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# Subsidies, new firms, and productivity in global manufacturing

Filippo Belloc [a,*], Antonino Lofaro [b]

[a] DEPS, U Siena, Piazza San Francesco 7, Siena, Italy
[b] Dep. of Political Sciences, U Bari, Via Giuseppe Suppa 9, Bari, Italy

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ABSTRACT

We investigate how government subsidies influence the productivity of new firms, by leveraging data on more than 30,000 government subsidy initiatives and about 1.2 million manufacturing firms distributed worldwide in the years 2012-2019. First, using a DiD framework with multiple time periods, we document that sectors exposed to subsidies experience a statistically significant increase in new firm entry rates. We then examine the firm-level data through a series of augmented 3-way FE DiD models. Our findings reveal that subsidies have significant effects on the productivity of new firms. On average, subsidies lead to the entry of new firms with 5.53 % lower productivity compared to those entering untreated markets. The productivity gap of new firms in subsidized markets persists in the years after entry. We also apply a text recognition method to analyze the effects of specific subsidy attributes. We find that unconditional tax breaks and loans are mostly responsible for the negative effects of subsidies, while subsidies promoting firm internationalization and investments by small firms may lead to the establishment of more productive firms. Subsidies aimed at supporting the adoption of green and automation technologies do not always reduce the productivity of new firms. Finally, estimates about incumbents' performance show that subsidies may intensify competition in the market and do not necessarily lead to greater resource misallocation within sectors.

## 1. Introduction

Industrial policies, intended as government actions directed at changing the structure of economic activity within sectors and countries, have been extensively used in the 19th century to shape the business sector and to promote industrialization, capital accumulation, and economic growth (Juhász and Steinwender, 2024). Today, despite widespread skepticism (e.g., Dabla-Norris et al., 2024; Imf et al., 2022; Heuvelen, 2023), industrial policies are still largely implemented, in order to address newer and more specific challenges, about innovation, the green transition and firm international competitiveness (Bown, 2024; Evenett et al., 2024; Juhász et al., 2024; Rodrik, 2024; Reenen, 2023).

Modern industrial policy is complex and can touch any sector of the economy while taking different forms. Nevertheless, recent data show that, far most commonly, industrial policies are subsidies and state aids (e.g., export and production subsidies, grants, tax reliefs, and government loans), typically focused on manufacturing industries (Juhász et al., 2023). The evident escalation in the use of government subsidies worldwide is illustrated in Fig. 1. Subsidies have been constantly on the rise since 2009, with the number of subsidy announcements per year going from about 1000 in 2009 to more than 3500 in 2020.

Government subsidies have attracted significant attention in economic research, as they are a major item of government expenditure in many countries (Schwartz and Clements, 1999). Within a broad literature evaluating the impacts of subsidies on industrial

* Corresponding author.
*E-mail addresses:* filippo.belloc@unisi.it (F. Belloc), antonino.lofaro@uniba.it (A. Lofaro).

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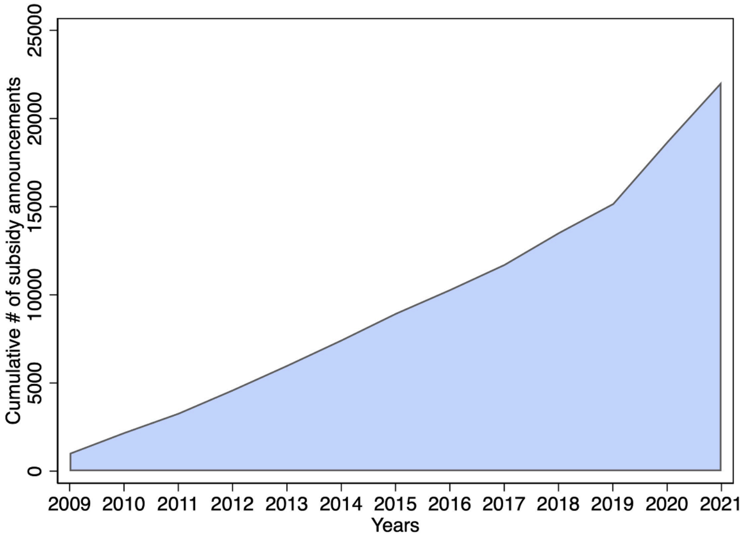


**Fig. 1.** Global subsidies in force.

dynamics from various perspectives, recent case-focused works in particular have shown that government subsidies may have a positive effect on firm entry in highly stylized settings (Banares-Sanchez et al., 2024; Criscuolo et al., 2019; Santoleri et al., 2024).

Against this background, less understood is how government subsidies influence the productivity of new firms that enter targeted sectors from scratch (*de novo* entrants) and the extent to which subsidy attributes matter. This gap in the literature is puzzling because evidence in this direction would be a key compass for industrial policy-makers, particularly for what concerns the optimal design of government programs aimed at improving the efficiency of new production units in order to accelerate the productivity-enhancing reallocation of resources.

From a theoretical viewpoint, the effects of subsidies on new entrants' productivity are ambiguous. Assume that firms are required to pay a fixed cost to enter the market (Hopenhayn, 1992). Moreover, prospective firms are ex-ante heterogeneous, due to asymmetric dispersion in managerial skills (Lucas, 1978) and in other possibly relevant capabilities. Let high-capabilities firms paying a lower fixed entry cost and enjoying higher initial productivity. In equilibrium, only better firms enter the market. Now, suppose that a subsidy reducing entry costs is implemented. More firms will enter the market. All else being equal, the additional new firms have worse capabilities and, therefore, lower initial productivity. However, possibly depending on specific subsidy attributes, the subsidy may also allow new firms to acquire better equipment. In this case, the additional new entrants may show higher productivity.

We shed light on these effects empirically, by looking at the relationship between the implementation of subsidy programs with different attributes and the productivity of newly established firms in the global manufacturing.

We take advantage of the Corporate Subsidy Inventory 2.0 of the Global Trade Alert database (CSI-GTA, hereafter), which tracks subsidy initiatives at the country, sector, and year levels, for more than one hundred countries over the last fifteen years, thereby offering the most comprehensive compilation of subsidy measures available (Evenett and Espejo, 2023). The CSI-GTA database covers 31,116 subsidy measures, providing, for each measure, a detailed description of the measure itself, including the jurisdiction responsible for the subsidy, its implementation and removal dates, and the list of sectors where the measure applies. We explore each subsidy measure with text recognition techniques and identify a number of subsidy attributes, including the type of the subsidy (direct transfers, tax breaks, loans, export promotion interventions), selectivity (i.e., whether the subsidy targets small firms), and objectives (development of green innovation and adoption of automation technologies). We then match these data with firm-level data obtained by elaborating information from Orbis (Bureau van Dijk), which contains company accounts for a very large sample of manufacturing firms distributed worldwide. As a result, focusing on the years 2012-2019, 121 countries and 105 3-digit manufacturing sectors, after data cleaning we obtain a dataset of 1,258,558 firm-level observations, distributed in 31,408 country-sector-year tuples, with 14,722 (46.87 %) being tuples for which a subsidy is active.

The main challenge that makes evaluating the effects of subsidy programs difficult is the inherent endogeneity that these policies entail. Governments do not sprinkle subsidies on different sectors randomly. The selection of the industry to be subsidized is often driven by the need to correct market failures and at times by lobbying and rent-seeking (Juhász et al., 2024). We deal with this identification threat by leveraging on the combination of the very large coverage of our dataset and the multiple implementation of different subsidy programs across different countries and sectors with different periods of treatment, which allows us to exploit both the method proposed by Callaway and Sant'anna (2021) and the three-way fixed-effect estimators in a difference-in-differences (3WFE DiD) framework to absorb time-variant unobservable attractors of subsidy policies at the country and sector levels.

The structure of our data is best suited to ascertain the effects of different government subsidies on new firm entry. In setups with a single treatment period, a typical concern is that contemporaneous trends driven by factors other than the treatment could confound the effect of the treatment itself, violating the parallel trends assumption, as highlighted by previous literature (Baker et al., 2022).

Our multiple subsidies and multiple periods design plausibly alleviates concerns that the estimated treatment effects are driven by contemporaneous trends and provides more credible and robust evidence with respect to single event studies.

Our analysis provides the broadest quasi-experimental evidence on the impact of government subsidies on new firms' productivity and delivers some important results.

At first, using the method of Callaway and Sant'anna (2021), we document that countries and sectors exposed to subsidies experience a statistically significant increase in new firm entry rates at the 3-digit sector level. This effect is weak in the first years after the implementation of a subsidy and becomes stronger in both magnitude and statistical significance after four years of treatment.

By exploiting the firm-level dimension of the data, in a 3-way fixed effects (3WFE) DiD framework, we study the productivity of the new firms that enter markets treated by subsidies of any type and, in more granular regression models, by subsidies with different attributes. In particular, we measure the performance of newly established firms both in the first year after entry and through the subsequent years of activity in a treated country-sector relative to the performance of their counterparts in untreated markets. Given the structure of our data, that cover more than 31,000 subsidy programs, our empirical strategy equals running as many event-specific DiD estimations involving more than 1,250,000 firm-level observations exposed to multiple treatments in multiple periods, also controlling for event-specific fixed-effects. Our firm-level findings show interesting effects. On average, government subsidies seem to attract new firms with lower productivity. Specifically, at the end of the first year of activity after entry, new firms in subsidized sectors have a Total Factor Productivity (TFP) that is 5.5 % lower than new firms in unsubsidized sectors. Moreover, new firms created during a subsidy program tend to show lower productivity also in subsequent years of activity after entry. We then dig into the subsidy descriptions with a text recognition method (Juhász et al., 2023) to identify the specific attributes of each subsidy and to measure the attribute-specific effects on new firms' productivity. We find that unconditional subsidies aimed at relaxing the firm budget constraint (in particular, tax breaks and loans) are largely responsible for the negative effects on productivity, causing new firms to have a productivity gap of about 10.8 %. On the other hand, measures pursuing better defined objectives, such as export promotion initiatives and subsidies aimed at facilitating investments by small and medium enterprises (SMEs), may lead to the entry of more productive firms, with a TFP that is 11.8 % to 18.2 % higher than the counterfactual average. Furthermore, we find that subsidies supporting the diffusion of green and automation technologies do not have systematic negative effects on the productivity of the new entrants, while arguably helping to address the technology transition. Our results resist in several robustness checks, including when alternative productivity measures are used.

We complement these findings by also looking at how subsidies affect the market position of incumbents. We show that, despite being on average less productive, the new firms that enter treated sectors tend to erode the market shares of pre-existing firms, with negative consequences on their productivity. Nevertheless, high-productivity incumbents are also shown to respond to increased competitive pressure in subsidized industries by implementing strategies that may enhance their survival prospects. Hence, taken together, our analysis proves that subsidies may have a significant impact on industry transformation, by altering competition, resource allocation, and productivity dispersion.

In conclusion, to correctly interpret our results, it is important to emphasize that our measure of TFP is revenue-based. As such, it may capture both true productivity and demand-side factors. This implies that the differences in TFP we observe between firms in treated and untreated sectors may partly reflect differences in demand shares. Our findings, therefore, suggest that subsidies may have broader effects beyond productivity itself (including potential impacts on market structures) in ways not fully captured by our analysis, and that do not necessarily involve adverse transformations in firms' productive structures.

*Related literature*

Our study improves on different lines of literature.

First and closest is the small body of recent work documenting a positive link between the supply of subsidies and firm entry. Of particular relevance are the studies of Criscuolo et al. (2019), Santoleri et al. (2024) and Banares-Sanchez et al. (2024), which adopt rigorous identification strategies. Criscuolo et al. (2019) analyzed the causal effects of a major policy change implemented in the year 2000 in the Regional Selective Assistance program in the United Kingdom. This program provided discretionary grants to firms in disadvantaged areas characterized by low levels of per-capita GDP and high unemployment. Criscuolo et al. (2019) measured the effects of a change in area eligibility criteria on employment, investment, and productivity. They found significant program effects, including positive, although weakly significant, effects on the extensive margin of economic activity, as reflected by the number of manufacturing plants (i.e., higher net entry). Santoleri et al. (2024) focused on the Small and Medium Enterprise Instrument, the first European R&D grant program directly targeting innovative small and medium-sized businesses. Under this program, firms compete to secure grants of up to €2.5 million to finance R&D activities. Among other effects, Santoleri et al. (2024) found significant sectoral spillovers in the form of increased rates of entrepreneurial entry. In a rather different context, Banares-Sanchez et al. (2024) examined the effectiveness of local, city-level policies in China, to encourage growth and innovation in the solar industry. Using data on solar panels subsidy policies, they found large effects, including a substantial increase in the number of new firms.[1] More recently, Slattery (2025) analyzed subsidy competition among state and local governments in the U.S. and showed that discretionary subsidies can have a meaningful effect on firm attraction, by influencing firm location decisions. These studies greatly contributed to our understanding of the nuances of particular initiatives and to the identification of the direct effects of subsidies on firm entry in specific empirical contexts. At the same time, however, the ability of these works to make informative comparisons between different

[1] In contrast, analyzing other Chinese subsidy programs, Branstetter et al. (2023) examine microdata on listed firms and show that subsidies failed to enhance productivity growth.

subsidy programs remains limited, and less is what we know about whether different subsidy attributes lead to different effects on new firms' productivity. Our paper fills this gap. More generally, we contribute to the broader literature on the various impacts of government subsidies, which is mostly based on event-focused studies. Slattery and Zidar (2020) review some of this literature with emphasis on the wage and employment effects of certain subsidy programs in the US.[2] Outside the US context, other papers have measured the effects of subsidies on incumbent firms' performance, focusing in particular on subsidies targeting small and medium-sized firms (e.g., Bloom et al., 2019; Brown et al., 2024; Garcia-Santana and Pijoan-Mas, 2014; Garicano et al., 2016; Martin et al., 2017; Rotemberg, 2019). We contribute to this literature by providing evidence on some effects of specific subsidy attributes, including SME, green and automation-related attributes, in a broad scale, virtually global context, by leveraging the CSI-GTA database, that is the largest-coverage database on government subsidies available.[3]

Our paper closely relates also to the body of very recent work documenting the empirical patterns of industrial policies, including subsidies, with the same GTA-based data used in the present paper (e.g., Evenett et al., 2024; Imf et al., 2022; Juhász et al., 2023). In particular, Rotunno and Ruta (2024) use GTA data to investigate the effects of domestic subsidies on international trade flows, with DiD techniques. They find that the implementation of government subsidies is associated with higher export and import levels in targeted markets relative to non-targeted ones. Behind this average effect, Rotunno and Ruta (2024) also show that subsidy programs of a different type may exert different effects, with tax breaks having more important effects than direct transfers (e.g. state aids and grants) and loans. Our paper complements this line of study by delivering a novel set of findings on the impact of government subsidies at the firm level, overlooked in previous literature using GTA data.

