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When is organisational resizing helpful or harmful for innovation outputs?

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ABSTRACT

Research on the effect of changing staffing levels (i.e. resizing) on organisational innovation has generated mixed and often contradictory results. Recent research has attempted to reconcile such inconsistencies by showing that this effect on innovation depends on the firm's staffing level prior to downsizing. Since firms seek to downsize as well as upsize their staffing levels, the effect of resizing (downsizing and upsizing) on innovation and the magnitude of such effect is still unknown. Using a longitudinal dataset of UK firms, we examine the effect of resizing on innovation outputs and its magnitude in resource-rich and resource-constrained firms. Our results suggest that upsizing in resource-constrained firms and downsizing in resource-rich firms is helpful for innovation, whereas upsizing in resource-rich and downsizing in resource-constrained firms have the reverse effect. Compared with resource-rich firms, the effect of resizing on innovation outputs is more pronounced in resource-constrained firms. These results have several practical managerial implications.

1. Introduction

Although a large body of research has looked at the effect of downsizing on innovation, the effect of upsizing on innovation remains a blind spot. The notion of organisational resizing does not only consider downsizing or reduction of workforce, but also upsizing or hiring new employees. This has also been referred to as 'employment instability', which "*reflects the volatility of a firm's employment levels, capturing both increases and decreases in employment by a given firm*" (Ji et al., 2014, p.355). Resizing encompasses both the upsizing and downsizing of human resource (HR) levels. According to Ji et al. (2014), upsizing and downsizing are not mutually exclusive since firms simultaneously increase and decrease their HR levels. They argue that there is an inverse relationship between resizing and firm performance, suggesting that neither high nor low levels of resizing are beneficial. This is in line with dominant conventional wisdom put forward by Nohria and Gulati (1996) that neither too much slack nor too little of it is good for organisational innovation. However, studies on the effect of downsizing on organisational innovation have generated mixed and even contradictory results (Acar et al., 2019). This could be due to neglecting the conditional relationship between organisational downsizing and the existing resource situation of the firm prior to resizing.

The literature has placed a heavier emphasis on downsizing (e.g. Fernández-Menéndez et al., 2020; Mellahi and Wilkinson, 2010; Ramdani et al., 2020; Tan and Peng, 2003), ignoring organizational upsizing. Drawing primarily on organisation studies and agency

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theories, scholars stand divided on whether downsizing is helpful or harmful for innovation. These studies use reduction in slack as a proxy for downsizing. On the one hand, scholars advocate that innovation can be stimulated by slack since it acts as buffer from environmental instability, and promotes making proactive strategic choices, taking risks and experimenting with new ideas (Cyert and March, 1963; Singh, 1986). On the other hand, other scholars argue that slack inhibits innovation by breeding inefficiency, limiting risk taking, and reducing experimentation (Jensen, 1986; Leibenstein, 1969), losing fit with the external environment (Love and Nohria, 2005) and management self-serving and wasteful behaviour (Marlin and Geiger, 2015). This study seeks to reconcile these inconsistencies by examining the effect of not only downsizing, but also the effect of upsizing on organisational innovation.

To answer the question of whether organizational resizing is helpful or harmful for innovation, this paper has two main objectives. Firstly, this paper will examine the effect of resizing (both upsizing and downsizing) on innovation in resource-rich and resource-constrained firms. Secondly, this paper will examine the magnitude of the resizing effect in resource-rich and resource-constrained firms. With the exception of Ramdani et al. (2020), previous studies did not pay much attention to the role of corporate resources prior to downsizing. As Ramdani et al. (2020) show, both the direction and the level of the impact of downsizing depend on whether the firm experiences resource slack or constraints prior to downsizing. This paper moves the investigation one step further by considering the moderating effect of existing resources in the relationship between resizing and innovation.

Our study advances prior research by considering the magnitude of the effect of resizing over time (Desai, 2020; Brauer and Zimmermann, 2019). According to Mellahi and Wilkinson (2010), the effect of downsizing over time has been ignored in previous research. They found that the effect of downsizing occurs two years after initiating it, during which innovation is considerably stifled after substantial downsizing, and slightly improved after moderate downsizing. Ramdani et al. (2020) found that the effect of downsizing is more immediate in resource-constrained firms. However, the magnitude of the effect of resizing, rather than downsizing, over time remains unknown. This study adds important evidence on the effect of both upsizing and downsizing on innovation and the magnitude of such effects over time.

Examining the effect of resizing on innovation outputs adds important insights and practical managerial implications. Even after economic recovery, layoffs have become a common workplace practice (Ji et al., 2014). Downsizing has become an accepted strategy for reconfiguring organisational routines and human capital (Brauer and Laamanen, 2014; Palmeira et al., 2023). Many firms simultaneously seek to downsize as well as upsize their staffing levels. Thus, it is critical to understand when organisational resizing is helpful or harmful for innovation.

2. Hypotheses Development

2.1. Organisational Resizing and Innovation

Studies on the effect of slack on organisational performance have generated contradictory results (Altaf and Shah, 2017). Based on organisation studies theory, supporters of slack advocate that organisational innovation can be stimulated by slack since it acts as buffer from environmental instability, and promotes making proactive strategic choices, taking risks and experimenting with new ideas (Cyert and March, 1963; Singh, 1986). However, according to agency theory, opponents of slack argue that it inhibits innovation by breeding inefficiency, limiting risk taking, and reducing experimentation (Jensen, 1986; Leibenstein, 1969). Excess resources can inhibit innovation due to losing fit with the external environment (Love and Nohria, 2005) and management self-serving and wasteful behaviour (Marlin and Geiger, 2015). Excess resources can make firms sluggish in responding to potential threats because they are less motivated to do so effectively (Suzuki, 2018). Senior executives tend to often allocate resources to other projects away from innovation (Mousa et al., 2017). Moreover, management behaviour leads to terminating projects that could stimulate innovation and invest in projects that should not have been funded at all (Nohria and Gulati, 1996). Thus, downsizing can be used as a tool to limit these agency problems.

