.0165* [0.0087]
Business prospects: same				-0.0053 [0.0101]				0.0019 [0.0070]
Business prospects: deteriorate				0.0185 [0.0144]				-0.0173* [0.0103]
Profits before tax: 2% to 4%				0.0099 [0.0140]				-0.0121 [0.0098]
Profits before tax: 5% to 9%				0.0347** [0.0141]				-0.0180* [0.0097]
Profits before tax: 10% to 14%				0.0151 [0.0165]				-0.0150 [0.0115]
Profits before tax: 15% or more				0.0714*** [0.0173]				-0.0093 [0.0125]
Observations	40,690	37,937	33,738	10,421	40,690	37,937	33,738	10,421
R^2	0.027	0.076	0.089	0.152	0.033	0.045	0.053	0.128

Notes: Robust standard errors in brackets. *** p<0.01, ** p<0.05, * p<0.1. A constant, country, sector, and year dummies are included in all of the regressions but not reported in detail.

Table A10.2 shows that firms at or above maximum capacity are actually *less* likely to invest in R&D, possibly focusing on short-term priorities while neglecting longer-term investments such as R&D (Garicano and Steinwender, 2016). Table A10.2 also shows that firms above maximum capacity are more likely to invest in training and organization/business process improvements, which are investments with more immediate payoffs that could help these firms to alleviate the pressures of overcapacity through a more efficient use of inputs.

Table A10.2. Regression results for investment activity according to capacity utilisation states

	Inv_R&D			Inv_IT			Inv_Training			Inv_Process		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Above maximum capacity	-0.0137	-0.0270**	-0.0261**	0.0422***	0.0166	0.0050	0.0645***	0.0309***	0.0254**	0.0472***	0.0374***	0.0386***
	[0.0115]	[0.0120]	[0.0128]	[0.0122]	[0.0125]	[0.0134]	[0.0117]	[0.0118]	[0.0125]	[0.0128]	[0.0132]	[0.0142]
At maximum capacity	-0.0418***	-0.0597***	-0.0531***	0.0017	-0.0249***	-0.0268***	0.0404***	0.0046	0.0013	-0.0231***	-0.0428***	-0.0339***
	[0.0079]	[0.0081]	[0.0087]	[0.0086]	[0.0088]	[0.0095]	[0.0084]	[0.0084]	[0.0090]	[0.0085]	[0.0087]	[0.0095]
Somewhat below maximum capacity	-0.0127	-0.0303***	-0.0282***	0.0230***	0.0007	-0.0065	0.0560***	0.0236***	0.0167*	0.0165*	-0.0021	0.0047
	[0.0080]	[0.0082]	[0.0087]	[0.0086]	[0.0088]	[0.0094]	[0.0084]	[0.0084]	[0.0090]	[0.0086]	[0.0088]	[0.0095]
log_sales		-0.0599***	-0.0745***		0.0970***	0.0652***		0.247***	0.223***		0.0147	0.0042
		[0.0110]	[0.0122]		[0.0122]	[0.0137]		[0.0149]	[0.0163]		[0.0121]	[0.0142]
log_sales_sq		0.0029***	0.0022***		-0.0020***	-0.0018***		-0.0066***	-0.0070***		0.0005	0.0002
		[0.0003]	[0.0004]		[0.0004]	[0.0004]		[0.0005]	[0.0005]		[0.0004]	[0.0004]
Profit status: loss			-0.0326***			-0.0460***			-0.0227***			-0.0123
			[0.0071]			[0.0082]			[0.0076]			[0.0080]
Profit status: break-even			-0.0051			-0.0332***			-0.0189**			0.0181*
			[0.0084]			[0.0097]			[0.0093]			[0.0098]
log_wagebill			0.0336***			0.0253***			0.0385***			0.0221***
			[0.0029]			[0.0031]			[0.0031]			[0.0032]
Age: 2 ≤ age < 5 years			-0.0260			-0.0752*			-0.0300			-0.0847*
			[0.0386]			[0.0398]			[0.0377]			[0.0437]
Age: 5 ≤ age < 10 years			-0.0115			-0.0772**			-0.0359			-0.0796*
			[0.0375]			[0.0385]			[0.0364]			[0.0425]
Age: 10 ≤ age < 20 years			-0.0428			-0.0792**			-0.0267			-0.0989**
			[0.0372]			[0.0380]			[0.0359]			[0.0421]
Age: 20+ years			-0.0462			-0.0575			-0.0283			-0.101**
			[0.0370]			[0.0378]			[0.0357]			[0.0419]
Subsidiary			-0.0130**			-0.0505***			0.0170***			-0.0260***
			[0.0059]			[0.0061]			[0.0056]			[0.0065]
Directly exported			0.124***			0.0634***			0.0214***			0.0481***
			[0.0054]			[0.0058]			[0.0055]			[0.0060]
Invested in another country			0.178***			0.0745***			0.0226***			0.0888***
			[0.0102]			[0.0085]			[0.0086]			[0.0107]
Observations	40,690	37,937	33,738	40,690	37,937	33,738	40,690	37,937	33,738	40,690	37,937	33,738
R^2	0.084	0.104	0.139	0.045	0.064	0.075	0.046	0.087	0.091	0.033	0.050	0.057

Notes: Robust standard errors in brackets. *** p<0.01, ** p<0.05, * p<0.1. A constant, country, sector, and year dummies are included in all of the regressions but not reported in detail.

