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Innovation through Patents and Intangible Assets: Effects on Growth and Profitability of European Companies

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Abstract: Innovation is widely considered one of the most important drivers for firm growth in the contemporary economy. However, the 'elusive' as well as heterogeneous nature of innovation has generated a lively debate among scholars with regards to the best metrics to capture its features and effects. Often, this has led to a reliance on R&D and/or patent-related measures. We contribute to this debate by pushing forward the idea that a positive effect of investing in intangibles like patents can't be taken for granted, since it is significantly influenced by the way a firm's portfolio of patents is created, assembled, and renewed over time. Starting from a sample of 6677 observations derived from a sample of listed European companies with patents and intangibles booked in their financial statements, this study sheds a new light on how a company creates, composes, and renews over time their portfolio of intangibles, with specific attention on patents. In particular, this contribution discusses the different effects that emerge by making a distinction among different forms of patents, considering two dimensions: broadening vs. deepening investments, and application-specific vs. general purpose investments. We notice that as a company increases investments in intangibles and simultaneously enlarges the breadth of their range of activities, its growth becomes particularly remarkable.

Keywords: intangible; patents; profitability

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1. Introduction

Innovation is widely considered one of the most important drivers for firm growth in the contemporary economy [1–3]. However, the 'elusive' as well as heterogeneous nature of innovation has generated a lively debate among scholars with regards to the best metrics to capture its features and effects. Often, this has led to a reliance on R&D (research and development expenses) and/or patent-related measures [2,4–6].

We contribute to this debate by pushing forward the idea that a positive effect of investing in intangibles like patents can't be taken for granted, since it is significantly influenced by the way a firm's portfolio of patents is created, assembled, and renewed over time. We classify different types of patents via two dimensions advanced by Gary Pisano in 2017: broadening versus deepening, and application-specific versus general purpose. The simultaneous adoption of these variables offers a novel perspective in strategic management and innovation studies, leading to both confirmations and unexpected findings. In doing so, we show that different types of patent portfolios are differently affected by the progressive decay of these intangibles over time, which is particularly impacting in specific conditions. In doing so, we consider effects in both the short and long run, using both profitability and growth measures.

Our work also offers a significant contribution in establishing a bridge between strategic management studies (especially those exploring dynamic capabilities) and adoption of accounting metrics (such as written intangible assets). The latter are becoming more and more relevant in giving scholars a better picture of intangible resources. The adoption of

IFRS and the large number of business combinations completed under the new accounting framework have determined the explicit recognition of 'latent' intangibles, which were previously indistinctly drowned in the goodwill item. Therefore, the analysis of firms' investments in intangible assets provides a tangible trace of the capability-building route planned by top management. This evidence is further supported by two related trends: the increasing amount of intangibles written in firms' balance sheets and the increasing number of business combinations. Consequently, accounting information is becoming, over time, a better and more reliable representation of the portfolio of intangible resources held by firms. The accounting information, following the adoption of the IFRS, constitutes value-relevant information used by financial investors to price listed financial assets and to make investment decisions. Our research shows how this disclosure is not only value-relevant but also constitutes a valid tool for evaluating the strategies adopted by management in terms of managing its portfolio of intangibles. This is a fruitful field of research for a better understanding of links between firm performance and capability development strategy.

The empirical survey relies on longitudinal panel data covering 12 years and consisting of 5441 European listed firms. The focus, as mentioned above, is on intangible assets written into annual reports, such as trademarks, patents, copyrights, design models, and so on. Our contribution also discusses advantages and disadvantages of this choice. The empirical section consists of two parts: the first one relies on the whole sample and investigates intangibles intensity and decay. The second part focuses only on those companies owning patents, as a way to catch data for the operationalization of different intangible typologies.

Findings show that companies benefit from investments in intangibles assets, but also that this advantage persists for a limited amount of time. Therefore, the risk of throwing money away is high when plans for capability building are not paired with renewal plans. Nevertheless, these effects vary across different typologies of intangibles, discriminated thanks to a novel perspective based on a revised view of the dynamic capability theory.

The article is organized as follows. Section 2 reviews the theoretical framework and the literature. Section 3 describes the methodology, sample, and variables used. Section 4 describes the results. Finally, Section 5 discusses the findings and conclusions.

2. Theoretical Framework

Strategic management literature and innovation studies assign a central role to the notion of dynamic capabilities [7–10]. The construct was defined and discussed for the first time by David Teece, Gary Pisano, and Amy Shuen in 1997 as "*the firm's ability to integrate, build, and reconfigure internal and external competences to address rapidly changing environments*" (p. 516).

Despite a huge effort from scholars, the validation of the dynamic capability framework is still controversial [9,11,12]. According to the resource-based view [13,14], the competitive advantage of the firm is largely based on assets that are scarce and unique, like those related to innovation. A significant body of literature emphasizes the merits of tacit knowledge, which is difficult to imitate due to stickiness and, therefore, preservation over time (Ricardian rents). By contrast, articulation and codification support innovation, replication, and control [15]. Collaboration and open innovation practices are also facilitated by codified knowledge, which is easiest and fastest to share and integrate, both within and without firm boundaries [16,17]. In short, we first argue that a modern view on dynamic capabilities (also) needs to pay more attention to codified intangible resources, like patents.

These assets are cumulative by nature, and this highlights the need for investigations about their dynamics over time [18]. Their intangible essence assigns to this form of assets two peculiarities that distinguish them from physical capital accumulation [19]: economies of scale in the generation of the intangible asset base from the existing asset stock (a), and time compression diseconomies (b), meaning diminishing returns to current-period investments in intangible assets.

Since firms are proven to be heterogeneous in terms of their resources and capabilities, the composition of their asset portfolios has a central merit in defining strategic position and chance of success and growth [14,20,21]. Strategic management literature has assigned a strategic role to the broad range of resources belonging to the 'intangible' resources. Chareonsuk and Chansa-Ngavej [22,23] empirically showed a positive relationship between intangible resources and long-term growth. Interestingly, their analyses also highlight the need for accounting control and monitoring of these dynamics to achieve such a goal. The study of Denicolai, Cotta Ramusino, and Sotti [24] uses a sample of 294 listed companies to confirm the relevant impact of intangibles on firm growth, adding that a significant portion of this advantage stems from externally generated intangibles, and that these mechanisms are contingent on firm size.

Future company performance depends on the level of intangible assets within the company, but also on the way different typologies of these resources are mixed. Higón et al. (2017) showed that the interactions between R&D and advertising investments and between advertising and human capital increase firm productivity. Hall, Montresor, and Vezzani [25] study the impact of intangible investments on firm innovativeness and show that a greater effect is expected from investing more in technological intangibles rather than in intangibles overall, and from using internal rather than external resources. [26] showed that for quoted companies, intangible assets and particularly brands are strictly related to their market prices.