Finally, there is a prominent literature on firm entry itself. A body of literature has studied the entry of new firms to explain industrial dynamics, viewing it both as a key driver of job creation (Geurts and Biesebroeck, 2016) and as a catalyst for the innovation process sparked by competition between new entrants and incumbent firms (Aghion et al., 2009). New entrants have been found also to shape sectoral outcomes, in terms of firm size and survival (Audretsch et al., 1999)), profits dynamics (Mukherjee and Zhao, 2017), and welfare (Nachbar et al., 1998). Related to this, a line of research focused on the factors driving new firm entry and performance (see, for example, Geroski, 1995; Geurts and Biesebroeck, 2016; Jovanovic, 1982; Shapiro and Khemani, 1987), including the role played by regulation and public intervention (Klapper et al., 2006), without, however, addressing subsidies as a potentially relevant variable. A notable exception is the work of Fan and Xiao (2015), who study various subsidy policies designed to encourage entry into the US local telephone industry. Fan and Xiao (2015) posit that different potential entrants may face different levels of entry costs, and study the effects of subsidies on entry dynamics. They find that subsidies reduce entry costs, change the timing of firms' entry behaviour, and accelerate the arrival of competition. Our paper takes a step toward broadening these findings across multiple sectors and countries.

The rest of the paper is organized as follows. Section 2 introduces the theoretical underpinnings of our study in a very simplified framework. In Section 3, we present the data used in our empirical analysis. In Section 4, we measure the impact of subsidies on entry rates, while Section 5 presents an analysis of the effects of subsidies on the productivity of new entrants. In Section 6, we check the stability of our main results in a number of robustness checks. In Section 7, we look at the effects of subsidies on the market performance of incumbent firms. Section 8 concludes.

## 2. Theoretical insights

*Setup*

Suppose that new firms must pay a fixed cost to buy a fixed amount of capital and labor inputs ($K$ and $L$, respectively), in order to enter the market, given a minimum efficient scale. Assume that prospective firms are ex-ante heterogeneous, due to differences in managerial skills and other capabilities (Lucas, 1978). Let each firm $i$ initially be characterized by its capability parameter $\vartheta_i$, which is drawn from a distribution $F(\vartheta)$ with support on the interval $[\vartheta_{\min}, \vartheta_{\max}]$. The fixed entry cost for firm $i$ is $C(\vartheta_i)$, where:

$$C(\vartheta_i) = C_0 - \rho\vartheta_i \tag{1}$$

where $C_0$ denotes the fixed base cost and $\rho > 0$ captures the relationship between a firm's capabilities and the idiosyncratic fixed costs incurred by firm $i$. Hence, potential entrants are heterogeneous in entry costs (Fan and Xiao, 2015), with higher-capability firms paying lower entry costs. Let $A_i$ denote the productivity realized by firm $i$ upon entering the market as a function of $\vartheta_i$:

$$A_i(\vartheta_i) = A_0 + \phi\vartheta_i \tag{2}$$

where $A_0$ is a baseline level of productivity and $\phi$ is a coefficient reflecting how firm capabilities translate into productivity. We ignore the time dimension for the sake of simplicity and suppose a one-period production. Output $Y_i(A_i, K, L)$ follows from a Cobb-Douglas production function:

$$Y_i(A_i, K, L) = A_i L^{\beta_L} K^{\beta_K} \tag{3}$$

*Entry decisions without subsidy*

[2] Older studies are surveyed in Schwartz and Clements (1999).

[3] A recent study (Oecd, 2025) presents firm-level international evidence on the market implications of subsidies, by using data from the OECD MAGIC database, which covers a sample of 482 firms in different jurisdictions.

Firm $i$ enters the market if the expected profits from entering are greater than the fixed entry cost. The expected profits of firm $i$ are given by:

$$\pi_i = pA_i(\vartheta_i)L^{\beta_L}K^{\beta_K} - C_i \tag{4}$$

To simplify, suppose that the competitive market price $p$ is given. Firm $i$ enters the market if $\pi_i > 0$, i.e. if:

$$p\big(A_0 + \phi\vartheta_i\big)L^{\beta_L}K^{\beta_K} - \big(C_0 - \rho\vartheta_i\big) > 0 \tag{5}$$

Thus, before any subsidy is introduced, the cutoff capability level for firms to enter the market is:

$$\overline{\vartheta}_{before} = \frac{C_0 - pA_0L^{\beta_L}K^{\beta_K}}{p\phi L^{\beta_L}K^{\beta_K} + \rho} \tag{6}$$

Only firms with $\vartheta_i \geq \overline{\vartheta}_{before}$ will enter the market. This means that, in equilibrium, only better firms (i.e., firms with higher initial capabilities) will enter.

*Entry decisions with subsidy*

Now, suppose that the government implements a subsidy that reduces the entry cost. Let the subsidy reduce the fixed cost of entrants by a factor of $z$, where $0 < z < 1$. The new fixed entry cost becomes:

$$C(\vartheta_i) = (1 - z)C_0 - \rho\vartheta_i \tag{7}$$

The new profit condition for firm $i$ in the presence of a subsidy is:

$$p\big(A_0 + \phi\vartheta_i\big)L^{\beta_L}K^{\beta_K} - \big[(1 - z)C_0 - \rho\vartheta_i\big] > 0 \tag{8}$$

The new cutoff capability is:

$$\overline{\vartheta}_{after} = \frac{(1 - z)C_0 - pA_0L^{\beta_L}K^{\beta_K}}{p\phi L^{\beta_L}K^{\beta_K} + \rho} \tag{9}$$

Because $z > 0$, the cutoff in a subsidized market is lower than in an unsubsidized market, i.e. $\overline{\vartheta}_{after} < \overline{\vartheta}_{before}$. This implies that more firms enter the market.

*Effects on initial productivity*

All else being equal, the new additional firms entering the market after the subsidy will be those with a lower capability parameter and, hence, a lower initial productivity $A_i(\vartheta_i)$. However, the subsidy may also allow new entrants to acquire better equipment or more qualified management. Let $M(\vartheta_i) = m\vartheta_i$ represent the capability advantage due to the supply of a subsidy, with $m$ reflecting how much the subsidy allows new entrants to improve their capabilities. In this case, the productivity of the new entrant $i$ after the subsidy is:

$$A_i(\vartheta_i) = A_i(\vartheta_i) + M(\vartheta_i) = A_0 + (\phi + m)\vartheta_i \tag{10}$$

which is higher than the productivity of the new entrant in the absence of the subsidy (Eq. (2)).

Therefore, the effect of the subsidy on the productivity of new entrants is ambiguous, because it depends on the extent to which the subsidy allows the new firms to improve their initial capabilities, possibly as a result of the attributes of the subsidy itself.

## 3. Data

In order to conduct our empirical analysis, we use two main sources of data. On the one side, we gather information on government subsidies from the Corporate Subsidy Inventory 2.0 of the Global Trade Alert (CSI-GTA) database, released in May 2023 and covering 31,116 subsidy programs implemented over 148 customs territories after 2008 (the first version of the database, presented in 2021, is described in Evenett and Fritz, 2021). In the CSI-GTA database, government subsidies are identified as subsidy initiatives involving an action or a commitment to action by a public body, the actual or potential outlay of a public body's resources, an advantage on firms, and possible selectivity (e.g., across sectors) in some meaningful respect. Measures in the form of direct welfare state payments to individuals or transfers to other levels of government or to foreign governments are excluded. To be included in the database, subsidies must be meaningful, i.e. a subsidy must be an intervention with a volume exceeding \$10 million (different thresholds may apply to interventions targeted exclusively at SMEs). Small changes in the costs of complying with regulations (e.g., in the cost of obtaining a license) are not considered meaningful. Also regional policies are excluded, i.e. activities of local governments, constituencies, and other sub-national units. Finally, we remove from the dataset subsidies that have been implemented targeting an individual firm (e.g., the provision of financial help to an individual corporation which otherwise would be on the brink of bankruptcy). Each entry in the database is supported by credible and official statements issued by the acting institution. Consistency is double-checked through press clippings from multiple original sources. For each subsidy, the CSI-GTA database provides a detailed description of the intervention, including the jurisdiction responsible for the intervention, implementation and removal dates, and the list of sectors where the intervention applies. We focus on manufacturing sectors, classified according to the 3-digit level Central Product Classification 2.1.

On the other side, we obtain the variables used to measure entry rates and firm performance from Orbis, which is a database maintained by Bureau van Dijk. Orbis covers a large longitudinal sample of firms distributed worldwide, providing balance-sheet

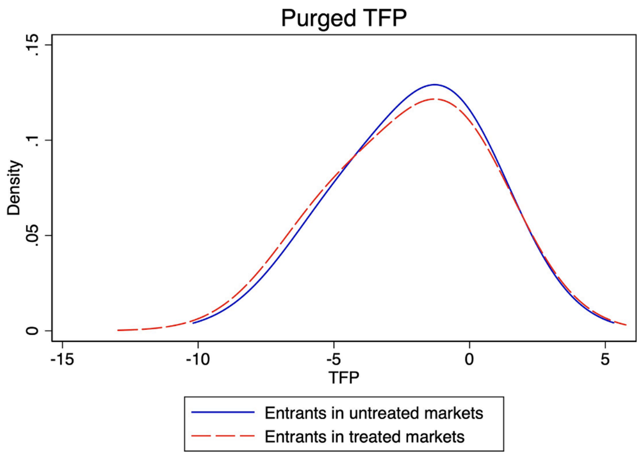


**Fig. 2.** Distribution of TFP of new entrants in treated and untreated sectors.

data on a broad set of financial items, in addition to other demographic characteristics of firms, including location and sector of main activity. Over the 2012-2019 period of our interest and considering the whole manufacturing section of the database, Orbis covers 1,706,456 firm-year observations (i.e., on average, more than 200,000 firms per year).[4] In our analysis, we use variables on firm demography, input and outputs. As the main performance variable, we focus on Total Factor Productivity (TFP). We recover a measure of TFP by estimating within-sector firm-level production functions with the approach proposed by Wooldridge (2009). This is a proxy variable approach to deal with unobserved productivity and simultaneity, which is shown to be more efficient than the two-step semi-parametric procedures introduced by Olley and Pakes (1996) and Levinsohn and Petrin (2003). In words, we implement a one-step generalized method of moments (GMM) estimator, where the moment conditions are specified within a two-equations system, with the log of revenues as the dependent variable and different sets of instruments across equations used for identification. The log of intermediate inputs is used as the proxy variable required to consistently estimate the TFP term.[5] Fig. 2 displays the kernel distributions of TFP for new firms entering treated and untreated markets separately (TFP values are purged of country-sector, country-time, and sector-time FEs), showing that the TFP of new firms in treated sectors is slightly shifted to the right. In the empirical analysis, we also use a number of other firm-level variables in order to account for possibly relevant firm-level characteristics, by elaborating information on capital assets, revenues, employees, liquidity, and listing.[6]

We merge CSI-GTA and Orbis data at the country, sector, and years levels, by using three-step concordance chains from the Central Product Classification 2.1 used in CSI-GTA to ISIC 4 to NACE 2.1 used in Orbis. After data cleaning, our final dataset covers 1,258,558 firm-level observations, distributed over 121 countries, 105 manufacturing 3-digit sectors, and 8 years, for a total of 31,408 country-sector-year tuples.[7] We focus on the 2012-2019 time-span to avoid exceptional policy events in the years around the 2009 Great Recession, on the one side, and exceptional initiatives associated with the COVID-19 pandemic, on the other. More recent years may also involve sample distortions in Orbis due to delays in balance-sheet reporting.[8]

Clearly, while many firms tracked in Orbis operate in sector-country-year tuples where a subsidy is active (treated tuples), many others are in tuples where no subsidy is implemented (untreated tuples). In our final matched dataset, we observe that 46.87 % of the sector-country-year tuples is treated by a subsidy, corresponding to 64.67 % of our firm-level observations. Related to this, it is important to note that, as one might expect, subsidy interventions are sectorally selective. To help grasping sectoral differences in the supply of subsidies, we aggregate our data at the 2-digit level, as shown in Fig. 3. Some sectors emerge as favorite targets both across countries and in terms of the average duration of subsidy programs. The production of vehicles and other transport products and the production of machinery and electronic products are broadly targeted by subsidies and tend to remain under treatment longer with respect to other sectors. At the opposite side of the spectrum, we find pharmaceuticals, printing and reproduction of recorded media.