In Appendix 11, further regressions present evidence to suggest that firms above maximum capacity are more likely to invest in digitalization. This is consistent with their higher likelihood of reporting access to digital infrastructure as a "major obstacle" (Appendix 9).

Digging deeper into differences in investment patterns for firms in different states of capacity utilisation, we now distinguish between HGEs and non-HGEs. Firms that have experienced a burst of rapid growth may have different investment priorities (e.g. if they have used up all available slack in corporate infrastructure, and need to invest in buildings, machinery as well as perhaps a new IT system better adapted to their larger size). Appendix 12 shows the determinants of investment for subsamples of HGEs vs non-HGEs. Many of the results are not statistically significant, however. The most interesting result from Appendix 12 is perhaps the finding that firms "above maximum capacity" are significantly more likely to invest in equipment (column (9)) if they are HGEs than if they are non-HGEs.

Appendix 11. Investment after capacity utilisation states

Table A11. Investment after capacity utilisation states. Digitalization and Energy audits (dummies).

	Digitalization				NRG audits			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Above maximum capacity	0.0652***	0.0393**	0.0213	0.0747*	-0.0369***	0.0161	0.0210	0.0073
	[0.0182]	[0.0198]	[0.0225]	[0.0453]	[0.0130]	[0.0131]	[0.0143]	[0.0283]
At maximum capacity	0.0244**	-0.0093	-0.0207	0.0049	-0.0174**	0.0355***	0.0435***	0.0391*
	[0.0120]	[0.0130]	[0.0153]	[0.0327]	[0.0088]	[0.0088]	[0.0097]	[0.0212]
Somewhat below maximum capacity	0.0290**	0.0047	-0.0074	0.0194	-0.0325***	0.0136	0.0187*	0.0164
	[0.0122]	[0.0131]	[0.0153]	[0.0321]	[0.0089]	[0.0089]	[0.0097]	[0.0209]
log_sales		-0.108***	-0.149***	-0.172***		0.0470***	0.0841***	0.0631**
		[0.0232]	[0.0265]	[0.0493]		[0.0138]	[0.0145]	[0.0308]
log_sales_sq		0.0045***	0.0050***	0.0056***		-0.0039***	-0.0038***	-0.0030***
		[0.0007]	[0.0009]	[0.0015]		[0.0004]	[0.0005]	[0.0009]
Profit status: loss			-0.0210*	-0.0303			0.0149*	0.0237
			[0.0118]	[0.0237]			[0.0083]	[0.0168]
Profit status: break-even			-0.0181				0.0052	
			[0.0138]				[0.0094]	
log wagebill			0.0292***	0.0256**			-0.0465***	-0.0414***
			[0.0048]	[0.0102]			[0.0035]	[0.0070]
Age: 2 ≤ age < 5 years			-0.0202	-0.0406			0.0021	-0.0648
			[0.0755]	[0.0485]			[0.0434]	[0.0942]
Age: 5 ≤ age < 10 years			-0.00656				0.0113	-0.0346
			[0.0737]				[0.0423]	[0.0914]
Age: 10 ≤ age < 20 years			-0.0265	-0.0511			-0.0003	-0.0489
			[0.0729]	[0.0316]			[0.0420]	[0.0908]
Age: 20+ years			-0.0499	-0.0679**			-0.0307	-0.0892
			[0.0725]	[0.0298]			[0.0418]	[0.0904]
Subsidiary			0.0257**	0.0146			-0.0248***	-0.0243*
			[0.0101]	[0.0192]			[0.0070]	[0.0129]
Directly exported			0.0351***	0.00821			0.0079	0.0245*
			[0.0092]	[0.0198]			[0.0062]	[0.0129]
Invested in another country			0.0946***	0.0303			-0.0141	0.0291*
			[0.0182]	[0.0293]			[0.0114]	[0.0176]
R&D investment dummy				0.0044***				-0.0024**
				[0.0016]				[0.0011]
IT investment dummy				0.0060***				-0.0007
				[0.0021]				[0.0014]
Training investment dummy				0.0028				-0.0033**
				[0.0023]				[0.0015]
Business processes inv. dummy				0.0024				-0.0044***
				[0.0016]				[0.0011]
Replacing capacity - investment (%)				-0.0010*				-0.0003
				[0.0005]				[0.0004]
Expanding capacity - inv. (%)				-0.0009*				8.8×10^{-5}
				[0.0006]				[0.0004]
Investment in R&D				-0.0005				0.0003
				[0.0005]				[0.0004]
Investment wrt t-1: broadly stayed the same				-0.0300*				0.0129
				[0.0175]				[0.0115]
Investment wrt t-1: less than prev. year				-0.0138				-0.0516***
				[0.0225]				[0.0155]
Innov: new to country				0.0109				-0.0321**
				[0.0233]				[0.0154]
Innov: new to global mkt				0.0771***				-0.0120
				[0.0229]				[0.0147]
Business prospects: same				-0.0513***				0.0259**
				[0.0179]				[0.0114]
Business prospects: deteriorate				-0.0388*				0.0165
				[0.0225]				[0.0165]
Profits before tax: 2% to 4%				0.0124				-0.0146
				[0.0239]				[0.0163]
Profits before tax: 5% to 9%				0.0147				-0.0136
				[0.0238]				[0.0164]
Profits before tax: 10% to 14%				0.0538*				-0.0050
				[0.0285]				[0.0190]
Profits before tax: 15% or more				0.0999***				-0.0235
				[0.0299]				[0.0200]
Observations	13,165	11,162	9,151	2,640	34,871	31,467	27,263	7,598
R^2	0.040	0.083	0.100	0.155	0.065	0.160	0.173	0.171

Notes: Robust standard errors in brackets. *** p<0.01, ** p<0.05, * p<0.1. A constant, country, sector, and year dummies are included in all of the regressions but not reported in detail here.