In short, there are convincing motives to support the idea that companies should strategically invest in, build, and renew intangible assets for innovation, such as patents. However, this body of literature provides little guidance concerning how managers should adjust their strategy in different conditions, besides generic instruction to leverage unique and inimitable resources. Similarly, the dynamic capability stream has largely debated the question of why some firms are more adaptable and agile than others. By contrast, scarce attention has been devoted to the normative aspect of the framework, meaning which trajectories are more likely to provide an advantage and which situations optimize their positive impact on the firm's performance [27,28].

2.1. The Management of a Diversified Portfolio of Patents

Arrighetti, Landini, and Lasagni [18] leverage the capability-based theory of the firm to show that the firm's propensity to invest in intangible assets is significantly explained by firm-specific factors. In particular, they confirm the existence of a progressive process of intangible asset accumulation, which accounts for most of the intra-industry heterogeneity among companies. Investments in intangibles are therefore heterogeneous among companies and—above all—'strategic', meaning they are not random or inevitably determined. It follows that this set of decisions are critical in determining company success and future options. It is also reasonable to surmise that the ratio of intangible assets and the pace of their renewal should be tuned consistently with features of developed assets.

How to discriminate among alternative investments is a key aspect in intangible assets. A large body of literature focuses on the nature and ontology of such resources: brand [29,30], knowledge [31–33], human resources [34,35], organizational routines [36,37], customer base [38,39], and so on.

In such a context, we support overcoming a distinction based on the nature of intangibles in favor of a taxonomy which takes into account why investments in intangibles have been made—a purposeful view—and which options they leave open for future development trajectories. Pisano (2017) argues that the firm's portfolio of capabilities can be analyzed thanks to two main dimensions: 'broad' versus 'deep', and 'application-specific' versus 'general purpose'. Though we recognize that capabilities and intangible assets are not synonymous, the theoretical foundations and logics of this taxonomy fit particularly well with the goal and subject of our study as discussed hereafter.

Firstly, the investments of the firm can be intended at deepening the firm's existing portfolio of intangibles into a specific domain, or at broadening the spectrum of areas covered by several heterogeneous intangibles (broad vs. deep intangibles). Several studies support the need for high variety in terms of technologies and capabilities possessed by the firm [27,40–42]. This kind of heterogeneity yields opportunities for novel combinations of complementary resources. It provides the agility to compete in a wide spectrum of contexts and problems. Therefore, we posit the following research hypothesis:

Hypothesis 1 (H1). *Breadth of intangibles positively moderates the effect of the 'intangible intensity' on firm growth.*

The second dimension suggested by Pisano (2017) regards the specificity of intangibles, more precisely, the span of tasks and goals that can be achieved by each asset. 'Application-specific' intangibles are designed for a particular purpose and are idiosyncratic to a particular task/situation. For example, a patented machine dealing with a specific production problem. These kind of assets boost the efficacy of organizational routines. At the opposite end, 'general purpose' intangibles are those assets potentially applicable in a number of relatively different situations. For instance, consider a well-known trademark (e.g., Ferrari) and its brand extension strategy (luxury cars, but also sunglasses, perfumes, theme parks, videogames, etc.). This type of investment increases the number of strategic options available to the firm [43].

Both application-specific and general purpose assets are needed. Application-specific intangibles are fundamental to developing a superior capability in a specific field, as a key building block and competitive advantage. On the other hand, firm dynamicity requires a certain orientation towards general purpose intangibles since the latter provide the necessary premise to develop further application-specific knowledge. Secondly, general purpose intangibles offer a high number of future strategic options (Pisano, 2015).

Accordingly, with these considerations and given the focus on dynamic capabilities of this study, we formulate the following research hypothesis:

Hypothesis 2 (H2). *General purpose intangibles positively moderate the effect of the 'intangible intensity' on the firm growth.*

A clarification is needed: broad versus deep, and application-specific versus general purpose are not dichotomies. It is rather a matter of degrees, since a range of infinite configurations among the extremes is of course possible. Moreover, here we study the *dominant* orientation of the firm towards some of these options, to reveal the strategic intent, though the situation where the firm asset portfolio consists simultaneously of multiple typologies of intangibles is the norm.

2.2. The Interplay among Patents Portfolio and Intangible Decay

Investments in patents are subject to contingent factors, like any other managerial decisions. Dutta et al. [44] show that absorptive capability, based on technological capabilities and R&D investments, affects the firm profitability, though this effect is moderated by the pace of technological change: the greater the pace of change, the greater the impact. Wei and Lin use a population ecology perspective and show controversial findings regarding the effect of intangibles on firm effectiveness. On the other hand, these authors report convincing evidence supporting intangibles as a moderating variable in explaining the variation of the relationship between environmental pressure and organizational decline, arguing the need for accumulation and continuous renewal of this kind of assets to face the threats of environmental scenarios [45]. Scholars showed that technological activities oriented to knowledge exploration have more potential than those technological capabilities focused on the mere maintenance of a certain competitive advantage [46].

The resource-based view is quite elusive about the dynamics of capability accumulation and renewal. It doesn't provide any guidance in explaining managers' choices related to investment for capability creation and/or rejuvenation, nor about the effect of resources' obsolescence as time goes by.

Patents are a central part of this reasoning. These are specific assets that contribute to innovation since they generate potential for competitive advantage at any point in time.

Choices regarding the portfolio of patents set the R&D investment strategy: as such, they are almost irreversible in the short run, and define paths ahead of the company and future strategic options.

The rapid pace of knowledge obsolescence in several sectors leads to a progressive intangible decay, and makes it fundamental for companies to renew their technological capabilities constantly [36,44]. Scientific progress is running more and more fast, so every day, capability obsolescence is becoming more of a central concern in managers' agendas. The issue has started becoming pronounced, especially in high-tech industries [47–49], though now it is central in almost all sectors [50]. Scholars have also discussed the importance of reducing product time-to-market, largely focusing on investments regarding 'changeover flexibility' [47,51]. Firms invest in capability renewal to mitigate changeover costs and thus support the reconfiguration to new generations of products/services [47,52].

According to these considerations, we address the issue by focusing on the effect generated by the 'intangible decay', defined as the ratio between cumulated amortization and gross book value of intangibles. Hence, we posit the third research hypothesis as follows:

Hypothesis 3 (H3). *The intangible decay ratio influences the way in which different configurations of patent portfolios affect firm growth.*

The intangible decay ratio assumes a unit value of 1 when a company no longer makes investments in intangible assets, and a value of zero if a company has just made new investments in intangible assets.

3. Methodology, Sample, and Variables

We investigate the effects of patents development on firm performance as intangibles assets that are written in firms' books on the basis of effective requirements derived from IAS 38 (intangible assets) and IFRS 3 (business combinations). We consider the net book value of this type of intangible asset (i.e., cost less accumulated amortisation and impairment losses), considering both acquired and internally generated, excluding goodwill. The adoption of accounting metrics is becoming more and more accepted and popular in the strategic management stream [18,53]. Rules and controls starting from when the financial crisis began in 2008 have further secured the reliability of this measurement, also for management studies.

