

Leadership diversity, business advice and firm-level innovation outcomes

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A report for Innovate UK

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EXECUTIVE SUMMARY

Business advice has been shown to contribute to business growth and performance. Providing business advice has therefore been seen as having the potential to address the impact of gender and ethnic differences on business start-up rates, growth and survival. Internationally, these considerations have led to advice programmes directing targeted advice at female-owned and minority-owned enterprises.

Interest in diversity and its impact on business leadership and performance has also increased significantly in recent years as organisations seek to establish a business case for supporting diversity.

Here, we consider the relationship between diversity, business advice, and innovation outcomes. We address two specific research questions:

- Does diversity in firms' leadership teams influence their willingness to seek external business advice?
- And, does diversity in firms' leadership team impact firms' ability to benefit from external advice?

Our analysis uses new data from the UK Innovation State of the Nation Survey (ISNS 2023) which provides information on firm-level innovation-related indicators, as well as information on diversity in firms' leadership teams. We use a two-stage model which simultaneously reflects the impacts of diversity on firms' willingness to take, and ability to benefit from, external advice.

The analysis suggests three key findings:

- First, both gender and ethnicity diversity in leadership are positively associated with a higher likelihood of a firm seeking external advice.
- Second, when firms seek external advice, they significantly and consistently outperform their non-advice-seeking counterparts in product and process innovation. These effects are stronger for product innovation.
- Third, the effect of advice on innovation becomes stronger as firms gravitate towards gender-balanced and ethnic-balanced management. Statistically, this effect is strongest for gender diversity and product innovation.

Overall, gender and ethnic diversity in leadership have a twin effect on the link between business advice and innovation. Greater diversity means firms are more likely to seek advice, and when they do, greater diversity means advice provides stronger innovation benefits.

Our results suggest that promoting diversity in leadership is likely to maximise the innovation benefits of business advice. In short, firms with more diverse teams are more likely to seek advice and to be able to leverage its benefits to support innovation.

For providers of business advice, the implication is that the innovation payoff will be greatest where firms have more diverse leadership teams. For firms, our findings reinforce the broader case for diversity, helping to maximise the benefits derived from external advice.

1. INTRODUCTION

Interest in diversity and its impact on business leadership and performance has increased significantly in recent years (Vieira, Madaleno and Lobão, 2022) as organisations seek to establish a business case for supporting diversity (Azmat and Boring, 2020). In the UK, Azmat and Boring (2020) date policy concerns with diversity to 2003 and the Tyson Report on the Recruitment and Development of Non-Executive Directors. Tyson commented: ‘The most fundamental business rationale for a company’s commitment to greater diversity in the boardroom, like its commitment to diversity at all levels, is a simple and compelling one - the desire to find and employ the best talent (Tyson Report, 2003, p. 7).¹ A range of countries have subsequently adopted statutory or non-binding gender quotas on company boards although ‘causal evidence for the business case is limited, with much of the analysis often ignoring important selection effects’ (Azmat and Boring, 2020, p. 763).

Alongside the talent recruitment point made by Tyson (2003), the business case for diversity often draws on broader resource-acquisition arguments. Promoting diversity can provide reputational benefits by helping firms to recruit a diverse workforce, lead to cost savings by reducing labour turnover and, have performance benefits by drawing on a more cognitively diverse workforce (Cox and Blake 1991). In terms of firms’ innovation performance, in particular, the benefits of cognitive diversity may be particularly important, although the empirical evidence on the relationship between workforce diversity and firm-level innovation outcomes remains relatively limited². Studies also vary in their focus, considering the innovation effects of diversity in different aspects of the business, e.g. leadership diversity, workforce diversity³.

At the firm level, Ritter-Hayashi, Vermeulen and Knoblen (2019) find that gender diversity in firms’ leadership teams and workforces, positively impacts innovation in developing countries, particularly in the presence of measures to support women’s economic opportunity. Similarly, Østergaard, Bram and Kari (2009) use data from matched employee-employer data for Danish firms and find that gender diversity in the workforce has a strong effect on the propensity to innovate, i.e. ‘the most balanced firms (50-60% of same gender) are almost twice as likely to innovate compared to the most concentrated firms (90-100% of same gender)’ (Østergaard, Bram and Kari, 2009, p. 13).

Despite the differences in approach these studies typically suggest a positive relationship between gender diversity and firm-level innovation outcomes. However, they often provide little insight into the mechanisms through which this positive linkage occurs. Here, we explore one potential mechanism, focusing on the impact of gender and ethnic diversity in firms’ leadership teams on firms’ use and gains from external business advice. Accessing such advice has been seen as having the potential to contribute to differences in business start-up

¹ See <https://internationalwim.org/wp-content/uploads/2020/06/TysonReport.pdf>. Accessed 26 Feb 2024.

² Evidence on diversity and the performance of R&D and R&D teams is more extensive. Although, even here empirical studies provide inconsistent evidence. See <https://www.enterpriseresearch.ac.uk/wp-content/uploads/2018/10/No8-SOTA-Diversity-in-Innovation-Teams-M.-Garcia.pdf>.

³ See <https://www.enterpriseresearch.ac.uk/wp-content/uploads/2021/03/No49-Building-a-creative-work-force-T.-Friedrich-2.pdf>.

rates, growth and survival (Yazdanfar and Abbasian, 2015). We address two specific research questions:

- First, does gender and ethnic diversity in firms' leadership team influence their willingness to seek external business advice?
- And, secondly, does gender and ethnic diversity in firms' leadership team impact firms' ability to benefit from external advice?

Our analysis uses data from the UK Innovation State of the Nation Survey (ISNS 2023). This provides information on firm-level innovation-related indicators, as well as diversity in firms' leadership teams (Teruel, Parra and Blasco 2015). It is important to note that as the ISNS is a cross-sectional survey our analysis can only establish correlations and not causal linkages.

In considering both the effect of diversity (gender and ethnicity) on the propensity to access business advice and firms' ability to benefit from that advice, we make two contributions to the existing literature. First, we expose how diversity moderates the relationship between business advice and innovation (Ali and Mustafa, 2023). This is important in evidencing the potential value of alternative policy interventions. Should the focus of policy attention be firms' propensity to seek advice, firms' ability to benefit from that advice, or both? Second, focusing on both research questions together also helps address the concerns relating to selection effects raised by Azmat and Boring (2020) regarding the link between business advice and innovation.

The remainder of this report is organised as follows:

- Section 2 briefly reviews earlier evidence on the role of business advice in supporting innovation and what is known about gender and ethnic diversity and firms' attitudes to business advice.
- Section 3 describes the data and analysis and Section 4 presents the key results.
- Section 5 summarises the key findings and policy implications.

2. BUSINESS ADVICE, DIVERSITY AND INNOVATION – PRIOR EVIDENCE

2.1 Business advice and innovation

There is substantial evidence of the importance of collaboration for innovation, particularly in the literature on open innovation (Arsanti, Rupidara and Bondarouk, 2022; Hervas-Oliver, Sempere-Ripoll and Boronat-Moll, 2021; Ebersberger *et al.*, 2021; Davies *et al.*, 2021). External relationships linked to firms' innovation activity vary significantly, however, in the advantages they provide (Zacharias, Daldere and Winter, 2020). Partnerships which involve collaborative R&D, for example, might help firms to share the risks and costs of innovation as well as providing new knowledge or information which may shape firms' innovation activity. Accessing external business advice may help provide new knowledge or information about technologies or markets but is less likely to involve cost-sharing.