Appendix 12. Determinants of investment, for subsamples of HGEs and non-HGEs.

Table A12. Determinants of investment, for subsamples of HGEs and non-HGEs.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)
	State-art mchnry/Eqpt		Inv. buildings		Inv. Eqpmt		Inv. Eqpmt		Inv. IT		Inv. Training		Inv. Process		Digitalisn		NRG audit	
	HGE=1	HGE=0	HGE=1	HGE=0	HGE=1	HGE=0	HGE=1	HGE=0	HGE=1	HGE=0	HGE=1	HGE=0	HGE=1	HGE=0	HGE=1	HGE=0	HGE=1	HGE=0
Above maximum capacity	6.420	4.933***	0.0721	-0.0109	0.106**	-0.0188	-0.0045	-0.0019	0.0188	-0.0125	-0.0070	0.0106	0.0237	0.0064	0.153	0.0742	0.0535	0.0025
	[4.277]	[1.724]	[0.0739]	[0.0266]	[0.0493]	[0.0204]	[0.0200]	[0.0073]	[0.0187]	[0.0078]	[0.0166]	[0.0076]	[0.0178]	[0.00703]	[0.133]	[0.0511]	[0.0814]	[0.0312]
At maximum capacity	5.066	4.066***	0.0241	5.8×10^{-6}	0.0676	-0.0085	-0.0071	-0.0036	-0.0020	-0.0051	-0.0016	0.0069	0.0250	0.0081*	0.159	-0.0170	0.0686	0.0380*
	[3.618]	[1.230]	[0.0634]	[0.0186]	[0.0454]	[0.0144]	[0.0176]	[0.0050]	[0.0165]	[0.0053]	[0.0139]	[0.0053]	[0.0155]	[0.0049]	[0.126]	[0.0359]	[0.0692]	[0.0229]
Somewhat below maximum capacity	0.625	2.486**	0.0664	0.0017	0.0859*	0.0046	-0.0101	-0.0019	-0.0071	-0.0034	-0.0165	0.0034	0.0159	0.0037	0.124	0.0024	0.0781	0.0113
	[3.600]	[1.188]	[0.0631]	[0.0183]	[0.0452]	[0.0142]	[0.0176]	[0.0049]	[0.0164]	[0.0052]	[0.0137]	[0.0052]	[0.0154]	[0.0048]	[0.124]	[0.0351]	[0.0680]	[0.0225]
log_sales	4.769	3.055*	-0.0861	-0.0230	-0.0030	0.0037	0.0927***	0.103***	0.0994***	0.106***	0.0751***	0.111***	0.0787***	0.0890***	-0.435***	-0.154***	-0.109	0.0536
	[4.849]	[1.783]	[0.0778]	[0.0264]	[0.0698]	[0.0191]	[0.0328]	[0.0106]	[0.0305]	[0.0106]	[0.0211]	[0.0110]	[0.0288]	[0.0110]	[0.148]	[0.0556]	[0.100]	[0.0336]
log_sales_sq	-0.130	-0.0923*	0.0037	0.0020*	0.00012	-7.2×10^{-5}	-0.0031***	-0.0035***	-0.0038***	-0.0041***	-0.0029***	-0.0040***	-0.0029***	-0.0032***	0.0126***	0.0051***	0.0022	-0.0027***
	[0.151]	[0.0538]	[0.0025]	[0.0008]	[0.0020]	[0.0006]	[0.0010]	[0.0003]	[0.0010]	[0.0003]	[0.0007]	[0.0003]	[0.0009]	[0.0003]	[0.0045]	[0.0017]	[0.0031]	[0.0011]
Profit status: loss	-3.967	-2.107**	-0.0462	-0.0553***	0.0181	-0.0375***	-0.0227	-0.0049	-0.0084	-0.0060	0.0099	0.0044	0.0141	-0.0036	-0.0034	-0.0525**	0.0149	0.0236
	[2.827]	[1.004]	[0.0470]	[0.0157]	[0.0345]	[0.0124]	[0.0142]	[0.0043]	[0.0136]	[0.0046]	[0.0117]	[0.0045]	[0.0114]	[0.0044]	[0.0753]	[0.0254]	[0.0524]	[0.0181]
log wagebill	0.313	-0.749*	0.0050	0.0115*	0.0047	0.0192***	-0.0209***	-0.0185***	-0.0158***	-0.0283***	-0.0316***	-0.0308***	-0.0105**	-0.0184***	0.0614**	0.0264**	-0.0270	-0.0437***
	[1.037]	[0.434]	[0.0179]	[0.0065]	[0.0113]	[0.0049]	[0.0048]	[0.0021]	[0.0050]	[0.0023]	[0.0051]	[0.0021]	[0.0047]	[0.0019]	[0.0254]	[0.0112]	[0.0181]	[0.0078]
Age: 2 ≤ age < 5 years	-3.498	4.567	0.0401	0.143	-0.174***	-0.142***	-0.0743	0.0383	-0.0344	-0.0089	-0.0178	-0.0435	-0.0322	-0.0415*	-0.107	-0.0366	-0.0772	-0.0326
	[15.02]	[7.816]	[0.178]	[0.132]	[0.0593]	[0.0463]	[0.105]	[0.0392]	[0.121]	[0.0302]	[0.104]	[0.0286]	[0.126]	[0.0247]	[0.117]	[0.0590]	[0.200]	[0.199]
Age: 5 ≤ age < 10 years	-9.463	6.884	0.0209	0.161	-0.163***	-0.158***	-0.0586	0.0420	-0.0481	-0.0147	-0.0489	-0.0445	-0.0378	-0.0345			0.0017	0.0201
	[14.54]	[7.659]	[0.168]	[0.130]	[0.0500]	[0.0422]	[0.105]	[0.0386]	[0.120]	[0.0291]	[0.103]	[0.0277]	[0.126]	[0.0237]			[0.192]	[0.196]
Age: 10 ≤ age < 20 years	-9.810	5.305	-0.0140	0.176	-0.181***	-0.148***	-0.0633	0.0400	-0.0640	-0.00437	-0.0435	-0.0397	-0.0237	-0.0346	-0.0048	-0.0562	-0.0076	0.0083
	[14.49]	[7.600]	[0.166]	[0.129]	[0.0474]	[0.0408]	[0.105]	[0.0384]	[0.120]	[0.0288]	[0.103]	[0.0274]	[0.126]	[0.0234]	[0.0686]	[0.0375]	[0.190]	[0.196]
