Performance outcomes of interaction, balance, and alignment between exploration and exploitation in the technological innovation domain

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Abstract: A key point in previous research on ambidexterity is the operationalisation of the ambidexterity concept. Usually, multiplicative interaction (i.e., showing high scores in exploration and exploitation) and balance are the two facets considered. We argue that a third facet should be added: alignment, which refers to the extent to which exploration and exploitation are certainly interrelated and complement each other. The results of the research show that, unlike previous research, what truly matters for firm performance is to focus on radical innovation and to develop incremental innovations that truly complement the former (‘alignment’). On the contrary, interaction and balance between both types of innovation do not show a significant influence on company performance. Specific measures to operationalise the alignment construct are provided.

Keywords: ambidexterity; alignment; exploration; exploitation; technological innovation; firm performance.


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1 Introduction and research purpose

According to Tushman and O’Reilly (1997), the complexity and pace of change faced by many organisations in the current economy, together with the time needed to develop new products and services, requires companies to pursue exploitation and exploration simultaneously. In the field of technological innovation, ‘exploitation’ refers to incremental innovation, whereas ‘exploration’ is related to radical innovation. Along these lines, Benner and Tushman (2003) defined exploitative (i.e., incremental) innovations as the ones intended to meet the needs of existing customers or markets, and exploratory (i.e., radical) innovations as the ones focused on emerging customers or markets.

The ambidexterity premise establishes that firms capable of simultaneously pursuing exploitation and exploration are more likely to achieve superior performance than firms emphasising one at the expense of the other (Tushman and O’Reilly, 1996). This premise has been tested in several studies (Gibson and Birkinshaw, 2004; He and Wong, 2004; Jansen, 2005; Lubatkin et al., 2006; Venkatraman et al., 2007), but empirical evidence still remains limited and mixed (Raisch and Birkinshaw, 2008). While some studies corroborate the ambidexterity premise (Gibson and Birkinshaw, 2004; He and Wong, 2004; Jansen, 2005; Lubatkin et al., 2006), others do not support it (Bierly and Daly, 2007; Lin et al., 2007; Venkatraman et al., 2007) and some do support it only under certain conditions (Chiu et al., 2011; Jansen et al., 2012; Sarkees et al., 2010).

A key point in previous studies is the operationalisation of the ambidexterity concept. In their research, He and Wong (2004) operationalised ambidexterity in two ways. First, they considered a firm to be ambidextrous when it scored high on both exploration and exploitation. Hence, the product of both scores was calculated (i.e., ambidexterity was considered the non-substitutable combination of exploration and exploitation) and the significance of this interaction effect on performance was tested. A similar approach can be found in Gibson and Birkinshaw (2004), Jansen (2005), Lubatkin et al. (2006), and Venkatraman et al. (2007). Second, He and Wong (2004) regarded balance between exploration and exploitation as another facet of the ambidexterity concept. Consequently, they calculated the absolute difference between exploration and exploitation scores and tested whether relative imbalance between them was negatively related to firm performance. This complementary approach was also considered by Jansen (2005), and Lubatkin et al. (2006). Additionally, the latter contemplated a third possibility: summing exploration and exploitation scores, even though this was done mainly from an ‘arithmetic’ perspective, rather than from a conceptual point of view related to the meaning awarded to the ambidexterity concept.
However, in these attempts to operationalise the ambidexterity concept, a piece is missing: the degree of alignment between exploration and exploitation activities. Considering that exploration and exploitation have to be recombined to create value (Eisenhardt and Martin, 2000; O’Reilly and Tushman, 2008; Teece, 2007), the mere coexistence of exploratory and exploitative activities is not enough: both exploration and exploitation should be complementary and mutually reinforcing. This being the case, multiplying exploration and exploitation scores does not fully capture the extent to which both types of activity are interconnected. Multiplying both elements only allows testing whether the greater the exploitation effort, the greater the influence of exploration on performance (or vice versa). Therefore, we argue that, apart from the two angles reported in the ambidexterity literature, a third facet should be added: alignment, which refers to the extent to which exploration and exploitation are actually interconnected and complement each other.

In fact, incremental innovation represents the best way to extract the maximum value from radical innovations carried out in the past. By providing small improvements, a company can sustain its product market share and profitability for a longer time, avoiding commoditisation (Davila et al., 2006). On the opposite side, discontinuity is often the result of unexpected conjunctions, which do not necessarily constitute radical shifts at the technological or market frontier. Hence, recombinant innovation (i.e., packaging existing things up by making new connections between elements, or linking users’ needs to technological means) can often be the trigger of radical innovation (Bessant and Tidd, 2007). Therefore, knowledge should flow smoothly between exploration and exploitation activities, and direct measures should be used to capture the degree of alignment achieved.