To reconcile such inconsistencies, a middle ground has become the conventional wisdom (Acar et al., 2019), claiming that "*too little slack is as bad for innovation as too much slack*" (Nohria and Gulati, 1996, p.1246). Beyond a certain level of slack, innovation decreases as slack increases because of complacency and lack of discipline. Recent evidence shows that downsizing positively influence organisational innovation in resource-rich firms (Ramdani et al., 2020). Earlier studies claim that downsizing is helpful because it reduces costs and creates leaner and more efficient organisations (Fisher and White, 2000; Freeman and Cameron, 1993). Downsizing is claimed to empower surviving employees by encouraging them to do multi-dimensional work rather than focus on routine tasks (Hammer and Champy, 1993). Downsizing is also claimed to be an effective strategy that could improve innovation (Ramdani et al., 2020) and even the overall business performance of the organisation (De Meuse and Dai, 2013).

In resource-rich firms, resizing can also have a dual effect on innovation. Ramdani et al. (2020) posit that downsizing enhances innovation in firms with excess resources because of increasing competition among employees who survived earlier rounds of downsizing as well as the new organisational setting as a result of downsizing. To save their positions, employees will outperform each other by introducing new ideas and solving existing problems resulting in improved organisational innovation. Moreover, as a result of downsizing, firms change processes and routines, and allocate new teams, which lay the grounds for new ideas. However, upsizing the workforce when excess resource exist will only have the reverse effect by breeding inefficiencies and creating an environment that limits innovation. Based on this, we argue that downsizing (upsizing) will improve (inhibit) innovation in firms experiencing excessive resources. Thus, we suggest the following hypothesis:

Hypothesis 1. *Downsizing (upsizing) has a positive (negative) effect on innovation outputs in resource-rich firms.*

In resource-constrained firms, resizing can have a dual effect on innovation. Ramdani et al. (2020) posit that downsizing restrains

innovation in resource-constrained firms. Earlier evidence suggests that resource constraints typically inhibit organisational innovation and learning (Desai, 2020; Gibbert et al., 2014). Organisations with limited resources may not take risks (Nohria and Gulati, 1996) on innovation project, develop new technologies or experiment with new ideas (De Carolis et al., 2009). Thus, resource constraints prevent senior executives from championing projects that enable firms to introduce new products and patents (Rao and Drazin, 2002). Furthermore, innovation in resource-constrained firms will be inhibited due to decreasing competition among employees who survived earlier rounds of downsizing. Indeed, employees are less motivated to compete against each other due to having below normal staffing level, and the fear of layoff in future rounds of downsizing. Resource-constrained firms often adopt damage limitation strategies. Having recognised the negative effect of downsizing on employees, managers are deterred from implementing further restructuring. Indeed, as Ramdani et al. (2020, p.4) argue, "*downsizing in organisations already facing resource constraints will trim their resources to the bones and leave little room for what is already minimum innovation-oriented activities*".

Upsizing resource-constrained firms will have the reverse effect, as it helps these firms acquire the necessary resources to stretch their capabilities, take risks, and experiment with new ideas. Following this line of reasoning, we expect that downsizing (upsizing) is likely to restrain (improve) innovation in resource-constrained firms. Based on this, we posit the following hypothesis:

Hypothesis 2. *Downsizing (upsizing) has a negative (positive) effect on innovation outputs in resource-constrained firms.*

The magnitude of the resizing effect on innovation in resource-rich and resource-constrained firms has not yet been examined in the literature. We contend that the magnitude of the effect of resizing on innovation depends on the firm's existing resources prior to resizing. Both positive and negative effects are much more pronounced in resource-constrained firms.

Resource slack and constraints can be considered as two resource position at the extreme ends of a spectrum (Dolmans et al., 2014). The two positions, however, are not equivalent. A firms with resource-constraints is at a more critical and concerning position because it may not possess resources that are essential for its survival. Innovation activities, being low in the pecking order of priorities, are first to go when a firm is in a precarious position. So, innovation is highly sensitive to resource constraints. In other words, innovation is highly affected because of resource-starvation (in the case of downsizing) or resource-relief (in the case of upsizing) of innovation-specific resources. A resource slack position is quite different in terms of precariousness. Being in a position of excess resources is not ideal, but it is not life threatening either. It is a question of efficiency rather than existence. Thus, both the benefit (of downsizing) and harm (of upsizing) will not be as extensive as in resource-constrained firms.

Resource constraints create stress that can affect firm growth and increase the risk of bankruptcy (Musso and Schiavo, 2008). Resource constraints can cause project delays, and increase stress among employees. This induce senior executives to focus on short-term survival, rather than strategic tasks. Thus, as far as innovation is concerned, a resource-constrained firm is on a cliff, and downsizing can precipitate its fall. On the other hand, upsizing a resource-constrained firm will replenish much needed resources for innovation. Additional employees will help with operational tasks freeing surviving staff to solve existing problems, experiment with new ideas, and take risks. Under stress, firms often layoff or reposition R&D employees in departments deemed more important. Upsizing revives innovation related sections by replenishing much needed R&D staff. Upsizing also reduces employee stress and is often accompanied by management refocus on strategic decisions.

In slack-rich firms, the effect of resizing on innovation is expected to be less pronounced. A slack resources position is generally perceived to be financially beneficial for a firm (Daniel et al., 2004). While excess resources also act as a buffer to a variety of business shocks and gives the firm greater flexibility in exploration and experimentation (George, 2005), resource slack can also hinder innovation. The problem with resource slack is one of efficiency. Resizing is simply a means of increasing or reducing a firm's efficiency in producing innovation. In that, downsizing an already resource-rich firm will trim excess resources and hence reduce existing inefficiencies. Upsizing a firm with resource slack would have the opposite effect. In both cases, the impact will be less severe because the required resources needed for innovation projects and teams remain intact. Only the efficiency of these resources is affected by resizing.