Age: 20+ years	-8.995	4.529	0.0156	0.192	-0.144***	-0.153***	-0.0704	0.0368	-0.0695	-0.0068	-0.0562	-0.0413	-0.0260	-0.0325	-0.109	-0.0761**	-0.0608	-0.0273
	[14.46]	[7.571]	[0.166]	[0.129]	[0.0469]	[0.0401]	[0.104]	[0.0383]	[0.120]	[0.0287]	[0.103]	[0.0272]	[0.126]	[0.0233]	[0.0688]	[0.0356]	[0.190]	[0.196]
Subsidiary	-2.360	-0.807	-0.0439	-0.0708***	-0.0380*	-0.0257***	-0.0028	0.0044	-0.0082	0.0031	-0.0008	-0.0152***	-0.0129*	-0.0031	0.108*	0.0044	0.0042	-0.0292**
	[1.838]	[0.758]	[0.0300]	[0.0119]	[0.0204]	[0.0081]	[0.0079]	[0.0030]	[0.0078]	[0.0033]	[0.0074]	[0.0032]	[0.0072]	[0.0031]	[0.0584]	[0.0211]	[0.0345]	[0.0144]
Directly exported	7.203***	2.118***	-0.0289	-0.0616***	-0.0340	-0.0199**	-0.0092	-0.0012	-0.0015	0.0014	-0.0047	0.0017	-0.0024	0.0047	0.0645	-0.0059	0.0028	0.0288**
	[2.053]	[0.806]	[0.0325]	[0.0123]	[0.0223]	[0.0094]	[0.0082]	[0.0031]	[0.0086]	[0.0035]	[0.0081]	[0.0035]	[0.0080]	[0.0033]	[0.0539]	[0.0222]	[0.0351]	[0.0143]
Invested in another country	-1.114	2.239**	0.0221	-0.0081	0.0019	0.0078	-0.0296***	-0.0393***	-0.0339***	-0.0328***	-0.0255***	-0.0219***	-0.0325***	-0.0194***	-0.0059	0.0507	0.0268	0.0279
	[2.328]	[1.040]	[0.0370]	[0.0167]	[0.0243]	[0.0111]	[0.0109]	[0.0049]	[0.0101]	[0.0045]	[0.0094]	[0.0046]	[0.0107]	[0.0044]	[0.0681]	[0.0333]	[0.0422]	[0.0200]
R&D investment dummy	0.177	0.302***	0.0040	0.0046***	-0.0005	0.0006	0.0849***	0.0863***	-0.0013*	-0.0020***	-0.0020***	-0.0018***	0.0007	-0.0008***	0.0050	0.0048***	-0.0014	-0.0029**
	[0.157]	[0.0628]	[0.0026]	[0.0010]	[0.0016]	[0.0007]	[0.0007]	[0.0003]	[0.0007]	[0.0003]	[0.0006]	[0.0003]	[0.0007]	[0.0003]	[0.0048]	[0.0017]	[0.0029]	[0.0012]
IT investment dummy	0.606***	0.212**	0.0122***	0.0047***	0.0018	-0.0005	-0.0007	-0.0005	0.0882***	0.0912***	-0.0007	-0.0014***	-0.0007	0.0005	0.0140**	0.0052**	-0.0004	-0.0002
	[0.219]	[0.0843]	[0.0034]	[0.0013]	[0.0025]	[0.0010]	[0.0009]	[0.0003]	[0.0011]	[0.0004]	[0.0009]	[0.0004]	[0.0009]	[0.0003]	[0.0063]	[0.0024]	[0.0038]	[0.0015]
Training investment dummy	-0.0408	0.286***	0.0011	0.0042***	0.0035	0.0045***	-0.0017*	-0.0008**	-0.0029***	-0.0017***	0.0930***	0.0975***	-0.0008	-0.0006	-0.0022	0.0042*	-0.011***	-0.0022
	[0.249]	[0.0926]	[0.0039]	[0.0014]	[0.0027]	[0.0011]	[0.0011]	[0.0004]	[0.0011]	[0.0004]	[0.0012]	[0.0005]	[0.0009]	[0.0004]	[0.0064]	[0.0025]	[0.0041]	[0.0017]
Business processes inv. dummy	-0.179	-0.0082	0.0074***	0.0043***	0.0004	-0.0004	0.0014**	0.0008***	-0.0002	-0.0012***	-0.0021***	-0.0029***	0.0916***	0.0934***	-0.0050	0.0034*	-0.0054*	-0.0043***
	[0.165]	[0.0639]	[0.0026]	[0.0010]	[0.0017]	[0.0007]	[0.0007]	[0.0003]	[0.0007]	[0.0003]	[0.0007]	[0.0003]	[0.0007]	[0.0003]	[0.0049]	[0.0018]	[0.0029]	[0.0012]
Replacing capacity - investment (%)	-0.0420	0.0415*	-0.0001	0.0006*	0.0010	0.0016***	0.0002	0.0001	-0.0002	1.9×10^{-5}	-0.0003	-0.0001	-0.0005	-0.0002*	-0.0030*	-0.0009	-0.0007	-0.0002
	[0.0665]	[0.0244]	[0.0011]	[0.0004]	[0.0007]	[0.0003]	[0.0003]	[0.0001]	[0.0003]	[0.0001]	[0.0003]	[0.0001]	[0.0003]	[0.0001]	[0.0017]	[0.0006]	[0.0010]	[0.0004]
Expanding capacity - inv. (%)	-0.0374	0.0533**	-4.8×10^{-6}	0.0010**	0.0007	0.0010***	3.1×10^{-5}	-3.2×10^{-5}	-0.0003	1.0×10^{-5}	-0.0002	-0.0002	-0.0003	-0.0002	-0.0011	-0.0009	-0.0009	0.0002
	[0.0638]	[0.0256]	[0.0011]	[0.0004]	[0.0007]	[0.0003]	[0.0003]	[0.0001]	[0.0003]	[0.0001]	[0.0003]	[0.0001]	[0.0003]	[0.0001]	[0.0016]	[0.0006]	[0.0009]	[0.0004]
Investment in R&D	0.0956	0.0770***	-0.0025**	-0.0017***	-0.0014**	-0.0014***	-0.0007***	-0.0005***	-0.0006**	-0.0004***	-0.0006**	-0.0004***	-0.0005*	-0.0004***	-0.0011	-0.0004	-0.0002	0.0003
	[0.0631]	[0.0244]	[0.0011]	[0.0004]	[0.0007]	[0.0003]	[0.0003]	[0.0001]	[0.0003]	[0.0001]	[0.0003]	[0.0001]	[0.0003]	[0.0001]	[0.0016]	[0.0006]	[0.0009]	[0.0004]
