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Confronting Theories of Firm Growth in Light of Degrees-of-Freedom Analysis

Confrontando Teorias de Crescimento da Firma à Luz da Análise de Graus de Liberdade

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Abstract

This article aims to confront four theories of firm growth – Optimum Firm Size, Stage Theory of Growth, The Theory of the Growth of the Firm and Dynamic Capabilities – with empirical data derived from a backward-looking longitudinal qualitative case of the growth trajectory of a Brazilian capital goods firm. To do so, we employed Degree of Freedom-Analysis for data analysis. This technique aims to test the empirical strengths of competing theories using statistical tests, in particular Chi-square test. Our results suggest that none of the four theories fully explained the growth of the firm we chose as empirical case. Nevertheless, Dynamic Capabilities was regarded as providing a more satisfactory explanatory power.

Keywords: Firm Growth. Degree of Freedom Analysis. Dynamics Capabilities. Firm Trajectory.

Resumo

Este artigo objetiva confrontar quatro teorias de crescimento da firma – Tamanho Ótimo da Firma, Teoria de Estágio de Crescimento, Teoria de Crescimento da Firma e Capacidades Dinâmicas – com dados empíricos oriundos de um estudo longitudinal da trajetória de crescimento de uma empresa brasileira de bens de capital. Para tanto, nós utilizamos a Análise de Graus de Liberdade para análise de dados. Esta técnica tem como propósito testar a força empírica de teorias rivais utilizando dados estatísticos, especificamente o Teste de Qui-quadrado. Os nossos resultados sugerem que nenhuma das quatro teorias explica totalmente o crescimento da firma escolhida como caso empírico. No entanto, a teoria de Capacidades Dinâmicas foi vista como sendo a que possui o poder de explanação mais satisfatório.

Palavras-chave: Crescimento da firma. Análise de Graus de Liberdade. Capacidades Dinâmicas. Trajetória da Firma.

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Introduction

Quite often empirical studies of firm growth come up with some puzzling results. For example, Coad (2007) found that growth of profits had no influence on the subsequent growth of employment or sales. Geroski, Lazarova, Urga and Walters (2003, p.55) revealed that firm size followed a random walk (LEVINTHAL, 1997). This means that "[…] firms move[d] more or less randomly, changing their relative size and rank on a regular if unpredictable basis […]". In other words, differences in growth rates between firms were suggested to be transitory. Dosi, Lechevalier and Secchi (2010, p.1867) reminded us about the persistent heterogeneity "[…] in all dimensions of business firms' characteristics and dynamics […]" whereas Serrasqueiro, Nunes, Leitão and Armada (2010) brought nonlinearities between determinants and firm growth to the fore. Yet, Henderson, Raynor and Ahmed (2012) found a degree of support for the notion of imprint on firm growth.

In our view, these results are puzzling because they are at odds with some well-known theories, models and hypotheses on firm growth (COAD, 2009), in particular those selected by Geroski (1998; 2000) for closer examination: Optimum Firm Size (OFS), Stage Theory of Growth (STG), The Theory of the Growth of the Firm (TGF) and Dynamic Capabilities (DC).

How can we reconcile the hypothesis on random walks (LEVINTHAL, 1997) with Penrose's (1959) TGF? On the one hand, random walks assume that adjustment costs are fixed whereas TGF suggests they are variable (GEROSKI, 1998; 2000). By the same token, how can we accommodate the existence of nonlinearities between causal factors and firm growth to OFS which claims that a single determinant (price mechanism) sets the limits to firm growth (DEMSETZ, 1991)? This idea is also difficult to reconcile with STG theories such as Greiner's (1972) model that suggest that firms grow in stages or phases. In addition, the concept of imprint has no place in OFS (CONNER, 1991) even though it is in accordance with DC (TEECE; PISANO; SHUEN, 1997).

More broadly, the mismatch between theory and data about firm growth has been spearheaded by Geroski and co-authors for a decade (GEROSKI, 1998; 2000; GEROSKI; MAZZUCATO, 2002; GEROSKI et al., 2003; GEROSKI; MATA; PORTUGAL, 2010). Specifically, Geroski (1998; 2000) carried out a quantitative panel study in order to confront the tenets of the aforementioned theories with empirical data. He found that none of these theories fully explained the growth of the sampled firms. In a similar vein, Geroski, Mata and Portugal (2010) were unable to claim absolute superiority of a particular theory over the others. Interestingly enough, whereas Geroski (1998; 2000) suggests that DC is a more promising theory for unpacking firm growth, Geroski, Mata and Portugal (2010) imply that a combination of theories is required so as to provide a finer-grained understanding of the growth of the firm.

Geroski's (1998; 2000) contention is the starting point of this piece of research. It aims to confront the four theories of firm growth chosen by the American-born author with empirical data derived from a backward-looking qualitative case of the growth trajectory of a Brazilian capital goods firm. To do so, we built a matrix prediction that confronted the four theories of firm growth mentioned earlier. Subsequently we employed Degrees of Freedom Analysis (DFA) for data analysis. Based on Campbell (1975), this technique aims to test the empirical strengths of competing theories using statistical tests, in particular the Z-test and/or Chi-square test (WILSON; WOODSIDE, 1999).

Although our data comes from a quite different context and our findings are drawn from a distinct research method, they are strikingly similar to Geroski's (1998, 2000). Accordingly, none of the four theories fully explained the growth of the firm we chose as empirical case. Nevertheless, DC was regarded as providing a more satisfactory explanatory power.

This article is structured as follows. The following section covers the theoretical background of study. Initially we outline four theories of firm growth: OFS, STF, TGF and DC. We then build the prediction matrix with similar, complementary and competitive propositions about firm growth. Subsequently we present detailed information about

how our investigation was carried out, and place particular emphasis on DFA. Our results comprise an overview of the growth trajectory of the selected firm as well as DFA outcomes. The final two sections contain the theoretical implications as well as contributions and limitations of our research.