From the above discussion, we expect the magnitude of the effect of resizing on innovation output to be dependent on the level of resource slack or constraints prior to resizing. Specifically, the effect of downsizing is more pronounced in resource-constrained firms compared to slack-rich firms. Thus, we propose the following hypothesis:

Hypothesis 3. *The (absolute) impact of resizing is more pronounced in firms experiencing resource constraints compared with firms experiencing resource slack.*

3. Data and Method

3.1. Data

Our data consists of a panel of hand-collected firm data from UK firms between 1995 and 2016. The data contain details on patents, firm size and R&D, which offers a good setting to assess the impact of resizing on innovation. The data also allows us to construct the slack variable, which helps us to consider the moderating role of resource slack and constraints.

We select a sample of UK medium and large firms based on four criteria. First, because small firms are sensitive to financial and business risk, they are less able to restrict hiring and firing due to the limited nature of their financial resources. Thus, following previous studies (e.g. Mellahi and Wilkinson, 2010; Ramdani et al., 2020), we select firms with 250 employees or greater. Second, we discard firms that are not UK-located single businesses. This condition mitigates survival bias due to overseas relocation of firms, and excludes possible downscoping by diversified firms (Zyglidopoulos, 2005). Third, we exclude firms that do not reduce employees

significantly enough to be treated as downsizing. It is generally accepted that a 5 % reduction in employees is large enough to be considered as corporate event (Ahmadjian and Robinson, 2001). Fourth, as we focus on innovation-driven firms, only firms with 10 granted patents or more during the sample period are included. As a result, our final sample included 122 firms.

The panel data was hand-collected from three main resources. Successful patents were obtained from the European Patent Office database. FAME (Financial Analysis Made Easy) database, was the source for the number of employees, R&D expenditure, industry size, and sales. The remaining data were obtained from the UK Office for National Statistics.

3.2. Variables

Our dependent variable, innovation outputs, reflects the number of patents as in previous studies within this journal (e.g. Wang et al., 2021, Lakhal et al., 2024). The main explanatory variables are resizing and slack. Resizing is based on the yearly change in the number of employees. Human resource (HR) slack is a tricky concept. Ideally, one would measure HR slack directly, but this is difficult to say the least (Mishina et al., 2004). A direct measure of slack would require knowledge of the optimal size of each firm. Instead, we adopt a more feasible approach by measuring relative slack, which does not require us to measure organisational efficiency.

Our proxy for slack follows the view of Welbourne et al. (1999), who used employees to sales ratio. Hence, we proxy slack by measuring the distance between the firm's size to sales ratio and the average industry's size to sales ratio. Specifically, as in Mishina et al. (2004, p.1187), the slack for a given firm i is calculated as:

$$Slack_i = SS_i - ISS_i$$

where $SS_i = Size_i/Sales_i$ and ISS_i is the average firm i industry size relative to the average industry sales. $Size_i$ is the number of employees for firm i. When $Slack_i > 0$ the firm experiences resource slack, since it has a ratio that is higher than the industry average. In other words, this definition of slack reflects the extent of excess HR relative to competitors (Greve, 2003). A negative slack, however, indicates that the firm experiences resource constraints.

We use two control variables. The first control variable is firm size, measured by the total number of employees. Chabchoub and Niosi (2005) argue that size is an important determinant of organisational innovation. Large firms are able to produce more patents compared to smaller ones (Bound et al., 1982). We use R&D expenditure as our second control variable. It is well-known that R&D plays a significant role in the production of patents (Pakes and Griliches, 1984; Peeters and van Pottelsberghe de la Potterie, 2006).

Firms are long lasting entities, and their characteristics are persistent. Consequently, patents are also persistent. We control for this persistence by using lagged values of the number of patents. Lagged patents reflect firm characteristics, such as internal processes, staff experience and knowledge, and market share. Lagged patents can also capture time invariant firm characteristics, including the industry type, export-orientation, and the type of ownership. Thus, by including lagged patents, these time invariant variables become redundant.

3.3. Empirical Method

We adopt a negative binomial specification:

$$E(P_{it}|X) = \exp(\gamma P_{it-1})\mu_{it}\vartheta_i$$

$$\vartheta_i = \exp(\nu_i)$$

where P_{it} is the patent number for firm i in year t. $E(.|X)$ is the conditional expectation given X, the set of explanatory variables, and ν_i is unobserved heterogeneity or individual fixed effects.

A fixed effect negative binomial model is estimated where ϑ_i is assumed to be fixed. We estimate the model using maximum likelihood. We measure the effect of downsizing via the examination of μ_{it}. We use two specifications. In the simple (symmetric) model, μ_{it} is given by:

$$\mu_{it} = \exp\left[\alpha_0 + \alpha_1 S_{it} + \alpha_2 R\&D_{it} + (\alpha_3 + \alpha_4 L_{it-1})R_{it-1}\right] \quad (1)$$

We also estimate a model with two years lag since Mellahi and Wilkinson (2010) found that it may take more than one year for the effect of the change in number of staff to occur. The intercept, α_0, represents low patent firms. Lagged patents, P_{it-1}, is expected to be a highly significant variables given the persistence of patents. S_{it} is the total number of employees, and $R\&D_{it}$ is R&D expenditure.

Resizing, R_{it}, is some pre-defined change in the total of employees. Resizing impacts patents via two routes. The first is a direct route, measured via the parameter α_3. The expected sign of this parameter is positive since upsizing (downsizing) should increase (reduce) innovation. The second route is via the interaction of resizing with slack. This interaction captures the moderating effect of slack on the resizing-patents relationship. The interaction parameter, α_4, measures this moderating effect. We redefine $Slack_{it}$ from a relative ratio to a scale factor, $L_{it} = 1 + Slack_{it}$.

For resource-constrained firms, $L_{it} < 1$, thereby decreasing the contribution of the interaction term, and hence increasing the direct effect of resizing on patents. On the other hand, $L_{it} \geq 1$ for slack-rich firms, thus decreasing the direct effect of resizing on patents. The combined effect can therefore be negative or positive depending on the scale factor L_{it}.

In order to capture the possible asymmetric moderating effect of slack, we define $L_{it}^{+} = 1 + Slack_{it}$ if slack is positive and zero otherwise. L_{it}^{-} is defined similarly but for resource-constrained firms. We split the sample into two, one containing resource-rich firms

and one containing resource-constrained firms.