Investment wrt t-1: broadly stayed the same	-1.330	-2.432***	-0.102***	-0.141***	-0.0042	-0.0400***	0.0008	0.0013	0.0256***	0.0084***	0.0123*	0.0014	0.0165**	0.0037	-0.132***	-0.0227	-0.0065	0.0236*
	[1.741]	[0.697]	[0.0290]	[0.0110]	[0.0192]	[0.0075]	[0.0074]	[0.0029]	[0.0075]	[0.0030]	[0.0070]	[0.0030]	[0.0068]	[0.0029]	[0.0454]	[0.0195]	[0.0316]	[0.0127]
Investment wrt t-1: less than prev. year	0.402	-0.912	-0.0836*	-0.109***	0.0123	-0.0555***	0.0197*	0.0111***	0.0140	0.0142***	0.0152	0.0122***	0.0241**	0.0115***	-0.0453	-0.0160	-0.103**	-0.0341**
	[2.611]	[0.917]	[0.0429]	[0.0147]	[0.0235]	[0.0106]	[0.0111]	[0.0037]	[0.0118]	[0.00411]	[0.0098]	[0.0040]	[0.0106]	[0.0038]	[0.0813]	[0.0244]	[0.0481]	[0.0169]
Innov: new to country	7.112***	4.730***	0.0022	-0.0065	0.0033	-0.0099	0.0098	0.0037	-0.0082	-0.0083**	0.0019	-0.0062	0.0089	-0.0128***	0.0008	0.0157	-0.0074	-0.0390**
	[2.357]	[0.959]	[0.0372]	[0.0147]	[0.0228]	[0.0105]	[0.0104]	[0.0038]	[0.0106]	[0.0042]	[0.0096]	[0.0041]	[0.0100]	[0.0039]	[0.0714]	[0.0259]	[0.0421]	[0.0169]
Innov: new to global mkt	8.599***	7.789***	-0.0388	-0.0104	0.0219	-0.0303***	-0.0264***	-0.0280***	-0.0108	-0.0059	-0.0037	-0.0080**	-0.0042	-0.0062*	0.0880	0.0766***	0.0238	-0.0197
	[2.202]	[0.888]	[0.0347]	[0.0137]	[0.0206]	[0.0099]	[0.0098]	[0.0039]	[0.0095]	[0.0038]	[0.0085]	[0.0037]	[0.0086]	[0.0036]	[0.0601]	[0.0259]	[0.0390]	[0.0163]
Business prospects: same	-0.817	-1.922***	-0.0083	0.0018	-0.0521***	0.0133*	0.0097	0.0037	0.0060	0.0004	0.0020	0.0046	-0.0058	-0.00238	-0.0507	-0.0600***	0.0845***	0.0126
	[1.734]	[0.704]	[0.0292]	[0.0111]	[0.0185]	[0.0077]	[0.0076]	[0.0028]	[0.0076]	[0.0031]	[0.0071]	[0.0030]	[0.0071]	[0.0029]	[0.0501]	[0.0198]	[0.0303]	[0.0125]
Business prospects: deteriorate	-4.989*	-3.238***	0.104**	0.0087	-0.0089	-0.0112	0.0150	0.0006	-0.0055	0.0047	-0.0119	0.0019	0.0119	0.0022	-0.0962	-0.0373	0.0119	0.0094
	[2.725]	[0.991]	[0.0442]	[0.0156]	[0.0266]	[0.0113]	[0.0115]	[0.0041]	[0.0113]	[0.0043]	[0.0108]	[0.0043]	[0.0109]	[0.0041]	[0.0655]	[0.0248]	[0.0465]	[0.0183]
Profits before tax: 2% to 4%	4.248	2.489***	0.0146	0.0077	0.0269	-0.0157	-0.0239**	-0.0122***	-0.0168	-0.0048	0.0131	-0.0084**	-0.0169	-0.0026	-0.0628	0.0194	-0.117**	0.0058
	[2.641]	[0.942]	[0.0438]	[0.0152]	[0.0302]	[0.0105]	[0.0114]	[0.0039]	[0.0121]	[0.0042]	[0.0106]	[0.0041]	[0.0105]	[0.0040]	[0.0833]	[0.0260]	[0.0468]	[0.0179]
Profits before tax: 5% to 9%	6.120**	4.446***	0.0587	0.0286*	0.0345	-0.0250**	-0.0147	-0.0084**	-0.0181	-0.0056	0.0147	-0.0067	-0.0084	-0.0044	0.0252	0.0007	-0.126***	0.0052
	[2.603]	[0.947]	[0.0436]	[0.0152]	[0.0299]	[0.0105]	[0.0115]	[0.0040]	[0.0119]	[0.0042]	[0.0108]	[0.0042]	[0.0106]	[0.0040]	[0.0840]	[0.0256]	[0.0457]	[0.0179]
Profits before tax: 10% to 14%	11.03***	4.411***	0.0446	0.0056	0.0066	-0.0189	-0.0280**	-0.0266***	-0.0086	-0.0134***	0.0086	-0.0139***	-0.0090	-0.0094*	0.0006	0.0652**	-0.148***	0.0161
	[2.950]	[1.139]	[0.0488]	[0.0180]	[0.0332]	[0.0126]	[0.0134]	[0.0048]	[0.0134]	[0.0051]	[0.0117]	[0.0050]	[0.0114]	[0.0049]	[0.0875]	[0.0313]	[0.0504]	[0.0210]
Profits before tax: 15% or more	5.315	6.318***	0.0856	0.0722***	0.0261	-0.0115	-0.0102	-0.0205***	-0.0287**	-0.0197***	-0.0035	-0.0109**	-0.0167	-0.0215***	0.0174	0.107***	-0.0615	-0.0195
	[3.268]	[1.220]	[0.0525]	[0.0188]	[0.0359]	[0.0135]	[0.0141]	[0.0050]	[0.0143]	[0.0053]	[0.0131]	[0.0052]	[0.0131]	[0.0051]	[0.0935]	[0.0332]	[0.0547]	[0.0218]
Observations	1,408	8,589	1,424	8,665	1,424	8,665	1,424	8,665	1,424	8,665	1,424	8,665	1,424	8,665	393	2,165	1,107	6,237
R^2	0.217	0.139	0.154	0.156	0.135	0.135	0.941	0.943	0.892	0.894	0.891	0.896	0.946	0.942	0.290	0.160	0.187	0.176