Theoretical Background

Four theories of firm growth

OFS has its roots in mainstream economics (KUPFER; HASENCLEVER, 2002; SAUDERBRONN; SAUDERBROON; HASENCLEVER, 2011), which assumes that the firm operates within a perfectly competitive market (CYERT; MARCH, 1963), i.e., an economic institution (WILLIAMSON, 1985) represented by agents having complete information (CONNER, 1991) about inputs and prices (CYERT; MARCH, 1963) at zero costs (DEMSETZ, 1991). Under perfect competition, abnormal profits are washed away rapidly (DOSI; LECHEVALIER; SECCHI, 2010), which prevents the firm from sustaining a competitive advantage (ROSSETTI, 2003). Against this backdrop, firm growth is a "movement towards the optimum size", as put nicely by Geroski (1998, p.2). Graphically represented by the lowest point of the firm's cost curve (SLATER, 1980), the optimum size means that (all) firms maximize profits (RICHARDSON, 1972), stemming from the ideal mix of products and factors (CYERT; MARCH, 1963). As equilibrium is reached with optimum size, in the long run firms are likely to display the same size (GEROSKI et al., 2003).

Although STG is illustrated by a number of models (NECYK; FREZATTI, 2010; KLANN; KLANN; POSTAI; RIBEIRO, 2012), following Geroski (1998; 2000), we look closer at Greiner's (1972, 1988) and Mueller's (1972) models. Broadly speaking, both models suggest that the firm grows in stages or phases, this process being contingent on firm size and age (COSTA; BOENTE, 2012). Greiner's (1972; 1998) model is grounded on the idea that the firm goes through periods of evolution and revolution which can be theoretically divided into five interconnected phases: creativity, direction, delegation, coordination and collaboration. Mueller's (1972) model suggests that each phase of growth is associated with innovation either in terms of products or processes. The earlier phases embrace the foundation of the firm and product or process renewals whereas the later phases involve agency conflicts and diversification.

TGF is built upon two assumptions (GEROSKI, 1998): i) services rendered from resources fuel firm growth (PENROSE, 1959); ii) there are managerial limits to the firm growth rate (KOR; MAHONEY, 2000) - the so-called Penrose effect (SLATER, 1980). TGF suggests that the growth of the firm is largely determined by firm's internal resources (PENROSE, 1956). Resources such as machines, managers and the like (KOR; MAHONEY, 2000) are indivisible or discrete (GEROSKI, 2000) therefore the firm is likely to have underutilized resources (FLECK, 2009) which can render services at near zero marginal cost (PITELIS, 2002; 2007). This provides an incentive for firm growth (PENROSE, 1959). Penrose (1956; 1959; 1971) places particular emphasis on the managerial limits to firm growth. As the administrative cadre is considered an inelastic resource (TAN; MAHONEY, 2007), the firm takes deliberate and costly actions to develop and maintain it internally (JACOBIDES; WINTER; KASSBERGER, 2012). This takes time notwithstanding, hindering firms from growing as smoothly (FOSS, 2002) or quickly as planned (SLATER, 1980).

DC suggests that firm's capabilities are positively correlated to sustained superior returns (TEECE; PISANO; SHUEN, 1997; TEECE, 2007) or Schumpeterian returns (AUGIER; TEECE, 2009). These capabilities refer to the ability of the firm to deploy resources (AMIT; SCHOEMAKER, 1993) or "[…] to achieve new and innovative forms of competitive advantage […]" (TEECE; PISANO; SHUEN, 1997, p. 516). In this sense, DC emphasizes sense-making in fast-changing environments (EISENHARDT; MARTIN,

2000) such as opportunity discovery (AUGIER; TEECE, 2009) and environmental adaptation and reshaping (TEECE, 2007; DRNEVICH; KRIAUCIUNAS, 2011; HELFAT; WINTER, 2011). Dosi, Lechevalier and Secchi (2010) put forward that dynamic capabilities are grounded on organizational knowledge whereas Arikan and McGahan (2010) state that they are embedded in activities and routines. Regardless, authors such as Amit and Schoemaker (1993) and Teece, Pisano and Shuen (1997) forcefully suggest that dynamic capabilities are developed over time, usually through experiential learning (FLEURY; FLEURY, 2004). This makes them hard to observe and difficult to imitate (DUTTA; NARASHIMAHAN; RAJIV, 2005; TEECE, 2007). It goes without saying that DC views the growth of the firm as the result of the development and maintenance of dynamic capabilities (GEROSKI, 2000).

The prediction matrix

The four theories reviewed earlier are the bedrock of a prediction matrix comprised of similar, complementary and competitive propositions about firm growth (WILSON; WOODSIDE, 1999). We drew each proposition from a particular theory and then contrasted it with the other three theories in order to show whether it can be confirmed (C), partially confirmed (P), or not confirmed (N) in each of them (see Table 1).

The first proposition states that the firm is able to sustain competitive advantage. This goes against OFS as this theory posits that sustained competitive advantages are difficult, even impossible (GEROSKI, 1998; 2000). Although STG does not deal with this explicitly, Klann et al. (2012) suggest a positive relation between firm life cycle and competitive advantage. If this holds, competitive advantage may be sustained in more successful stages or phases. This reasoning rests on the assumption that competitors are not able (BARNEY, 1991) and do not want (MADHOK; LI; PRIEM, 2010) to imitate the firm life cycle, in particular the successful stages or phases. However, if they want and succeed in mimicking it, the competitive advantage of the firm will, at best, be