Considering this, this paper adds to the growing body of research on the ambidexterity premise by analysing the performance outcomes (productivity, profitability and growth) of interaction, balance, and alignment between exploration and exploitation activities in the technological innovation domain. In particular, we will report results from research in medium-high and high-technology firms from the Basque Region, Madrid and Barcelona (Spain), showing that, unlike previous research, what is of utmost importance for firm performance is to focus on radical innovation and to develop incremental innovations that certainly complement the former (‘alignment’). On the contrary, interaction and balance between both types of innovation do not show a significant influence on company performance. Specific measures to operationalise the alignment construct are provided.

2 Theoretical background

In recent years, there has been an explosion of interest and research on the topic of organisational ambidexterity. Unfortunately, although this proliferation of interest has broadened and deepened our understanding of the topic, it has also blurred some of the clarity about the construct itself (Birkinshaw and Gupta, 2013; O’Reilly and Tushman, 2013; Nosella et al., 2012). Broadly speaking, organisational ambidexterity refers to an organisation’s ability to perform differing (and often competing) strategic actions at the same time (Simsek et al., 2009). For instance, trying to achieve both flexibility and efficiency (Burns and Stalker, 1961; Thompson, 1967), search and stability (Rivkin and
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Siggelkow, 2003), competence leveraging and competence building (Hamel and Prahalad, 1993; Sanchez et al., 1996), single-loop and double-loop learning (Argyris and Schön, 1978), incremental and radical innovation (Abernathy and Clark, 1985; Burton et al., 2012; Tushman et al., 2010), to name but a few. Therefore, the study of organisational ambidexterity has been carried out from different perspectives, namely: organisational design, organisational adaptation, strategic management, organisational learning, and technological innovation (Raisch and Birkinshaw, 2008).

Central to the notion of organisational ambidexterity is the need to strike a balance between ‘exploration’ and ‘exploitation’. These two concepts were introduced by March in his landmark article of 1991, which has frequently been cited as the catalyst for the current interest in the field (Raisch and Birkinshaw, 2008). According to March (1991), exploration refers to notions such as ‘search, variation, experimentation, and discovery’, whereas exploitation is associated with activities such as ‘refinement, efficiency, selection, and implementation’ (p.102). Successful firms “engage in enough exploitation to ensure the organization’s current viability and engage in enough exploration to ensure future viability” [Levinthal and March, (1993), p.105]. Therefore, none of the activities should be performed at the expense of the other. Whereas too much focus on exploitation (to the exclusion of exploration) may enhance short-term performance, it can result in a ‘competence trap’, since firms may not be able to respond adequately to environmental changes. Conversely, too much focus on exploration could lead to a ‘failure trap’ in which organisations gain no returns from their knowledge (Levinthal and March, 1993).

Depending on the specific perspective from which ambidexterity is studied, the concepts of ‘exploration’ and ‘exploitation’ may have slightly different meanings. In the case of organisational adaptation, exploration and exploitation would refer to the need of implementing changes while maintaining daily operations (i.e., the need to strike a balance between continuity and change) (Meyer and Stensaker, 2006). In the field of strategic management, exploitation and exploration could refer to induced strategic processes (i.e., searching within the scope of the organisation’s current strategy) versus autonomous strategic processes (i.e., searching outside the scope of the firm’s current strategy) (Burgelman, 1991, 2002). In the case of organisational learning, they could refer to the mere reuse of existing knowledge versus all instances of learning (Rosenkopf and Nerkar, 2001), or to learning gained through local search, experiential refinement, and selection and reuse of existing routines versus learning gained via processes of concerted variation, planned experimentation, and play (Baum et al., 2000). Finally, in the case of technological innovation (i.e., the perspective adopted in this paper), exploitation and exploration refer to the balance between incremental and discontinuous (i.e., radical) innovation (Caspin-Wagner et al., 2012; Tushman et al., 2010; Phene et al., 2012). Along these lines, O’Reilly and Tushman (2013, p.324) defined organisational ambidexterity as “the ability of an organisation to both explore and exploit – to compete in mature technologies and markets where efficiency, control, and incremental improvement are prized and to also compete in new technologies and markets where flexibility, autonomy, and experimentation are needed”.

Because exploitation and exploration may require fundamentally different organisational structures, strategies, and contexts (Raisch and Birkinshaw, 2008) and compete for scarce resources and attention, sustaining an optimal mix of both activities is enormously challenging, and involves some potential tradeoffs (Simsek et al., 2009).
Earlier studies often regarded these tradeoffs as insurmountable (e.g., Hannan and Freeman, 1977; McGill et al., 1992; Miller and Friesen, 1986). However, recent research argues that firms are most successful when managers think and act ‘ambidextrously’, by trying to attain high levels of exploitation and exploration simultaneously (e.g., Gibson and Birkshaw, 2004; He and Wong, 2004; Jansen, 2005; Lubatkin et al., 2006). As Simsek et al. (2009, p.867) point out: “To these researchers, exploration and exploitation are fundamentally two distinct organizational activities that should be pursued fully and concurrently to attain competitive advantage and long-term survival”. The research reported in this paper adopts this perspective.