We first gathered data from the well-known FactSet database. All of the 6425 European listed companies included in the database at the date of our analysis have been considered. We selected listed companies only due to the more rigorous process of preparation and control of financial statements compared to non-listed first, especially as a result of the wider presence of third-party stakeholders. Although [54] have highlighted how intangible resources are an important asset in the financial sector, we excluded 984 entities in the financial sector (banks, insurance, asset management, and financial holding companies), as classified by the FactSet industry standards, because of the nature and composition of their intangibles, which may introduce a bias in our analysis. At this step, this left a sample of 5441 companies (6425 − 954 = whole sample − financial companies) over a period of 12 years, beginning from 2008 (giving a potential sample of 65,292 companies). We filtered those companies that own at least one registered patent. It led to a final sample of 1193 firms, giving a potential database consisting of 14,316 observations (=1193 × 12). Because for some companies, no accounting data is available, due to delisting, the final unbalanced panel is reduced to 6724 observations (total number of observations over 12 years).

3.1. Sample(s) Description

Table 1 shows the sector composition of the two samples (for phase 1 and 2): the most represented sector is the technological one, which constitutes 26.98% of the sample. In terms of country of origin (Table 2), 17.88% of companies have their headquarters in the UK, followed by France with 16.55%. Table 3 shows the size distribution of the different firms.

Table 1. Sample distribution in terms of sectors.

Sectors	Distribution
Technology	26.98%
Services	14.54%
Product Manufacturing	21.92%
Consumer Goods	11.12%
Process Industrial	10.34%
Retail/Trade	1.83%
Transportation	2.16%
Non-Energy Min.	3.84%
Utilities	2.94%
Other	4.33%

Table 2. Sample distribution in terms of countries.

Countries	Distribution
United Kingdom	13.76%
France	16.95%
Germany	19.36%
Sweden	6.25%
Poland	6.13%
Switzerland	5.52%
Greece	0.82%
Italy	4.86%
Finland	4.73%
Netherlands	2.31%
Norway	2.60%
Denmark	2.57%
Belgium	2.96%
Spain	3.93%
Other	7.26%

Table 3. Sample distribution in terms of firm size.

Firm Size	Distribution
Small Companies (<10 mil€)	5.47%
Medium Companies (10–50 mil€)	12.76%
Large Companies (50–500 mil€)	36.96%
Very Large Companies (>500 mil€)	44.81%

3.2. Variables

Table 4 sums up the definition of variables used in the empirical procedure, whilst below we briefly discuss why we chose these variables and how they have been operationalized.

Table 4. Description of variables.

Variable	Description
GROWi,t	Firm growth measured as the natural logarithmic difference between sales at time t and sales at time t − 1 = log SALESi,t − log SALESi,t − 1 where: SALESi,t = sales for company i at the end of year
INTi,t	Value of written intangibles assets reported into annual reports (e.g., patents, copyrights, design models, etc.) divided by total assets = INTANGIBLEi,t/TAi,t where: INTANGIBLEi,t = intangible assets (net of amortization) and goodwill for company "i" at the end of year "t" TAi,t = total Assets for company "i" at the end of year "t"
BREADTH i,t	Number of different categories covered by the portfolio of patents of the company i at time t, according to International Patent Classification (IPC)
GPR i,t	Number of patents showing a basic classification (no more than 3 digits, e.g., H03) out of the total number of patents owned by company i at time t
DECAYi,t	Decay of written intangibles operationalized using data about amortization. Range is between 0 and 1, where "0" means "brand new intangible" and "1" means " totally amortized intangible/end of business life" = ACC_INT_AMi,t/GROSS_INTi,t where: ACC_INT_AM,t = accumulated amount of amortization of intangible assets for company "i" at the end of year "t" GROSS_INTi,t = gross amount of intangible assets before amortization for company "i" at the end of year "t"
IFRSi,t	Dummy variable equals one if company adopts IFRS and zero otherwise
SIZEi,t	Natural logarithm of sales expressed in € for company i at the end of year t
INTGROWi,t	Net intangible growth measured as the natural logarithmic difference between intangible asset at time t and intangible asset at time t − 1 = log INTANGIBLEi,t − log INTANGIBLEi,t − 1 where: INTANGIBLEi,t = intangible assets (net of amortization) and goodwill for company "i" at the end of year "t"
TGROW i,t	Net tangible growth measured as the natural logarithmic difference between net tangible invested capital at time t and net tangible invested capital at time t − 1 = log NET_TANG_INVESTED_CAPITALi,t − log NET_TANG_INVESTED_CAPITALi,t − 1 where: NET_TANG_INVESTED_CAPITALi,t = total cash investment that shareholders and debtholders have made for company "i" at the end of year "t" net of intangible asset written in balance sheet at the end of year t for company i = BVi,t + NET_DEBTi,t − INTANGIBLEi,t

3.2.1. Firm Performance (Dependent Variables: GROW, ROIC)

The presence of intangibles in a company's assets portfolio is expected to be associated with different forms of performance. Firstly, we consider firm growth (GROW): it has been demonstrated as one of the most robust and reliable measures of performance in strategic management studies [1]. Helfat [55] concludes that this is also the best indicator to reveal when organizations develop strong dynamic capabilities. We operationalized GROW by taking the difference between the natural log of sales at time 't' minus the log of sales at time 't − 1'.

In order to support the reliability of our findings, we also used a second indicator aimed at investigating the relationships between intangibles and operational profitability. In particular, we adopt the 'return on invested capital' (ROIC), measured as the ratio between net operating profit after taxes and net invested capital. The reason why we used ROIC as a profitability indicator is twofold: firstly, it includes in the numerator a measure of operating profitability not affected by financial structure decisions, as in the case of 'equity side' measures of profitability (as ROE). Compared to other measures of operating profitability, ROIC better represents the actual amount of capital invested in the firm. This is particularly true for working capital, which is computed as the 'net'—coherently with the representation of net fixed assets—in the denominator of ROIC. By contrast, other ratios—namely ROI and ROA, based on total assets—include gross working capital in the denominator, determining a dilution of the percentage of net fixed assets, among which are included intangible assets. Therefore, we support ROIC as the profitability indicator showing the best fit with the goal of our study.

The presence of significant intangible assets in a company ensures greater operating income, all things being equal, thanks to (i) higher revenues, due, for example, to the presence of the brand, customer relationships, patents; or (ii) lower cost, on the basis of innovative technologies or exploiting the advantages of business model scalability as described above.

To sum up, we use two variables to operationalize the firm performance: sales growth (GROW) and an asset-side measure of operational profitability (ROIC).

3.2.2. Intangible Intensity (INT)

As mentioned above, we define 'intangible assets intensity' as the total value of intangibles written in the balance sheet compared to the value of total assets. This ratio is a proxy of the actual intangible intensity in place at a given firm at a given moment. Indeed, some intangible assets cannot be directly observed, because they are simply not written in firm's books (as mentioned before, a company cannot book in its IFRS balance sheet internally generated intangible assets; under IAS 38, a company can recognize in its balance sheet only externally intangible assets, acquired through a business combination: "*Internally generated goodwill shall not be recognised as an asset. No intangible asset arising from research (or from the research phase of an internal project) shall be recognised. Expenditure on research (or on the research phase of an internal project) shall be recognised as an expense when it is incurred ... Internally generated brands, mastheads, publishing titles, customer lists and items similar in substance shall not be recognised as intangible assets*". (International Accounting Standard—IAS 38)). On the other hand, we consider this ratio a reliable proxy of actual intangible intensity since, as mentioned in the introduction, the adoption of IFRS and the growing number of business combinations completed under the new accounting framework determine the recognition of 'latent' intangibles, which were previously indistinctly drowned in the goodwill item.