Table 1 – Prediction matrix

Propositions	OFS	STG	TGF	DC
1. Firm is able to sustain competitive advantage	N	C	C	C
2. Firm growth is determined by outputs (products)	C	N	N	N
3. There is firm optimum size	C	P	N	N
4. Firm growth is characterized by phases	N	C	N	N
5. Firm growth is influenced by firm size	C	C	N	N
6. Firm growth is influenced by firm age	N	C	P	P
7. Firm growth is characterized by stable and long-standing phases	N	C	N	N
8. Firm growth in (t+1) is dependent on firm growth in (t0).	N	C	C	C
9. Growth opportunities depend on underutilized internal resources	N	N	C	N
10. Firm's managers have a pivotal role in firm growth	N	C	C	C
11. Firm growth is dependent on firm's internal activities	N	C	C	P
12. Learning influences firm growth	N	C	C	C
13. There is no relation between firm growth and industry growth	N	N	C	C
14. Firm performance changes as firm evolves	N	C	P	P

C: Confirmed; P: Partially Confirmed, N: Not Confirmed.
Source: Authors.

temporary. This proposition is in line with TGF and CD, although TGF does not discuss inimitability (AUGIER; TEECE, 2009), which is germane to the competitive advantage debate (POSEN; LEE; YI, 2013).

The second proposition points out that firm growth is determined by outputs (products). Whereas this proposition is one of OFS's tenets (CYER; MARCH, 1963), it is not line with STG, TGF and DC. STG associates growth with firm age and size (GREINER, 1972) and innovation (MUELLER, 1972). TGF explains firm growth by singling internal resources out (PENROSE, 1959) and DC replaces internal resources with dynamic capabilities (TEECE; PISANO; SHUEN, 1997).

The optimum size of the firm is the base of our third proposition. Needless to say, it is line with OFS. In relation to STG, we assume that this proposition can be partially confirmed to the extent that Mueller (1972) points to a limit to the growth of the firm. However, it has a place in neither TGF nor DC. For instance, Penrose (1959) starts her acclaimed book by saying that there is no limit to firm growth.

Our next four propositions are inspired by STG. The fourth proposition maintains that firm growth is characterized by phases. This goes against the tenets of OFS, TGF and DC. In OFS, "[…] growth is simply a matter of adjusting to the equilibrium size of the firm" (FOSS, 2002, p.154). As TGF views firm growth as an evolutionary process driven by the interplay of resources and services (KOR; MAHONEY, 2000), there is no room for pre-determined stages or phases. DC subscribes to the notion of path dependence (TEECE; PISANO; SHUEN, 1997; TEECE, 2007), which dismisses pre-determined stages or phases as well (ARAUJO; REZENDE, 2003).

The fifth proposition suggests that firm size influences firm growth. This is in accordance with OFS inasmuch as it pioneers the idea of optimum firm size. This is also in line with STG. For instance, Greiner (1972, p.8) suggests that size is one of the dimensions for building what he calls "a model of organization development". In contrast, proposition five is supported in neither TGF nor DC.

Our next proposition states that firm growth is influenced by firm age. OFS disregards age as it assumes that all firms are identical (CONNER, 1991). Together with size, age is one of the key dimensions of STG for explaining firm growth (GREINER, 1972). Although age is not explicitly discussed in TGF and DC, we suggest that this proposition can be partially confirmed in both theories. Whereas TGF assumes that firm growth is the result of a cumulative process of resource learning (FOSS, 2002), DC advances the idea that the development of dynamic capabilities is to a certain degree related to firm experience (MAKADOK, 2001).

Proposition seven asserts that firm growth is characterized by stable and long-standing growth phases. The same logic of reasoning developed in proposition four applies here. Apart from STG, this proposition is supported in none of the theories formerly outlined. For STG firm growth comprises stable and long-standing growth phases, each one ranging from four to eight years (GREINER, 1972).

The eighth proposition highlights firm history as it suggests that firm growth in t=1 is dependent on firm growth in t=0. Whereas history does not matter in OFS, it plays a pivotal role in STG, TGF and DC. In OFS the firm is considered a-historical (CONNER, 1991). In STG history comes to the forefront for explaining firm growth (GREINER, 1972). This also holds for TGF (BLOCH; FINCH, 2010) and DC (ZOLLO; WINTER, 2002).

Proposition nine indicates that growth opportunities depend on underutilized internal resources. This proposition can only be confirmed in TGF: it is one of its spokes (GEROSKI, 1998). In OFS it has no room as this theory views firm growth as regulated by the price mechanism (COASE, 1937), which means that market forces set the limits to firm growth (VASCONCELOS; CYRINO, 2000). It cannot be confirmed in STG or DC either. The focus of STG is on stages or phases, not on underutilized resources (MUELLER, 1972), whereas in DC dynamic capabilities "drive the flow of resources" (LE MENS; HANNAN; POLOS, 2011, p. 96).

The tenth proposition highlights the manager as a conduit for firm growth. Only in OFS are purposeful decisions by managers disregarded (AUGIER; TEECE, 2009). In STG managers have some discretion as the firm evolves, and this influences its

growth (MUELLER, 1972). The Penrose effect has to do with the limits to firm growth set by managerial resources (SLATER, 1980). DC also places emphasis on agency for explaining the development of dynamic capabilities and consequently firm growth (DI STEFANO; PETERAF; VERONA, 2010), especially in the earlier years of the firm (WINTER, 2012).

Proposition eleven states that the growth of the firm is endogenous, i.e., it is based on the firm's internal activities. This proposition is at opposite ends of OFS (DEMSETZ, 1991). However, it can be confirmed both in STG and TGF. In relation to DC, we suggest that this proposition can be partially confirmed. On the one hand, dynamic capabilities are the result of internal processes (TEECE; PISANO; SHUEN, 1997) and, therefore, reside within the firm (MAHMOOD; ZHU; ZAJAC, 2011). On the other hand, they are shaped by the context in which the firm is embedded (EISENHARDT; MARTIN, 2000; TEECE, 2007).

The twelfth proposition states that learning affects firm growth. Whereas this proposition is not in line with OFS (GEROSKI, 2000) it can be confirmed in STG, TGF and DC. For example, in STG learning is the result of each stage or phase, and it can be used in subsequent phases or cycles (GREINER, 1972). Yet, in TGF learning has to do with resource using (PENROSE, 1959) and in DC with previous activities (TEECE; PISANO; SHUEN, 1997).