3 Research hypotheses

As previously mentioned, this paper aims to analyse the performance outcomes of interaction, balance, and alignment between exploration (i.e., radical innovation) and exploitation (i.e., incremental innovation) in the technological innovation domain. More precisely, the ambidexterity premise will be tested, under which firms capable of simultaneously pursuing exploitation and exploration are more likely to achieve superior business performance (productivity, profitability and growth) than firms emphasising one at the expense of the other (Tushman and O’Reilly, 1996).

Thus, the first condition for the ambidexterity premise to be satisfied is that companies simultaneously engage both in incremental (i.e., exploitative) and radical (i.e., exploratory) innovation activities. By introducing small refinements in products and services, a company can sustain its product market share and profitability for a longer time (Davila et al., 2006). Likewise, small changes in processes could lead to efficiency gains and cost reductions (Grant, 2008). On the contrary, radical innovation has the potential to rewrite the rules of the game in the industry (Davila et al., 2006), and to enlarge markets either by attracting new customers or by encouraging existing ones to consume more (Markides, 2008). Therefore, the following hypotheses have been formulated:

H1 Engaging in incremental innovation efforts positively affects business performance.

H2 Engaging in radical innovation efforts positively affects business performance.

However, considering exploration and exploitation as non-substitutable elements (Gibson and Birkshaw, 2004), ambidexterity requires high levels of both capacities. Therefore, the multiplicative interaction of the two should be tested. In their research, He and Wong (2004) found that the multiplicative interaction between exploration and exploitation was positively related to sales growth, while Jansen (2005) found a significant influence of the former on firm profitability and on return on equity (ROE). In the same vein, Gibson and Birkshaw (2004) found a positive relationship between the multiplicative interaction between exploration and exploitation and firm performance. However, Venkatraman et al. (2007) concluded in their study that sequential temporal balancing of exploration and exploitation (and not simultaneous) had a superior effect on firm performance. Meanwhile, Bierly and Daly (2007) found that the interaction between exploitation and exploration did not significantly influence financial performance. Thus, the following hypothesis has been formulated:
H3 The multiplicative interaction between incremental and radical innovation has a positive influence on business performance.

Moreover, previous research suggests that a balance is needed between exploration and exploitation activities. Along these lines, He and Wong (2004) found that the relative imbalance (absolute difference) between exploratory and exploitative innovation strategies is negatively related to sales growth, whereas Jansen (2005) did not find a significant relationship between the absolute difference between both types of innovation and firm profitability and ROE. Hence, empirical evidence is not conclusive at this point. To test this, we hypothesise that:

H4 The relative imbalance (absolute difference) between incremental and radical innovation has a negative influence on business performance.

Finally, for an organisation to be ambidextrous, incremental and radical innovation should be interconnected. As already explained, considering that exploration and exploitation have to be recombined to create value (Eisenhardt and Martin, 2000; O’Reilly and Tushman, 2008; Teece, 2007), the mere coexistence of exploratory and exploitative activities is not enough: both exploration and exploitation should be complementary and mutually reinforcing, and knowledge should flow smoothly between exploration and exploitation activities. Thus, the following hypothesis has been formulated:

H5 Alignment between incremental and radical innovation positively affects business performance.

4 Research method

The study has been developed in two phases. In the first phase of the research, the population subject to study was made up of medium-high and high technology firms from the Basque Region (Spain) which carry out R&D activities and which have more than 20 employees. These companies (306) have been identified thanks to EUSTAT (the Basque Institute of Statistics). All of them were contacted and, eventually, 105 agreed to participate in the study, representing a response rate of 34%.

Subsequently, in order to achieve increased presence of large firms in the analysed sample, in the second phase of the research, medium-high and high technology companies with 250 or more employees, based in Madrid or Barcelona and with registered accounts in SABI database, were the target population. A total of 208 companies meeting these conditions were identified, from which, due to the time available, 147 organisations could be randomly contacted. 20 of these companies have finally participated in the study, representing a response rate of 14% and a 10% coverage of the universe identified.

Therefore, the group of companies analysed is composed of a total of 125, from which only 116 combine incremental and radical innovation simultaneously within the organisation, which are those on which we have focused in this research. Table 1 shows the sectors and companies included in the study.
This sample size is large enough to carry out a statistical study based on structural equation modelling (SEM) (partial least squares – PLS approach) by means of PLS-graph software (Chin and Frye, 2003). In particular, the sample size required when using this technique is that which would support the most complex multiple regression of the model. For this regression to be identified, the following should be observed:

a the formative construct with the largest number of indicators (i.e., the largest measurement equation)

b the dependent latent variable with the largest number of independent latent variables influencing it (i.e., the largest structural equation).