As such, external business advice may help firms offset the technological and/or commercial risks implicit in innovation (Rhaiem and Amara, 2021; Astebro and Michela, 2005). Where advice provides a firm with new technical information, for example, it may help diagnose and reduce risks, particularly in radical innovation projects (Keizer and Halman, 2007). Market or consumer information on the other hand may help firms to reduce the potential for customer complaints (Arora and Chakraborty, 2021; Heidenreich and Kraemer, 2015), and increase the expected returns to innovation.

Business advice can vary widely in terms of both content and provider with Mole, North and Baldock (2017) making three distinctions:

- Informal assistance is provided by friends, family or business contacts, and formal assistance is provided by private sector advisors such as lawyers or accountants, incubators or accelerators, public sector providers or advice agencies.
- Generic advice may relate to government regulations or legislation, while advice may also relate to more context-specific tacit knowledge related to strategy, markets or technologies.
- Transactional advice to support the day-to-day operations of the business and transformational or strategic advice may help the firm to make a step change in performance.

Regardless of its source or nature, a key issue is whether firms choose to take up external advice. As Mole, North and Baldock, (2017, p. 379) comment, this may depend on 'the trust between the owner-manager and adviser; the degree to which they feel able to interact with advisers and implement advice; and, whether the owner-manager cocoons themselves within a wall of silence'. Several reasons have been suggested as to why firms may not seek or use external advice (Mole, North and Baldock, 2017): firms may have insufficient information on potential sources of external advice; firms may be unaware or unable to assess the potential benefits of external advice and have concerns about the cost of obtaining assistance or implementing recommendations received; or, firms may not feel they can trust external advisors who may not fully understand the business.

Direct evidence on the role of business advice on innovation is limited, although there is some evidence on the impact of working with innovation consultants. Here, previous studies suggest that working with consultants may help firms innovate more efficiently by providing both market and technical knowledge (Sandberg and Werr, 2003). As Tether and Tajar (2008, p. 1082) suggest: 'Consultancies and private research organisations also have a definite role in this model of innovation. Consultants and private research organisations are amongst the obvious sources of external ideas; ideas that they develop themselves and that they have observed elsewhere'.

Such engagement is more likely where firms have 'open' approaches to innovation and strong social capital (Tether and Tajar, 2008). However, firms' ability to benefit from external advice or consultancy also depends on absorptive capacity and management processes which can counter 'knowledge filters' (Sandberg and Werr, 2003). Other studies have also suggested that external consultancy may raise issues for firms by providing standardised solutions, creating dependency (Back, Praveen Parboteeah and Nam, 2014), and risking knowledge leakage (Hoecht and Trott, 2006).

On balance, however, the evidence suggests that we would expect a positive relationship between business advice and firms' innovation performance.

2.2 Diversity and business advice

Business advice has been shown to contribute to business growth and performance both among the general population of firms (Robson and Bennett, 2000) and also in women-owned enterprises (Lakovleva et al. 2013). Providing business advice has therefore been seen as having the potential to address gendered differences in business start-up rates, growth and survival (Yazdanfar and Abbasian, 2015). Internationally, these considerations have led to a range of advice programmes directing targeted advice at female-owned enterprises (Chian, Hanifah and Vafaei-Zadeh, 2022)⁴.

Specific evidence on gender diversity in firms' leadership teams and business advice is, limited. Early studies emphasised the specific needs of women-owned businesses: 'Women have different ways in which they can benefit from business advice because of family commitments and a greater fear of financial or debt problems, leading to a larger use of informal finance' (Bennett, 2008, p. 391). Scott and Irwin, (2009) also found that among a sample of UK SMEs, male-owned firms were more likely to seek external advice from private sources (accountants, lawyers etc.) while women-owned firms were more likely to access advice from government advice agencies as well as friends or family (Robson, Jack and Freel, 2008; Bennett, 2008).

Yazdanfar and Abbasian (2015) adopt a slightly different approach in their more recent study of gendered differences in the use of external advice by Swedish start-ups, focusing on the types of advice sought rather than the type of advice provider. Their analysis suggests that female entrepreneurs are more likely to seek advice relating to strategy, goals or visions; business planning; marketing or sales; tax; how to start and develop a business; and, building

⁴ See also <https://www.oecd.org/cfe/smes/Policy-Brief-on-Women-s-Entrepreneurship.pdf>. Accessed 7th March 2024.

a Website. Supply-side factors may also play a part in shaping the take-up of advice by female and male owner-managers, with Widerstedt, Månsson and Rosdahl (2018) finding gendered responses to new client inquiries by service providers.

Few, if any studies, have directly considered the potential link between ethnic diversity and the take-up or benefits that firms derive from business advice. Several studies have, however, highlighted the specific challenges faced by ethnic-minority entrepreneurs, and therefore their specific business advice needs (Ram et al., 2012). Cunningham & McGuire, (2019), for example, note earlier studies which suggest that ethnic-minority-led businesses are less likely to access publicly funded business advice. Their analysis among Scottish family-run, minority-ethnic businesses suggested a preference for 'individual, trust-based relationships' rather than more generic advice. Other earlier studies suggest similar findings in the context of firms in the West Midlands (Fallon & Brown, 2004) and other parts of the UK (Deakins et al., 2003).

The existing evidence on diversity and firms' absorptive capacity (ACAP) – their ability to benefit from any external advice they receive – is limited. Widerstedt, Månsson and Rosdahl (2018) argue that absorptive capacity may depend on leadership style, differentiating between adaptive and assimilation leadership styles but that gender may then moderate the leadership style-ACAP relationship. They suggest women business leaders may have higher ACAP as: 'Women tend to exhibit less impulsiveness than men, which means they are more likely to plan, follow procedures, and deliberate before acting. This difference could contribute to female top decision-makers' ability to foster and maintain routines in their firm, such as the routines that undergird Absorptive Capacity' (Pryor, Hirth and Jin, 2021, p.6).

3. DATA AND METHODOLOGY

3.1 Data

Before embarking on any econometric estimation, it is essential to provide a comprehensive description of the data used, including an overview of all the variables used in the analysis and explore how the main variables under investigation are related. Data is taken from the Innovation State of the Nation 2023 Survey (ISNS 2023) which collected information from over 2,000 companies to provide insight into firms' current innovation activities and challenges. The survey was conducted using a combination of Computer Assisted Telephone Interviewing (CATI) and an online B2B panel between November 2022 and February 2023. Firms were included in the survey if they had more than five employees and were not part of the public sector or a not-for-profit company. The aim was to provide a representative view of UK firms' R&D and innovation activity which could help to identify particular challenges and opportunities for policy development and advice. The ISNS 2023 includes companies from 12 UK regions (North East, North West, Yorks & Humber, East Midlands, West Midlands, East of England, London, South East, South West, Scotland, Wales, and Northern Ireland), 9 broad sector (SIC codes: ABDE, C, F, G, H, I, K, JLM, NPQRS), and 4 firm size bands (5-9, 10-49, 50-249, 250+ employees). A descriptive analysis of the data is shown in Tables 1 and 2, and Figures 1, 2 and 3.