Proposition thirteen suggests that there is no relation between firm growth and industry growth. This proposition cannot be confirmed in both OFS and STG. For example, in STG industry is considered one of the cornerstones of organizational development (GREINER, 1972). However, it is in accordance with TGF and DC since both models accommodate the idea of idiosyncratic patterns of firm growth trajectories (DRNEVICH; KRIAUCIUNAS, 2011).

Finally, our last proposition states that firm performance changes as firm evolves. Although this is not directly discussed in OFS, it cannot be confirmed in it. In OFS market forces eliminate abnormal rents very rapidly (DOSI; LECHEVALIER; SECCHI, 2010), forcing firms to reach a similar level of performance (GEROSKI et al., 2003). STG has a different view to the extent that it suggests that firm performance is contingent upon the stage or phase which the firm goes through (MILLER; FRIESEN, 1984). In relation to both TGF and DC, we suggest that this proposition is partially confirmed. Both models argue that differences in performance across firms persist for a while (RUGMAN; VERBEKE, 2002) due to either heterogeneous resources (TGF) or dynamic capabilities (DC). This implies that firm performance has a stable component in order to maintain these differences (DOSI; LECHEVALIER; SECCHI, 2010). However, as Penrose states (1956), there is no reason to assume that this will continue indefinitely. If this holds, firm performance is likely to change, yet not as long as the firm evolves.

Methodology

We constructed a single case study to address our research aim (EASTON, 2000). Initially, we collected backward-looking qualitative data (BLUHM; HARMAN; LEE; MITCHELL, 2011) as we intended to trace the trajectory of the firm (GEORGE; BENNETT, 2005) - defined as a chain of causally connected events (BURGELMAN, 2011) - by highlighting events related to firm growth (FLECK, 2009). Subsequently, this data was analyzed in light of Degrees of Freedom Analysis (DFA).

We selected the growth trajectory of EIP (fictitious name) based on two broad criteria. First, it was required that this trajectory would comprise a "number" of events that illustrated firm growth. Based on the assumption that the trajectory of older firms is likely to exhibit more of this type of event, our first criterion was firm age (SERRASQUEIRO et al., 2010). Second, access not only to primary data collected from face-to-face interviews with upper-echelon managers and directors, but also secondary data, in particular archival data and financial figures which are usually hard to obtain (GRAHAM; HARVEY; RAJGOPAL, 2005), was also required. In this sense, our second criterion was data access (LANGLEY, 1999).

Having gotten the consent of the firm, we started collecting data by gathering secondary data. In addition to official data about the capital goods industry obtained from the Brazilian Institute of Geography and Statistics (IBGE, 2011) and the National Bank for Economic and Social Development (BNDES, 2011), between November 2010 and February 2011 we collected data from EIP's accounting registers, in particular financial statements between 1977 and 2009. The 1989 financial statement was missing because the accounting register had been eaten by moths. We were not able to find the financial statements between 1964 (foundation of the firm) and 1976 either. In this period, accountancy was outsourced, and the financial management of the firm was based on cash flow.

We also collected archival data such as a number of managerial reports, especially those aimed at detailing the plant production capacity to potential buyers as well as EIP investments over the years, all documents prepared for bids in which EIP participated over nearly fifty years, and an extensive amount of documents containing the description and technical details of all equipment manufactured by the firm. All this data was later coded and compiled resulting in nearly 600 pages of singled-space text.

In terms of primary data, we interviewed the founder and seven individuals such as the CEO, directors, upper-echelon managers and former managers. These interviews were carried out and tape-recorded between May and August 2011, each one lasting 163 minutes on average.

The interviews were supported by a protocol divided into three parts. In the first part we aimed to get an overview of EIP growth trajectory since EIP inception. To do so, we asked the following questions: i) What are the roots of EIP?; ii) Tell me the history and the trajectory of EIP by pointing out the events you consider relevant; iii) What were the major transformations of the firm over the course of its history?

In the second part we furthered our understanding of the EIP growth trajectory by asking more specific questions which were formulated based on five indicators built from secondary data. The first indicator, the evolution of the firm, is illustrated by the ratio of the turnover of the firm to the Brazilian Gross National Product (GNP) (T/G). According to Fleck (2004; 2009), this indicator embeds automatic adjustments in terms of inflation and deflation that are considered relevant in studies of firm growth. The second indicator is turnover annual growth, calculated from the ratio of EIP turnover in t=1 to t=0. The third indicator is gross profit annual growth, based on the ratio of EIP gross profit in t=1 to t=0. The fourth indicator is GNP annual growth, based on the ratio of GNP in t=1 to t=0. The fifth and last indicator is similar to the fourth one to the extent that it refers to the GNP measured for the capital goods industry (GNP BK). We took into account the GNP implicit deflator retrieved from the IBGE site in order to calculate all indicators except the first. We also cared about currency changes over the years.

These indicators were plotted in graphs and used as the bedrock for the second part of the interview. We encouraged the interviewees to explain the curves according to their point of view by placing emphasis on their highest and lowest points. Finally, the last part of the interview was dedicated to asking questions directly related to the theoretical propositions of our research.

The inductive data analysis began by merging secondary and primary data texts, which, in turn, enabled us to triangulate data at three levels (JICK, 1979): secondary data itself, primary data itself and secondary data *vis-à-vis* primary data. As a number of divergences were found, we went back to the original documents as well as carried out another interview with the founder of the firm, which lasted 90 minutes.