## 4. Subsidies and new firm entry rates

We start by studying whether the supply of a government subsidy in a sector-country-year influences that rate of new firm entry, with sectors defined at a 3-digit level. New firm entry rates are measured as the share of new firms entering a sector-country-year

[4] Fig. 8 in Appendix A shows the entry rates of new (*de novo*) firms across 2-digit sectors.

[5] The estimated production function coefficients are reported in Table A.3 in Appendix A.

[6] Fig. 9 in Appendix A shows the average TFP of new (*de novo*) entrants with respect to the average TFP of the firms already active in the same market, across 2-digit sectors.

[7] We remove empty tuples and tuples with a very low number of firm-level observations (we test different minimum levels, of 5, 10, and 20 firms within tuples, and verify that our main empirical results, presented below in the paper, do not change substantially). Complete lists of the countries and the 3-digit sectors included in the database are provided in Table A.1 and in Table A.2 in Appendix A.

[8] Note that CSI-GTA data lack information on the stock of subsidies introduced before 2009. By starting our analysis from 2012, we attenuate any effect of these older, unrecorded interventions.

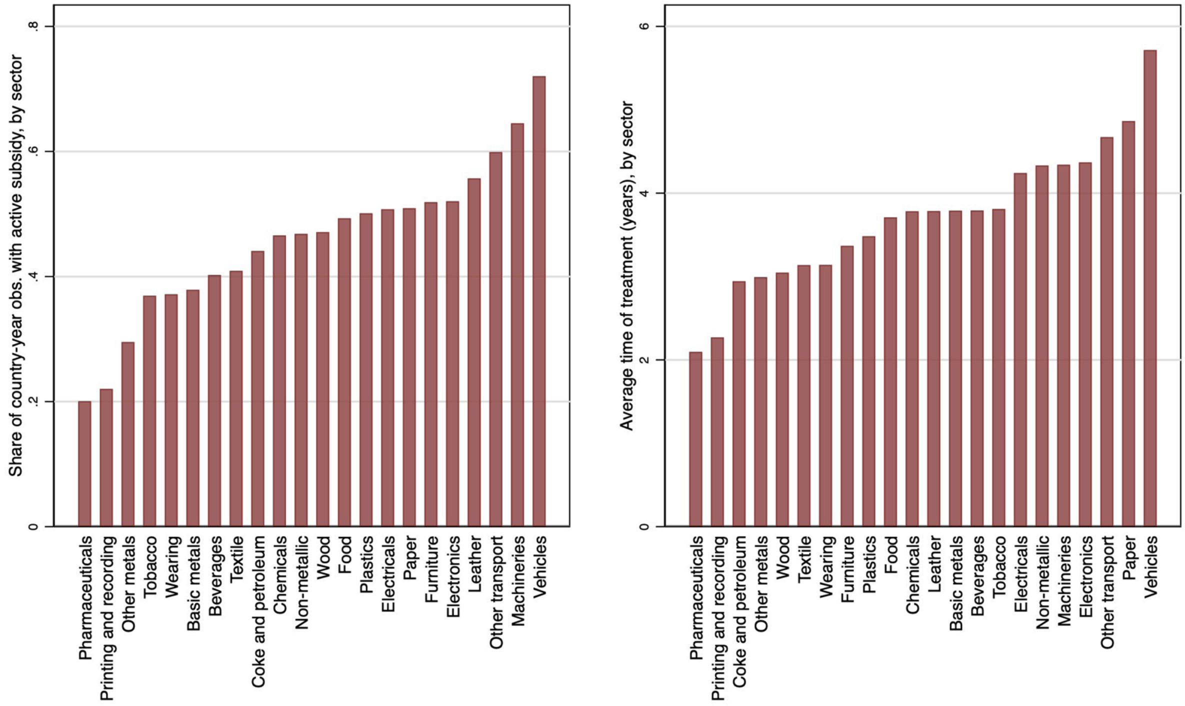


**Fig. 3.** Sectoral distribution of subsidy programs.

from scratch. While previous literature has already shown that certain subsidy programs may increase firm entry in specific settings (Banares-Sanchez et al., 2024; Criscuolo et al., 2019; Fan and Xiao, 2015; Santoleri et al., 2024), we want to study whether the effects of subsidies on entry rates are systematic across many programs, over different countries and different sectors.

As already mentioned, the main critical challenge in evaluating causal effects of government subsidies in this broader research context relates to the fact that the supply of subsidies is not random across countries and sectors. For example, governments may subsidize disproportionately sectors of the economy that are more exposed to international trade or that are at initial stages of technology adoption. Other sources of market failure and strategic reasons (e.g., considerations about government capacity and comparative advantages) may lead to targeting certain industries in particular. We need to account for these unobservable differences across countries and sectors.

To deal with this issue, we employ the method discussed in Sant'anna and Zhao (2020) and Callaway and Sant'anna (2021), which extends two-way fixed-effect (TWFE) estimation in settings with differential treatment timing by implementing doubly-robust multiple periods DiD estimators. At the core of this approach is the disaggregation of causal parameters in group-time average treatment effects on the treated (ATTs), i.e. the average treatment effects for each group at each time, where a group is defined by the time period when units are first treated. Callaway and Sant'anna (2021) propose to estimate each group-time ATT using the doubly-robust estimator introduced by Sant'anna and Zhao (2020), to then aggregate the ATTs with appropriate weights. In our empirical setup, this means that we compute every group-time ATTs, relative to the year of first treatment between 2012-2019, and turn them into a weighted ATT, by aggregating cohort-specific ATTs into event study estimates. Aggregation is based on stabilized inverse probability weighting. In our empirical exercise, we use not-yet-treated observations as the control group, a strategy that allows us to fully exploit variations in the treatment status while being less robust to violations of the no anticipation assumption (Freedman et al., 2023). Standard errors are clustered at the country-sector level.

Denote the outcome of interest, i.e. new firm entry rates, with $v_{c,s,t}$. Let $e$ the event-time, $t \in 1, \ldots, \mathcal{T}$ the current period and $g \in \mathcal{G}$ the time of first treatment (i.e., the first implementation of a subsidy of any type). Hence, $e = t - g$ measures the time elapsed since the subsidy was introduced. Moreover, $G_{c,s,g}$ is a binary variable that takes value 1 if a country-sector unit is first treated in period $g$ (and 0 otherwise), while $W$ is a binary variable that equals 1 for units that do not participate in the treatment. We recover the ATT as

$$\text{ATT}(g,t) = \mathbb{E}[v_t - v_{g-1} | G_g = 1] - \mathbb{E}[v_t - v_{g-1} | W = 1] \quad (11)$$

Then, we aggregate the ATT$(g,t)$'s with the following weighting scheme:

$$\psi_e(e) = \sum_{g \in \mathcal{G}} \mathbf{1}\{g + e \leq \mathcal{T}\} \text{ATT}(g, g+e) \mathbb{P}(G = g | G + e \leq \mathcal{T}, W \neq 1) \quad (12)$$

where $\psi_e(e)$ is the average effect of participating in the treatment for the group of units that have been exposed to the treatment for exactly $e$ time periods.

**Table 1**
Estimated dynamic effects of subsidies on new firm entry rates.

| | [1] Coef. | (Std. Err.) |
|---|---|---|
| −6 years before 1st treatment | −0.004 | (0.005) |
| −5 years before 1st treatment | 0.008 | (0.003) |
| −4 years before 1st treatment | −0.002 | (0.005) |
| −3 years before 1st treatment | −0.003 | (0.004) |
| −2 years before 1st treatment | −0.003 | (0.002) |
| −1 years before 1st treatment | 0.001 | (0.001) |
| Year of 1st treatment | 0.002 | (0.001) |
| +1 years after 1st treatment | −0.000 | (0.001) |
| +2 years after 1st treatment | 0.000 | (0.002) |
| +3 years after 1st treatment | −0.001 | (0.002) |
| +4 years after 1st treatment | 0.002 | (0.002) |
| +5 years after 1st treatment | 0.008*** | (0.002) |
| +6 years after 1st treatment | 0.011*** | (0.003) |

Note. Estimates obtained with the method of Callaway and Sant'anna (2021). New firm entry rates are measured as the share of new firms entering a sector-country-year from scratch. Sectors are defined at a 3-digit level. The number of observations used in the analysis is 31,408, distributed over 121 countries, 105 manufacturing 3-digit sectors, and 8 years (2012-2019 time-span). We exclude sector-country-year observations with less than 10 firms. Treatment means the implementation of a subsidy of any type. Standard errors in parentheses. Statistical significance: * significant at 10 %, ** significant at 5 %, *** significant at 1 %.

An important aspect that should be highlighted is that the method of Callaway and Sant'anna (2021) is most appropriate in staggered treatment designs, where the treatment is "irreversible", i.e. once a unit is treated, it is forever treated. In our setting, a subsidy could be withdrawn during the period of analysis, implying that the empirical treatment variable can switch back to zero one or more years after the subsidy came into force for the first time. In order to circumvent this problem while avoiding forcing the binary treatment to be absorbing (see Chaisemartin and uille, 2024), in this empirical exercise we remove country-sector-year tuples after they return untreated (when it is the case).

The results are reported in Table 1 and graphically in Fig. 4.

We find that sector-country-years exposed to subsidies experience a statistically significant increase in new firm entry rates at the 3-digit sector level. On average, the post-treatment effect is 0.003, statistically significant at a 10 % level, while the pre-treatment effects are never significant. Post-treatment effects appear weaker in the first years after the implementation of a subsidy and become stronger both in magnitude and statistical significance after four years of treatment. In particular, at the 5th and 6th years of treatment, the ATTs are 0.008 and 0.011 respectively, both significant at the 1 % level. These results document an average positive effect of subsidies on new firm entry rates, thereby suggesting that the implementation of a subsidy may attract the establishment of new firms in targeted sectors. Moreover, given the average entry rate of *de novo* firms, that in our sample is around 3 %, the estimated ATTs have a non-negligible economic magnitude.[9] We will investigate the link between subsidies and shifts in the within-industry composition of new entrants more closely below.

## 5. Subsidy effects on the productivity of new entrants

### *5.1. Average subsidy effects on productivity*

We want to study whether new firms entering treated sectors show systematic productivity differences with respect to new firms in untreated sectors. We next examine this issue digging into the within-sector composition of newly established firms, as reflected by their productivity performance.

We identify new firms by exploiting the firm-level dimension of our database. We elaborate the information about the year of incorporation of each firm and identify new firms as those entering a country-sector from scratch, for each year included in our observation period (2012-2019). In our data, 53.13 % of the new firms are established in country-sector-year tuples where a subsidy of any type is active. The remaining share of new firms appears in untreated tuples.

[9] Given that our data span from 2012 to 2019, the effects that we detect at the 5th and 6th years of treatment should be mostly attributed to subsidy initiatives first implemented at the beginning of our observation period.

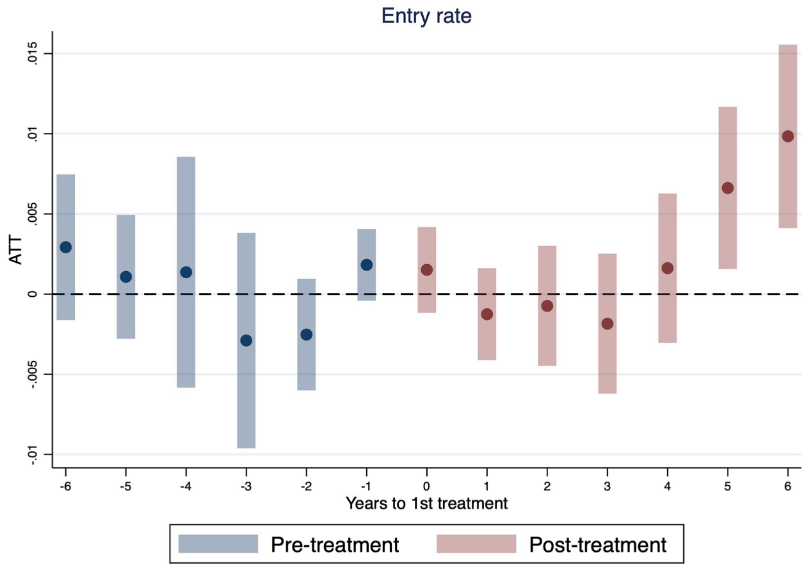


**Fig. 4.** Estimated dynamic effects of subsidies on new firm entry rates.

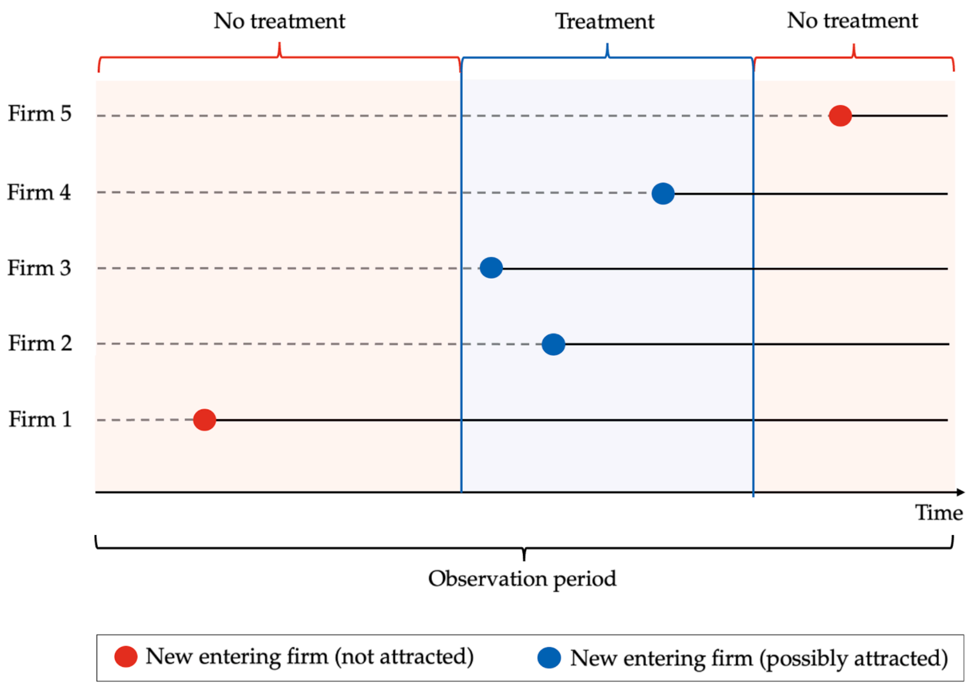


**Fig. 5.** Empirical design: single-treatment country-sector scenario.

We design our empirical study as illustrated in Fig. 5. In each country-sector, we identify which new firms are established during the years of treatment and which are not. Treatment means the implementation of a subsidy of any type. Then, we observe the TFP of the new firms at the end of the first year of activity, and study if new firms' TFP differs systematically between new firms created in treated years and those created in untreated years within and across countries and sectors. Since we have data on more than 30,000 subsidy programs, our empirical analysis here equals running as many event-specific studies of the type represented in Fig. 5, with possibly many new firms involved in each event study.[10]

[10] Note that we examine new firms that may be attracted by the availability of a subsidy. This attraction process does not necessarily require that new firms in the treated sectors are direct recipients. In fact, new firms may expect to benefit indirectly from the subsidy through the within-sector spillovers it generates.