We then estimate two models:

$$\mu_{it} = \exp\left[\alpha_0 + \alpha_1 S_{it} + \alpha_2 R\&D_{it} + (\alpha_3 + \alpha_4 L^{+}_{it-1})R^{+}_{it-1}\right] \quad (2)$$

$$\mu_{it} = \exp\left[\alpha_0 + \alpha_1 S_{it} + \alpha_2 R\&D_{it} + (\alpha_3 + \alpha_4 L^{-}_{it-1})R^{-}_{it-1}\right] \quad (3)$$

where R^{+}_{it} and R^{-}_{it} are resizing in resource-rich and resource-constrained firms respectively. Eq. (2) tests the effect of resizing within resource-rich firms, while Eq. (3) does the same test for resource-constrained firms.

To control and test for potential endogeneity of downsizing, we use the Control Factor approach (Wooldridge, 2014). This is essentially a two-stage instrumental variable approach. In the first stage, the endogenous variable (R_{it}) is regressed against a set of instruments. The residuals from this regression, say η_{it}, are then used as an additional variable in the negative binomial estimation. This is operationalised by simply redefining the error term above as:

$$\vartheta_i = \exp(\nu_i + \delta\eta_{it})$$

A significant coefficient δ confirms endogeneity (Wooldridge, 2010, p.744).

4. Results

We estimate model (1), (2) and (3) using an unbalanced panel negative binomial model. We use lagged values of resizing because it takes time for a change in staffing numbers to influence a firm's patents' production (Mellahi and Wilkinson, 2010; Ramdani et al., 2020). As the dependent variable (i.e. number of patents) is discrete, the usual (continuous) random and fixed effect panel data models are inappropriate because of the inability to make inference on any single outcome (Winkelmann, 2008, p.65). Count variables define positive integer values, and are typically modelled using Poisson regression models. However, since the Poisson model imposes equality between the conditional mean and variance, the model is inappropriate when the observed data is over-dispersed (i.e. when the conditional variance is greater than the conditional mean). Given the large variance in patents across time and the cross-sectional nature of our data, our dependent variable is likely to be over-dispersed.[1] The Poisson model is therefore inappropriate, and we use a more flexible model, namely, the Negative Binomial model. This is a generalised version of the Poisson model which allows the conditional mean to be distinct from the conditional variance, and thus allows for the over-dispersion effects. The Negative Binomial model is generally recommended for research involving count data (Hausman et al., 1984).

Table 1 shows some summary statistics for the variables used in the estimation. As can be seen from the first column, the data has missing observations, with R&D expenditure showing the highest number of missing observations. Firms typically produce around 9 patents per year on average, but patent production varies across firms and years between zero and nearly 400 patents.

The sample average slack is small but positive (0.19 %). However, the range of slack, between −4.7 % and 4.1 %, shows that the sample contains both extremes of slack. R&D expenditure is very high at nearly £68 million per year. This high figure is mainly due to the fact that small firms mostly failed to report this figure in their accounts. Our treatment of these cases as missing may have biased our R&D sample mean upwards. Clearly, R&D is important, with large firms dedicating more than £1 billion to this activity.

The average firm size is 6431 employees, but the standard deviation of more than 17000 employees suggests substantial cross-sectional diversity and potentially important resizing by firms throughout the years. The bottom part of the table shows several statistics on upsizing, downsizing and resizing. There are 937 firm-year where upsizing occurred. Within this sub-sample, the average upsizing was 561 employees. On the other hand, there are more downsizing cases (1289) and with an even higher average of 685 layoffs. The resizing is shown for three definitions (continuous, 5 % and 10 %). The average resizing shows that the scale of downsizing is marginally more important than that of upsizing.

Pairwise correlations between the three independent variables are given in Table 2. There is one large correlation between R&D and size. Although significant at the 1 % level, the correlation of 0.327 is not high enough to cause perfect collinearity. The remaining correlations are small and/or insignificant. In particular, the correlation between resizing and slack is insignificant, suggesting that slack does not tend to push firms towards upsizing or downsizing. Clearly, while resizing can in principle change the level of slack, slack does not necessarily lead to resizing. This, perhaps, is a good reason why studies should not use slack as a measure of downsizing.

Table 3 highlights the results for two resizing definitions. Panel A and B show the 5 % and 10 % definition results respectively. The 5 % and 10 % definitions sets $R_{it} = S_{it} - S_{it-1}$ if the percentage change in staff is more than 5 % and 10 % (in absolute value) respectively, and zero otherwise. Focusing on downsizing, Freeman and Cameron (1993) argue that small changes are inconsistent with downsizing as an intentional proactive strategy. A similar argument should also hold for upsizing.

Before we proceed with the results, it is worth noting that the coefficient of the Control Factor

η_{it} is insignificant at the 5 % in all estimated models, suggesting that endogeneity is not an issue.

To test Hypotheses 1 and 2, we estimated the model in Eq. (1). Here, the effect of resizing is assumed to be identical for firms experiencing resource-slack and resource-constraints. The results are shown for one and two lags models (the first and second columns). We first note that the 5 % and 10 % definitions provide very similar results, suggesting that our results are not sensitive to the definition of resizing. We will therefore focus on the 5 % definition only.

[1] The sample mean of patents is 9.20, while the variance is 743.19.

Table 1
Summary Statistics.

	N (Valid)	Mean	Std Error
Number of Patents	2383	9.20	27.26
Slack (%)	2267	0.19	0.91
R&D expenditure (£million)	1764	67.809	219.894
Size (×1000 employees)	2383	6.431	17.099
Upsizing (×1000) (continuous)	937	0.561	2.496
Downsizing (×1000) (continuous)	1289	−0.687	3.112
Resizing (×1000) (continuous)	2260	−0.159	2.912
Resizing (×1000) (−5 % definition)	1281	−0.264	3.828
Resizing (×1000) (−10 % definition)	727	−0.478	4.935

Notes: Our data consists of a panel of hand-collected firm data from 122 UK medium and large firms between 1995 and 2016. The maximum size available is 2806 firm-years. We report the total number of valid observations.