Our next step in terms of data analysis was to select the critical events in the EIP growth trajectory. Borrowing the concept of critical events introduced by Halinen, Havila and Salmi (1999) and further developed by Halinen, Tornroos and Elo (2013) in the context of business networks, we considered critical events as those incidents that left a mark on the firm's growth trajectory. Based on the interpretations of the interviewees as well as secondary data, we concluded that the critical events in the EIP growth trajectory were empirically illustrated by the following categories: number and types of bids, number and types of equipment manufactured, and diversification

strategies. In this sense, we wrote a first draft of the case guided by the presence of any of these types of event. This version was sent to the founder of the firm for comments and criticisms. In general, he considered that the case mirrored the EIP growth trajectory.

We proceeded with data analysis by guaranteeing that the case contained enough empirical evidence to enable the judges to assess the theoretical propositions of the prediction matrix. Grounded on the literature review, we wrote a document in which we detailed such evidences, reaching an average of 2.6 instances of evidences per theoretical proposition.

At this point, we were ready to use DFA. According to Wilson and Woodside (1999), the heart of DFA is the development of a prediction matrix. As shown in the theoretical background, our matrix had 56 cells (14 propositions versus 4 theories) indicating whether each theoretical proposition could be confirmed (C), partially confirmed (P) or not be confirmed (N) in each theory.

We selected three judges familiar with the four theories (a CFO who holds a MBA and two senior lecturers in Management, both holding a PhD in Management) to whom in November 2011 we sent the case of the EIP growth trajectory, a brief description of each theoretical proposition and a blank table. They were asked to indicate whether each theoretical proposition could be confirmed, partially confirmed or not be confirmed in the case. We received the filled tables in December 2011.

Initially, we assessed the level of agreement across the judges. Following Wilson and Woodside (1999), four agreement levels could be reached by the judges: perfect – the three judges would agree (CCC), partially agree (PPP) or not agree (NNN); near perfect – two judges would agree (CCP), partially agree (CPP or NPP) or not agree (NNP); some – two judges would agree and one would not agree (CCN) or two judges would not agree and one would agree (CNN); and finally, none – the three judges would not agree (CPN). By chance it is expected that the distribution would be 11% perfect, 44% near perfect, 22% some and 22% none.

The agreement levels across the judges were 22% perfect, 64% near perfect, 7% some and 7% none. Based on the chi-square test (x^2), these distributions are not significantly different (x^2=0.138, ns). This means that they display agreement levels that are not different from those expected by chance (FONSECA; MARTINS, 1996).

Having tested the agreement levels across the judges, the last step of data analysis using DFA was to contrast the prediction matrix with the matrix built from the assessments of the judges (WILSON; WOODSIDE, 1999). This means counting the number of hits, i.e., confirmed theoretical propositions. For a second time, we used the chi-square test. Our aim was to evaluate the 42 results (14 theoretical propositions versus 3 judges) so as to detect whether there was a "[…] significant difference between the observed distribution of hits (i.e., confirmed predictions) and the distribution one would expect by chance" (WILSON; WOODSIDE, 1999, p. 222). The results are detailed in next section.

Results

EIP growth trajectory: an overview

EIP is a capital goods firm organized in three business units: Energy, Industry and Petroleum. Its growth trajectory, illustrated by the ratio of its turnover to the Brazilian GNP (T/G), can be seen in Figure 1. Broadly, there is a rising curve between 1977 and 1979, the best T/G in the EIP growth trajectory being reached in 1979. From this year on, T/G declines, touching the lowest point in 2001. This decline, however, is not smooth and constant inasmuch as the curve that illustrates it is characterized by a number of peaks (1981, 1984, 1988, 1992, 1995 e 1999). In 2001, the decline of the curve is interrupted. It is the beginning of an eight-year period in which T/G grows, although not linearly.

Source: Authors.

Figure 1 – Turnover/Brazilian GNP

Going into detail, EIP dates back to 1964. It was founded in São Paulo by three individuals, one of them an engineer. In the very beginning, there were only three machines (a lathe, a drill press and a grinder motor) for manufacturing nuts, special screws and machined parts. One year later, one of the founders bought the shares from the other two and soon afterwards sold them to the current President of the board of EIP. At that time he was only twenty years old. His first decision was to transfer EIP to Belo Horizonte, in the state of Minas Gerais, into an area of less than 90 square meters. In the following years, he invited his three brothers to become shareholders of the firm.

The first worthy business opportunity was identified three years later when EIP made an agreement with a multinational firm in the aluminum business for manufacturing hardware for aluminum spools. To a certain degree, this contract enabled EIP to buy, via loan, an 80-ton hot stamping screw press. In doing so, EIP increased the quality of special screws considerably which, in turn, attracted new buyers interested in higher quality products.

During the first National Development Plan (PND), EIP began to supply series parts for earthmoving machines to another multinational firm. In 1974, EIP's owners identified a business opportunity to rebuild the aluminum multinational's electrical furnace used for manufacturing ferroalloys. Later, EIP won a bid for producing 168 aluminum melting furnaces (electrolytic cells) for this same firm.

The second PND, implemented in 1975, provided incentives for constructing national roads and building electrical and nuclear power stations. In this context, EIP's owners mapped out new business opportunities and, as a result, decided to acquire a 51,000 m^2 area where they built a new plant for increasing the production capacity of the firm.

A couple of years later, one of the largest Brazilian state-owned steel producers invited bids for enlarging a number of its plants. With the aim of increasing its chance to win some of the bids, EIP signed an agreement for producing plate processing equipment with the Brazilian subsidiary of a French multinational. This paid off to the extent that EIP won two bids for manufacturing continuous steel coil galvanizing lines. As a result, EIP's turnover increased 21% in 1977 and 56% in 1978. As mentioned earlier, the best T/G in EIP's growth trajectory is reached in 1979 (see Figure 1).

The financial resources resulted from these contracts were partly used for building a new plant which came into operation in 1977. From this time on, EIP would not only manufacture equipment, but also develop custom engineering projects.

In this same year, due to the particular interest of a shareholder, EIP diversified its activities into a cattle farm and a eucalyptus plantation. In 1978, EIP furthered its diversification by acquiring a project for building silicon and manganese alloys plant, which came into operation in 1980 (herein RSZ). Interestingly enough, T/G started declining in this year (see Figure 1).