**Table 2**
Estimated effects of subsidies (any type) on new firm TFP.

| | [1] TFP | [2] TFP | [3] TFP | [4] TFP |
|---|---|---|---|---|
| $E_{i,t}$ | −2.056*** | −2.225*** | −1.731*** | −1.458*** |
| | (0.028) | (0.024) | (0.024) | (0.025) |
| Any subsidy | 0.224*** | 0.000 | 0.018*** | −0.007** |
| | (0.006) | (0.005) | (0.003) | (0.003) |
| Any subsidy × $E_{i,t}$ | −0.169*** | −0.150*** | −0.261*** | −0.160*** |
| | (0.036) | (0.033) | (0.032) | (0.034) |
| Constant | 5.714*** | 6.204*** | 6.196*** | 6.292*** |
| | (0.007) | (0.002) | (0.020) | (0.002) |
| Firm-level controls | Y | N | N | Y |
| Country×Year FEs | N | Y | N | Y |
| Sector×Year FEs | N | Y | N | Y |
| Country×Sector FEs | N | Y | N | Y |
| Firm-level FEs | N | N | Y | Y |
| $R^2$ | 0.228 | 0.448 | 0.888 | 0.898 |
| # obs. | 937,512 | 974,973 | 955,789 | 917,591 |

Note. 3WFE DiD augmented with firm-specific FEs. Observations are at the firm-level. The treatment is the implementation of any subsidy at the sector-country-year level. $E_{i,t} = 1$ denotes the new firm in the year of first entry. New firms means firms created from scratch. TFP is Total Factor Productivity recovered with Wooldridge (2009). Firm-level controls: number of employees, capital assets, liquidity ratio, total revenues, stock market listing. Standard errors in parentheses. Statistical significance: * significant at 10 %, ** significant at 5 %, *** significant at 1 %.

In formal terms, we start from the following baseline 3WFE DiD model:

$$\begin{aligned} \mathrm{TFP}_{i,c,s,t} =& \alpha_i + \alpha_{c,s} + \alpha_{c,t} + \alpha_{s,t} + \theta E_{i,t} + \\ & \delta D_{c,s,t} + \beta\left(D_{c,s,t} \times E_{i,t}\right) + X_{i,t} + \varepsilon_{i,c,s,t} \end{aligned} \tag{13}$$

where $E_{i,t} = 1$ denotes new firms ($E_{i,t} = 0$ otherwise), $D_{c,s,t}$ is the treatment dummy ($D_{c,s,t} = 1$ for treated sector-country-year units, $D_{c,s,t} = 0$ for untreated ones), $X_{i,t}$ is a vector of firm-level controls, and where our parameter of interest $\beta$ is a variance-weighted average of treatment effects for $E_{i,t} = 1$ firms (see, e.g., Goodman-Bacon, 2021). That this is an augmented 3WFE DiD model. We include country-sector, sector-time and country-time FEs ($\alpha_{c,s}$, $\alpha_{s,t}$ and $\alpha_{c,t}$, respectively). Moreover, since the model exploits also time-varying firm-level information in the years after firm entry, in Eq. (13) we can include firm-level FEs ($\alpha_i$), which absorb event-specific FEs at the country-sector level. Standard errors are robust to heteroskedasticity and clustered at the firm level.

The estimation results are reported in Table 2.

In column [1], we control for firm-level FEs; in column [2], we control for country-sector, country-time, and sector-time FEs; in column [3], we control for additional observable firm-level characteristics; in column [4], we consider the full model specification.

We find significant compositional effects of subsidies on new firms. While new firms show lower TFP in both treated and untreated sectors systematically (the coefficient associated with $E_{i,t}$ is negative and statistically significant), new firms entering sector-country markets in the years of a subsidy implementation show a disproportionately lower TFP. In terms of economic magnitude, our full model specification (column [4]) suggests that new firms in treated sectors have a TFP that is lower by 5.53 % with respect to new firms in untreated sectors.

In the full model specification, we control for a number of firm-level characteristics, such as proxies of firm size, liquidity ratios, and whether the firm is listed in a stock market, i.e. we control for several observable characteristics of the new firms when they enter the market. Moreover, we absorb time-invariant unobservable FEs at the firm level. Hence, the productivity gap of new firms in treated sectors can be arguably attributed to unobservable factors associated with the implementation of the subsidy and shaping the productivity capacity of the new firms when they enter the market. A subsidy may facilitate the acquisition of fixed capital by new firms that would otherwise have not entered the market, but it may lead such new firms to adopt older or lower quality assets (see, e.g., Ma et al., 2022). The new firms attracted by a subsidy may also have less qualified management or may rely on a workforce with lower human capital. In general, new firms that take entry decisions regardless of the supply of a subsidy may exploit better inputs than the new, laggard firms attracted by a subsidy. By reading these results together with our previous finding of higher entry rates in subsidized sectors, it is plausible to argue that some of these less efficient firms would never be created in the absence of the subsidy.

A question that naturally arises is whether new firms that are attracted by a subsidy show lower TFP only when entering the market in the first year of subsidy implementation, due to some sort of “announcement effect”. Alternatively, it may be that new firms show lower TFP when entering treated countries and sectors in any year of treatment, and not only in the first year of subsidy implementation. It may also be interesting to explore whether firms that entered a treated market continue to show lower TFP in the subsequent years after entry, i.e. whether the TFP gap of attracted firms persist over time when these firms become older.

**Table 3**
Dynamic effects of subsidies (any type) on new firm TFP.

| | [1] TFP | | [2] TFP |
|---|---|---|---|
| Year of 1st treatment × $E_{i,t}$ | −0.161** | Year of 1st treatment × $B_{i,t}$ | −2.940*** |
| | (0.067) | | (0.069) |
| +1 years after 1st treatment × $E_{i,t}$ | −0.169*** | +1 years after 1st treatment × $B_{i,t}$ | −2.053*** |
| | (0.062) | | (0.044) |
| +2 years after 1st treatment × $E_{i,t}$ | −0.104* | +2 years after 1st treatment × $B_{i,t}$ | −1.598*** |
| | (0.058) | | (0.035) |
| +3 years after 1st treatment × $E_{i,t}$ | −0.098* | +3 years after 1st treatment × $B_{i,t}$ | −1.206*** |
| | (0.056) | | (0.031) |
| +4 years after 1st treatment × $E_{i,t}$ | −0.282*** | +4 years after 1st treatment × $B_{i,t}$ | −0.882*** |
| | (0.066) | | (0.028) |
| +5 years after 1st treatment × $E_{i,t}$ | −0.120 | +5 years after 1st treatment × $B_{i,t}$ | −0.562*** |
| | (0.080) | | (0.025) |
| +6 years after 1st treatment × $E_{i,t}$ | −0.291*** | +6 years after 1st treatment × $B_{i,t}$ | −0.318*** |
| | (0.102) | | (0.020) |
| Constant | 6.293*** | Constant | 6.311*** |
| | (0.007) | | (0.003) |
| Linear (not interacted) terms | Y | Linear (not interacted) terms | Y |
| Firm-level controls | Y | Firm-level controls | Y |
| Country×Year FEs | Y | Country×Year FEs | Y |
| Sector×Year FEs | Y | Sector×Year FEs | Y |
| Country×Sector FEs | Y | Country×Sector FEs | Y |
| Firm-level FEs | Y | Firm-level FEs | Y |
| $R^2$ | 0.898 | $R^2$ | 0.893 |
| # obs. | 917,591 | # obs. | 917,591 |

Note. 3WFE DiD augmented with firm-specific FEs. Observations are at the firm-level. The treatment is the implementation of any subsidy at the sector-country-year level. $E_{i,t} = 1$ denotes the new firm in the year of first entry. $B_{i,t} = 1$ denotes a firm entered in any year after treatment. New firms means firms created from scratch. TFP is Total Factor Productivity recovered with Wooldridge (2009). Firm-level controls: number of employees, capital assets, liquidity ratio, total revenues, stock market listing. Linear (not interacted) terms are omitted for reasons of space. Standard errors in parentheses. Statistical significance: * significant at 10 %, ** significant at 5 %, *** significant at 1 %.

We next address these questions by implementing two different dynamic versions of Eq. (13).[11]

The first version is as follows:

$$\mathrm{TFP}_{i,c,s,t} = \alpha_i + \alpha_{c,s} + \alpha_{c,t} + \alpha_{s,t} + \theta E_{i,t} + \sum_{e=0}^{6} \delta^e D^e_{c,s,t} + \sum_{e=0}^{6} \beta^e \left( D^e_{c,s,t} \times E_{i,t} \right) + X_{i,t} + \varepsilon_{i,c,s,t} \tag{14}$$

where $e = t - g$ measures the years since a subsidy was introduced (with $g$ being the first year of subsidy implementation).

The second version is:

$$\mathrm{TFP}_{i,c,s,t} = \alpha_i + \alpha_{c,s} + \alpha_{c,t} + \alpha_{s,t} + \theta B_{i,t} + \sum_{e=0}^{6} \delta^e D^e_{c,s,t} + \sum_{e=0}^{6} \beta^e \left( D^e_{c,s,t} \times B_{i,t} \right) + X_{i,t} + \varepsilon_{i,c,s,t} \tag{15}$$

where $B_{i,t} = 1$ denotes a firm that entered a treated country-sector during a subsidy program (in the first year of a subsidy implementation or in the years after the first implementation, provided that the subsidy is still active), and where all the other terms have the same meaning as in Eq. (14). While Eq. (14) allows us to measure the TFP differential of possibly attracted new firms when they enter the market in different years during a multi-year subsidy program, Eq. (15) allows us to quantify the TFP differential of attracted firms during their years of activity after entry in treated sectors.

We report the estimation results in Table 3. In column [1] we report the results of Eq. (14) and in column [2] those of Eq. (15).

The estimated coefficients of interest are statistically significant and relatively stable over time. In particular, in column [1] we observe that new firms entering treated countries and sectors have a disproportionately lower TFP regardless of the year of entry, i.e. both when they enter the market during the first year of a subsidy implementation and when they enter markets that have been treated since more years. Moreover, in column [2] we find new firms created during a subsidy program tend to show lower TFP also in the subsequent years of activity after entry in treated sectors. Although the magnitude of the coefficient of interest declines over

[11] See Sun and Abraham (2021) for a discussion about the issues related with dynamic DiD models.

**Table 4**
Estimated effects of multi-subsidy programs (any type) on new firm TFP.

| | [1]<br>TFP |
|---|---|
| $E_{i,t} \times N^1_{i,t}$ (program with one subsidy) | −0.146*** |
| | (0.044) |
| $E_{i,t} \times N^2_{i,t}$ (program with two subsidies) | −0.041 |
| | (0.049) |
| $E_{i,t} \times N^3_{i,t}$ (program with three subsidies) | −0.143** |
| | (0.056) |
| $E_{i,t} \times N^4_{i,t}$ (program with four or more subsidies) | −0.128* |
| | (0.075) |
| Constant | 6.290*** |
| | (0.003) |
| Linear (not interacted) terms | Y |
| Firm-level controls | Y |
| Country×Year FEs | Y |
| Sector×Year FEs | Y |
| Country×Sector FEs | Y |
| Firm-level FEs | Y |
| $R^2$ | 0.898 |
| # obs. | 917,591 |

Note. 3WFE DiD augmented with firm-specific FEs. Observations are at the firm-level. The treatment is the implementation of any subsidy at the sector-country-year level. $E_{i,t} = 1$ denotes the new firm in the year of first entry. New firms means firms created from scratch. $N^n_{c,s,t}$ is a set of dummy variables each measuring the number of subsidy initiatives coexisting in a same country-sector in a given year. The number of simultaneous subsidies in a same tuple is denoted by $n$, ranging from 0 to 4, with $n = 4$ meaning 4 or more subsidies. TFP is Total Factor Productivity recovered with Wooldridge (2009). Firm-level controls: number of employees, capital assets, liquidity ratio, total revenues, stock market listing. Standard errors in parentheses. Statistical significance: * significant at 10 %, ** significant at 5 %, *** significant at 1 %.

time, it never becomes statistically insignificant during our observation period.[12] This finding suggests that the negative effects of subsidies on the TFP of new entrants do not disappear when the new firms start to compete with incumbent firms. Phrased differently, new firms attracted by subsidies remain under-performing, thereby providing little contribution to productivity dynamics in treated sectors.