If one were to use a regression heuristic of ten cases per predictor, the sample size requirement would be ten times either (a) or (b), whichever the greater (Barclay et al., 1995; Chin and Newsted, 1999). In this case, the minimum sample size required is made up of 50 companies.

<table>
<thead>
<tr>
<th>Sector</th>
<th>Frequency</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chemical industry</td>
<td>9</td>
<td>7.8%</td>
</tr>
<tr>
<td>Manufacture of pharmaceutical products</td>
<td>2</td>
<td>1.7%</td>
</tr>
<tr>
<td>Manufacture of computer, electronic and optical products</td>
<td>14</td>
<td>12.1%</td>
</tr>
<tr>
<td>Manufacture of electrical equipment</td>
<td>15</td>
<td>12.9%</td>
</tr>
<tr>
<td>Manufacture of machinery and equipment</td>
<td>21</td>
<td>18.1%</td>
</tr>
<tr>
<td>Manufacture of motor vehicles and trailers</td>
<td>4</td>
<td>3.4%</td>
</tr>
<tr>
<td>Manufacture of other transport equipment</td>
<td>10</td>
<td>8.6%</td>
</tr>
<tr>
<td>Manufacture of instruments and medical and dental supplies</td>
<td>3</td>
<td>2.6%</td>
</tr>
<tr>
<td>Motion picture, video and television program production, sound recording and music publishing</td>
<td>2</td>
<td>1.7%</td>
</tr>
<tr>
<td>Telecommunications</td>
<td>1</td>
<td>0.9%</td>
</tr>
<tr>
<td>Computer programming, consultancy and other activities related to computer</td>
<td>21</td>
<td>18.1%</td>
</tr>
<tr>
<td>Information services</td>
<td>1</td>
<td>0.9%</td>
</tr>
<tr>
<td>Research and development</td>
<td>13</td>
<td>11.2%</td>
</tr>
</tbody>
</table>

Four models have been run for each performance dimension under analysis (productivity, profitability and growth). In the first one, only the degree of engagement in exploitative and exploratory innovation has been included, together with company performance. The other models are alternative extensions of the first model. In the second one, ambidexterity measured as the multiplicative interaction between exploration and exploitation has been added; in the third one, ambidexterity as balance has been considered; and in the fourth one, ambidexterity as alignment between incremental and radical innovation has been included. In the next section, the measurement model is presented in more detail.

In order to gather information about the relevant variables of the research, two questionnaires were designed, one for the managing director of the company (or someone that has an overall perspective of the firm), and the other one for the innovation manager. In the first questionnaire, items measure both company performance and the degree of
Performance outcomes of interaction, balance, and alignment

5 Constructs and measures

To measure ambidexterity in the field of technological innovation, exploitative (i.e., incremental) and exploratory (i.e., radical) innovation efforts should be assessed. To this end, two scales were developed that capture the degree of emphasis put on the two pillars of technological innovation (products and processes), the degree of novelty of the innovations being introduced, and the focus of the innovation efforts: meeting the needs of existing customers and markets, or trying to access new customers or markets (Benner and Tushman, 2003). In the case of exploitative innovation, indicators measure the extent to which the company develops innovation projects aimed at:

1. improving current products and services
2. improving current processes
3. improving the technologies currently used
4. serving current customer segments better.

Conversely, in the case of exploratory innovation, indicators measure the extent to which the company develops innovation projects aimed at:

1. introducing completely new products and services
2. introducing completely new processes
3. developing new technologies
4. accessing new customer segments.

All the indicators used were measured by means of 1 to 7 Likert scales and are considered to shape or (give rise to) the exploitation/exploration orientation of the company (i.e., they are formative in nature).

Setting out from these constructs, the multiplicative interaction between exploitative and exploratory innovation efforts was then calculated, as well as the absolute difference (i.e., imbalance) between both of them. For the third ambidexterity dimension to be measured (alignment), a specific scale was developed which is made up of four indicators:

1. we are very good at extending the life of radical innovations carried out by incorporating successive incremental innovations
2. we are very satisfied with the degree of fit between incremental and radical innovation in our company
in our company incremental and radical innovation are mutually reinforcing.

we are very good at combining incremental and radical innovation.

The four indicators have been measured by means of 1 to 7 Likert scales and are reflective in nature.

Finally, as far as business performance (productivity, profitability and growth) is concerned, in this first stage of the research we used perceptual measures to capture the position occupied by the company vis-à-vis its competitors (1 to 7 Likert scales), based on empirical evidence that suggests that top managers’ self-reports on performance significantly correlate with some objective measures of firm performance (Dess and Robinson, 1984; Robinson and Pearce, 1988).