In 1983, the RSZ's second furnace came into operation enabling RSZ to increase production capacity as well as sales considerably. As RSZ overtook EIP in terms of turnover and profitability, it received more financial and managerial resources. Unable to obtain new contracts, EIP went adrift and later became dependent on RSZ. This situation went on up to 1991 when EIP won three important contracts, thus interrupting the decline of T/G.

Meanwhile, the firm shareholders unexpectedly split due to a number of divergences. As a consequence, they decided that the first shareholder would be in charge of EIP whereas the other three would run RSZ. Following the shareholder split, a new CEO for EIP was hired. In addition, the sons of the remaining shareholder began their professional careers at EIP.

At this point, it is interesting to highlight that the initial diversifications snowballed covering unrelated areas such as IT, iron exporting, hydraulic pump manufacturing, but they failed after a while.

In 1999, PETROBRAS, the Brazilian state-owned petroleum firm, invited EIP to make a bid for manufacturing equipment called Cyclone. The firm won the bid, and this hallmarked its entry into the petroleum industry. Three years later, EIP started operating in the petroleum refinement value chain by developing more value-added equipment. At this time, EIP decided to reorganize itself by creating three business units: Energy, Industry and Petroleum.

The initial equipment supplies to PETROBRAS, however, resulted in financial loss. For example, EIP's turnover jumped from R$ 8.2 million in 2000 to R$ 43.4 million in 2005 whereas its gross profit went down from 23% to 13% in the same period. In fact, manufacturing and delivery of this type of equipment required engineering, manufacturing and welding capabilities not totally mastered yet.

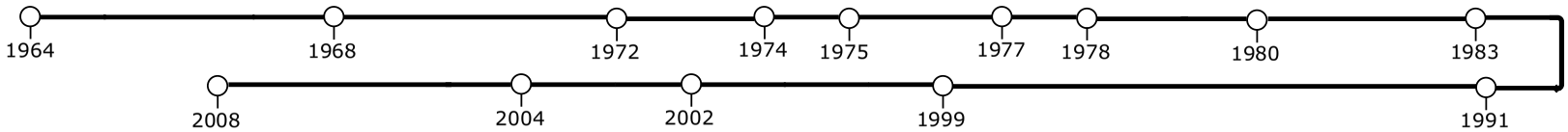
Despite this, EIP succeeded in developing them. Later, they became a springboard for manufacturing new products for the petroleum industry such as cooling towers. On top of that, it made and won a number of bids invited by either PETROBRAS or its suppliers. As a consequence, the petroleum unit became EIP's most important business unit.

In the following two years, there were two critical events in the EIP growth trajectory. First, PETROBRAS paved the way for EIP to become a partner of an American firm for manufacturing submarine petroleum equipment. Second, together with a German Firm EIP founded a new firm called EIP Services by taking over the Brazilian subsidiary of the German firm's plant.

This acquisition was controversial notwithstanding these circumstances. Some managers and directors considered managerial resources to be already scarce and insufficient to render enough services to run the acquired firm. To a certain degree they were right inasmuch as underpriced orders were taken and a number of deliveries were delayed. Yet, operational activities nearly collapsed.

Facing these issues, they came to the conclusion that management practices in EIP should be revised entirely. In addition, the sons of the shareholder gained control of the firm, each one being in charge of a particular functional area such as marketing, procurement and human resources. The CEO quit the firm.

In 2008 EIP took over EIP Services by acquiring the shares of the German firm. Soon afterwards, new management changes were introduced once again. For example, new directors were hired and seats on the board of EIP were offered to the sons. EIP's growth trajectory ends at this point with the implementation of governance



- o 1964
  - EIP foundation
- o 1968
  - Made an agreement with a multinational firm in the aluminum business.
  - Acquisition of an 80-ton hot stamping screw press.
- o 1972-1974
  - Started supplying series parts for earthmoving machines to another multinational firm.
- o 1974
  - Rebuilt the aluminum multinational's electrical furnace used for manufacturing ferroalloys.
  - Produced 168 aluminum melting furnaces (electrolytic cells) for the aluminum multinational.
- o 1975
  - Built a new plant for increasing the production capacity.
- o 1977
  - Made an agreement for producing plate processing equipment.
  - Won bids for manufacturing continuous steel coil galvanizing lines.
  - Built a new plant.
  - Started developing custom engineering projects.
  - Diversified into a cattle farm and a eucalyptus plantation.
- o 1978
  - Further diversification by acquiring a project for building silicon and manganese alloys plant.
- o 1980
  - Silicon and manganese alloys plant came into operation (RSZ).
- o 1983
  - The RSZ's second furnace came into operation.
  - RSZ overtook EIP in terms of turnover and profitability.
- o 1983-1991
  - Became dependent on RSZ.
- o 1991
  - Won three important contracts.
  - The firm shareholders split.
  - Diversification into IT, iron exporting and hydraulic pump manufacturing failed.
- o 1999
  - Won a bid for manufacturing equipment called Cyclone.
  - Entered the petroleum industry.
- o 2002
  - Started operating in the petroleum refinement value chain by developing more value-added equipment.
  - Created three business units: Energy, Industry and Petroleum.
  - Developed engineering, manufacturing and welding capabilities.
- o 2004
  - Entered into a partnership with an American firm for manufacturing submarine petroleum equipment. Founded a new firm called EIP Services together with a German firm.
- o 2008
  - Took over EIP Services by acquiring the shares of the German firm.

Source: Authors.

Figure 2 - EIP growth trajectory

mechanisms that were expected to help the firm face upcoming challenges. Figure 2 portrays EIP growth trajectory by highlighting its major events.