We complement these findings by looking at whether the productivity gap of new entrants, which we observe on average, can be partly attributed to an increase of rent-seeking firms with no real business. A recent literature highlights in many sectors the rise of the so-called zombie firms, i.e. formally registered firms that are unable to run actual operational activity (see, e.g., Mcgowan et al., 2018). We translate the notion of zombies in our empirical context, by distinguishing genuine startups and subsidy-driven ("empty") entities using indicators of actual firm activity. We consider as "empty" those firms with zero employees or revenues over all the first three years of activity after the year of incorporation. Interestingly, we observe that in treated sectors the share of "empty" firms increases from 3.15 % to 4.30 % on average after the introduction of a subsidy. The share of such "empty" firms is too low in many country-sector-year cells to perform a more systematic econometric analysis. Nevertheless, this descriptive evidence seems to suggest that at least some of the new firms created in subsidized sectors may be rent-seeking and merely established to capture the financial benefits of subsidies.

Finally, it is worthwhile to explore whether the negative productivity effects that we observe on average are associated with government intervention *per se*, regardless of the design of the intervention, or if they depend on the complexity of the intervention. A simple way to address this issue is to allow our baseline 3WFE DiD model to account for the number of different subsidies that a government runs at the same time over a same sector. Indeed, we observe in our data that many subsidies are implemented within broader policy programs in which more than one subsidy is in place. In particular, about 61 % of subsidies overlap with at least one other subsidy for at least one year during our observation period. We therefore estimate:

$$\mathrm{TFP}_{i,c,s,t} = \alpha_i + \alpha_{c,s} + \alpha_{c,t} + \alpha_{s,t} + \theta E_{i,t} + \sum_{n=0}^{4} \delta^n N^n_{c,s,t} + \sum_{n=0}^{4} \beta^n \left( N^n_{c,s,t} \times E_{i,t} \right) + X_{i,t} + \varepsilon_{i,c,s,t} \tag{16}$$

[12] The decline in the magnitude of the effects through the seven years of observation is coherent with previous literature, showing that most entrants take five to ten years before they are able to compete on a par with incumbents (Geroski, 1995).

where $N^n_{c,s,t}$ is a set of dummy variables each measuring the number of subsidy initiatives coexisting in a same country-sector in a given year. The number of simultaneous subsidies in a same tuple is denoted by $n$, ranging from 0 to 4, with $n = 4$ meaning 4 or more subsidies. The results are reported in Table 4.

We find that the effects of subsidies on new firms' productivity tend to remain negative when more subsidies are combined. Nevertheless, both the magnitude and the statistical significance of these effects are lower under more complex government programs. Governments may use a sequence of two or more partly overlapping interventions to pursue broader industry outcomes, which do not always correlate with the attraction of less productive firms. In different words, the effects of subsidies on new firms' productivity may vary across different types of programs and the average effects that we detect in our baseline models may hide some significant heterogeneity across subsidy types. We explore this issue next.

### 5.2. *Attribute-specific effects on productivity*

#### 5.2.1. *Subsidy attributes*

Are subsides all alike in their productivity effects on new firms? This question is important, because different subsidies may be implemented in a same country-sector in the pursuit of different goals, thereby generating effects which may go in different directions. For instance, the acquisition of costly and more productive technologies by small firms may be facilitated with SME-specific interventions, while in the same sector a government may also spread unconditional tax reliefs more broadly, causing possibly opposite effects on the productivity of new firms. We would like to capture these heterogeneous and potentially simultaneous effects.

In order to explore the differences between the government interventions, we dig into subsidy descriptions with a text recognition method (Juhász et al., 2023) and isolate the specific attributes of each subsidy.

Fortunately, the spectrum of subsidy programs included in the CSI-GTA database covers a rich variety of types of intervention. Building on prior studies (e.g., Rotunno and Ruta, 2024), first we distinguish subsidies between four main types: direct transfers, tax breaks, loans and export promotion subsidies.[13] Direct transfers involve production subsidies and direct provision of financial resources to firms, such as state aids, capital injections, equity stakes, financial grants, and in-kind grants. Grants are a substantial part of this type of subsidy, defined by UNCTAD (2019) as financial or in-kind support to enterprises, which can be conditional or unconditional, one-time or periodic, with or without interest. A notable example is the system of subsidies provided in 2019 by the National Integrated Circuit Industry Investment Fund in China, aimed at realizing direct investments into strategic sectors, such as microchips, semiconductors and related inputs. Tax breaks (or revenue-reducing subsidies) include import incentives, tax reliefs, and price stabilization measures that reduce firms' financial obligations. For instance, the French finance law enacted in 2020 implemented a tax credit scheme covering up to 50 % of innovation-related expenses incurred by firms. Loans (or risk transfers) are measures that shift financial risks from firms to the government. This includes loan guarantees, state loans, and interest subsidies. An example is Brazil's Inovacred 4.0 credit program in 2019, designed to support the digitalization of local enterprises. Finally, export promotion subsidies support firms' competitiveness in foreign markets and the export process.[14] These include trade finance, export tax incentives, and export credit insurance. A significant example is the $25 million support to US firms through export credit insurance, provided in 2019 by the US Export-Import Bank.

Moreover, we look at the presence, if any, of size-based eligibility criteria. In particular, we identify subsidies with eligibility requirements based on firm size, namely subsidies providing more favorable economic conditions for SMEs.[15] Of this type is the production subsidy introduced by the Canadian government in 2016 to support local small craft breweries in Alberta, with the subsidy per liter depending on production volume and an annual cap of 12 million CAD per company. A broad line of research has investigated the link between SME-specific subsidies and employment growth and entry rates of SMEs (e.g., Bloom et al., 2019; Brown et al., 2024; Garicano et al., 2016; Martin et al., 2017).[16]

We also isolate the green content of subsidy programs, by considering whether subsidies aim at facilitating the development and the adoption of cleaner productions. A subsidy of this type is the Energy Efficient Equipment Finance Program, launched by the Australian Clean Energy Finance Corporation in 2016, which provided a 0.7 % discount on the standard interest rate paid by national businesses for the purchase of energy-efficient and low-emission equipment and machinery. The effectiveness of green subsidies has been studied by previous work with a focus on case-specific measures (e.g., Banares-Sanchez et al., 2024).

Finally, a literature has recently been developed on the issue of automation policies, including both the taxation of automation technologies (Costinot and Werning, 2023; Guerreiro et al., 2022; Thuemmel, 2023) and robot-specific subsidies (Ma, 2024). In our dataset, we define automation subsidies as those that include provisions supporting the diffusion of automation technologies. Among others, the Chinese government 2016 "Smart Manufacturing" initiative falls within this type of subsidies, with its system of preferential tax reductions and lower import duties on technical equipment (e.g., computer numerical control machinery, industrial robotics, optical sensors, simulation software) to domestic manufacturing firms.

[13] This classification builds on the influential UNCTAD MAST classification on the subject Unctad (2019), widely employed by major international institutions (see, for instance, Imf et al., 2022). Similarly, a comparable classification is applied by Oecd (2019) and in the 28th Global Trade Alert report Evenett and Fritz (2021).

[14] Readers interested in government support through export promotion may refer to Broocks and Biesebroeck (2017), who assess whether such measures in Belgium have increased firms' propensity to begin exporting outside the EU market.

[15] The threshold, in terms of number of employees, defining SMEs may change across countries and government programs. We keep the original coding provided in the CSI-GTA database and consider SME-specific subsidies that are labeled as such in the original database.

[16] Related results are provided by Criscuolo et al. (2019) and Dechezleprêtre et al. (2023).

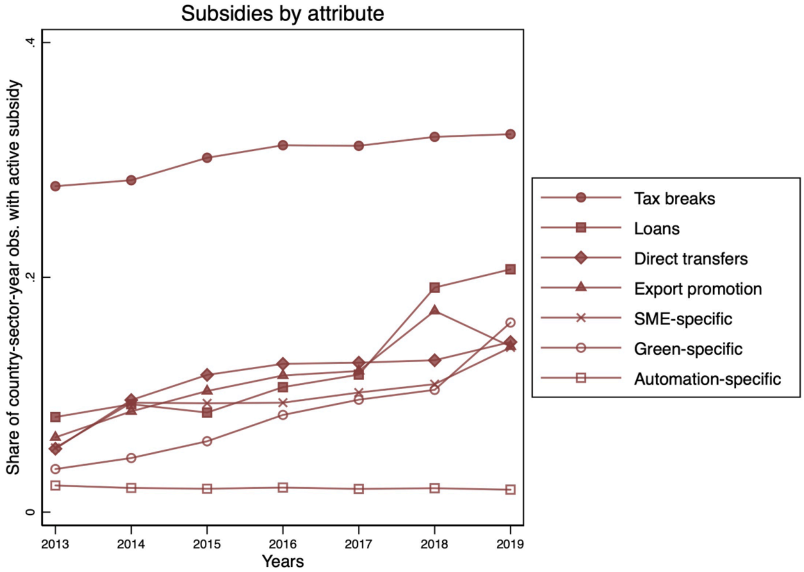


**Fig. 6.** Implementation of subsidy programs with different attributes over time.

Fig. 6 shows the relative frequency with which subsidies with these attributes occur among the countries and 3-digit sectors covered in our analysis. In general, the share of treated countries and sectors increases over time, with tax breaks being the most frequent attribute.[17]

*5.2.2. Within-sector multiple-treatment analysis*

In order to estimate the productivity effects on new firms for each attribute, we enrich our empirical model by distinguishing multiple treatments, if present, within each country and sector.

To better grasp the design of our study here, let us refer to Fig. 7, where we consider a country-sector that over subsequent years is treated by two different subsidies, one of type $j$ and one of type $k$ (with $j \neq k$). Since we can distinguish the distinctive attributes of the two subsidies, we can also measure the effects on new firm productivity associated with their attributes separately.

Formally, the 3WFE DiD model now takes the following form:

$$\begin{aligned}\mathrm{TFP}_{i,c,s,t} =& \alpha_i + \alpha_{c,s} + \alpha_{c,t} + \alpha_{s,t} + \theta E_{i,t} + \\ & \sum_{h=1}^{H} \delta^h D^h_{c,s,t} + \sum_{h=1}^{H} \beta^h \left( D^h_{c,s,t} \times E_{i,t} \right) + X_{i,t} + \varepsilon_{i,c,s,t}\end{aligned} \quad (17)$$

where $h \in [1, H]$ is a subsidy attribute. We are interested in the $\sum_{h=1}^{H} \beta^h$ set of parameters. The other terms in Eq. (17) have the same meaning as in Eq. (13).

The estimation results are collected in Table 5. We control for country-sector, country-time, and sector-time FEs in column [1], for firm-level FEs in column [2], for observable firm-level characteristics in column [3], and finally we consider the full model specification in column [4].

The estimated coefficients reveal a heterogeneous picture. The results from our full, preferred specification (column [4]) show that tax breaks and loans are mostly responsible for the negative effects of subsidies on the TFP of new entrants (these subsidies are also the most frequent in our sample, as shown in Fig. 6), while other attributes may even play a positive role. Specifically, subsidies targeted at SMEs and at the promotion of firm exports are associated with a positive and significant coefficient. Also direct transfers tend to have positive effects on new firms' TFP, although to a lower extent. Subsidies supporting the adoption of green and automation technologies do not seem to attract low-TFP new entrants to a statistically significant extent.

In terms of economic magnitude, the estimated coefficients are not negligible. Tax breaks and loans induce new firms to enter targeted sectors with a TFP gap of 10.82 % to 10.86 %. On the other side, export promotion initiatives and SME-specific subsidies lead to the entry of new firms with a TFP that is, respectively, 11.82 % and 18.22 % higher than the average TFP of new entrants.

These results illustrate that, while on average subsidies may attract less productive firms (as shown in Section 5.1), subsidy attributes matter. The association between subsidies and the productivity of new firms is shown to differ across different subsidy programs systematically, with important implications for the optimal design of government policies. In particular, initiatives softening firm budget constraints unconditionally and relaxing tax obligations (such as loans and tax advantages) may encourage the

[17] Note that some of these attributes are not mutually exclusive, and a same subsidy program may show more than one attribute (e.g., a direct transfer may also have a green or SME-specific target). A list of illustrative examples is provided in Table A.4 in Appendix A.