3.2.3. Intangible Typology (a): Breadth (BREADTH)

We counted the number of different areas of technology covered by the patent portfolio of the company i at time t as proxies for intangible breadth. Areas of technologies are identified consistently with the international patent classification (IPC). We considered the macro-category (initial letter) and the first code number as baseline. Further specifications are ignored. For instance, H03 'Basic Electronic Circuitry' and H04 'Electric Communication Technique' are taken as two different areas (therefore, BREADTH = 2), whilst patents belonging to H03F 'Basic Electronic Circuitry/Amplifiers' and to H03G 'Basic Electronic Circuitry/Control Of Amplification' here are considered as in the same group (BREADTH = 1). Data about patents come from the Orbis database.

3.2.4. Intangible Typology (b): General Purpose Ratio of Intangible Investments (GPR)

In order to reveal the orientation of the firm towards 'general purpose' or 'application-specific' intangibles, we use as proxy the depth in the specification of the technology areas for all the patents owned by company i at time t. The assumption is that if the firm registers a patent using a simple code composed by only few initial digits, this is likely to be a general purpose technology (e.g., *"H03", 'Basic Electronic Circuitry').* By contrast, a longer code (e.g., *"H03D9/04", 'Demodulation or transference of modulation of modulated electromagnetic waves, for angle-modulated oscillations')* is expected to reveal an application-specific technology. Starting from this assumption, we calculated the "*general purpose ratio"* as the number of patents showing a basic classification (no more than 3 digits, e.g., H03) out of the total number of patents. Data about patents come from the Orbis database.

3.2.5. Intangible Decay (DECAY)

We leverage intangible decay as a moderator for a better understanding of the relationship between depth/breadth, on one side, and firm performance, on the other. ‘Intangible assets decay’ is here defined as the ratio between accumulated intangible amortization for company i at a given financial year-end t and gross intangible asset written in the balance sheet for company i at time t. The ratio assumes a unit value = 1 when a company no longer has investments in intangible assets and a zero value if a company has just made new investments in intangible assets. For example, if a company without intangibles on its balance sheet has made an investment of 100 CU (currency unit) in acquiring a brand with a remaining useful life at the acquisition date of 10 years, the indicator will assume a value of 10% at the end of the first year (accumulated depreciation = 10; gross carrying amount of the brand = 100; net carrying amount = 90) and a value equal to 100% at the end of year 10 (accumulated amortization = 100; gross carrying amount of the brand = 100; net carrying amount = 0).

3.2.6. Control Variables

A set of control variables has been used to control for size, country effects, accounting principles adopted (IFRS), and tangible and intangible growth (year on year). As a proxy for size, the natural logarithm of sales (expressed in € mln) has been used, as it is widely adopted among academic researchers. The majority of firms in the sample have drawn up their balance sheets in accordance with International Financial Reporting Standards (IFRS). Some companies prepare their financial statements in accordance with US GAAP. The literature [56] highlights how the relevance of accounting information is independent of the different accounting principles used (endorsing the idea that the use by market participants of accounting information is the same all over the world and harmonization of accounting principles should be achieved to enhance the consistency, comparability, and efficiency of financial statements, enabling global markets to move with less friction). However, in order to consider any potential differences attributable to different accounting principles, a dummy variable has been introduced, which assumed the unit value in the event that the financial statement was prepared in accordance with IFRS and a value of zero otherwise. To avoid the possibility that different sectors might affect the results of the analysis, we included a set of dummy variables accounting for different sectors. Furthermore, it can be argued that some companies can achieve sales growth thanks to (i) the acquisition of tangible and/or intangible assets by third parties or (ii) the realization of new investments in the existing business (so called ‘organic growth’). In order to isolate the contribution to the company growth coming from intangible intensity and intangible decay from other factors, we have inserted two explanatory variables of company growth, represented by the amount of new investments in tangible assets and the amount of new investments in intangible assets. Finally, we add to our analysis year dummy variables (Y2–Y12; Y2 corresponds to the second year in our analysis, and Y12 to the 12th year) to capture any time-related effects that are not already in the model.

3.3. Variables

Table 5 presents the means and standard deviations, while Table 6 presents the Pearson correlation coefficients for our variables. The risk of multicollinearity issues is low. We also report no correlation among the two variables related to intangible types (BREADTH and GPR), suggesting they are indeed two different dimensions.

Table 5. Descriptive statistics.

Variable	Mean	Std. Dev.	Min	Max
GROW	0.051	0.269	−1.942	2.228
SIZE	5.642	2.257	0.003	12.586
INT	0.062	0.093	0.000	0.884
TGROW	0.049	0.581	−7.155	6.848
INTGROW	0.260	1.177	−4.925	13.62
DECAY	0.377	0.257	0.000	0.999
BREADTH	3.753	3.341	0.000	17.000
GPR	0.699	0.272	0.000	1.000

Table 6. Correlation matrix.

Variable	Grow	Size	Int	Tgrow	Intgrow	Decay	Breadth
GROW							
SIZE	−0.0973 *						
INT	0.0372	−0.1196 *					
TGROW	0.3210 *	−0.0022	−0.0250				
INTGROW	0.1746 *	−0.0387	−0.0784 *	0.1219 *			
DECAY	−0.0947 *	−0.2969 *	−0.1522 *	−0.0708 *	0.0599		
BREADTH	−0.0399	0.2577*	−0.0341	−0.0110	−0.0202	−0.0394	
GPR	0.008	−0.0373	0.0011	0.0146	0.0173	0.0703 *	0.0167

* correlations at $p < 0.01$.

4. Findings

Table 7 shows the regression analysis. First, Model 1 considers control variables only. As expected, intangible intensity positively affects the sales growth. We also reported a negative effect of firm size. This is not surprising: in relative terms, large companies are less prone to grow than small firms. Models 2 and 3 show the effects of BREADTH. It does not cause any direct effect on growth. By contrast, there is a positive interaction with intangible intensity (see model 3). Therefore, the positive effect on the firm growth of investing in intangibles is higher when the company possesses a broad portfolio of different technological capabilities. This finding supports Research Hypothesis 1: breadth of intangibles is important, but as a contingent variable that tunes the positive role of intangible intensity, more than as a success factor in itself and a priori.

Models 4 and 5 explore effects of GPR. This analysis does not reveal any direct effect on growth for this variable, though it plays a role as moderator.