Dependant variables

Here, we consider two main dependent variables, product innovation and process innovation. In the survey firms were asked 'Have you introduced any new products or services or made any changes to existing products or services over the last 12 months'. This suggests our binary product innovation indicator which takes the value of 1 if the firm introduced any innovation and 0 otherwise. Process innovation is defined in the same way following a survey question 'Have you made any changes to the processes which you use to produce goods or deliver services over the last 12 months'. There are more product innovators in our sample (60%) than there are process innovators (47%) (Table 1). The correlation between the two innovation measures is relatively weak, suggesting product/service innovators in our sample are a rather different group of firms to those undertaking process innovation (See Table A1 in the appendix for the correlation matrix).

Table 1. Descriptive statistics of variables used in the analysis

Variable	obs.	Mean	Std. Dev.	Min	Max
Product innovation	1,993	0.60	0.49	0	1
Process innovation	1,994	0.47	0.50	0	1
External advice	1,980	0.37	0.48	0	1
Gender diversity	1,894	0.28	0.22	0	0.5
Ethnic diversity	1,846	0.09	0.17	0	0.5
Frontier firm	1,980	0.27	0.44	0	1
External partnership	1,972	0.45	0.50	0	1
Exporter	2,009	0.52	0.50	0	1
Group	2,010	0.38	0.49	0	1
Size (50+ employee)	2,018	0.29	0.45	0	1
Investment in equipment	1,991	0.59	0.49	0	1
Investment in patent license	2,018	0.10	0.30	0	1
Investment in innovation training	2,018	0.39	0.49	0	1
Investment in product design	2,018	0.33	0.47	0	1
Investment in market research	2,018	0.23	0.42	0	1
Investment in market channel	2,018	0.34	0.47	0	1

Table 2. Distribution of gender and ethnicity in firms' leadership team

<i>Gender</i>	Leadership
Male only	29%
Female only	6%
Equal number of male & female	20%
Other combinations of male & female	45%
Total number of firms	1,894
<i>Ethnicity</i>	
Majority only	72%
Minority only	3%
Equal number of majority & minority	4%
Other combinations of majority & minority	21%
Total number of firms	1,846

Business advice

Our first variable of interest relates to firms seeking external assistance on matters affecting their business. In the survey, firms were asked: 'In the last 12 months have you sought external advice or information on matters affecting your business? We are only interested when this has been more than a casual conversation?' Here, we represent external advice by an indicator variable which takes a value of 1 if a firm answered yes to having sought external advice in the past 12 months and 0 otherwise. Assistance may be in the form of advice around digital technology, strategy to help grow or run their business, advice with net zero, or help with introducing new or upgraded products. There is a positive association between firms' innovation capability and seeking external advice. That is, the descriptive statistics shown in

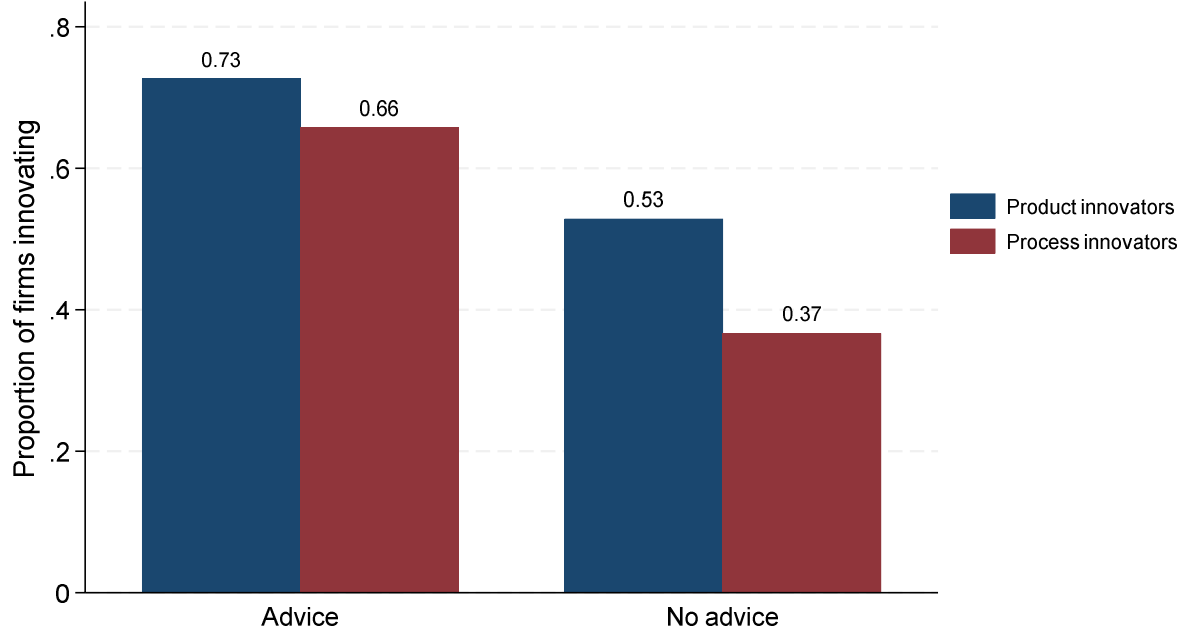
Figure 1 suggest that 73% (66%) of firms that sought external advice undertook product (process) innovation, while 53% (37%) of firms that did not seek advice undertook product (process) innovation.

Ethnic and gender diversity

In terms of the leadership team, the ISNS survey includes a question which asks: ‘Including owners or partners, how many people manage this business on a day-to-day basis?’ How many of the people who manage this business are women? How many are from ethnic minority groups?. In Table 2 we show the distribution of firms in our data across various constituents of gender and ethnic members in the leadership team. Table 2 shows that 29% of firms in the data have a male-only leadership team, 20% have equal proportions of male and female managers, and 6% have a female-only leadership team. In terms of ethnicity, 72% of firms in the data have a leadership team including only those from a majority ethnic background, 4% of firms have an equal distribution of members from majority and minority backgrounds, while 3% of firms have leadership consisting of only people with an ethnic minority background.

Now we want to investigate if firms with diverse leadership teams are more likely to leverage external advice for innovation. We measure diversity using the widely used Blau index (1977). Blau’s index, originally developed by Simpson (1949) as a measure of species diversity in an ecosystem, is calculated as $1 - \sum p_k^2$ where p is the proportion of unit members in the k th category. The index ranges from a lower bound of zero to an upper bound of $(k-1)/k$. So, for a diversity variable with two categories, $k=2$ and has an index with a lower and upper bound of 0 and 0.5. Similarly, a diversity variable with three categories has $k=3$ and an index ranging between 0 and 0.67. The lower bound suggests a sole representation of one category in the unit members while the upper bound represents a uniform distribution, with an even spread of members across all possible k categories of diversity.

Figure 1. Proportion of external support seekers and non-seekers innovating



Gender is represented by two categories (male and female) and in reference to the above formula, gender diversity in the leadership of each firm is calculated as $= 1 - (p_{male}^2 + p_{female}^2)$, where p_{male}^2 is square of the proportion of males in leadership and p_{female}^2 is the square of the proportion of females in management. Here a gender diversity index of 0 occurs when members of the leadership team are all male or all female, and the maximum diversity index of 0.5 occurs when leadership comprises an equal number of males and females. Due to the nature of the survey, ethnic diversity is also constructed using only two categories, namely, an ethnic-majority group and an ethnic-minority group. Similar to gender diversity, the ethnic diversity index ranges from 0 to 0.5.

