How does public support for innovation affect cooperation between firms? Evidence from Uruguay *

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Abstract

In this paper we estimate the behavioural additionally of public support for innovation activities, on the decision to cooperate. Using Uruguayan data from 2007 to 2015, and controlling for endogeneity, we find that public support for innovation increases the likelihood of different types of cooperation agreements. The empirical evidence suggests that public support leads to organizational changes within supported firms that increase their propensity to cooperate with other firms. The implications of these results are relevant for policy design as they contribute to the understanding of the unintended positive (or negative) impacts of public support for innovation on the behaviour of supported firms. We find that the Average Treatment Effect of public support on cooperation is 0.027. Which means that holding everything else constant, public support increases the probability of cooperating by 0.027.

JEL: H25, H81, L2, L60, M21, O3.

Keywords: Innovation subsidies, Impact evaluation, Cooperation, behavioural additionality, IV, Mundlak device.

1 Introduction

The aim of this article is to study the impact of public support for innovation activities on promoting cooperation between supported firms and other external partners.

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The empirical evidence regarding firms behavioural changes in response to public support is scarce, in part because of the problem on the measurement the behavioral dimensions and also to the additional methodological challenges of identification. This paper contributes to this literature by addressing the following questions and sorting the identification challenges: Does public support for innovation activities, foster cooperation among firms? If yes, why? and what policy lessons can we learn from our data?

This paper contributes to the behavioral additionality literature in several ways. First, from a methodological point of view, by providing causal evidence of the impact of public support for innovation activities on the probability of cooperation with other firms. Our empirical strategy exploits the panel structure of our data and uses instrumental variables methods to address the endogeneity of public grants in order to identify the additionality effects of public support on the propensity to cooperate. Second, our data allows us to estimate not only the effect of public support on cooperation agreements for technological development but also the effect on other types of cooperation agreements between firms, such as commercialization agreements, marketing, purchase of inputs, and employee training. Finally, by presenting evidence of behavioral additionalities resulting from public support for innovation in a Latin American country for which evidence is very scarce, as most of the existing empirical literature focuses on more advanced economies.

The literature on innovation policy has mainly examined the impact of public support on input and output additionality (Zúñiga-Vicente et al. (2014)). Input additionality refers to the extent to which public support leads to more innovation expenditures or whether it substitutes expenditures that would have taken place anyway, the so called crowding-out effect (Wallsten, S. J. (2000); Lach, S. (2002); Almus, M., and Czarnitzki, D. (2003); González, X., Jaumandreu, J., and Pazó, C. (2005); González, X., and Pazó, C. (2008); Aerts, K., Schmidt, T. (2008) and Hussinger, K. (2008)). Output additionality focuses on measuring the outcomes generated by the innovation project that was partially financed by the public grant, like for instance patents, new products introduced in the market, publications, revenues derived from new products or productivity (Crespi, G. A., Maffioli, A. (2014); Czarnitzki, D.et al. (2007); Czarnitzki, D., and Delanote, J. (2015); Cin, B. C. et al. (2017); Czarnitzki, D., and Hussinger, K. (2018) ; Guo, D. et al. (2016)).

More recently, the innovation literature started to evaluate behavioral additionalities as a complement to the input and output additionalities. Behavioral additionalities refer to organizational changes triggered by public support for innovation activities (Buisseret, T. J. et al. (1995); Busom, I. and Fernández-Ribas, A. (2008); Clarysse et al. (2009); Afcha Chavez, S. M. (2011)).

The remainder of the paper. The rest of the paper is organized as follows. Section 2 discusses the existing literature and frames the problem. Section 3 presents the data used in the analysis and descriptive statistics. Section 4 discusses the identification strategy. Section 5 presents the results. Finally, section 6 concludes.

2 Background

This section reviews the existing literature on firm cooperation and on the effect of public support on cooperation.

2.1 Why firms cooperate

Different theoretical approaches analyze the reasons why firms engage in cooperation agreements with external parties (Caloghirou, Y. et al. (2003); Kim, Y. and Vonortas, N. S. (2014)). Some perspectives ground on a neoclassical view of the firm like the industrial organization and transaction costs literature (Williamson, O. E. (1981)). Others take a strategic management approach, like the resource-based theory of the firm (Barney, J. (1991)), the knowledge-based view and organisational learning (Kogut, B., and Zander, U. (1993)), the social network theory (Gulati, R. (1995)), or the dynamic capabilities approach (Teece, D. J.et al. (1997)). All these theoretical perspectives identify several aspects of cooperation deals that can benefit firms.