5.1 Multivariate analysis

SEM based on PLS was used to test the hypotheses of the research. SEM constitutes a second generation of multivariate analysis (Fornell, 1982) which combines multiple regression concerns (by examining dependency relationships) and factor analysis (by representing unobserved variables by means of multiple observed measures), in order to estimate a set of dependency relationships which are all simultaneously interrelated.

When applying SEM, two approaches can be used: the covariance-based approach and the PLS approach. In the first case, the aim is to determine the matrix of model parameters in such a way that the resulting covariance matrix predicted by the theoretical model is as close as possible to the sample covariance matrix (Haenlein and Kaplan, 2004). In the second case, however, the primary objective is the minimisation of error (or, equivalently, the maximisation of variance explained) in all endogenous constructs (Hulland, 1999). The use of the PLS approach avoids some of the problems linked to the variance-based one, such as those related to non-unique or otherwise improper solutions (Fornell and Bookstein, 1982), and to the use of small data samples (Fornell, 1982).

A PLS model is analysed and interpreted in two stages: firstly, an assessment of the reliability and validity of the measurement model is made, and secondly, an assessment of the structural model is carried out. This sequence ensures that the measures making up the constructs are valid and reliable before attempting to draw conclusions regarding relationships among constructs (Barclay et al., 1995).

5.1.1 Measurement model evaluation

As far as the measurement model evaluation is concerned, this differs depending on the nature of the construct being analysed (reflective or formative). In the case of constructs made up of reflective indicators, individual item reliability, construct reliability, convergent validity and discriminant validity should all be checked.

Individual item reliability refers to the extent to which a particular indicator effectively measures the latent variable to which it has been connected. For this to be assessed, the loadings or simple correlations of the measures with their respective construct should be observed. A rule of thumb is to accept items with loadings of 0.707 or more, which implies greater shared variance between the construct and its measures than error variance (Barclay et al., 1995; Carmines and Zeller, 1979). Since loadings are correlations, this means that more than 50% of the variance in the observed variable is shared with the construct.
Construct reliability or internal consistency refers to the extent to which all the indicators of a specific construct measure the same latent variable. If this is the case, all the indicators making up the construct should be highly correlated. For this to be tested, two options exist: Cronbach’s alpha and composite reliability ($\rho_c$). The latter was developed by Werts et al. in 1974 and is considered to be a better measure than Cronbach’s alpha. Composite reliability is calculated as follows:

$$\rho_c = \frac{\left(\sum \lambda_i^2\right)^2}{\left(\sum \lambda_i^2\right)^2 + \sum \text{var}(\varepsilon_i)}$$

Convergent validity is assessed by means of the so-called average variance extracted (AVE). This measure was created by Fornell and Larcker in 1981 and it provides the amount of variance that a latent variable captures from its indicators, relative to the amount due to the measurement error:

$$AVE = \frac{\sum \lambda_i^2}{\sum \lambda_i^2 + \sum \text{var}(\varepsilon_i)}$$

It is recommended that AVE should be greater than 0.50, this meaning that 50% or more of the variance of the construct is due to its own indicators.

Finally, discriminant validity indicates the extent to which a given construct is different from other constructs (i.e., the extent to which the constructs making up the research model actually measure different things). For this to be true, a construct should share more variance with its measures than it shares with other constructs of the model (Fornell and Larcker, 1981). In other words, AVE should be greater than the variance shared between the construct and other constructs (i.e., the squared correlation between the two constructs). As PLS-graph software (Chin and Frye, 2003) provides the correlation matrix for the constructs and not the squared correlations, it would be easier to calculate the root value of AVE for each construct (this would be the diagonal of the correlation matrix) and to compare it with the correlations obtained. For adequate discriminant validity, the diagonal elements (i.e., the root values of AVE) should be greater than the off-diagonal elements in the corresponding rows and columns.

In the case of constructs made up of formative indicators (i.e., when the observed measures give rise to the existence of the latent variable), multicolinearity problems should be explored.

### 5.1.2 Structural model evaluation

Once the quality of the measurement model has been guaranteed, the quality of the structural model should then be assessed. This refers to the strength of the research hypotheses and to the predictive power achieved.

In order to assess research hypotheses, path coefficient levels should be examined. They should be interpreted in the same way as $\beta$ coefficients in traditional regression. For their degree of stability and precision to be tested, non-parametric techniques of re-sampling such as jackknifing and bootstrapping should be used. Although jackknifing requires less computational time than bootstrapping, it is considered less efficient than the latter. Indeed, jackknifing is viewed by several authors as an approximation to
bootstrap (Chin, 1998; Efron and Tibshirani, 1993). Hence, bootstrapping was the technique of analysis used in this research.

More specifically, bootstrapping provides a 't' value for each relationship represented in the model. A student 't' distribution with n–1 degrees of freedom ('n' being the number of subsamples analysed: 500) should then be used to assess the 't' values obtained. If the sign of the relationships has been specified (as is our case) a one-tailed distribution could be used. Otherwise, a two-tailed distribution applies.