Table 1 shows that firms' leadership teams are far from being balanced in ethnicity (the Blau index is between 0.09 and 0.12) while they are above midway towards a balanced composition in terms of gender with the Blau index of around 0.29. Figures 2 and 3 provide the distribution of our data in terms of advice, innovation and diversity index. There is no clearly defined pattern in Figure 2 to indicate that the proportion of firms in our data that engaged in innovating increases with diversity. What we do observe is that, regardless of the diversity level, the proportion of firms that undertook product innovation is higher than those that undertook process innovation. Figure 3 suggests a positive association between ethnic diversity in leadership and firms seeking external advice (right graph), and to some extent between gender diversity in leadership and firms seeking external advice (left graph). That is, as we move towards a more balanced ethnic diversity in management, the proportion of firms in our data that sought external advice increases.

Figure 2. Proportion of innovating firms across diversity index

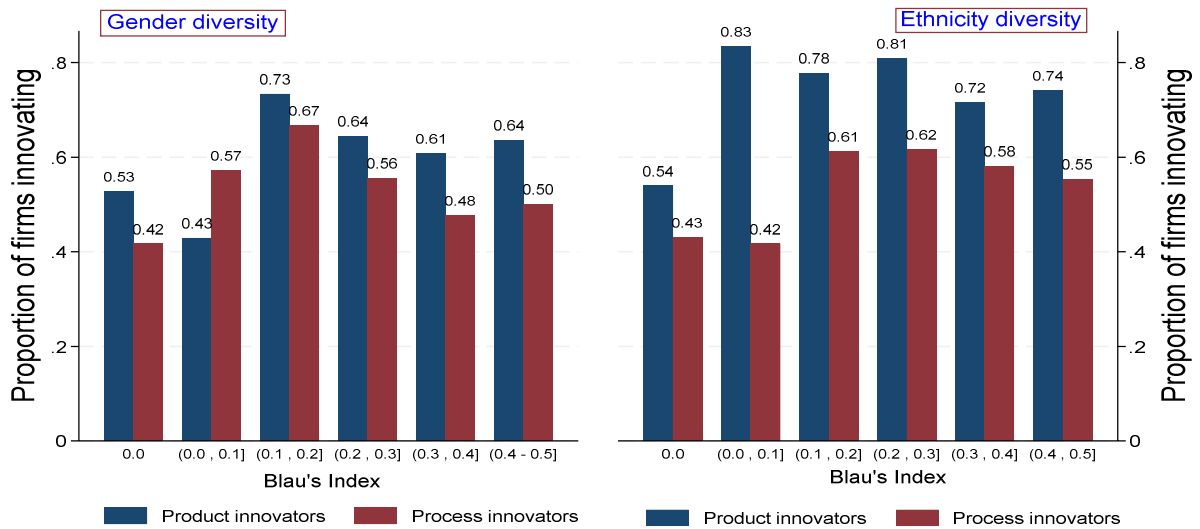
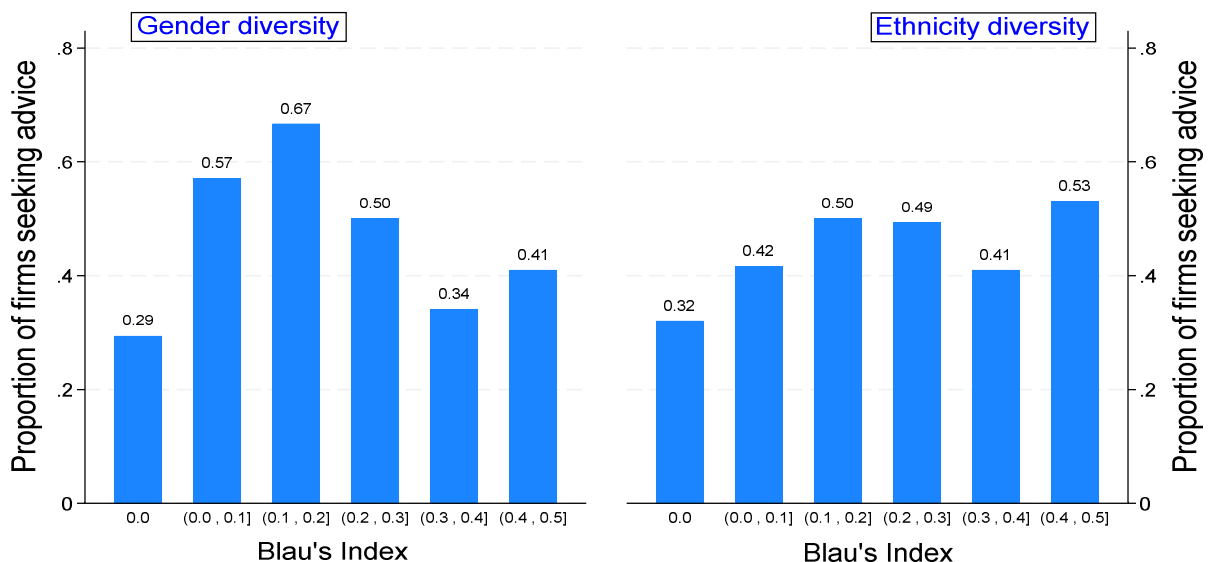


Figure 3. Proportion of firms seeking external advice across diversity index



Control variables

In the econometric analysis, we control for other firm-level characteristics that have been found in previous research to exert influence on the innovativeness of firms:

- **Partnerships** - Using a dummy variable we control for the firm's external partnership links to account for the potential effect of external knowledge spillovers (Laursen and Salter 2006; Roper et al. 2017).
- **Frontier firms** - We include a dummy variable for frontier firms which takes a value of 1 if the firm is indicated as a lead in the sector in terms of service or product quality and 0 otherwise. Frontier firms may be more innovative as they tend to invest

substantial amounts of their resources, both financial and human capital into researching and developing new ideas and technologies.

- **Multi-plant and exporting** - several studies have established a positive association between exporting and firms' innovativeness. Exporting firms engage with foreign partners, suppliers and distributors thereby developing networks which facilitate collaboration, knowledge sharing and exchange of innovative ideas and technologies. Multi-plant organisations imply diverse teams with varied perspectives, skill capabilities and backgrounds spread across different locations each with unique market demands, regulations and challenges. Proximity in technological know-how means multi-plant organisations can easily and readily adapt successful innovations and best practices developed in one plant to other plants.
- **Size** – this is represented by a dummy variable taking a value of 1 if the firm has 50-plus employees and 0 otherwise. Large firms are often more resource-endowed, which facilitates continuing investment in exploring and developing new technologies and processes. Over 70% of our sample are small firms.
- **Innovation investments** - we include dummies reflecting investments which firms make to help them with product/service development, or organisational changes. These include investment in: licensing of patents or know-how, training specifically linked to product/service changes, product/service design, market introduction of innovations, and development of new marketing relationships. Each of these indicators takes a value of 1 if the firm indicated yes to having made such investments in the past 12 months and zero otherwise. We observe that the majority of firms invested in equipment (59%) while only 10% of firms in our sample invested in licensing of patents. A similar proportion of firms made investments in product design and developing new marketing relationships.

The correlation matrix of all the variables included in this study is presented in Table 1A in the appendix and it shows that the correlations among the covariates are relatively weak suggesting few issues with possible multicollinearity.