Degrees of freedom analysis

We started DFA by assessing the agreement levels across the judges. As detailed in Table 2, they were in perfect agreement for 21% of the evaluations, corresponding to three propositions. Near perfect agreement occurred for 64% of the evaluations, i.e., nine propositions. Some agreement and none agreement occurred for 7% of the evaluations each.

Table 2 - Agreement levels across the judges

PROPOSITIONS	MATCHES									
	PERFECT			PARTIALLY				SOME		NONE
	CCC	NNN	PPP	CCP	CPP	NNP	NPP	CCN	CNN	CNP
1. Firm is able to sustain competitive advantage		1								
2. Firm growth is determined by outputs (products)					1					
3.There is firm optimum size						1				
4. Firm growth is characterized by phases		1								
5. Firm growth is influenced by firm size						1				
6. Firm growth is influenced by firm age						1				
7. Firm growth is characterized by stable and long-standing phases									1	
8. Firm growth in (t+1) is dependent on firm growth in (t0).						1				
9. Growth opportunities depend on underutilized internal resources										1
10. Firm's managers have a pivotal role in firm growth	1									
11. Firm growth is dependent on firm's internal activities					1					
12. Learning influences firm growth				1						
13. There is no relation between firm growth and industry growth					1					
14. Firm performance changes as firm evolves				1						
Total	1	2	0	2	3	4	0	0	1	1
Percentage to Predictions	21%				64%			7%		7%

Source: Authors.

Specifically, the judges perfectly agreed that one proposition was confirmed in the case of EIP growth trajectory. Accordingly, EIP's managers had a relevant role in the growth of the firm, thus supporting proposition ten. They also perfectly agreed that propositions one and four were not confirmed in this case. Whereas proposition one highlights the ability of the firm to sustain competitive advantage, proposition four states that firm growth is characterized by phases. Empirically, this means that EIP was neither able to maintain competitive advantages nor grew in stages or phases.

A near perfect agreement level occurred for nine propositions, representing three different situations. First, two judges disagreed and one partially agreed on four propositions. In their point of view, EIP did not reach an optimum size (proposition three), its growth was not influenced by size (proposition five), age (proposition six) and was not dependent on previous historical events (proposition eight). Second, one judge agreed and two partially disagreed on three propositions: propositions two, eleven and thirteen. In this sense, the evaluations of the judges slightly suggest that EIP growth was neither determined by outputs nor by internal resources. Yet, they related EIP growth with the capital goods industry growth. Third, two judges agreed and one disagreed on propositions twelve and thirteen. The twelfth proposition states that learning influences firm growth whereas the thirteenth proposition suggests that firm performance changes as the firm evolves.

The two remaining propositions had some and zero agreement levels. Some agreement occurred for the proposition that states that firm growth is characterized by stable and long-standing phases. One judge agreed and two disagreed that this proposition was confirmed in the case of EIP growth trajectory. No agreement level occurred for proposition nine: growth opportunities depend on underutilized internal resources.

Altogether, these results demonstrate that OFS had 14 out of 42 hits, corresponding to 33%. STG had 11 out 42 hits, which is equivalent to 26%. TGF had a 45% hit rate, meaning 19 out of 42 hits. DC had the highest hit rate: 48% (20 out of 42 hits). That is, according to the judges none of the theories considered here (OFS, STG, TGF and DC) can fully explain EIP's growth trajectory. Against this backdrop, it is suggested that DC is the theory with the highest explanatory power (48%) followed by TGF (45%). The explanatory power of OFS and STG is lower: 33% and 26% respectively. As shown in Table 3, this distribution is not significantly different from the one expected by chance (x^2=0.337, ns).

Table 3 – Results: four theories of firm growth

Theories	OFS		STG		TGF		DC	
Judges	Sum	%	Sum	%	Sum	%	Sum	%
Judge 1	4	29%	2	14%	5	36%	6	43%
Judge 2	5	36%	6	43%	6	43%	6	43%
Judge 3	5	36%	3	21%	8	57%	8	57%
Total hits: found	14	33%	11	26%	19	45%	20	48%
Total hits: random	16		16		16		16	

Source: Authors.

Discussion and Implications

The results show that hit rates ranged from 26% to 48%. This means that none of the four theories considered here provided a crystal-clear explanation of the EIP growth trajectory. According to the judges, DC stood out nevertheless: it had the highest hit rate (48%). Provided we consider DC hit rate at face value we can make a

bold comparison with firm growth quantitative studies r^2 (e.g. GEROSKI; MAZZUCATO, 2002), and conclude (again boldly) that the DC hit rate is not bad at all!

Interestingly, these findings are amazingly akin to those presented by Geroski (1988; 2000) even though they are embedded in a rather distinct context as well as being drawn from a diverse research method.

Together with our qualitative data, we offer two different, yet overlapping interpretations of these results. The first interpretation is backed up by Coad's (2010) claim that firm growth is a multidimensional phenomenon, which militates against an overarching theory of firm growth, as well as Geroski, Mata and Portugal's (2010) assertion of the lack of superiority of a particular theory for accounting for the growth of Portuguese firms. This interpretation explains why none of the theories considered here fully explained the case of EIP's growth trajectory. The second interpretation is supported by Geroski's (1998; 2000) findings that indicate DC as the most promising theory of firm growth. This interpretation lends a degree of support to the fact that DC had the highest hit rate, although not much higher than TGF. In our view, the first interpretation implies combining theories to further our understanding of firm growth whereas the second one requires strengthening the explanatory power of DC by relaxing some of its assumption.

According to the first interpretation, a more satisfactory explanation of the EIP growth trajectory requires a bridge between theories of firm growth. Framed by our empirical results, we suggest a conversation between OFS and DC gravitating towards the trade-off between competitive markets (OFS) and idiosyncrasy of firm growth trajectory (DC). This conversation is encapsulated by the following proposition: firm growth is a rather idiosyncratic process that unfolds within competitive markets.