Notes: Robust standard errors in brackets. *** p<0.01, ** p<0.05, * p<0.1. A constant, country, sector, and year dummies are included in all of the regressions but not reported in detail here.

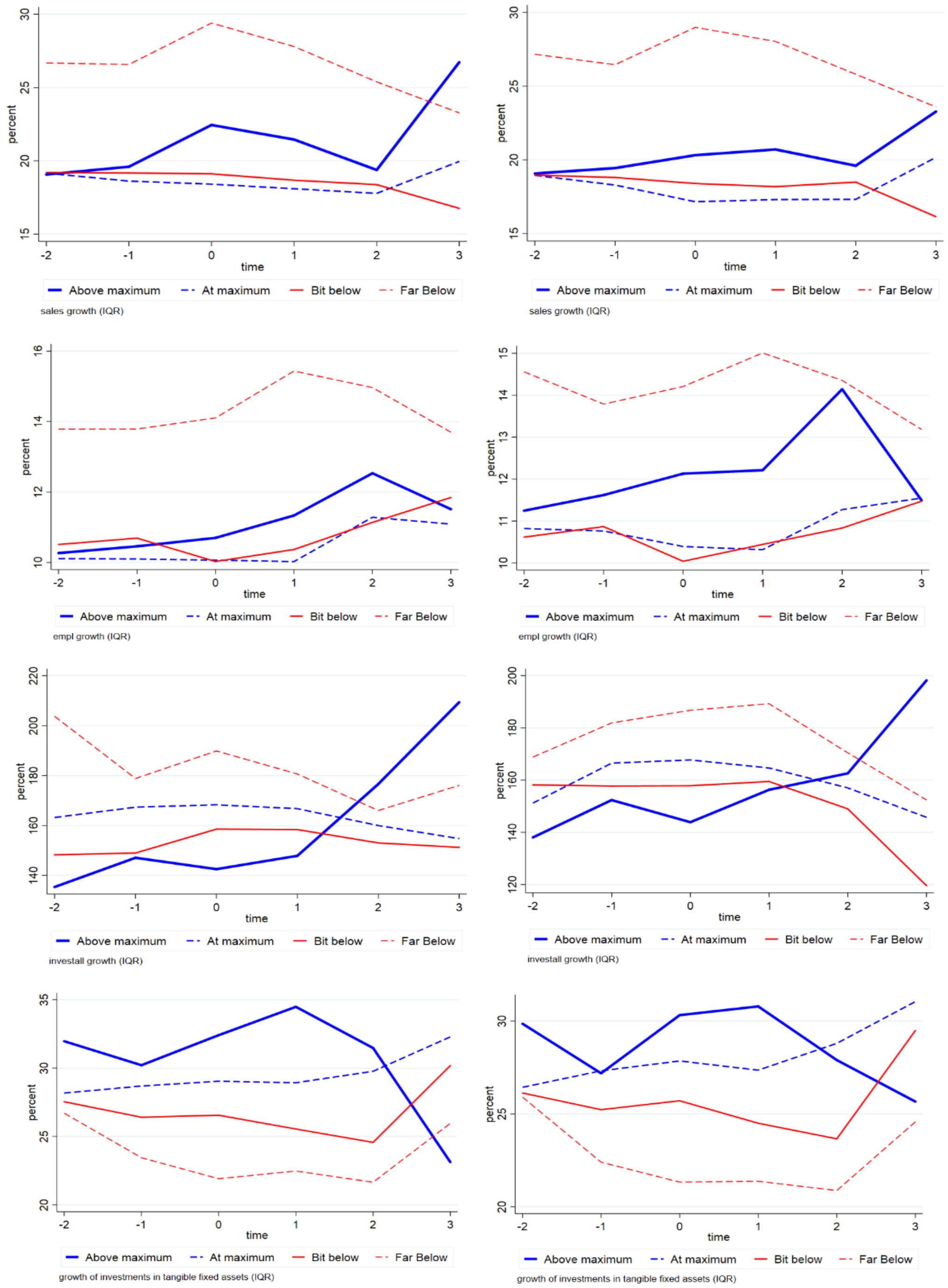
Appendix 13: Capacity utilisation and subsequent HGE status