Table 8 explores hypothesis 3 by adding to the variables represented in Table 7 the variable linked to intangible decay, which is always statistically significant. Model 1 in Table 8 considers control variables and the intangible decay variable. As expected, intangible intensity positively affects the sales growth, though this effect is negatively moderated by intangible decay. Models 2 and 3 show the effects of BREADTH considering the variable INT x DECAY. Results obtained in Table 7 are confirmed. Finally, like in Table 7, Models 4 and 5 explore the effects of GPR. This analysis does not reveal any direct effect on growth for this variable, though it plays a role as moderator. However, the term INT x GPR is negative, thus showing that the firm growth benefits from significant investments in intangibles, especially in the case of a relatively low GPR, meaning when they are application-specific. This is in contrast with Research Hypothesis 2, which established a positive relationship, instead of a negative one. This evidence about BREADTH and GPR are not confirmed for ROIC (see Appendix A).

Table 7. Effect of breadth and GPR on firm growth.

Dependent Variable = Firm Growth	(1)	(2)	(3)	(4)	(5)
Y2	0.0510	0.0513	0.0521	0.0264	0.0264
	(0.0673)	(0.0673)	(0.0673)	(0.0774)	(0.0774)
Y3	0.184 ***	0.184 ***	0.186 ***	0.162 **	0.162 **
	(0.0618)	(0.0618)	(0.0618)	(0.0701)	(0.0701)
Y4	0.169 ***	0.170 ***	0.171 ***	0.119 *	0.119 *
	(0.0585)	(0.0585)	(0.0585)	(0.0662)	(0.0662)
Y5	0.231 ***	0.232 ***	0.234 ***	0.187 ***	0.188 ***
	(0.0579)	(0.0579)	(0.0579)	(0.0655)	(0.0655)
Y6	0.250 ***	0.251 ***	0.253 ***	0.208 ***	0.208 ***
	(0.0578)	(0.0578)	(0.0578)	(0.0652)	(0.0652)
Y7	0.244 ***	0.246 ***	0.248 ***	0.210 ***	0.211 ***
	(0.0579)	(0.0579)	(0.0579)	(0.0653)	(0.0653)
Y8	0.106 *	0.108 *	0.110 *	0.0691	0.0699
	(0.0579)	(0.0580)	(0.0580)	(0.0654)	(0.0654)
Y9	0.260 ***	0.262 ***	0.264 ***	0.219 ***	0.219 ***
	(0.0578)	(0.0579)	(0.0579)	(0.0653)	(0.0653)
Y10	0.251 ***	0.254 ***	0.256 ***	0.218 ***	0.219 ***
	(0.0579)	(0.0581)	(0.0581)	(0.0654)	(0.0654)
Y11	0.229 ***	0.232 ***	0.234 ***	0.198 ***	0.199 ***
	(0.0580)	(0.0582)	(0.0582)	(0.0655)	(0.0655)
Y12	0.232 ***	0.236 ***	0.237 ***	0.200 ***	0.201 ***
	(0.0581)	(0.0584)	(0.0584)	(0.0657)	(0.0657)
SIZE	−0.300 ***	−0.300 ***	−0.300 ***	−0.320 ***	−0.320 ***
	(0.00960)	(0.00960)	(0.00960)	(0.0107)	(0.0107)
TGROW	0.0917 ***	0.0917 ***	0.0914 ***	0.0913 ***	0.0913 ***
	(0.00542)	(0.00542)	(0.00542)	(0.00587)	(0.00587)
INTGROW	0.0151 ***	0.0151 ***	0.0153 ***	0.0133 ***	0.0132 ***
	(0.00260)	(0.00260)	(0.00260)	(0.00288)	(0.00288)
INT	0.373 ***	0.372 ***	0.238 **	0.110	0.198
	(0.0753)	(0.0753)	(0.102)	(0.120)	(0.137)
BREADTH		−0.00251	−0.00500	−0.00758	−0.00787
		(0.00383)	(0.00403)	(0.00557)	(0.00558)
INTxBREADTH			0.0424 **	0.0629 ***	0.0659 ***
			(0.0216)	(0.0242)	(0.0243)
GPR				0.00960	0.0317
				(0.0455)	(0.0485)
INTxGPR					−0.394
					(0.298)
Constant	1.498 ***	1.505 ***	1.513 ***	1.675 ***	1.673 ***
	(0.0730)	(0.0739)	(0.0740)	(0.0876)	(0.0876)
Observations	6,677	6,677	6,677	6,070	6,070
R−squared within	0.2895	0.2896	0.2901	0.2921	0.2923
Number of FirmID	1,193	1,193	1,193	1,170	1,170
R−sq: between	0.0175	0.0175	0.0175	0.0177	0.0177
R−sq: overall	0.0189	0.0189	0.0189	0.0161	0.0161

Standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table 7; Table 8 also report all three R-squared indicators generated by fixed effect regressions: "within", "between", and "overall". The within value is the main interest in our analysis, as fixed-effects is known as a within estimator. Within R-squared is equal to 0.30 in the full Model 5, supporting good reliability for our findings. The same goes for Table 9.

Table 8. Effect of breadth and GPR on firm growth, under the effect of intangibles decay.

Dependent Variable = Firm Growth	(1)	(2)	(3)	(4)	(5)
Y2	0.0439	0.0443	0.0451	0.0139	0.0136
	(0.0670)	(0.0670)	(0.0670)	(0.0770)	(0.0770)
Y3	0.174 ***	0.174 ***	0.176 ***	0.146 **	0.147 **
	(0.0615)	(0.0615)	(0.0615)	(0.0697)	(0.0697)
Y4	0.163 ***	0.164 ***	0.165 ***	0.107	0.107
	(0.0582)	(0.0582)	(0.0582)	(0.0658)	(0.0658)
Y5	0.222 ***	0.223 ***	0.225 ***	0.173 ***	0.173 ***
	(0.0576)	(0.0576)	(0.0576)	(0.0651)	(0.0651)
Y6	0.241 ***	0.243 ***	0.245 ***	0.193 ***	0.194 ***
	(0.0575)	(0.0575)	(0.0575)	(0.0649)	(0.0649)
Y7	0.236 ***	0.238 ***	0.240 ***	0.196 ***	0.197 ***
	(0.0576)	(0.0576)	(0.0576)	(0.0650)	(0.0650)
Y8	0.0988 *	0.101 *	0.103 *	0.0572	0.0581
	(0.0576)	(0.0577)	(0.0577)	(0.0651)	(0.0651)
Y9	0.257 ***	0.260 ***	0.262 ***	0.209 ***	0.210 ***
	(0.0575)	(0.0576)	(0.0576)	(0.0650)	(0.0650)
Y10	0.250 ***	0.253 ***	0.255 ***	0.211 ***	0.212 ***
	(0.0576)	(0.0578)	(0.0578)	(0.0650)	(0.0650)
Y11	0.228 ***	0.232 ***	0.234 ***	0.193 ***	0.194 ***
	(0.0577)	(0.0579)	(0.0579)	(0.0651)	(0.0651)
Y12	0.235 ***	0.240 ***	0.241 ***	0.198 ***	0.200 ***
	(0.0579)	(0.0582)	(0.0581)	(0.0653)	(0.0653)
SIZE	−0.306 ***	−0.306 ***	−0.306 ***	−0.329 ***	−0.330 ***
	(0.00959)	(0.00959)	(0.00959)	(0.0107)	(0.0107)
TGROW	0.0898 ***	0.0898 ***	0.0895 ***	0.0891 ***	0.0891 ***
	(0.00540)	(0.00540)	(0.00540)	(0.00585)	(0.00584)
INTGROW	0.0158 ***	0.0158 ***	0.0159 ***	0.0139 ***	0.0138 ***
	(0.00259)	(0.00259)	(0.00259)	(0.00286)	(0.00286)
INT	0.836 ***	0.836 ***	0.698 ***	0.602 ***	0.733 ***
	(0.0973)	(0.0973)	(0.118)	(0.137)	(0.154)
INTxDECAY	−1.822 ***	−1.825 ***	−1.830 ***	−1.922 ***	−1.957 ***
	(0.244)	(0.244)	(0.244)	(0.263)	(0.264)
BREADTH		−0.00292	−0.00550	−0.00808	−0.00850
		(0.00381)	(0.00401)	(0.00555)	(0.00555)
INTxBREADTH			0.0439 **	0.0604 **	0.0645 ***
			(0.0214)	(0.0241)	(0.0242)
GPR				0.00661	0.0374
				(0.0453)	(0.0482)
INTxGPR					−0.550 *
					(0.297)
Constant	1.542 ***	1.550 ***	1.559 ***	1.746 ***	1.743 ***
	(0.0729)	(0.0738)	(0.0739)	(0.0877)	(0.0877)
Observations	6677	6677	6677	6070	6070
R-squared	0.2967	0.2968	0.2974	0.2997	0.3002
Number of FirmID	1193	1193	1193	1170	1170
R-sq: between	0.0207	0.0208	0.0207	0.0214	0.0214
R-sq: overall	0.0205	0.0205	0.0205	0.0174	0.0174

Standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table 9. Intangible intensity and decay within contexts of different intangible types (growth): regressions.

	A1. Broadening	A2. Deepening	B1. General Purpose	B2. Application-Specific
VARIABLES	(high BREADTH)	(low BREADTH)	(high GPR)	(low GPR)
Y2	0.147 *	0.0111	0.0427	5.52×10^{-05}
	(0.0850)	(0.106)	(0.0842)	(0.131)
Y3	0.262 ***	0.151	0.168 **	0.109
	(0.0797)	(0.0970)	(0.0782)	(0.122)
Y4	0.186 **	0.203 **	0.202 ***	0.0750
	(0.0757)	(0.0916)	(0.0743)	(0.117)
Y5	0.278 ***	0.212 **	0.281 ***	0.0937
	(0.0751)	(0.0906)	(0.0734)	(0.116)
Y6	0.259 ***	0.274 ***	0.288 ***	0.139
	(0.0748)	(0.0904)	(0.0733)	(0.116)
Y7	0.278 ***	0.255 ***	0.287 ***	0.138
	(0.0749)	(0.0906)	(0.0735)	(0.116)
Y8	0.130 *	0.135	0.148 **	0.00998
	(0.0750)	(0.0907)	(0.0736)	(0.116)
Y9	0.291 ***	0.291 ***	0.304 ***	0.166
	(0.0748)	(0.0905)	(0.0734)	(0.116)
Y10	0.307 ***	0.268 ***	0.311 ***	0.160
	(0.0748)	(0.0910)	(0.0735)	(0.116)
Y11	0.274 ***	0.263 ***	0.271 ***	0.157
	(0.0750)	(0.0911)	(0.0736)	(0.116)
Y12	0.274 ***	0.287 ***	0.285 ***	0.156
	(0.0752)	(0.0916)	(0.0738)	(0.116)
SIZE	−0.344 ***	−0.312 ***	−0.335 ***	−0.347 ***
	(0.0136)	(0.0147)	(0.0132)	(0.0155)
TGROW	0.0840 ***	0.0896 ***	0.0893 ***	0.0739 ***
	(0.00681)	(0.00847)	(0.00750)	(0.00806)
INTGROW	0.0159 ***	0.0199 ***	0.0196 ***	0.0148 ***
	(0.00317)	(0.00421)	(0.00347)	(0.00401)
INT	0.307 **	0.773 ***	0.178	0.801 ***
	(0.127)	(0.175)	(0.156)	(0.157)
DECAY	−0.182 ***	−0.142 ***	−0.213 ***	−0.120 ***
	(0.0307)	(0.0399)	(0.0339)	(0.0383)
INTxDECAY	−0.220	−2.031 ***	0.0557	−2.127 ***
	(0.332)	(0.406)	(0.405)	(0.364)
Constant	1.922 ***	1.472 ***	1.773 ***	1.875 ***
	(0.106)	(0.110)	(0.0990)	(0.142)
Observations	3499	3178	3568	3109
R-squared within	0.3596	0.2729	0.3336	0.2916
Number of FirmID	660	673	743	676
R-sq: between	0.00429	0.0282	0.0166	0.0277
R-sq: overall	0.0149	0.0264	0.0218	0.0183

Standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

We ran additional analysis to figure out the overall interplay between intangible intensity and decay with our theoretical model and to deepen the controversial finding reported for HP2.

Table 9 thus explores Hypothesis 3 by simultaneously investigating the interaction among intangible intensity, decay, and typology. This procedure runs the same set of regressions on four sub-samples. First, we split data into two groups around the median value of BREADTH (equal to 3): high levels of BREADTH (Model A1, all companies having BREADTH > 3), meaning the "broadening" type of intangibles, and low levels of BREADTH (Model A2, all companies having BREADTH < 3), meaning the "deepening" type of intangibles. The sum of observations in Model A1 (3499) and Model A2 (3178) is equal to the whole sample (6677 observations, represented in Table 7).

Similarly, we make a second split of data around the median value of GPR (equal to 0.75): high levels of GPR for Model B1 (all companies having GPR > 0.75), meaning "application-specific" type of intangibles, and low levels of GPR in Model B2 (all companies having GPR < 0.75), meaning "general purpose" type of intangibles. Figure 1 supports a better understanding of this outcome. The sum of observations in model B1 (3568) and Model B2 (3109) is equal to the whole sample (6677 observations, represented in Table 7).