A measure of the predictive power achieved by a PLS model is provided by the $R^2$ value of the endogenous construct (Barclay et al., 1995). Once more, these values should be interpreted in the same manner as the $R^2$ obtained from a multiple regression analysis. Consequently, $R^2$ values indicate the amount of variance in the constructs which is explained by the model.

According to Falk and Miller (1992), the amount of variance explained ($R^2$) of an endogenous construct should be equal to or greater than 0.10 (i.e., 10%). They argue that although lower values of $R^2$ could be statistically significant, they provide very little information and therefore, the predictive power of the hypotheses formulated with respect to the latent variable under analysis is very low.

6 Results

Following the sequence of analysis previously described, the main findings of the multivariate analysis carried out are as follows:

6.1 Measurement model evaluation

Table 2 shows that all the indicators except alignment1 and productivity far exceed the value for loadings of 0.707 suggested by Barclay et al. (1995) as indicators of individual reliability. However, the loadings of these two items exceed 0.5, which is considered acceptable for early stages of scales development. These results also fulfil the requirements suggested for both construct reliability (composite reliability greater than 0.8) and convergent validity (AVE over 0.5).

In the case of the formative constructs, Table 2 shows that there are no problems of multicollinearity among the indicators. As Garson (2013) recommends, all the tolerance figures are well over 0.2, the variance inflation factors (VIF) are under four and condition indices are under 30 in every case.

Regarding the analysis of discriminant validity, Table 3 shows that the diagonal elements (i.e., the root values of AVE) are much greater than the off-diagonal elements in the corresponding rows and columns.

6.2 Structural model evaluation

Once the quality of the measurement model has been guaranteed, the quality of the structural model should then be assessed. This refers to the strength of the research hypotheses and to the predictive power achieved.
<table>
<thead>
<tr>
<th>Constructs and measures</th>
<th>Questions</th>
<th>Parameters</th>
</tr>
</thead>
<tbody>
<tr>
<td>Size (control variable)</td>
<td>Natural logarithm of the number of employees.</td>
<td>NA</td>
</tr>
<tr>
<td>Environmental dynamism (control variable) (reflective)</td>
<td>Rate from 1 to 7 (1 = not at all; 7 = totally) to what extent the following is the case in your company:</td>
<td>$\rho_c = 0.871$</td>
</tr>
<tr>
<td></td>
<td>AVE = 0.629</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Loadings</td>
<td></td>
</tr>
<tr>
<td>DYN1</td>
<td>Environmental changes in our market are intense.</td>
<td>0.7379</td>
</tr>
<tr>
<td>DYN2</td>
<td>In our market changes are taking place continuously.</td>
<td>0.8304</td>
</tr>
<tr>
<td>DYN3</td>
<td>During the last year, many changes have occurred in our market.</td>
<td>0.8481</td>
</tr>
<tr>
<td>DYN4</td>
<td>In our market, the volumes of products and services to be delivered change fast and often.</td>
<td>0.7504</td>
</tr>
<tr>
<td>Exploitation (formative)</td>
<td>Rate from 1 to 7 (1 = not at all; 7 = very much) the extent to which your company develops innovation projects aimed at:</td>
<td>Highest VIF = 1.417</td>
</tr>
<tr>
<td></td>
<td>Highest CI = 21.466</td>
<td></td>
</tr>
<tr>
<td>EXPLOIT1</td>
<td>Improving current products and services.</td>
<td>0.2764 (–)</td>
</tr>
<tr>
<td>EXPLOIT2</td>
<td>Improving current processes.</td>
<td>0.7043*</td>
</tr>
<tr>
<td>EXPLOIT3</td>
<td>Improving technologies currently used.</td>
<td>0.6241†</td>
</tr>
<tr>
<td>EXPLOIT4</td>
<td>Better serving current customer segments.</td>
<td>0.7103 (–)†</td>
</tr>
<tr>
<td>Exploration (formative)</td>
<td>Rate from 1 to 7 (1 = not at all; 7 = very much) the extent to which your company develops innovation projects aimed at:</td>
<td>Highest VIF = 1.392</td>
</tr>
<tr>
<td></td>
<td>Highest CI = 13.728</td>
<td></td>
</tr>
<tr>
<td>EXPLORA1</td>
<td>Introducing completely new products and services.</td>
<td>0.3387</td>
</tr>
<tr>
<td>EXPLORA2</td>
<td>Introducing completely new processes.</td>
<td>0.3443</td>
</tr>
<tr>
<td>EXPLORA3</td>
<td>Developing new technologies.</td>
<td>0.5570*</td>
</tr>
<tr>
<td>EXPLORA4</td>
<td>Accessing new customer segments.</td>
<td>0.2129</td>
</tr>
</tbody>
</table>