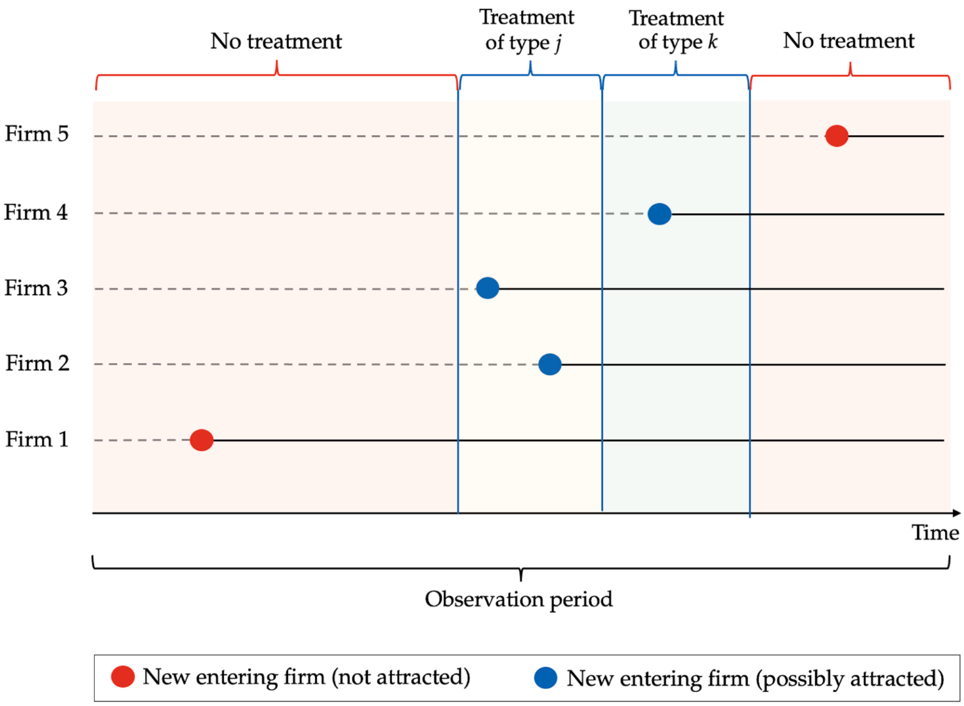


**Fig. 7.** Empirical design: multiple-treatment country-sector scenario.

injection of less efficient firms into the production system, thereby impeding productivity-enhancing reallocation of resources from low productivity producers towards high productivity producers. On the other hand, measures pursuing better defined objectives, such as promoting firm internationalization and investments by small and medium-sized firms may have a "cleansing" impact on productivity dynamics. It is interesting to observe that automation-related subsidies and subsidies targeting the adoption of green technologies do not attract new firms with less efficient productions. This latter result may be explained through the lens of recent literature. Under both types of subsidies, new firms benefit from reduced technology adoption costs. On the one side, cleaner technologies may enable a more efficient use of polluting inputs (Forslid et al., 2018), without necessarily affecting output volumes and revenues. On the other, automation technologies may increase output per unit of labor, while also leading to negligible productivity improvements in specific contexts (Acemoglu and Restrepo, 2019).

## 6. Robustness checks

### *6.1. Alternative productivity measures*

In our main analysis, we use a measure of TFP as our main dependent variable of interest, obtained by estimating within-sector firm-level production functions with the approach proposed by Wooldridge (2009). While this approach is acknowledged as more efficient with respect to other procedures proposed in the productivity literature, one may wonder if alternative productivity measures lead to different results. Here, we test the robustness of our results for this possibility.

First, we recover alternative TFP estimates, by using the methods introduced by Levinsohn and Petrin (2003) and by Ackerberg et al. (2015) Levinsohn and Petrin (2003) propose a control function approach to address the simultaneity problem (Marschak and Andrews, 1944), in which they use intermediate materials (strictly increasing in the unobserved productivity) conditioned on the state variable. Inverting this control function results in a nonparametric function of capital and the proxy variable, that can be used in the production function estimation to account for the unobserved firm productivity. Ackerberg et al. (2015) shows a functional dependence problem in the first stage of the procedure of Levinsohn and Petrin (2003), due to the fact that output is regressed on labor input and the nonparametric function of other inputs. This functional dependence may result in a non-identification problem. As an alternative, Ackerberg et al. (2015) propose inverting the input demand function, conditional on state variables (including labor input). See Ackerberg (2023) for a detailed discussion of the technical issues.[18] Second, to further cross-check of the validity

[18] Other methods have been proposed in the literature in order to address the transmission bias in production function estimation. Most notably, Doraszelski and Jaumandreu (2013) propose using lagged prices as instruments, counting on weak correlation between previous prices and the contemporary productivity shocks unobserved by the econometrician. In our paper, we limit our robustness checks to using the methods of Levinsohn and Petrin (2003) and Ackerberg et al. (2015) due to data availability constraints. Nevertheless, among others, Gandhi et al. (2020) show that prices

**Table 5**
Estimated effects of subsidy attributes on new firm TFP.

| | [1] TFP | [2] TFP | [3] TFP | [4] TFP |
|---|---|---|---|---|
| Subsidy based on tax breaks × $E_{i,t}$ | −0.556*** | −0.354*** | −0.185*** | −0.313*** |
| | (0.059) | (0.039) | (0.039) | (0.054) |
| Subsidy based on loans × $E_{i,t}$ | −0.370*** | −0.340*** | −0.321*** | −0.314*** |
| | (0.071) | (0.047) | (0.046) | (0.065) |
| Subsidy based on direct transfers × $E_{i,t}$ | 0.074 | −0.109** | −0.029 | 0.153** |
| | (0.078) | (0.051) | (0.051) | (0.068) |
| Subsidy targeting export promotion × $E_{i,t}$ | 0.711*** | 0.498*** | 0.233*** | 0.342*** |
| | (0.079) | (0.053) | (0.051) | (0.065) |
| Subsidy targeting SMEs × $E_{i,t}$ | 0.429*** | 0.312*** | 0.479*** | 0.527*** |
| | (0.093) | (0.068) | (0.085) | (0.082) |
| Subsidy targeting green technologies × $E_{i,t}$ | −0.965*** | −0.162** | 0.043 | −0.033 |
| | (0.082) | (0.064) | (0.059) | (0.066) |
| Subsidy targeting automation technologies × $E_{i,t}$ | 0.582*** | 0.053 | 0.151* | 0.091 |
| | (0.091) | (0.089) | (0.084) | (0.082) |
| Constant | 5.376*** | 6.208*** | 6.193*** | 6.574*** |
| | (0.008) | (0.004) | (0.001) | (0.007) |
| Linear (not interacted) terms | Y | Y | Y | Y |
| Firm-level controls | Y | N | N | Y |
| Country×Year FEs | N | Y | N | Y |
| Sector×Year FEs | N | Y | N | Y |
| Country×Sector FEs | N | Y | N | Y |
| Firm-level FEs | N | N | Y | Y |
| $R^2$ | 0.280 | 0.448 | 0.890 | 0.910 |
| # obs. | 886,993 | 974,973 | 955,789 | 867,869 |

Note. 3WFE DiD augmented with firm-specific FEs. Observations are at the firm-level. The treatment is the implementation of any subsidy at the sector-country-year level. $E_{i,t} = 1$ denotes the new firm in the year of first entry. New firms means firms created from scratch. TFP is Total Factor Productivity recovered with Wooldridge (2009). Firm-level controls: number of employees, capital assets, liquidity ratio, total revenues, stock market listing. Linear (not interacted) terms are omitted for reasons of space. Standard errors in parentheses. Statistical significance: * significant at 10 %, ** significant at 5 %, *** significant at 1 %.

of our results, we also measure firm productivity by means of the average revenues per-employee (i.e. total revenues divided by the number of employees).

We estimate Eq. (17), i.e. our richest model specification, by using productivity measures obtained with these alternative methods. The results are reported in Table 6. The estimates obtained by using TFP as recovered with the method of Levinsohn and Petrin (2003) are in column [1], those obtained by using TFP as recovered with the method of Ackerberg et al. (2015) are in column [2], and finally those obtained by using revenues per-employee are collected in column [3]. Reassuringly, we do not observe critical differences with respect to our main results reported in the paper.

### 6.2. Sectoral heterogeneity

We further leverage the broad sectoral coverage of our dataset to investigate whether our main results are driven by specific sectoral characteristics. We focus on three key dimensions of sectoral heterogeneity: market concentration, the presence of dominant innovative players, and the degree of openness to international trade.

A stylized fact highlighted by previous research (Geroski, 1995) is that entry tends to be proportional to expected post-entry profits. In particular, a prominent literature has showed that entry may depend on the strategic behavior of incumbents (e.g., Dixit, 1980), especially in innovation intensive sectors (e.g., Marinucci and Vergote, 2011) and in sectors exposed to international competition (e.g., Melitz, 2003). Therefore, an additional potential concern about the robustness of our results is related to the role of the market conditions that new firms expect to face once entered the market. Our findings may hold only for more competitive industries and for sectors with a certain degree of international openness. For example, in highly concentrated markets, the effects of subsidies on new entrants may be weak, or even negligible, if the market power of dominant incumbents is strong enough to offset the cost advantages that subsidies provide to new firms. This may be the case of markets that are very concentrated or dominated by big innovative players. Moreover, in domestically oriented sectors, new entrants may face smaller markets and may be less exposed to knowledge spillovers, all of which may reduce the effects of subsidies on post-entry productivity.

are a relatively weak source of identifying variation. More in general, it is largely acknowledged that even the most improved methods fail to robustly identify production function parameters, and obtaining precise TFP estimates remains challenging.

**Table 6**
Robustness checks: alternative productivity measures.

| | [1]<br>TFP<br>(Levinsohn and Petrin, 2003) | [2]<br>TFP<br>(Ackerberg et al., 2015) | [3]<br>RpE<br>(Revenues per-Employee) |
|---|---|---|---|
| Subsidy based on tax breaks × $E_{i,t}$ | −0.239*** | −0.254*** | −0.269*** |
| | (0.037) | (0.036) | (0.036) |
| Subsidy based on loans × $E_{i,t}$ | −0.268*** | −0.187*** | −0.065 |
| | (0.045) | (0.045) | (0.043) |
| Subsidy based on direct transfers × $E_{i,t}$ | 0.021 | 0.096* | 0.082* |
| | (0.048) | (0.049) | (0.049) |
| Subsidy targeting export promotion × $E_{i,t}$ | 0.190*** | 0.165*** | 0.122** |
| | (0.046) | (0.048) | (0.049) |
| Subsidy targeting SMEs × $E_{i,t}$ | 0.399*** | 0.282*** | 0.154** |
| | (0.059) | (0.058) | (0.064) |
| Subsidy targeting green technologies × $E_{i,t}$ | 0.076 | 0.064 | 0.175*** |
| | (0.047) | (0.048) | (0.049) |
| Subsidy targeting automation technologies × $E_{i,t}$ | −0.010 | −0.042 | −0.171** |
| | (0.056) | (0.056) | (0.068) |
| Constant | 6.607*** | 3.911*** | 3.627*** |
| | (0.006) | (0.007) | (0.007) |
| Linear (not interacted) terms | Y | Y | Y |
| Firm-level controls | Y | Y | Y |
| Country×Year FEs | Y | Y | Y |
| Sector×Year FEs | Y | Y | Y |
| Country×Sector FEs | Y | Y | Y |
| Firm-level FEs | Y | Y | Y |
| $R^2$ | 0.936 | 0.914 | 0.896 |
| # obs. | 867,869 | 867,869 | 925,144 |

Note. 3WFE DiD augmented with firm-specific FEs. Observations are at the firm-level. The treatment is the implementation of any subsidy at the sector-country-year level. $E_{i,t} = 1$ denotes the new firm in the year of first entry. New firms means firms created from scratch. TFP is Total Factor Productivity recovered with Levinsohn and Petrin (2003) in column [1] and with Ackerberg et al. (2015) in column [2]. RpE (Revenues per-Employee), in column [3], is the log of total revenues divided by the number of employees. Firm-level controls: number of employees, capital assets, liquidity ratio, total revenues, stock market listing. Number of employees and total revenues are omitted in column [3]. Linear (not interacted) terms are omitted for reasons of space. Standard errors in parentheses. Statistical significance: * significant at 10 %, ** significant at 5 %, *** significant at 1 %.

We address the role of these sources of sectoral heterogeneity in different ways. First, we compute the Herfindahl-Hirschman Index (HHI) using revenue-based market shares within countries, years and 3-digit sectors, and estimate Eq. (17) on two subgroups of markets with the HHI below and above the median (i.e., 0.1) respectively. Second, we exploit the Intellectual Property extension of the Orbis database, containing information on patent portfolios at the firm level, and compute the firm-level shares of patents within countries, years and 3-digit sectors; then, we estimate Eq. (17) on two subgroups of markets, with and without a big innovative player, defined as a firm which alone has a patent share higher than 50 %.[19] Third, we use the dataset Trade in Goods by Enterprise Characteristics (TEC), compiled jointly by the OECD and Eurostat, which reports the share of firms engaged in export activities for each year and sector across 34 countries. We compute the average export share for each sector over our sample period and use the cross-sector median, equal to 64.3 %, as a threshold to classify sectors into low and high export intensity subgroups (i.e., with an export share below or above the median, respectively). We then estimate Eq. (17) separately for these two sectoral subgroups.

The results are reported in from Tables 7 to 9. In columns [1]-[2] of Table 7, we report the estimates of markets with the HHI, respectively, below and above the median. In columns [1]-[2] of Table 8, we report the estimates of markets with and without a dominant innovative player. In columns [1]-[2] of Table 9, we show estimates for sectors below and above the median export intensity, respectively. We observe that the statistical significance of the estimated parameters of interest is higher in more competitive contexts (i.e., where the HHI is lower and where there are not big innovators) and in sectors more broadly open to international competition, as the theory would suggest. International openness, in particular, seems to amplify the effects of export promotion subsidies, pointing to government intervention in this context as possibly strategic to facilitate access to foreign markets by new firms and to reduce the fixed costs associated with exporting. Nevertheless, most of our main results also resist in less competitive markets and more domestically oriented sectors. This reassures us that our findings are general enough and are not substantially driven by a subset of sectors.

[19] The distributions of the HHI and patent shares are shown in Figs. 10 and 11 in Appendix A.