Table A13. HGE status (representing employment growth from *t:t+3*) is the dependent variable, instead of firm growth from *t:t+1*. Robust standard errors in brackets. *** p<0.01, ** p<0.05, * p<0.1

	(1)	(2)	(3)	(4)
	f3_HGE_dummy	f3_HGE_dummy	f3_HGE_dummy	f3_HGE_dummy
State-of-art mchnry/eqmt	-2.4×10^{-5} [0.0003]	-9.7×10^{-5} [0.0003]	-0.0001 [0.0003]	-0.0007 [0.0006]
Innov: new to the firm	-0.0770* [0.0397]	-0.0824** [0.0403]	-0.0766* [0.0420]	
Innov: new to country	-0.0319 [0.0406]	-0.0312 [0.0411]	-0.0356 [0.0427]	-0.0529 [0.0543]
Innov: new to global mkt	-0.0607 [0.0479]	-0.0621 [0.0485]	-0.0541 [0.0512]	-0.0919 [0.0657]
R&D investment (IHS)	0.118 [0.177]	0.0514 [0.181]	0.0045 [0.189]	-5.559 [22.91]
Above maximum capacity	0.109* [0.0621]	0.111* [0.0637]	0.106 [0.0646]	0.321** [0.162]
At maximum capacity	-0.0096 [0.0291]	-0.0198 [0.0298]	-0.0036 [0.0279]	0.0342 [0.0558]
Somewhat below maximum capacity	0.0160 [0.0299]	0.0113 [0.0309]	0.0332 [0.0290]	0.0676 [0.0594]
log_sales		0.0300 [0.0649]	0.0603 [0.0737]	0.0950 [0.128]
log_sales_sq		-0.0007 [0.0021]	-0.0016 [0.0023]	-0.0020 [0.0041]
Profit status: loss			-0.0383 [0.0261]	-0.0457 [0.0515]
Profit status: break-even			-0.0176 [0.0327]	-
log_wagebill			-0.0012 [0.0116]	-0.0212 [0.0303]
Age: 2 ≤ age < 5 years			-0.166 [0.185]	-0.152 [0.141]
Age: 5 ≤ age < 10 years			-0.0504 [0.184]	0.216 [0.138]
Age: 10 ≤ age < 20 years			-0.143 [0.179]	0.107 [0.0916]
Age: 20+ years			-0.169 [0.178]	0.0576 [0.0858]
Subsidiary			0.0175 [0.0238]	0.0312 [0.0504]
Directly exported			0.0114 [0.0231]	0.0483 [0.0442]
Invested in another country			0.0796* [0.0450]	0.0738 [0.0669]
R&D investment dummy				0.0605 [0.243]
IT investment dummy				-0.0071 [0.0050]
Training investment dummy				0.0042 [0.0046]
Business processes inv. dummy				0.0005 [0.0038]
Replacing capacity - investment (%)				-0.0011 [0.0013]
Expanding capacity - inv. (%)				0.0007 [0.0014]
Investment in R&D				-0.0008 [0.0013]
Investment wrt t-1: broadly stayed the same				-0.0087 [0.042]
Investment wrt t-1: less than prev. year				-0.0229 [0.0525]
Business prospects: same				-0.0430 [0.0434]
Business prospects: deteriorate				0.0071 [0.0610]
Profits before tax: 2% to 4%				0.0006 [0.0537]
Profits before tax: 5% to 9%				-0.0391 [0.0572]
Profits before tax: 10% to 14%				-0.0150 [0.0656]
Profits before tax: 15% or more				-0.0581 [0.0648]
Observations	1,293	1,254	1,173	415
R^2	0.034	0.038	0.058	0.174