Notes: $\rho_c$: composite reliability; AVE: average variance extracted; VIF: variance inflation factor; CI: condition index; $^*p < 0.05$, $^†p < 0.1$ (based on $t_{499}$, one-tailed test).
# Table 2: Measurement model evaluation (part 1) (continued)

<table>
<thead>
<tr>
<th>Constructs and measures</th>
<th>Questions</th>
<th>Parameters</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interaction</td>
<td>Exploitation x exploration</td>
<td>NA</td>
</tr>
<tr>
<td>Imbalance</td>
<td>Absolute difference between exploitation and exploration</td>
<td>NA</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$\rho_c = 0.888$</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$AVE = 0.673$</td>
</tr>
<tr>
<td>ALIGN1</td>
<td>We are very good at extending the life of radical innovation projects carried out by incorporating successive incremental innovations.</td>
<td>0.5505</td>
</tr>
<tr>
<td>ALIGN2</td>
<td>We are very satisfied with the degree of fit between incremental and radical innovation in our company.</td>
<td>0.9009</td>
</tr>
<tr>
<td>ALIGN3</td>
<td>In our company, incremental and radical innovation are mutually reinforcing.</td>
<td>0.8948</td>
</tr>
<tr>
<td>ALIGN4</td>
<td>We are very good at combining incremental and radical innovation.</td>
<td>0.8810</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$\rho_c = 0.785$</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$AVE = 0.549$</td>
</tr>
<tr>
<td>CP1</td>
<td>Profitability</td>
<td>0.7320</td>
</tr>
<tr>
<td>CP2</td>
<td>Sales growth</td>
<td>0.7876</td>
</tr>
<tr>
<td>CP3</td>
<td>Productivity</td>
<td>0.7011</td>
</tr>
</tbody>
</table>

Notes: $\rho_c$: composite reliability; $AVE$: average variance extracted; VIF: variance inflation factor; CI: condition index; *$p < 0.05$, †$p < 0.1$ (based on $t_{499}$, one-tailed test).
Table 3

<table>
<thead>
<tr>
<th></th>
<th>Size (1)</th>
<th>Environmental dynamism (2)</th>
<th>Exploitation (3)</th>
<th>Exploration (4)</th>
<th>Interaction (5)</th>
<th>Imbalance (6)</th>
<th>Alignment (7)</th>
<th>Company perf. (8)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1.000</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>-0.065</td>
<td>0.793</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>0.112</td>
<td>0.074</td>
<td>NA</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>0.393</td>
<td>-0.001</td>
<td>0.121</td>
<td>-0.058</td>
<td>1.000</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>-0.086</td>
<td>0.083</td>
<td>-0.146</td>
<td>-0.058</td>
<td>-0.584</td>
<td>1.000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>0.064</td>
<td>-0.108</td>
<td>-0.056</td>
<td>-0.016</td>
<td>-0.584</td>
<td>1.000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>0.064</td>
<td>-0.072</td>
<td>0.000</td>
<td>0.185</td>
<td>-0.013</td>
<td>-0.040</td>
<td>0.820</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>0.160</td>
<td>-0.175</td>
<td>0.161</td>
<td>0.296</td>
<td>-0.046</td>
<td>-0.011</td>
<td>0.220</td>
<td>0.741</td>
</tr>
</tbody>
</table>

Notes: Diagonal elements are the square root of the variance shared between the constructs and their measures, relative to the amount due to measurement error (AVE). Off-diagonal elements are the correlations among constructs. For discriminant validity, diagonal elements should be larger than off-diagonal elements.
NA: not applicable (formative construct).
Table 4  Structural model evaluation – path coefficients and amount of variance explained ($R^2$)

<table>
<thead>
<tr>
<th>Control variables</th>
<th>Endogenous construct</th>
<th>Exploratory constructs</th>
<th>( R^2 )</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Company performance</td>
<td>-0.030</td>
<td>0.030</td>
</tr>
<tr>
<td></td>
<td>Endo. dynam.</td>
<td>-0.173*</td>
<td>-0.173*</td>
</tr>
<tr>
<td></td>
<td>Exploitation</td>
<td>0.141</td>
<td>0.141</td>
</tr>
<tr>
<td></td>
<td>Intervention</td>
<td>0.237*</td>
<td>0.237*</td>
</tr>
<tr>
<td></td>
<td>Imbalance</td>
<td>0.090</td>
<td>0.090</td>
</tr>
<tr>
<td></td>
<td>Alignment</td>
<td>0.161*</td>
<td>0.161*</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>16.36%</td>
</tr>
</tbody>
</table>

Note: *p < 0.05 (based on t499, one-tailed test).
The results obtained show that, in the companies studied, engaging in radical (i.e., exploratory) innovation efforts is the main explanatory factor of business performance. Hence, Hypotheses H2 is clearly supported. On the contrary, incremental (i.e., exploitative) innovation efforts do not make any significant difference in business performance. Thus, Hypotheses H1 is not supported. Although descriptive analyses carried out show that, in general terms, innovation efforts are more biased towards incremental innovation than towards radical innovation, it is only the latter that exerts a significant influence both on company growth and on firm profitability.