Some approaches emphasize that cooperation agreements allow firms to get access to complementary assets that are needed to develop innovations. As technological developments involve an increasing number of processes, it has become significantly harder for a firm to deploy all the required assets and capabilities at a reasonable cost. Under such circumstances, cooperation with other firms can be an effective strategy to get access to those complementary assets and capabilities needed during the innovation process (Kim, Y. and Vonortas, N. S. (2014)).

In addition, cooperation agreements have also been proposed in the literature as a mechanism to exploit economies of scale and scope. Cooperation might lower costs or translate into faster technological advance, due to the elimination of redundant efforts when firms enter into research joint ventures (Vilasuso and Frascatore (2000)). It also facilitates firms to share risks and deal with the the uncertainty that characterizes innovation activities (Caloghirou, Y. et al. (2003)).

Another important factor that motivates cooperation is the existence of spillovers during the innovation process, both incoming and outcoming. Outcoming spillovers refer to information that is leaked out while the firm is performing innovation activities that could benefit other firms. The existence of outcoming spillovers is particularly important in industries where appropriability mechanisms are less effective and cooperation agreements can be a mechanism to internalize such spillovers, that is to appropriate the returns of their joint innovation efforts (Afcha Chavez, S. M. (2011)). Incoming spillovers refer to the firm ability to benefit from the knowledge generated by others. Cooperation agreements can also facilitate firms to benefit from incoming spillovers (Cassiman, B., and Veugelers, R. (2002)). Finally, cooperation can also be motivated to gain market power in the product market (Greenlee, P., and Cassiman, B. (1999); Sovinsky, M. (2022)).

The literature on cooperation also explores the choice of the type of partners (customers,

competitors, suppliers, public organizations, etc). The type of partner depends on the main motivation for the cooperation agreement. When cooperation is mainly motivated by getting access to complementary assets cooperation partners tend to be more heterogeneous in the relevant dimension, while when the motivation is more related with internalizing spillovers or increasing market power symmetric partnerships are more likely (Busom, I. and Fernández-Ribas, A. (2008)).

Even though there are many reasons to believe that cooperation may be beneficial for firms, there exist obstacles that prevent these agreements to materialize. Information asymmetries and the corresponding transaction costs associated to mitigate them are identified by the literature (Bianchi et al. (2019)) as barriers to the formation of welfare enhancing R&D collaborations.

2.2 Empirical evidence of the impact Public Support on Cooperation

There are several mechanisms proposed by the behavioral additionality literature to explain why public support for innovation could incentivize cooperation between the recipient firm and other external parties.

First, some studies emphasize the role of organizational learning (Clarysse et al. (2009); Chapman, G. et al. (2018)). Public support allows the firm to undertake innovation projects that increase its stock of knowledge. The improvement in the firm internal capabilities provide granted firms with greater ability to exploit knowledge developed outside the firm. This higher levels of absorptive capacity (Cohen, W. M., and Levinthal, D. A. (1990)) increase incentives to cooperate as granted firms are more able to monitor knowledge and technological developments and or to benefit from incoming spillovers. Moreover, the increased in the firm absorptive capacity that results from undertaking the subsidized project, can also facilitate the identification of good external collaborative partners that could provide the firm with access to complementary assets, or allow the firm to exploit economies of scale or scope, or to share risk (Zhang, J. (2016)). Thus, public support for innovation by increasing the firm absorptive capacity, can incentivize cooperation between the granted firm and external partners.

A second mechanism than has been highlighted in the literature is related with technological opportunities. When firms undertake innovation projects, new technological opportunities can arise, that firms will try to pursue in future projects (Lee, C. Y. (2011); Hottenrott, H. et al. (2017)). These opportunities identified during publicly supported innovation projects will increase incentives to collaborate in future projects with external partners, since, as discussed in section 2.1, the resources required to successfully exploit these new opportunities might not be within the firm but spread across external partners.