3.2. Econometric strategy

One important concern when analysing the link between external advice and innovation is the possibility of endogeneity regarding their relationship. Innovation and external advice might be interdependent through unobserved variables (Wooldridge, 2010; Roodman, 2011). That is, the factors influencing innovation may also influence seeking external advice which can lead to biased estimates due to confounding. We therefore adopt the conditional mixed process (CMP) model (Roodman, 2011) which permits correlation among the factors influencing both innovation and external advice. The CMP allows us to simultaneously estimate two equations, one for innovation and one for the propensity to access external advice to account for the fact that unobserved characteristics may influence innovation and advice simultaneously. We estimate our CMP using probit models of the form:

$$INNO_i = \beta_1 EXT_i + \beta_2 DIV_i + \beta_3 (EXT * DIV)_i + \beta_4 X_i' + \mu_{2_i} \quad (1)$$

$$EXT_i = \phi_1 DIV_i + \phi_2 W_i' + \mu_{1_i} \quad (2)$$

$$\begin{pmatrix} \mu_{1_i} \\ \mu_{2_i} \end{pmatrix} \sim N_2(0, V) \quad (3)$$

Where $INNO_i$ is innovation (product innovation or process innovation), EXT_i is external advice, DIV_i is the diversity index representing either gender diversity in management or ethnicity diversity in management, X_i' consist of the control variables explained in Section 3.1 to have influence on innovation, W_i' consists of some of the control variables explained in Section 3.1 which may influence firms' decision to seek external advice. μ_{1_i} and μ_{2_i} are the error terms which are assumed to be correlated and fall into a two-dimensional normal distribution. Also, prior research shows an association between gender and ethnicity diversities. So, in Equation 2, we include in the covariates (W_i') the corresponding gender or ethnicity of DIV_i . For instance, the correlation between the two diversity variables in leadership is not very strong ($r = 0.25$) (see Table 1A in the appendix) so including both variables in Equation 2 does not create multicollinearity in our model.

4. EMPIRICAL RESULTS

Using the CMP bivariate probit model, we can first show how diversity is associated with the likelihood of firms seeking external advice. Second, we show that diversity helps firms leverage the benefits of external advice for innovation. Our choice of using a bivariate estimation approach assumes that there may be unobserved or omitted factors which simultaneously drive the propensity to introduce innovation and the likelihood of seeking external advice. Table 3 presents the probit estimation results for innovation and advice for analysis relating to diversity in firms' leadership teams. Table 3a presents the corresponding marginal effects, which measure, on average, how many percentage points (pp) the dependent variable (i.e., the likelihood of innovation or seeking advice) is expected to change when a specific independent variable (e.g., gender diversity in management) changes by a unit while keeping all other independent variables in the model unchanged.

The Rho values reported at the bottom of Table 3 measure the correlation between the error terms of our innovation and advice equations. A significant Rho estimate means that the correlation between the error term of the innovation equation and that of the advice equation is significantly different from zero. This suggests that there are factors which affect both innovation and advice which are not accounted for in our model. In such situations, estimating the two equations separately will generate inconsistent results, thereby suggesting the need for an estimation approach such as CMP which jointly estimates the two equations. On the other hand, if the estimated Rho is not significantly different from zero, then univariate probit models which separately estimate the propensity to innovate and the likelihood of seeking advice will generate consistent results. For instance, the significantly negative Rho estimate in Model 1 in Table 3 (Rho = -0.586 at 1% significance level) suggests that there is a negative correlation between the unobserved factors affecting both innovation and external advice, and being significant means that separate estimation results are likely to be biased. Complete results for both methods are presented in the appendix.

The bivariate probit estimation results for the innovation-advice-diversity link are presented in Table 3. Here unlike the marginal effects reported in Table 3a, the probit regression estimates reported in Table 3 can only be interpreted as positive or negative relationships between our independent variables and the dependent variables without referring to the magnitude of the relationship. We observe from the lower part of models M1, M2 and M3 in Tables 3 that both gender and ethnic diversity in leadership significantly increases the likelihood of a firm seeking external advice in matters affecting their business (i.e., significant coefficients between 0.302 and 0.328 for gender, and between 0.350 and 0.420 for ethnicity), while external advice subsequently increases the likelihood of innovation (upper part of Table 3). The interaction term for advice and leadership diversity is significant only for M1. That is, in terms of whether firms with more diverse leadership teams are better able to leverage innovation advantage from external advice, we find significant results only for gender and advice for product innovation ($b=0.506$ at 10% significance level).

The corresponding marginal effects are displayed in Table 3a. We find that all things being equal, a unit move towards an even gender constitution in the leadership team increases the likelihood of the firm seeking advice by between 10pp and 11pp, while a more ethnic-balanced leadership increases the likelihood of seeking advice by between 11pp and 14pp (lower part

of M1a to M3a). Subsequently, seeking advice increases the likelihood of product innovation between 25pp and 31pp (upper part of M1a and M3a), and the likelihood of process innovation between 39pp and 44pp (upper part of M2a and M4a).

Figure 4 presents the graphical representation of the innovation effect of advice and diversity in management. The first row represents advice and gender diversity in leadership relating to product and process innovation (M1 & M1a; M2 & M2a). The second row represents advice and ethnic diversity in leadership relating to product and process innovation (M3 & M3a; M4 & M4a). We observe from all four graphs that firms that seek advice (red line) are significantly more likely to innovate compared to their non-advice-seeking counterparts (blue line). Also, the product innovation gain from seeking advice is larger compared to process innovation gain.

In the top left graph, which relates to product innovation and gender diversity, we observe that as a firm moves from a leadership team which is solely males or females (diversity=0.0) towards an even representation of males and females (diversity=0.5) it gains stronger product innovation benefits from seeking external advice and loses more product innovation benefit for not seeking advice. That is, the gap between the product innovation gain of advice-seekers and that of non-advice seekers widens as gender diversity in leadership increases.

The remaining three graphs relate to product innovation and ethnic diversity, and process innovation and both ethnic and gender diversity. Here, while firms that seek external advice consistently and significantly outperform non-advice seekers in the likelihood of innovating in all contexts, diversity has no significant effect on firms' ability to leverage advice for innovation benefits.