**Table 7**
Robustness checks: competitive and concentrated markets.

| | [1] TFP (HHI below median) | [2] TFP (HHI above median) |
|---|---|---|
| Subsidy based on tax breaks × $E_{i,t}$ | −0.347*** | −0.036*** |
| | (0.061) | (0.116) |
| Subsidy based on loans × $E_{i,t}$ | −0.236*** | −0.746*** |
| | (0.075) | (0.164) |
| Subsidy based on direct transfers × $E_{i,t}$ | 0.176** | −0.176 |
| | (0.077) | (0.162) |
| Subsidy targeting export promotion × $E_{i,t}$ | 0.338*** | 0.442*** |
| | (0.074) | (0.148) |
| Subsidy targeting SMEs × $E_{i,t}$ | 0.536*** | 0.468*** |
| | (0.118) | (0.136) |
| Subsidy targeting green technologies × $E_{i,t}$ | −0.081 | 0.086 |
| | (0.079) | (0.127) |
| Subsidy targeting automation technologies × $E_{i,t}$ | 0.155* | 0.450** |
| | (0.093) | (0.178) |
| Constant | 6.445*** | 7.017*** |
| | (0.008) | (0.019) |
| Linear (not interacted) terms | Y | Y |
| Firm-level controls | Y | Y |
| Country×Year FEs | Y | Y |
| Sector×Year FEs | Y | Y |
| Country×Sector FEs | Y | Y |
| Firm-level FEs | Y | Y |
| $R^2$ | 0.901 | 0.942 |
| # obs. | 621,452 | 235,055 |

Note. 3WFE DiD augmented with firm-specific FEs. Observations are at the firm-level. The treatment is the implementation of any subsidy at the sector-country-year level. $E_{i,t} = 1$ denotes the new firm in the year of first entry. New firms means firms created from scratch. TFP is Total Factor Productivity recovered with Wooldridge (2009). The HHI is computed at the country-sector-year level (sectors at a 3-digit level). Firm-level controls: number of employees, capital assets, liquidity ratio, total revenues, stock market listing. Linear (not interacted) terms are omitted for reasons of space. Standard errors in parentheses. Statistical significance: * significant at 10 %, ** significant at 5 %, *** significant at 1 %.

### 6.3. *Outlier countries*

Works based on GTA data (e.g., Juhász et al., 2023) show that industrial policies have been heavily used by leading manufacturing countries to promote infant industries. China and the United States in particular have used government subsidies to target specific strategic objectives (Evenett et al., 2024). Hence, it may be useful to check whether our main results are significantly shaped by the industrial strategies of China and the United States and by the way subsidies are designed in these important countries.

To address this point, we estimate Eq. (17) with two additional regression analyses, by excluding observations from China and the United States respectively. The results are reported in Table 10. In column [1] we report the estimates obtained without China and in column [2] those obtained by excluding the United States. Again, our main results remain broadly stable. This allows us to rule out that the industrial policies of these two countries alone drive our findings. Notably, however, we find that the effect of green subsidies on the TFP of new entrants is negative when China is omitted from the sample, thereby highlighting the prominent position of China in devising productivity-improving green policies (see, e.g., Banares-Sanchez et al., 2024). The opposite seems to hold for automation-oriented subsidies.

### 6.4. *Sample composition*

Finally, we test whether our main estimates remain statistically significant when a more tightly comparable control group is used. In the design of our empirical analysis, we rely on the interaction between the implementation of a subsidy and a dummy variable for new entrants for identifying the effect of subsidies on new firm's productivity. In words, the coefficient associated with the interaction term captures the effect of being a new firm entering a treated sector *vis-à-vis* being a new firm entering an untreated sector. In order to exploit cross-firm variation in the data at the broadest level, we leave in the sample all the firms active within the countries, sectors, and years considered in the analysis, meaning that firms entered in the market before the beginning of our observation period (i.e., incumbent firms) are not excluded. As Wooldridge (2021) notes in a different context, this may provide an advantage in the precision of the estimator, because more of the data is being used, without altering the control group of untreated new entrants with respect to which our interaction term is evaluated. Nevertheless, a concern might be that the presence of incumbents in the sample may distort coefficient estimates significantly.

**Table 8**
Robustness checks: markets with and without big innovative players.

| | [1] TFP (W/out big innovator) | [2] TFP (W/ big innovator) |
|---|---|---|
| Subsidy based on tax breaks × $E_{i,t}$ | −0.420*** | −0.145 |
| | (0.066) | (0.101) |
| Subsidy based on loans × $E_{i,t}$ | −0.279*** | −0.443*** |
| | (0.077) | (0.120) |
| Subsidy based on direct transfers × $E_{i,t}$ | 0.132* | 0.001 |
| | (0.077) | (0.162) |
| Subsidy targeting export promotion × $E_{i,t}$ | 0.238*** | 0.593*** |
| | (0.073) | (0.148) |
| Subsidy targeting SMEs × $E_{i,t}$ | 0.633*** | 0.440*** |
| | (0.099) | (0.159) |
| Subsidy targeting green technologies × $E_{i,t}$ | 0.082 | −0.273 |
| | (0.074) | (0.161) |
| Subsidy targeting automation technologies × $E_{i,t}$ | 0.070 | 0.526 |
| | (0.086) | (0.532) |
| Constant | 6.695*** | 6.355*** |
| | (0.009) | (0.014) |
| Linear (not interacted) terms | Y | Y |
| Firm-level controls | Y | Y |
| Country×Year FEs | Y | Y |
| Sector×Year FEs | Y | Y |
| Country×Sector FEs | Y | Y |
| Firm-level FEs | Y | Y |
| $R^2$ | 0.905 | 0.920 |
| # obs. | 591,956 | 272,228 |

Note. 3WFE DiD augmented with firm-specific FEs. Observations are at the firm-level. The treatment is the implementation of any subsidy at the sector-country-year level. $E_{i,t} = 1$ denotes the new firm in the year of first entry. New firms means firms created from scratch. TFP is Total Factor Productivity recovered with Wooldridge (2009). Big innovator means a firm with a share of patents higher than 50 % at the country-sector-year level (sectors at a 3-digit level). Firm-level controls: number of employees, capital assets, liquidity ratio, total revenues, stock market listing. Linear (not interacted) terms are omitted for reasons of space. Standard errors in parentheses. Statistical significance: * significant at 10 %, ** significant at 5 %, *** significant at 1 %.

Here, we clean our sample by removing all incumbent firms. In particular, we exclude from the sample firms born before 2012 (i.e., the first year of our observation period). Note that some of these incumbent firms are active in sectors that are never treated by a subsidy during the period 2012-2019, while others may belong to sectors where a subsidy is implemented during the period. Then, we estimate Eq. (17) on this cleaned sample. The results are reported in column [1] of Table 11. The sign and statistical significance of our coefficients of interest remain unchanged. If anything, we observe that the coefficient associated with green subsidies, which was statistically insignificant in most of our previous regressions, is now negative and significant.

## 7. Broader effects on industry performance

Our empirical analysis shows that subsidies cause the entry of new firms with a TFP that is disproportionately different from the TFP of new firms in unsubsidized sectors. But how does this process affect industry performance more broadly in targeted sectors? Although less productive on average, the additional new firms entering subsidized sectors may still erode the market shares of pre-existing firms (Fan and Xiao, 2015; Kalouptsidi, 2018), thereby generating negative productivity spillovers for incumbents (Oecd, 2025) and potentially intensifying market competition, with asymmetric effects on the exit dynamics of more versus less productive firms. We explore this issue with a set of firm-level 3WFE DiD models that allow us to estimate the effect of subsidies on the market performance of incumbents and the exit dynamics, thereby providing some indirect evidence of the competition channel linking subsidy interventions and industry transformation.

To study the effect of subsidies on incumbents' performance, we consider a 3WFE DiD model that is similar to our baseline Eq. (13). However, instead of interacting the subsidy variable $D_{c,s,t}$ with the new entrant dummy, we look at the interaction between $D_{c,s,t}$ and a dummy $Incumbent$ that equals 1 if the firm was already active before the subsidy implementation and 0 otherwise. Moreover, in two different model specifications, the dependent variable is the firm's market share (MRKS) and the firm's TFP, respectively, both computed within the country, 3-digit sector, and year. Formally, we estimate:

$$\begin{aligned} \text{MRKS}_{i,c,s,t} =& \alpha_i + \alpha_{c,s} + \alpha_{c,t} + \alpha_{s,t} + \theta Incumbent_i + \\ & \delta D_{c,s,t} + \beta\left(D_{c,s,t} \times Incumbent_i\right) + X_{i,t} + \varepsilon_{i,c,s,t} \end{aligned} \quad (18)$$

**Table 9**
Robustness checks: markets with low and high export intensity.

| | [1]<br>TFP<br>(Low export intensity) | [2]<br>TFP<br>(High export intensity) |
|---|---|---|
| Subsidy based on tax breaks × $E_{i,t}$ | −0.275*** | −0.242*** |
| | (0.083) | (0.078) |
| Subsidy based on loans × $E_{i,t}$ | 0.024 | −0.555*** |
| | (0.086) | (0.097) |
| Subsidy based on direct transfers × $E_{i,t}$ | −0.042 | 0.355*** |
| | (0.091) | (0.105) |
| Subsidy targeting export promotion × $E_{i,t}$ | 0.225** | 0.349*** |
| | (0.090) | (0.093) |
| Subsidy targeting SMEs × $E_{i,t}$ | 0.431*** | 0.612*** |
| | (0.125) | (0.108) |
| Subsidy targeting green technologies × $E_{i,t}$ | −0.052 | −0.009 |
| | (0.092) | (0.098) |
| Subsidy targeting automation technologies × $E_{i,t}$ | 0.642*** | 0.075 |
| | (0.134) | (0.099) |
| Constant | 6.326*** | 6.813*** |
| | (0.010) | (0.011) |
| Linear (not interacted) terms | Y | Y |
| Firm-level controls | Y | Y |
| Country×Year FEs | Y | Y |
| Sector×Year FEs | Y | Y |
| Country×Sector FEs | Y | Y |
| Firm-level FEs | Y | Y |
| $R^2$ | 0.906 | 0.908 |
| # obs. | 433,313 | 434,457 |

Note. 3WFE DiD augmented with firm-specific FEs. Observations are at the firm-level. The treatment is the implementation of any subsidy at the sector-country-year level. $E_{i,t} = 1$ denotes the new firm in the year of first entry. New firms means firms created from scratch. TFP is Total Factor Productivity recovered with Wooldridge (2009). Export intensity is defined as the sectoral average share of firms engaged in exporting over our timespan. Sectors with export intensity above the cross-sectoral median are classified as high export intensity. Firm-level controls: number of employees, capital assets, liquidity ratio, total revenues, stock market listing. Linear (not interacted) terms are omitted for reasons of space. Standard errors in parentheses. Statistical significance: * significant at 10 %, ** significant at 5 %, *** significant at 1 %.

and

$$\text{TFP}_{i,c,s,t} = \alpha_i + \alpha_{c,s} + \alpha_{c,t} + \alpha_{s,t} + \theta Incumbent_i + \delta D_{c,s,t} + \beta\left(D_{c,s,t} \times Incumbent_i\right) + X_{i,t} + \varepsilon_{i,c,s,t} \tag{19}$$

In Eqs. (18) and (19), our parameter of interest is $\beta$, which measures the difference, respectively, in the market share and in the TFP of incumbents in subsidized markets with respect to unsubsidized ones.

To help to better explore how the process of firm entry, as induced by subsidies, influences the market position of incumbents, we run both Eqs. (18) and (19) on two sub-samples, distinguishing sectors with high and low product heterogeneity. Economic intuition would suggest that the changes in competition faced by incumbent firms is lower in industries with highly heterogeneous products. We classify sectors in two groups, by using the method proposed by Rauch (1999). Products traded on organized exchanges are considered homogeneous, otherwise they fall into the differentiated products category.[20]

To examine how subsidies influence exit dynamics in targeted sectors, we estimate a 3WFE DiD model where the dependent variable of interest, $Exit_{i,c,s,t}$, is a dummy equal to 1 if the firm $i$ exits the market and 0 otherwise. Specifically, $Exit_{i,c,s,t}$ is constructed by checking whether the firm is no longer observed in $t + 1$, which implies that it has exited all manufacturing industries. Moreover, to disentangle how the effects of subsidies on exit may change across firms with different productivity, we run two different specifications where, on the right-hand-side of the model, we interact the subsidy variable $D_{c,s,t}$ with two dummies that equal 1, respectively, for firms in the bottom 25 % ($LowTFP_{i,c,s,t}$) and for firms in the top 25 % ($HighTFP_{i,c,s,t}$) of the TFP distribution within the country, 3-digit sector, and year. Formally, we estimate:

$$Exit_{i,c,s,t} = \alpha_i + \alpha_{c,s} + \alpha_{c,t} + \alpha_{s,t} + \theta LowTFP_{i,c,s,t} + \delta D_{c,s,t} + \beta\left(D_{c,s,t} \times LowTFP_{i,c,s,t}\right) + X_{i,t} + \varepsilon_{i,c,s,t} \tag{20}$$

[20] This classification is widely used in empirical industrial organization research (see, e.g., Bratti and Felice, 2018.)