Finally, public support has been also identified in the literature as providing a "certification effect" that is, a signal of the quality of the subsidized firm (Lerner (1999)). Government

bodies that assign public support certify the granted firm´s merits which differentiate the firm from other firms competing for collaboration partners. This signal helps thus reducing the uncertainty of the firm´s viability as a partner facilitating collaboration with external parties (Bianchi et al. (2019)).

Empirical evidence on the impact of public support for innovation on cooperation agreements is mixed (Bianchi et al. (2019)). For instance, out of 18 papers reviewed by these authors covering the period 2003 - 2018, two report negative effects of public support on collaborative efforts, ten find positive effects and the remaining six find no conclusive evidence.

Even though this literature suffers from a relative lack of good quality data, both in terms of measurement and availability, a number of empirical studies have explored various types of behavioural additionally effects. Georghiou and Clarysse (2006) review some empirical evidence on this topic from a series of national studies auspiced by the OECD´s Working Party on Innovation and Technology Policy (TIP) during 2004 and 2005. In general, these studies provide evidence of behavioral additionality effects of public support such as an acceleration of the completion time of business R&D projects, an expansion of their scale and scope and increased incentives within supported firms to conduct more challenging research. Related with incentives to cooperate, Falk (2007) documents positive effects of public funding on the consolidation of technological cooperation agreements in Austrian firms and Fier et al. (2006) find that public support encourages collaboration amongst German firms. Finally, Clarysse et al. (2009) find that public support positively affects different measures of behavioural additionally, including learning that occurs through collaboration agreements amongst firms.

3 Data

We use publicly available Uruguayan data from the Business Innovation Survey (BIS) between 2007 and 2015. The BIS is a joint effort conducted by the National Institute of Statistics (INE) and the National Agency for Innovation and Research (ANII). It has been specially designed to identify a firm's innovation activities, and thus it provides measures to characterize a firm's innovation process.

The survey is representative of firms with more than ten employees, and all firms with 50 or more employees are included in every wave. Among the information collected from the survey, we are particularly interested in the public funding source for innovation activities and the cooperation agreements held by firms. The survey is performed every three years, although some variables are reported yearly, and in some other cases, firms are asked to report averages for the given wave. We exploit the panel structure of the surveys, and our sample is composed of 1,342 firms and 4,026 observations.
We describe below the main variables of interest.

Cooperation agreements. The survey collects information on different kinds of cooper-

ation agreements held by firms. It is important to note that all surveyed firms must report this information regardless of whether they have undertaken any innovation activity. The firms must indicate whether they have entered into cooperation agreements with other firms during the wave period.[1]

From the BIS, we cannot to distinguish among partners; we are only able to know that the partners are *other firms* that may operate in horizontally and/or vertically related markets.

The information about the agreements include: (a) commercialization-marketing agreements, (b) agreements to purchase inputs, (c) agreements to purchase technology, (d) agreements for joint technology development, (e) agreements to train employees and other minors categories.

Based on the reported information, we construct five binary cooperation measures, one for each kind of cooperation agreement. Each of the variables takes a value of 1 if the firm reports having an agreement in the corresponding category of the cooperation agreement. The variable "Cooperation" takes the value of 1 if the firm has a cooperation agreement in at least one of the listed categories in the wave period.

Table 1 suggests that almost 14% of firms held a cooperation agreement with other firms, and the most common agreement is related to commercialization-marketing agreement (8.4%) and agreement to purchase of input. (5.6%).

Public Support. Those firms undertaking innovation activities must report whether they received public support to finance their innovation activities in the wave period. The main mechanisms implemented in Uruguay to support firms' innovation activities are: a) partial direct subsidies (matching grants), and b) tax incentives. Based on this information, we construct a binary measure of public support ("Public Support"). The variable takes a value of 1 if the firm reports receiving public support to undertake innovation activities. Table 1 shows that 8.1% of the surveyed firms got financial support to undertake innovation activities during the period of the study. It is important to highlight that to be a beneficiary from these sources firms are not required to hold or to enter into any cooperation agreement with other firms.