As far as ambidexterity facets are concerned, traditional dimensions related to the multiplicative interaction between exploitation and exploration and to the degree of balance between both of them are completely non-significant. Hence, Hypotheses H3 and H4 are not supported. What truly matters for firm performance is that exploitative (i.e., incremental) innovation and exploratory (i.e., radical) innovation efforts are interconnected and mutually reinforcing. The results obtained show that Hypothesis H5 is supported.

7 Discussion and implications

This research adds to the growing literature on organisational ambidexterity by contrasting the positive effect it has on company performance (productivity, profitability and growth) in the technological innovation domain.

The ambidexterity premise establishes that firms capable of simultaneously pursuing exploitation and exploration are more likely to achieve superior performance than firms emphasising one at the expense of the other (Tushman and O’Reilly, 1996). This premise has been already tested in several studies (Gibson and Birkinshaw, 2004; He and Wong, 2004; Jansen, 2005; Lubatkin et al., 2006; Venkatraman et al., 2007).

Table 5  Orientation of the perceived imbalance between incremental and radical innovation

<table>
<thead>
<tr>
<th>Orientation</th>
<th>Frequency</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>No answer</td>
<td>1</td>
<td>0.86%</td>
</tr>
<tr>
<td>No bias (i.e., complete balance)</td>
<td>21</td>
<td>18.10%</td>
</tr>
<tr>
<td>Bias towards incremental innovation</td>
<td>72</td>
<td>62.07%</td>
</tr>
<tr>
<td>Bias towards radical innovation</td>
<td>22</td>
<td>18.97%</td>
</tr>
</tbody>
</table>

Our research shows that, on the contrary, what is of utmost importance for firm performance is to focus on radical innovation, even though returns on exploration are more uncertain and more distant in time. It is also important to highlight that none of the facets reported in the literature for the measurement of ambidexterity has proved to be relevant. That is, neither the multiplicative interaction (i.e., the non-substitutable combination of exploration and exploitation), nor the balance between exploration and exploitation (i.e., the absolute difference between them) has shown a significant impact on firm performance (i.e., company productivity, growth and profitability). On the contrary, for firms to succeed, results show that the most important factor is that exploitative (i.e., incremental) innovation and exploratory (i.e., radical) innovation efforts are interconnected and mutually reinforcing (i.e., high level of alignment). In other words, incremental innovation should be related to and complement radical innovation.
efforts, but there is no need to balance or developed them to the same extent. In fact, radical innovation efforts should be further enhanced.

Although descriptive analyses carried out (see Table 5) show that, in general terms, innovation efforts are more biased towards incremental innovation than towards radical innovation, it is only the latter that exerts a significant influence on firm performance. Therefore, companies wishing to obtain superior performance should emphasise exploration efforts at the expense of exploitation ones.

8 Limitations and future research opportunities

The study carried out has several limitations. The first one refers to the use of perceptual measures to capture company performance. Given that most of the companies involved in the study are not listed, it was very difficult to obtain accounting information about firms’ current results at the time of developing the field work of the research. Thus, we had no choice but to apply to the companies themselves. However, firms are often reluctant to provide this kind of information. Consequently, we decided to use perceptual indicators, based on empirical evidence that suggests that CEO self-reports on performance significantly correlate with some objective measures of firm performance (Dess and Robinson, 1984; Robinson and Pearce, 1988). In fact, this is common practice in organisational ambidexterity research (Andersen and Nielsen, 2007; Bierly and Daly, 2007; Chiu et al., 2011; Çömez et al., 2011; Gibson and Birkinshaw, 2004; Lubatkin et al., 2006; Sarkees et al., 2010; Schudy, 2010; Stubner et al., 2012; Lee et al., 2012).

The second limitation refers to how desirable it is to have longitudinal data in order to check the impact of a firm’s ambidexterity at present in its future results. However, that possibility exceeds the expected timeframe for this research, so it is suggested as a future research direction.

In addition, our sample includes a significant majority of companies located in the Basque Region (Spain) and we used a convenience sample for Madrid and Barcelona.

Finally, future research could examine the validity of the operationalisation approach (i.e., alignment) proposed for ambidexterity in different populations.

References


Jansen, J.J.P. (2005) *Ambidextrous Organizations: A Multiple-Level Study of Absorptive Capacity, Exploratory and Exploitative Innovation and Performance*, Erasmus Research Institute of Management (ERIM), Rotterdam, NL.