Table 3: Probability of innovating and seeking external advice

	Gender Diversity model				Ethnic Diversity model			
	M1		M2		M3		M4	
	Product Innovation		Process innovation		Product Innovation		Process innovation	
	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.
1. Innovation								
Advice	0.863***	0.234	1.222***	0.257	0.796***	0.289	1.258***	0.253
Gender diversity	-0.142	0.178	0.032	0.181				
Gender diversity * Advice	0.506*	0.301	-0.348	0.296				
Ethnic diversity					0.069	0.286	-0.217	0.266
Ethnic diversity * Advice					0.593	0.427	0.359	0.370
Frontier	0.318***	0.078	0.079	0.073	0.310***	0.081	0.079	0.071
Exporter	0.307***	0.070	0.071	0.068	0.299***	0.073	0.080	0.067
Group	0.157**	0.074	-0.045	0.070	0.157**	0.077	-0.040	0.068
Firm size	-0.068	0.085	0.006	0.082	-0.103	0.090	-0.012	0.085
Equipment	0.178**	0.087	0.496***	0.095	0.199**	0.096	0.441***	0.102
Patent license	0.003	0.132	0.231 *	0.127	0.081	0.143	0.204	0.132
Innovation training	0.338***	0.070	0.282***	0.067	0.368***	0.075	0.269***	0.068
Product design	0.546***	0.076	0.307***	0.071	0.587***	0.082	0.280***	0.071
Market research	0.230***	0.087	0.189**	0.083	0.248***	0.092	0.188**	0.082
Market channel	0.180**	0.089	0.063	0.083	0.211**	0.096	0.014	0.085
Constant	-1.548***	0.224	-1.278***	0.221	-1.603***	0.230	-1.223***	0.219
Sector dummies	YES		YES		YES		YES	
Region dummies	YES		YES		YES		YES	
2. External advice								
Gender diversity	0.307**	0.156	0.302*	0.157	0.328**	0.152	0.251	0.156
Ethnic diversity	0.420**	0.206	0.350**	0.212	0.351*	0.212	0.352	0.216
External partnership	0.564***	0.068	0.611***	0.068	0.570***	0.068	0.609***	0.065
Firm size	0.101	0.081	0.126	0.081	0.118	0.081	0.129	0.081
Equipment	0.460***	0.069	0.452***	0.069	0.462***	0.069	0.449***	0.069
Patent license	0.276**	0.111	0.260**	0.111	0.262**	0.111	0.255**	0.111
Market channel	0.329***	0.070	0.324***	0.070	0.329***	0.070	0.329 ***	0.070
Constant	-0.892***	0.225	-0.857	0.230	-0.886***	0.227	-0.843***	0.231
Sector dummies	YES		YES		YES		YES	
Region dummies	YES		YES		YES		YES	
Rho	-0.586***	0.183	-0.506**	0.204	-0.457**	0.212	-0.654***	0.243
LogL [Chi2]	-1950.05	[936.3]	-2020.30	[897.09]	-1925.65	[869.36]	-1994.89	[997.39]
No. of observations	1,845		1,845		1,801		1,800	

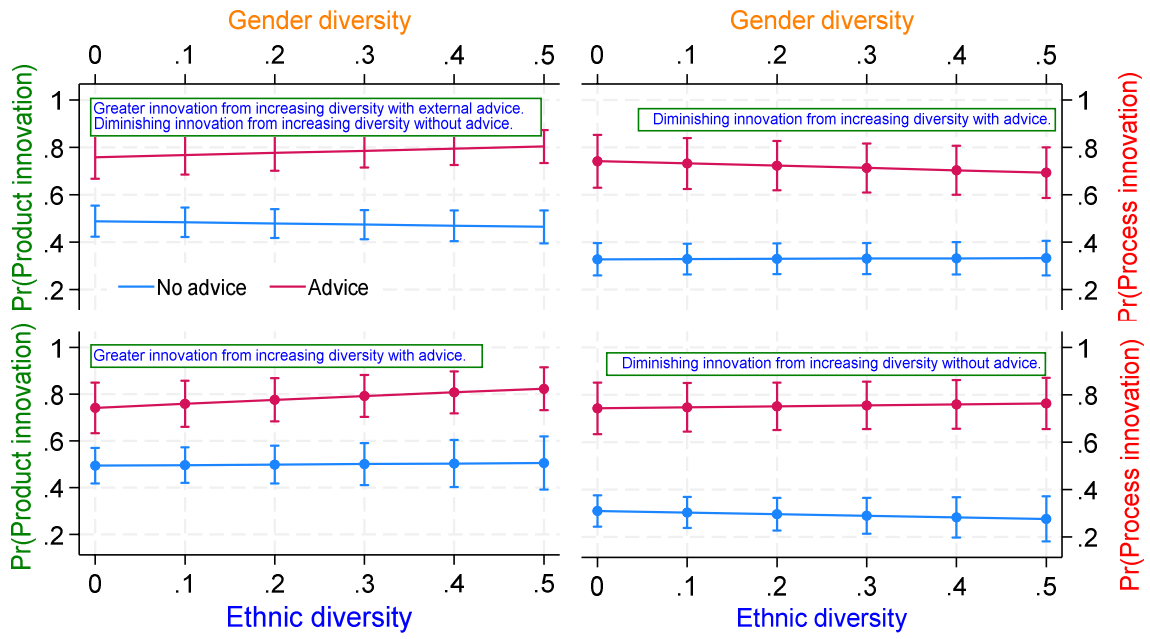
Note: *** p<0.01, ** p<0.05, * p<0.1

Table 3a: Marginal effects on the probability of innovating and seeking external advice

	Gender Diversity model				Ethnic Diversity model			
	M1a		M2a		M3a		M4a	
	Product Innovation		Process innovation		Product Innovation		Process innovation	
	AME	Std. Err.	AME	Std. Err.	AME	Std. Err.	AME	Std. Err.
1. Innovation								
Advice	0.307***	0.066	0.385***	0.083	0.257***	0.088	0.443***	0.084
Gender diversity	-0.001	0.045	-0.026	0.045				
Ethnic diversity					0.069	0.071	-0.028	0.063
Frontier	0.093***	0.023	0.024	0.022	0.091***	0.023	0.023	0.021
Exporter	0.091***	0.022	0.021	0.020	0.089***	0.022	0.023	0.020
Group	0.046**	0.022	-0.013	0.021	0.046**	0.023	-0.012	0.020
Firm size	-0.020	0.024	0.002	0.024	-0.030	0.026	-0.003	0.024
Equipment	0.053**	0.026	0.156***	0.035	0.059**	0.029	0.134***	0.037
Patent license	0.001	0.038	0.070*	0.040	0.023	0.042	0.060	0.040
Innovation training	0.100***	0.021	0.086***	0.022	0.110***	0.023	0.080***	0.022
Product design	0.164***	0.023	0.094***	0.023	0.178***	0.025	0.083***	0.023
Market research	0.067***	0.026	0.057**	0.026	0.073***	0.027	0.055**	0.025
Market channel	0.053**	0.027	0.019	0.025	0.062**	0.029	0.004	0.025
Sector dummies	YES		YES		YES		YES	
Region dummies	YES		YES		YES		YES	
2. External advice								
Gender diversity	0.099**	0.050	0.097*	0.05	0.106**	0.049	0.081	0.050
Ethnic diversity	0.136**	0.066	0.112*	0.068	0.113*	0.068	0.113	0.069
External partnership	0.194***	0.024	0.210***	0.024	0.196***	0.024	0.210***	0.023
Firm size	0.033	0.027	0.041	0.027	0.039	0.027	0.042	0.027
Equipment	0.152***	0.023	0.148***	0.023	0.152***	0.023	0.148***	0.023
Patent license	0.093**	0.038	0.087**	0.038	0.088**	0.038	0.085**	0.038
Market channel	0.111***	0.024	0.108***	0.024	0.111***	0.024	0.110***	0.024
Sector dummies	YES		YES		YES		YES	
Region dummies	YES		YES		YES		YES	
No. of observations	1,743		1,743		1,743		1,743	

Note: *** p<0.01, ** p<0.05, *p<0.1

Figure 4. Marginal effects of diversity in management on probability of innovation with 95% CI



5. KEY FINDINGS AND IMPLICATIONS

We consider two research questions reflecting two routes through which diversity may influence innovation outcomes. Are firms with more diverse leadership teams more likely to seek external business advice? Are firms with more diverse leadership teams better able to leverage innovation advantage from external advice?