Table 2 shows that the pattern by type of agreements among those who received public support for innovation and those who did not receive it is similar, except that among those who did not receive public support, there is a higher percentage of commercialization-marketing agreements (28% vs. 23%), and a relatively lower number of cooperation agreements for personnel training (19% vs. 22%), and cooperation agreements that involve some technological issues.[2]

Control variables. As controls in our analysis, we include the following variables at

[1] According the BIS, a cooperation agreement is an explicit agreement, formal or informal, between two or more independent firms, by which joining or sharing part of their capabilities and resources, establish a certain degree of interrelation in order to increase their competitive advantages.

[2] For firms who did not receive public support, agreements to purchase technology plus agreements to joint development technology account for 28% of the total agreements they held versus 33% of the agreements held among those who receive public support for innovation activities.

the firm level: (a) firm size measured as the number of employees ("Employees"), (b) firm's ratio of exports to sales ("Export share"), (c) firm's age in years ("Age"), (d) firm's technological gap measured as the difference between firm's labor productivity and the labor productivity of leading firm in its sector ("Technology gap"), and (e) the ratio of the number of professionals and technicians in the firm to its total number of employees ("White-collar share").

Table 1: Descriptive Statistics

	mean	sd	min	max
Cooperation	0.136	0.343	0.000	1.000
Commercialization	0.084	0.277	0.000	1.000
Purchase of Input	0.056	0.230	0.000	1.000
Purchase of Technology	0.044	0.206	0.000	1.000
Technology Development	0.044	0.204	0.000	1.000
Public Support	0.081	0.273	0.000	1.000
Employees	167	555	0.000	11,045
Export share	0.116	0.269	0.000	1.000
Age	26.516	20.413	0.000	160
Technology gap	0.665	0.311	0.000	1.000
White collar share	0.170	0.237	0.000	1.000
N	4,026			

Source: Innovation Survey 2007–2009, 2010–2012 and 2013–2015.

Table 2: Agreements and public support

	Commercialization	Purchase of Input	Purchase of Technology	Technology Development	Training Employees	Others	Total
Public Support	23.2%	16.8%	16.5%	17.1%	21.6%	4.9%	100%
No Public Support	28.4%	18.1%	13.9%	13.5%	18.9%	7.2%	100%

4 Identification Strategy

This section presents the two approaches taken in the paper to recover the causal effect of interest. The first one is centered around the notion that self selection can be explained by some unobserved fixed characteristic by firms. The second builds over the first one and relaxes the notion that the only source of endogeneity is time-invariant and firm specific.

4.1 Chamberlain device

The underlying identification logic is following Mundlak (1978) and Chamberlain (1982). We claim that the unobserved effects are exogenous from the treatment once we control for firm specific unobservable which are models as time-averages of observable characteristics ($\bar{X}_i$). If we specify $E(Y_{it}|D_{it}, X_{it}, \bar{X}_i)$ parametrically as a logit the sign of the coefficient on D_{it} can be interpreted as the sign of the average causal effect. The main identification assumption disposing of the parametric distribution is that $E(Y_{it}|D_{it}, X_{it}, \bar{X}_i) = E(Y_{it}|, X_{it}, \bar{X}_i)$. The structural system of equations for firm i at time t is:

$$\begin{aligned} Y_{it} &= 1(\alpha_0 + \alpha_1 D_{it} + \alpha_2 X_{it} + c_i - u_{it} > 0) \\ &= 1(\alpha_0 + \alpha_1 D_{it} + \alpha_2 X_{it} + E(c_i|X_{it}, D_{it}, \bar{X}_i) - w_i - u_{it} > 0) \\ E(c_i|X_{it}, D_{it}, \bar{X}_i) &= \beta_0 + \beta_1 \bar{X}_i \end{aligned}$$

Where Y_{it} is cooperation, D_{it} is public support, X_{it} is a vector of firm-level control variables, c_i is a firm's fixed effect, $w_i + u_{it}$ is an error term with logistic distribution independent of everything, $\bar{X}_i$ is the time average of the vector of firm level controls. Note D_{it} might not be independent of c_i, even conditional on X_{it}. By substitution we get:

$$Y_{it} = 1(\tilde{\alpha_0} + \alpha_1 D_{it} + \alpha_2 X_{it} + \beta_1 \bar{X}_i - w_i - u_{it} > 0)$$

After using the fact that $w_i + u_{it}$ is logistic and independent of X and D once controlled for $\bar{X}$:

$$\Gamma(\tilde{\alpha_0} + \alpha_1 D_{it} + \alpha_2 X_{it} + \beta_1 \bar{X}_i) = P(Y_{it} = 1|X_{it}, D_{it}, \bar{X}_i)$$

This equation is estimable by Maximum Likelihood. Note $\tilde{\alpha_0} = \alpha_0 + \beta_0$. Recall $P(Y_{it} = 1|X_{it}, D_{it}, \bar{X}_i) = E(Y_{it}|X_{it}, D_{it}, \bar{X}_i)$.