Table 2
Correlations.

	Resizing (5 %)	Slack	R&D
Slack	0.016		
R&D	0.038*	−0.005**	
Size	0.027	−0.020	0.327***

Notes: *** significant at the 1 % level, ** significant at the 5 % level. We use the continuous definition for downsizing.

Table 3
Negative Binomial Estimation Results.

	One Year Lag		Two Year Lags		Resource Constrained Firm		Resource Slack Firm	
Variable	Coeff	p-val	Coeff	p-val	Coeff	p-val	Coeff	p-val
Panel A: 5 % Definition								
Constant	0.787	0.000	0.803	0.000	0.798	0.000	0.775	0.000
P_{it-1}	0.008	0.000	0.009	0.000	0.009	0.000	0.007	0.000
D_{it-1}	6.864	0.008	7.672	0.013	21.915	0.001	4.621	0.221
$L_{it-1}D_{it-1}$	−6.862	0.008	−7.667	0.013	−21.968	0.001	−4.624	0.220
D_{it-2}			−1.249	0.746				
$L_{it-2}D_{it-2}$			1.256	0.745				
$R\&D_{it}$	0.000	0.427	0.000	0.337	0.000	0.192	0.000	0.509
S_{it}	0.012	0.001	0.011	0.008	0.013	0.000	0.014	0.000
η_{it}	−0.009	0.225	−0.007	0.372	−0.011	0.114	−0.009	0.158
Loglik	−1380.43		−1379.81		−1378.88		−1382.65	
Panel B: 10 % Definition								
Constant	0.785	0.000	0.798	0.000	0.800	0.000	0.778	0.000
P_{it-1}	0.009	0.000	0.009	0.000	0.010	0.000	0.007	0.000
D_{it-1}	6.796	0.006	6.818	0.008	27.988	0.000	2.959	0.030
$L_{it-1}D_{it-1}$	−6.791	0.006	−6.811	0.008	−28.052	0.000	−2.962	0.030
D_{it-2}			−0.978	0.783				
$L_{it-2}D_{it-2}$			0.983	0.782				
$R\&D_{it}$	0.000	0.390	0.000	0.324	0.000	0.096	0.000	0.402
S_{it}	0.012	0.000	0.012	0.001	0.014	0.000	0.014	0.000
η_{it}	−0.009	0.292	−0.008	0.321	−0.015	0.059	−0.009	0.176
Loglik	−1380.33		−1380.01		−1373.39		−1383.27	

Notes: The table shows unbalanced panel estimation results of a Negative Binomial model using the symmetric representation, $\mu_{it} = \exp[\alpha_0 + \alpha_1 S_{it} + \alpha_2 R\&D_{it} + (\alpha_3 + \alpha_4 L_{it-k})D_{it-k} + \alpha_5 v_{it}]$ for $k = 1, 2$. The dependent variable is the number of patents, P_{it}. η_{it} is the residual control factor obtained from a regression of downsizing on R&D, Size, Market Share, and two sector dummies. Expected patents are given by $E(P_{it}|X) = \exp(\gamma P_{it-1})\mu_{it}\vartheta_i$. Two definitions of downsizing are considered. Downsizing is set equal to $D_{it} = S_{it} - S_{it-1}$ if the percentage change in employees was greater than τ in absolute value. The 5 % and 10 % definitions use $\tau = 0.05$ and 0.10 respectively. The sample size was 1362 firm-year.

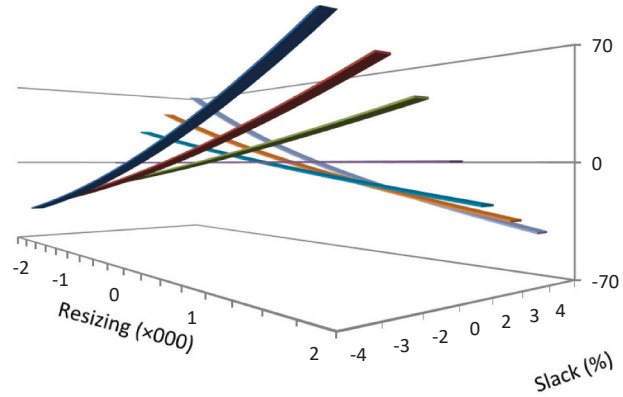
The two year lag model suggests that the coefficients of resizing and interaction terms for the year $t-2$ are insignificant, suggesting that the effect of resizing is fully absorbed within a year. The one year lag model shows that patents are persistent; the coefficient of lagged patents (P_{it-1}) is significant and positive, suggesting that firms with high patent production tend to continue their performance. R&D is small and insignificant (it is likely that the information contained in R&D is already explained by lagged patents and/or size). Size, on the other hand, is highly significant and an important control variable. The size coefficient is 0.012 and is highly significant. The resizing coefficient is positive and highly significant, suggesting that resizing has a positive direct impact. The indirect impact

coefficient, however, is negative and also highly significant.

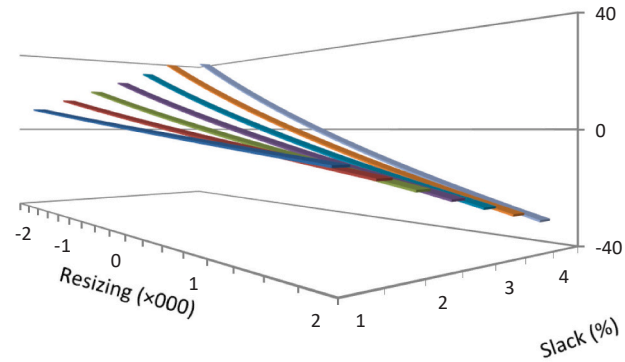
The full impact is dictated by slack. Given that R_{it} can be both positive and negative, and given that L_{it} can be greater or less than 1, the total and moderation effects of resizing are difficult to visualise. Panel A of Fig. 1, however, shows a clear pattern. The direction of the effect of resizing depends on the firm's level of resource slack or constraints prior to resizing. Specifically, downsizing is bad (good) for resource-constrained (rich) firms; while upsizing is good (bad) for resource-constrained (rich) firms.