Our analysis suggests three key findings:

- First, both gender and ethnicity diversity in leadership are positively associated with a higher likelihood of a firm seeking external advice. This is consistent with the majority of the prior evidence which, although not specifically referring to managerial diversity, does point to a positive link between female leadership and external advice-seeking (Bennett, 2008; Scott and Irwin, 2009; Robson, Jack and Freel, 2008).
- Second, when firms seek external advice, they significantly and consistently outperform their non-advice-seeking counterparts in product and process innovation. These effects are stronger for product innovation.
- Third, the effect of advice on innovation becomes stronger as firms gravitate towards gender-balanced and ethnic-balance management. Statistically, this effect is strongest for gender diversity and product innovation.

Overall, both gender and ethnic diversity in leadership have a twin effect on the link between business advice and innovation: greater diversity means firms are more likely to seek advice, and when they do, greater diversity means advice provides stronger innovation benefits.

Policies to increase diversity have been promoted as a means of addressing gendered and ethnic differences in business growth and performance (Yazdanfar and Abbasian, 2015). Our results suggest that promoting diversity in leadership teams is likely to maximise the innovation benefits of business advice. In short, firms with more diverse teams are more likely to seek advice and be able to leverage its benefits to support innovation. For providers of business advice, the implication is that the innovation payoff will be greatest where firms have diverse leadership teams. And, by promoting diversity, organisations will help in maximising the innovation value of advisory services. For firms our findings reinforce the broader case for diversity, helping to maximise the benefits derived from external advice.

Our analysis is subject to several limitations, some of which suggest avenues for future research. First, given our data comes from a single cross-sectional survey we can only talk in terms of correlation rather than causality. Future longitudinal analyses might help to disentangle the advice-diversity-innovation relationship further, and establish any time lags inherent in any causal relationships. Second, limited by data availability, we focus solely here on ethnic and gender diversity. Other aspects of diversity related to skills, age, and disability may also be worth considering in future studies. Finally, we focus on the overall population effect here and it may be worth considering in future analyses how diversity effects differ between populations sub-groups (sizebands, sectors).

APPENDIX – ADDITIONAL TABLES

Table A1. Correlation matrix of variables used in analysis

	Variable	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	Product innovation	1														
2	Process innovation	.37*	1													
3	External advice	.20*	.28*	1												
4	Gender diversity	.10*	.07*	.10*	1											
5	Ethnicity diversity	.17*	.11*	.14*	.25*	1										
6	Frontier	.20*	.13*	.10*	.05	.12*	1									
7	External partnership	.27*	.30*	.32*	.07*	.13*	.14*	1								
8	Exporter	.23*	.14*	.11*	.06*	.20*	.18*	.18*	1							
9	Group	.16*	.09*	.11*	.12*	.22*	.12*	.14*	.18*	1						
10	Size (50+ employees)	.14*	.11*	.12*	.19*	.35*	.12*	.16*	.22*	.38*	1					
11	Inv. in equipment	.25*	.34*	.26*	.08*	.09*	.10*	.26*	.12*	.08*	.11*	1				
12	Inv. in patent license	.15*	.17*	.16*	.08*	.15*	.13*	.21*	.11*	.15*	.19*	.15*	1			
13	Inv. in innovation training	.23*	.23*	.13*	.07*	.08*	.09*	.22*	.04	.10*	.09*	.29*	.12*	1		
14	Inv. in product design	.33*	.26*	.15*	.06	.08*	.18*	.24*	.19*	.08*	.06*	.23*	.11*	.20*	1	
15	Inv. in market research	.24*	.20*	.16*	.09*	.16*	.20*	.26*	.20*	.17*	.16*	.18*	.19*	.15*	.25*	1
16	Inv. in market channel	.24*	.20*	.20*	.06*	.11*	.15*	.27*	.14*	.08*	.07*	.16*	.09*	.17*	.25*	.32*

Table A2: Probability of innovating and seeking external advice (CMP Model)

	Gender Diversity model				Ethnic Diversity model			
	M1		M2		M3		M4	
	Product Innovation		Process innovation		Product Innovation		Process innovation	
	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.
1. Innovation								
Advice	0.863***	0.234	1.222***	0.257	0.796***	0.289	1.258***	0.253
Gender diversity	-0.142	0.178	0.032	0.181				
Gender diversity * Advice	0.506*	0.301	-0.348	0.296				
Ethnic diversity					0.069	0.286	-0.217	0.266
Ethnic diversity * Advice					0.593	0.427	0.359	0.370
Frontier	0.318***	0.078	0.079	0.073	0.310***	0.081	0.079	0.071
Exporter	0.307***	0.070	0.071	0.068	0.299***	0.073	0.080	0.067
Group	0.157**	0.074	-0.045	0.070	0.157**	0.077	-0.040	0.068
Firm size	-0.068	0.085	0.006	0.082	-0.103	0.090	-0.012	0.085
Equipment	0.178**	0.087	0.496***	0.095	0.199**	0.096	0.441***	0.102
Patent license	0.003	0.132	0.231 *	0.127	0.081	0.143	0.204	0.132
Innovation training	0.338***	0.070	0.282***	0.067	0.368***	0.075	0.269***	0.068
Product design	0.546***	0.076	0.307***	0.071	0.587***	0.082	0.280***	0.071
Market research	0.230***	0.087	0.189 **	0.083	0.248***	0.092	0.188**	0.082
Market channel	0.180**	0.089	0.063	0.083	0.211**	0.096	0.014	0.085
Constant	-1.548***	0.224	-1.278***	0.221	-1.603***	0.230	-1.223***	0.219
Sector dummies	YES		YES		YES		YES	
Region dummies	YES		YES		YES		YES	
2. External advice								
Gender diversity	0.307**	0.156	0.302*	0.157	0.328**	0.152	0.251	0.156
Ethnic diversity	0.420**	0.206	0.350**	0.212	0.351 *	0.212	0.352	0.216
External partnership	0.564***	0.068	0.611***	0.068	0.570***	0.068	0.609***	0.065
Firm size	0.101	0.081	0.126	0.081	0.118	0.081	0.129	0.081
Equipment	0.460***	0.069	0.452***	0.069	0.462***	0.069	0.449***	0.069
Patent license	0.276**	0.111	0.260**	0.111	0.262**	0.111	0.255**	0.111
Market channel	0.329***	0.070	0.324***	0.070	0.329***	0.070	0.329***	0.070
Constant	-0.892***	0.225	-0.857	0.230	-0.886***	0.227	-0.843***	0.231
Sector dummies	YES		YES		YES		YES	
Region dummies	YES		YES		YES		YES	
Rho	-0.586***	0.183	-0.506**	0.204	-0.457**	0.212	-0.654***	0.243
LogL [Chi2]	-1950.05	[936.3]	-2020.30	[897.09]	-1925.65	[869.36]	-1994.89	[997.39]
No. of observations	1,845		1,845		1,801		1,800	

Note: *** p<0.01, ** p<0.05, * p<0.1

Table A2a: Marginal effects on the probability of innovating and seeking external advice (CMP Model)