Appendix 14. The ‘fork in the road’ hypothesis: do firms ‘above maximum capacity’ have higher variation in subsequent growth?

Figure A14. Interquartile range (IQR) of the growth distribution for selected growth rate variables (sales growth, employment growth, growth of total investment, and growth of fixed assets) before and after being in overcapacity. Left: unconditional values. Right: ‘cleaned’ conditional values, obtained after applying OLS regressions to remove the potential influence of standard controls (i.e. sales, sales squared, and dummies for country, sector, and year).



NOTES: At time $t=0$, some firms are at overcapacity (at time $t=0$), while at the same time other firms are assigned to categories ‘at maximum’ (at time $t=0$), ‘bit below’ (at time $t=0$) or ‘far below’ (at time $t=0$). We then see what happened to these firms in the years leading up to $t=0$, and the years after $t=0$. Of course, a firm at overcapacity($t=0$) is probably not likely to be at overcapacity in years before $t=0$, or the years after $t=0$. Similarly, a firm at ‘far-below($t=0$)’ is probably not ‘far-below’ in the years before $t=0$, or the years after $t=0$, but we assign firms to categories based on their status in year $t=0$. Then, we pool together observations where t corresponds to different years.

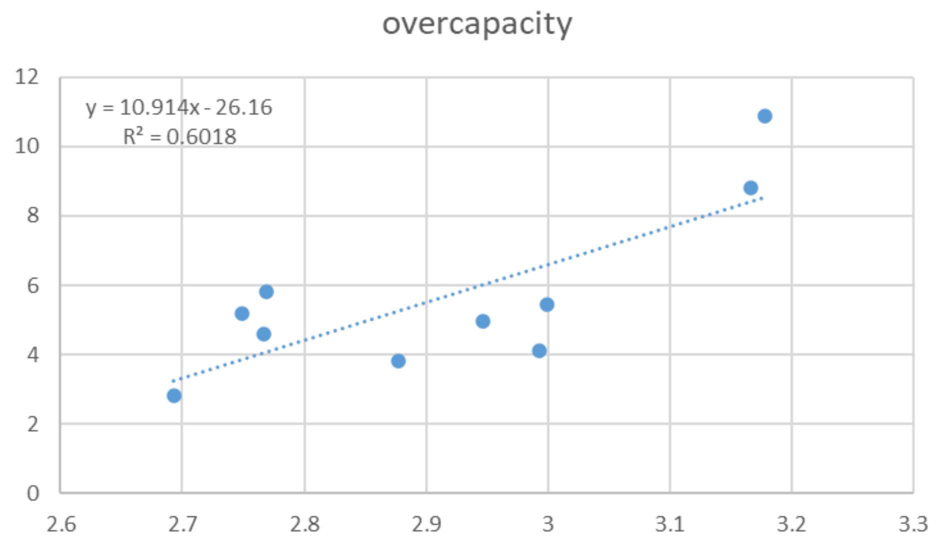
Appendix 15. Overcapacity and management scores at the country level

Does operating at overcapacity correspond to good management (e.g. allowing for some overbooking as a means of dealing with uncertainty) or bad management (drifting from an optimal scale for operations)? In this appendix, country-level management scores are linked to country-level capacity utilisation responses.

Management score draws on Bloom et al. (2014) and corresponds to the "Average of all management questions", from the Manufacturing: 2004-2014 combined survey data, downloaded from https://worldmanagementsurvey.org.

Figure A15 below shows the relationship between management scores and shares of firms operating above maximum capacity. This supports the idea that overcapacity is positively (rather than negatively) linked to good management practices.

Figure A15. Management score (horizontal axis) and percentage of firms reporting to be operating "above maximum capacity" (vertical axis), for 10 European countries. Data available upon request.



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