The above results clearly support the contingent effect of resizing on innovation, and confirm our Hypotheses 1 and 2 suggesting that both upsizing and downsizing are right for the right circumstances and wrong for the wrong circumstances. However, such a contingent effect might not have the same magnitude for resource-rich and resource-constrained firms.

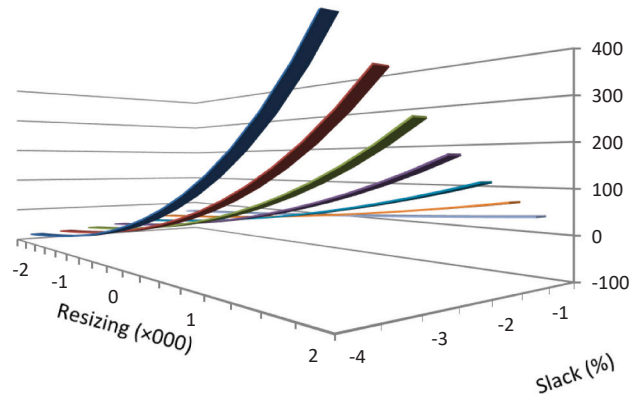
To test Hypothesis 3, we estimated two subsamples (Eqs. 2 and 3). The results are shown in the last two columns of Table 3. Again,



(A) All Firms



(B) Resource-Rich Firms



(C) Resource-Constrained Firms

Fig. 1. The Impact of Resizing on Innovation Outputs. Notes: The figure shows the effect of resizing (5 % definition) for selected values of resource-slack and resource-constraints. Negative slack values indicate resource constraint. The vertical axis shows the percentage change in patents.

Panel A and B show similar results. Both subsamples suggest the same pattern found in the full sample (i.e. positive resizing coefficient and negative interaction coefficient). Thus, resizing has the same effect discussed above.

However, there are two major differences across the two types of firms. First, the resizing and interaction coefficients for slack-rich firms are insignificant for the 5 % definition (Panel A). Given that the same coefficients are highly significant and greater in magnitude for the resource-constrained firm, this is a clear evidence in support of our third hypothesis. Nevertheless, for the 10 % definition (Panel B), the resizing and interaction coefficients are highly significant for resource-rich firms. This suggests that the relationship between resizing and patents is moderate at best for resource-rich firms.

Second, the scale of resource-constrained firms resizing coefficients is more than four times greater than that of slack-rich firms for the 5 % definition (and more than nine times greater in the 10 % definition). This suggests that the good and bad effect can be far greater for the resource-constrained firms.

In the following illustrations, we will use the 5 % definition results. Although the resizing coefficients are insignificant for slack-rich firms, they are greater in magnitude than those in the 10 % definition. More importantly, the effect produced by the 5 % definition result is less extreme and reflects more cases than that of the 10 % definition. Fig. 1 shows that the effect of resizing in the 10 % definition. For slack-rich firms the effect (Panel A) is less pronounced than that of the 5 % definition (Fig. 1, Panel B). On the other hand, for resource-constrained firms, the positive impact of resizing (Panel B) is roughly double that of the 5 % definition (Fig. 1, Panel C). Beside these modelling considerations, the contrast between the effect on slack-rich and resource-constrained firms is very clear for both the 5 % and 10 % definitions.

Taking the 5 % definition, Panel B and C of Fig. 1 confirms this disparity. For slack-rich firms the highest effect is about 40 % increase in patents, and the lowest effect is around −40 %. In contrast, the highest effect for resource-constrained firms is more than 400 % (800 % in the 10 % definition), but the lowest effect is almost −100 %.

Thus, the models provide strong evidence that, while resizing has moderate effects on resource-rich firms (Panel B), these effects (positive and negative) are extremely large in resource-constrained firms (Panel C). Moreover, within resource-constrained firms, the effect of resizing is close to linear (and relatively moderate) for limited constraints, but shows greater exponential growth as constraints become more prominent. On the other hand, the effect of resizing on patents is roughly linear for all levels of slack and less pronounced for resource-rich firms.

The way the effect of resizing on innovation outputs shown in Fig. 1 will be discussed below. The calculation of the effect is not straightforward as this impact is dependent on whether the firm is experiencing slack resources or resource constraints. The effect of resizing can only be seen in relative terms. Ignoring the fixed effect term, the expected patent is given by:

$$E(P_{it}|X) = \exp(\alpha_0 + \gamma P_{it-1} + \alpha_1 S_{it} + \alpha_2 R\&D_{it})\mu_{it}$$

which depends on:

$$Impact_{it} \equiv \mu_{it} = \exp\big((\alpha_3 + \alpha_4 L_{it-1})R_{it-1}\big)$$

Thus, the effect of resizing can only be seen in terms of the expected patent when there was no resizing for the past year, that is:

Table 4
Examples of Percentage Changes in Patents Following Downsizing.

Resizing	Panel A: Resource Slack (%)						
	1	1.5	2	2.5	3	3.5	4
−2000	10.35	15.57	21.04	26.77	32.77	39.05	45.63
−1500	7.67	11.46	15.40	19.47	23.69	28.05	32.57
−1000	5.05	7.50	10.02	12.59	15.23	17.92	20.68
−500	2.49	3.68	4.89	6.11	7.34	8.59	9.85
500	−2.43	−3.55	−4.66	−5.76	−6.84	−7.91	−8.97
1000	−4.80	−6.98	−9.11	−11.18	−13.21	−15.20	−17.14
1500	−7.12	−10.29	−13.34	−16.30	−19.15	−21.91	−24.57
2000	−9.38	−13.47	−17.38	−21.12	−24.68	−28.08	−31.33
	Panel B: Resource Constraints (%)						
	−4	−3.5	−3	−2.5	−2	−1.5	−1
−2000	−80.82	−76.11	−70.24	−62.93	−53.82	−42.48	−28.35
−1500	−71.02	−65.83	−59.71	−52.49	−43.98	−33.95	−22.12
−1000	−56.21	−51.12	−45.45	−39.12	−32.05	−24.16	−15.35
−500	−33.82	−30.09	−26.14	−21.97	−17.57	−12.91	−8.00
500	51.11	43.04	35.39	28.16	21.31	14.83	8.69
1000	128.35	104.60	83.32	64.25	47.16	31.85	18.14
1500	245.07	192.65	148.20	110.50	78.52	51.40	28.41
2000	421.45	318.61	236.05	169.77	116.56	73.85	39.56