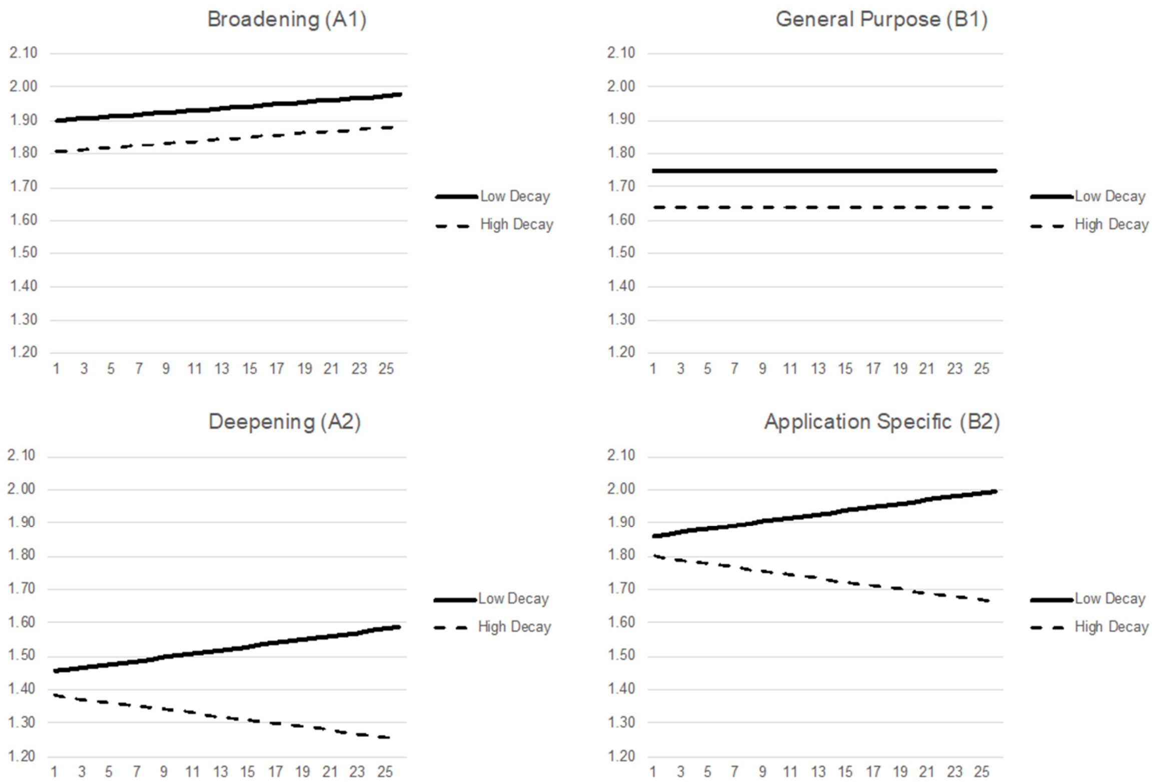

Figure 1. Intangible intensity and decay within contexts of different intangible types (growth): graphs.

Regression models and graphs A1 and A2 reveal the effect of the value of BREADTH on the interaction between intangibles intensity and decay. When intangibles are new (low decay), the firm growth benefits from high intensity, regardless of BREADTH or depth degrees—the curve has a positive slope in both A1 and A2—though broadening strategies perform better at equal levels of intangible intensity. The intangible-broadening strategy has a further advantage: it halts the adverse effect of decay as the intangible intensity goes up. Indeed, the negative interaction between decay and intangibles is in place only in the case of low levels of BREADTH (A2). In short, companies focused on deepening investments should continuously invest in the renewal of intangibles, whilst broadening investments mitigates this need.

The variable 'general purpose ratio of intangibles' (GPR)—see models and graphs B1 and B2—generates patterns showing both analogies and differences compared to 'intangibles breadth' (BREADTH). The similarity is that as the company extends the set of options for future investments through general purpose intangibles it becomes more resistant to the negative moderating effect of decay at high levels of intangible intensity (B1), though the decay has a kind of negative impact on firm growth anyway (see both B1 and B2).

Besides this, there are significant differences compared to the 'broadening' vs. 'deepening' dimension. When application-specific intangibles cover a large portion of an assets portfolio (right of graph B2), the impact on firm growth is particularly positive if intangibles are new (low decay), and very detrimental when the latter are obsolete (high decay). By contrast, having up-to-date intangibles is no longer a priority when they are just a limited share of total assets (left of graph B2), where the two curves (low and high decay) are close each other.

Therefore, general purpose intangibles emerge as a kind of 'all-seasons' investment: the intangible decay still erodes sales growth, but this effect is constant regardless of intangible intensity (B1). This type of intangible leaves the company relatively freer in defining the asset portfolio composition.

Finally, intangible decay is confirmed as being crucial overall: it weakens the firm growth in all four conditions. However, this effect varies according to intangible intensity degree within 'focused' companies, meaning those with 'deepening' (A2) and 'application-specific' (B2) orientations.

5. Discussion and Conclusions

This study sheds a new light on how a company creates, composes, and renews over time their portfolio of intangibles, with specific attention on patents. In particular, this contribution discusses the different effects that emerge by making a distinction among different forms of patents, considering two dimensions: broadening vs. deepening investments, and application-specific vs. general purpose investments. We notice that as the company increases investments in intangibles and simultaneously enlarges the breadth of their range of activities, its growth becomes particularly remarkable. The choice between 'application-specific' and 'general purpose' investment is instead dependent on intangible intensity: application-specific strategies are effective when intangibles are cutting edge and predominant in the assets portfolio. Both strategies based on broadening and general purpose investments boost the strategic agility and leave open many future options, so that the company is quite free in making decisions about the resource portfolio composition: the need for dynamic capability is relevant but unrelated to intangible intensity degree. By contrast, organizations should tune the pace of change in accordance with intangible intensity when they leverage their deepening or application-specific capabilities. More precisely, the role of dynamic capabilities is crucial when intangible intensity is high, whilst it is less a priority for tangible-based companies which have invested in focused capabilities (deepening and application-specific conditions). This evidence is noticed when the performance indicator is sales growth, whilst profitability in the short run emerged as not associated to the type of intangibles.

In a nutshell, the need for dynamic capabilities is crucial in all conditions: tangible- and intangible-based organizations, regardless of the type of intangibles, support both growth and profitability. However, the detrimental effect of intangible decay over time is contingent on internal conditions. Therefore, managers should adjust, year by year, the amount of investments and the pace of renewal consistent with intangible intensity and type, taking into account if the priority is growth or profitability (or both).

These findings offer relevant managerial implications since they suggest insights for the optimization of investments in intangibles in different situations. They also have significant theoretical implications: they reinforce the normative value of the dynamic capability view, and add that companies find factors to set the pace of renewal first of all within the organizational boundaries, whilst the majority of extant literature has focused its research on the turbulence degree of environment. Of course, both internal and external variables are crucial: here we are just highlighting the need to make a step forward in the dynamic capability stream looking for insights which can drive managers' choices. However, we also suggest a 'step back' from the original ontology of dynamic capabilities and its Schumpeterian nature, where organizations see themselves as key engines of change and market creation, instead of passively suffering the events of turbulent scenarios.

This study also has some limitations. We studied listed companies only, meaning the sample was unbalanced towards big companies. Future studies should investigate if and how the above-mentioned dynamics vary within SMEs. Secondly, implications regarding the type of intangibles are limited to patents: findings can be biased by sectoral factors.

Similarly, we do not take into account environmental variables, an important aspect when the goal is to emphasize the normative value of the dynamic capability framework.

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Appendix A

Table A1. Effect of breadth and GPR on firm Return on Invested Capital (ROIC).