More specifically, the judges considered the relation between EIP growth and the capital goods industry growth. From a theoretical standpoint, this assessment goes against the idea of matchless growth trajectory espoused by DC, but it is in accordance with OFS. We wonder whether a particular firm's dynamic capabilities can be conceptualized as exhibiting common features across other firms' dynamic capabilities (EISENHARDT; MARTIN, 2000). If it can, we are able to advance the idea that the development and maintenance of dynamic capabilities is to an extent shaped by market forces. This reduces the degree of idiosyncrasy in terms of firm growth trajectories, but does not erase it. At the same time, it opens up the possibility of commonalities across growth trajectories brought about by market forces.

Two issues lie behind this proposition. First, a careful definition and delimitation of competitive markets is needed so as to avoid conflating them with the concept of an industry as advocated by OFS. As Dosi, Lechevalier and Secchi (2010) remark, theories of firm growth need to rethink the locus of competition by considering the notion of submarkets populated by heterogeneous firms. In submarkets, market forces are not too effective as they are in perfect competition because they do not equalize firm size and firm growth trajectories. Notwithstanding, they do have the causal power to reduce idiosyncrasies. Under competition pressure in submarkets, firms with different sizes attempt to imitate one another. This leads us to the second issue, that is, some imitation is likely to occur across firms. However, it is neither near totally perfect as espoused by OFS nor near totally imperfect as conceived by DC. In submarkets, it lies in between like the notion of imperfect imitation recently discussed by Posen, Lee and Yi (2013). If firms imitate one another although imperfectly, it is expected that at least some of their dynamic capabilities (or their effects) will be alike (EISENHARDT; MARTIN, 2000; DRNEVIC; KRIAUCIUNAS, 2011).

By following the second interpretation, some assumptions of DC are to be relaxed with the aim of increasing its explanatory power of firm growth. This is carried out without borrowing concepts from the other theories of firm growth considered here. Grounded on our empirical results, we select the proposition that highlights firm performance fluctuation along the existence of the firm, that is to say, firm performance does not necessarily have a stable component. This interpretation is captured by the following proposition: firm performance fluctuates non-linearly as the firm grows.

More specifically, the judges considered performance fluctuations along the EIP growth trajectory, which is, in our view, partially confirmed in DC. As discussed earlier, DC subscribes the idea that firm performance has a stable component so as to sustain the firm competitive advantage. We wonder whether uneven and erratic performance can be accommodated by DC (GEROSKI, 1998). If it can, we open up the possibility of conceptualizing firm growth trajectory as stochastic. In this regard, firm growth trajectory and performance will be driven by boundedly rational individuals facing "[…] strategic choices that involve high levels of uncertainty, causal ambiguity, and chaotic complexity" (HENDERSON; RAYNOR; AHMED, 2012, p. 389). This means that firm growth trajectory will be driven by choices made in a world populated by boundedly rational decision-makers (WILLIAMSON, 1985)[1]. In this world, the happenstance of history (MEYER; BROOKS; GOES, 1990) plays a role which, in turn, brings randomness to the forefront (LEVINTHAL, 1997). Because random events usually fall off the decision-makers' radar screen, they can only be fully grasped with the benefit of hindsight (ARTHUR, 1989).

Differently put, firm growth will be a combination of expected and unexpected determinants, or, as Geroski (1998) names them, shocks. This is similar to say that firm growth will follow a random walk (LEVINTHAL, 1991). In this conception, the heterogeneity across firms, one of the tenets of DC (DI STEFANO; PETERAF; VERONA, 2010), remains untouchable.

Conclusion

By using DFA to analyze backward-looking qualitative data about the growth trajectory of a Brazilian capital goods firm, we found that none of the four theories of firm growth selected here – Optimum Firm Size, Stage Theory of Growth, The Theory of the Growth of the Firm and Dynamic Capabilities – provided a satisfactory explanation for the growth of the selected firm. In spite of this, DC was judged to offer the best account. Two theoretical implications are drawn from these results. The first proposes a bridge between OFS and DC (JACOBIDES; WINTER; KASSEBERGER, 2012). In this regard, firm growth trajectory is still considered idiosyncratic, but embedded within competitive markets. The second implies relaxing some assumptions of DC, in particular the one related to nonlinearities in firm performance (GEROSKI, 1998; 2000).

On the face of it, our contributions to research on firm growth are as follows: i) we provided a detailed account of the growth trajectory of a particular firm from its inception using not only qualitative, but also quantitative data collected from multiple sources. Subsequently, we employed qualitative and quantitative data analysis techniques simultaneously (BYRNE; RAGIN, 2009), which is far from trivial. To our knowledge, DFA as a case data analysis technique had not been used in firm growth studies until now; ii) we built a prediction matrix composed of similar, complementary and competitive propositions about firm growth. In our view, it can be used as a starting point in future studies of firm growth; and iii) we suggested news avenues of exploration for theories of firm growth. It either combines theories such as OFS and DC or relaxes some assumptions of DC without compromising its building blocks.

Nevertheless, these claims should be treated with cautions. Firstly, our findings are based on a single case study which prevents us from making statistical generalization (YIN, 2005). Closely related, they are bounded by a number of contextual factors such as industry and geography (POULIS; POULIS; PLAKOYIANNAKI, 2013). Secondly, the account of EIP's growth trajectory was guided by three categories of critical events. In doing so, other types of event considered relevant in the studies of firm growth were disregarded (FLECK, 2009). Thirdly, we took into account four theories of firm growth, thus leaving theories such as Population Ecology (HANNAN; FREEMAN, 1984), Evolutionary Theory of the Firm (NELSON; WINTER, 1982), Resource-based View (BARNEY, 1991) and Institutional Theory (SCOTT, 2001) out. Fourthly, our

[1] *We are indebted to a reviewer for this suggestion.*

propositions covered sets of the four theories selected here therefore they cannot be taken as fully representing them. By the same token, the propositions did not provide a sharp limit between TGF and DC, which might have contributed to the tiny difference between their hit rates.

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