The table shows the effect of downsizing as percentage changes from pre-downsizing patents. The percentages are calculated as $100(\text{Impact}-1)$ where $Impact_{it} = \exp\big(\big[4.621 - 4.624L^{+}_{it-1}\big]D^{+}_{it-1}\big)$ for resource-rich firms, and $Impact_{it} = \exp\big(\big[21.915 - 21.968L^{-}_{it-1}\big]D^{-}_{it-1}\big)$ for resource-constrained firms.

$$E(P_{it}) = Impact_{it} \times E(P_{it}|No\ Resizing)$$

where,

$$E(P_{it}|No\ Resizing) = \exp(\alpha_0 + \gamma P_{it-1} + \alpha_1 S_{it} + \alpha_2 R\&D_{it})$$

In order to gauge the combined effect of resizing and slack, we use the 5 % definition model. The effects are shown in Table 3. For resource-constrained firms, resizing has a more accentuated effect, which is given by the negative slack sample using the following model:

$$Impact_{it} = \exp\left(\left[21.915 - 21.968 L^{-}_{it-1}\right] R^{-}_{it-1}\right)$$

For resource-rich firms, we use the positive slack sample results:

$$Impact_{it} = \exp\left(\left[4.621 - 4.624 L^{+}_{it-1}\right] R^{+}_{it-1}\right)$$

Table 4 and Fig. 1 provide a summary of the effect of resizing under a number of different assumptions. Fig. 1 shows the limited effect of resizing in resource-rich firms (Panel B). The effect is more important and increasingly non-linear with both resizing and level of slack in firms experiencing resource constraints (Panel C). As can be seen from Panel C, for small slack (in absolute value) the effect is roughly linear, but for larger slack (in absolute value) the effect becomes exponential. Table 4 shows the various changes expected for a selection of slack and resizing values. We used the 5 % definition models.

As Panel A shows, firms with high levels of slack experience greater benefit from downsizing, but nearly symmetric fall in patents from upsizing. For example, for an extreme slack of 4, a substantial 2000 layoff increases patents by about 45.63 %. The table suggests that the more downsizing the better at all levels of positive slack. Upsizing has the opposite effect, and again, more upsizing leads to greater loss of patents. Again, the most pronounced effect is for firms with higher levels of slack. For example, for firms with low levels of slack (say 1 %), increasing downsizing from 500 to 2000 increases the loss from −2.43 % to −9.38 %. In contrast, the same upsizing change for a firm with high slack (say 3 %) increases patents from −8.97–31.33 %.

For resource-constrained firms, resizing has a much greater effect on innovation outputs. Downsizing an extremely constrained firm wipes out more than half of its patents. For example, for a resource-constrained firm of −4 %, the effect of downsizing 500 employees is −33.82 % and jumps to −80.82 % for a 2000 reduction in staff. In general, the more constrained the firm, the higher the damage from downsizing. On the other hand, upsizing is good news for innovation in resource-constrained firms, especially for firms with high levels of constraints. The positive effect reaches more than 400 % increase for highly constrained firms.

The main feature revealed by Table 4 is that resource slack and constraints are critical in understanding the effect of resizing on innovation outputs. When a firm is experiencing resource constraints, it needs upsizing to recover its lost innovation outputs; and the benefit from upsizing is significant. On the other hand, downsizing an already constrained firm worsens innovation outputs and can potentially wipe out the firm's ability to produce patents.

On the flip side, upsizing an already slack-rich firm is harmful and drives patents down. It may be counter-intuitive, but downsizing actually helps a slack-rich firm improve its patent production.

5. Discussion

This study attempts to answer the question of when organisational resizing is helpful or harmful for innovation outputs. A summary of our results is highlighted in Fig. 2. We examine the effect of resizing on innovation outputs. Our empirical analysis confirms that this effect is contingent of the resource slack and constraints prior to initiating resizing. Particularly, upsizing in resource-constrained firms and downsizing in resource-rich firms is helpful for innovation, whereas upsizing in resource-rich and downsizing in resource-constrained firms have the reverse effect. Compared with resource-rich firms, the effect of resizing on innovation outputs is more pronounced in resource-constrained firms.

This study contributes to earlier research on the effect of downsizing on innovation (Fernández-Menéndez et al., 2020; Mellahi and Wilkinson, 2010; Ramdani et al., 2020; Tan and Peng, 2003) in three main ways. First, instead of only examining the downsizing-innovation relationship, this study incorporates and also examines the upsizing-innovation link. Unlike previous studies,

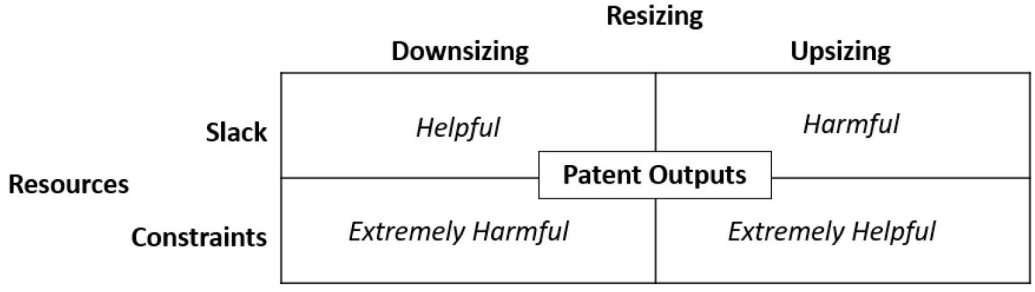


Fig. 2. The Impact of Resizing on Patent Outputs in Resource-Rich and Resource-Constrained Firms.