4.2 Bivariate probit model

The previous analysis relies on controlling properly for the endogeneity which we assume to be an individual preference parameter c_i, which we can model as a function of observed characteristics. Such strategy might be questioned since self selection might not be properly controlled with the average characteristics of observables. In light of that possibility we complement the analysis with an instrumental variables analysis. In particular, since the setting implies a treatment variable that is binary, i.e. where there is unobserved heterogeneity present, $2SLS$ would provide an estimate for the local average treatment effect as noted by Imbens and Angrist (1994). To obtain estimates of the average treatment effect, we follow Ashford and Sowden (1970), Heckman (1978) and use a bivariate probit model, a widely used framework. The bivariate probit model provides enough structure to point-identify traditional parameters of interest such as the average treatment effect (ATE), and its counterparts for the treated (ATT) and untreated (ATU) groups.

The instruments proposed is the percentage of the total amount of public funding available for any given sector at any given time. The justification of the instrument is based on the notion that variations in the available amount of research financing create an exogenous shock affecting the total number of potentially beneficiaries projects, but do not impact the expected valorisation outcome. An increase in the overall budget available for the research funding programme will affect the decision about how many projects will receive the grant, but will not impact the project plan itself and firms decisions to apply. The choice (and ability) to perform any type of valorisation activities remains an independent decision.

In this context, consider the following extension of the previous model but accounting for the endogenous choice of D_{it}:

$$\begin{aligned} Y_{it} &= 1(\alpha_0 + \alpha_1 D_{it} + \alpha_2 X_{it} + \alpha_3 \bar{X}_i + v_{it} > 0) \\ D_{it} &= 1(\gamma_0 + \gamma_1 Z_{st} + \gamma_2 X_{it} + \gamma_3 \bar{X}_i + e_{it} > 0) \end{aligned}$$

Where Z_{st} is the percentage of the amount of public support for the sector s at time t to whom firm i belongs. v_{it}, e_{it} are distributed jointly standard normal. Z_{st} is independent of e_{it}, v_{it}.

Once again, the system can be estimated by Maximum Likelihood.

5 Results

This section presents the results from the two identification strategies and discusses them.

The first column in Table 3 reports the results from the model without the time-mean controls, and the second column reports the results with these additional controls. The average marginal effect of public support is 0.17 which is significant at 1 percent. This fact implies that public support increases the likelihood of cooperation by 0.17.

Table 3: All forms of Cooperation

VARIABLES	(1) Simple Logit Model	(2) Chamberlain Logit Model
Public Support	1.096***	1.106***
	(0.143)	(0.143)
Employees	0.000	0.000
	(0.000)	(0.000)
Export share	0.005***	-0.003
	(0.002)	(0.005)
Age	0.005	0.005
	(0.003)	(0.003)
Technology gap	0.175	-0.105
	(0.185)	(0.297)
White collar share	1.607***	0.559*
	(0.211)	(0.330)
Constant	-2.363***	-2.597***
	(0.226)	(0.262)
Observations	4,020	4,020
Sector Dummy	2-digit	2-digit

Note: This table presents the Logit and the Chamberlain Logit. Each column estimates the probability of cooperation assuming that the unobserved component follows a logistic distribution. Column 1 reports the results from the model without the time-mean controls, and Column 2 reports the results with these additional controls. Coefficients remain significant and similar in magnitude.Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Table 4 presents the Chamberlain logit estimation for the different types of cooperation, assuming, as above, that the unobserved component follows a logistic distribution. The average marginal effects of public support on distinct kinds of cooperation are positive and significant at 1 percent. The magnitude of the effect is substantive: the public support increases the probability of entering into a cooperation agreement between 7.9% to 5.1% depending on the type of agreement. Regarding cooperation for technological development, we find that size ("Employees"), experience ("Age"), and skilled employees ("White-collar share") are important drivers of the likelihood of cooperation. We can interpret this result through the lens of the capability theory as this evidence suggests that having absorptive capacity is crucial to establishing this kind of agreement. This result is also in line with the existing literature (see, for example, Busom, I. and Fernández-Ribas, A. (2008)).