**Table 10**
Robustness checks: excluding China and the United States.

| | [1]<br>TFP<br>(W/out China) | [2]<br>TFP<br>(W/out the US) |
|---|---|---|
| Subsidy based on tax breaks × $E_{i,t}$ | −0.237*** | −0.314*** |
| | (0.062) | (0.054) |
| Subsidy based on loans × $E_{i,t}$ | −0.343*** | −0.278*** |
| | (0.069) | (0.065) |
| Subsidy based on direct transfers × $E_{i,t}$ | 0.034 | 0.152** |
| | (0.072) | (0.069) |
| Subsidy targeting export promotion × $E_{i,t}$ | 0.540*** | 0.307*** |
| | (0.072) | (0.067) |
| Subsidy targeting SMEs × $E_{i,t}$ | 0.505*** | 0.543*** |
| | (0.084) | (0.082) |
| Subsidy targeting green technologies × $E_{i,t}$ | −0.261*** | −0.048 |
| | (0.077) | (0.067) |
| Subsidy targeting automation technologies × $E_{i,t}$ | 0.505*** | 0.096 |
| | (0.080) | (0.083) |
| Constant | 6.595*** | 6.553*** |
| | (0.009) | (0.007) |
| Linear (not interacted) terms | Y | Y |
| Firm-level controls | Y | Y |
| Country×Year FEs | Y | Y |
| Sector×Year FEs | Y | Y |
| Country×Sector FEs | Y | Y |
| Firm-level FEs | Y | Y |
| $R^2$ | 0.908 | 0.908 |
| # obs. | 748,463 | 861,281 |

Note. 3WFE DiD augmented with firm-specific FEs. Observations are at the firm-level. The treatment is the implementation of any subsidy at the sector-country-year level. $E_{i,t} = 1$ denotes the new firm in the year of first entry. New firms means firms created from scratch. TFP is Total Factor Productivity recovered with Wooldridge (2009). Observations from China are excluded in column [1]; observations from the US are excluded in column [2]. Firm-level controls: number of employees, capital assets, liquidity ratio, total revenues, stock market listing. Linear (not interacted) terms are omitted for reasons of space. Standard errors in parentheses. Statistical significance: * significant at 10 %, ** significant at 5 %, *** significant at 1 %.

and

$$Exit_{i,c,s,t} = \alpha_i + \alpha_{c,s} + \alpha_{c,t} + \alpha_{s,t} + \theta HighTFP_{i,c,s,t} + \delta D_{c,s,t} + \beta\left(D_{c,s,t} \times HighTFP_{i,c,s,t}\right) + X_{i,t} + \varepsilon_{i,c,s,t} \quad (21)$$

We run both Eqs. (20) and (21) on the sub-sample of only incumbent firms. In both Equations, our parameter of interest $\beta$ measures the effect of subsidies on the probability of exit of incumbents, respectively, at the bottom and the top of the TFP distribution with respect to incumbents in the same segment of the TFP distribution in unsubsidized sectors.

We report the results from estimating Eqs. (18) and (19) in Tables 12 and 13, respectively, while the results from estimating Eqs. (20) and (21) are displayed in Table 14.

In both Tables 12 and 13, column [1] reports the results obtained for differentiated products, while column [2] those for homogeneous products. We find that the market share and the TFP of incumbents in subsidized markets is disproportionately lower than in unsubsidized markets. Moreover, by disentangling sectors with different degrees of product heterogeneity, we also find that the economic magnitude of the negative effect of subsidies on the performance of incumbents is different between markets with heterogeneous and with homogeneous products. In particular, given the average market shares within each sub-sample, the estimated coefficient of interest translates into an economic magnitude of 0.086 for heterogeneous products and of 0.114 for homogeneous products. As for the TFP, we find consistent results. Specifically, the economic magnitudes of the parameter of interest are 0.118 for heterogeneous products and of 0.165 for homogeneous products. This means that changes in competition faced by incumbents are lower in industries where incumbents enjoy greater market power, as expected. It is worthwhile recalling that in our analysis we use a revenue-based measure of TFP, which may reflect both true productivity and demand factors. It is therefore unsurprising that Eqs. (18) and (19) lead to similar estimates.

Table 14 shows the results about firm exit, with column [1] reporting the effects of subsidies for low-TFP incumbents and column [2] those for high-TFP incumbents. We find that subsidies are associated with a higher probability of exit for low-TFP incumbents that would otherwise have remained in the industry. By contrast, in treated sectors, high-TFP firms are less likely to exit than their counterparts in unsubsidized sectors. These results suggest that subsidies, by attracting new firms, increase competitive pressure in

**Table 11**
Robustness checks: cleaner sample.

| | [1] TFP (W/out incumbents) |
|---|---|
| Subsidy based on tax breaks × $E_{i,t}$ | −0.247*** |
| | (0.054) |
| Subsidy based on loans × $E_{i,t}$ | −0.218*** |
| | (0.064) |
| Subsidy based on direct transfers × $E_{i,t}$ | 0.170*** |
| | (0.065) |
| Subsidy targeting export promotion × $E_{i,t}$ | 0.310*** |
| | (0.064) |
| Subsidy targeting SMEs × $E_{i,t}$ | 0.250*** |
| | (0.090) |
| Subsidy targeting green technologies × $E_{i,t}$ | −0.182*** |
| | (0.070) |
| Subsidy targeting automation technologies × $E_{i,t}$ | 0.112 |
| | (0.086) |
| Constant | 5.744*** |
| | (0.020) |
| Linear (not interacted) terms | Y |
| Firm-level controls | Y |
| Country×Year FEs | Y |
| Sector×Year FEs | Y |
| Country×Sector FEs | Y |
| Firm-level FEs | Y |
| $R^2$ | 0.832 |
| # obs. | 104,680 |

Note. 3WFE DiD augmented with firm-specific FEs. Observations are at the firm-level. The treatment is the implementation of any subsidy at the sector-country-year level. $E_{i,t} = 1$ denotes the new firm in the year of first entry. New firms means firms created from scratch. TFP is Total Factor Productivity recovered with Wooldridge (2009). Observations of incumbent firms (i.e., firms born before 2012) are excluded from the sample. Firm-level controls: number of employees, capital assets, liquidity ratio, total revenues, stock market listing. Linear (not interacted) terms are omitted for reasons of space. Standard errors in parentheses. Statistical significance: * significant at 10 %, ** significant at 5 %, *** significant at 1 %.

**Table 12**
Subsidy effects on incumbents' shares.

| | [1] MRKS (Heterogeneous products) | [2] MRKS (Homogeneous products) |
|---|---|---|
| Any subsidy × $Incumbent_i$ | −0.001*** | −0.005*** |
| | (0.000) | (0.002) |
| Constant | 0.019*** | 7.017*** |
| | (0.001) | (0.019) |
| Linear (not interacted) terms | Y | Y |
| Firm-level controls | Y | Y |
| Country×Year FEs | Y | Y |
| Sector×Year FEs | Y | Y |
| Country×Sector FEs | Y | Y |
| Firm-level FEs | Y | Y |
| $R^2$ | 0.970 | 0.978 |
| # obs. | 559,886 | 20,341 |

Note. 3WFE DiD augmented with firm-specific FEs. Observations are at the firm-level. The treatment is the implementation of any subsidy at the sector-country-year level. $Incumbent_i = 1$ denotes incumbent firms (time-invariant, not interacted $Incumbent_i$'s effects are absorbed by firm-level FEs). A firm is considered incumbent if created before a subsidy is implemented. MRKS is the firm's market share, computed within countries, 3-digit sectors, and years. Firm-level controls: number of employees, capital assets, liquidity ratio, total revenues, stock market listing. Statistical significance: * significant at 10 %, ** significant at 5 %, *** significant at 1 %.

**Table 13**
Subsidy effects on incumbents' TFP.

| | [1] TFP (Heterogeneous products) | [2] TFP (Homogeneous products) |
|---|---|---|
| Any subsidy × $Incumbent_i$ | −0.734*** | −1.077*** |
| | (0.037) | (0.299) |
| Constant | 6.242*** | 6.479*** |
| | (0.004) | (0.042) |
| Linear (not interacted) terms | Y | Y |
| Firm-level controls | Y | Y |
| Country×Year FEs | Y | Y |
| Sector×Year FEs | Y | Y |
| Country×Sector FEs | Y | Y |
| Firm-level FEs | Y | Y |
| $R^2$ | 0.891 | 0.855 |
| # obs. | 521,801 | 19,305 |

Note. 3WFE DiD augmented with firm-specific FEs. Observations are at the firm-level. The treatment is the implementation of any subsidy at the sector-country-year level. $Incumbent_i = 1$ denotes incumbent firms (time-invariant, not interacted $Incumbent_i$'s effects are absorbed by firm-level FEs). A firm is considered incumbent if created before a subsidy is implemented. TFP is Total Factor Productivity recovered with Wooldridge (2009), computed within countries, 3-digit sectors, and years. Firm-level controls: number of employees, capital assets, liquidity ratio, total revenues, stock market listing. Statistical significance: * significant at 10 %, ** significant at 5 %, *** significant at 1 %.

**Table 14**
Subsidy effects on incumbents' exit.

| | [1] $Exit$ | [2] $Exit$ |
|---|---|---|
| Any subsidy × $LowTFP_{i,c,s,t}$ | 0.006*** | |
| | (0.000) | |
| Any subsidy × $HighTFP_{i,c,s,t}$ | | −0.007*** |
| | | (0.00) |
| Constant | 0.013*** | 0.013*** |
| | (0.000) | (0.000) |
| Linear (not interacted) terms | Y | Y |
| Firm-level controls | Y | Y |
| Country×Year FEs | Y | Y |
| Sector×Year FEs | Y | Y |
| Country×Sector FEs | Y | Y |
| Firm-level FEs | Y | Y |
| $R^2$ | 0.425 | 0.425 |
| # obs. | 837,192 | 837,192 |

Note. 3WFE DiD augmented with firm-specific FEs. Observations are at the firm-level. Only incumbents are included in the sample. The treatment is the implementation of any subsidy at the sector-country-year level. $Exit_{i,c,s,t} = 1$ denotes incumbents exiting the sample (any sector). A firm is considered incumbent if created before a subsidy is implemented. TFP is Total Factor Productivity recovered with Wooldridge (2009), computed within countries, 3-digit sectors, and years. $LowTFP_{i,c,s,t}$ is a dummy variable equal to 1 for firms in the bottom 25 % of the TFP distribution within countries, 3-digit sectors, and years. $HighTFP_{i,c,s,t}$ is a dummy variable equal to 1 for firms in the top 25 % of the TFP distribution within countries, 3-digit sectors, and years. Firm-level controls: number of employees, capital assets, liquidity ratio, total revenues, stock market listing. Statistical significance: * significant at 10 %, ** significant at 5 %, *** significant at 1 %.

the market, thereby generating negative spillovers for less productive firms, while more productive firms may respond to heightened competition by implementing strategies that improve their survival prospects. It is also possible that incumbents benefit directly from subsidies, with more productive firms being better able to use them strategically than their less productive counterparts.

## 8. Conclusions

Over the last decade, industrial policies have regained attention in empirical economic research, stimulating the construction of broad-based datasets for evaluating the deployment of industrial policies and helping to orient government intervention on a wide range of areas (Evenett et al., 2024). With the use of these fresh broad-based data sources, recent research has focused its interest in particular on government subsidies (e.g., Rotunno and Ruta, 2024), in an attempt to complement a dense previous econometric literature which analyzes subsidy programs in highly stylized settings, without however addressing the question of how government subsidies affect the process of firm entry and in particular how they shift the productivity of new (*de novo*) entrants.

In this paper, we provide rigorous global evidence on this issue, by using the CSI-GTA database, which is the most comprehensive compilation of subsidy measures available today (Evenett and Espejo, 2023). We analyzed data on about 1.2 million manufacturing firms and more than 30,000 subsidy programs across 121 countries and 105 3-digit manufacturing sectors over the period 2012-2019, with cutting-edge DiD techniques for causal identification in multiple treatment designs. We found that government subsidies tend to increase the share of new firms entering targeted sectors and countries from scratch, with new firms in treated markets having on average lower productivity than their counterparts in untreated markets. Specifically, our 3WFE DiD analysis reveals that unconditional subsidies aimed at relaxing the firm budget constraint (such as tax reliefs and loans) are largely responsible for the negative effects on productivity, whereas government initiatives targeting export promotion initiatives and investments in new technologies, particularly for SMEs, may lead to entry of more productive firms. Dynamic specifications of our empirical model show that the productivity differentials of new firms in treated markets tend to persist for several years after entry, possibly distorting competition dynamics, resource allocation, and productivity dispersion.

Related to the latter point, it is worth highlighting that our analysis provides some indirect evidence that subsidies generate spillovers of different sorts. Our result that subsidized sectors attract new firm establishment suggests that subsidies generate positive spillovers on entrepreneurship, as highlighted by previous literature (Santoleri et al., 2024). Moreover, the negative correlation that we find between subsidies and the market performance of incumbent firms may indicate that subsidies cause negative externalities through altered competition between new entrants and incumbents. At the same time, however, we observe that in targeted sectors, high-productivity incumbents tend to respond to increased competitive pressure by implementing strategies that may enhance their survival prospects. This suggests that subsidies do not necessarily lead to greater resource misallocation, nor do they necessarily induce a self-selection of less productive firms into subsidized industries. Unfortunately, our data do not allow to explore spillover effects and externalities more directly. We believe that this is an important area that should deserve to be extensively analyzed by future work. In addition, future research may focus on alternative measures of TFP (e.g., based on quantities rather than revenues) to better disentangle the productivity and demand effects of subsidies, which may in turn allow for a more precise understanding of their consequences.

## Credit Author Statement

Both authors contributed equally to the conception, design, data collection, analysis, interpretation, and writing of the manuscript. Both authors have read and approved the final version of the article and take full responsibility for its content.

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Siena, June 25, 2025

## CRediT authorship contribution statement

**Filippo Belloc:** Writing – original draft, Supervision, Formal analysis, Data curation, Conceptualization; **Antonino Lofaro:** Writing – review & editing, Writing – original draft, Methodology, Formal analysis, Data curation, Conceptualization.

## Data availability

Data will be made available on request.

## Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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## Supplementary material

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