this study looks at the effect of downsizing without ignoring the effect of upsizing. As well as going through contraction in staffing levels, firm also seek expansion (Ji et al., 2014). By looking at both upsizing and downsizing, our study provides evidence that demystifies the existing contradictory results. Second, our study also confirms the moderating role of resource slack and constraints in determining the impact of resizing on innovation outputs. This adds to the recent finding by Ramdani et al. (2020), which emphasises the resource situation of the firm prior to changing the staffing level. In line with expectations, the results show that resizing impact on innovation is contingent on the resource slack and constraints prior to initiating resizing. Third, our study provides a more comprehensive understanding on the impact on innovation outputs as a result of organisational resizing. Our study shows that the effect of resizing on innovation outputs is more pronounced in resource-constrained firms. Ramdani et al. (2020, p. 16) argue that "*downsizing 'fat' firms does indeed lead to leaner and fitter firms, whereas downsizing anorexic firms leads to more anorexia.*" Using this metaphor, upsizing 'anorexic' firms is extremely helpful and downsizing them is extremely harmful for organizational innovation.

The effect of resizing on innovation carries significant managerial and policy implications. First, resizing is no longer a mystified managerial action. Managers and senior executives can now take upsizing and downsizing with confidence knowing that these actions are dependent on existing resources prior to resizing. If the firm possesses slack, downsizing is likely to be helpful for the firm because this will increase the firm's innovation outputs. Although counterintuitive, this action will decrease inefficiency and change employees' behaviour into competing amongst each other in order to survive future cuts. Moreover, upsizing an already slack-rich firm is likely to be detrimental to its innovation outputs. Therefore, hiring new employees when excess resource already exist will only hinder organisational innovation. In this case, senior executives may need to downsize first before hiring new employees. Overall, managers need to keep an eye on existing resources and strive to right-size as having more than needed HR will be harmful to innovation. Second, senior executives need to be cautious in downsizing the firm when only limited resources exist and employees are stretched - having to do more with less (Taylor, 2020). Indeed, our results suggest that downsizing an already stretched firm would be extremely harmful and could potentially wipe out the innovation capacity of that firm. At the same time, managers should be encouraged to upsize an anorexic firm given the extremely helpful impact of upsizing in resource-constrained firms. Senior executives should act quickly to replenish much needed resources that will be extremely beneficial for future patent outputs. Thus, to help the firms innovate, it is critical that managers taking actions on resizing their organisation must first know what is their existing resource situation, then act accordingly with upsizing and downsizing strategies.

Policymakers need to be aware of the negative consequences of resizing especially for resource-constrained firms. Policymakers are encouraged to use the findings of this study to devise guidelines and measures to inform senior executives in key industries. These measures may include state support and employment protection (Johnstone, 2023) for these firms. The UK government Furlough Scheme is an example of government support during a crisis to all companies promoting job retention.

Finally, this study has several implications for scholars interested in resizing-performance relationship, which are highlighted further in the section below. In this study, we have demonstrated that resizing effect on innovation outputs depends on resource slack and constraints prior to downsizing. We show that the magnitude of this effect is much more pronounced in resource-constrained firms. Thus, we call for further research to assess the validity of these results and whether resizing affects other areas of business performance (Ji et al., 2014).

6. Conclusion

This study has sought to examine the effect of resizing (upsizing or downsizing) on innovation. Our results suggest that this effect and its magnitude are contingent on the resource situation of the firm prior to resizing. In particular, upsizing in resource-constrained firms and downsizing in resource-rich firms have positive effects on innovation outputs, whereas upsizing in resource-rich firms and downsizing in resource-constrained firms have the reverse effects. In addition, the effect of resizing on innovation outputs is more pronounced in resource-constrained firms compared with resource-rich ones.

This study has seven limitations that could motivate future research. First, we use the production of patents as a measure of innovation outputs. This does not consider other innovation outputs measures such as patent value. Earlier studies (e.g. Hall et al., 2001) have shown that patents differ in their economic value. Future research could re-examine the resizing-innovation relationship with measures that reflect the value of patents to verify the results of this study. Second, our measure of organizational resizing does not consider the different types of occupations being upsized and downsized. Thus, it will be interesting to use measures that relate to resizing innovation activities such as R&D employees. Third, our study assessed organizational resizing by considering only one type of resources, namely HR. However, this disregards the effect of resizing on other types of resources, such as operational and financial resources (Symeou et al., 2019). As suggested by Ramdani et al. (2020), it may be worth examining which distinct bundle of resources (Paeleman and Vanacker, 2015) affects the resizing-innovation relationship, because organisations tend to possess a mixed set of resources. Fourth, this study examines the resizing-innovation link over 22 years without capturing the effects during uncertain times, where resizing is a common practice. It will worth studying whether our results are any different during these times (Halinski et al., 2023; Johnstone, 2023). Fifth, this study focuses on organisational outcomes and disregards the impact on individual innovative behaviour. Future studies may complement the findings of this study by looking at the impact of resizing on the innovative behaviour of employees (Marques et al., 2014). Sixth, this study examined the impact of organisational resizing on innovation outputs, which is only one of the existing business performance indicators. Future research can re-examine the effect of resizing on other business performance outcomes (Ji et al., 2014). Seventh, our sample is limited to UK medium and large firms. Future research could replicate this study on other types of organisation (SMEs), industries, and/or institutional contexts (Fawad Sharif et al., 2022; Ritter-Hayashi et al., 2020; Vanacker et al., 2017).

CRediT authorship contribution statement

Boumediene Ramdani: Writing – review & editing, Writing – original draft, Validation, Project administration, Methodology, Formal analysis, Data curation, Conceptualization. **Cherif Guermat:** Writing – review & editing, Writing – original draft, Validation, Software, Methodology, Formal analysis, Conceptualization. **Elias Boukrami:** Writing – review & editing, Writing – original draft, Validation, Software, Methodology, Formal analysis, Conceptualization.

Declaration of Competing Interest

None.

Data Availability

Data will be made available on request.

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