Dep = ROIC	(1)	(2)	(3)	(4)	(5)
Y2	0.425 ***	0.425 ***	0.424 ***	0.369 **	0.369 **
	(0.137)	(0.138)	(0.138)	(0.157)	(0.157)
Y3	0.376 ***	0.376 ***	0.375 ***	0.404 ***	0.405 ***
	(0.126)	(0.126)	(0.126)	(0.142)	(0.142)
Y4	0.480 ***	0.480 ***	0.479 ***	0.505 ***	0.505 ***
	(0.119)	(0.119)	(0.119)	(0.134)	(0.134)
Y5	0.502 ***	0.501 ***	0.500 ***	0.499 ***	0.500 ***
	(0.118)	(0.118)	(0.118)	(0.133)	(0.133)
Y6	0.496 ***	0.494 ***	0.493 ***	0.495 ***	0.496 ***
	(0.118)	(0.118)	(0.118)	(0.133)	(0.133)
Y7	0.487 ***	0.486 ***	0.484 ***	0.501 ***	0.502 ***
	(0.118)	(0.118)	(0.118)	(0.133)	(0.133)
Y8	0.446 ***	0.444 ***	0.443 ***	0.459 ***	0.461 ***
	(0.118)	(0.118)	(0.118)	(0.133)	(0.133)
Y9	0.427 ***	0.425 ***	0.423 ***	0.438 ***	0.439 ***
	(0.118)	(0.118)	(0.118)	(0.133)	(0.133)
Y10	0.496 ***	0.493 ***	0.491 ***	0.505 ***	0.507 ***
	(0.118)	(0.119)	(0.119)	(0.133)	(0.133)
Y11	0.457 ***	0.453 ***	0.452 ***	0.471 ***	0.473 ***
	(0.118)	(0.119)	(0.119)	(0.133)	(0.133)
Y12	0.475 ***	0.471 ***	0.470 ***	0.492 ***	0.494 ***
	(0.119)	(0.119)	(0.119)	(0.133)	(0.133)
SIZE	0.0723 ***	0.0723 ***	0.0725 ***	0.0563 ***	0.0552 ***
	(0.0191)	(0.0191)	(0.0191)	(0.0211)	(0.0211)
INT	0.139	0.140	0.234	0.277	−0.368
	(0.191)	(0.191)	(0.233)	(0.268)	(0.523)
INTxDECAY	−0.570	−0.567	−0.560	−0.357	−0.416
	(0.487)	(0.488)	(0.488)	(0.523)	(0.524)
BREADTH		0.00248	0.00428	0.00216	0.00155
		(0.00782)	(0.00823)	(0.0113)	(0.0113)
INTxBREADTH			−0.0308	−0.0483	−0.0425
			(0.0437)	(0.0487)	(0.0488)
GPR				−0.000659	−0.0492
				(0.0916)	(0.0976)

Table A1. *Cont.*

Dep = ROIC	(1)	(2)	(3)	(4)	(5)
INTxGPR					0.858
					(0.597)
Constant	−0.840 ***	−0.847 ***	−0.853 ***	−0.776 ***	−0.732 ***
	(0.147)	(0.148)	(0.149)	(0.184)	(0.186)
Observations	6724	6724	6724	6114	6114
R-squared	0.0115	0.0115	0.0116	0.0090	0.0094
Number of FirmID	1196	1196	1196	1173	1173
R-sq: between	0.0284	0.0287	0.0278	0.0304	0.0293
R-sq: overall	0.0242	0.0245	0.0241	0.0236	0.0244

Standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$.

Table A2. Effect of breadth and GPR on ROIC.

	(1)	(2)	(3)	(4)	(5)
Y2	0.451 ***	0.451 ***	0.451 ***	0.354 **	0.354 **
	(0.123)	(0.123)	(0.123)	(0.140)	(0.140)
Y3	0.423 ***	0.423 ***	0.423 ***	0.418 ***	0.418 ***
	(0.113)	(0.113)	(0.113)	(0.127)	(0.127)
Y4	0.513 ***	0.513 ***	0.512 ***	0.487 ***	0.487 ***
	(0.107)	(0.107)	(0.107)	(0.120)	(0.120)
Y5	0.541 ***	0.540 ***	0.539 ***	0.501 ***	0.502 ***
	(0.106)	(0.106)	(0.106)	(0.118)	(0.118)
Y6	0.547 ***	0.547 ***	0.546 ***	0.508 ***	0.509 ***
	(0.106)	(0.106)	(0.106)	(0.118)	(0.118)
Y7	0.529 ***	0.529 ***	0.528 ***	0.508 ***	0.508 ***
	(0.106)	(0.106)	(0.106)	(0.118)	(0.118)
Y8	0.489 ***	0.489 ***	0.488 ***	0.467 ***	0.467 ***
	(0.106)	(0.106)	(0.106)	(0.118)	(0.118)
Y9	0.483 ***	0.483 ***	0.482 ***	0.458 ***	0.459 ***
	(0.106)	(0.106)	(0.106)	(0.118)	(0.118)
Y10	0.542 ***	0.541 ***	0.540 ***	0.515 ***	0.516 ***
	(0.106)	(0.106)	(0.106)	(0.118)	(0.118)
Y11	0.517 ***	0.516 ***	0.515 ***	0.497 ***	0.498 ***
	(0.106)	(0.107)	(0.107)	(0.118)	(0.118)
Y12	0.525 ***	0.524 ***	0.524 ***	0.508 ***	0.509 ***
	(0.107)	(0.107)	(0.107)	(0.119)	(0.119)
SIZE	0.0525 ***	0.0525 ***	0.0527 ***	0.0354 *	0.0351 *
	(0.0173)	(0.0173)	(0.0173)	(0.0190)	(0.0190)
INT	0.384 **	0.385 **	0.452 **	0.332	0.398
	(0.177)	(0.177)	(0.216)	(0.248)	(0.280)
INTxDECAY	−1.516 ***	−1.515 ***	−1.513 ***	−1.141 **	−1.158 **
	(0.448)	(0.448)	(0.448)	(0.479)	(0.480)
BREADTH		0.000485	0.00173	−0.00254	−0.00275
		(0.00702)	(0.00739)	(0.0101)	(0.0101)
INTxBREADTH			−0.0213	−0.0210	−0.0189
			(0.0395)	(0.0438)	(0.0440)
GPR				0.0361	0.0515
				(0.0824)	(0.0878)
INTxGPR					−0.275
					(0.541)
Constant	−0.754 ***	−0.755 ***	−0.759 ***	−0.635 ***	−0.637 ***
	(0.133)	(0.134)	(0.134)	(0.157)	(0.157)
Observations	6677	6677	6677	6070	6070
R-squared	0.0144	0.0144	0.0145	0.0103	0.0104
Number of FirmID	1193	1193	1193	1170	1170
R-sq: between	0.0148	0.0149	0.0144	0.0157	0.0154
R-sq: overall	0.0188	0.0188	0.0187	0.0174	0.0176

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

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