Table 4: Chamberlain Logit according type of cooperation

VARIABLES	(1) Commercialization	(2) Input Purchase	(3) Techno Purchase	(4) Techno Development
Public Support	1.060***	1.126***	1.418***	1.370***
	(0.169)	(0.185)	(0.212)	(0.216)
Employees	-0.001	-0.000	0.001	0.001**
	(0.000)	(0.000)	(0.000)	(0.000)
Export share	0.001	0.005	-0.012	-0.001
	(0.006)	(0.007)	(0.010)	(0.009)
Age	0.005	0.004	0.006	0.013***
	(0.003)	(0.004)	(0.005)	(0.004)
Technology gap	0.055	0.116	-0.193	-0.251
	(0.382)	(0.432)	(0.467)	(0.413)
White collar share	0.387	0.153	0.494	0.865*
	(0.397)	(0.475)	(0.601)	(0.465)
Constant	-3.215***	-3.715***	-3.174***	-3.708***
	(0.322)	(0.372)	(0.398)	(0.389)
Marginal effects				
Public Support	0.079***	0.058***	0.057***	0.051***
Observations	4,020	4,020	4,020	4,020
Sector Dummy	2-digit	2-digit	2-digit	2-digit

Note: The table presents the Chamberlain Logit estimations. Each column estimates the probability of different types of cooperation assuming that the unobserved component follows a logistic distribution. All of them include the time-mean controls. Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1..

From the policy perspective, these results mean that supporting innovation activities has an important effect on cooperation behavioral among firms. Nonetheless, recognizing that potential unobservable factors may be simultaneously related to the probability of receiving support and cooperating, we carry out the following strategy.

As discussed in the identification section, Table 5 presents the results of the estimation that address the potential selection biases that is not time invariant and not controlled by the Chamberlain strategy. Findings reported in Table 5 implies that the average marginal effect of the variable of interest of 0.027 which is significant at the 5 percent level. Therefore, holding everything else constant, public support increases the likelihood of cooperating by 0.027. It is important to highlight that the magnitude of this effect is smaller than the one found in Table 3 suggesting that a fraction of the self-selection was not being properly corrected by the Chamberlain logit model and it implies an overestimation of the effect. Repeating the same procedure by type of cooperation we get the marginal effect of public support to be of similar magnitude and significant at 1 percent for all forms of cooperation except commercialization.

Table 5: All forms Cooperation-Bivariate probit strategy coefficient estimates

VARIABLES	(1) First Stage on public support	(2) Second stage on cooperation
Public Support	-	1.201703*
	-	(0.6194132)
% of public support for the sector the firm belongs	9.126703***	-
	(2.205077)	-
Constant	-1.303375***	-1.47604***
	(0.2295787)	(0.2017239)
Observations	4,020	4,020
Sector Dummy	2-digit	2-digit
Chamberlain controls	Yes	Yes
Other Controls in Table 3	Yes	Yes

Note: This table presents the Bivariate probit model estimates assuming that the unobservables follow a jointly standard normal distribution. Column 1 reports the results from the first stage, showing that the instrument is relevant. Column 2 reports the results for the outcome variable of interest. Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

6 Conclusions

In this paper we estimate the behavioural additionally of public support for innovation activities, on the decision to cooperate. Using Uruguayan data from 2007 to 2015, and controlling for endogeneity, we find that public support increases the likelihood of different types of cooperation agreements. Precisely, it increases the probability of cooperation by 0.027. The empirical evidence suggests that public support leads to organizational changes within supported firms that increase their propensity to cooperate with external partners. The implications of these results are relevant for policy design as they contribute to the understanding of the unintended positive and negative impacts of public support for innovation on the behaviour of supported firms.

We are currently working on several extensions that will complement the results reported in this study. Some empirical analysis that we are undertaking focuse on understanding the underlying mechanism/s driving the behavioral effect reported. In addition, we are also exploring heterogeneity in the estimated behavioral effect between different groups of firms.

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