	Gender Diversity model				Ethnic Diversity model			
	M1a		M2a		M3a		M4a	
	Product Innovation		Process innovation		Product Innovation		Process innovation	
	AME	Std. Err.	AME	Std. Err.	AME	Std. Err.	AME	Std. Err.
1. Innovation								
Advice	0.307***	0.066	0.385***	0.083	0.257***	0.088	0.443***	0.084
Gender diversity	-0.001	0.045	-0.026	0.045				
Ethnic diversity					0.069	0.071	-0.028	0.063
Frontier	0.093***	0.023	0.024	0.022	0.091***	0.023	0.023	0.021
Exporter	0.091***	0.022	0.021	0.020	0.089***	0.022	0.023	0.020
Group	0.046**	0.022	-0.013	0.021	0.046**	0.023	-0.012	0.020
Firm size	-0.020	0.024	0.002	0.024	-0.030	0.026	-0.003	0.024
Equipment	0.053**	0.026	0.156***	0.035	0.059**	0.029	0.134***	0.037
Patent license	0.001	0.038	0.070*	0.040	0.023	0.042	0.060	0.040
Innovation training	0.100***	0.021	0.086***	0.022	0.110***	0.023	0.080***	0.022
Product design	0.164***	0.023	0.094***	0.023	0.178***	0.025	0.083***	0.023
Market research	0.067***	0.026	0.057**	0.026	0.073 ***	0.027	0.055**	0.025
Market channel	0.053**	0.027	0.019	0.025	0.062**	0.029	0.004	0.025
Sector dummies	YES		YES		YES		YES	
Region dummies	YES		YES		YES		YES	
2. External advice								
Gender diversity	0.099**	0.050	0.097*	0.050	0.106**	0.049	0.081	0.050
Ethnic diversity	0.136**	0.066	0.112*	0.068	0.113*	0.068	0.113	0.069
External partnership	0.194***	0.024	0.210***	0.024	0.196***	0.024	0.210***	0.023
Firm size	0.033	0.027	0.041	0.027	0.039	0.027	0.042	0.027
Equipment	0.152***	0.023	0.148***	0.023	0.152***	0.023	0.148***	0.023
Patent license	0.093**	0.038	0.087**	0.038	0.088**	0.038	0.085**	0.038
Market channel	0.111***	0.024	0.108***	0.024	0.111***	0.024	0.110***	0.024
Sector dummies	YES		YES		YES		YES	
Region dummies	YES		YES		YES		YES	
No. of observations	1,743		1,743		1,743		1,743	

Note: *** p<0.01, ** p<0.05, *p<0.1

Table A3: The probability of introducing innovation (Probit Model)

	Gender Diversity model				Ethnic Diversity model			
	M5		M6		M7		M8	
	Product Innovation		Process innovation		Product Innovation		Process innovation	
	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.
Advice	0.029	0.116	0.507***	0.116	0.118	0.084	0.374***	0.081
Gender diversity	-0.077	0.185	0.093	0.186				
Gender diversity * Advice	0.650**	0.324	-0.278	0.316				
Ethnic diversity					0.145	0.295	-0.122	0.282
Ethnic diversity * Advice					0.696	0.444	0.49	0.402
Frontier	0.349***	0.083	0.083	0.077	0.333***	0.084	0.09	0.078
Exporter	0.352***	0.073	0.092	0.072	0.322***	0.074	0.100	0.073
Group	0.182**	0.078	-0.037	0.074	0.168**	0.080	-0.040	0.075
Firm size	-0.026	0.088	0.046	0.082	-0.066	0.093	0.036	0.086
Equipment	0.342***	0.072	0.655***	0.070	0.330***	0.073	0.651***	0.070
Patent license	0.120	0.132	0.350***	0.121	0.187	0.137	0.372***	0.125
Innovation training	0.377***	0.073	0.312***	0.069	0.396***	0.075	0.312***	0.070
Product design	0.599***	0.080	0.331***	0.074	0.635***	0.082	0.324***	0.075
Market research	0.268***	0.094	0.227***	0.086	0.276***	0.096	0.233***	0.088
Market channel	0.323***	0.078	0.176**	0.073	0.328***	0.079	0.162**	0.074
Constant	-1.455***	0.240	-1.166***	0.227	-1.506***	0.241	-1.087***	0.228
Sector dummies	YES		YES		YES		YES	
Regional dummies	YES		YES		YES		YES	
Log Likelihood [R2]	-944.75	[0.2203]	-1013.43	[0.1851]	-916.77	[0.2251]	-988.62	[0.1841]
Correctly classified obs. (%)	74		72		74		72	
No. of observations	1,799		1,797		1,755		1,752	

Note: *** p<0.01, ** p<0.05, * p<0.1

Table A3a: Marginal effects of the probability of introducing innovation (Probit Model)

	Gender Diversity model				Ethnic Diversity model			
	M5a		M6a		M7a		M8a	
	Product Innovation		Process innovation		Product Innovation		Process innovation	
	AME	Std. Err.	AME	Std. Err.	AME	Std. Err.	AME	Std. Err.
Advice	0.062***	0.022	0.144***	0.024	0.052**	0.023	0.140***	0.024
Gender diversity	0.041	0.046	-0.003	0.049				
Ethnic diversity					0.110	0.071	0.019	0.071
Frontier	0.104***	0.024	0.027	0.025	0.099***	0.025	0.029	0.025
Exporter	0.108***	0.023	0.030	0.023	0.098***	0.023	0.032	0.024
Group	0.054**	0.024	-0.012	0.024	0.050**	0.024	-0.013	0.024
Firm size	-0.008	0.026	0.015	0.026	-0.020	0.027	0.012	0.028
Equipment	0.106***	0.023	0.225***	0.024	0.101***	0.023	0.224***	0.025
Patent license	0.036	0.039	0.114***	0.039	0.055	0.040	0.121***	0.040
Innovation training	0.115***	0.022	0.103***	0.023	0.120***	0.023	0.103***	0.024
Product design	0.185***	0.024	0.110***	0.025	0.196***	0.025	0.108***	0.025
Market research	0.080***	0.028	0.074***	0.029	0.082***	0.028	0.076***	0.029
Market channel	0.098***	0.024	0.057**	0.024	0.099***	0.024	0.053**	0.024
Sector dummies	YES		YES		YES		YES	
Region dummies	YES		YES		YES		YES	
Number of observations	1,799		1,797		1,755		1,752	

Note: *** p<0.01, ** p<0.05, * p<0.1

Table A4: The probability of seeking external advice (Probit Model)

	M9	
	Coef.	Std. Err.
Gender diversity	0.322**	0.157
Ethnic diversity	0.350	0.214
External partnership	0.555***	0.070
Firm size	0.128	0.081
Equipment	0.467***	0.069
Patent license	0.267**	0.112
Market channel	0.339***	0.070
Constant	-0.892***	0.231
Sector dummies	YES	
Region dummies	YES	
Log Likelihood [R2]	-1011.66	[0.1338]
Correctly classified observations (%)	70	
No. of observations	1,783	

Note: *** p<0.01, ** p<0.05, * p<0.1

Table A4a: Marginal effects of the probability of seeking advice (Probit Model)

	M9a	
	AME	Std. Err.
Gender diversity	0.104**	0.050
Ethnic diversity	0.112	0.069
External partnership	0.190***	0.024
Firm size	0.042	0.027
Equipment	0.153***	0.023
Patent license	0.089**	0.038
Market channel	0.114***	0.024
Sector dummies	YES	
Region dummies	YES	
No. of observations	1,783	

Note: *** p<0.01, ** p<0.05, * p<0.1

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